Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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New Bascule Bridge at Deering Station, Chicago

Bridge Erected With Minimum Traffic Interruption—Old Bridge in Service Until the Last Moment—Signal Arrangement of the New Bridge

A few months ago the Chicago & North Western Railway put in operation a new bridge over the North Branch of the Chicago River, at Deering Station, Chicago. This bridge is a Strauss steel trunnion bascule bridge carrying three tracks. It double track, swing bridge of 176 ft. in length supported on a pier in the middle of the river. The old bridge, built in 1887, was worn out, and it had become necessary to replace it with a bridge of greater capacity and strength, on account of of which were passenger trains. The river traffic, while not heavy, was sufficient to require keeping one channel continuously available for navigation.

In addition to the increased facilities for handling the heavy railway traffic, the

CHICAGO & NORTH WESTERN RAILWAY BASCULE BRIDGE OVER THE CHICAGO RIVER NEAR DEERING, ILL. VIEW SHOWS BASCULE BRIDGE IN POSITION, READY FOR TRAFFIC.

spans a channel of 145 ft., clear width between fenders, crossing the stream at an angle of 16 degs. The rest pier and the front end of the movable span are skewed so as to be parallel with the channel.

The new structure replaces an old, the greater volume of traffic and the heavy power now on this line, which is the railway's main line between Chicago and Milwaukee. The railway traffic during construction consisted of about 200 trains every 24 hours, about 80 per cent. conditions for river navigation are greatly improved with the new bridge. A single channel, of 145 ft. clear width, replaces the narrow channel on each side of the old center pier, and this channel was deepened to 215 ft. below the water level. The vertical clearance under the span was increased from 16.5 ft. to 18.25 ft., which permits a large proportion of the boats navigating the channel to pass without opening of the bridge. The superstructure is here arranged under four heads for convenience in description. (1) Movable span and counterweight. This includes all moving parts except machinery. (2) Tower. (3) Operator's house. (4) Machinery, power and operating equipment. The movable span, being skewed at one end to fit the angle of the channel, has trusses of unequal length, the long truss being 185 ft. from the center of the main trunnion to the center of the bearing at the front end. Our illustration shows the general outline of the bridge in the closed position, and the general dimensions of the superstructure.

The live load used in designing was Cooper's Class E 55, applied as follows: Stringers—Track fully loaded. Floor Beams—Full load on middle track and 5/8 of full load on two outside tracks. Trusses—Three-quarters of full load on all three tracks. The design, detail and material were in accordance with the C. & N. W. Ry. specifications for bridges, supplemented by special specifications prepared by the Strauss Bascule Bridge Co. to cover all features not covered by the C. & N. W. specifications.

The counterweight consists of two reinforced concrete wings, one on each side of the bridge and outside the clearance lines. They were cast around the framework of the counterweight trusses, which are mounted on trunnions set in heavy bearings at the top of the tower. The aggregate used in the counterweights was Fayalite, a very heavy and hard rock obtained in Northern Illinois. The concrete was mixed in different proportions for the two wings, in order to keep the volume and outline the same for each, but to give to each wing the weight necessary to counter-balance its corresponding side of the movable span. The concrete in the counterweight for the short truss weighed about 160 lbs. per cu. ft. at 20 days; that for the counterweight of the long truss about 168 lbs. per cu. ft.

C. & N. W. RY. DEERING BRIDGE—FIRST STAGE OF ERECTION. THE COUNTER WEIGHT PIVOT AND BASCULE SPAN PLACED READY FOR PERMANENT SETTING.

The detail of the counterweights provided a number of horizontal, cylindrical pockets for adjusting blocks. These pockets are 1 ft. 11 ins. in diameter, and extend all the way through the counterweight, except where interrupted by the members of the counterweight trusses, where they extend only 1 ft. 11 ins. from the surface.

Cylindrical concrete adjusting blocks 1 ft. 10 ins. in diameter and 1 ft. 8 ins. to 1 ft. 10 ins. long were cast for these pockets. The volume of the pockets constitutes about 7 per cent. of the total volume of the counterweight, and it was estimated that the counterweights would balance the span when half of the pockets were filled with adjusting blocks. This gave a possible adjustment of 3½ per cent. of the total amount of the counterweight either way from the estimated requirement.

On account of the great weight of the moving parts, the trunnions are of unusual size. The trunnions at the top of the tower, carrying the counterweight trusses, are 24 ins. in diameter. The heel trunnions are 17 ins. in diameter, and those at the ends of the connecting links are correspondingly large. The four trunnions on each side of the bridge are so arranged that the four lines connecting their centers form a true parallelogram, a condition essential in applying the principle of counter-balance of this type of bridge. The counterweight, while revolving around a center different from that of the moving span, always moves through the same degree of angle as the span, but in the opposite quadrant of the circle.

The machinery is designed to open the bridge the full angle of 87 degs. in one minute, against an unbalanced load of 2½ lbs. per sq. ft., acting normally to the floor of the bridge. The specifications also provide that machinery shall be of such strength, and the power as to be sufficient, to open the bridge slowly against an unbalanced snow load of 10 lbs. per sq. ft. of floor area of moving span, combined with an unbalanced wind pressure of 10 lbs. per sq. ft. of this area; also, to hold the bridge stationary in any position against the snow load of 10 lbs. per sq. ft. combined with a wind pressure of 15 lbs. per sq. ft. The power installation consists of two 150 H. P. motors coupled in parallel. The power is alternating current, 3 phase, 60 cycle, 440 volts.

Auxiliary power is provided, consisting of a 50 H. P. gasoline engine connected through reduction gearing and reversible friction clutches with the spur gear driven by the motors. This arrangement makes the motors run idle when operating the bridge with the engine. The solenoid brakes on the motors, which are normally released only when current is driving the motors, are held in release position during the operation of the engine by special mechanism provided for this purpose. Auxiliary hand brake is provided for control of bridge when operating with engine. The emergency brakes to be described, are also available for this purpose.

To relieve the operating machinery

from the effect of applying brakes at the motor shaft, emergency brakes operated by compressed air are mounted on the operating shafts, enclosing the operating pinions. When set, these brakes seize the operating struts and transmit the action of the strut direct to the bearings of the operating shafts, without passing it through a single gear of the machinery. Compressed air for these brakes is furnished by a small electrically driven compressed air unit which is automatically controlled by the pressure of the air in the storage tank. The following is a table of quantities in the superstructure:

Moving parts	1,769,000
Tower	757,800 lbs.
Machinery and trunnions	255,800 lbs.
Total	2,782,600 lbs.
Concrete in counterweight	2,360,000 lbs.

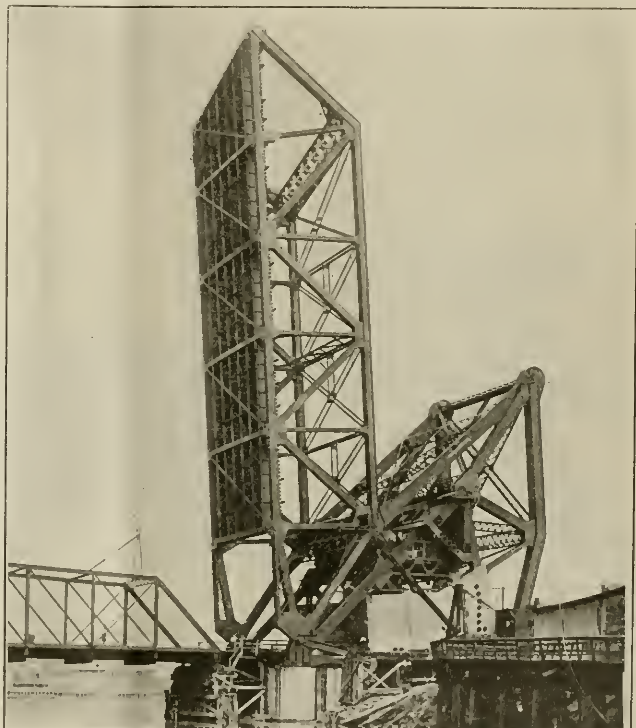
When the bridge is in the fully open position, the counterweights extend about 14 ft. below the base of rail and their inner surfaces are 8 ft. 3 ins. from the centers of adjacent tracks. The operating struts are between the counterweights and the tracks, and when bridge is fully open extend about 12 ft. below the base of rail. This circumstance made it necessary to build retaining walls just beyond the pier to hold the embankment, placing the walls inside the limits of clearance required by counterweights and operating struts. To provide the necessary clearance for the operating struts, the face of the retaining wall was placed at 5 ft. 8 ins. from the center of track, for a distance of 15 ft. 6 ins. adjacent to the pier. This was so close to the track that hand railings could not be erected on top of this section of wall. To safeguard this section, a movable platform hinged at one end and carrying a hand rail, was built level with the top and just clear of the face of the wall. The other end was suspended by a rod from the framework of the counterweight truss bracing directly above. As the bridge opens, the platform, swinging round its hinged end, drops down out of the way of the operating strut, returning to normal position at the top of the wall as the bridge closes.

The pier at the front end of the span consists of two cylinders, 12 ft. in diameter, connected by a concrete girder 8 ft. thick and reinforced with two embedded trusses. The details are similar to those of corresponding parts of the substructure under the tower. All cylinders were carried down by open excavation, to rock about 50 ft. below water level. The lower section of each cylinder was provided with a horizontal diaphragm 8 ft. above the cutting edge, to make a working chamber. In the center of this diaphragm is a circular opening 3 ft. in diameter over which is built up the working shaft, consisting of a steel cylinder 3 ft. in diameter. The horizontal diaphragm is rigidly braced to the section of the cylinder below, with solid webbed radial braces extending from the diaphragm to the lower edge, which is heavily reinforced to make a cutting edge that would not be crushed by hard pan or boulders.

The cylinders were delivered at the bridge site riveted up in sections of about 8 ft. length. As the cylinder was carried down by the excavation in the working chamber, sections were riveted on above, carrying up the working shaft at same time as the large cylinders were handled. As fast as sections were riveted on they were filled with concrete; this gave the weight necessary to overcome the friction against the sides of the cylinder and carry it down, as excavation progressed. As the cylinders approached the final depth, it became necessary to add pig-iron on top of the concrete to overcome this friction and make them sink.

When the cylinders reached their final position on the rock, it was leveled off and cleaned, and the working chambers and shafts were filled with concrete. In the top of each of four of the cylinders 18 track rails 12 ft long were set, embedded half their length in the cylinder, the other half projecting above the top to be built into the concrete girders, to strengthen the bond between cylinders and girders. These rails were omitted from the two rear cylinders, because the vertical posts of the towers were embedded in the tops of these cylinders and, in addition to doing duty as tower posts, they served the purpose for which rails were provided in the other cylinders.

As the concrete girders were to extend down to 2 ft. below water level it was necessary to enclose the piers in a coffer dam. A dam of sheeting and puddle was constructed on the river side of each pier and run shoreward well into the river bank. The bank formed the fourth side of the dam. The reinforced concrete girders were built in place, inside this dam, on top of the cylinders, first erecting the structural steel trusses, building the forms around them, assembling the reinforcing inside the forms, and proceeding in the usual way with the filling of the forms with concrete.



C. & N. W. RY. DEERING BRIDGE, PREPARATORY TO THE REMOVAL OF THE OLD SPAN. LOWER FLOOR SYSTEM OMITTED TO ALLOW TRAINS TO PASS WHILE ERECTING THE STRUCTURE IN THE VERTICAL POSITION SHOWN.

The bridge was erected in the open position, the usual method of erecting this type of bridge where traffic must be maintained during erection.

As the floor members of first panel (and some bracings between counterweight trusses and certain minor parts of the bridge) could not be erected while traffic was still being carried on the old bridge, the plan of erection was to suspend traffic on railway and river while the old bridge was taken out and the new bridge put into service. To make this interruption as short as possible, every member that could be erected was put in place and riveted up before traffic was suspended. Power transmission connections were completed and the operation of the machinery under power was tested. The bridge was also moved through a small angle and the counterbalance adjusted.

Immediately after the last train had passed, the old span was swung open and the arms blocked up on the old timber pier protection. Eight oxyacetylene torches were immediately set to work to cut the old bridge into three parts so that the middle portion could be removed to make way for the lowering of the new span. While the torches were cutting the span apart, a scow derrick was at work on each side of the span, removing the operator's house, operating machinery and deck. At the same time erectors were busy erecting the remaining members of the new bridge. By 8:00 o'clock in the morning the old span had been cut apart, the middle portion lifted out and taken away on scows, and at 8:15, the time fixed in the schedule, the new span was lowered to the horizontal position.

After lowering the bridge, the few remaining members were erected, the deck completed, and the end rails put on and adjusted. At the same time track gangs were at work re-aligning the tracks on the approaches and raising them to the established grade. By 6:00 P. M. the bridge and tracks were in shape for trains and traffic was resumed, after an interruption of less than 18 hours.

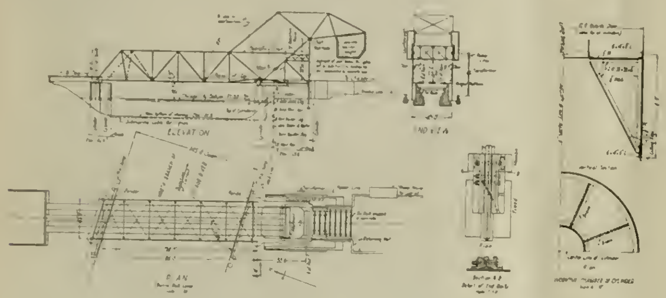
The signal operating mechanism of the bridge is interlocked with the switch and signal system controlling the traffic on all tracks adjacent to the bridge. The system of tracks controlled by the interlocking plant includes the switches about 200 ft. south of the bridge where the three-track system merges into a two-track system; also the switches to a number of industrial tracks on both sides of the river whose turnouts are close to the bridge.

The operating mechanism of the bridge is so interlocked with the signal system that it is impossible to unlock or open the bridge when a signal is given clear for a train, or while a train is within the limits of the interlocking plant. It is also impossible to clear a signal while the bridge is open or unlocked. The interlocking is effected by means of electrically operated locks applied to the controllers of the bridge-lock motor and the bridge operating motors, and to the operating shaft of the engine clutches. All operating levers are electrically interlocked to insure proper sequence of operation in manipulating the levers.

The interlocking machine has a capacity of 44 levers. It contains 18 levers for signals, 16 levers for switches and derails, and 3 levers for special locks between bridge and interlocking apparatus. This leaves 7 unused spaces, reserved for possible future extension of the interlocking plant. The power for operating the interlocking plant is 110 volt D. C. from storage batteries housed in a building adjacent to the tracks and about 100 feet from the bridge. The batteries are charged by motor-generator sets receiving power from the same source as the bridge motors.

The signals installed are of the three-position, upper-quadrant type, conforming to the latest established practice on the Chicago & North Western Railway. Detector bars are installed only at facing points. The usual channel lights are provided for navigation. These are electrically lighted by lamps set on the fenders on either side of channel; also bridge lights at front end of movable span, consisting of lamps with uncolored lenses, suspended in such manner that they hang vertically whatever the position of bridge may be. In front of each lamp is an arc of red and green glass, the red glass being in front of the lamp when bridge is closed. As the bridge opens, the lamp, swinging about its point of support, passes behind the green section of the arc. In addition to the lights required by the government, a special wigwag signal for boats was installed on each side of the span, just outside the lower chord and over the middle of the channel. This is a swinging lamp with a red lens, hooded so that the red light is distinctly visible against the dark background, even in bright day light. The purpose of this signal is to warn approaching boats, by the swinging of the lamps, that the bridge cannot be opened immediately, and that they must come to a stop. The lamps are operated by electric motors in the same manner as the swinging signals which are now much in use at dangerous highway crossings.

The general plan of construction, and the designs of substructure, approaches, interlocking system, and temporary structures, were made by the engineering department of the C. & N. W. Ry., under the direction of Mr. W. H. Finley, Chief Engineer. The superstructure was designed by the Strauss Bascule Bridge Company and built by the American Bridge Company. It was erected by the Kelly-Atkinson Construction Company, and the power and operating equipment installed by Mr. C. H. Norwood. The substructure was constructed by The Great Lakes Dredge and Dock Company. Mr. H. M. Spahr was Resident Engineer in charge of all field work for the railway company.



DETAILS OF THE DEERING LIFT BRIDGE ON THE C. & N. W.

Oil Fuel for Locomotives.

Twenty-five locomotives have been changed from coal to oil burners on the Florida East Coast Railway. A Clarke burner is used. The fire pans are of the round bottom variety, and slope from back to front so that any surplus of oil accumulating in the pan is drained out at the forward end. A course of brick is set on edge along the sides of the fire pan to protect the lower portions of the side sheets from the intense heat, and also to add to the sealing of the pan at its attachment to the mud ring. Air is admitted at two points through a damper at the front wall of the fire pan, and also through a second damper controlling the supply through the flash hole located about two-thirds of the distance from the burner back to the rear of the pan. This second damper is manipulated by means of a notched lever set in the floor of the cab. Careful comparisons show a saving of 18 per cent. in the cost of fuel resulting from the use of oil.

Increased Demurrage Charges.

The Interstate Commerce Commission, with a view to relieving the freight car situation, has issued a circular announcing that the commission on car service had increased the rate for the use of freight cars to 75 cents a day, operative from December 15, 1916, until May 1, 1917.

Pulverized Coal for Locomotives

Increasing Cost of Fuel—Amount Used by Locomotives—Its Cost—The Use of the By-product—The Method of Application to a Locomotive—The Chemistry of Combustion—Results Achieved—Economies Effected.

A most interesting paper on the comparatively new subject of pulverized fuel for locomotives was recently presented to the members of the American Society of Mechanical Engineers. The paper was prepared by Mr. John E. Muhlfeld, president of the Locomotive Pulverized Fuel Company of New York. Before giving a brief résumé of the paper, permit us to say that the success of the whole scheme depends (after the mechanical details have been worked out) in the complete combustion of the finely divided particles of coal, and this can only be accomplished by a liberal and a properly directed supply of air, delivered to the highly inflammable mass. Dealing with his subject Mr. Muhlfeld spoke in part as follows:

Next to labor, the largest single item of cost for transportation in this country is the fuel for locomotive operation, and as in the final analysis the cost per passenger or per ton mile is largely conditioned upon the unit of motive power per hour, it is easy to realize what the cost must be if power is wasted.

In order to show how the use of pulverized fuel will materially assist in improving steam railway operation, the following facts and conclusions resulting from a number of years of investigation and research, and of slow and painstaking development in coal dust burning, may be of immediate interest.

The expenditure for locomotive fuel for the steam railways in the United States now approximates $300,000,000 per annum, of which from $75,000,000 to $100,000,000 represents the proportion that is expended to kindle, prepare, clean and maintain fires on grates when locomotives are standing, drifting or otherwise not actually using steam to move themselves, either light or with trains. Changes in the domestic and foreign supply and demand, as well as in the regulations, methods and labor governing mining operations, cause a progressive increase in the price per ton of fuel.

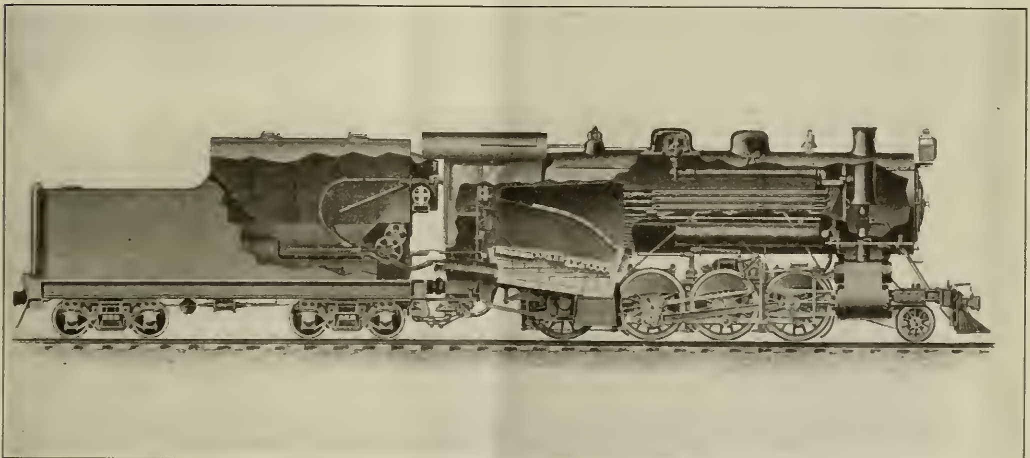
The necessity for conserving the supply of oil in the rapidly exhausting fields for other than railway fuel purposes will soon eliminate it from locomotive service, while the higher prices and shortage in supply of the larger sizes and better grades of solid coals now in demand for the commercial trade will bring about the use of the less salable, by-product of the mines in pulverized form.

Steam locomotives will eventually have to be equipped so as to approximate to electric machines by the use of pulverized fuel, which in turn will eliminate smoke, soot, cinders, sparks and fire hazards; reduce noise, bring down the time for dispatching at terminals, and stand-by losses; and increase the daily mileage by providing for longer runs and more nearly continuous service between general repair periods.

In order to provide the maximum draw-bar horsepower per hour, the steam locomotive must be so improved as to secure continuity of working steam pressure, greater sustained boiler capacity, boiler efficiency, reduced cylinder back pressure, and more highly superheated steam, all of which can be produced by the use of pulverized fuel.

The large quantity of steam required by the modern locomotive necessitates excessive rates of evaporation, such as can only be effectively and economically produced by the burning of fuel in suspension, in order to utilize the heat units that now go out of the stack and into the ash-pan when solid fuel is fired on grates.

By mechanically feeding and burning pulverized fuel, arduous labor on the part of the fireman is replaced by the more skilled manual control of combustion, and assistance is given to the engineer in the operation of the locomotive, and permits a better chance for the observation of track and signals. The future steam locomotive, on account of its various limitations of size, height, etc., will be required to produce the maximum possible hauling capacity per unit of total weight. As the cylinder horsepower available is entirely dependent upon the boiler horsepower and the temperature of the superheated steam produced, the use of pulverized fuel to increase the heat value per cubic foot of firebox volume, and provide a higher average and more uniform firebox tem-



SECTIONAL VIEW OF A LOCOMOTIVE ARRANGED FOR BURNING PULVERIZED FUEL.

perature in combination with a reduced front-end or waste-heat temperature, appears to be the most logical means for the solution of the problem.

The opportunity for reducing the non-productive time of existing locomotives, and for relieving terminal congestion that is now caused by the necessity for cleaning fires, ash pans, flues and smoke-boxes; inspecting and repairing draft, grate and ash-pan appliances, and for firing-up and supplying firing tools and equipment to locomotives burning coal on grates, makes the use of pulverized fuel one of the most effective and economical means for increasing the net earning capacity of present single- and double-track steam roads.

From investigations up to the present time, it has been found that any solid fuel that, in a dry, pulverized form, has two-thirds of its content combustible, is suitable for steam-generating purposes. Domestic and steam sizes and qualities of anthracite, bituminous, and semi-bituminous coals and lignite and peat, as well as the inferior grades, such as anthracite culm, dust and slush and bituminous and lignite slack, screenings and dust, are all suitable for burning in pulverized form.

To produce the best results these fuels should be mechanically dried and milled so that they will be of about the same dryness and fineness as Portland cement; or so that the moisture will not exceed 1 per cent., and that 95 per cent. of the total will pass through a 100-mesh screen, and 85 per cent of the total will pass through a 200-mesh screen. These figures apply to anthracite as well as to bituminous coals.

As over 8,000,000 tons of pulverized fuel are now being used annually in the United States for industrial kilns and furnaces, it is not thought that the equipment or process for preparing pulverized fuel requires any comment.

The total cost to prepare pulverized fuel properly in a suitably equipped drying and pulverizing plant ranges from 15 to 45 cents per ton, depending upon the capacity of the plant. For a railway coaling station of average capacity, this total cost will be less than 25 cents per ton.

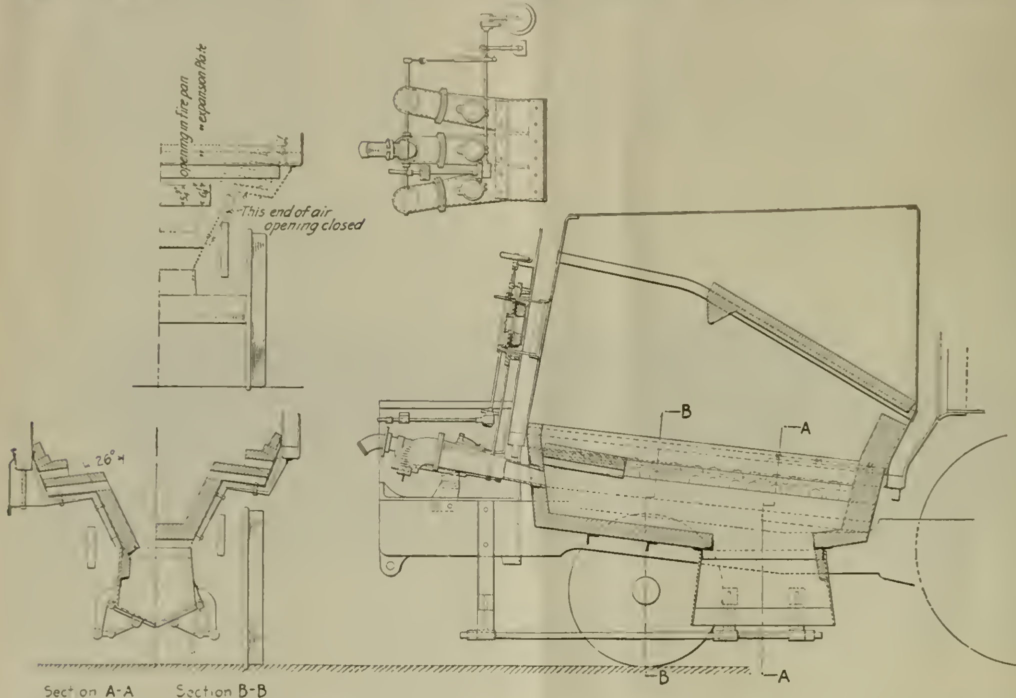
The raw fuel should be dried, pulverized and stored in metal or other fireproof material containers. After pulverizing it should not be exposed to open lights or to the atmosphere, and the production of light "dust-clouds" should be avoided.

Pulverized fuel should be handled with the same care as fuel oil.

Equipment for supplying tenders consists of one or more overhead storage bins equipped with suitable means for supplying 15 tons of pulverized fuel to a tender in 3 or 4 mts. without exposing the fuel to the atmosphere during its conveyance, or producing dust-clouds.

Complete control of the fuel flowing to, and of the air exhausting from, the tender must be maintained, and this can only be done by installing special equipment suitable for the requirements.

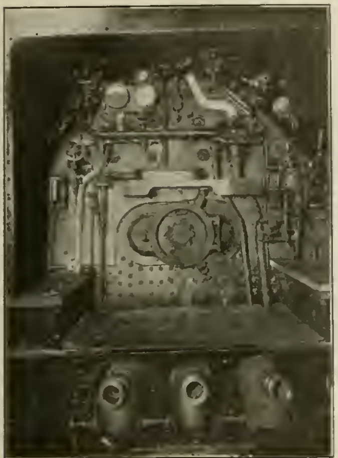
For firing up a locomotive, the usual steam blower is turned on in the stack, a piece of lighted waste is placed on the furnace floor, just ahead of the primary arch, after which the pressure fan and one of the fuel and pressure-air feeders can be started. From 45 to 60 mts. is ordinarily sufficient to get up 200 lbs. of steam pressure form boiler water at 40 degs. Fahr. After firing up, the regulation of the fuel and air supply is adjusted to suit the standing, drifting or working conditions, the stack blower being used only when the locomotive is not using steam.



TRIPLE BURNER FOR PULVERIZED FUEL ON THE NEW YORK CENTRAL.

The operation of the fuel-burning equipment is as follows: The prepared fuel, having been supplied to the enclosed fuel tank, gravitates to the conveyor screws, which carry it to the fuel and pressure-air feeders, where it is thoroughly commingled with the pressure-air and carried by it through the connecting hose to the fuel and pressure-air nozzles and blown into the fuel and air mixers.

Additional induced air is supplied in the fuel and air mixers, and this mixture, now in combustible form, being mixed with air, is induced into the furnace by the smokebox draft. The flame produced at the time the combustible mixture enters the furnace, obtains its average maximum temperature from 2,500 to 2,900



ENGINE UNCOUPLED FROM TENDER SHOWING CONNECTIONS FOR PULVERIZED FUEL.

degs. Fahr., at the forward combustion zone under the main arch, and at this point more air is induced by the smokebox draft so as to finally complete combustion.

Any liquid ash which may form runs down the underside of the main arch and the front and sides of the forward combustion zone of the furnace, and is precipitated into the self-clearing slag pan, where it accumulates and is air-cooled and solidified into a button of slag which can be readily dumped.

As each of the fuel and pressure-air feeders has a range in capacity of from 500 to 3,000 lbs. of pulverized fuel per hour, and as from one to five of these may be easily applied to the ordinary locomotive tender, there is no difficulty in meeting any desired boiler and superheater capacity. The uniformity with which locomotives can be fired is indicated by the fact that the regularly assigned firemen can maintain the steam within a variation of 2 lbs. of the maximum allowable pressure without safety valves popping off.

An interesting and important point is the chemistry of the combustion of pulverized fuel. The principal fuels adaptable for use in pulverized form in locomotives are anthracite, semi-anthracite, semi-bituminous and bituminous coals and lignite and peat. (Pulverized-fuel-burning locomotives are also readily convertible for the use of fuel oil.)

Generally speaking, it is necessary to break up any fuel to such uniform size that the oxygen in the air can unite with it for combustion. A deficiency of air results in some portions of the fuel passing off as unburnt hydrocarbons, and other portions being left as incompletely burned coke. It is equally important that the proper quantity of air should be admitted to the furnace, as any insufficiency or excess lowers the efficiency.

For example, the preventable fuel loss with 8 per cent. of CO_2 in the stack gases will be about 10 per cent., with 12 per cent. of CO_2 it is reduced to about 3 per cent., and with 16 per cent. of CO_2 there is practically no waste. A 1-in. cube of coal exposes but 6 sq. ins. of area for obsorbing oxygen and liberating heat, but when pulverized to the proper fineness will expose from 20 to 25 sq. ft. of area for oxidation by diffusing the fine particles so that each may be surrounded with air, it will be possible to burn practically all of the available combustible, regardless of the percentage of non-combustible present.

The value of a fuel is determined by the quantity of heat that it will generate when burned, and this in turn is dependent upon how much combustible carbon, hydrogen, hydrocarbons and sulphur it contains, and how much non-combustible moisture, ash, oxygen and nitrogen it has. Of the non-combustibles, ash, which usually contains a mechanical mixture of silica, alumina, iron, lime, potassium, sodium and magnesium, is the most detrimental. Like moisture, it is anti-calorific, and furthermore it acts as an obstruction to the flow of air and gases, reduces the boiler capacity and efficiency, and produces heavy expense in delays for cleaning fires and ash pans and in the final disposition of the ash. The "clinkering" and "honeycombing" of ash is one of the worst troubles to be dealt with in the combustion of coal, and its formation may be either chemical or simply due to fusion.

Clinker is of two kinds, "hard" and "soft." "Hard clinker" is formed by the direct melting of some of the ash. It hardens as it forms and usually gives but little trouble. "Soft clinker" is formed by the slagging of the ash, and is either pasty or fluid, and steadily grows in size. "Honeycomb" or "flue-sheet" clinker is formed by the condensation or coking of tarry matter or vapor as it strikes against the firebox sheets, and results in the accumulation of a relatively soft, light, ashy substance that grows or spreads over certain areas of the arch and the metal parts of the furnace.

With the use of pulverized fuel the usual difficulties resulting from the formation of hard and soft clinker are eliminated, but with fuels containing certain intrinsic combinations of ferrous silicates, which fuse at comparatively low temperatures (2,000 to 2,300 degs. Fahr.), the honeycomb formation will result when the proper air supply and combustion conditions do not obtain. Then ferric silicates, which fuse at relatively high temperatures (2,500 degs. Fahr. and above) are formed. For example, during the process of combustion ferric sulphide (FeS_2), commonly known as iron pyrites, is reduced to ferrous sulphide (FeS) as the result of the chemical reduction may be illustrated by the following formula:

$$FeS_2 = FeS + S.$$

As ferrous sulphide (FeS) melts at a comparatively low temperature (2,138 degs. Fahr.), it may surround itself with fuel and ash, and form a pasty mass which may act as a binder to collect other ferrous sulphide (FeS), fuel and ash, all of which may tend to collect on, and adhere to, the hottest parts of the firebox sheets, such as staybolt heads, flue beads

SECURITY BRICK ARCH FORMING FURNACE FOR PULVERIZED FUEL.

and like parts, which are higher in temperature than the melting point of ferrous sulphide (FeS) and the surrounding metal surfaces, while the temperature of the latter may be lower than the melting point of the ferrous sulphide (FeS).

The following formula shows the result of incomplete combustion owing to insufficient air:

$$2\,FeS + 2\,O = 2\,FeO + 2S$$

By providing sufficient air through an excess supply, the following formula shows the result of complete combustion:

$$2\,FeS + 9\,O = Fe_2O_3 + 2\,SO_3$$

For this latter process an oxidizing atmosphere must at all times be in the firebox to prevent the reduction of ferric sulphide (FeS_2) to ferrous sulphide (FeS), as expressed in the first formula.

The ferrous sulphide (FeS), as has been shown, is the direct cause of honeycomb, for the reason that it produces ferrous oxide (FeO), which unites with the silica to form a honeycomb that is very fusible at temperatures over 2,400 degs. Fahr., whereas by the production of ferric oxide (Fe_2O_3), in combination with the silica present, a highly infusible ash is formed.

As a general rule an increase in the percentage of silica, alumina and magnesium in the fuel tends to decrease, while an increase in the percentage of iron, lime, potassium and sodium in the fuel matter will tend to increase the fusibility of ash, but in every case a relatively high percentage of ferrous oxide (FeO), resulting from an insufficient supply of air for combustion, will be accompanied by honeycomb formation, which will tend to adhere to various parts of the firebox.

For the fiscal year ended June 30, 1914, the Interstate Commerce Commission reports a total of 64,760 locomotives of all classes in the United States having made a total of 1,755,972,325 miles. This gives an average for each locomotive owned of about 27,115 miles per annum, 74 miles per day, or but little over 3 miles per hour. From the foregoing figures one may easily suspect that over one-half of the time of locomotives is now spent at terminals in the hands of the transportation and mechanical departments, and that most of this delay is probably due to the necessity for cleaning fires, ash pans, flues and smoke boxes; inspecting and repairing draft, grate and ash-pan appliances; and for firing up and supplying firing tools and equipment.

With pulverized fuel a locomotive having the boiler filled with cold water may be brought under maximum steam pressure within an hour, and the fuel feed then stopped until it is called for service. When standing or drifting, at terminals or on the road, the fuel feed may also be discontinued, as the steam pressure can be quickly raised. After the trip or the day's work is over, the locomotive can be immediately stored or housed, the ashpit delays being entirely eliminated.

In this respect the use of pulverized coal is one of the most attractive and quickest methods for increasing the earning capacity of present single and double-track steam railways.

From the actual operation of steam locomotives in regular train service the use of pulverized fuel has demonstrated in particular the practicability of eliminating smoke, cinders, sparks and fire hazards; increasing draw-bar horsepower per hour per unit of weight; improving the thermal effectiveness of the steam locomotive as a whole; reducing non-productive time at terminals; utilizing otherwise unsuitable or waste fuels; eliminating arduous labor; providing greater continuity of service and producing more effective and economical operation and maintenance.

TABLE 1. PERFORMANCES OF TEN-WHEEL TYPE OF FREIGHT LOCOMOTIVE

Item	Pulverized No. 1 Bituminous	Pulverized No. 2 Bituminous	Pulverized No. 3 Bituminous
Fuel:			
Fineness, per cent through 200 mesh	0.85	0.85	0.85
Moisture, per cent	0.40	0.81	0.59
Volatile, per cent	24.72	36.27	24.36
Fixed carbon, per cent	68.43	58.29	65.05
Ash, per cent	6.85	5.44	10.59
Sulphur, per cent	1.96	0.68	0.84
B.t.u., per lb	14,739	14,334	13,912
Miles run, total	1,324	426	398
Cars per train, average	61	65	60
Adjusted tonnage per train, average	1,719	1,808	1,759
Speed when train was in motion, miles per hour, average	26	25	24
Boiler pressure when using steam (200 lb.), average	198.3	193.5	194.9
Front-end draft when using steam, ins. of water, average	7.15	7.79	6.69
Firebox draft when using steam, ins. of water, average	3.50	3.22	3.18
Temperature of steam, deg. fahr	562	573	555
Coal fired per hour of running time, lb. (average)	3.275	3,063	3,457
Adjusted ton-miles per lb. of coal (average)	12.84	13.97	11.59

The performances given in Table I may be of interest. They relate to a ten-wheel type of freight locomotive, rated at 31,000 lbs. of cylinder tractive power, with 69-in. diameter driver wheels, when used in fast through-freight service on runs of from 91 to 138 miles in length for the purpose of testing various fuels under identical adjustment conditions. The locomotive was worked at its maximum capacity on all trips, about 10 per cent. more tonnage than usual was hauled at practically fast-freight schedule speed. The exhaust-nozzle opening was about 25 per cent. larger than the maximum for hand firing.

With the highest sulphur coal (No. 1) and the highest ash coal (No. 3) there was less than 1 cu. ft. of slag in the slag box at the end of each run, and practically no collection of ash or soot on the flue or firebox sheets. In fact, with the No. 3 fuel there was less than two handfuls of slag, ash and soot collected on each trip. This is a good showing.

The steam railways in the anthracite coal-mining district generally use for their locomotive fuel mixtures which will run from 25 to 50 per cent. bituminous and the rest of anthracite pea and buck sizes which will pass through a 7/8-in. and over a 5-16-in. round opening. As anthracite coal is very low in volatile matter ignites slowly, and is a poor conductor of heat, the bituminous mixture is used to overcome the trouble this causes when the smaller sizes must be burned on grates, and even then it necessitates the use of unusually small exhaust nozzles to create sufficient draft.

In the experiments with pulverized anthracite fuel for locomotives the idea has been to utilize the grade of coal of lowest commercial value, such as birdseye, which is of a size that will pass through a 5-16-in. and over a 1-16 in. round opening, as well as the refuse called culm or slush, which passes through the 1-16-in.

To reclaim this slush a couple of wooden bins were installed, through which the washery water could be finally passed for the collection of the solid matter.

The analysis of the various fuels used may be approximated as given in Table 2.

Further work of this kind will determine just how great a percentage of anthracite slush can be used with advantage, but the evaporative results so far obtained, may be stated at about 7 lb. of water from feed-water temperature per lb. of coal. This indicates that considerably more than a 60 per cent. anthracite slush mixture may be utilized. This accomplishment not only means a decrease of 25 per cent. in the cost per ton for locomotive fuel, but also the release of a large tonnage of commercial anthracite, which is becoming more scarce and in greater demand each year.

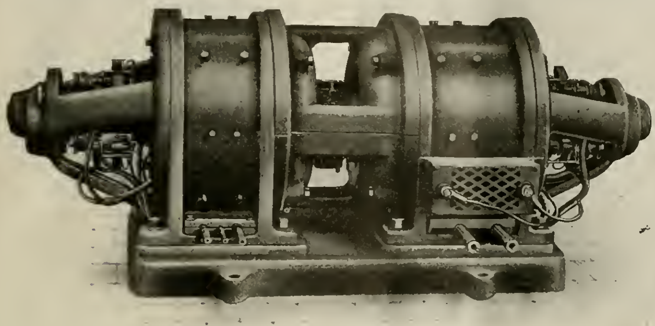
TABLE 2. ANALYSES OF FUELS USED IN EXPERIMENTS.

Item	Pulverized		
	Bituminous Run-of-Mine	Anthracite Birdseye	Anthracite Slush
Moisture, per cent	0.50	0.50	1.00
Volatile, per cent	29.50	7.50	6.00
Fixed carbon, per cent	60.00	77.00	71.00
Ash, per cent	10.00	15.00	22.00
Sulphur, per cent	1.50	1.00	2.5
B.t.u., per lb	13,750	12,750	11,250
Fineness, per cent through 200 mesh	86.00	86.00	86.00

Electric Arc Welding

III—Details of Electric Welding Apparatus and Illustrations of Work Done by the General Electric Company, and the Wilson Welding and Metals Company

As we have already stated, the metal electrode process of welding is the latest and most efficient method of electric arc welding. The improvements that have come by prolonged experiments in alloys calculated to make the most durable welds are such that little more improvement in this direction can be expected. The same may be said of the apparatus generally, and it is only in the large field of untried work that new developments may be expected. A number of enterprising firms have been employing the best electrical engineering skill, with a view to perfect their devices. And the general approval with which they are meeting the requirements of the service, and the remarkable degree of economy secured by the use of their appliances are such that their universal use is merely a matter of time. Among these the General Electric Company, Schenectady, N. Y., has already won an enviable reputation for the stability and variety of their appliances designed to meet a vast number of requirements, and these are being constantly added to, so that the engineering skill may be said to keep pace with the demand. The Wilson Welder and Metals Company, New York, has also made several important improvements, especially in the economical use of the electric current, and the excellent quality of their metal electrodes, that the demand for their various equipments is increasing rapidly and bids fair to take a high place in the realm of electric welding.



FOUR ARC, OR 600 AMPERE CAPACITY, MOTOR-GENERATOR SET FOR DIRECT CURRENT.

WELDING TOOL OR ELECTRODE HOLDER WITH DISTANT CONTROL SWITCH.

RECLAMATION OF FREIGHT CAR KNUCKLES.

As at present perfected the essential requirements for electric arc welding are—a suitable source of direct current supply—a steadying resistance to be placed in series with the arc, together with means for adjusting the same; in other words, a suitable control equipment—a means of holding the electrode so that it can be properly controlled by the operator—protective covering for the operator—suitable filling material—miscellaneous material, such as fire-clay or carbon blocks, for making molds, fluxes, brushes and other tools.

In regard to the current supply, while this may be secured by the use of a shop circuit, it is neither economical nor altogether safe unless arrangements are made for insulating the work. The best, and at the last analysis, the cheapest, method is that of a motor generater set, the motor being constructed with characteristics suitable for operation on the shop or other circuit, and used to drive a low voltage generator. The generator may be either shunt or compound wound, the shunt-wound machine being satisfactory where only one arc is to be operated, while the compound-wound machine is preferable if several arcs are to be supplied for the same unit. Generators giving a potential of 75 volts will enable satisfactory results to be obtained.

The regulation of the current supply is necessary because different welds require different strengths of currents. This is effected by inserting resistance in the welding circuit and connecting it in series with the arc. Without this resistance a condition of practical short circuit would occur at the moment the electrode was touched to the work when striking the arc. The series resistance is also necessary for the purpose of steadying the arc, similar to the ordinary arc lamp.

Before starting the arc the operator

sets the dial switch for the value of the current he needs for the work, so that, in starting, the circuits are in normal running position, and in order to weld

BUILDING UP FLAT SPOTS ON LOCOMOTIVE DRIVERS.

there is no necessity for having relays or switches open or closed, or in any way disturb the electrical circuit.

It is also necessary that a suitable electrode holder be provided, both in the case of carbon and metal electrode welding. There are a number of forms of these already in use, and all of them are arranged with either a spring or a reliable clamp for holding the electrode, the construction of either being such that the electrode may be instantly removed. The metal electrode holder most commonly in use differs from that of the carbon electrode in that it is lighter and more compact. The carbon electrode holder has a disc shield on the handle to protect the hand of the operator from the heat of the arc. This shield is not necessary in the case of the metal electrode, the gloves of the operator affording sufficient protection.

As we have already stated, a protective hood is necessary for the operator on account of the intense brilliancy of the electric flame. These are furnished with vari-colored glasses—several layers of glass, one or more of red, and one or more of blue or green, the combination being more satisfactory than any one of these colors used alone. Sufficient enclosures are frequently necessary around the work so that the dazzling light will not interfere with the vision of other workmen in the vicinity.

The operation of welding was referred to in our previous article, and as we stated, can only be completely mastered by experience. It is advisable under all conditions to make one continuous application of the arc. When more than a single application is necessary, care should be taken to remove all scale. The application of a stiff wire brush will usually have the desired effect. Sometimes chipping may have to be resorted to, or the piece may be tilted and the arc applied and the impurities be allowed to run off by gravity. The metal electrodes are supplied in various sizes, ranging from 1/16 in. to 9/32 in., and are furnished in various lengths, usually about 12 ins.

In regard to the tensile strength of the welded parts it has been demonstrated beyond controversy that in an endless variety of tests the strength of the welded portion exceeds that of the other parts of the metal. This, of course, implies that the weld has been made by an experienced welder complying with the best methods in vogue and taking the best care necessary in the accomplishment of a perfect weld. In this connection it may be stated that all skilled mechanics cannot become expert welders. What is almost impossible to some, comes easy to others, and the natural law of the survival of the fittest applies to the art of welding as to all other arts.

Coming to samples of work and the important matter of saving in cost, we have selected a few examples taken at random from authentic sources which have been verified by particular enquiry, and are absolutely reliable. In the reclamation of freight car knuckles, an appliance peculiarly subject to wear or breakage, it is shown that in one year repair work has been done on these appliances by the electric arc welder at a cost of less than $5,000, which effected a saving of $26,000. Another example shows that in building up flat spots on locomotive drivers the expenditure by the use of the electric arc welder did not exceed $2, whereas by the older methods the cost would at least have exceeded $200.

Statistics further show that on a certain trunk line it was carefully estimated that the cost of work to flues applied in the old way was about $54 per engine per year, while for those electrically welded

VARIETY OF OPERATIONS AT ONE AND THE SAME TIME WITHOUT INTERFERING WITH EACH OTHER. FOUR OPERATORS WELDING FOUR DIFFERENT METALS, EACH WITH A DIFFERENT AMPERAGE FROM A SINGLE GENERATOR.

the cost was $15 for welding and literally nothing for repairs. For a road with several hundred engines in operation it can be seen at a glance what a large saving could be effected. It is generally claimed that no other investment in relation to motive power and rolling stock will yield similar returns.

SECTION OF LOCOMOTIVE FLUE SHEET WITH TUBES IN PLACE READY FOR WELDING.

Indeed, as is well known, on railroads wherever the electric arc process has been tried in welding flues, it has been found most economical and satisfactory, and therefore has been adopted by the largest railroads and large locomotive builders. Maintenance cost is entirely eliminated, and the flues can, in many cases, be run about the three-year limit without removal. Not only the flues, but, as we have pointed out, all firebox work and many other details of locomotive repairs can be quickly made by this method. Welded joints can safely be substituted for riveted joints in tank cars, and in passenger and freight cars, practically any of the metal work can be repaired by the use of the electric arc.

STEAM WELDED BY ELECTRIC ARC IN COMPRESSED AIR TANK.

Apparently there is no limit to the wide range of work to which the electric arc may be applied, and in any case an arc-welding equipment is a very valuable addition to a general repair shop. In many cases the results will be just as satisfactory if the piece be repaired rather than replaced with a new one, and much time and material will be saved, and the repair can often be done with the broken part in place and without any dismantling.

SECTION OF LOCOMOTIVE FLUE SHEET WITH TUBES WELDED BY METALLIC ELECTRODE.

A few more examples of comparative cost of repairs may be added. Repairing mud rings, cost of welding, $6.50; by other methods, $24.57. Welding two spokes in driving-wheel center, cost of welding, $7.98; by other methods, $99.98. Repairing firebox, $134.89; by other methods, $869.50.

FIRE BOX END OF LOCOMOTIVE BOILER TUBES PARTIALLY WELDED. LIGHT AREAS SHOW WELDED TUBES AND DARK AREA SHOWS TUBES READY FOR WELDING.

To recapitulate, as we have already stated, the motor-generator set is the most desirable equipment for several reasons. It is a self-contained unit, does not demand constant attention when running, and the maintenance cost is low. The welding circuits and the shop circuits are electrically independent so that short circuits in the welding circuit will not seriously interfere with the shop circuits. The voltage in the welding circuit can be regulated to suit the work in hand by adjustment of the generator field rheostat.

The control consists of a main generator panel and a separate panel for each operator. Double-circuit panels can be provided for, so that two operators can work from, the same panel through separate equipments. If the circuits are duplicates, a set of switches can be provided for connecting the entire capacity of both circuits to one electrode. This can be used for carbon electrode welding.

A convenient type of switch is provided for adjusting the resistance in series with the arc and providing a number of steps in changing the current.

SAMPLES OF PIPE WELDING.

If an operator leaves his electrode in contact with the work longer than necessary to start the arc, a relay on his panel operates and introduces additional resistance in series with the electrode, thus reducing the current to a low value. To restore the circuits to the normal condition and to resume working it is only necessary to remove the electrode from the work and break the circuit. By this means a large number of operators can work from the same machine since trouble on any one operating circuit is localized and does not affect any other.

Circuit breakers are mounted on the main generator panel, which will open the circuit in case of a short circuit in the cables or in the event of any excessive load being thrown on the generator. Provision for the shortage of gas, carbide or other material of that nature is unnecessary. The equipment is simple and is easily understood by the operators. Since no combustible or explosive material is used in this process, there is practically no danger of explosion or fire.

According to press despatches, the Saxon State railways are now proposing to employ women in the place of signalmen, pointsmen and locomotive stokers, as well as in the loading and unloading of goods trains.

The Yard Engine Question

Tests of Two Engines in Switching Service—Superheated vs. Saturated Steam—Three Classes of Switching Work Included in the Test—Carefully Collected Data—Conclusions Favoring the Superheater Engine

In a previous issue we pointed out that the use of an old, unserviceable road engine in yard service was not good practice. The road engine was originally built to haul cars straight along with a long, steady pull. It was therefore not adapted to sudden, quick shifts, with prompt starting and stopping, and with considerable running and standing time. The fundamental idea in road engine service is steady work; that of the yard engine is intermittant. Yard engine work in its particular line is as vital as road work, and the yard engine is capable of responding to the effect of improvements which mean as much to the railway company as do those applied to the road engine.

There are, of course, more road engines on a railway than there are switchers, but, engine for engine, the one is as important as the other. It does not follow that a bathroom faucet may be permitted to leak because the use of that room is occasional and because the faucet does not supply a steady stream for watering the lawn. An inefficient yard engine means a certain amount of loss every time it is used, and this loss probably becomes greater and greater as time goes on. With some such ideas in view one of our leading railways has turned serious attention to the yard engine question and has carried out a number of very carefully conducted experiments to ascertain and put into actual figures the difference in results between two sister engines, manned by the same crew, doing exactly similar work in each case, the one being an ordinary saturated steam engine and the other equipped with a superheater.

To do the work of testing with the greatest accuracy an indicator was used and the analysis of the cards taken was close and definite The railway company's higher officials, in reporting the results of this experimenting, indicate that: The object of this test was to determine the saving in coal and water per indicated horse-power per hour of a superheated engine over a saturated steam engine of the same class, in several kinds of switching service. The test was made possible by the use of a Maihak indicator, which, with a recording attachment, measures the total amount of work done by the engine, whether going forward or backward.

The Maihak Indicator is of foreign make and embodies the latest improvements in indicator design. This indicator is fitted with Bottcher's Efficiency Reckoner which enables the immediate establishment of the mean indicated efficiency of all piston engines by simply reading off a counting instrument and multiplying by an apparatus constant. The latest form of Crosby indicator practically performs the same work.

With the instrument used careful readings were taken and the results were worked out in minute form. There has been a considerable amount of clerical and mathematical work involved, but the railway conducting the tests has not shrunk from this labor and is now in possession of invaluable and clear-cut information in the form of data on the subject, and this has guided the decision. We are able through the courtesy of this railway company to place before our readers the results of the tests, which show a decided superiority of performance for the superheated locomotive over that using saturated steam.

Tests were made with both engines in three classes of switching, these classes being the Hill Job, the Twelfth Street Job, and the Nine-thirty Transfer. Giving more specific information, it may be said the Hill Job consists in taking the incoming freight trains and sorting them out. The classification yard is on a slight grade which permits of the cars being cut loose after they are started down the lead by the engine. The only heavy pull on the job is taking a string of cars from the incoming track to the head of the yard.

In the Twelfth Street Job the engine takes a string of cars from one of the yards to another of the yards, a distance of about seven miles, in the morning, and also brings back a train to the first at night. During the day the work done is all about the Twelfth Street yard, which is light intermittent switching.

The Nine-thirty Transfer, as the name implies, is transfer work from the owning company's yards to the yards of other roads. Most of the transfers are heavy, and this work is more like road work than it is to switching.

In conducting the tests the tank was calibrated by weighing off an inch of water at a time with platform scales, the tank being leveled up with jacks. The tanks were fitted up with two reading boards, at the right back corner and at the left front corner, to average of the two readings, giving the actual height of water in the tank.

The reducing motion for the indicator was the railway company's standard. The indicator was attached to the front end of the left cylinder at the steam chest peephole by means of a short elbow of long radius. This brought the indicator to a perpendicular position and maintained it at the same height as the horizontal rod of the reducing motion.

In testing, the engine was sent out on a regular switching run and the following items were taken: Recorder reading, coal used, water used, time (total and standing), number of times injector was used, minutes pop-valves were open, strokes of engine and state of the weather. The tank was leveled off at the beginning of a run and at the end of the run. The weight of coal was taken by the coal dock scales, and to level the tank, the same amount was taken as the pounds of coal used. Water readings were taken by both measuring boards at a start of a run, also before and after taking water, during the day, and at the finish of a run. The total time of a run was the time from leaving the coal dock at the beginning of a run until the return to the coal dock at the finish of a run. Standing time was the time when the engine was not actually engaged in switching, such as waiting for blocks, bridges, trains, etc. The switching time, upon which the results are based, is the difference between the total time and the standing time.

The number of applications of the injector was noted for each test and an average of the amount of water lost through the overflow was found for each engine by weighing several times. The total weight of water passing through the overflow was deducted from the amount of water used in order to get the amount of water evaporated by the engine. The number of minutes the pops were open was noted for each test and the discharge per hour by the standard formula, $E = 105 \times L \times P \times D$, was calculated. The pounds of coal equivalent to this discharge were deducted from the total weight of coal. This corrected weight of coal is the weight upon which the results are based. The number of strokes made on each test was recorded by means of a Crosby Stroke Counter attached to the horizontal rod of the reducing motion. Reducing the strokes made to miles gave a comparison of the distance traveled on each test.

In the formula quoted above

E = Discharge in pounds per hour.

L = Vertical lift of valve in inches.

P = Absolute pressure in lbs. per sq. in.

D = Nominal diameter of the valve in inches.

The factor L is generally assumed to be 0.1 inch, but in view of the fact that the pop-valves were simmering and not wide open for a part of the time set down or noted as "pops open," the value of L was taken of one-half of this figure, or 0.05 ins. In this case $E = 105 \times .05 \times 3\frac{1}{2} \times 195$ or 3,583 lbs. of steam discharged through the pops per hour. If they were open 47 minutes, then 47/60 of 3,583, or 2,794 lbs. of steam would have been lost in that time.

Below we give the results of tests made for each class of switching service, i. e., the terminal yard, the transfer service and the hump yard work, and the explanation of the data sheet is placed close to the table.

The data sheet shows column 1—the date of the test; 2, the engine number; 3, the run on which engine was tested; 4, the engineer and fireman; it will be seen that the same engineer and fireman handled both engines on any one run; 5—The time on the road in hours and minutes, which was time from leaving coal dock until return to coal dock. 6—Standing time in hours and minutes which was time the engine was not actually engaged in switching, such as waiting for blocks, bridges, trains, etc. 7—Switching time, which is difference between column 5 and column 6. 8—Pounds of water used. Water readings were taken before and after taking water. From calibration curve, set down, the pounds of water corresponding to those readings were determined. 9—Total weight of coal used. 10—Recorder reading. The recorder reading was taken at the start and at the finish of a run, the difference shows reading for the day. 11—Average length of cards. Several cards were taken during each run and the average length of these cards determined. 12—Strokes of engine by the stroke counter. 13—Miles traveled equal circumference of main drivers in feet times column 12, divided by 5,280. 14—Average speed in miles per hour. Column 13 divided by column 7. 15—Average mean effective pressure in lbs. per sq. in. Column 10 times 15.5, times 140 divided by column 11, divided by column 12. 16—Average R. P. M. equals column 12, divided by column 7 times 60. 17—Engine constant equals $\frac{La}{33{,}000}$ where L is stroke of engine in ft. a, is area of cylinders in sq. in. 18—Average indicated horse-power which is column 15 times column 16 times column 17 times 4. 19—Total I. H. P. H. equals column 18 times column 7. 20—Injector, times. 21—Pounds of water through overflow equals injector applications times 11, which was average amount lost through overflow for each application. 22—Water evaporated equals column 8 minus column 21. 23—Pounds of water evaporated per pound of coal equals column 22 divided by column 9. 24—Minutes pops were open. 25—Pounds of steam through pops equals column 24 divided by 60 times discharge per

COMPARISON OF TWO ENGINES, SUPERHEATER AND SATURATED, ON THREE CLASSES OF WORK.

OBSERVED AND CALCULATED DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
																													Average for Run		Per Cent Saving in	
Date.	Engine Number.	Run.	Engineer—Fireman.	Time on Road. Hours—Min.	Time Standing. Hours—Min.	Time Switching. Hours.	Lbs. of Water Used.	Lbs. of Coal Used.	Recorder Reading.	Average Length of Cards—Ins.	Strokes of Engine.	Miles Traveled.	Average Speed—M. P. H.	Average M. E. P.	Average R. P. M.	Engine Constant $\left(\frac{LA}{33000}\right)$	Average I. H. P.	Total I. H. P. H.	Injector, Times On.	Lbs. of Water through Overflow.	Lbs. of Water Evaporated.	Lbs. of Water Evaporated per Lb. of Coal.	Pops Open—Min.	Lbs. of Steam through Pops.	Lbs. of Coal equivalent to Steam through Pops.	Corrected Weight of Coal—Lbs.	Lbs. of Water Evaporated per I. H. P. H.	Lbs. of Coal Used per I. H. P. H.	Lbs. of Water per I. H. P. H.	Lbs. of Coal per I. H. P. H.	Water.	Coal.
11-4-15	4570	Hill	Broadhead Dwyer	8—54	1—32	7.36	47000	6900	728.38	3.42	13412	34.3	4.66	34.34	30.4	.020627	86.0	633.2	40	440	46560	6.75	47	2794	415	6485	73.5	10.2	73.5	10.2	19.8	16.6
11-13-15	4560	Hill	"	8—40	1—33	7.28	35200	6100	669.75	3.42	10878	25.7	3.54	38.93	24.9	.020755	80.5	586.0	54	594	34606	5.68	103	6148	1080	5020	59.0	8.5	59.0	8.5		
11-5-15	4570	12th St.	Cunningham Hertler	11—30	1—38	8.87	47200	7840	706.06	3.42	15846	40.5	4.56	28.17	29.6	.020627	69.3	614.0	38	418	46782	5.97	23	1372	230	7610	76.1	12.3				
11-6-15	4570	12th St.	"	11—45	1—34	10.18	49200	5700	781.23	3.42	14939	38.2	3.75	33.07	24.4	.020627	66.8	680.4	32	352	48848	8.58	38	2268	264	5436	71.8	7.9	72.5	9.1		
11-7-15	4570	12th St.	"	11—30	2—35	8.92	56000	6600	937.48	3.42	15532	39.7	4.45	38.17	29.0	.020627	91.3	815.2	32	352	55648	8.43	41	2447	290	6310	68.2	7.7				
11-8-15	4570	12th St.	"	11—00	2—14	8.76	43500	5800	670.20	3.42	14550	37.2	4.24	29.12	27.7	.020627	66.5	582.8	32	352	43148	7.45	90	5374	722	5078	74.4	8.7			17.8	17.5
11-15-15	4560	12th St.	"	11—30	3—12	8.30	43800	6500	853.07	3.42	14596	34.5	4.15	36.95	29.3	.020755	89.9	746.4	34	374	43426	6.68	115	6843	1012	5488	58.1	7.3				
11-16-15	4560	12th St.	"	12—00	2—10	9.83	48200	6800	958.03	3.42	17616	41.7	4.20	34.39	29.8	.020755	85.2	838.0	33	363	47837	7.05	86	5123	727	6073	57.0	7.2	59.6	7.5		
11-17-15	4560	12th St.	"	11—50	2—47	9.05	44400	6400	787.56	3.42	15237	36.0	3.97	32.68	28.0	.020755	76.1	689.2	27	297	44103	6.90	82	4872	706	5694	63.9	8.2				
11-9-15	4570	9:30 a.m. Transfer	Weldon Moss	12—10	3—32	9.63	82800	9900	1427.56	3.42	22778	58.3	6.06	39.63	39.4	.020627	128.8	1241.2	40	440	82360	8.33	94	5589	672	9228	66.3	7.4	66.1	7.7		
11-10-15	4570	9:30 a.m. Transfer	"	12—20	2—39	9.68	77500	9900	1343.60	3.42	22461	57.3	5.92	37.82	38.6	.020627	120.7	1168.4	35	385	77115	7.80	61	3583	460	9440	66.0	8.0			25.8	23.4
11-18-15	4560	9:30 a.m. Transfer	"	12—35	4—11	8.40	53900	6900	1191.10	3.42	18595	43.9	5.22	40.50	36.8	.020755	124.0	1042.0	27	297	53603	7.77	105	6270	808	6092	51.4	5.8	49.0	5.9		
11-19-15	4560	9:30 a.m. Transfer	"	12—40	4—22	8.30	54100	7500	1318.97	3.42	19881	47.0	5.66	41.95	39.9	.020755	139.1	1154.4	27	297	53803	7.18	61	3583	500	7000	46.6	6.0				

hour from formula $E = 105 \times L \times P + D$. 26—Pounds of coal equivalent to discharge through pops equals column 25 divided by column 23. 27—Corrected weight of coal equals column 9 minus column 26. 28—Pounds of water evaporated per I. H. P. H. equals column 22 divided by column 19. 29—Pounds of coal per I. H. P. H. equals column 27 divided by column 19. 30 and 31—Average in water and coal per I. H. P. H. is the average for the several tests on a given run. 32—Per cent saving in water is the difference between the average value of water per I. H. P. H. used by engine 4570 and that for engine 4560 shown in column 30 times 100, divided by value for engine 4570. 33—Per cent saving in coal is the difference between the average value of coal per I. H. P. H. used by engine 4570 and that for engine 4560 shown in column 31, times 100, divided by value for engine 4570.

The accuracy of the results is beyond question, as all the data were taken in a careful manner and as deliberately as possible under existing conditions. Corrections were made for the loss of water through the injector and for the loss of steam through the pops, which would give a correct value for the water evaporated by the engine.

In weighing the coal there was probably a small error due to the fact that it was weighed by the coal dock scales. However, it is believed that this error would be less than 1 per cent, which would affect the final results very little.

SUMMARY OF RESULTS.

Engine 4560, superheater, showed a saving in coal and water in all three classes of switching as shown below:

Run.	Percentage of— saving in water per *I.H.P.H.	saving in coal per *I.H.P.H.
Hill	19.8	16.6
12th St.	17.8	17.5
9:30 Transfer	25.8	23.4

*I.H.P.H.—Indicated horse-power-hour.

The saving in the 9:30 Transfer run, which was the heaviest class of switching is the most pronounced. However, this is to be expected as most of the work done on this run is heavy compared to the light switching done on the Hill Job and the 12th St. Job.

From the above summary of results the following conclusions may be drawn:

First—The superheater shows an appreciable saving on switch engines in all classes of switching work. Second—The saving shown in light switching while not so great as that shown in the transfer work, is sufficiently large to warrant the use of superheated engines in that service.

From this it appears that the superheater engine is the best in any and all kinds of switching service. The whole investigation has very satisfactorily demonstrated the fact that superheating steam has a dollar and cent value for yard service. The superheater is acknowledged to be efficacious as far as road engines are concerned, and the table given above sets the matter for switchers above doubt, and points the way for an economy which has not hitherto been generally sought, but which is there, and can be had, by any railway which desires to appropriate it to its own use. Superheating is not only a scientific success, but it is a legitimate and logical economy for present day equipment and operation.

The reason why the reduction in number of engines has been effected is that engines will run longer on water, longer on fuel and longer between fire cleanings. They will also move more promptly and do more efficient work. There is less escaping steam in cool or cold weather to make condensation from cylinder cocks, etc., and enginemen as well as all the men concerned in yard operation, like the superheater engines very much better than the others.

We have found by tests that a superheater engine can do a given amount of work with less water and coal than the saturated steam engine. This being true, the superheater engine will go longer for coal and water, than the saturated engine, and thus save the time necessary to take water or go to the dock for more coal. This being true, it is apparent, since less coal is used, the fire does not have to be cleaned so often, which is another timesaver for the superheater engine.

It is an accepted fact that a superheated engine moves more promptly and works more efficiently than a saturated engine, and since the engine moves more promptly or gets under way in a shorter time it will cut down the time necessary for a given amount of switching. In other words, the superheater engine will handle more tonnage at a high speed and at the same time, show an appreciable saving in coal and water.

New Railway in Ecuador.

A new railway is about to be constructed in Ecuador, from the city of Chone to Quito, passing through Santo Domingo de los Colorados. This road will connect Quito with the ports of Manta and Bahia de Caraquez on the central western coast of Ecuador, and a part of the import and export duties collected at these ports will be used for the construction of the road. Additional funds are provided by the assignment of a portion of the taxes now used for other public purposes, and the appropriation of certain sums formerly destined to other construction. For the immediate financing of this work the government of Ecuador will endeavor to secure loans, to be guaranteed by the revenues mentioned in detail in the laws providing for the construction of both these railroads.

Canadian Snow Plows.

An order was recently placed with a Nova Scotia company by Canadian railways for 20 snowplows to be completed with as little delay as possible. The specifications differ only in slight degree from those in previous orders. In the new plows the large drawbar castings on the front are extended to enable them to be coupled together, if necessary, "nose to nose." The side wings are remodeled and have curved plates instead of straight ones. An ice cutter is fitted to the forward truck.

The essential particulars of the new plows are: Length over all, 32 feet 1 9/16 inches; width over side sills, 8 feet 9⅛ inches; height, rail on top of cupola, about 11 feet 3 inches; height, rail to top of cupola, about 14 feet 10 inches; width over wings extended, 16 feet; extreme width cupola, 8 feet 9 inches; extreme length cupola, 4 feet 11⅛ inches; truck center, 18 feet; wheel base leader truck, 4 feet 2 inches; wheel base rear truck, 5 feet 3 inches; weight, approximately 60,700 pounds; draft gear, tandem springs; couplers, 5 by 7 shank, 8½ inches end; air brakes, Westinghouse K. D. 812; trucks (front end), 30-ton truck; wheels, cast steel, 28 inches diameter; journal boxes, tender type; trucks (rear end), 30-ton standard; wheels, M. C. B., 33 inches; axles, M. C. B. standard; brake shoes, steel back; springs, M. C. B. class; brake beams, M. C. B.

Railway Equipment for Colombia.

An increase will be made in motive power and rolling stock on the Colombian Railway, Ferrocarril de Girardot, connecting the city of Bogota with Girardot. The management has recommended the purchase of 12 locomotives, 12 passenger coaches and 25 freight cars. The railroad is of the narrow gauge type, 112 miles in length. There are at present 14 locomotives, and 111 cars of various kinds in service. Correspondence should be in Spanish and addressed to Mr. Daniel J. Reyes, manager of the railway at Bogota, Colombia.

Railroad Ownership in Great Britain.

In great Britain the railroads are in the hands of the government. This war measure has thrown some light on government operation of railroads. During the recent debate on the national food supply question in the House of Commons, Mr. Runciman, speaking for the government, said of the railroads, that it was impossible to get the best use of tonnage out of any government department. This frank admission should check the demand for government ownership and operation, or it should stimulate someone to devise a method of making government operation, pay like the Glasgow tramway system.

Passenger Locomotive for the St. Louis Southwestern

Comparison with Types Formerly Used—Traffic Conditions Influence Design—New Devices for Economical Operation

The Baldwin Locomotive Works has recently built, for the St. Louis Southwestern Railway, eight ten-wheel locomotives which are a direct development of a design constructed in 1913. These engines are used in through passenger service, and it is interesting to compare their leading dimensions with those of American (4-4-0) and Atlantic (4-4-2) type locomotives built for similar service on this road in 1906 and 1909 respectively. Such a comparison is as follows:

Type	Cylinders	Drivers	Steam Pressure	Grate Area	Water Heating Surface	Super-heating Surface	Weight on Drivers	Weight, Total Engine	Tractive Force
4-4-0	19" x 26"	69"	200	28.9	1,856	...	92,100	145,400	23,100
4-4-2	20" x 26"	70"	200	30.8	2,480	...	91,100	181,900	25,200
4-6-0	22" x 28"	69"	200	49.6	2,474	532	165,200	209,400	33,400

Conditions on the St. Louis Southwestern are such that it is necessary for the through trains to make comparatively frequent stops; and this design of Ten-wheel (4-6-0) locomotive, while it does not afford the steaming capacity in proportion to adhesion that could be obtained in the Pacific or 4-6-2 type, has proved itself fully qualified to meet the service requirements of that road. Attention may be called to the use of a large boiler with wide firebox, a superheater, and a liberal ratio of adhesion which is 4.9. Such a ratio should permit full tractive force to be developed without difficulty, even with somewhat unfavorable rail conditions.

The boiler has an extended wagon-top, and measures 72 in. in diameter at the first ring and 80¼ in. at the domering. The dome contains a Rushton throttle, with drifting valve. The vertical throttle pipe is flattened in cross section, permitting the valve to be placed well forward in the dome, so that there is room for a man to enter the boiler while the pipes are in place. Some of the features of the furnace equipment include a brick arch supported on two water tubes, a power-operated fire-door, and a grate which is divided down the center and is arranged to use the company's standard grate bar, which also fits narrow fireboxes. The superheater flues, 30 in number, are electrically welded into the back tube sheet.

These locomotives are fitted with 14-in. piston valves, which are driven by Baker gear. Vacuum relief valves are applied. The piston heads are of rolled steel, with cast iron bull-rings riveted to them. The bull-rings have a width of 6 in. The main frames are 4½ in. wide and 5¾ in. deep over the pedestals, and are arranged with double front rails.

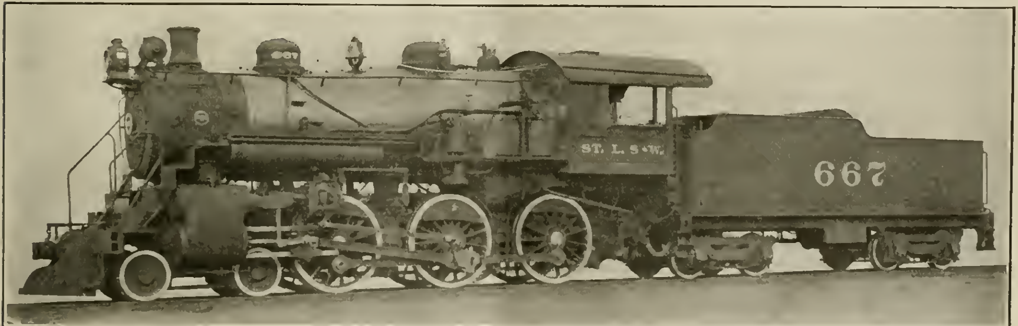
The front truck is of the Adams type, with a rigid center and side frames and transom of cast steel, in one piece. All the driving tires are flanged, those of the front and rear pairs of wheels having ⅜ in. greater lateral play between rails and flanges than those of the main pair. Flange oilers are applied to the leading drivers.

The tender frame is of the Commonwealth cast steel pattern, in one piece, and the trucks are of the Adams equalized type. The tank has a water bottom, and carries 9,000 gal. of water and 15 tons of coal.

These are heavy engines of their type, embodying in their design proportions and details which have proved successful in the difficult service for which they are intended. It is practically the conditions of service which have determined the size, type and equipment of these engines.

The following table contains further particulars.

Gauge, 4 ft. 8½ ins.; cylinders, 22 ins. by 28 ins.; valves, piston, 14 ins. diameter. Boiler—Type, wagon-top; diameter, 72 ins.; thickness of sheets, ¾ ins. and 13/16 ins.; working pressure, 200 lbs.; fuel, soft coal; staying, radial. Fire box—Material, steel; length, 102 ins.; width, 70 ins.; depth, front, 72 ins.; depth, back, 58¼ ins.; thickness of sheets, sides, ⅜ ins.; thickness of sheets, back, ⅜ ins.; thickness of sheets, crown, ⅜ ins.; thickness of sheets, tube, 9/16 ins. Water space—Front, 5 ins.; sides and back, 4 ins. Tubes—Diameter, 5⅜ ins. and 2 ins.; material, 5⅜ ins., steel, 2 ins., iron; thickness, 5⅜ ins., No. 9 W. G., 2 ins., No. 11 W. G.; number, 5⅜ ins., 30; 2 ins., 212; length, 15 ft. 0 ins. Heating Surface—Fire box, 173 sq. ft.; tubes, 2,285 sq. ft.; firebrick tubes, 16 sq. ft.; total, 2,474 sq. ft.; superheater, 532 sq. ft.; grate area, 49.6 sq. ft. Driving wheels—Diameter, outside, 69 ins.; diameter, center, 62 ins.; journals, main, 10½ ins. x 13 ins.; journals, others, 10 ins. x 13 ins. Engine Truck Wheels—Diameter, front, 33 ins.; journals, 6 ins. x 12 ins. Wheel Base—Driving, 15 ft. 0 ins.; rigid, 15 ft. 0 ins.; total engine, 26 ft. 2 ins.; total engine and tender, 61 ft. 5¼ ins. Weight—On driving wheels, 165,200 lbs.; on truck, front, 44,200 lbs.; total engine, 209,400 lbs.; total engine and tender, 386,600 lbs. Tender—Wheels, number, 8; wheels, diameter, 36 ins.; journals, 6 ins. x 11 ins.; tank capacity, 9,000 gals.; fuel capacity, 15 tons; service, passenger.



PASSENGER 4-6-0 FOR THE ST. LOUIS SOUTH WESTERN RAILWAY.

W. J. Miller, Supt. Motive Power. Baldwin Loco. Works, Builders.

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The Old and the New Year.

It does not require an array of statistics to demonstrate the fact that the year that has just passed has been the most prosperous in the history of American railroads. Government statistics are of little value because they are a year and a half old when they come to see the light, and they fall very far short of completeness at that. The railroads are the arterial circulation system of the industrial continent, and the quickening is seen and felt by all who have eyes to see; with the exception of an occasional car shortage at some of the busiest centers, the work has been admirably handled. In spite of increased traffic with its attendant extra hours of service, the list of accidents among railway men has been much lessened. The added mechanical appliances that have come into use with the present century have been improved and their service extended during the year with the result that a degree of economy in the use of fuel, and the expense in general repair have been reduced to a degree hitherto unapproached. Worn-out locomotives and rolling stock are being rapidly replaced with more powerful engines and heavier cars, and every city and town and village through which the railroads pass feels the beneficial influence of the increased volume of traffic. Our congratulations are offered to the men who have met the tide of emergencies. A fuller share of the well-earned rewards of honest industry will be theirs, and the New Year is full of hope.

We desire to specifically wish our readers, advertisers and our many friends throughout the country, what may prove to be a truly happy New Year in more ways than one. RAILWAY AND LOCOMOTIVE ENGINEERING will endeavor, by the introduction of some slight changes in the method of handling railroad news, to further stimulate the interest and support which it has been our earnest effort to deserve.

Coal Dust as Fuel.

We wish to call particular attention to the digest, appearing elsewhere in this issue, of Mr. Muhlfeld's paper on pulverized fuel for locomotives. We have not quoted it word for word but have endeavored to bring out the salient features of the whole subject. Mr. Muhlfeld is president of the Pulverized Locomotive Fuel Company, and has given a great deal of painstaking effort and much careful thought to the developing of apparatus, which when applied to a modern locomotive, will burn finely divided coal, and actually consume what has heretofore been regarded as commercial refuse, and not only can it be used with advantage, but it produces such highly beneficial results that it competes with, and in some cases beats the good performance of high grade fuel as generally fired.

The use in almost any form of a by-product is one of the surest ways to secure economy and reap a profit. The gas industry and the derivatives of the treatment of coal-tar products are two very good examples of the commercial value obtained from the use of by-products. The use of waste, which is the tangling of broken, knotted or catching treads of cotton in the winding of bobbins, has grown to such proportions, that a cotton mill would to-day loose much of its productive value, if it was possible to entirely eliminate the constantly formed bundles of what at one time nobody wanted, and which cost money to remove.

In the mining and handling of coal the tendency is to break large lumps into small ones, and the small ones are still further reduced as the handling process goes on, and finally the coal, irrespective of its quality, becomes too finely divided for use on a grate. In this state it becomes practically useless for the majority of furnaces and the locomotive with its hard service and its sudden and imperative calls for steam in large quantities, seemed to be the most unpromising field for the use of a by-product with its value practically unreachable. Notwithstanding all this, pulverized fuel—the by-product of the mine and the ceaseless jolt of the coal car is now a recognized and legitimate source of steam generating material. The successful use of a by-product invariably cuts into the total cost of production by yielding a revenue which offsets part of the overhead charges which haunt the mine, the factory and the store. This is the strict view taken by the science of industrial economics, but there is not a man concerned nor one who even hears of it, but will feel some sense of satisfaction at the disposal of what everybody was willing should go to Davy Jones' Locker. When all this is done at a profit, it has almost the uncanny appearance of an eight wheel switcher beating the speed record of a "Superior Flyer."

Burning coal dust requires oxygen and for a moment glancing at the six inch surface of a one inch cube, and knowing that the surface exposed to the air can be almost indefinitely increased as the cube is broken up, one can get an idea of what rapid and complete oxidizing really is in the flame way of a locomotive in heavy service. If an ordinary track tie was burned it might take a week to thoroughly consume it. If, however, it was split up into sticks it might be burned in a day. Suppose the sticks had been reduced to shavings, an hour might see it completely consumed, and if the shavings had been cut into small chips, perhaps fifteen minutes would suffice for it go up in smoke.

In all these states, taken in the order mentioned, the area capable of combining with oxygen had been progressively increased and the combustion correspondingly accelerated. The tie, when burned, gave out a definite amount of heat, whether it took a week or fifteen minutes, but the rapidity of combustion, concentrated the whole thing in a few minutes in the finely divided state.

Suppose the total heat obtainable to have been 1500 B. T. U., little steam would have been generated by a week's application of this quantity. The few minutes required by the chips to deliver the 1500 B. T. U. produces some result, but the longer process is like trying to push a nail into a board with a hammer instead of concentrating the effect of the energy in a sharp well-directed blow. The pulverized fuel used in locomotives can be burned at any desired rate. It can be shut off for economy's sake as occasion arises, and can be re-ignited by the heat of the firebox when the engine is drifting and the copious and enveloping flow of oxygen which vigorously attacks each particle as soon as the fuel is turned on again, starts combustion. The reason for the warning concerning dust clouds becomes apparent on account of the intimate mixture of coal dust and air, which brings the whole al[illegible] to the expl[illegible]sive point.

First Ai[illegible] Injured.

Surely we li[illegible] progressive age when every wo[illegible]s its medicine chest and tables [illegible]uctions in regard to first ai[illegible] injured, and selected experts trained like medical graduates are ready to meet scientifically the blows of circumstance that come even to the most careful worker. Why was this not thought of before? In the clash of contending arimes there has been centuries of preparation for the wounded, yet in the battle of life among dynamic forces and revolving machinery, and flying rivets, and roasting temperatures, there was formerly nothing but a quid of tobacco for a gaping wound or a piece of string for a ruptured artery. Doubtless the workingmen's compensation act has something to do with this, but underneath it all there is a kindlier spirit that recognizes that after all we are our brother's keeper. In all the leading railroad shops this spirit shows itself in the admirable equipment, the keen interest of the best and the brightest of the mechanics who have come to look upon safety first as a kind of preparedness that involves a part of the necessary education to get the best results in the constant battle with the elemental forces of nature.

The Chemical Treatment of Locomotive Feed Water.

The Dearborn Chemical Company has been requested by Railway and Locomotive Engineering to furnish some information with reference to that company's theory of the treatment of scale forming waters, especially from the locomotive point of view, in an effort to explain how it is possible for the Dearborn treatment to result in scale removal and scale prevention, through the addition of less reacting material than is necessary to cause complete reactions, with the scale-forming elements in the water, and to treat the water at an expense rarely to exceed three cents per thousand gallons of water evaporated.

The theory underlying the Dearborn method of treatment depends very largely upon the reactions that take place under slightly different conditions in organic solutions from those of inorganic solutions. Furthermore, it is rarely the Dearborn Company's intention to completely treat a water with reactive material but rather to partially treat it, depending upon certain cumulative actions which result in the removal of the excess. For instance, in a specific case it might be stated that the basis of the preparation is an extract extremely rich in tannin, the element found in tea, sugars (saccharides and glucosides), and starches. With these materials are incorporated reactive agents dependent upon the character of the water which is treated and the entire mixture subjected to continued "digestion" until as far as possible the tannic acid in the rich extract has united with the soda salts to form what is known as commercial tannate of soda. The excess soda reagents present are designed to react upon lime and magnesia in other forms than carbonate. The tannins react very largely upon the carbonate and also upon the other salts of lime and magnesia, as the tannate of lime or magnesia is a very insoluble material and accomplishes the removal of lime and magnesia ultimately to a much greater extent than is the case with strictly inorganic salts such as caustic soda, soda ash, or tri-sodium phosphate.

The tannates of lime and also of magnesia which are both produced as a result of the reaction, are bulky in general appearance and structure and at the same time are low in molecular weight and specific gravity for which reason they do not settle readily in the water unless it is very quiet, but, on the other hand, move readily with the currents set up in the heated water, due to the application of heat at some particular part of the boiler. In this form, which is non-crystalline, the flocculent precipitate has a further property of coagulating light, suspended matter which might be precipitated, thereby resulting in a much clearer water, which, to a very great extent, overcomes a more or less foaming tendency which otherwise would develop by other methods of treatment for the removal of the lime and magnesia salts.

The reaction, however, that precipitates the lime and magnesia as tannate is not complete, as tannates of lime and magnesia are materials very rarely seen in the dry state and under the proper temperature conditions the tannates very gradually change in the boiler to amorphous carbonate of lime or carbonate of magnesia. The reliberation, into the water, of the tannate radicle allows it to combine either with the alkaline salts of lime and magnesia, or with the free alkalis, such as carbonate of soda (in case such alkalis are present). This results in a still further reduction in the lime and magnesia and makes it possible to have one pound of reactive material ultimately precipitate five to ten times as much scale-forming material, as its ordinary reaction would lead one to believe.

Small amounts of the tannates of lime and magnesia remain in the sludge in an undecomposed form but 80 to 90 per cent decompose readily. The resulting product is, as a rule, carbonate of lime, but never, in the presence of vegetable matter, in a crystalline form. It is a fairly well known fact that if an amorphous precipitate can be produced, and if the precipitate can be retained indefinitely in the amorphous condition, that it is practically impossible to incorporate such a precipitate in scale-formation. It stays rather in the form of mud and has no great power to solidify or pack together.

It is also a fairly well known fact that lime and magnesia precipitated in an organic medium go from solution in the amorphous rather than in the crystalline form as even a small amount of vegetable matter will prevent the formation of a pure crystal. The medium, or more definitely, the tannins and the other vegetable materials which are present, cause a gradually concentrating organic medium to be established, in which the lime and magnesia, as above stated, are first precipitated as tannate and gradually converted into carbonate but are prevented from passing further into a final crystalline state owing to this characteristic. The presence of the vegetable matter guards against the crystalline deposition of the lime and magnesia salts.

Furthermore, the presence of sugars which are always present in a very crude form as glucosides and saccharides results in a very material change in solubility. There is a method for the separation of lime from magnesia based upon the solubility for these salts in a sugar solution and this property of dissolving lime and magnesia in sugar syrups of various strengths is something that has been known for a long time. The product is not so much a solubility product as it is a so-called addition product of which the so-called saccharate of lime, for instance, is the soluble product. By reason of the presence of this medium the reactions are carried much further, apparently, than they would be if tannate of soda was the only reactive material in the preparation. As the precipitated material increased due to the large amount of incrustants thrown down, the vegetable material in the water had gradually increased, due to frequent additions in each succeeding treatment with new water, the proper balance is always maintained and with a proper system of blowing out to remove the amorphous sludge, from time to time, conditions can be kept under perfect control.

Summing up the problem then, the Dearborn Company bases its theory of treatment first on a partial treatment with the original introduction of a compound; a continued removal of incrustants due to possible catalytic action,* during which the compound is left practically unchanged, owing to the continual returning to the solution of the tannate radicle which is the more important one, from the standpoint of reaction; retaining at all times an organic medium so that the carbonates of lime and magnesia may never be allowed to become crystalline; and in the production of certain conditions of solubility which ultimately take care of the last traces which cannot be removed by the action of tannate alone. The coagulating action of the precipitate itself assists in keeping the water clear and prevents the development of the foaming troubles which so frequently occur owing to the chemical treatment of waters for locomotive boilers.

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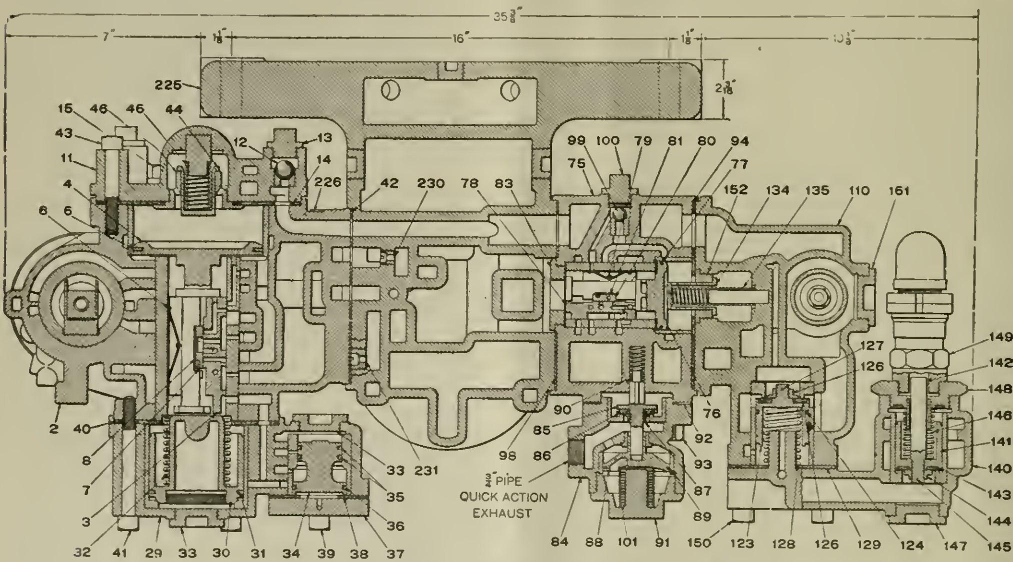
*Catalytic action is an intermediate state in which a compound is formed, and that by the alternate composition and decomposition of the compound the original agent is left practically unchanged.

Air Brake Department

The Universal Valve of the U. C. Brake Equipment

The type of universal control valve for passenger car service shown here is the one adopted as a standard by the Pennsylvania Railroad and is being operated in what is known as direct release, that is, the graduated release feature is temporarily cut out or is not being used. A blanking flange is shown on the pipe bracket and is at this time substituted for the electric portion, the electric portion being used only on the cars of certain trains at this time, so that the valve as shown in the present form is the identical type now in use on hundreds of the passenger cars of this railroad These valves are mixed indiscriminately in trains and improve the brake operation wherever they are mixed with triple valve equipments.



SECTIONAL VIEW OF ACTUAL CONSTRUCTION OF UNIVERSAL VALVE.

One of the cuts shown is a diagrammatic view of the universal valve in release and charging position, the cut showing a sectional view is of actual construction and is the first cut of this kind that we have been able to secure and we take pleasure in giving our readers a view of the actual construction of this valve which in a few years will no doubt be the standard air brake operating valve for passenger cars.

Before going into this matter in detail it may be well to state that the brake equipment is not being advertised to any great extent and it is only recently that we have been able to obtain permission to illustrate the operation of the universal valve. One of the reasons for this is that there are certain men in Railroad service who are laboring under the impression that a new type of brake equipment is manufactured only for selling purposes. Certainly the manufacture of brake apparatus is a business proposition, and while we have no figures with which to back up any statements, it is safe to say that it would startle the average railroad man to know just what an enormous sum of money that has been spent in the development of this brake, enough at least to have made it a hopeless effort for any individual to develop and place it on the market.

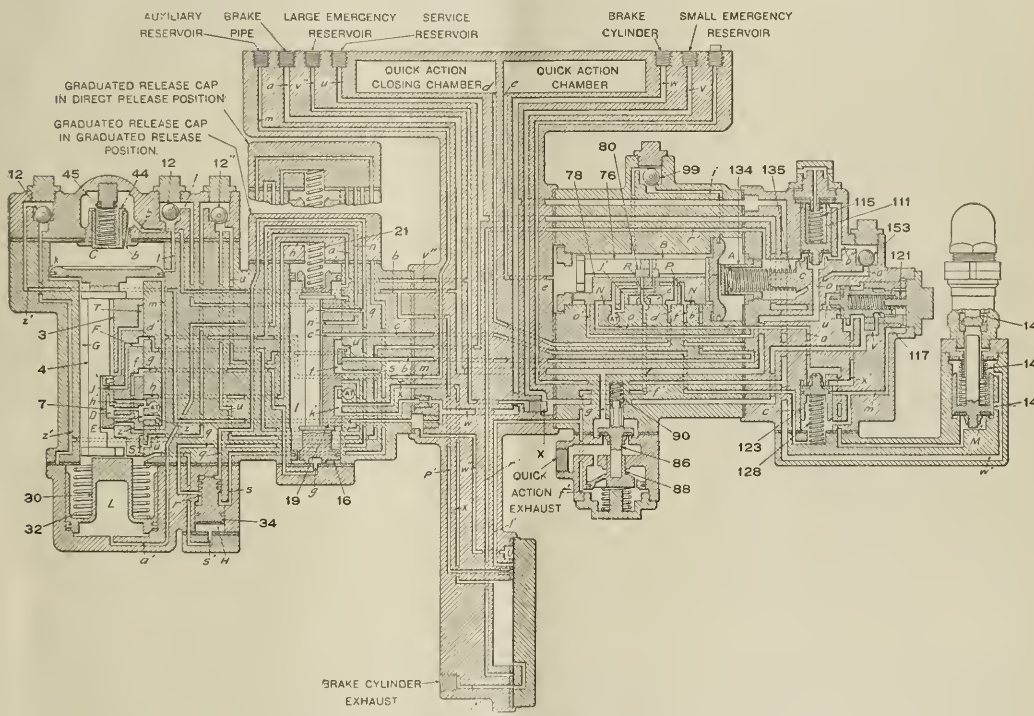
The Engineers of the Westinghouse Air Brake Company have repeatedly stated and insist that an electrically operated air brake cannot become a necessity until after all of the features of the present types of air brakes have been fully utilized and found inadequate. As an example, under certain conditions the high speed brake may be stopping trains from 60 mile per hour speeds on level track in say 1800 feet distance and operating the same brake with electric current might result in cutting off 200 feet distance from the stop or bring it to 1600 feet, while applying an efficient foundation brake gear and a modern type of brake equipment, the stop distance might be cut down to about 1100 feet from a 60 mile per hour speed without using any electric current whatever.

After the pneumatic features of a brake are fully utilized, the use of electric current may become necessary to provide certain features that are not only desirable but in some instances absolutely necessary, as an example the Interborough Rapid Transit Company finds it an absolute necessity, for in order to transport about 1,500,000 passengers per day, it is necessary to run 10 car multiple unit trains about 90 seconds apart and in order to do this, the highest type of pneumatic brake was found to be inefficient and the only brake that could be made to meet the traffic conditions was the electro-pneumatic. This particular traffic condition has become such in the past few years that even something more than an electrically operated brake was necessary and the Air Brake Company designed an empty and load passenger car brake for use in the subways, which is now in use.

On certain railroads the rapid developments in recent years in weights of car, speeds, traffic, equipment and requirements has imposed conditions which previous types of brakes were inadequate to meet in a satisfactory manner, and as the Pennsylvania Railroad demanded certain improvements over the operation manifested by triple valve equipments, it became evident that the ordinary functions of the triple valve must be supplemented. Certain of these novel functions might be considered desirable for a certain condition of service and undesirable for other conditions, therefore provision was made for the building up of parts containing all of the improved features, or whereby functions that are not required may be omitted or again added when conditions warrant it, and because of this the universal valve is provided, the term universal being adopted because of the facility provided for adapting the equipment, later. The equalizing portion is bolted to one side of the bracket, and the emergency portion on the other. The equalizing portion is in one body complete and governs the service operation of the brake. On the other side of the bracket the emergency portion is in two separate section bolted together, one being the quick-action portion, the other the high-pressure cap. As has been explained the electric portion will be bolted at the point on the bracket that the blanking flange is now located.

Opposite the blanking flange, the pipe connections to the brake pipe, brake cylinder, and reservoirs are made, so that per one of these one inch tap holes is for the pipe connection to the service reservoir, the next one, or the one in the middle of the bracket is for the small emergency reservoir connection, the next one is for the brake cylinder pipe connection and the lower one is the brake pipe connection.

It has been stated that there but one size of universal valve for all sizes of brake cylinders and that the flow of air for charging the reservoirs was primarily the same as all auxiliary reservoir volumes were the same regardless as to the size of the brake cylinder, however the flow of air to and from the brake cylin-



UNIVERSAL VALVE IN RELEASE AND CHARGING POSITION.

by a proper combinations of mechanism, to all conditions of passenger service.

We mention the foregoing so that our readers will understand that this type of brake was designed and manufactured to meet a condition on the Pennsylvania Railroad, and similar condition may or may not develop on other roads, but in the majority of cases certain ones are present even if not recognized.

In last month's issue the objects of the reservoirs used was explained and now the bracket which is a fixture on the car, contains two chambers, the quick action chamber and the quick action closing chamber their duties will be explained any part of the universal valve may be removed without disturbing any pipe joints.

It will be noted that there are 8 pipe connections or pipe taps used in the bracket, 5 one inch, 2 one-half inch and one ¾ inch, the latter leading to the auxiliary reservoir. The upper one of the one-half inch taps is for the pipe connection to the large emergency reservoir and the lower one is the brake cylinder exhaust port. One of the one inch tap holes is always plugged with the single brake cylinder per car and it is only used with two cylinder equipments, leading to the emergency brake cylinder. The upper ders is controlled by chokes in the passages in the bracket which is a fixture on the car and the sizes of the brass choke fittings correspond with the size of the brake cylinder. For 14, 16 and 18 inch brake cylinders the sizes of the opening through the choked fittings are 3/16, 15/64 and ¼ inches, respectively, for the service port chokes and the exhaust port chokes or the ones through brake cylinder pressure escaped to the atmosphere during a release of brakes are 17/64 inches for the 14 and 16 inch brake cylinders and there is no choke used with the 18 inch cylinder, the maximum size of cylinder and the exhaust port is wide open.

Before it will be possible for anyone to learn the operation of the universal valve it is necessary to learn the names of the principal parts of the valve, these parts are numbered on the sectional view and the names of the principal parts or of these that will be mentioned in the description are:

3. Equalizing slide valve.
4. Equalizing piston.
7. Equalizing graduating valve.
12. Service port check valve.
12 Emergency reservoir check valve.
12. Service reservoir check valve.
16. Release piston.
19. Release slide valve.
21. Release piston spring.
30 Graduated release piston.
32. Graduated release piston spring.
34. Charging valve.
76. Emergency piston.
78. Emergency slide valve.
80. Emergency graduating valve.
85. Quick action valve.
88. Quick action piston.
90. Quick action valve spring.
99. Quick action chamber charging port check valve.
111. Protection valve.
115. Protection valve spring.
117. Intercepting valve.
121. Intercepting valve spring.
123. High pressure valve.
128. High pressure valve spring.
134. Emergency piston stop.
135. Emergency piston stop spring.
141. Cut off valve.
146. Cut off valve spring.
149. Safety valve.

The U-12 universal valve consists of the following portions: (1) A three-face pipe bracket, designated as type C, to which are bolted the quick action and equalizing portions, the third face being covered by the blanking flange. The bracket is bolted to the underframing of the car, all pipe connections being made to it so that no pipe connections need be disturbed in the removal or replacement of any one of the operating portions of the Universal Valve. This bracket contains two chambers, the quick-action chamber and the quick-action closing chamber.

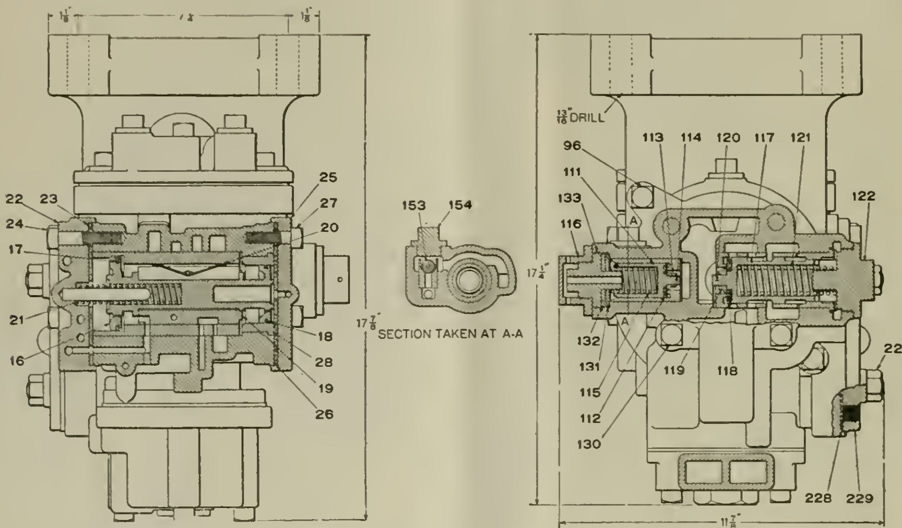
(2) *The Equalizing Portion*, which controls (either directly or indirectly through the medium of the other portions of the universal valve) the desired charging of the reservoirs, the applications of the brakes, whether in service or emergency, and the release of the brakes.

(3) *The Quick-Action Portion*, which includes the various parts controlling the quick action and high pressure functions.

These different portions contain parts which are as follows:

1. The *pipe bracket* contains the quick action and quick action closing chambers which supply pressure to control the emergency piston and open the quick action exhause in emergency applications. The quick action closing chamber also supplies the pressure to keep the quick action exhaust open.

2. The *equalizing portion* contains the equalizing piston which moves the equalizing graduating and slide valves when the brake pipe pressure is varied. The equalizing graduating valve which controls the flow of air (1) From the auxiliary reservoir to the resistance-increasing cavity through the equalizing slide valve to atmosphere. (2) From the auxiliary reservoir through the equalizing and release slide valves to atmosphere. (3) From the end chambers of the release piston through the equalizing slide valve to atmosphere. (4) From the auxiliary reservoir through the equalizing slide valve to the brake cylinder. The equalizing slide valve which controls the flow of air (1) From the auxiliary reservoir through the equalizing graduating valve and release slide valve to atmosphere. (2) From the end chambers of the release piston through the equalizing graduating valve to atmosphere. (3) From the auxiliary reservoir by the equalizing graduating valve to the brake cylinder. The equalizing stop and spring which forces the equalizing piston slightly away from the cylinder cap gasket following a service application and thereby causes the graduating valve to lap. Without the stop and spring, the seating of the equalizing piston against the gasket, especially when soft and flexible, might result in exposing a considerably larger piston area to the action of brake pipe pressure when the piston moves back to lap position than is exposed to brake pipe pressure when the movement away from application position first commenced in response to the slight differential between brake pipe and auxiliary reservoir pressure that must be obtained in order to cause the piston to move to lap position. The consequence of this is that the differential is suddenly allowed to act on the full area of the equalizing piston, which may be enough greater (depending upon the amount of contact between the piston and gasket) to result in the total pressure on the pis-



END VIEWS OF UNIVERSAL VALVE SHOWING RELEASE PISTON AND SLIDE VALVE, PROTECTION AND INTERCEPTING VALVES.

ton being slightly more than the resistance of the piston and slide valve, in which case the parts might move back to release position. In other words, this stop and spring are for the same purpose as has always been that of the graduating stop and spring. The service port check valve which prevents the flow of high pressure air from the brake cylinder to the equalizing piston chamber (auxiliary reservoir) during an emergency application. The emergency reservoir charging check valve which prevents the flow of air from the emerency reservoir to the brake pipe or the equalizing piston chamber during a service or emergency. application. The service reservoir check valve which prevents the flow of air from the auxiliary reservoir to the service reservoir. The graduated release piston which holds the equalizing slide valve in graduated release position when making a graduated release with the cap set for graduated release. The charging valve which provides for the recharging of the service reservoir without drawing any air from the brake pipe until all the brakes have been released. The release piston which is a differential piston which causes movement of the release slide valve. The release slide valve which controls the flow of air (1) From the large emergency reservoir through the charging valve to the service reservoir. (2) From the large emergency reservoir to the auxiliary reservoir (only with graduated release cap in graduated release position). (3) From the large emergency reservoir to the back of the high pressure valve. (4) From the back of the high pressure valve through the emergency slide valve to atmosphere. (5) From the auxiliary reservoir through the equalizing graduating and slide valves to atmosphere. (6) From the brake cylinder to atmosphere.

3. The *quick action portion* contains the quick action chamber charging check valve which prevents the flow of quick action chamber and quick action closing chamber air to the brake pipe during a service application. The emergency piston which removes the emergency graduating and slide valves when the brake pipe pressure is reduced at the proper rate. The emergency graduating valve which controls the flow of quick action and quick action closing chamber air through the emergency slide valve to atmosphere during service applications and controls the flow of air from these two chambers to the quick action piston in emergency. The emergency slide valve which controls the flow of air (1) From the back of the high pressure valve through the release slide valve to atmosphere (2) From the quick action chamber to the quick action closing chamber. (3) From the quick action, chamber to the quick action piston. (4) From the quick action closing chamber to the quick action piston. (5) From the quick action chamber through the emergency graduating valve to atmosphere. (6) From the top of high pressure valve and bottom of cut-off valve to atmosphere. (7) From the brake cylinder to the quick action chamber. The quick action valve and piston which vents brake pipe air to atmosphere during an emergency application.

4. The *high pressure cap* contains the protection valve which vents brake pipe to atmosphere, causing an emergency application when the brake pipe pressure has fallen to approximately 35 lbs. The emergency piston stop which increases the differential required to move the emergency piston from service to emergency position. The intercepting valve which, during an emergency application, causes the service reservoir to equalize with the brake cylinder and then cuts off the service reservoir and permits the small emergency reservoir air to equalize with the brake cylinder. The high pressure valve which separates the small emergency reservoir from the brake cylinder except in an emergency application. The safety valve which limits the service brake cylinder pressure. The cut-off valve which cuts off the safety valve from the brake cylinder during an emergency application. The emergency check valve prevents the sudden admission of air from the brake pipe to the emergency piston chamber but permits unrestricted flow of air from this chamber during emergency applications.

Blackening Brass Work.

The brass, which should be clean and free from grease, is simply dipped in a boiling solution of water 1 gallon, sugar of lead 8 ounces, hyposulphite of soda 8 ounces. The work is allowed to remain in the boiling solution until it turns first blue and then black, which will take about two minutes. The work should then be removed and well washed in hot water and dried. The deposit consists of sulphide of lead, and can be given a high lustre by being polished with a dry brush or a soft leather. An excellent lacquer is the ordinary French polish as sold at any oil shop. A thin coating should be put on when cold and then gently warmed, until the shellac melts and appears bright. The lacquer should be kept in a well-corked bottle when not being used, and applied with a good soft camel-hair brush.

Promoting Economy.

A considerable number of railway employes believe that the company for which they work has unlimited wealth, and they do not seem to realize that if the financial resources are large the expenditures are such as to leave only a small margin of profit. They feel justified in getting all they can out of the company and occasionally waste their time or throw into the scrap pile a tool that could be repaired at a slight cost. There is a wide opportunity for economy in bringing railway men generally and shop men particularly to realize that time and material which they can save have a direct and considerable bearing on the condition of the company's treasury. Probably the place for the most earnest efforts is in the apprentice school. Lessons early learned are more apt to be kept in mind, and a thorough process of education and enlightenment will result in an increase toward economy.

Changes in the American Locomotive Company.

The voluntary resignation of Mr. W. H. Marshall, president of the American Locomotive Company, and that of Mr. James McNaughton, vice-president in charge of the purchasing department, came as a surprise to the railroad world. The directors of the American Locomotive Company have elected Mr. Andrew Fletcher president, to succeed Mr. William H. Marshall. Mr. Fletcher has been a director and a member of the executive committee for several years. A successor to Mr. J. McNaughton, the vice-president, whose resignation was also accepted by the board, to take effect in February next, has not been selected.

Mr. Fletcher is president of the W. & A. Fletcher Company, manufacturers of marine engines, with a plant in Hoboken. The corporation is one of the oldest concerns of the kind in the country. He is a director of the William Cramp & Sons Ship and Engine Building Company, president of the Consolidated Iron Works and the North River Derrick Company, and besides being a director of these companies also, he is a director of the Hoboken Trust Company and the First National Bank of Hoboken.

Improvements on the Illinois Central.

Considerable improvements are being made in the Illinois Central at Louisville, Ky. The work includes a 17-state roundhouse with an 85-ft. turntable, to cost $56,000; a machine shop of brick and steel with tile roof, $20,000; a two-story lavatory building for enginemen and shopmen, $10,000; a one-story building of similar construction and purposes for car repairmen, $3,500; a paint shop and office for car repair foremen, $3,500; sanding facilities, including a sand drying house, a wet sand bin of nine carloads capacity and a dry sand bin of one carload capacity, $4,000, and a station and yard office building costing approximately $6,000.

In running a line of pipe in new work it is a wise thing to cut in a tee now and then and plug the outlet instead of using a coupling, as very likely a branch line will be wanted sooner or later. The extra expense is not great.

Electrical Department

Beginning a New Series of Articles—Explanation of Terms Used—The Production of Electricity—Conductors—Varied Resistance of Metals

With the opening of 1917 it is our purpose to conduct the Electrical Department on somewhat more extensive lines than formerly. We intend to begin with the explanation of a few fundamentals and pursue our investigations step by step with a view of the needs of our railway readers and men to whom the information we propose to give will be specially valuable. We will deal with the machinery used in the generation of electricity and in the locomotives used on the various railways in the country. We intend to go into the various methods of applying electrical force—direct and alternating current—phase cycle and other terms will be explained and concrete examples made plain by reference to existing installations. The department will, as in the past, be conducted by our associate editor, Mr. A. J. Manson, of the Westinghouse Electric and Manufacturing Company.

We are all more or less familiar with electricity. We know it rather by what it does than what it actually is. We see every day to what various uses it is being applied, and we have a general conception of the electrical units such as the volt, the ampere and the watt. The use of these words is so common that we frequently use them, and other electrical terms, without understanding fully what they actually mean and what they stand for. The purpose of this article is to explain the meaning of some of the various electrical terms, and to show what relation exists between them.

Electricity is the name which has been given to this invisible agent which produces certain effects. Although many of the effects produced by electricity are now well understood, still little is known of the precise nature of electricity itself. It is not matter, nor is it energy alone; yet it can be combined with matter, and energy can be expended to create and move it. Its greatest importance is due to the fact that the energy spent in generating electricity in one part of a system can be transformed into heat or light, or work at some other part of the system, and this transfer of energy may take place at great distances. Apparently electricity is indistrucible.

When we speak of electricity we usually think of it as connected with lights, or with power, as with something which is flowing through conducting wires. There are, however, several kinds of electricity. We have what is known as statical electricity and also magnetism—these two forms of electrical phenomena being known long before the current electricity.

Static electricity is produced by friction and remains upon the surface of bodies. If one takes a glass rod and rubs it with a piece of silk or flannel it will be found to have acquired a property which it did not previously possess, namely, the power of attracting to itself pieces of paper, light bodies, dust, etc. The glass is said to be charged with static electricity. The same condition exists if a stick of sealing wax is rubbed with flannel or woolen cloth or with fur. The quantity of electricity produced by friction is spoken of as a charge and a body when electrified is said to be charged. When the electricity is removed it is said to be discharged.

We know that certain materials are better suited for the passage of electric currents than others. To those bodies which readily allow electricity to flow through them or rather over their surfaces the term "conductors" is given. To those bodies which do not conduct electricity the term "insulators" is given. All of the metals are "conductors"—some are better than others. The human body is a conductor and so also is water. On the other hand, oil, glass, silk, shellac, mica, rubber, porcelain, micarta, etc., are "insulators." These substances are therefore used for supporting electrical apparatus and wires which carry electricity.

The ancients gave the name "magnet" to certain hard black stones, which possessed the property of attracting small pieces of iron. These stones were natural magnets or loadstones. It was later found that artificial magnets could be made from these natural ones. If a piece of iron was rubbed with one of these loadstones, it would acquire the same characteristics as the stone itself, and would attract small pieces of iron, and if hung on a thread, it would point north and south. It was found that there were two opposite kinds of magnetic poles; one was called the "North Pole" and the other the "South Pole." Between these two poles, it was discovered, there existed invisible "lines of force" forming what is known as a magnetic "field." Later experiments proved that the magnet and magnetic "field" could be produced by winding a coil of wire around an iron center and passing electricity through the wire. This is the method used to produce the "field" in the electric generators and motors of today.

We have mentioned above certain materials which are conductors of electricity and others which are non-conductors or insulators. The static electricity on a body will be conducted away if the body is touched by a conductor. If by any arrangement electricity could be supplied to the body as fast as it flowed away, a continuous current would be produced; that is, if the ends of the conductor were kept at different electric pressures or voltages. In like manner a current of heat will flow through a metal rod if the ends are kept at different temperatures, the flow being always from the higher temperature to the lower. Electricity flowing in a wire is analogous to water flowing in a pipe. In water pipes a difference of level produces a pressure, and the pressure produces a flow as soon as the faucet is turned. So it is with electricity—a difference of potential produces electric motive-force or voltage and the voltage sets up a current as soon as the circuit is closed. In the pipe we have a certain number of units—let us say, cubic inches—which are flowing at a certain rate per minute, and these units are at a certain pressure in pounds per square inch. In the wire carrying electricity, there is the unit of electricity, the ampere; the unit of quantity, the coulomb; and the unit of pressure, the volt. Increasing the pressure in the pipe increases the flow of water, so also increasing the voltage increases the current or amperes. The amount of water flowing depends also on the size of the pipe. With a small pipe (offering high resistance) the amount of water will be much less than with a larger pipe of lower resistance. With electricity, the amount passing through depends on the voltage and on the resistance of the conductor. With a constant pressure the quantity of electricity will be directly proportional to the resistance. The unit of resistance is designated as the ohm.

The ampere is the unit of electric current and, as we have seen, is analogous to the water flowing through the pipe. The unit of current or the ampere is defined in terms of the amount of silver which is deposited when electricity is passed through a nitrate of silver solution. To be exact, it is the amount of current which will deposit silver at the rate of 0.001118 of a gram per second, when flowing through a solution made up of 15 parts by weight of a neutral solution of silver nitrate and 85 parts of water. We may further explain that electricity is closely related with chemistry and can be generated by means of chemical action. Take, for instance, the so-called voltaic pile and the various cells. The voltaic pile is made by placing a pair of disks—one of zinc and one of copper—in contact with one another, then laying on the copper disk a piece of flannel or blotting paper moistened with brine, then placing a similar pair of disks, and so on through the series, each pair of disks in the pile being separated by a moist conductor.

Battery cells are made by placing two metals in a weak acid solution. For instance, zinc and copper in a solution of sulphuric acid, or zinc and carbon in a solution of salammoniac.

It is also possible to bring out chemical action by the passage of current through certain solutions. When electricity is passed through a solution of sulphate of copper or "blue vitroil," as it is usually called, the solution is split up. Metallic copper is picked up and carried forward by the current and deposited on one of the terminals in the solution. The amount of copper deposited is proportional to the amount of current passing through. One of the early forms of electric meters for house circuit was of this kind. The current taken by the lights in passing through the solution would deposit copper. The amount of this deposit in ounces was determined by weighing the terminal every month. From the increase in weight the amount of current was known and the consumer was billed accordingly. The same chemical action takes place when current is passed through the silver nitrate solution.

The quantity of electricity that passes through a circuit is comparable to the quantity of water in the pipe, and equals the product of the rate of flow and the time. The quantity of electricity conveyed by one ampere in one second is called one ampere-second, or one coulomb; that is, $Q = C \times t$, where Q is coulombs, C is current in amperes, and t is time in seconds. If five amperes is flowing then, after 45 seconds, $5 \times 45 = 225$ coulombs of electricity have passed.

The ohm is the unit of resistance. All substances offer some resistance to the passage of electricity through them. The value depends on the substance itself, on its length and on its cross section. The analogy between electricity and the water in a pipe will help us again. The amount of water which flows under a constant pressure depends on the resistance it meets with. If the pipe is small, long and full of bends, the water will run slowly through, whereas if it is straight and of short length the resistance to the flow will be less. If the metal wire is very small and of considerable length, only a very feeble current may flow even when considerable voltage or pressure has been applied. Different metals have different resistances. Copper is of very low resistance, while iron is of relatively high resistance. The resistance of all metals increases with an increase in temperature, while carbon and electrolytic solutions decrease with increased temperature.

The ohm is defined in terms of the resistance of a column of mercury. To be exact, one ohm is the resistance of a uniform column of mercury 106.3 centimeters long and 14.4521 grammes in mass at 0° C. A conductor has a resistance of one ohm when the pressure required to send one ampere through it is one volt. This brings us up to the definition of the volt.

The ampere, the ohm and the volt bear a certain relation to one another. The volt is the pressure which will drive one ampere through a resistance of one ohm. There is, however, a standard which determines the value of the volt directly—namely, the Clark Standard Cell at 15 degs. Cent. The voltage of this cell is 1.434 volts.

As the power obtained from the water in the pipe is equal to the product of the amount and the pressure, so with electricity the power is equal to the volts multiplied by the amperes. This power we call by the name watts. One ampere at one volt equals one watt. For instance, if we have 100 amperes at 10 volts, the power will be $10 \times 100 = 1{,}000$ watts or one kilowatt. (Kilo is a Greek word, and means one thousand.) There would still be the same power if 10 amperes at 100 volts were flowing, as the product is 1,000. If this current was flowing for, say, three hours the energy consumed would be three kilowatt hours.

Successful Hardening.

Uniform heating is essential for successful hardening; care should be exercised in the time allowed to bring the object to the right temperature, and every effort should be made to heat all parts of the object at the same rate. If the heating is unequal, stresses will be set up that may ultimately cause failure. In the case of large objects the heating of the interior lags behind that of the outside; when the outside of the object has attained the desired temperature it should not be allowed to exceed this point. The final approach to the hardening heat should be done slowly, so that the interior may reach the desired point without carrying the outside beyond that point. Until the object is uniformly heated throughout it will appear darker towards the center, as the heating proceeds the dark shadow gradually disappears, and when the object is uniformly heated throughout, the surface assumes an almost pellucid appearance.

Railroad Difficulties.

Transportation may be called a commodity, but it is not merchandise. What a railroad sells is a capacity to effect transportation; and what the public buys is the use of that capacity and not the means itself. All the money a railroad spends, whether for labor, capital, materials, intelligence, or terminal structures, is directly or indirectly for the purpose of producing train miles. All the money a railroad takes in is for passenger and ton miles. A railroad does not sell its trains; it sells only their capacity. What it gets from the passengers and tons occupying that capacity is out of its control entirely. Rates are made by state laws or by the Interstate Commerce Commission. Unable to control its income, the railroad has all the greater reason to look at the cost of its train miles, that is, to the control of its outgo. If it should lose control of its outgo, having already lost control of its income, it would obviously be in a parlous condition. But exactly that is taking place.

Westinghouse Air Brake and Union Switch Companies to Consolidate.

It is reported that at separate meetings of the directors of the Westinghouse Air Brake Company and the Union Switch and Signal Companies each board unanimously voted to consolidate these two important Westinghouse interests. It has not been decided when the stockholders will be called upon to act on the consolidation.

New Zealand Railways.

According to the railways statement made to parliament by the minister of railways there were on March 31, 1916, 2,970 miles of railway in New Zealand, against 2,955 miles at the end of the fiscal year ended with March 31, 1915.

American Locomotives in China.

The setting up of 400 locomotives of American make in the shops of the Chinese Eastern Railway at Harbin for the Russian Government served as a good advertisement for American machinery and led to inquiries and to the placing of many small orders that must have escaped the statistician. This sort of trade grows silently but effectively, and it produces large results if cultivated.

The Baker Locomotive Valve Gear

Two Separate Motions Combined—Objects of the Baker Design—Result of Test Made on the M. K. & T.

This valve gear is what is called an outside gear, and it is really compounded of two motions derived from different sources. In other words, the crank affixed to the main crank pin gives the principal motion to the valve, while that derived from the crosshead and combination lever moves the valve to a distance equal to the lead plus the lap.

Our main consideration, however, is not so much with the construction and operation of the gear, as with the fundamentals of the design and what it is intended to accomplish, and why it has a place among the locomotive valve gears at the present time. That it is a formidable rival of other valve gears is conceded by those interested in such matters.

The primary object of this valve gear is to provide a constant lead opening, to provide a full and rapid uncovering of the steam port at a time when a generous supply of steam is required—a supply that shall follow the retreating piston with a pressure undiminished by any of the "wire drawing" effects of restriced or obstructed passages, and to close the port opening promptly and effectively at the desired moment. Having done this, the whole gear, as a valve mechanism, has performed its function and has done all that is expected of it.

There are certain incidental advantages which go with the gear, and there are certain highly valuable by-products which are necessarily present with this gear, but the primary object of the valve-moving mechanism is to effect an efficient and clean-cut steam distribution.

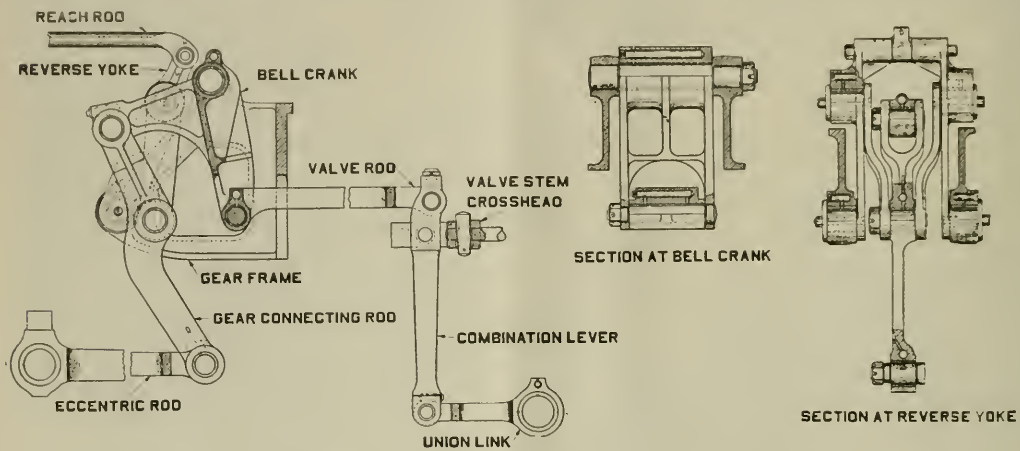
The movement of the valve is the result of, or rather the compounding of two separate and independent motions, each with its own function to perform and united only in their total result. The motion may, in a sense, be said to be the algebraic sum of two motions which essentially have nothing to do with one another.

The lead and the lap distance is produced by the motion of the locomotive cross-head back and forth, reduced by the motion of the combination lever which pivots on a point above the valve stem for inside admission, and below for outside admission, and placed at a particular distance from the valve stem cross-head. This distance is arranged so as to always give a motion equal to the lap, plus the lead, and this state of affairs is not altered by the fact that the pivot moves backward and forward, as actuated by the motion of the lower end of the bell-crank, which moves by connection with the main crank pin. The union link, combination lever and cross-head of the engine gives the valve its lap and lead motion, and the main crank pin, the eccentric crank, with its connections, supplies the valve gear its reversing movement and its variable cut-off motion.

The correct position of the eccentric pin determines the motion of the valve, so that it will give port opening at the proper end of the cylinder and at the right time, and also that it will close promptly. These two motions from the main pin eccentric and the locomotive cross-head are separate and distinct, but when combined, as they are in the Baker valve gear, they give highly satisfactory results.

The maintenance of the valve gear is rendered economical by reason of the large pins which can be used and these are possible because the levers and other parts have been reduced to a minimum of weight. The large pins have the effect of reducing the rapidity of the inevitable wear; they do not eliminate it, but this reduction of the rate of wear is undoubtedly beneficial in more ways than one. In order to bring this reduced wear, by reason of the large pins and light gear, to its very lowest terms, the moving parts are well lubricated, so that the whole mechanism is exceedingly efficient.

One of the fundamentals which must be borne in mind is that the Baker valve gear is not primarily intended to save coal or to reduce water consumption. It does both of these things, but they are rather in the nature of logical results, or if one may so say, these economies are something like the by-products of the gear, much as ordinary waste is a by-product of the cotton industry. The saving of coal and water which is effected as a by-product is largely due to the distribution of steam—so managed as to approximate to the theoretical. The constant lead makes the engine smart and capable of maintaining full capacity in the various kinds of service which it may be called upon to perform. To put it in other words: the engine in no case works against itself, as it might with large lead, by admitting steam a moment or so before



ESSENTIAL PARTS OF THE BAKER VALVE GEAR FOR LOCOMOTIVES.

it can possibly assist in making the piston move. Correctly designed and properly maintained valve gear distributes steam so that it will be applied only where and when it is wanted, and reaches the piston without loss or waste. Steam is as well and economically applied by this gear as water is by a man watering a lawn who sprays only the sod and prevents the water from reaching any of the gravel walks, or the sides of the green house.

Some months ago a road test and cylinder indication of engine No. 825, a 2-8-2 type, was made on the Missouri, Kansas & Texas Railroad, by Mr. W. L. Kellogg, superintendent of motive power, at Denison, Texas. This engine was fitted with a Baker valve gear, and its cylinders are 28 x 30 ins.; driving wheels, 61 ins. in diameter; weight on drivers, 233,500 lbs.; tractive power, 60,600 lbs.; factor of adhesion, 3.85; grate area, 62.7 sq. ft.; dual heating surface, 4,341 sq. ft.; superheating surface, 1,026 sq ft.; steam pressure, 185 lbs.; piston valves 14 ins. diameter, 7 ins. travel, 3-16 ins. lead; fuel, soft coal. The average amount of coal per scoop was about 12½ lbs. The trial took place between Denison and Muskogee, a distance of 159 miles. Twenty-eight single trips were made, or to put it another way, 14 round trips were completed. A few of the principal results of this test have been secured through the courtesy of Mr. Kellogg and are here appended for reference:

TRIAL OF M. K. & T. LOCOMOTIVE NO. 825 OR 2-8-2 TYPE AT DENISON, TEX.

Trip No.	Tonnage per 100 Ton Miles	No. of Stops	Running Time Term. to Term. Hrs.	Min.	Tons Coal Burned Term. to Term.	Kind of Coal	Total No. of Scoops	Average Steam Pressure—Lbs.	Gallons of Water Evaporated	Miles Run Per Ton of Coal	Pounds of Coal Per 100 Ton Miles	Pounds of Water Evaporated Per Lb. of Coal	Diameter of Nozzle Tip—Ins.
1	3,429.1	5	10	23	20.1	McAlester	2,235	175	23,566	7.1	11.7	4.8	6½
2	2,873	5	9	12	15.5	Illinois	1,780	170	19,319	10.2	10.08	5.1	6½
3	3,286.6	7	8	06	14.1	Lehigh McAlester	1,570	178	21,987	11.2	8.6	6.4	6¾
4	2,832.6	7	8	35	14.2	Illinois	1,625	175	22,226	11.2	10	6.5	6¾
5													
6	3,092.7	5	8	15	15.6	Illinois McAlester	1,300	180	23,967	10.2	10.08	6.4	6¾
7	3,590	8	10	00	21.9	Lehigh McAlester	2,360	160	26,681	7.2	12.2	5.07	6¾
8	3,324	8	9	15	14	Illinois McAlester	1,684	165	19,322	11.3	8.4	5.7	6¾
9	3,904	10	9	00	16.9	Lehigh McAlester	2,257	160	22,803	9.4	8.6	5.6	6½
10	3,131	10	8	55	15.2	Illinois McAlester	2,035	175	25,116	10.4	9.7	6.8	6½
11	3,518	4	8	30	12.3	Lehigh McAlester	1.628	180	19,786	13	6.9	6.7	6½
12	2,628	6	9	16	10.8	Higbee McAlester	1,400	183	18,358	14.7	8.2	7.08	6½
13	3,130	12	9	15	12	Lehigh McAlester	1,860	180	21,180	13.2	7.6	7.3	6½
14	3,219	6	9	13	10.9	Illinois McAlester	1,755	189	22,064	14.5	6.7	8.0	6½
15	3,387	8	9	00	13.1	Lehigh McAlester	1,881	183	22,016	12.1	7.7	7.0	6½
16	2,851	7	9	15	12	McAlester	1,550	175	19,869	13.2	8.4	7.0	6½
17	3,582	8	9	28	15.5	Mineral McAlester	2,036	178	25,414	10.2	8.6	6.8	6½
18	3,086	10	8	45	14.5	Mineral McAlester	1,942	182	25,682	10.9	9.4	7.4	6½
19	3,072.5	8	10	00	14.5	Lehigh McAlester	2,135	181	24,451	10.9	9.4	7.02	6½
20	3,437	7	9	00	11.4	Midland Valley McAlester	1,701	182	19,434	13.9	6.6	7.1	6½
21	3,005	11	8	43	12.4	Lehigh McAlester	1,555	180	23,062	12.8	8.4	7.7	6¼
22	3,171	17	13	48	13.3	Mineral McAlester Lehigh	1,669	180	24,841	12	8.3	7.7	6¼
23	2,510	7	7	37	12	Lehigh McAlester	1,330	180	19,149	13.2	9.5	6.6	6¼
24	3,165	10	8	33	14.6	Mineral McAlester	1,835	180	23,344	10.9	9.2	6.6	6¼
25	2,250	13	7	47	9.2	Lehigh McAlester	1,155	180	15,904	13.8	8.0	7.2	6¼
26	3,584	18	15	45	14	Mineral McAlester	1,735	180	23,536	11.3	7.8	7.0	6¼
27	2,815	12	7	40	12.8	Lehigh McAlester	1,708	180	17,890	12.4	9.1	6.0	6¼
28	2,825	9	7	16	11.4	Mineral McAlester	1,430	180	19,520	13.9	8.0	7.1	6¼

The necessity for making the working parts of the gear light, has been forced upon the attention of railroad men and the designers of valve gear; as engines themselves came to be built heavier with each successive installment. When heavy valve gear on large engines was worked at high speed it soon became apparent that a good deal of wear resulted and derangement frequently took place, and many breakages and other failures could be traced to this very objectionable cause.

In order to avoid what could be avoided, valve gear was, wherever possible, reduced in weight and alloy steel, having enduring qualities, was substituted for the heavy eccentrics, huge rockers and other parts of the Stephenson motion. In order to carry out this substitution properly, the Dynamic Augument, as it is called, was studied by those having to do with valve gear.

This scientific term, more or less formidable in appearance, is not so terrifying when properly understood. The "augment," as far as it applies to valve gear, is not essentially different from the same term applied to counterbalancing. It may in general be defined as, the tendency of reciprocating parts, when once they have been set in motion, to keep on moving; and this necessarily requires a force to stop them and to reverse their motion.

It is, therefore, easy to see that the lighter the static weight of any part of the gear can be made, the less the dynamic augument will be for a given speed, and the less wear and the less possibility of derangement that will exist. In these particulars the Baker valve gear possesses excellent features.

It is needless to point out the mechanical features of the Baker gear; suffice it to say that the eccentric crank is set at 90 degs. to the center line of the eccentric rod. It always follows the main pin in forward motion. The lead is constant, but the pre-admission is variable. In full cut-off there is practically no pre-admission, but at 25 per cent. cut-off there is about ⅞ inches pre-admission.

The efficacy of good valve gear consists in doing the right thing at the right time. If a golfer hits his ball squarely he can knock it off the tee without disturbing the earth and his "drive" will be strong and free. If, however, he uses part of the power of the stroke to destroy the tee and grub up the earth, his ball will fall short of the otherwise normal distance. In like manner if the valve gear delivers steam to the piston at the right time and in the required quantity and ceases to flow in at the proper instant, the driving force of the stroke, that is derived from the steam, will be full, free and normal.

Continued Electrification on the Chicago, Milwaukee & St. Paul.

An addition of 76 miles was made in the electrification of the Chicago, Milwaukee & St. Paul, completing the electrification from Harlowton, Mont., to East Portal, at the east end of the St. Paul Pass tunnel, a total distance of 406 miles. A length of only 34 miles remains to be electrified, which includes 1.7 miles through the tunnel. The lining of the tunnel with concrete has been completed, and the bonding of rails and the construction of trolleys are under way.

Comparative Compressed Air Consumption of the Empty and Load and the Single Capacity Brake

By WALTER V. TURNER, Assistant Manager Westinghouse Air Brake Co.

It will of course be understood that the design of an empty and load brake would be a comparatively simple proposition if it were possible to use two complete brake equipments for a car, one for the operation of brakes when the car is empty and both when the car is heavily loaded, but this is entirely impracticable because of the fact that the volume of compressed air now to be handled during a brake operation is excessive and effectually prevents the attainment of uniformity in brake operation, in fact the time element incident to the transmission of the compressed air through large brake pipe volumes is now the insurmountable obstacle preventing the uniform operation of freight car brakes and will no doubt continue as such until electric current is used for the transmission of the operators' intent.

As to the comparative volumes of compressed air required for the operation of two brake cylinders per car with the empty and load brake, and where the two cylinders are of the same diameter, the volume of air required for a certain brake pipe reduction is, roughly, 1½/8 or 19 per cent. more for the two cylinders than for the standard single cylinder brake, instead of 100 per cent. more as would ordinarily be expected with the use of two cylinders as compared with one. A more accurate estimate or analysis of the relative volumes of air required may be made by considering the auxiliary, load reservoir and brake pipe volumes per car. Adding an average brake pipe volume per car of 800 cubic inches, to the auxiliary reservoir volume of 2450 cubic inches, for a 10 inch equipment, the result is a total of 3250 cubic inches for the single capacity brake. The empty and load brake adds a load reservoir volume of 525 cubic inches to this to care for the load cylinder when it is being operated making an addition of 525/3250 or 17 per cent. increase in volume, or in other words, for the same brake pipe reduction, the empty and load brake uses 17 per cent. more air than the single capacity brake, instead of 100 per cent. more if two complete brake equipments were used to produce the same results.

As the empty brake cylinder takes up all of the shoe clearance and slack in the brake rigging, a high leverage ratio may be used for the load cylinder without any evil effects of high leverage on the single capacity brake or on the empty cylinder. If the empty cylinder has a leverage ratio of 9 to 1 and the load cylinder force in multiplied 1½ times by the time it comes to the empty cylinder push rod, the final leverage multiplication for the load cylinder is 1½x9 or 13½, and thus, if the empty cylinder is responsible for 16 per cent. breaking ratio with the loaded car, to the load cylinder is due, 1½x16 per cent. or 24 per cent. braking ratio, and the total for both is 40 per cent. This is accomplished by the use of a special clutch with a notched push rod for the load cylinder and explains briefly why the remarkably low air consumption is possible for the empty and load brake.

For the same brake cylinder pressure the comparative effectiveness of the two brakes is proportional to their respective braking ratios. For fully loaded cars having a load ratio of 3.75 to 1, the empty and load brake is 40/16 or 2½ times as effective as the single capacity brake, the cylinder pressure being the same in each case. The standard, 10-20 lb. retaining valve is furnished with the empty and load brake, and is rarely if ever used, in any but the 10 lb. position. The 20 lb. position is provided for use with the loaded car when the load brake is not cut into operation due to the presence of too few empty and load brakes in the train, operation over a foreign road, etc. To retain a pressure as effective for the single capacity brake as is the 10 pounds retained for the empty and load brake, it would be necessary to employ a $2\frac{1}{2} \times 10 = 25$-pound retainer. Similarly, the average brake of cylinder pressure—by which is meant the mean between the average maximum (resulting from the average brake pipe reduction) and the average minimum (the retained pressure, when the retainer is used)—must be for the single capacity brake 2½ times that for the empty and load brake. This average, in the following comparison, is taken as the arithmetical mean between the average maximum and the retained brake cylinder pressures, for the same brake operation cycle will be assumed for each type of brake and one so divided between the application and release phases that the "arithmetical mean" assumption will be the correct one.

Assuming an average cylinder pressure for the empty and load brake of 20 pounds, the average maximum will be 30 pounds in order that $(30+10)/2$ should equal 20 pounds. The average brake pipe reduction required to give 30 pounds cylinder pressure on 10 pounds retained pressure is 6½ pounds. This is equivalent in air consumption to a $1.17 \times 6.5 = 7.6$ pounds reduction for the single capacity brake.

The average cylinder pressure for the single capacity brake to be of equal effectiveness must be $2\frac{1}{2} \times 20 = 50$ pounds. The average maximum must then be 75 pounds in order that $(75+25)/2$ should equal 50 pounds. The average brake pipe reduction required to give 75 pounds on 25 pounds retained pressure is 15.7 pounds The comparative air consumption is therefore $7.6/15.7 = .485$. That is, the empty and load brake, in doing the same work, requires only 48.5 per cent. or, in round numbers, 50 per cent. of the air required by the single capacity brake.

But this is not all. Leakage has been neglected for the reason that it is something difficult of computation, but when it is considered that the brake cylinder pressures are in every instance 2½ times higher with the single capacity brake than with the empty and load the leakage must be at least twice as great for the former.

The question of brake reserve is even more important. In order to get a 75-pound cylinder pressure with a 15.7-pound reduction, it is necessary that the brake pipe pressure carried be at least $75 + 15.7 = 90.7$ pounds. This would provide no margin or reserve whatever. Equalization from 100 pounds brake pipe would be had on 25 pounds retained pressure with an 18-pound reduction. The margin in this case would be $(18 - 15.7)/15.7 = 14.7\%$. That is to say, the reserve braking force for stops and other emergencies is only 15 per cent. of the maximum used in controlling the train down the grade. With the empty and load brake, on the other hand, a 14.5-pound reduction from 70 pounds brake pipe (instead of 100 pounds) gives equalization on 10 pounds retained pressure and the flexibility or reserve is $(14.5-6.5)/6.5 = 123\%$. If a 90-pound brake pipe pressure is carried, the reserve is $(19.5-6.5)/6.5 = 200\%$. Quite a difference when it is necessary to stop in a hurry, 200 per cent. as compared with 15 per cent. It is a serious difference when the tax on the skill and nerve of the man "dropping" the train is considered!

It is true that the retainer pressure may be boosted with the single capacity brake to 30 pounds, or even 50 pounds, which is done, as a matter of fact, on one road. But while this reduces in a measure the air consumption and increases the reserve braking force, as above figured, by reducing the average brake pipe reduction required, it decreases the brake flexibility in rendering a train more liable to stall. The difference between the average maximum and average minimum cylinder pressures is much reduced, giving a smaller range of braking force to be used by the engineer in making allowances for curves, changes in grade, etc. Therefore, the comparison was made with the release flexibility, or flexibility depending upon the retainer pressure, the same for both types of brake. If the braking reserve is bettered by increasing the retainer pressure, the flexibility is impaired.

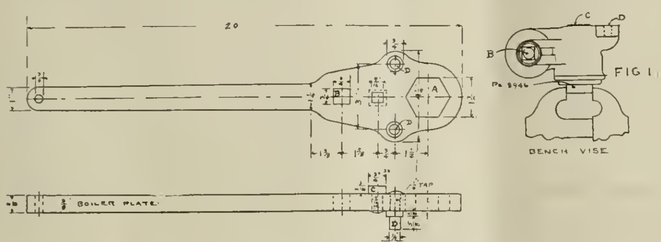
The superior air consumption performance and reserve braking force of the empty and load brake may be utilized in several ways. The speed of trains down grades may be increased, the speed restriction or limitation now passing from the brake to the question of wheel temperatures. The length of trains and the loading of cars may be increased or all these increases made and still leave the reserve in air supply and braking force comfortably great, and remember that this means increased traffic capacity, reduced unit costs and correspondingly increased net revenue.

Set of Tools for Air Brake Repair Work Devised and Applied to Every Requirement

By GEORGE K. DORWART, Denver, Colo.

The importance of the air brake in modern transportation is such that a complete knowledge of the most minute details of the device and all that relates to it is of estimable value not only to those in charge of its operation, but particularly to those who are engaged in the repair work incident to the rapid deterioration of the numerous parts that make up the complex device. That many skilled mechanics have labored under the disadvantage of a lack of proper tools is well known, and it is towards remedying this defect that Railway and Locomotive Engineering has secured the services of a leading air brake expert who with years of experience and opportunities for devising a full set of tools calculated to meet every requirement, has prepared drawings which embody the result of his work in this direction. It will have been observed that much space has already been given to this subject, and many clever devices invented by ingenious mechanics have been described and illustrated and have been warmly appreciated by the readers of Railway and Locomotive Engineering, but it is in the hope of covering the entire subject that this series of articles has been begun, and towards this end it will be carried on.

The descriptive matter will necessarily be brief, as the drawings themselves convey the complete details of each particular tool and the use to which it may be put will immediately be evident to the skilled mechanic. It may be added that while many of the devices are much superior both in their design and the uses to which they may be put than many patented articles, there is no proprietary right claimed to their manufacture, and any mechanic who finds the material and time can readily equip himself with a complete set of these tools, and in doing so will greatly enhance his own value as an air brake expert.



TOOL FOR TAKING APART THE FEED VALVE.

No. 1. Taking Apart the Feed Valve.

The feed valve, as shown in Fig. 1, is placed in an ordinary bench vise clamping nut as is indicated, Pc. No. 8946.

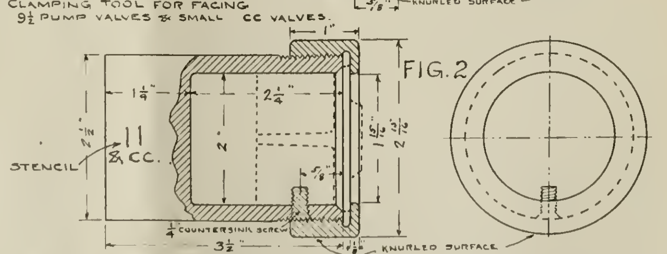
Referring to parts of wrench as lettered, they engage the following parts of feed valves: A for turning spring box, Hex. Pc. 1062. B for turning regulating valve cap nut, Pc. 6905. C for turning flush nut, Pc. No 18458. D for engaging bracket bolt holes to turn body for removing cap nut, Pc. 8946.

Thus the entire valve may be taken apart with a single tool in a very short time.

No. 2. Clamping Tools for Facing Air Pump Valves.

Fig. 1 holds 9½ ins. and small cross compound pump valves. Fig. 2 holds 11 ins. large cross compound pump valves. The shank of Fig. 1 is inserted in lathe spindle and the base of Fig. 2 is to be held in self-centering lathe chuck. The valves can be held securely by tightening the knurled clamp nuts by hand. The ¼ in. countersunk screw comes in contact with one of the valve wings, preventing valve from turning.

DOTTED LINES SHOW VALVE CLAMPED IN POSITION FOR FACING.

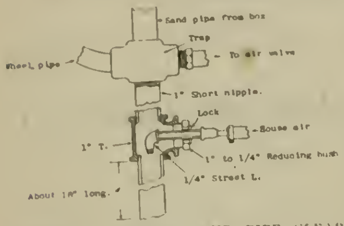


SECTION VIEW OF CLAMPING TOOLS FOR FACING AIR PUMP VALVES

Clearing Sand Pipes and Testing Injectors

By F. W. BENTLEY, Missouri Valley, Iowa.

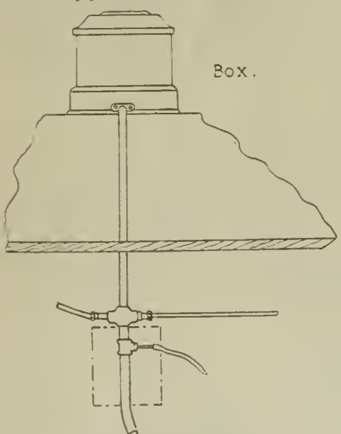
Air sanding arrangements with the trap located below the runboard are frequently the cause of not a little trouble, because



SECTION VIEW OF SAND PIPE CLEARING DEVICE.

of the sand in the long drop or fall pipe from the box becoming damp, sometimes as far upwards as the box, with the result that the sand will not run freely, if at all. It is often a tedious job to clear the pipe with a piece of wire or anything that can be used for the purpose, and it is sometimes necessary to disconnect the pipe at the box when the sand has been dampened or clogged to such an extent that its release is difficult.

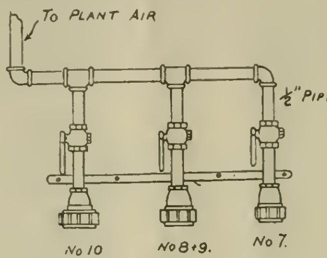
The accompanying sketches show a very handy and easily constructed device that can be attached to the trap below, and by means of the house air the pipes can be quickly cleaned of all moist sand or other obstruction. The appliance is constructed out of pipe fittings on the siphon prin-



VIEW OF JIG AS APPLIED TO 1-IN PLUG HOLE IN BOTTOM OF TRAP.

ciple, and is very powerful, and by simply plugging up the wheel pipe will instantly draw everything free in any long drop pipe from the sand box. It is quickly applied and does away with the tapping of pipes and disconnecting of parts to loosen the damp or hardened sand. During recent wet weather the device made short work of our sand pipe troubles.

Still I add another convenient device recently applied in connection with the testing of injector bodies and reground seats, which is the most important feature of overhauling these parts. The annexed sketch shows a simple arrangement for this purpose which can be located near the injector bench. Connected to the same air pressure lead the different sized nuts take the various sized injector body steam connections. Placed close to the vise, the injectors are readily swung out of the same to the rack and tested out. The ease with which this part of the work can be done cannot fail to make the device fully appreciated.



INJECTOR TESTING DEVICE.

Locomotive Maintenance.

By F. A. Whitaker.

The above topic is one that everyone connected with the mechanical side of railroading is very much interested in, and one that is not given the attention it ought to have. As every one knows, or should know, a locomotive is one of the principal sources of revenue of a railroad, and when it is tied up for repairs it means a decrease in the earning powers of the railroad. The majority of our railroads in the past, whenever a reduction was to be made in operating expenses, cut the mechanical department, and the reason for this is that other departments automatically cut themselves with the decrease in business, and this is why engines are tied up for repairs when business is heavy and power is needed. The practice on a good many roads is to give the mechanical department a good allotment for maintenance of engines when business is good, and when business is dull, shut down all but actual running repairs. When necessity forces a company to take engines in the shop during heavy business they spend two dollars to do a dollar's worth of work. To my mind the mechanical department should have a sufficient appropriation every month so that it could maintain the same force all the year round and maintain the power in the same shape all the time.

Any mechanical man knows that when you run an engine until it forces itself into the shop you have extra work to do that you wouldn't have had if engine had been stopped when she showed signs of being run down. To cite a small instance, take driving tires; when tires are allowed to run the limit in regard to tread worn and sharp flanges; this means having to turn off a considerable amount more to get the flange up again besides reducing the mileage of the tires, also boxes allowed to run when pounding badly, you take the risk of broken frames and rods. All this, by shopping your engines periodically, could be avoided and leaves more money to spend in more profitable work. As everyone knows, money spent on running repairs to an engine after the engine has reached a certain condition, is money wasted, as most of the work is temporary and cannot be guaranteed against engine failure. If the work on engines is done regularly, not spasmodically, it gives the mechanical man a better chance to always have his engines in good shape; as the old saying, "A stitch in time saves nine," is a good thing to apply to engines.

I have seen shops that if they were worked regularly all the year round could have turned out more engines in the year than they did for the amount of money expended, but on account of working more floor force than they had machines for in the three or four months that the allowance was high, spent two dollars to do a dollar's worth of work. This could have been avoided by working only enough men on floor that machines could take care of and dividing the allowance up into 12 regular periods. This policy of either a feast or a famine is an expensive one to the railroads. I have seen shopmen make $120 to $140 a month for two or three months in a year and the balance of the year $60 to $70, and when you take into account that when men are making anything over $90 the rest is overtime at time and a half, that means a dollar and a half for a dollar's worth of work, and invariably more than that, as when a man is worked a day, his capacity decreases the longer he works. Let us hope that some of our executives when they are making the appropriations for the mechanical departments will look ahead far enough and see that we have a regular appropriation every month. I believe the engines will be in better shape and we will have a better organization and more work turned out in the year than when we had the fat months and then the lean.

Railways in Ceylon.

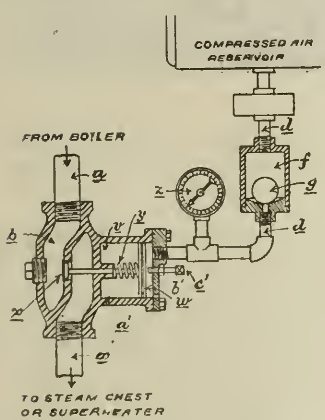
From the latest statistics it appears that the length of railway open for traffic in Ceylon at the close of September, 1915, was 692½ miles as against 672 miles at the corresponding period of 1914. The increase was due to the opening of a section of a line to Chilaw. In the course of 1914-15, rolling stock was increased by 18 new passenger and 86 new goods vehicles.

The Zerbe Automatic Drifting Device.

By C. L. Zerbe, Acting Road Foreman of Engines, Central Vermont R. R., Saint Albans, Vermont.

Since the introduction of the superheater, there has been constant desire to secure an automatic drifting device that will supply steam to valves and cylinders when the locomotive is drifting, and shut off when the engine stops. In the accompanying drawing it will be observed that there is a ball in a supplemental valve. The action is automatic. It does not require any opening or closing of valve before starting and after returning. There is no steam escaping at cylinder cocks or relief valve while engine is standing around stations or other places where it is necessary to stop obscuring the vision of the enginemen and carrying off oil intended for lubrication. It opens when the locomotive gets in motion and closes when it stops, and there is no steam in valve chambers when engine is standing to cause engine to reverse hard.

It will be noted that the supplemental valve is placed in the pipe line at a point in the cab where the air gauge can be easily seen by the enginemen. Steam being turned on from the boiler never need be shut off unless it is necessary to make repairs, as the supplemental valve controls the steam that goes through the pipe line to the header. The air pipe connection to the head of the supplemental valve



SECTION VIEW OF ZERBE AUTOMATIC DRIFTING DEVICE.

cylinder has a ball valve in the pipe, and an air gauge connected. The ball valve case is connected to main reservoir, and receives air at reduced pressure. When a locomotive is standing the ball is on its seat, and allows no air to pass. When the locomotive moves the swaying and jarring unseats the ball causing it to roll about in the chamber, allowing air to pass through the pipe continuously to the air piston, which is connected to a disc valve, and the latter is held open against boiler pressure while the engine is moving, allowing steam to pass through the pipe line to the header.

When the locomotive stops, the ball valve seats itself, cutting off the flow of air to the air cylinders of the supplemental valve. A small vent port allows the air to escape. The coiled spring around the piston stem, and steam acting in the disc will close the same cutting off steam through the pipe line. In the event of the throttle valve connections becoming disconnected while the valve is closed, there is a set screw in the cylinder head of the supplemental valve that can be turned in and hold the valve off its seat, destroying the automatic feature of the device. Then the flow of steam can be controlled by the admission valve, and an engine can be brought to terminal under its own steam.

The reducing valve connected to the independent brake in the E. T. equipment, or signal line can be used to supply air to the device thereby eliminating the use of an additional feed valve. The air connection could also connect to the trainline in passenger service and in case an emergency arose where it was necessary to make an emergency application of the brakes, and deplete the trainline, air would be drawn from the ball valve also and allowing the air to escape from the supplemental valve cylinder causing all steam to be cut off from the header.

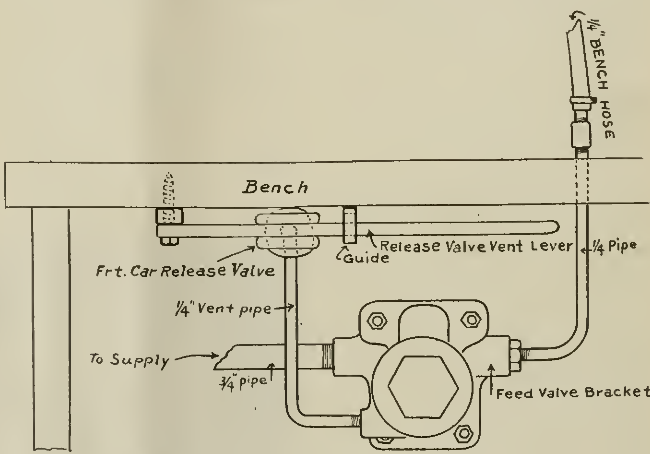
The Central Vermont Railway have several of these devices in use on their freight and passenger engines, and they are meeting all the requirements expected of them.

It should be remembered that the areas of pipes vary as the squares of their diameters—that is, a 2-inch pipe has four times the area of a 1-inch pipe.

Bench Hose Venting Device.

By J. A. Jesson, Louisville & Nashville Railroad, Corbin, Ky.

The accompanying diagrammatic illustration shows the details of an automatic air blast, adapted for attachment to the shop bench. It consists of a discarded feed valve, a feed valve bracket, and a



DETAILS OF BENCH HOSE VENTING DEVICE.

freight car release valve with a specially attached handle. The feed valve may be easily fastened to any suitable location on the bench, the release valve and its accompanying handle being located at the outer edge of the bench and parallel to the side of the bench. A slight pressure applied by the hand or leg of the operator on the release valve handle admits the air from the piston chamber of the feed valve, which operates the valve in the usual manner. The drawing shows the regulating portion cut off and tapped, and while this is not absolutely necessary it simplifies matters considerably in the operation.

Air Brake Cylinder Pressures.

By W. D. Scott, Fort Worth, Texas.

In the course of your able articles on air brake subjects, it would be gratifying if more attention were given to the brake cylinder. I have been in two instruction cars within the last five months and both instructors complained of a lack of interest in air brakes by the men. I said to both of them that the men had heard too much about ports and passages. I advised them to switch off to brake cylinder pressures and difference in braking power, also call in the officials and car men, giving both classes about four lecture per day on the great benefit of equal cylinder pressures. It would be instructive and, I am sure, interesting to hear from Mr. Turner on the subject.

Locomotive Superheaters.

By W. R. Davis, Columbus, Ohio.

The excellent article on Superheater Performance on Locomotives recently published in Railway and Locomotive Engineering is very interesting, and all employees in the mechanical department should be familiar with the details of the appliance in order to carry out the inventor's plans to obtain the best results. Too much cannot be said on this subect in the way of educating those working with superheater locomotives. All the early troubles have now been solved, and the superheater has come to stay, and it is a very satisfactory device when properly handled and maintained.

The fact that there is an average saving of about 30 per cent. in the use of coal and water, is now beyond controversy, but to my mind the most important fact is that it has overcome steam failures on locomotives. This is not only a real gain to those who invest their money in railroads, but particularly to the locomotive engineer in lessening his troubles and answering correspondence as to why his engine failed, and therefore it is well to become familiar with the apparatus in order that one may be able to make an intelligent report in case of failure, as well as to obtain the best results from its use.

As is well known the application of a superheater is placing an additional generator or auxiliary boiler on the locomotive, in order to have all the water out of the steam, which could not be done while the steam was so closely associated with the water in the boiler, so superheater units were placed in the large flues in order to transfer the steam from the boiler through these units before it reaches the cylinders, thus absorbing the heat that would otherwise largely be lost, but which, thus utilized, increases the temperature of the steam from 250 to 300 degrees above its heat when leaving the boiler. This added heat permits a greater expansion of the steam, so that it can be used economically in the cylinders, which admits of equal efficiency with a shorter cut-off of the valve opening after the train had attained speed. Engineering authorities show that we do not derive any more tractive effort from an engine on account of the application of the superheater. In actual experience, however, we find that an engine using superheated steam, with no other changes to overcare the tractive effort, is able to handle from 300 to 400 tons additional over the same kind of engine using saturated steam. Furthermore, the size of the cylinders may be advantageously increased from one to two inches in diameter, which will still further considerably increase the tractive power. The locomotive can also be worked harder, increasing the horse power, and still have a liberal margin to go on without failing for steam.

In our own experience engine No. 999, when using saturated steam, hauled 3,500 tons over a ruling grade of a division, with 200 pounds of steam pressure, full stroked, starting at the foot of the grade from a standstill, and was barely able to haul nine trains out of ten over the hill, but when this same engine was taken into the shop and converted to a superheater engine, it was able to take ten trains consisting of 3,800 and 3,900 tons, over the same hill, working in full stroke, with boiler steam pressure at 185 ponds.

In applying the superheater, there is apt to be a mistaken impression that is all that is necessary, but it should be remembered that its benefits and efficiency can only be maintained by proper handling, by seeing that the superheater unit flues are properly cleaned, to note that the water in the boiler is not carried so high that there is a possibility of spray overflowing into the superheater units which nullifies the use of the superheater, and converts it into an auxiliary boiler. Also, before starting the train, especially in cold weather, the cylinders should be heated by opening the throttle and working the condensation out of the cylinders, so as to obtain the full effect of the device.

In may cases no attention is paid to the exhaust nozzle. It is allowed to corrode and not being cleaned out from one shopping to another has the effect of increasing the back pressure in the cylinders, and consequently, causes the burning of more coal than would be the case if the nozzle were given the proper attention. In short, if all concerned would take as much care of the superheater units, flues and nozzle as they should do to keep them in proper condition, the same amount of effective work would be derived from the engine on the last day same as on the first day out of the shop.

In conclusion it will be admitted that unless a pyrometer is applied to reach engine, the engineer and firemen are unable to determine the exact amount of superheat obtained, and as this appliance is an added cost at first, our experience shows that if the superheater apparatus is kept in good condition at all times and free from cinders in the superheater tubes, so that all of the units are exposed to the heat of the firebox, and the units are kept free from leaks, and the nozzle kept clean, we will obtain the efficiency from the superheater at all times, whether the crew are familiar with the degree of superheat or not, as they can easily tell whether the superheater is working properly by the action of the locomotive and the amount of fuel and water consumed.

METHOD OF REMOVING AND SUSPENDING A CYLINDER HEAD.

Cylinder Head Manipulation.

By John F. Long, General Foreman St. Louis & San Francisco Railway, Springfield, Mo.

The heavier the locomotives become the heavier the cylinder heads are, and especially when heated to any extent it is no easy matter to remove them or place place them in position without some assistance. The attached photograph shows a roundhouse kink which overcomes the difficulty at little cost. By means of a stud nut one stud is removed from the cylinder at the top and a treaded rod as shown in the illustration is screwed into the hole. After the nuts are removed from the other studs holding the cylinder head in place, the head may be readily slid off on the rod to a convenient distance and allowed to remain suspended on the rod until replacement. This not only saves some hard lifting, but is quicker and safer.

"Let him who has bestowed a benefit be silent; let him who has received it tell of it."

Items of Personal Interest

Mr. Thos. Carr has been appointed traveling fireman on the Chicago & Alton, with headquarters at Bloomington, Ill.

Mr. C. B. Porter has been appointed purchasing agent and general storekeeper of the International & Great Northern, succeeding Mr. J. O. Griffin.

Mr. R. B. Marchant, formerly treasurer of J. G. White & Company, New York, has been elected vice-president of the corporation by the Board of Directors.

Mr. Edward L. Pollock, People's Gas Building, Chicago, Ill., has been appointed Western representative of the Wilson Welder & Metals Company, New York.

Mr. Frank S. Bogan, formerly assistant car foreman of the Illinois Central, has been appointed general car foreman on the same road, with office at Clinton, Ill.

Mr. H. D. Ponton has been appointed assistant general storekeeper of the Southern Pacific, Texas and Louisiana Lines, with headquarters at Houston, Tex.

Mr. James Porteous, formerly car inspector for the Grand Trunk Pacific at Smithers, B. C., has been appointed car foreman at that place, succeeding Mr. F. E. Dymond.

Mr. W. J. Deneen has been appointed chief dispatcher of the St. Louis, Brownsville & Mexico, with headquarters at Kingsville, Tex., succeeding Mr. O. O. Hollingsworth.

Mr. Charles Leat has been appointed road foreman of engines on the Atchison, Topeka & Santa Fe, eastern division, with office at Argentina, Kas., succeeding Mr. A. F. Bauer.

Mr. W. R. Culver, formerly storekeeper of the Pere Marquette, at Grand Rapids, Mich., has been appointed general storekeeper of the same road, with office at Saginaw, Mich.

Mr. A. C. Everham, formerly engineer of construction for the Kansas City Bridge Company, has been appointed terminal engineer of the Union Pacific, with office at Kansas City, Mo.

Mr. E. L. Cruger, formerly assistant engineer of the Illinois Central at Chicago, Ill., has been appointed district engineer, with office at New Orleans, La., succeeding Mr. C. F. Weaver.

Mr. W. A. Carter, formerly passenger car foreman of the Illinois Central, has been appointed steam heat and air-brake inspector of the Southern line of the same road, with office at Memphis, Tenn.

Mr. William B. Smith has been appointed road foreman of engines on the Boston division of the Boston & Albany, with office at Beacon Park yard, Allston, Mass., succeeding Mr. F. A. Hussey.

Mr. J. P. Harrison, formerly assistant purchasing agent of the Louisville & Nashville, at Louisville, Ky., has been appointed purchasing agent on the same road, succeeding Mr. P. P. Hurton, retired.

Mr. Samuel T. Armstrong, formerly division master mechanic of the International & Great Northern, has been appointed superintendent of motive power of the same road, succeeding Mr. C. W. Taylor, resigned.

Mr. John Birse, formerly road foreman of locomotives of the Canadian Government Railways at Graham, Ont., has been appointed district master mechanic, district No. 3, with office at Transcona, succeeding Mr. H. G. Reid.

Mr. Harvey Rhoads has been appointed roundhouse foreman on the Louisville & Nashville, with office at Covington, Ky., succeeding Mr. J. E. Mayhall, assigned to other duties, and Mr. H. C. Jones has been appointed night roundhouse foreman, also at Covington.

Mr. F. A. Purdy, general Canadian representative of the Chicago Car Heating Company, Montreal, has also been appointed direct representative of the United States Light & Heat Corporation to the railroads of Canada, with office at 61 Dalhousie street, Montreal.

Mr. C. W. Taylor, formerly superintendent of motive power on the International & Great Northern, at Palestine, Tex., has been appointed superintendent of motive power of the Missouri, Kansas & Texas, with office at Denison, Tex., succeeding Mr. W. J. Kellogg, resigned.

Mr. William J. Tyers has been appointed supervisor of bridges and buildings, Belleville division of the Grand Trunk, with office at Belleville, Ont., succeeding Mr. J. McMahon, deceased, and Mr. J. Phelan has been appointed supervisor of bridges and buildings, with office at Montreal, Que., succeeding Mr. Tyers.

Mr. Ellis Corey, chairman of the Midvale Steel & Ordnance Company, has been elected a director of the Baldwin Locomotive Works. Other new directors are Mr. Sidney F. Hutchinson and Mr. S. F. Tyler, of Philadelphia. The new directors take the place of Mr. E. T. Stotesbury, Mr. T. De Witt Cuyler, and Mr. John G. Shedd, retired.

Mr. George McCormick, formerly assistant general manager, mechanical, of the Southern Pacific Texas lines, with office at Houston, Tex., has been appointed general superintendent of motive power of the Southern Pacific, with headquarters at San Francisco, Cal. Mr. McCormick is a native of Texas, a mechanical engineer and a railway man of wide experience

Mr William Barlow Ross, formerly secretary and assistant treasurer of Mudge & Company, manufacturers of railway specialties, Chicago, has been elected secretary and assistant treasurer of the Safety First Manufacturing Company, selling agents for railway supplies, with the same offices. Mr. Ross has had wide experience among the Western railways.

Mr. H. G. Reid, formerly master mechanic, district No. 3, transcontinental division of the Canadian Government Railways at Transcona, Man., has been appointed superintendent of rolling stock, with headquarters at Transcona. Mr. Reid has had over thirty years' experience in the mechanical department of the Canadian Pacific railway, and is from Pembroke, Ont.

Mr. Hugh E. Creer, formerly sales agent of the Union Railway Equipment Company, Chicago, Ill., has been appointed general sales representative of the Camel Company, manufacturers of railway specialties, with headquarters at Chicago. Mr. Creer has had considerable experience at railways, and was for some years associated with McCord & Company, of Chicago, as a mechanical expert.

Mr. G. H. Peabody, vice-president, and Mr. W. A. Austin, A. S. M. E., consulting engineer of the Railway and Mine Supply Company, 332 South Michigan avenue, Chicago, have been appointed Western representatives of the Southern Locomotive Valve Gear Company, of Knoxville, Tenn., and will handle matters pertaining to the Southern valve gear, and the Brown power reverse gear in the Chicago territory. Mr. Peabody was formerly Western sales manager for the Lima Locomotive Works and Mr. Austin was formerly connected with the Baldwin Locomotive Works, and later chief mechanical engineer of the Lima Locomotive Works.

Mr. A. C. Deverell and Mr. R. D. Hawkins, superintendents of motive power of the Great Northern, with offices at St. Paul, Minn., have had their jurisdiction extended over the line of the Watertown & Sioux Falls, and Mr. A. G. Bruce, master mechanic of the Great Northern, with office at St. Paul, has had his jurisdiction extended over the Watertown & Sioux Falls, with office at St. Paul, and Mr. D. W. Morrison, superintendent of the employment bureau of the Great Northern, has had his jurisdiction extended over the Watertown & Sioux Falls. The latter road has recently been acquired by the Great Northern, and a general extension of jurisdiction is being carried out in other departments.

George F. Johnson.

The Scandinavian dramatist Ibsen said that no man is great until he stands alone. If this is so, then George F. Johnson, of the Baldwin Locomotive Works, has reached that enviable distinction. For over seventy years he has been placing locomotives in commission, and he is still on the job. He was born in Philadelphia, on December 17, 1826, and took naturally to railroading as an engine house was built on his father's farm, and the family had free access to the locomotives and other machinery. The early locomotives came in pieces from England, and were assembled at their destination. At the age of sixteen, Mr. Johnson was apprenticed to a machine and millwrighting establishment, and began his career as a railroad man as fireman on the Philadelphia and Reading railroad, in 1846, and was promoted to engineer in 1847. In the same year, Mr. Johnson was selected by Mathias W. Baldwin to place a new locomotive, the "America," on the Baltimore & Ohio railroad. This resulted in a permanent engagement with Mr. Baldwin for that particular branch of engineering, and it is safe to state that Mr. Johnson has placed more locomotives in commission than any other man, probably more than any other two men.

GEORGE F. JOHNSON.

It would be interesting, indeed, to follow the details of his notable career. Among his early exploits was the placing of 74 locomotives for the New York and Erie, in 1849, every one of which he ran over the road. Special offers came to him, and he occasionally ran night express trains when it was difficult to secure the services of experienced engineers. Sometimes he was engaged by the railroad companies as special inspector during constructing periods, and when the locomotives were finished he had other periods of instruction to engineers, besides testing the engines, but he never wandered far from the Baldwin works. As a mark of the company's esteem he was presented with a massive gold watch, one of the first of the stem winders. This was in the early fifties and Mr. Johnson still has the watch and it looks like himself, a little older in the face, but may go on forever.

In war time he placed hundreds of locomotives for the government, at one time having 60 engines, which he ran under their own steam to Nashville, Tenn., passing each locomotive safely through a portion of the country traversed by the contending armies. It became a common saying that when Mr. Johnson passed a locomotive through his hands it was reliable as far as human skill and experience could give a good start as a safeguard for its future operations. Among his later achievements was the placing of the great and only triplex compound locomotive, "Matt Shay," on the Erie railroad. Mr. Johnson not only placed the great locomotive in service, but remained with it until it was proven eminently satisfactory.

It is gratifying to know that Mr. Johnson is still in excellent health, and in every way apparently good for many years service, and it is generally expected that he will round out the century before he makes the long run where "all the lamps are white."

OBITUARY

J. Sterling Goddard

Mr. J. Sterling Goddard, for the last ten years chief engineer of the American Steel Foundries, Chicago, Ill., died at his home at Riverside, Ill., recently, in his forty-fifth year. He was a graduate of Cornell University, and was for some years employed in the engineering department of the Western Tube Company, Kewanee, Ill., and was also chief draftsman in the motive power department of the Chicago, Burlington & Quincy, at Chicago, Ill. His early death is much regretted.

David McNicoll

David McNicoll recently resigned senior vice-president of the Canadian Pacific, died on November 26 at Guelph, Ontario. He was a native of Arbroath, Scotland, and emigrated to Canada at an early age. He was over forty years in the employ of the Canadian Pacific, beginning as clerk in the freight department, and filled many positions with honor and distinction. He retired from active service in January, 1915.

William C. Nixon.

William C. Nixon, vice-president of the St. Louis & San Francisco Railroad, died at St. Louis, Mo., on December 15, in his 59th year. He was from Illinois. He had nearly forty years experience in the transportation departments of several of the leading Western railroads, and latterly was in charge of maintenance and operation of the St. Louis & San Francisco. He was a member of the American Railway Guild and other prominent societies.

T. E. Calvert.

The death is reported of T. E. Calvert, chief engineer of the Chicago, Burlington & Quincy. He was a graduate of Yale University, and entered the service of the Burlington in 1871. He was thirty-five years in the engineering department and in various positions was closely identified with the extensive developments of the road. He was seriously injured in a motor car accident over a year ago, and never completely recovered. He was in his sixty-eighth year.

Application for Work on the Pennsylvania.

The Pennsylvania offers the first opportunities for work to people who are its neighbors. To aid in this laudable purpose, every one of the 1,500 station agents on the lines east of Pittsburgh and Erie are appointed employment agents. The agent will interview each applicant and direct him to the nearest available vacancy. If there are no vacancies, the application will be forwarded to the general manager, in whose office a clearing house plan is being established. The arrangement, it is thought, will greatly aid in equalizing the distribution of labor, and the opportunities for work in the railroad service. The results cannot be other than beneficial, and is well worthy of imitation.

Bonus to Santa Fe Employees.

President E. P. Ripley of the Atchison, Topeka & Santa Fe, in a circular, announces that a bonus equal to ten per cent of a year's pay will be distributed to all employees who have been in the service at least two years. About 25,000 employees will share in the distribution. All are included whose annual remuneration is less than $2,500, except those who work under special contract schedules.

International Railway General Foremen's Association.

William Hall, secretary of the International Railway General Foreman's Association, has changed the address of his office from 1136 West Broad, Winona, Minn., to 1061 West Wabash, Winona, where permanent headquarters for the secretary's office has been recently established.

Railroad Equipment Notes.

The St. Louis Southwestern has placed contract for 13,000 tons of rails for 1918 delivery.

The Chicago Great Western has ordered five passenger cars from the Pullman Company.

The Great Northern has ordered 50 Mikado locomotives from the Baldwin Locomotive Works.

The Lehigh Valley has ordered 6,500 tons of steel from the Bethlehem Steel Bridge Corporation.

The Los Angeles & Salt Lake has ordered 1,000 gondola cars from the Pressed Steel Car Company.

The Chicago, St. Paul, Minneapolis & Omaha has issued inquiries for 50 machine tools for car shops.

The Atchison, Topeka & Santa Fe has ordered 30 locomotives from the Baldwin Locomotive Works.

The British Government has ordered 40 Consolidation locomotives from the Canadian Locomotive Company.

The Cudahy Refining Company has ordered 500 30-ton tank cars from the American Car & Foundry Company.

The New York Central Lines have ordered 100 steel under-frames from the American Car & Foundry Company.

The Texas & Pacific has issued inquiries for 12 Santa Fe type, 7 Pacific type and 6 switching locomotives.

The Baltimore & Ohio has ordered 30 Mallet and 10 Pacific type locomotives from the Baldwin Locomotive Works.

The French Government is reported ordering 100 additional small locomotives from the Baldwin Locomotive Works.

The Missouri, Kansas & Texas has ordered 10 Pacific (4-6-2) type locomotives from the American Locomotive Company.

The Pittsburg & Shawmut has ordered 100 50-ton steel underframe gondola cars from the American Car & Foundry Company.

The Canadian Government Railways have recently ordered 10 Santa Fe type locomotives from the Montreal Locomotive Works.

The St. Paul & Tacoma Lumber Company, Tacoma, Wash., has ordered a 70-ton Shay locomotive from the Lima Locomotive Works.

The Norwegian State Railways and other Norwegian railways have ordered 22 locomotives from the Baldwin Locomotive Works.

The Minneapolis, St. Paul & Sault Ste. Marie has ordered 50 miles of 85-lb. open hearth rail from the Illinois Steel Company for 1918 delivery.

The William Dederich Company, London, Eng., has ordered 24 light locomotives from the H. K. Porter Company for use in the Belgian Congo.

The Duluth, Missabe & Northern has ordered 4 eight-wheel (0-8-0) and 2 Mallet (2-8-8-2) type locomotives from the Baldwin Locomotive Works.

The French State Railways have ordered 100 80-ton Consolidation locomotives from the American Locomotive Company for delivery in January and February, 1918.

The Union Pacific, which recently placed order for 1,000 box and 1,500 automobile cars, is in the market for 2,500 refrigerator cars for the Pacific Fruit Express, and for 100 ore cars.

The Delaware, Lackawana & Western has ordered 200 50-ton steel gondola cars from the Standard Steel Car Co. and 300 40-ton composite gondolas from the Barney & Smith Car Company.

The New York Central's recent order for 25 baggage cars given to the Pullman Company has been divided as follows: Michigan Central, 10, and the Cleveland, Cincinnati, Chicago & St. Louis, 15.

The Maine Central has ordered 2 superheater six-wheel switching locomotives from the American Locomotive Company. These engines will have 21 by 28-in. cylinders, 51-in. driving wheels, and a total weight in working order of 166,000 pounds.

The Erie has ordered 10 Pacific (4-6-2) type locomotives from the American Locomotive Company. The cylinders will be 25 by 28 inches; driving wheels, 69 inches in diameter, and total weight of engine in working order 287,000 pounds, will be expended.

The Wheeling & Lake Erie has ordered 10 superheater Mallet (2-6-6-2) type locomotives from the American Locomotive Company. These locomotives will have 25½ and 39 by 32 in. cylinders, 63-in. driving wheels and a total weight in working order of 435,000 lb.

The Russian Government is reported as having closed for 66 additional locomotives with the American Locomotive Company, 66 with the Baldwin Locomotive Works, and 21 with the Canadian Locomotive Company.

The Richmond, Fredericksburg & Potomac has awarded a contract to install automatic block signals on its double-track line from North Acca, near Richmond, Va., northward for a distance of 102 miles. The work will be done by the General Railway Signal Company.

The Chicago & North Western plans in 1917 to equip 177 miles of road, single track, with automatic block signals; Milwaukee, Wis., to Manitowoc, 75 miles, and Clyman Junction, Wis., to Wyeville, 102 miles. In connection with this work, all passing tracks will be lengthened so as to hold 100 cars each, and this will mean 20 miles of new track.

The Russian Government has placed additional orders for locomotives, bringing the total now ordered to 331 engines, divided as follows: American Locomotive Company, 140; Baldwin Locomotive Works, 150, and Canadian Locomotive Company, 41. It is understood that a total of 350 locomotives will be placed at this time, and probably more later.

Improvements are planned for the Cincinnati, New Orleans & Texas Pacific at Danville, Ky., to cost about $500,000. Additions will be made to the shops and yards, a new roundhouse erected, a fireproof office building and an overhead bridge at the Perryville pike crossing. The railroad company which has just acquired 300 acres of land will be given possession of a part the first of the year and the remainder in the early spring.

The Illinois Central has completed 170 miles of automatic block signaling during the past year. It is to be found on the line from Gilman, Ill., to Mattoon, 90 miles, and 80 miles between Paducah, Ky., and Eddyville, and between Dugan and Cecilia. On the Mississippi division, in the states of Mississippi and Tennessee, automatic block signals are now in course of construction on 183 miles of line, the work to be completed about March 1 next, and on the Louisiana division, in the states of Mississippi and Louisiana, 191 miles, now about half completed, will be put in operation March 1 next.

Increase of Wages on the Southern Pacific.

The directors of the Southern Pacific Company have authorized the payment of a ten per cent bonus to all employees not under special contracts. Five per cent will be paid on January 1, and five per cent on July 1, 1917.

Increase in Railroad Men's Wages.

It is very gratifying to observe the reports coming to us from all over the country of the increase of wages to that large body of railroad men who are, without any fault of their own, working at occupations that are not sufficiently organized to demand national attention, but whose needs of betterment are as great if not greater than those who are in a position to command special legislation. The best feature in this spirit of generous consideration on the part of railroad companies is the fact that nearly everywhere the increase is unasked, and, we might venture to say, unexpected, and that in nearly every case that has come to our attention so far, the increase is retroactive. To have ten per cent added to the wages of last year passed over by the employers to the employees at once is a proof that after all there is some soul in a corporation. Doubtless the past year has been a prosperous one in railroad work, but the increase in prices has struck the railroads, perhaps, harder than it has their employees. In any event, the generous action of the companies kindles the lamp of hope in the mind of the humble toiler. He feels that he is not altogether forgotten, and he will begin the year's work with a degree of cheerfulness begotten of appreciation by those for whom he will undoubtedly put forth increased efforts.

Westinghouse Electric Grants Employees a Bonus.

A step in the right direction has been taken by the Westinghouse Electric and Manufacturing Company by granting an extension of its present bonus system to include salaried and office employees on hourly rates, by which they will receive a bonus of eight per cent. of their salary each month prividing that their total excusable time absent and late during the month does not exceed six hours, incurred on not over three occasions. An additional four per cent. will be given each month to the employee who has not lost any time from work during the month through absence or tardiness, thus making those affected to obtain an increase in twelve per cent. for one hundred per cent. attendance.

Several thousand employees in the Pittsburgh district will be benefited by the granting of the bonus. We trust to hear of this shining example being followed by other corporations. The lamp of hope should be kept burning in the dark brow of constant labor.

Southern Pacific plants now give employment to 75,000 persons, 35,000 of whom are in California, and they receive annually more than $35,000,000 in wages, or in the aggregate nearly $100,000 a day.

Books, Bulletins, Catalogues, Etc.

Statistics of Railways in the United States.

The twenty-eighth annual report on the statistics of railways in the United States for the year ending June 30, 1915, has been issued from the Government Printing Office at Washington, and covers 80 pages of closely printed matter. Financial reports are presented with a degree of fulness that leaves little to be desired, and the report altogether shows considerable improvement over that of previous years. In regard to track mileage the report shows that there are 253,788.64 miles of single track in operation, to this must be added second, third, and all other main tracks, yards and sidings, making a total of 391,141.51 miles, being an increase of 3,933.20 miles, as compared with the track mileage of the previous year.

In regard to motive power and rolling stock there are 66,229 steam locomotives, and of other than steam, 273; passenger cars, 55,810; freight cars, 2,370,532; company service cars, 98,752. The number of employes listed, including officers, are 1,409,342. Of passenger engineers and motormen there are 11,274; road freight engineers and motormen, 22,966; yard engineers and motormen, 11,971, making a total of engineers and motormen numbering 47,839.

Electric Welding.

The Wilson Welder & Metals Company, New York, has just issued a catalogue of 63 pages of descriptions and illustrations furnishing details of the developments of the company's system of electric welding which is rapidly coming into favor as shown by the first ten months since the company began active operations the railway mileage covered in that period extending to about 60,000 miles, besides large orders from the United States government and the two largest locomotive works in the world. Apart from the substantial features of the appliances there is a marked gain in the economical use of the power required, and also a degree of perfection in the metal electrodes which are composed of iron homogeneously combined with such an excess of manganese and copper over the amount lost in the arc, as will insure to the welded joint a substantial additional degree of toughness and ductility. A full description of motor generator sets are furnished, and a mass of interesting data in regard to electrical units, shop wiring, tables, fusing point of metals, temperatures of furnaces, and other matter, the whole being an unusually valuable and attractive publication, copies of which may be had at the company's main office, 52 Vanderbilt avenue, New York.

Cold Metal Sawing Machines.

The Newton Machine Tool Works, Philadelphia, Pa., has issued catalogue No. 51, treating very fully of cold saw cutting off machines. The enterprising company has reached a high degree of perfection in this department of specialties by reason of the fact that it maintains a corps of representatives trained in shop and engineering departments to visit the various plants and observe machines of its manufacture under actual working conditions, and in many instances valuable suggestions are received and applied in perfecting the machines. Cold cutting saws up to 84 ins. diameter are now in use, and metal up to 35 ins. diameter is being cut. Among the recent devices that are meeting with popular favor are saw blade sharpening machines, slot sawing machines, and an endless variety of milling machines of single, duplex and multiple spindle type, portable drilling machines and locomotive rod boring machines. There are nearly 100 illustrations in the catalogue and all interested may secure a copy on application to the company's works, 23d and Vine streets, Philadelphia.

Fairbanks Power Hammers.

The United Hammer Company, 141 Milk street, Boston, Mass., announces in an illuminated circular the purchase of the power hammer business of the E. & T. Fairbanks & Co., of St. Johnsbury, Vt., and are prepared to furnish complete Fairbanks power hammers of all sizes. The company also furnishes parts and repair sections of Fairbanks hammers already in use. As is well known, the Fairbanks hammers have been in use over 25 years. They were first manufactured in 1890 by the Dupont Mfg. Co., St. Johnsbury, Vt., who marketed them under the name "Dupont" hammers. In 1902 the business was taken over by E. & T. Fairbanks & Co., St. Johnsbury who have been manufacturing them since, they giving the machine the name "Fairbanks" hammers, which title will be continued in future. During the time E. & T. Fairbanks manufactured these hammers, they were sold by their selling agents, the Fairbanks Co. of New York, and branches in the west, and by the Canadian Fairbanks Co. in Montreal and branches for Canada. They are also favorably known in Europe and other parts of the world.

Reactions.

This quarterly publication devoted to the science of aluminothermics and published by the Goldschmidt Thermit Company, 120 Broadway, New York, devotes much space in the latest issue to railroad repair work. Frames, driving wheels, pedestal jaws, guide yokes, link frames, heavy wheel lathe tools are shown with compound fractures before and after repair. The latter class of work is just looming into prominence, and is an illustration of the unexpected uses to which the Thermit process of welding may be put. The method of welding high speed steel tips to machine steel is fully shown and it is generally recognized that the Thermit steel improves the quality of high speed steel, and the adoption of the practice effects a large saving in this class of work. A variety of operations of various kinds are shown in the issue, and the high character of the publication is well maintained. Send for a sample copy to the company's New York office.

American Anvils.

The additional railroad repair shops that are springing up all over the country in these busy times are calling for new equipment, and in the blacksmith section the reliable American anvils, made by the Hay-Budden Manufacturing Company, Brooklyn, N. Y., are much in demand. The variety in sizes and designs aer of the familiar and popular type, but the enterprising firm, after extensive experimenting with alloys, have produced a steel which is conceded to have the double quality of taking a harder temper with a decreased liability to chip than any other anvil hitherto manufactured. Guarantees are furnished with all orders filled. Send for a catalogue to the company's works, No. 254-278 North Henry street, Brooklyn, N. Y.

Railway Motors.

The General Electric Company is doing a notable work in the solution of the problem of providing rapid and economical city transportation. The provision of suitable equipment for the lighter type of cars has been simplified by the development of high continuous capacity railway motors which are sufficiently small to be suitable for the smallest diameter of wheels used with these cars, and which offer a considerable reduction in weight compared with the usual electric equipment for city service. These various types of motors are fully described and illustrated in Bulletin No. 44417, and copies may be had on application to the company's office at Schenectady, N. Y.

Engineering Fellowships.

The University of Illinois maintains fourteen engineering fellowships for each of which there is an annual stipend of $500 open to graduates of American and foreign universities and technical schools. They must be accepted for two consecutive collegiate years, and if all requirements are met the degree of Master of Science will be conferred. Applications must be received not later than the first day of February. Preference is given those applicants who have had some practical engineering experience. Among the branches studies may be undertaken in mechanical engineering, electrical engineering and railway engineering. Full information may be obtained by addressing the Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Proceedings of the Gen. Fore. Assn.

The proceedings of the twelfth annual convention of the International General Foremen's Association, held at Chicago, Ill., last August, has been compiled and published by Wm. Hall, secretary, 1061 W. Wabash, Winona, Minn, and forms an elegant volume of 148 pages. The subjects of the various papers and the discussions are presented in full. These embrace "Car Department Problems," "The Counterbalance of the Steam Locomotive," "The Classification of Repairs," and "Relation of Foremen to the Men." It will thus be seen that the members of the association did not burden themselves with an overwhelming variety of subjects, but there is a genuine thoroughness and a note of sincerity all through the able papers and interesting discussions. The subjects taken up by the association are finished to the hour. Their close contact with the actual work involved in their particular departments gives them closer opportunities than falls to the lot of many who, perhaps, make more noise with less merit. Applications for copies of the book should be made to the secretary.

Books.

We ought to reverence books, to regard them as essential and mighty factors of our life. Archbishop Fenelon once said: "If the crowns of all the kingdoms and all the empires in the world were laid at my feet in exchange for my books, and for my love of reading, I would spurn them all." Books never pall on us. They are never troublesome, irksome, or in the way, but they immediately answer our questions. We can ask John Bourne re the early steam engines, the Earl of Worcester of his hundred inventions, and question James Watt, Trevethick, Stephenson and Murdoch on the mighty things they did in the early ages of steam. Ericsson and Fulton may be consulted on the first Monitor, and about the ship the latter built to cross the great Atlantic. And, so on, in respect of all the great men up to the present day, and things they have done. Books not only answer the mental questions we may put, but reveal to us the depths of knowledge with which we have and could have no access.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXX. 114 Liberty Street, New York, February, 1917 No. 2

The Ralston Steel Car Shop

Continuous Method of Assembling Applied to Railroad Cars—Thorough Equipment to Build and Repair Cars—Parts Supplied to Railroads Making Their Own Repairs—First Class Work Turned Out—Progressive Methods.

In the production of any vehicle economical methods of assembly are of importance. The manufacturers of automobiles have learned this, and in order to cut down assembly costs have universally adopted the progressive or continuous system of assembling. The Ralston Steel Car Company, Columbus, O., was among the first to adopt this method. Formerly, a car was assembled complete without being moved, and there was always a jumble of parts about the car. At the present time, at the Ralston plant, the car advances in 11 stages, until the completed car is run out into the yard. The various parts required are distributed along the erecting track in the order in which they are applied. The plant has a maximum capacity of 60 all-steel cars and about 25 composite cars a day. A specialty is made of miscellaneous repair work, including not only the repairing of cars in the Ralston shops, but also the furnishing of miscellaneous repair parts to railroads. The company was organized in 1905 by J. S. Ralston, president, and Anton Becker, vice-president and assistant to the president.

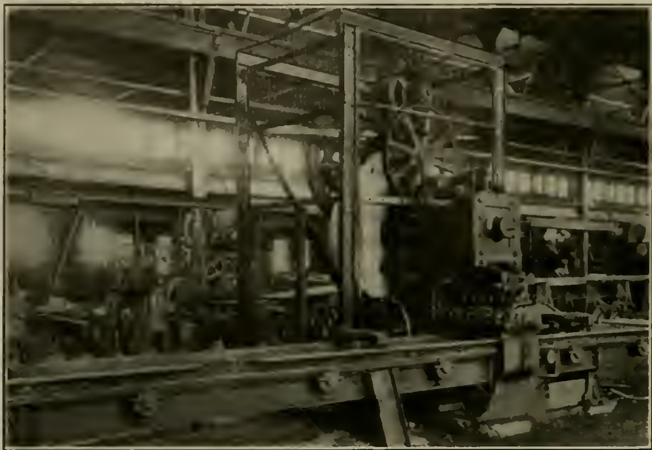
The works are situated on a site of 38 acres in East Columbus, a short distance from Columbus. The company has also provided for future extensions. The works include a main building, which houses the forging, punching, shearing, pressing, riveting and assembling equipment; power plant, pattern shop, machine shop, storehouses, paint shops, template shop, foundry, and a number of smaller structures including an oil and paint house, planing mill, electric storage and repair shop, hospital, air brake shop, rivet house and storage bins, emery grinding shop, tool steel storage, etc. The main shop extends in a general east and west direction and is divided into two main bays, each 1,410 x 63⅞ ft. wide. A 45 x 1,050-foot bay adjoins this shop on the north, giving a total floor space of 226,320 sq. ft. The west end of this building directly adjoins the storage yard for raw materials, and houses the shearing, pressing and punch-

GENERAL VIEW OF ASSEMBLING ROOM, RALSTON CAR COMPANY.

ing departments. The center section of the main building is devoted to riveting and general construction, while the east end of the building is given over to assembling the cars. Three tracks are provided for erection purposes. Each track is commanded by a number of Shepard electric hoists of from 2 to 5 tons capacity. The main building is of brick construction reinforced with steel and carrying a heavy truss roof.

The storage yard is directly west of the main building and is 500 ft. long and 109 ft. wide. It is commanded by a 10-ton Case overhead traveling crane having a span of 108 ft. 6 in. This span permits the one crane to serve both bays. The crane runway is 445 ft. long. There are two Long & Allstatter combination punches and shears and two heavy block out punches, one being a Cleveland type and one a New Doty type. These latter machines are designed for heavy shearing and group punching. The Long & Allstatter machines can shear a 3½-in. round or punch a 3-in. hole through a 1¾-in. plate. There are seven Hilles & Jones vertical double punches with silent chain drive, designed to punch a 1¼-in. hole through a 1-in. plate. The other punching equipment includes four Rarig machines having a capacity of 1⅛ in. through 1-in. Eight Cleveland vertical, four Bertsch vertical, and two New Doty horizontal, all with a capacity of 1-in. through 1-in.

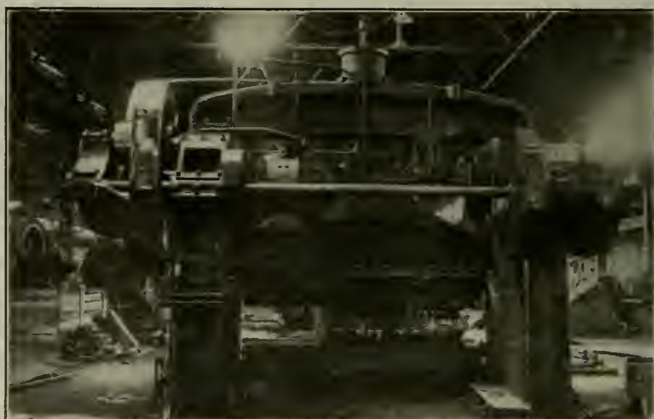
The pressing equipment includes four hydraulic presses, two being of 1,060 tons capacity and one of 300 tons capacity, made by R. D. Wood & Co., Philadelphia; the fourth is of 500 tons capacity, and was furnished by the Morgan Engineering Company, Alliance, Ohio. All of the presses are operated under a pressure of 1,500 lbs. This pressure is secured through a 200-gallon vertical triplex hydraulic pump furnished by the Dean Bros. Steam Pump Company, Indianapolis; two Dean duplex horizontal pumps having a capacity of 40 gals. a minute, and two Snow steam pumps, one with a capacity of 100 gals. and the other 50 gals. a minute, also are installed. The 200-gal. triplex pump is the largest of its type ever made by the Dean company. The two hydraulic presses are used for pressing center sills, truck bolsters, and for blanking and cold pressing small parts. The center sills are pressed cold while the truck bolsters are heated before pressing. A continuous plate heating furnace, designed by the Ralston company, is used for heating large plates previous to their being formed in the hydraulic presses. This furnace is equipped with two burners at each end and three burners on either side. The burners are so arranged that the flames from the sides strike the top of the plates, while the end burners heat the bottom. The plates heated in this furnace are used in making the large units. For truck bolsters they are 42¼ in. wide, 7 ft. 8 in. long and ¾-in. thick. Four plates are heated at one time.



AUTOMATIC SPACING TABLE AND PUNCH.

Directly north and adjoining the main building is the 45 x 1,050-foot bay which houses the forge shop, axle finishing, wheel boring, truck and miscellaneous order departments. The forging equipment consists of four Williams & White, one Long & Allstatter and one Ajax bulldozer; one 1¼-in. Ajax and one 1½-in. Acme bolt and rivet machine; one 3-in. Acme, one 2½-in. American and one 3½-in. Ajax upsetting and forging machine; one Ajax forging roll; one Ajax hot saw and burring machine; two Bradley steam hammers, one of 125-ton and one of 200-ton capacity; one 800 lbs. Morgan steam hammer and one 1,200-lb. Rarig hammer, and one electric welder, furnished by the Toledo Electric Welder Company, Cincinnati, O. Four overhead cranes operate in this department. All forging and riveting furnaces are heated with natural gas. The axle finishing department is equipped with eight lathes, seven Niles and one Bridgeford; four Niles boring mills; one 300 and one 200-ton Niles wheel press.

The miscellaneous order department where a wide variety of work is turned out is equipped with one 120-in. Cleveland plate shear; two Cleveland overhang punches with 48-in. stroke; two Hilles & Jones double punching and shearing machines and two small stem punching machines. A large 500-ton R. D. Wood hydraulic press has been installed.



SIDE STAKE PUNCHING MACHINE.

The forge shop is commanded by four overhead cranes built by the Ralston company, each crane having a span of 42 ft. and being equipped with a Shepard electric hoist of 5 tons capacity. An electrically operated transfer car running on a broad gauge track connects the forge shop with both of the main bays of the very fully equipped erecting shop.

The construction department is equipped with five deep gap 102-in. bull riveters of the Hanna type for riveting the sides of the cars. The material for each riveter is handled by Shepard electric hoists. The riveters are of 50 tons capacity, and are operated by compressed air. In addition, there are three 50-ton Hanna riveters with 48-in. reach; a Shepard riveter for riveting center sills, and many other riveters for miscellaneous work, ranging from 48-in. reach down. An hydraulic riveter of the alligator type is used for riveting truck bolts.

Oxy-acetylene equipment is provided in the paint shops for the final cutting out of defective parts. There are two paint shops, one being 467 ft. 7 in. x 104 ft. 10 in. and the other 465 x 120 ft. The former shop has six, while the latter has eight tracks. Their respective capacities are 60 and 80 standard 45-foot gondolas. The paint shops are heated with exhaust steam, the fan and coil equipment having only for repair work, but for the storage of electrical supplies. A large quantity of these supplies is carried on hand so that repairs can be made quickly. The equipment in the air brake house consists of Westinghouse air brake test racks for testing triple valves; a Landis cutting off and pipe threading machine of 2-in. capacity and a Landis threader and pipe bending machine. The power house occupies one-half of a building, 52 ft. 3 in. x 305 ft., the other half being given over to general storage.

The Ralston plant is served by the Pennsylvania, the Baltimore & Ohio and the Toledo & Ohio Central railroads, the latter being a branch of the New York Central Lines. The facts which we have here presented are drawn from Mr. R. V. Sawhill's article in the *Iron Trade Review*. The shop is very thoroughly equipped throughout and a fine and durable type of car is turned out by this company.

Every tool in the plant is equipped with

ONE END OF THE ASSEMBLING DEPARTMENT.

been furnished by the Bayley Manufacturing Company, Milwaukee.

The planing and woodworking mill is equipped with the usual complement of woodworking equipment, including planers, wood boring machines, jointers, etc. This mill is for the preparing the lumber used in the manufacture of composite cars, and has a capacity for turning out sufficient material for building from 20 to 30 cars a day. The pattern shop is located north of the woodworking mill and is 40 x 16 ft. The template shop is 100 x 50 ft.

The foundry, which is about 40 x 50 ft., has a capacity for making castings up to 1,200 lbs. It is equipped with one cupola built by the Ralston company and its products include gray iron castings employed in the new cars and in the manufacture of all of the dies used about the plant. A variety of small work such as ratchet wheels, pawls, etc., also is turned out.

The electrical repair shop is used not safety guards. The ends of the crane runways and the platforms have safety railings.

All cranes are painted yellow, and their appearance thus readily attracts attention as they operate overhead. This arrangement has been found to decrease accidents as a workman who fails to hear the warning bell is usually attracted by the conspicuous object approaching. All projecting parts on the crane runways are also painted yellow, making them plainly visible to the crane operators and avoiding any chance of collision with objects handled by the cranes.

The idea involved in painting the cranes and runways a yellow color appears to be a thoroughly practical way of calling the attention of employees to the possibility of accident, as far as it is possible to do so by a mute sign, unconnected with any operating or stop mechanism. The yellow crane looks like a move in the right direction, and it indicates the company's desire for safety.

Accident Prevention.

Marcus A. Dow, General Safety Agent, New York Central Lines, read a paper before the New York Railroad Club on January 19, and emphasized with much force and clearness the importance of the work with which he is so prominently identified. It will be remembered that Mr. Dow has already presented two moving picture dramas of an intensely interesting and realistic kind, showing the results of carelessness on the part of some railroad employees in contributing to the casualties on railways. These striking object lessons have borne excellent fruit, as shown in the statistics which he presented, and it is manifest that since the establishment of the earnest work in the direction of "Safety First," the casualty list of passengers has been almost reduced to a minimum, and while the same cannot be said in regard to the more exposed dangers to employees, the reduction of injuries to that class is also very great. Unfortunately it cannot be said of that large class of trespassers whose conduct is to a large extent beyond the reach of the railroad companies, but Mr. Dow is meeting this problem with an earnestness worthy of imitation, by rousing public opinion, and by continually hammering home the doctrines of safety vs. carefulness from every angle and in all phases in order to cultivate a formed habit of taking care; that will minimize the possibility of accidental death or injury in connection with railroads.

The moving picture shown at the N. Y. Railroad Club is called "The House that Jack Built," and is a railroad "movie" throughout of the most realistic kind. The picture is a serious endeavor of a large railroad company to show to all employees those things which many never see until they become the unfortunate victims of accident. The picture instantly arrests the attention, and the story deepens the effect so that a powerful and lasting impression wholly for good is forced upon even an inert and unreflecting mind. The railroad man needs such stimulation and Mr. Dow's picture gives it in full measure.

Pensions on the Pennsylvania.

The Pennsylvania has established a change in the pensions to be paid to retired employees, which will result in increased allowances in a number of instances. Pensions have been paid at the rate of one per cent. of the average monthly pay, during the ten years preceding retirement. It has been found that some employees were quite unable to make full time resulting in a reduction in the amount of pension. A full month's pay will now be considered as the basis, and a minimum of $15 per month is also established.

The Switch Engine Question

Modern View of the Switch Engine—Special Machine for Special Work—Proportion to Road Engines in the United States—Examples of Modern Switchers—Their Equipment—Details of Various Designs.

To use a homely phrase the yard engine has had to force itself into prominence and demand that the spotlight be turned on it when it holds the centre of the stage. The former theory about the yard engine was that any old decrepit road engine, waiting for its turn to enter the back shop, might put in a few weeks in the yard. This idea is gradually being discarded.

The latest annual report of the Interstate Commerce Commission gives the facts as they are. In the United States the total revenue-producing mileage is 1,210,000,000, and the total revenue-switching mileage is 310,000,000. This is an actual proportion of 0.39, which is over one-third, and a little less than two-fifths. Take the proportion at 1/3 as the established figure, and it is easy to see the importance of the switch engine as a special machine designed for a special purpose. Further than this, the total revenue mileage, represented by ten figures, as it is, is dependent on the 1/3 revenue mileage of the switcher. The switch engine is, therefore, not only an important factor, it is an essential part of the solution of the problem upon which cheap transportation rests. Road engines making the finest records on earth, and contributing materially to a low cost per ton-mile for the movement of cars, might easily have the whole of their efforts wiped out and a high cost per ton-mile produced by inefficient service in the yard; with delays, unnecessary handling, and slow movement. Efficient haulage by a good, economical road engine might be nullified in its results by poor yard work.

One of the most conspicuous features of locomotive development, during recent years, has been the introduction of special types for special conditions of service. and a constant improvement in the older types in order to secure the highest possible efficiency. This is quite as true of switching power as of road engines. As freight trains increase in weight, service requirements in terminal yards become more severe, and the necessity of doing the work in the most efficient manner possible becomes more and more apparent. These engines are subjected to such hard service that the best of design, materials and workmanship are none too good; and the day is rapidly passing, and has indeed passed, when any type of discarded road engine can be considered suitable for yard service.

Superheaters in large switching locomotives have become very common, and the use of them is rapidly increasing. The reduction in fuel and water consumption, which accompanies the use of superheated steam, results in certain advantages apart from a reduction in fuel charges, which are especially apparent in switching service. With a lower steam consumption, the fire does not have to be forced as hard to develop a given amount of power; hence, smoke can be more easily suppressed. Less time is lost on account of running for water. This is a most important consideration in a busy yard. Another point is that, when using superheated steam, there is less liability of water being ejected from the stack. This is a matter of special importance in switching service about passenger stations.

In corroboration of this general view of the superheater a superintendent of motive power on a prominent railroad, which has made some exceedingly instructive tests on superheater and non-superheater engines, writes us as follows:

"The reasons for the reduction in number of yard engines used by us having superheaters are that engines will run longer for water, longer for fuel and longer for fire cleaning. They will also move more promptly and do more efficient work. There is less escaping steam in cool or cold weather to cause condensation on account of cylinder cocks, etc., and our enginemen like them very much better than the others, as well as all the men concerned in yard operation. We have found by tests that a superheater engine can do a given amount of work with less water and coal than the saturated engine. This being true the superheater engine will go longer for coal and water than the saturated engine will, and thus it saves the time necessary to take water or go for more coal. This being true, it is apparent that since less coal is used, the fire will not have to be cleaned so often, which is another time saver for the superheater engine. It is an accepted fact that a superheated engine moves more promptly and works more efficiently than a saturated engine does, and since the engine moves more promptly or gets under way in a shorter time it will cut down the time necessary for a given amount of switching. In other words, the superheater engine will handle more tonnage at high speed and at the same time show an appreciable saving in coal and water."

Certain labor saving devices are also proving of great value on switching locomotives. Especially is this true of power reverse gears. The ability to reverse the engine with practically no physical effort, not only saves the engineman a large amount of labor, but also facilitates rapid movements. In a large yard a few seconds gained in each reversal amounts

HEAVY 8-WHEEL SWITCHER FOR THE LAKE TERMINAL RAILROAD.
G. N. Riley, Superintendent of Machinery. Baldwin Loco. Wks., Builders.

in the aggregate to a material saving in time. Simply because of the large amount of handling that is inevitable in the operation of an efficient switching locomotive, it is important to so arrange the fittings that the engine can be handled with the greatest possible convenience. The power reverse mechanism can be handled as easily as the brake valve. The locomotive engineer is enabled to see what he is doing all the time, and is not compelled to take a look and draw back into the cab to pull a heavy reverse lever over and then look out to see the effect. He sees and acts and modifies or alters the reverse lever as events develop and he does this on his own initiative and without depending on signals. As psychologists would say, this very largely reduces his "reaction time."

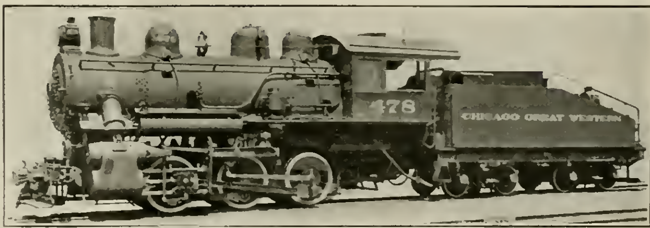
By this they mean that after a signal has been received or, in fact, when any stimulus flows into the consciousness, a certain time elapses before the nervous system of the man can perceive it in his brain, and put forth the necessary movements for the act. By seeing the thing he is concerned with himself, the "reaction time" due to a signal, is eliminated with a corresponding gain in time. With heavy work, such as moving a heavy reverse lever all day, fatigue sets in and this increases the "reaction time" as the day wears on, and the fatigue itself slows down the action in addition to increasing the "reaction time." Thus a double saving is effected, the man is more comfortable and happy at his work and the yard men feel confidence that the engineman sees clearly what he is about, and is not liable to misinterpret any of the signals given to him.

Our several illustrations represent several designs of switchers recently built by the Baldwin Locomotive Works. The engine for the Atlantic Coast Line, although of moderate weight, represents advanced construction as far as equipment is concerned. It is designated by the railroad company as Class E-11. This locomotive weighs 129,500 lbs., and is designed to traverse curves of 100 ft. radius. With 19x24-in. cylinders, driving-wheels 50 ins. in diameter, and a steam pressure of 180 lbs., the tractive force exerted is 26,500 lbs.

The boiler is 58 ins. in diameter, and has a radial stayed firebox placed above the engine frames. Special features of the boiler equipment include a "Security" brick arch, supported on water tubes, and a Schmidt type superheater composed of 18 elements. The firebox seams, including that around the firedoor opening, are electrically welded. This method of construction has been employed in a large number of Atlantic Coast Line engines, with most satisfactory results. The large flues are electrically welded into the back tube sheet. Four rows of Baldwin expansion stays support the forward end of the furnace crown. The heating surface of this boiler is as follows: Firebox, 110 sq. ft.; tubes and flues, 1,100 sq. ft.; arch tubes, 21 sq. ft.; total, 1,231 sq. ft.; superheater, 257 sq. ft.; grate area, 20.9 sq. ft.

The cylinder walls are of such thickness that they can be subsequently bored out for bushings, if necessary. The steam distribution is controlled by piston valves 9½ ins. in diameter, and these are driven by the Southern valve gear. The Lewis power reverse mechanism is applied.

The frames are of .40 carbon steel, and the structural parts and spring rigging are designed for severe service. The tender tank has a straight top, and carries 2,000 gals. of water and 6½ tons of coal. Some of the principle dimensions are appended for reference: Boiler—Type, straight; thickness of sheets, ⅝ in.; working pressure, 180 lbs.; fuel, soft coal; staying, radical. Fire box—Material, steel; length, 71⅝ ins.; width, 42 ins.; depth, front, 63⅛ ins.; depth, back, 61⅞ ins.; thickness of sheets, sides, back, and crown, ⅜ in.; tube, ½ in. Water space—front, 4 ins.; sides and back, 3 ins. Tubes—Diameter, 5½ ins. and 2 ins.; material, steel; thickness, 5½ ins., No. 9 W. G., 2 ins., No. 11 W. G.; number, 5½ ins., 18; 2 ins., 107; Length, 13 ft. 6 ins. Wheel base—Driving, 10 ft. 6 ins.; total engine, 10 ft. 6 ins.; total engine and tender, 41 ft. 10 ins. Weight—Total engine and tender, about 195,000 lbs.



SWITCHER 0-6-0, CHICAGO GREAT WESTERN RAILROAD.
G. M. Crownover, Supt. Motive Power. Baldwin Loco. Wks., Builders.

Locomotive No. 478, for the Chicago Great Western, represents a class which has been extensively built for that line, and is designated by the railroad company as Class B-5. This engine weighs 155,000 lbs., and exerts a tractive force of 35,350 lbs. It has 21x26 in. cylinders and 51-in. driving-wheels, and the working pressure is 185 lbs. The locomotive is, therefore, of considerable capacity for one of the 0-6-0 type.

The boiler is 68 ins. in diameter, and has a Gaines furnace; a design which has been applied to road engines built for the Chicago Great Western, as well as to switchers. In the present instance, the arch is supported on three water tubes. The fire door is power operated. Other features of the boiler construction include three rows of Tate flexible stays over the forward end of the crown, and the welding of the tubes into the back tube sheet. The heating surface provided is as follows: Firebox, 144 sq. ft.; tubes and flues, 1,416 sq. ft.; arch tubes, 19 sq. ft.; total, 1,579 sq. ft.; superheater, 299 sq. ft.; grate area, 32.5 sq. ft.

The superheater is composed of 24 elements. The ratio of superheating to water heating surface is not as high, in this engine, as in many other recent designs, but this is chiefly due to the comparatively short boiler barrel, as the tubes have a length of only 11 ft. 6 ins.

This locomotive is equipped with 13-in. piston valves, and the Walschaerts motion. The crank pins are of chrome-vanadium steel, and the materials used in the construction of the engine are in accordance with specifications issued by the American Society for Testing Materials.

The tender has a 12-in. steel channel frame, and the sloping back tank carries 6,000 gals. of water and 8 tons of fuel. The principal dimensions are as follows: Boiler—Thickness of sheets, ⅝ in.; fuel, soft coal; staying, radical. Fire box—Material, steel; length, 102 ins.; width, 66 ins.; depth, front, 63½ ins.; depth, back, 59½ ins.; thickness of sheets, sides, back and crown, ⅜ in.; tube, ½ in. Water space—Front, 4½ ins.; sides and back, 4 ins. Tubes—Diameter, 5½ ins. and 2 ins.; material, steel; thickness, 5½ ins., No. 9 W. G., 2 ins., No. 11 W. G.; number, 5½ ins., 24; 2 ins, 171; length, 11 ft. 6 ins. Wheel base—Driving, 11 ft. 6 ins.; total engine, 11 ft. 6 ins.; total engine and tender, 44 ft. 1¼ ins. Weight—Total engine and tender, about 265,000 lbs.

Locomotive No. 13, for the Donora Southern Railroad, is operating on a short line in the Pittsburgh District. This is a heavy engine, weighing 161,500 lbs., and developing a tractive force of 38,000 lbs. The cylinders are 22 x 26 ins. and the driving-wheels are 52 ins. in diameter. Steam at a pressure of 185 lbs. is supplied by a 74-in. boiler, which has a long firebox placed above the engine frames. The superheater is composed of 30 elements, and the heating surfaces are as follows: Firebox, 179 sq. ft.; tubes and flues, 1,546 sq. ft.: total, 1,725 sq. ft.; superheater, 363 sq. ft.; grate area, 31.5 sq. ft.

The longitudinal seams in the boiler shell have a strength equal to 30 per cent of the solid plate, and the firebox staying includes 700 flexible bolts. Three rows of Baldwin expansion stays support the forward end of the crown. The firebox contains a brick arch, which is supported on studs tapped into the side sheets. This engine is equipped with the Stephenson link motion, and piston valves 11 ins. in diameter. The principal dimensions are as follows: Boiler—Type, wagon-top; thickness of sheets, ¾ in. and 13/16 in.; fuel, soft coal; staying, radial. Fire box —Material, steel; length, 110 ins.; width, 41¼ ins.; depth, front, 75 ins.; depth, back, 71½ ins.; thickness of sheets, sides and back, 5/16 in.; crown, ⅜ in.; tube, ½ in. Water space—Front, 4 ins.; sides and back, 3½ ins. Tubes—Diameter, 5½ ins. and 2 ins.; material, steel; thickness, 5½ ins, No. 9 W. G.; 2 ins., No. 12 W. G.; number 5½ ins., 30; 2 ins., 201; length, 10 ft. 6 ins. Wheel base—Driving, 11 ft. 0 ins.; total engine, 11 ft. 0 ins.; total engine and tender, 44 ft. 10 ins. Weight—Total engine, 161,500 lbs.; total engine and tender, about 280,000 lbs. Tender, 6,000 gals. of water and 6 tons of coal.

Locomotive No. 32, for the Lake Terminal Railroad, is one of four heavy engines of the 0-8-0 type. Three of these, including engine No. 32, use saturated steam, the fourth has been equipped with a superheater composed of 30 elements. An excellent opportunity will thus be afforded to try saturated and superheated steam locomotives working in switching service under similar conditions.

These locomotives have 25x30-in. cylinders and 55-in. wheels; and with a steam pressure of 180 lbs., they exert a tractive force of 52,000 lbs. The saturated steam locomotives weigh 225,100 lbs., while the superheater engine is slightly heavier. The ratio of adhesion is approximately 4.33. Switching locomotives are frequently required to do their heaviest work in localities where rail conditions are unfavorable, and where a liberal ratio of adhesion is an advantage. In service, these locomotives traverse curves of 200 ft. radius.

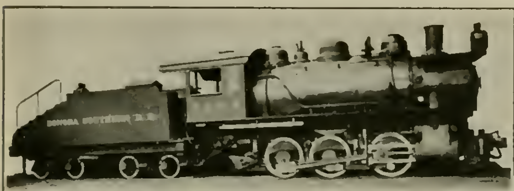
In this design, the boiler is of the extended wagon-top type, measuring 78 ins. in diameter at the front end. A wide firebox is used, the grate dimensions being 108x78 ins. The furnace equipment includes a Franklin power-operated firedoor, and the Security brick arch supported on tubes. There is a complete installation of flexible bolts in the water legs, and the front end of the crown sheet is supported by three rows of Baldwin expansion stays. The heating surfaces are as follows:

	Saturated.	Superheated
Firebox	186 sq. ft.	186 sq. ft.
Tubes	3,515 "	2,679 "
Arch tubes	28 "	28 "
Total	3,729 "	2,893 "
Superheater	... "	657 "
Grate area	54 "	54 "

The cylinders of the locomotives using saturated steam are designed for inside steam pipes, while the superheater engine has outside pipes. The latter locomotive is equipped with a Nathan five-feed lubricator, a separate feed being run to each cylinder barrel. The piston valves of all the locomotives are 12 ins. in diameter, and the valve gear is of the Walschaerts type, controlled by the Ragonnet power reverse mechanism.

The height limit on these engines is 14 ft. 8 ins., and with large, high pitched boilers the clearance is necessarily limited. The front sand box is centrally placed on the boiler, but in the case of the rear sand box there was not room to do this, on account of the wagon-top. Hence two sand boxes are employed, and they are situated right and left on the round of the boiler. The tender is carried on rolled steel wheels and archbar trucks. It has a frame composed of 13-in. longitudinal channels with cast steel end sills. The tank is of the water bottom type, with capacity for 7,000 gals. of water and 12 tons of coal.

These few illustrations by no means include all the principal designs now being built for switching service, but they clearly indicate that the modern switcher is a highly developed machine, and that, as far as details and equipment are concerned, it is now beginning to receive the attention that it should have. Some of the principal dimensions are as follows: Boiler—Type, Wagon-top; thickness of sheets, 13/16 in. and ⅞ in.; fuel, soft coal; staying, radial. Fire box—Material, steel; length, 108 ins.; width, 72 ins.; depth, front, 77½ ins.; depth, back, 65½ ins.; thickness of sheets, sides and back, 5/16 in.; crown, ⅜ in.; tube, ½ in. Water space—Front, sides and back 5 ins. Tubes—Diameter, 2 ins.; material, steel; thickness, No. 11 W. G.; number, 450; length, 15 feet 0 ins. Wheel base—driving, 15 ft. 0 ins.; total engine, 15 ft. 0 ins.; total engine and tender, 49 ft. 5 ins. Weight—Total engine and tender, 365,000 lbs.



DONORA SOUTHERN SWITCHER.
C. L. Miller, President.

ATLANTIC COAST LINE SWITCHER.
R. E. Smith, Gen. Supt. of Motive Power.

Baldwin Loco. Wks. Builders.

Car Heating Patent Suits.

The Chicago Car Heating Company issues the following: By a recent decision of the Commissioner of Patents in the interference suit between Chicago Car Heating Company and the Consolidated Car Heating Company, dating from 1908 over certain vapor heating system patent claims, the contentions of the Chicago Car Heating Company were sustained in all respects. The decision has now become final, from which no appeal has been or can be taken, and the Cosper Application (owned by the Consolidated Car Heating Company) has been abandoned, and no patent will be granted to the Consolidated Car Heating Company relating to any matter involved in that interference.

Manchurian Locomotives for Saigon.

The workshops of the South Manchuria Railway at Shahokon recently constructed and sent to Saigon, Cochin China, several locomotives for the French railways there. These locomotives were of what they call the "10-wheeler" type, weighing 64,103 pounds, or 103,053 pounds with tender. It is likely more will be built.

Nicaraguan Railway.

Mr. J. K. Choate, Vice-President of The J. G. White Management Corporation, has just returned from a six-weeks' trip to Nicaragua, where he spent considerable time inspecting the property of the Ferrocarril del Pacifico de Nicaragua, which is being operated by The J. G. White Management Corporation.

One Thousand Steel Frame Automobile Cars for the Chicago & North Western Railway

The Western Steel Car & Foundry Company recently constructed for the Chicago and North Western Railway 1,000 steel-framed automobile cars. After a thorough canvass among automobile shippers regarding sizes, clearances, etc., the following dimensions were employed: Length inside, 40 ft.; width inside of lining, 9 ft.; height on inside at side of car, 10 ft. 4¾ ins.; height on inside at center of car, 10 ft. 8¾ ins.; height of door opening, 10 ft.; width of door opening, 10 ft.; cubic capacity of car, 3,788 ft.

The car is of steel-frame construction, with girder center sills, which are of channel beams weighing 40 lbs. per foot, with ⅜ ins. top and bottom cover plates, the top extending the full length of the center sills, while the bottom plate extends for a distance of 24 ft. in the middle of the car. The side posts and braces are of ¼ ins. pressed shape, section riveted to the side sill channel and to the top plate Z-bar set edgewise, with the outer flange extending downward. The inner flange extends upward. This shape for posts and braces is used, because it had been found that greater damage is occasioned by side-swiping resulting from the square corner and the outside angle of Z-bar post and braces used heretofore.

An 8 x ¼ in. steel fascia plate extends from the side door opening to the corner of the car and across the ends, which is riveted to the web of the Z-bar side plate and to all posts and braces. The wooden lining is bolted to this fascia plate. The sheating is 1¼ ins. vertical grain Oregon fir and extends from the floor to the side plate fascia piece and is rabbeted over and bolted to the same. Special care is taken in the drying of the lumber, as it is realized that the success of a car constructed with inner lining depends on having lumber from which sides are constructed properly, and carefully dried to prevent excessive shrinkage. On the inside of the car for a height of 5 boards from the bottom and for a width of 9 boards at a point midway between the floor and the roof of the lining is made double in thickness to permit of the nailing of double decking and cleating for securing loads.

The end framing of the car has two center posts of 4-in. Z-bars weighing 10.3 lbs. per foot and two 3-in. Z-bars weighing 9.8 lbs. per foot. The corner posts are ¼-in. pressed section extending a sufficient distance on the side and end of the car for good secure bolting of the lining of both sides and ends, the latter of which is 1¾ ins. thick. To prevent the ends of the car from being forced out of shape, the center posts have been latticed from the top to the bottom. The roof is the Hutchins latest design of all-steel car roofing. Jacking brackets are secured on the inside of the side plates for convenience in loading. The door openings are staggered and are 10 ft. in width, and 10 ft. in height and are provided with Camel door fixtures having adjustable center posts, which adapts the car to the transportation of grain and merchandise, as well as automobiles and other bulky materials.

The car is equipped with Westinghouse KC-1012 brake, Simplex draw bars, Miner A-24-A draft gear, National Malleable Castings Co.'s oil boxes and lids, Vulcan type of cast steel truck sides with Buckeye steel truck boldsters. The stresses and strains have been carefully figured. The center girder section, which is considered the "backbone" of the car, has been made extra strong and has low fiber strains to withstand the violent shocks that these cars are frequently subjected to. The capacity of the car is 80,000 lbs. and its weight 46,100 lbs. The car has all the requisites for the shipment of automobiles and the means for securing them, so as to prevent shifting, but they are also well adapted for general service, especially so for the shipment of large, light and bulky materials.

Few people have any conception of the amount of transportation business done by the various automobile manufacturers in the country. The Chicago & North Western are fully alive to the requirements.

TYPE OF AUTOMOBILE CAR FOR THE CHICAGO & NORTHWESTERN RAILWAY.
Western Steel Car & Foundry, Builders.

Average Cars per Mile on the Lehigh.

The average number of freight cars per mile of railroad among those in trunk line territory was 20.4 in 1900 and 24.7 in 1915. The Lehigh Valley, however, had 25.3 cars to every mile of railroad in 1900, and fifteen years later had increased its average to 31.7 cars. In 1900 the Lehigh Valley had a total of 34,954 cars in service, while its mileage was 1,382. In 1915 its mileage had been increased to 1,442 and the total number of cars in service had increased to 44,974. This average of almost 32 freight cars to every mile of railroad looms large, particularly when compared with the average based on all the railroads in the United States, which is only 9.94, or less than 10 cars per mile.

A Study of "Engine Failures on the Santa Fe"

What a Failure Is and What Is Not—Remedies.

The subject of engine failures is not only of interest to railroad men, it is important. The first requisite is to have clearly in mind what an engine failure is, and then seek to avoid the causes which bring it about. Determining what an engine failure is or is not must of necessity be arbitrary. Some think all detentions caused by the mechanical department of one minute or over is an engine failure, others again have a different standard.

The Atchison, Topeka & Santa Fe have taken this matter up very carefully and Mr. M. E. Haig, their mechanical engineer, at Topeka, has taken considerable trouble to systematize the handling of the whole question. On that road an engine failure is ordinarily considered to be a failure, if resulting in delays to trains or a reduction of tonnage of trains from the time an engine with crew takes a train until the end of its run is reached. The reduction of tonnage is not, on all roads, conceived to be an engine failure, as it is on the Santa Fe. Including it, is logical because if an engine usually pulling say 30 cars, has to give up five, for any reason, it is really and practically asking for an easement in some form. It is manifest that to bring the other five cars on, will most certainly require the expenditure of time, power and the burning of coal.

The Santa Fe, however, while it maintains its theory of an engine failure in a general way, yet has formulated nine exceptions, in fairness to the mechanical department.

These are: (1) When a train is delayed as a result of an engine failure and afterwards makes up the time, such delay is not to be reported as an engine failure. Again, if the train is delayed and reaches the terminal late, due to other reasons, it is not an engine failure. (2) Delays to passenger trains where they are five minutes late or less, at terminal or junction points, do not constitute an engine failure. (3) Delays to scheduled freight trains, when less than fifteen minutes late at terminal or at junction points, is not an engine failure. (4) When an engine is given excessive tonnage and stalls on the maximum grades, providing the engine is in good condition, the extra tonnage saves its stalling on the grade from being viewed as an engine failure. (5) Engines steaming poorly, or flues leaking, on any run where the engine has been delayed on side tracks not caused by a legitimate engine failure, if the engine has been on the road fifteen hours or more per 100 miles, is not treated as an engine failure. (6) Engines going to shops after being taken out of service, the master mechanic having advised the Transportation Department what tonnage the engine can handle, but should engine fail, it is not to be reported as an engine failure. (7) It is not an engine failure when delays to fast scheduled freight trains occur when weather conditions are such that it is impossible to make time, provided engine is in good condition. (8) An engine failure should not be charged when a freight engine is taken between terminals for passenger service, in an emergency, and in such service runs hot. (9) An engine used after being ordered out of service for repairs, should not have a failure charged against it until the repairs have been made.

These exceptions are the result of careful work in appraising the value of standardization in the conception of an engine failure, modified by a series of circumstances which have come to the surface in practical daily life on an operated railroad. One may look in vain for any symptom of a desire to bolster up poor performance or take an undue or technical advantage, to protect the mechanical department. A failure is a failure, but where the contributing causes are outside the power or control of the mechanical department, which is vitally interested in engine performance, it is in accordance with the dictates of common sense to state the exact cause and to rate the engine accordingly.

When it comes to figures we may give what practically amounts to the Santa Fe railroad's estimate taken on the average. On that road the average figure given is number of failures from all causes per month on a railway of about 12,000 miles, with about 2,000 engines in daily service, and this figure, as given, comes to about 250. Usually about one-third of the engine failures are caused by locomotive parts breaking. It is interesting to note that in former years the number of failures due to broken parts approximated 165 per month. The number of failures now occurring from the same cause has been reduced to an average of about 90 per month.

One of the claims made by the Baker valve gear people is that their endeavor has been to facilitate this important point which has appealed so strongly to the Santa Fe. Their gear used on some of the engines we have illustrated, has had the effect of reducing the weight of the parts and has removed to a great extent the "whip lash" action of moving parts which has a tendency to set up heavy strains and which eventually leads to breakage of parts themselves, which are amply strong enough from a theoretical point of view, for the work they are called upon to do.

All this raises in the mind of any practical railroad man the strongly pertinent question, what can be done to forestall the engine failure which all would wish to avoid? Right here the matter of improved design and weakness of parts must be carefully looked after. In building new locomotives a thorough canvass of the Santa Fe road is made to gather the comments of mechanical and operating officers. This information concerns general performance of locomotives and relates to any weakness in parts which may have developed. Where any weaknesses are found, reinforcements can be made which will provide the required strength. Any undesirable feature observed in locomotives on the road and in regular service is eliminated when the time for ordering new power comes along. In addition to this, on the Santa Fe the matter is followed up carefully by a mechanical department representative of a System office. In our own experience we knew of a superintendent of motive power who followed this practice, and in the case of a steel tender frame and coupling attachments for engine and for cars, until at length he had a practically unbreakable tender frame, at which builders looked with long faces, but secretly admired.

Concerning failures due to other causes than broken parts there is one item which, no doubt, is responsible for preventing a number of engine failures and that is the inspection of locomotive front ends. This has been gone into carefully on the Santa Fe and front end arrangements have been provided that not only improve the steaming qualities of the engine, but cut down fire claims. The front ends are inspected periodically to see that no holes appear in the netting. The various parts and the bolts, etc., are properly secured to prevent them shaking loose or holes forming which would permit fire or sparks to be blown out.

Another matter which has a bearing on the number of engine failures is close roundhouse inspection. A number of defects are discovered and remedied instead of allowing the engine to go out on the road and cause an engine failure. In this, as in so many phases of railroad activity, "eternal vigilance is the price of safety." The formulation of a definite conception as to what does and what does not constitute an engine failure is the first step, and we invite our many readers to give us the benefit of their views, and to state what is the practice on their roads, and how it works out. We believe that the settling of the moot point what is a failure can be followed by a definite and systematic endeavor, where the efforts of all presses toward the same point. It is like putting a target before a firing squad; each man knows what he has to do, and fewer shots go wide, and the ring made around the bull's eye—economy—draws closer and closer to the central point, as practice leads towards perfection.

Ill Effects of Bad Water and the Causes Why Bad Water Exists.

Recently Dr. Sinclair gave some interesting facts as to the origin of water analysis and treatment, and the first tentative steps to secure good water for locomotives. Some remarks by Mr. W. A. Converse before the Pittsburgh Railway Club go further on the same interesting and important subject.

Water to the technical man is water in an absolutely pure state, devoid of all foreign substances, either gaseous, liquid or solid. Chemically, water is made up of two gases, hydrogen and oxygen. Hydrogen gas when pure is odorless, colorless, tasteless and non-poisonous. It has, however, the property of inflammability. It would not, however, give us the illumination, because of the absence of carbon. Oxygen gas has identically the same properties as hydrogen, with one exception, it is entirely devoid of the property of inflammability. It will not burn, but it is absolutely essential to all processes of combustion.

Going back to the composition of water, we will assume that we have three rectangular containers of identical capacity, one of which is filled with oxygen and the other two with hydrogen. If by any method we cause the two volumes of hydrogen to combine chemically with the oxygen we will produce water, and if the gases were pure we would naturally produce absolutely pure water.

It is believed that water as it leaves the clouds is in a practically pure condition. In falling through the atmosphere, either as rain or otherwise, it takes up certain substances. Naturally these substances taken up are dependent upon the substances contained in the atmosphere through which it falls, which in turn are to a large extent due to the industrial conditions existing upon the surface of the earth. But there is one substance always present in the air, and that is carbon dioxide (CO_2) or carbonic acid gas. In a district where bituminous coal is the chief fuel, and where this fuel is largely impregnated with sulphur, it is in the process of combustion converted into another gas just the same as is the carbon into CO_2. This sulphur gas naturally impregnates the atmosphere and is dissolved by water falling through the air, and eventually converted into sulphuric acid. Sulphuric acid is of such a character that when in even a weak solution in water it will dissolve metallic iron very rapidly. There is also present in the atmosphere, at all times, another class of substances commonly known as the ammonia class. All are conversant with ordinary household ammonia. The ammonia in the air is the same substance, but not present in sufficient quantity to give the odor. The atmosphere carries some of this in practically all neighborhoods at all times.

Assuming now that the water has passed down through the atmosphere and has reached the immediate surface of the earth, it has taken up some carbon dioxide (CO_2), some ammonia, undoubtedly some sulphur gases, and probably some oxygen (since the air is made up, to the extent of 20 per cent of this gas)—all of these gases being in solution in the water itself.

At the immediate surface of the earth further contamination takes place. That depending upon the refuse which covers the ground upon which the water falls. If the surface is strewn with decaying vegetable matter, the water takes up another portion of CO_2. Animal fats like tallow and lard are partly made up of fatty acids which are somewhat soluble in water, and they are extremely destructive to metallic surfaces.

Follow the water as it sinks into the ground we find that it takes up many other and different substances, mostly solid and mineral in character. If the water in traveling down through the earth comes in contact first with a deposit of carbonate of lime commonly known as limestone, it will take up or dissolve a quantity of carbonate of lime, the amount which it will take up above 3 1-2 grains per U. S. gallon being dependent upon the amount of carbon dioxide the water has previously accumulated in passing through the air and over the immediate surface of the earth, and the length of time the water remains in contact with the limestone. If in traveling through the earth it comes in contact with a deposit of sulphate of lime, or what we know in its natural state as gypsum, we would naturally expect that the sulphate of lime or gypsum would be the predominating substance in the water.

it had come in contact with a deposit of salt (chloride of soda) before passing through the deposit of sulphate of lime (gypsum), it would take up a very much larger amount of sulphate of lime than otherwise would be the case. In similar manner we could go on and consider each taken up from the earth, commonly found in natural waters, such as carbonate of magnesia, sulphate of magnesia, sulphate of soda, etc.

Water is practically a universal solvent. If we pass pure water through a layer of limestone, it would take up 3 1-2 grains to one U. S. gallon. Waters for locomotive use frequently contain as much as 53 1-2 grains. This means that 50 grains excess is due to the presence of CO_2 in the water taken in before the limestone presented itself. As the carbon dioxide gas is readily reduced in quantity, owing to a rise of temperature in the water. If the water be maintained at 212 degrees F. for a sufficient length of time, it will give up all its free and loosely combined carbonic acid gas, which would result in throwing out of solution these 50 grains of carbonate of lime, leaving in solution the 3 1-2 grains only.

First, silica. What is silica? Nothing more nor less than ordinary, white sea sand, so to speak. If we analyze nice white sand we will find that upwards of 99 per cent. of it is silica. Silica constitutes the base of our glassware, all of the enamels on our bath tubs, and all that class of material. Passing down to carbonate of lime, school crayon is the most common or ordinary form of this substance; all it contains other than carbonate of lime is a little binder to hold it together, and an abrasive substance like pumice stone to make it work satisfactorily for the purpose for which it is intended. Another common form of this substance is ordinary whiting.

Next we have sulphate of lime. In its native condition it is known as gypsum.

CHART No. 1.

TOTAL DISSOLVED SOLIDS	Incrusting or Scale forming solids	Silica
		Carbonate of Iron
		Alumina
		Carbonate of Lime
		Sulphate of Lime
		Carbonate of Magnesia
		Sulphate of Magnesia
		In presence with excess of Carbonate of Lime
	Non-Incrusting or Corrosive or Foaming Solids	Sulphate of Soda
		Chloride of Soda (Salt)
		Carbonate of Soda
		Chloride of Lime
		Chloride of Magnesia

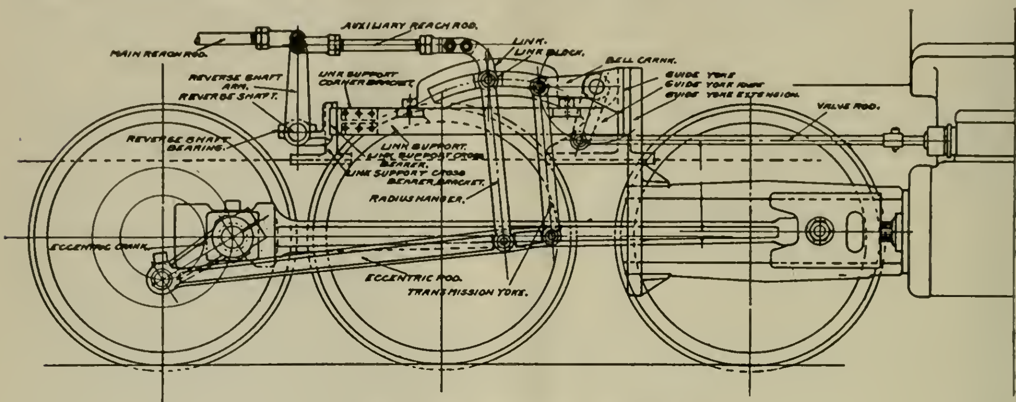
That is true in a sense. It is not necessarily true, however, because of this fact; if the water had previously come in contact with a deposit of carbonate of soda (soda ash) it would not dissolve or take into solution any appreciable amount of sulphate of lime. On the other hand if Next, sulphate of magnesia and this is Epsom salts. Chlorate of soda is common table salt, made up of metallic sodium which is vicious, and chlorene which is even more obnoxious. Sulphate of soda, even a weak solution of this is harmful to iron or steel.

The Southern Locomotive Valve Gear

The reports that come to us from time to time in regard to the suitability of the Southern Locomotive Gear are such that it will be of interest to the readers of Railway and Locomotive Engineering to present a brief resumé of its construction and operation.

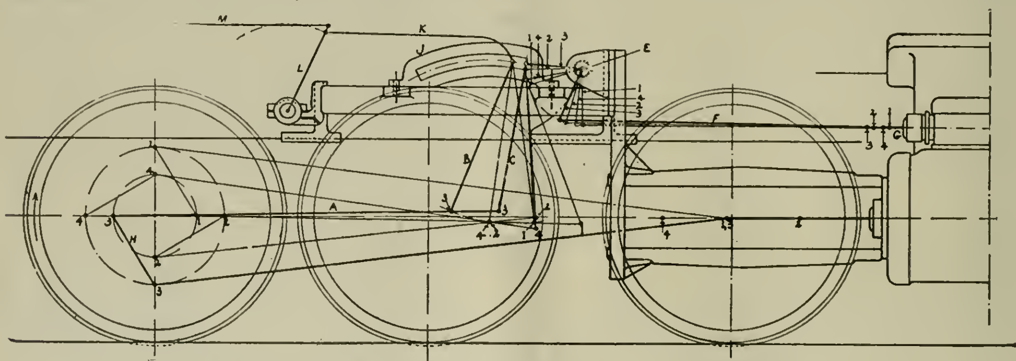
It should be known that it was designed and invented by W. S. Brown, a locomotive engineer on the Knoxville Division of the Southern Railway, and is named the Southern Locomotive Valve Gear. Fig. 1 shows that it is of the outside radial type of gear and obtains all of its motion from an eccentric crank attached to the main crank pin. To the eccentric crank there is attached an eccentric rod, the front end of the eccentric rod being attached to what is known as the transmission yoke, the upper end of the yoke being attached to one end of a bell-crank, and the valve rod being attached to the other arm of the bell-crank. Adjacent to the front end of the eccentric rod is attached a hanger, known as the radius hanger, the upper end of which is fulcrumed on the link block pin. The link used in this gear is stationary and rests in a horizontal position, the link block sliding forward and backward in the link only when the reverse lever is moved.

The motion may be followed by assuming that the reverse lever is in the extreme forward notch, and the link block consequently at the forward end of the link, instead of the center. As the wheel revolves the eccentric rod would move backward, and the end attached to the eccentric crank would also move upward, and this upward movement would pull down the forward end of the eccentric rod, and consequently pull down the upper arm of the bell-crank, and in pulling this end of the bell-crank downward the lower arm of the crank would be moved forward, thereby closing the front steam port of an outside admission valve. Not only so, but when the link block is in the front end of the link the radius hanger would be at an angle to the eccentric rod, and as the eccentric rod travels back this angle would be increased, thereby having a tendency to raise the forward end of the eccentric rod, which, in turn, would have the effect of raising the upper end of the bell-crank to move upward instead of downward and thus reversing the movement of the valve.



SOUTHERN LOCOMOTIVE VALVE GEAR ASSEMBLED.

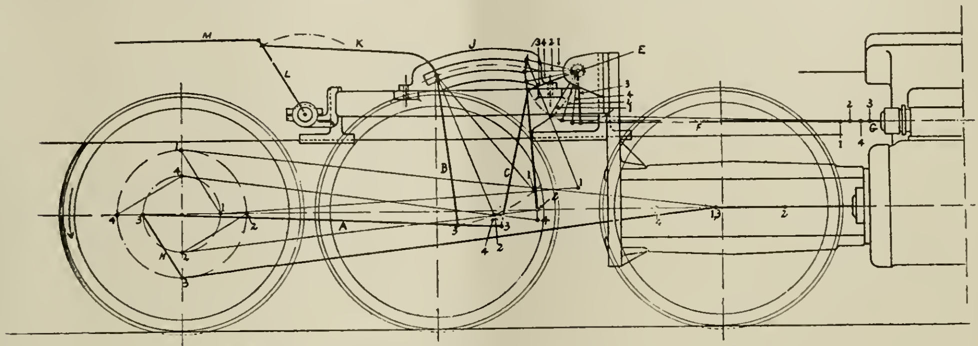
After the main crank pin has passed the bottom quarter the eccentric crank will have passed the back center, and from that point the motion of the valve being reversed, so that when the main crank pin reaches the back center the eccentric crank will have reached the upper quarter, the valve will have moved throughout its travel, and the back steam port will be opened for the admission of steam. The movement of the valve thus depends entirely upon the angularity of the radius hanger, and the position of the link block in the link determines the point of cut-off where the steam ceases to be admitted into the cylinder.



KINEMATIC DIAGRAM SHOWING VARYING POSITIONS IN FORWARD MOTION.

To elucidate the movement further reference may be made to Figs. 2 and 3, showing kinematic diagrams of the motion in full forward and backward gear, respectively. The cranks are fulcrum point be in the same ratio as are the diameter of the eccentric crank circle and the total lap twice the lead. As we have already stated, the alteration of the cut-off and reversal is ef- tion represents the travel of the valve in addition to the lap and lead.

It will thus be seen that there are but eight points at which wear can take place, or sixteen in all for an or-

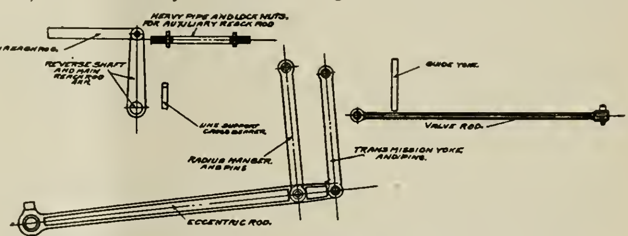


KINEMATIC DIAGRAM SHOWING VARYING POSITIONS IN BACK MOTION.

shown in four positions at 90 degrees to each other, the corresponding points being numbered, to render the sequences easy to follow. The lettering is the same in both drawings. The arrangement is for outside admission valves, the difference being in the eccentric crank, which is set in the case of outside admission valves at 90 degrees in advance of the main crank pin, and for inside admission valves the same amount behind the main crank. This is the only variation required for either inside or outside admission valves. It will be noted that the arms of the bell crank are set at rather less than right angles to each other, thus compensating to a certain extent for the angularity of the eccentric rod and main rod by causing the valve to travel equal distances backward and forward from its central position, and tending to square the valve events with the piston travel. The valve spindle G is united to the lower limb of the bell-crank by a rod in the usual manner.

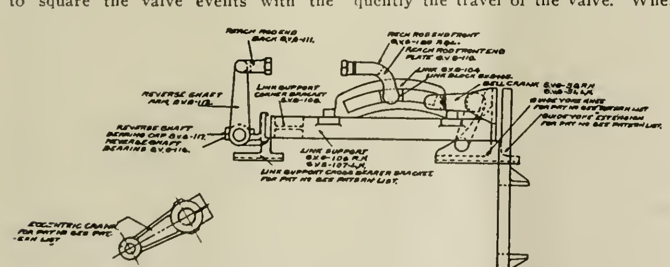
The eccentric rod, it will also be observed, is served as a lever, the fulcrum being the point of connection at B, and it is necessary so to proportion the eccentric rod that the lengths to this

fected by moving the block, from which the fulcrum lever B is suspended in the sector or link J, by means of the main reversing rod M, the reversing arm shaft I, and the auxiliary reach rod K.



WROUGHT FORGINGS IN SOUTHERN LOCOMOTOVE VALVE GEAR.

It is thus clearly shown that the position of the block in the link determines the inclination of the path traversed by the fulcrum pin, and consequently the travel of the valve. When the block stands in the center of the link, as shown in Fig. 1, there is no inclination of the travel of the fulcrum pin, and the valve is moved only the amount of lap and lead. If, however, the block be moved forward or backward, the fulcrum lever travels through an enclosed path, of which the inclina-



STEEL CASTINGS IN SOUTHERN LOCOMOTIVE VALVE GEAR.

dinary two-cylinder engine, and these consist of simple plain bushings. This is the most costly and troublesome detail of ordinary valve gear, not speaking of the inevitable wear of the link and link block in other valve gears equipped with oscillating links, and which in the case of the Southern Valve Gear may be said to be entirely eliminated.

It may be added that, when properly designed, the steam distribution is excellent, full admission being obtained very early in the stroke, and a rapid exhaust being obtained without excessive back pressure. Once carefully fitted, little attention is called for, but should adjustment be called for, it is very simply carried out by the insertion of suitable liners under the ends of the link J. Variations of the cut-off or reversal is performed with remarkable facility, even when working under full pressure, the design being such that all stresses on the reach rod connections are eliminated, and motors are not necessary for operating the reversing mechanism.

Figs. 4 and 5 show the details of the wrought iron forgings and steel castings respectively required in the construction of the gear, and it will be observed that they are all simple in construction and moderate in cost.

Regarding special tests that have recently been made with a view to secure data in comparison with locomotives equipped with other kinds of valve gear, a very exhaustive test of the Southern Locomotive Valve Gear was made, with the result that this style valve gear developed considerably more than the theoretical tractive power of the locomotive, the above test being conducted with dynamometer car, and engine equipped with Southern valve gear developed a draw bar pull of 47,346 pounds against two other type radial gears developing a draw bar pull of 43,393 and 45,233, respectively. These engines were worked under the same conditions, as near as possible to work locomotives. The Southern geared engine handled a total tonnage of 1,660 tons over the ruling grade, while the highest tonnage handled by either of the other engines was 1,586 tons. This test also developed that the increased tonnage was handled with no increase in fuel, thereby meaning a saving in the fuel account as well as increased tonnage handled.

Several other tests have been made from time to time; for instance, a test conducted between two passenger engines, one equipped with the Southern gear and another with the Walschaert, developed that the Southern geared engine only consumed 5.78 pounds of coal per car mile, or 52.04 pounds per engine mile, while the engine equipped with the Walschaert gear, on the same run, under as near same conditions as possible, consumed 8.2 pounds of coal per car mile, or 74.54 pounds of coal per engine mile. On this same test the water was measured, and it was found that the engine equipped with the Southern gear used 3,700 pounds of water less in a distance of 168 miles.

Mechanical Firing of Locomotives.

At a recent meeting of the St. Louis Railway Club, Mr. W. S. Bartholomew, President of the Locomotive Stoker Company, read a paper on mechanical firing of locomotives. He said in part as follows:

As a matter of fact, no stoker is automatic, and never has been, and I assure you that none will ever be made automatic. The use of that word "automatic" in connection with the mechanical firing of a locomotive is a misnomer. The fireman has to attend to his firing, and he has to use the shovel occasionally; he always will have to attend to the fire and use his head.

I would like to quote from a report of the Stoker Committee of the Master Mechanics' Association, for 1911, to give an idea of the standing of the stoker five years ago; because most, if not all, of what I have to say here, has to do with the development of the use and application of the stoker within the past five years. The summing up of the committee's reasons given for the non-application of stokers in any great numbers, up to the year 1911, is contained in this report; this was made in 1912, at the Atlantic City convention.

That most, if not all, of the locomotive stokers applied, up to the end of the year 1911, were not suited in one or more particulars to meet the variables in fuel, locomotives, and operating conditions, notwithstanding the fact that all the stokers applied up to that time actually had bona fide records of successful trips under certain conditions. That practically all such stokers had been designed without due consideration having been given to the usually severe requirements imposed upon strength of parts and correct mechanical design by the stress of operating conditions and the lower maintenance standards obtaining in railroad as compared with industrial service.

That the size of locomotives, particularly as to grate area and the tonnage hauled per train under the existing conditions of service up to the end of the year 1911, did not make mechanical stokers an absolute necessity. That nothing had developed up to that time to indicate that any less expensive fuel could be used for firing locomotives with a mechanical stoker than with hand-firing. That it would not be possible, as claimed by some of the stoker inventors and promoters, to do away with the regular locomotive fireman and have the work done by a helper.

The only consideration left as an argument for the general application of mechanical stokers to modern locomotives was the possible reduction in the amount of physical labor and suffering of the regular fireman sufficiently to enable him to do the work without other relief.

Reference to the history of the exploitation of labor-saving devices leads to the conclusion, regrettable as it may seem from a humanitarian point of view, that labor-saving devices are not purchased purely for the purpose of saving labor, unless there is some financial return—some conserving of energy or some contribution to the wealth of the individual —the purchaser—or the community at large. Otherwise labor-saving devices are not apt to be kept in general use.

That was about the situation, up to the end of the year 1911.

About that time conditions changed somewhat; two new factors came in, one of which was not the prime cause for bringing into use the mechanical stoker. At the last Traveling Engineers' Convention a paper on the subject of the mechanical stoker presented for consideration the fact that the mechanical stoker would do away with a second fireman. Railroads will not buy stokers for that purpose.

The real reason for the use of the mechanical stoker is the fact that the conclusion is now being reached that the locomotive is about the only thing on a railroad that earns money; and therefore the more money that you can make a locomotive earn, the better the returns will be in the matter of cost of moving the traffic, a thousand tons one mile, or a thousand tons one mile per hour, or a thousand tons one hundred miles per hour, or any other unit that you may want to bring your analysis down to. That is the real reason and the real purpose of the mechanical stoker.

The Barnum underfeed stoker was one of the stokers applied to locomotives experimentally. This stoker is of the underfeed type, having two or more stoking troughs placed longitudinally, but only three or four were used in the actual installations. The troughs were supplied with cast-steel helicoid screws, the flights of which were reduced in size at different points in their length, each diameter being about 2 ft. long, and at the offset, where the reduction in flight took place, deflectors or partial partitions were provided, with an aperture equal only to the screw. The effect of the use of these deflectors was to cause the coal to be lifted up out of the stoking troughs and forced over on to the grate areas at each side, and, of course, part of the coal was carried on through the reduced openings in the partitions until the next deflector was reached, where more coal was deducted from the quantity being forced along in troughs, and this continued until part of the coal had been carried to the next reduced diameter of the flight of the extreme forward end of the firebox and forced up out of the trough by the bottom being slightly inclined upward. These stokers were operated by the use of two double-acting steam engines, one placed on each side of the locomotive at the end of the cross shaft. The screws were driven with worm drive, the worms being on the cross shaft and the worm wheels being at the back end of the cast-steel screws. Separate crushers of ample capacity were placed on the locomotive tender to prepare the coal.

The Gee overfeed scatter type of stoker, with movable directing wings, are placed above the firing plate at the bottom part of the ordinary fire door. One of these stokers has been applied to a consolidation locomotive on the Pennsylvania Railroad, and is in operation in regular service today, firing the locomotive successfully. A crushing mechanism is placed at the back part of the conveyor of this stoker, which also serves as a measuring or feeding device to start the coal into the forwarding means of the conveyor.

The forwarding vanes of the conveyor are not made all in one piece, but are practically fingers which drop back of the coal in the backward movement of the reciprocating conveyor and serve to push part, or all, of the coal in their vicinity forward, to be engaged by the next succeeding set of fingers in the following action of the conveyor. The reciprocating action of this type of conveyor accomplishes the purpose not only of forwarding the coal but of partially measuring it and serving it to the firing plate in separate charges, and the steam blasts are operated in timed relation to the forwarding of these separate charges of fuel, and serve as plungers to inject the coal into the firebox in very much the same manner as it would be fired with a scoop.

The direction of these separate charges of fuel to the different parts of the firebox is accomplished by the movement of the wings, in relation to which the jets are also controlled, so that when the wings are pointed toward the left-hand side of the firebox the jet on that side is shut off and the right-hand jet serves to force the charge of fuel in conjunction with the wings over to the left-hand side of the firebox, and so on.

The individual characteristics of this particular stoker are the firing of the coal over the fuel bed in separate charges, representing very nearly the general scheme of hand-firing and the necessary intermittent action needed to permit each charge of fuel to be consumed before another is placed in the same location in the firebox.

The Standard stoker has arrangements for crushing or preparing the coal, this being accomplished by the use of a crushing zone at the forward end of the heavy cast-steel helicoid screw. The necessary flexibility for the movement between locomotive and tender is secured by the ball joint actions. Suitable arrangements are provided for adjusting the jets to different degrees of force and also to shut one or more of them off when it is desired to stop the forcing of coal to any given part of the firebox. The general action of the jets is intermittent, being controlled by an operating valve moved mechanically by the arm and rod connection shown.

The general arrangement of the Hanna overfeed scatter type locomotive stoker reveals the peculiar characteristic of this stoker. It is the use of a combination of movable mechanical directing means and continuously operating steam jets for distributing the coal over the grate area. It also has means for crushing the coal preparatory to forwarding it to the elevating and firing means.

The driving motor is a twin-cylinder, double-acting steam engine placed on the locomotive tender, usually in one of the forward ends of the water space. The operating routine is to have the coal passed to the crusher through the opening in the deck of tender, and after being crushed the coal is forwarded by a cast-steel helicoid screw to a receptacle at the base of the elevating means, which is another cast-steel screw placed in the vertical casing just at the left of the ordinary fire door of a locomotive. At the top of the elevating means is a large elbow, or goose-neck, through which the coal is forced by the pressure of the vertical elevating screw and finally falls by gravity over the directing vanes, or wings, to the firing plate placed inside of the regular firing door of the locomotive.

The Crawford mechanical underfeed stoker is in use on a large number of Consolidation and Pacific type locomotives on the Pennsylvania Lines West. The stoker was designed and developed by Mr. D. F. Crawford, general manager, Pennsylvania Lines West, and, as it was one of the first stokers to be applied to locomotives other than in an experimental way. The different stokers which have been developed have each individual characteristics as to mechanical design and method of handling the fire. This stoker is the foremost representative of the underfeed principle of firing; it has been in continual operation for the past four or five years, and well illustrates what can be done in the matter of successfully firing locomotives in that way.

The Crawford stoker is designed on the theory that the use, more or less completely, of the coking or gas producer process, during the progress of combustion, contributes toward economy and reduces the amount of black smoke usually made by a locomotive when working at or near its maximum output, and to secure this coking of the coal the fuel must be supplied to the fire from the bottom upwardly, hence the term underfeed stoker.

Having described the underfeed stoker which has so successfully demonstrated the correctness of the theory of that method of firing a locomotive, the next description is that of the Street locomotive stoker, of which more than one thousand are now in service on very large modern locomotives. It may very properly be considered as the principal representative of another method of firing: namely, that of supplying coal to the entire surface of the fire continuously at the rate of combustion, no coking periods being provided for as in the method just described.

A full description of the Street locomotive stoker will be found in one of our columns of our March, 1917, issue.

Mechanical Design of Electric Locomotives.

At the December, 1916, meeting of the American Society of Mechanical Engineers, Mr. A. F. Batchelder of Schenectady, N. Y., presented a paper on the "Mechanical Design of Electric Locomotives," a synopsis of which we have endeavored to give below. He said in part:

The steam locomotive has been developed by degrees to such a state of perfection that it is common to see it operate at nearly 80 m. p. h. and with perfect safety; but no one would think of operating at this speed backwards. With the coming of the electric locomotive, the railroad man must have a locomotive that will operate equally well in either direction.

With locomotives for the higher speeds it presents new problems requiring the most careful consideration of the running gear details.

The steam locomotive has what now seems to be natural characteristics to allow high speed operation in one direction. These characteristics are low center of at the point of the maximum lateral pressure.

To demonstrate more clearly, it is well to see what happens to a locomotive when entering a curve. A locomotive having a high center of gravity and with two driving axles guided by a two axle swivel truck will serve to illustrate the action. As the locomotive enters the curve, its tendency is to continue on in a straight line but the flange of the leading wheel gradually comes in contact with the outer rail giving the guiding truck an angular motion about its outer rear wheel and exerting a lateral pressure against the center pin thus giving the main frame an angular motion around its outer rear wheel.

The lateral pressure tending to displace the outer rail at the rear wheel of the leading truck is the amount of reaction from slipping the two inner wheels.

The lateral pressure tending to displace the outer rail at the rear wheel of the main frame is the amount of reaction from slipping the two leading drivers. The greater weight being concentrated at the drivers, and the distance of the truck center pin from the main truck wheels being greater, and the fact that there is but one wheel to take the strain, it follows that the point of the greatest concentrated lateral pressure is at the rear outer driving wheel.

These statements disregard the important factor of time, in the accelerating and centrifugal forces due to the rolling, governed by the height of the center of gravity above the wheel hubs, which tends to reduce the lateral pressure at the rear outer driving wheel. With a high center of gravity above the wheel tread the accelerating and centrifugal forces also tend to tip the locomotive up on the outer driving wheels relieving the weight from the inner wheels, thus lessening the force required to slip them and at the same time increasing the adhesion between the outer rail and tie by the additional weight.

If this locomotive is operated in the opposite direction, the lateral stresses at these wheels are of the reverse order, the guiding force now being applied at the driving wheel flanges and the reaction taken through the center pin to the truck wheel flanges. The swivel truck, now trailing, is free to oscillate from one side to the other, and the reaction from the force of turning the main frame may be applied at the center pin when the truck wheel flanges are tight against the inner rail allowing the force to accelerate the truck as well as the main frame through the gauge clearance to the outer rail, thus gravity at the front end carried on the center pin of a two axle guiding truck tending to prevent rolling over and having but little effect on the guiding and high center of gravity on the rear end with inside journal bearings allowing the locomotive to roll and increasing the time element which thus reduces and distributes the lateral pressure against the rail over a longer distance. This increases the vertical pressure on the rail, thus holding it more firmly in place. These same characteristics can be obtained in electric locomotives by the sacrifice of double end operation.

The advantages gained in operating the electric locomotive in either direction are important. One way of doing this is by using a four wheel guiding truck at each end of the locomotive. With the use of the extra truck, however, the value of a high center of gravity largely disappears. The lateral pressure against the rail at the rear end now appears at the truck flanges rather than at the flanges of the driving wheels and the high center of gravity no longer provides the same increased vertical pressure on the outer rail adding momentum, the value of which depends upon the lateral distance through which the truck is moved.

The momentum effect can be reduced by introducing resistance against swivelling, thus restricting the truck from oscillating from one side to the other of the track, the amount of this resistance to be determined by the allowable amount that can safely be applied to the truck when leading. To increase the vertical pressure on the outer rail the center bearing of the truck can be made wide, thus allowing the vertical component of the lateral pressure at the center of gravity to be transferred through the bearing to the wheel, or with the narrow center bearing the height may be made such that the lateral pressure at that point will result in an increased vertical component independent of the height of the center of gravity.

The electric locomotive besides being required to operate in either direction, is often also required to be adapted for operating high speed passenger trains and heavy low speed freight trains over main line tracks, to negotiate sharp curves, and to be easy on light track and bridge structures. With locomotives having geared motors, the requirement of operating the passenger and freight trains can often be met by changing the gearing to obtain the proper speed and draw bar pull. The running gear can be made with trucks of short wheel base and coupled together, the number of trucks depending upon the required weight of the locomotive for its maximum draw bar pull, and also on the allowable weight per axle. After providing all the safety appliances recommended by the Interstate Commerce Commission, it is important to arrange for the most convenient location of the operator to allow him an unobstructed view of the track and signals and to place conveniently the appliances he must use.

The power efficiency as affected by the mechanical design is governed largely by the type of the traction motors. It is apparent that the gearless motor mounted directly on the axle allows the design of the maximum efficiency on account of its few bearings and its absence of gearing and moving parts. The gearless motor which is mounted on a quill and driving through springs to the wheels may be considered second in its possibilities for high efficiency design, it having additional bearings and a greater number of moving parts. The single reduction geared motor with its additional bearings and gear losses can be given third place in its possibilities for high efficiency design. The single reduction geared motor driving through gears and side rods to the wheels may be placed fourth. The gearless motor driving through side rods and jack shaft to the wheels should be placed fifth.

The service time factor is dependent upon the ability of the locomotive to operate under all its service conditions and without undue strains.

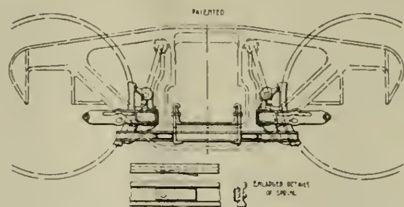
The cost of maintenance of the permanent way is a very important item and can be increased or reduced by the design of the locomotive, and the lowest cost is obtained when the locomotive meets its service requirements without undue strains, when the rotating parts are balanced, the weights per axle are suitable for the structures, a suitable equalizing system is provided to maintain the proper weight distribution, and when provision is made to protect against flange wear.

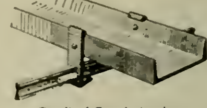
The cost of maintenance of the locomotive is dependent upon its safety of operation, its adaptability to service conditions, its reliability, its convenience of arrangement, and the same considerations that enter into its service time factor. The care with which the material is selected, the quality of workmanship, the ease with which the parts can be inspected, adjusted, repaired or replaced, and the simplicity of the design are the most important features that govern the maintenance cost.

The first cost of a locomotive will depend largely upon the design chosen, but its importance, except at the time of purchase, becomes of little moment when taking into consideration the eight foregoing features. The writer feels that too much importance cannot be given to developing to the utmost the mechanical part of the electric locomotive, that is the simplest in design and is the highest in efficiency. From the present outlook, the locomotive for high speed passenger service with the gearless motor, its armature being mounted directly on the axle, and the locomotive for freight and switching service with the single reduction geared motor, mounted on and geared to the axle lend themselves best to simple design and low cost of maintenance.

Atlas Safety Guard.

A safety guard designed to hold up brake beams in case of broken hangers or similar failures has been placed upon the market by the American Steel Foundries. After being thoroughly tested, a large number are already in use on several of the leading railroads. As shown in the accompanying illustrations, the device is simple in construction and durable in service. It consists of a supporting bar beneath each end of the spring plank, which absolutely prevents the brake beam from dropping to the track, and at the same time serves as a temporary hanger. The bar is locked in place automatically by the two springs, and may be readily removed by pressing down the spring. There are no rivets to cut, or bolts to be taken out, or cotter pins to be removed. The device is applicable to any kind of truck, and is a possible preventive of train detentions, and often derailments, that may arise from fracture of any part of the brake rigging. The device is highly spoken of where it is in service, and its adoption as an effective and popular rolling stock appliance is already assured.





Detail of Guard showing simplicity of construction

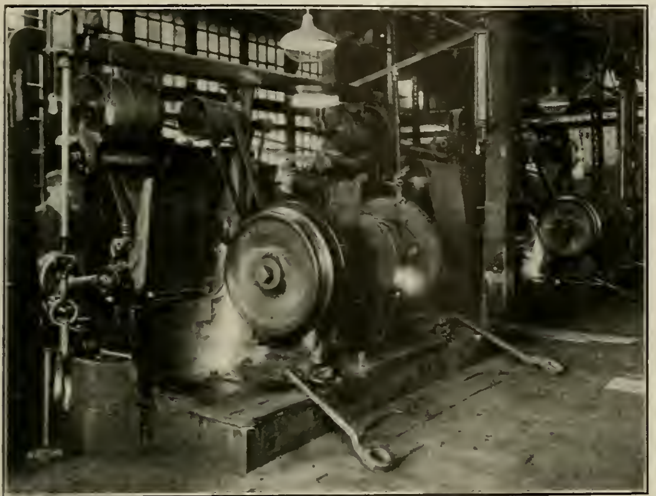
DETAILS OF ATLAS SAFETY GUARD.

Locomotive Caution Signs.

The Erie railroad company has adopted a system of using caution signs in the cabs of the locomotives intended for the protection of workmen who may be engaged under or about the engines. These signs are made of jacket iron, 6½ by 7 inches in size, and have inscriptions that explain themselves.

Making Davis Steel Wheels

Car wheels are subjected not only to excessive wearing conditions but to shocks and strains as well. It is desirable that the metal at the circumference of a wheel be tough and hard, for the larger the mileage obtained before removing the wheel, the lower the maintenance cost. At the same time the metal must not be brittle and it must have a certain ductility in order to resist the blows at frogs and crossings and to take up strains caused by brake shoe heating.



GRINDING THE DAVIS CAR WHEEL.

CALIBRATING THE DAVIS WHEEL.

The different types of car wheels embody these desirable qualities to a more or less degree. However, during the past few years a wheel which is believed to retain these desirable qualities is on the market. This is the Davis steel wheel, often called the "one-wear" steel wheel because of the mileage obtained without removal for turning. The essential feature of this wheel is that it combines a manganese steel tread and flange with a carbon steel plate and hub.

The method of producing such a wheel, containing these two kinds of steel in a single casting, is of special interest not only from a foundry standpoint but to the user of car wheels as well. The mold for the wheel is placed upon a table and revolved rapidly. The ladle is placed about the mold and the steel passes into the opening at the center. Powdered ferro-manganese is injected, through a small nozzle, into the first metal which enters the mold and combines with it to make manganese steel. The centrifugal action of the revolving mold immediately throws this manganese steel to the rim, where it forms a hard, tough, wear-resisting manganese steel tread and flange. The value of this low manganese steel in resisting abrasion is well known.

As the remainder of the metal entering the mold is not treated with manganese, there is a gradual blending or shading off of the manganese steel with the carbon steel which forms the plate and hub. The plate of the wheel is of a fan-like, corrugated design which is not only of value in allowing the metal to flow freely during the casting process, but also provides a design which takes up heat stresses readily. After the wheels are cast they are carefully annealed and finished. This includes grinding all treads to the proper M. C. B. contour and this insures a perfectly round wheel. This reduces the possibility of wheels sliding when brakes are applied.

By this unique process of casting the Davis wheel possesses the strength of the rolled steel wheel and at the same time retains the "one-wear" principle of the cast iron wheel, thus eliminating the trouble and expense of turning wrought steel wheels. Due to its higher resistance to wear the Davis wheel maintains a practically uniform wheel diameter throughout its life.

During the manufacturing process the wheels are very carefully tested and inspected at each step. The most severe test being the drop test. Here each wheel is supported at three equi-distant points on the flange and a 500-lb. weight is dropped upon the hub from a height of 6½ ft. This test is sufficiently severe to reveal any imperfections in the casting and at the same time does not permanently affect the strength of the wheel. Before being sent to the shipping room, each wheel is tested with a scleroscope for uniform hardness. The wheels are also taped, those of the same diameter being marked with the same tape number, in order to insure uniformity in mating the wheels when put into service.

Because the Davis Steel Wheel contains a combination of ductile open-hearth steel and also manganese steel, it combines strength with resistance to wear, and these qualities make it possible to reduce weight. As it is a "one-wear," steel wheel, it carries no added thickness at the rim.

Tests were conducted by Prof. L. E. Endsley (at that time of Purdue University) at the East St. Louis plant of the American Steel Foundries. The average maximum static load on the flanges of the Davis wheels was 381,000 lbs., that for the rolled steel wheel was 386,500 lbs.

THE DROP HAMMER TEST.

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Cold Weather Not a Handicap.

The fact that rubber hose is used between cars for the conveyance of fluid under pressure naturally indicates that an irregular sort of motion exists between the cars which can best be dealt with by a flexible connection. Flexibility necessarily excludes the idea of rigidity. One of the handicaps that rubber hose is compelled to bear, is the loss of flexibility in cold weather, the colder the weather the harder and more rigid the hose becomes.

One of the most successful ways, which we have heard of as used in the effort for continued flexibility and the holding off of the hard, rigid state, is the use of a suitable connector which automatically unites air, whistle and steam pipe connections between cars. A detailed description of the mechanics of this problem was given in RAILWAY AND LOCOMOTIVE ENGINEERING on page 405 of the December 1916 issue. It is well worth looking over again, because the device spoken of is simple and effective and is in fact the logical follower of the vertical plane coupler idea. There are one or two most important reasons which back up the consideration of the question and make it look interesting.

In the first place cold weather, really below zero temperatures, have a tendency to make rubber hose hard and rigid and if, when it is in that condition, it is moved or shaken about, it has a tendency to crack. A leak so formed blows away a lot of air that cost money to compress, and it may have the effect of holding the brakes set or making them drag, thereby using up more coal and steam in order to beat nature's hard weather handicap. When steam hose is used, as with passenger cars, the metal surfaces of the "gatherers" of such a device take up a small amount of heat from the steam, and this, slight as it is, produces some effect, just as a wet substance weighs slightly more than if dry. Whatever the effect be it large or small, it is on the right side and in favor of the much desired flexibility of rubber.

An effective method of coupling the hose does not cause the gaskets to rub on one another, as when coupled by hand, they come together fair and square as when a door is shut. The contact is made by straight pressure and there is consequently no turning or wearing action in making or breaking the contact. Further than this the connector retains the hose in one easy and natural position between the cars, the whole thing is held securely and it is too solid to sway or swash about in the wind or when rounding curves. In this way there is no movement forced upon the hose, when it is cold, and therefore ready to crack on the first opportunity.

Once again let us say that the fact that hose is usually coupled up by hand brings with it the necessity of bending the rubber. The effect of constantly kinking this material helps to wear it out by locating an artificially weak spot just where one does not want it to be, and when frozen, if the hose is pulled apart it is more than likely to be damaged there or to tear in two. When one examines the hose coupling as it usually is, he cannot fail to be struck with the ingenuity of the design, yet when following the course of the air through it, there are two right angle deflections to the flow of air to get it from one hose coupler head to the other, and past the gaskets. It is at this, one may almost say, "inopportune" place that the lowest point of sagged and hanging hose is seen, and the likelihood of moisture collecting there is great.

All air contains moisture and the act of compressing the air deposits some of the moisture, as when a damp sponge is partially squeezed. The correct connector has no deflection to the flow of air. It affords a straight course so that moisture is little or no worse there, than it is when distributed in a thin film along the inside of the air pipe.

These facts are presented to our readers for their information and benefit if they care to apply them; we are not concerned in the success or failure of the connector. The company concerned believes in its product so far that, taking the average life of ordinarily handled hose at eight months, the company will give their patrons a new hose, when it fails in their apparatus, in anything less than three years. That simply means that the connector company expects their hose to give a railway more than four times the service now expected of hose. A company that stands behind a guarantee of that kind would cut a sorry figure if they did not have facts and figures to back them up.

The Superheater.

When an engine has been built, the wheels, cylinders and frames, etc., are fixed, the maximum steam pressure is decided upon, and the boiler is made of a definite size. None of these things alter themselves to suit the varying conditions of nature, where wind and weather, grade and rail, play each a part in the engine's performance; they act without relation to each other, and where constancy is a thing unknown. These diversities in resultant values are yet further susceptible to modifications as day by day the engine tugs at a heavy train or draws one of lighter weight. Here, then, is the fixedness of the machine and its parts on the one hand, and the mutations which nature interposes to its operation on the other hand, and if this were the final statement of the case we would find ourselves face to face with an insoluble equation in which all the constants were on the one side and all the variables on the other.

It is evident since the constants of the equation constitute fixed parts of the locomotive any change of these parts will have the effect of making the engine more or less able to cope with variable conditions under which it must operate. A change in cylinder sizes for example will benefit or detract from the work it is able to do and will of course have an opposite effect upon the boiler. The reverse in general is true, that is an increase or decrease in the boiler capacity will be reflected in the performance of the cylinders.

In the first place superheated steam reduces cylinder condensation. One of the reasons is, superheated steam having less heat conductivity, the chilling effect of the cylinder is only able to effect a ring of steam less thick than if saturated steam was used. Therefore less steam turns to water in the cylinders.

There is, of course, always a factor in the problem which has a strongly beneficial influence on the result. It is the increased boiler capacity created by the use of superheated steam. By superheating, the engine uses what steam may be produced more economically than if the steam was simply saturated.

When one speaks of increased boiler capacity in this connection, he means that steam, when superheated, is expanded so that it occupies a greater volume than the same amount when saturated. A very important consequence of this is that less superheated steam is used when doing a definite amount of work than if it had been merely saturated. Less fuel is required and less water is used with superheated steam with a corresponding economy of both.

In the engine with the larger boiler capacity, the saving produced by the superheater acts as a reservoir which can be drawn upon at will. The more economical use of what steam is generated in the superheater engine, and its heating on the way to the cylinders, gives it an amount of extra heat which enables it to meet the inevitable losses produced by contact with the comparatively cool cylinder walls, and yet it suffers practically very little condensation. It loses some of the extra heat given to it, as it touches cylinders and valves, but even then it is too hot to lose enough to bring it down to the dew point. A regiment of soldiers may charge up to a fort or trench, with some loss of man-power but may still have enough to carry the position.

If the steam represents the charge it will be found that there are much fewer casualties among the "superheated" forces than if the regiment was represented by saturated steam. When we consider the heat units as representing the energy in the steam as regiments of soldiers, the greater number of heat units in the "superheated" steam regiment allow it to bear the losses in the charge, without impairing the regimental efficiency. The "saturated" steam regiment, however, has no excess of soldiers or heat units to repair losses. It reaches the trench which here represents the cylinders, but its force is already too much impaired to work most effectively.

As steam passes to the cylinders, the superheater constantly dries it, so that at the moment of maximum work the dry superheated steam is used in less quantity than saturated steam. Back pressure is reduced by reason of the smaller volume and lesser weight, and if one may say so, it moves faster and is more nimble than saturated steam.

It has long been known that after steam has been made hot enough to reach the state of being perfectly dry, any small addition of heat brings about an increase in volume, and for this reason the employment of superheated steam certainly shows itself to be more economical than steam on the point of condensation. The much higher temperature of superheated steam, together with its much smaller conductivity of heat and its much greater fluidity makes the avoidance of even a small leak a matter of importance.

Lastly the hauling power of the engine is increased, because the mean effective pressure in the cylinders is higher with superheated steam, owing to the minimizing of losses. The economies, which are produced by the use of superheated steam, briefly stated, are: 1, Reduction of cylinder condensation. 2, Low conductivity of heat, which prevents the chilling effect of the cylinder walls from reaching all but the film of steam in contact with them. 3, Reduction of back pressure owing to the less weight of steam to be exhausted, and the fluidity of the hot steam enabling it to get out of the exhaust passages with great rapidity. 4, Higher maximum mean effective pressure in the cylinders owing to the various smaller losses that superheated steam necessarily produces.

At the present time, when more accurate methods are employed, and when performance is looked at in detail, the use of superheated steam thus becomes a revenue-producer of such practical value as to reach the status of a paying investment with minimum expenditure. It is a triumph applied science directed to one of the transportation problems of today.

Railroad Clubs.

During the winter months the activity of the Railroad Clubs is an educative force of prime importance among railroad men. It is gratifying to observe that the attendance and interest is growing with the growing years. Not only so but the papers presented are of a higher order of excellence, while the discussions show a marked improvement both in matter and in manner over that of the earlier days when public speaking among railroad men was an undeveloped art. As is well known, men whose time is occupied in engrossing mechanical activity have little to say. Their work speaks for them, and while there are a few upon whom the gifts of tongues have fallen they are the exception. The railroad clubs have changed this, and the regular attender at the meetings realizes that we are all eloquent in the things that we understand.

Nothing could be more proper or becoming than that men who are engaged in the same occupation should meet together and compare notes, as it were, on the means and methods of obtaining the best results. Iron sharpeneth iron, and so does the record of experiences enlarge the mental vision and develop the spirit of mental activity essential to the best harnessing of the elemental forces and material incident to the great and growing problems of railroad transportation.

It has been occasionally pointed out that here and there there is a slight tendency to take advantage of the railroad club to exploit some marketable article by a member of some enterprising firm, and by this means advance the interest of some scheme, perhaps laudable in itself, but as yet in the realm of experiment, but in regard to this it is safe to state that the executive committees who supervise the introduction of such papers may safely be trusted as knowing that such subjects although conveying ideas embryonic and undeveloped are worthy of serious attention, and while the engineering press is the proper sphere for the presentation and promulgation of such matters, where the inventor or supply man may tell his story in his own words, in the advertising columns, supplemented by such other forms of publicity as the press may afford. When the device or process in question has been used on a railway and reported upon by serious railroad officials and has become more or less established as legitimate railroad practice, it may become a fit subject for explanation and description before a railroad club.

We thus are in an age of amazing progress, and the railroad clubs are doing good work in their chosen field, and their growing popularity is an incident that should meet the approval of all who are interested in the improvement of the social life and higher education of railroad men.

The Unstudied Reality.

On a large and well-known railway system, a locomtive engineer of the old school explained to some companions that he had developed a certain kind of caution. He said he always distrusted a brakeman who ran eagerly ahead to throw a switch for him. He had noticed that whether the switch was set for the main line or for the siding, the eager brakeman invariably threw it to the other position, and the engineman had been "on the ties," once or twice before he learned the value of distrust in such cases.

Mr. Marcus Dow, General Safety Agent, N. Y. C., showed a moving picture, "The House That Jack Built," to the N. Y. Railroad Club a short time ago. In it an instructive bit of scenic art is displayed, which throws a strong sidelight on the action of engineman and brakeman of which we speak, though the moving picture depicts a different incident.

The picture shows a railwayman at breakfast with his wife. Some misunderstanding arises, hot words and indignant looks are exchanged, and the man hastily goes off to his work with anger in his heart.

In this frame of mind, and brooding over the distressing incident, he enters the familiar railway yard. His mind is occupied with the details of the quarrel. A psychologist would tell you the man's mind was technically "interested" in the tiff with his wife, not pleasantly, of course, but interested so that his attention became absorbed in it and the unhappy occurrence constituted his dominant thought. The danger lies here. Amid the stream of sights and sounds entering by the sensory channels of eyes and ears, the man's mind did not recognize them.

They come to him as surely as they do to you and me, but he was so engrossed with sad or resentful thoughts that the other incoming sensations did not pass the threshold of consciousness, and all save the one gloomy idea was excluded.

He mechanically approaches the track, on which a box car is being pushed by a yard engine. He heeds it not. In his state of mind he cannot heed it. He may see it and hear it, but his ears are mentally dull and he looks at it with uncomprehending eyes. He is struck down by the moving car, which rolls upon him irresistibly, and to him it seems to come abruptly and from out a silent world.

The dominance of the one thought rendered him for the time, incapable of self-protection. The same phenomenon exists where a slight-of-hand performance focuses the attention of the spectators on the mysterious movements of one hand of the performer, while their eyes are practically blind to the movements of the other hand. They see it but they do not take it in. In any such case as those we have mentioned, the eager brakeman, the moving picture man, who truthfully represents an undoubted fact, and the spectator watching an entertainer, all are dominated by one idea, so overmasteringly powerful that each is blind and deaf to all else and may even appear idiotic in other directions.

It is wellnight impossible to break the strength of the engrossing thought, except in some more or less peremptory or violent way. Mr. Dow's picture shows the thing as it is, and by implication shows the need of studying this fact, for undoubted fact it is. The picture reveals the difficulties in the way, and the sinister suggestion of untoward results. The lesson must be taken, for himself, by each beholder. Bitter reflections, day-dreaming, mentally enacting or analyzing a course of conduct, lingering on the memory of friends or happy hours, all these are dangerous where the world around us is in vigorous action. In short, anything that tends to rob the mind of that swift alertness of thought and keen appreciation of present actualities, is terribly out of place among the intricacies of a busy yard, or in the operation of a railway train in daily life upon the road. Practical knowledge of surroundings must be unflinchingly maintained, often as the result of cruelly forced attention, amid inviting distractions. The hitherto unstudied reality of mind action exists and must be reckoned with, in the legitimate march of progress which we hope to make in the exacting and strenuous railroad world.

The Facts in Regard to Car Shortage.

The American Railway Association with the approval of the Interstate Commerce Commission has established means which has reduced the freight car shortage from 114,908 last November and 107,778 in December, to 59,892 on December 31. A spirit of co-operation has sprung up. Those who detain cars are compelled to pay increased demurrage charges, making delays unprofitable.

In regard to the charge that the railroad companies have not procured sufficient new equipment the association points out that the number of cars owned by the railroads increased from 1,840,000 in July, 1907, to 2,518,885 in July, 1916, a gain of over 36 per cent. Not only so but it is also shown that the railroads had a surplus of cars for nine years with the single exception of the year 1909, so that in spite of the financial troubles during recent years equipment was kept ahead of the demand. The orders for new equipment at present on hand exceed the capacity of supply, but the common cry against the railroads obscur the mental vision of all except those who take pains to discover the truth.

Development of Railroad Operating.

By Angus Sinclair.

For years after railroads were put into operation the lines under one management were nearly all short, one hundred miles being about the maximum length. Such lines were managed almost entirely from the head office, all rates for passengers and freight being arranged by the management, which took care that the charges should not deviate from the legal or established schedule.

In the control of train movements the station agents exercised considerable influence. They controlled the loading and unloading of freight and were at liberty to delay trains while freight was being handled. All trains were run on schedule, but station agents were at liberty to accelerate or delay train movements, and they enjoyed the privilege of deciding how many cars should be placed upon any train. For years each train had to take along all the cars ready for movement, and it was a common occurrence for engineers having to double on every hill they came to, a practice which tended to greatly demoralize traffic.

This condition of operating led to the appointment of a train inspector, who decided the load each engine should be called upon to haul. As the cars varied greatly in capacity, this inspector decided upon the loads being handled by the various locomotives. On some railroads the inspector was called train master and later superintendent.

The superintendent performed a variety of duties that had not previously fallen upon the station master or train master. In most cases he was responsible for the proper operation of the railroad, not only for the regulation of train movements but for the work of all railroad employees being properly performed. The station agents continued to decide on what rates should be charged for passengers and freight, but when any dispute arose between passengers or shipper with the agent the superintendent settled the matter, unless the question was of sufficient gravity to be appealed to the head office.

On nearly all railroads the machinery department has been managed repeatedly from the operative department and the locomotive superintendent had entire charge of his own force and was responsible to the general manager. When the responsibilities of the division superintendents came to be clearly defined they had supervision over the workmen engaged on the maintenance of way which was shared to some extent by the engineering department. In fact, before there were regular superintendents the civil engineers acted to some extent as supervisors of train and traffic operations; but by degrees the engineers' duties became curtailed to the engineering department proper, which included care of track, bridges and buildings.

In Great Britain, where my longest experience in railway work was gained, there was no diversity of rates for passengers or freight. A regular schedule of rates was established by the management under government supervision and no deviations from that schedule was attempted. I never heard of rate cutting on European railways, which prevented the business complications that became common in the United States.

I had a few years experience on a short railroad in New York State that was in a position to compete with other lines, and then the rates were fixed by the superintendent, who habitually attracted business by giving rates lower than those charged by competitive companies. Then the superintendent was supreme and the prosperity of the company depended upon his energy in securing business. I had heard him accused of being unfair, and he replied, "Fairness be damned; I must have the business."

Such sentiments became widespread by degrees and led eventually to State and Government control of rates. As consolidation of mileage resulted in railroads being very long, the superintendent lost his supreme authority he exercised on the shorter lines, but his position as a ruler has become more comfortable and his responsibility more limited.

Employees Insured on the Union Pacific.

Nearly 40,000 employees on the Union Pacific have been insured through the group plan of the Equitable Life Assurance Society. By the Continental Casualty Company, they are also insured against accident or sickness losses. All the employees come under the plan at the end of one year's service. The cost to the company will be about $750,000. In each case the insurance amounts to one year's salary, not to exceed $2,500.

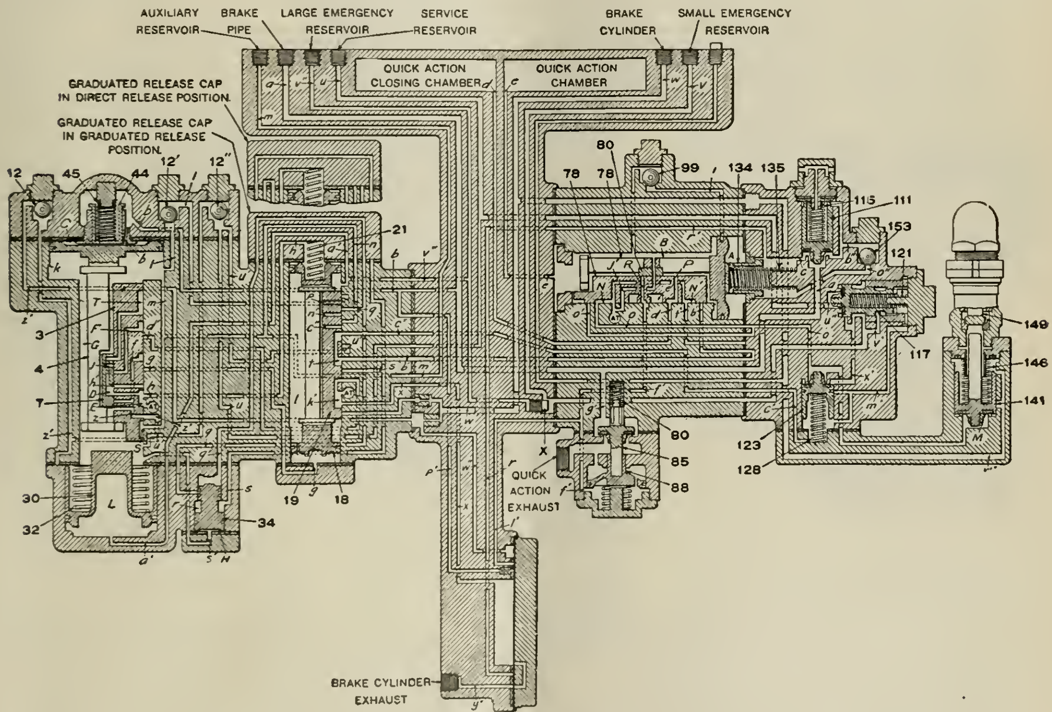
Air Brake Department

Operation of the Universal Valve—Elimination of the Brake Pipe Branch Cut Out Cock on Passenger Equipment Cars.

In the past issues we have printed a description of the general construction of the universal valve of the U. C. passenger brake equipment as applied to Pennsylvania Railroad cars and have given the names of the various parts. At the present time it is desired to explain the operation of the valve in charging the reservoirs and during a service application of the brakes.

duction made at a faster rate than at which it can flow from the auxiliary reservoir through the feed groove or past the equalizing piston packing ring into the brake pipe causes a differential in pressure between the brake pipe and auxiliary reservoir pressures, and as soon as the difference in pressure becomes sufficiently great to overcome the resistance of the equalizing piston and slide valve to move-

tem must be charged, and when compressed air enters the brake pipe, it is free to flow into the branch pipe leading to the universal valve and to the upper side of the equalizing piston, forcing the equalizing piston and its attached valves to the position shown in release and charging. As these valves are now being operated with the graduated release cap in direct release position, instead of gradu-



UNIVERSAL VALVE IN SERVICE POSITION.

The two views of the valve in service and in charging application position are diagrammatic, the actual construction of the valve having been shown last month.

It will of course be understood that the valve is operating under the same conditions as ordinary types of triple valves, a brake pipe reduction produces an application of the brake and an increase of pressure in the brake pipe releases the brake, provided, of course, that the proper differential in pressure necessary to secure movement is obtained in each case. With the brake system charged, a brake pipe re-

ment, the valve will move to application position and if the brake is in an operative condition it will apply. A release is then accomplished by increasing the brake pipe pressure at a sufficiently fast rate to build it up enough higher than the pressure in the auxiliary reservoir to overcome the frictional resistance to movement of the equalizing piston and slide valve. Provided that the valve is then in an operative condition, the parts will be returned to release position, opening the brake cylinder to the atmosphere.

Before a brake can be operated, the sys-

ated, therefore, as brake pipe pressure passes through the feed groove in the equalizing piston bushing into the auxiliary reservoir, auxiliary reservoir pressure is also free to flow through suitable ports to the chamber under the graduated release piston. This can be readily traced by following the port leading from the graduated release piston chamber to the graduated release cap where it will be observed that the auxiliary reservoir pressure is directly connected with the graduated release piston chamber when the valve is in direct release position.

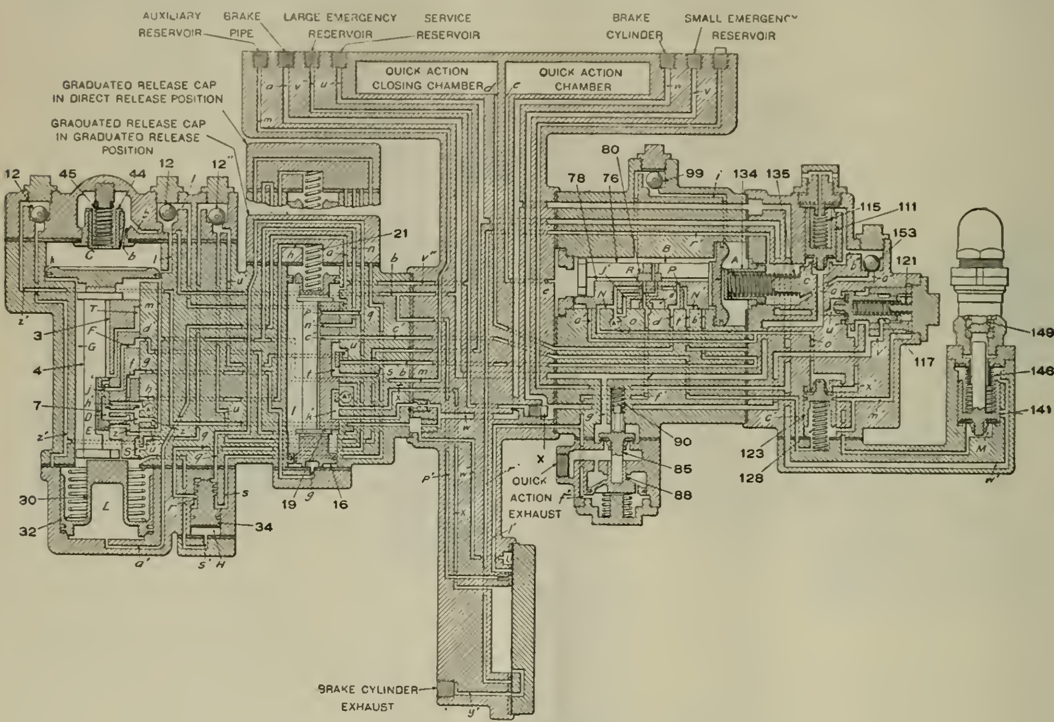
It will also be understood that the equalizing slide valve bushing is at all times in direct communication with the auxiliary reservoir and the pressure in the bushing is auxiliary reservoir pressure in a similar manner that the pressure surrounding the triple valve slide valve is at all times auxiliary reservoir pressure.

Auxiliary reservoir pressure is also free to flow to the chamber at the under side or large end of the charging valve, moving it upward to the position shown in release and charging position, in which the service reservoir and large emergency reservoir are connected.

At this same time brake pipe pressure reservoir pressure is always present in the release slide valve chamber, and the port leading to the emergency reservoir also extends to the quick action portion, but with the present arrangement this port is shown plugged, while another port leading from the released slide valve chamber passes through the quick action portion and runs to the back of the high pressure and intercepting valves. From this latter port the small emergency reservoir is charged from the large emergency reservoir (release slide valve chamber) through a feed groove in the intercepting valve bushing.

In this manner all of the reservoirs and position, when the system is charged, and move under identically the same condition.

The release piston is of a double ended piston type, with a small port drilled through each piston, and the ends of the pistons make a seal on the gaskets at either cylinder cover, that is, when the release piston and slide valve are in the position shown in release, the release end of the piston makes a seal against the cylinder cover gasket and a portion of its outside end is open through the equalizing slide valve and graduating valve to the release slide valve exhaust port and the atmosphere. The pressure at the ap-



UNIVERSAL VALVE IN RELEASE AND CHARGING POSITION.

is also free to flow to the seat of the quick action valve, and to the brake pipe seat of the protection valve moving it to the position shown, from where it can flow to the emergency piston chamber, thence through a ball check valve to the emergency slide valve bushing, charging the quick action chamber and the quick action closing chambers. These flows of pressure may be readily traced after a few moments' study of the diagram.

The large emergency reservoir, sometimes termed the quick recharge reservoir, receives its charge of compressed air from the equalizing piston chamber through a ball check valve. The large emergency chambers mentioned are charged to the pressure carried in the brake pipe. It must be noted, however, that the quick action chamber and the quick action closing chambers cannot start to charge until after there is about 40 lbs. pressure in the brake pipe, that is, the tension of the protection valve spring must be overcome before the protection valve can be lifted from its brake pipe seat and have the atmospheric seat closed.

The equalizing piston, slide valve and graduating valve are maintained in the positions shown in charging under the same conditions that a triple valve piston and slide valve are held in release plication end of the release piston is balanced through the port previously mentioned so that the emergency reservoir pressure in the release slide valve chamber positively holds the release piston in the position shown, however, a release piston spring assists in the movement of the structure to release position.

In release position, the brake cylinder is open to the atmosphere through the release slide valve and exhaust port in the bracket.

It will be noted that the protection valve is held to its seat with combined spring pressure and brake pipe pressure.

The intercepting valve is held to its

seat with combined emergency reservoir and spring pressure.

The high pressure valve is held to its seat with combined spring and emergency reservoir pressure.

The quick action valve is held to its seat with combined brake pipe pressure and spring pressure.

The cut off valve is held to its seat with spring pressure, while the universal valve is in release position.

It will also be noticed that each of the slide valves have an exhaust port, the equalizing slide valve exhaust port, the release slide valve exhaust port and the emergency slide valve exhaust port, and in addition to the brake cylinder and quick action exhaust ports, the protection valve cap nut contains an exhaust or vent port and the E-6 safety valve has the usual exhaust ports in the spring chamber. With all reservoirs and chambers of the system fully charged an application of the brake is produced by making the usual reduction in the brake pipe pressure, and when this reduction takes place at a faster rate than that at which the pressure in the auxiliary reservoir can flow back into the brake pipe through the feed groove in the equalizing piston bushing, the difference in pressure necessary to move the parts to application position is created.

When sufficient difference is obtained to result in a movement, the auxiliary reservoir pressure moves the equalizing piston and its attached graduating valve to first close the feed groove, thus positively separating brake pipe and auxiliary reservoir pressures.

The movement that causes the piston to close the feed groove also causes the graduating valve to open the friction increasing cavities in the face of the equalizing slide valve to the atmosphere, thus making the equalizing slide valve considerably harder to move than when these cavities are filled with compressed air and the slide valve more nearly balanced. When the cavities are opened in this manner a greater area of the face of the equalizing slide valve is exposed to atmosphere, consequently the slide valve is more difficult to move than when the pressure surrounding it is more nearly balanced; however, when 4 or 5 lbs. difference in pressure between the brake pipe and auxiliary reservoir pressure is obtained, the equalizing piston will move the slide valve to the position shown as service.

The first movement of the equalizing slide valve opens the application end of the release piston to the atmosphere and closes the port leading to the release end of the release piston, and as the pressure at the release end is promptly balanced by reason of the small port drilled through it, and as the pressure is exhausted from the application end, the large emergency reservojr pressure between the pistons forces the structure to its application position in which the brake cylinder exhaust port is consequently closed.

The full movement of the equalizing slide valve connects the auxiliary and service reservoirs, while the graduating valve has opened the service port, permitting pressure from both of these reservoirs to flow into the brake cylinder.

The same brake pipe reduction is effective on the brake pipe side of the emergency piston, and as there can be no flow back from the quick action or quick action closing chambers into the brake pipe the resultant difference in pressure moves the emergency piston until it comes in contact with the emergency piston spring stop, where the graduating valve of the emergency slide valve opens the chambers mentioned through the emergency slide valve exhaust port to the atmosphere, and the pressures in the chambers reduce at the same rate that at which the brake pipe pressure is reducing.

The lowering of auxiliary reservoir pressure permits the emergency reservoir pressure to move the charging valve to its lower position, thus separating the service and emergency reservoirs.

In this manner the brake is applied with any degree of force desired, as the brake pipe reduction ceases, the valve is moved to lap position, which will be explained in a future issue.

Elimination of the Brake Pipe Branch Cut Out Cock on Passenger Equipment Cars.

Undoubtedly all air brake men are working toward a goal of 100 per cent efficiency in air brake operation, and while some of them may realize that it may probably never be obtained, there is a continued improvement in brake operation on trains, and the attitude of many operating officers has apparently changed; in fact, the air brake is no longer regarded as a necessary evil, but rather as a dividend earning asset.

Before obtaining 100 per cent efficiency in operation it will first be necessary to have brakes on trains 100 per cent operative, and if we actually believe that the entire brake system of a train must be regarded as a unit and that any part of the system from the pump strainer to the angle cock at the rear of the train being defective, renders the brake on the train defective, and that it cannot be regarded as otherwise, it is evident that some radical action should be taken to maintain brakes on trains, especially in passenger service, 100 per cent operative.

The most formidable obstacle in the way of preventing the operation of brakes on passenger trains 100 per cent continuously is the cut out cock in the brake pipe branch leading to the triple or other operating valve, and we believe that the time has come to eliminate this cut out cock as a part of a passenger car brake system.

Many of our readers may take the position that because a convenient part of the brake system is improperly used or used when not necessary, there is no logical reason why it should be removed from the car, and from one point of view they may be right, but if it is earnestly desired to operate every brake on every car in a passenger train at all times there is no necessity for a cut out cock in the brake pipe branch leading to the operating valve. If there is a necessity for it, it is a very frank admission that brakes cannot be operated on all cars on a passenger train at all times.

The objection to the cut out cock is that it is being used to cut out brakes when there is no necessity for brakes being cut out, and the reason for being cut occurs through a mistaken idea and through a very convenient way of cutting them out. To remove the convenient way of cutting out would undoubtedly prevent all of the unnecessary cutting out of brakes, and in the event of it being absolutely necessary to cut out a triple valve, if such a thing ever becomes absolutely necessary, it could be done without the aid of a cut out cock in the brake pipe branch.

It is difficult to imagine just what kind of an occurrence along the road could make it necessary to use or close the cut out cock in the brake pipe branch on a passenger car if the brakes on the train have been properly tested at a terminal or originating point, or if triple valve or other repair work is of such an inferior grade that a triple valve will not operate correctly during the comparatively short time between cleaning and test periods, we must agree that the cut out cock is a necessity. On the other hand, if the car brake equipment can be properly cared for, where is the necessity for the cut out cock.

Even if the repair work and maintenance of passenger cars is admittedly faulty from an air brake point of view, it would no doubt result in a decided improvement if this cut out cock were eliminated, so that in the event of a stuck brake on a passenger train between stations, it would be necessary to disconnect the brake pipe branch and insert a blind gasket or plug the pipe, the delay resulting therefrom might be of sufficient duration or of enough consequence to attract enough attention to warrant an investigation of the conditions that lead up to the failure of the brake to release.

We print this for the purpose of advocating a better grade of air brake repair work and inspection, and for 100 per cent operative brakes in passenger service, rather than for the purpose of suggesting some radical departure from standard practices, and while this may be viewed from many different angles, we would be pleased to print any comments on this subject from any of our readers.

Automobile Checks and Reminders

The Psychological State Recognized—A Physical Barrier to Unbroken Speed Suggested—Methods of Compelling a Slow-Down or a Halt.

We have, before now, had occasion to refer to the numerous accidents to automobiles which have occurred on level highway crossings with railroads. It has been the constant endeavor of railroads to minimize, if they cannot altogether eliminate, the danger. Railway companies have often devised the most conspicuous signs and gates and have stationed watchmen carrying flags and lanterns. The signs and signals stand out clearly. They are conspicuous and striking, but instances are on record where they have proved unavailing.

The sign or signal is undoubtedly seen by the automobile driver, but is not acted on. There is no tangible connection between the signal and the mind of the man beholding it. Gates, lights or flag may be seen, but it is upon the action produced by such cognizance of the external object that means safety. How long will the mind notice of the external object

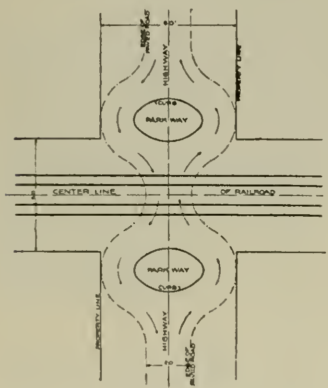


FIG. 1.

last? There is no settled state of consciousness, any more than there is no place where an arrow is when it flies. The attention of the driver may be diverted after he has seen the order to halt, or he may be the victim of suggestion, or become preoccupied.

Further than this, it seems to be detrimental to the enjoyment of the gratified desire for speed to submit to an interruption. Such an interruption is contemplated and indeed considered imperative by the railway showing flag or lamp. This interruption would require a special effort and this is irksome to the driver; he therefore mentally resists the thought of a halt, a pause, and a fresh start. Nearly every one of us has been conscious of this feeling at some time or

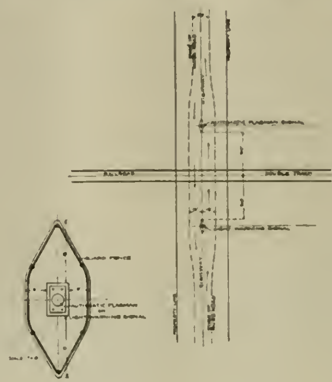


FIG. 2.

another. We would rather walk around the end of a slowly moving vehicle than alter our pace, although the detour necessitated would cover a longer distance than if we had made a stop, endured a detention and then began to proceed again. It is almost as if man were to be regarded as a species of machine, set to go at a certain pace, and from his mental makeup opposed to change. He exhibits mentally a condition analogous to inertia in the physical world.

One of the methods of holding the attention and compelling appropriate action is to place a physical handicap to unbroken progress before the chauffeur, compelling a deflection in his course or a slight detour, which no doubt causes momentary inconvenience. By this means it is hoped in part to supply the needed connection between visible cognizance of

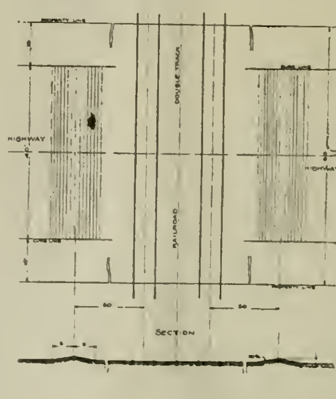


FIG. 3.

the crossing signals and the action which brings safety in its wake.

The railroad commission of the State of California, of which Mr. Richard Sachse is chief engineer at San Francisco, has before it six devices for the protection of crossings, which it is endeavoring to have adopted for trial purposes in the State.

In Fig. 1, devised by Mr. F. E. Peters, of Tropico, Cal., a parkway is interposed in the highway on either side of the railway track, which causes a motor car to make four pronounced deflections in its course in order to cross the tracks. A safety grade crossing, Fig. 2, based on a sketch from the Southern Pacific coast division engineer's office, shows a central light and necessitates a slight deflection of route by a motor car crossing the tracks.

Fig. 3 shows a device by Mr. J. H. Weatherford, city engineer of Memphis, Tenn., by which a "bump" is introduced

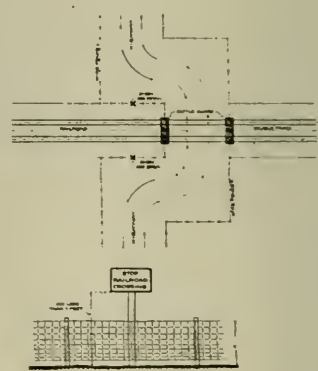


FIG. 4.

in the highway on each side of the railway track. This does not obstruct the view of the motor car driver, but it would (as it is intended to) produce an unpleasant jolt if passed over at high speed. Even if the chauffeur was willing to stand the inconvenience rather than reduce speed he would force the result of the unnecessary jar upon the attention of the other occupants of the car and it is more than likely that their remonstrances would have a deterrant effect upon reckless or excessive speed at this point.

Fig. 4 causes four sharp turns in short space, and was devised by Mr. Chas. R. Blake, health commissioner of Richmond, Cal. The four right angles have not only to be negotiated by the motor car driver, but the attempt has to be made under a notice to stop, almost thrust in the face of the vehicle driver, and where a strong woven wire fence adds difficulty to the unlawful effort to move straight along.

Fig. 5, devised by Mr. Scott W. Alexander, of Long Beach, Cal., supplies an enforced detour around a most inhospitable sharp pointed cairn of stone and in face of an imperative notice to stop. Fig. 6 shows a device by Mr. W. M. Humans, of Los Angeles, Cal., whereby a detour is rendered necessary to get across

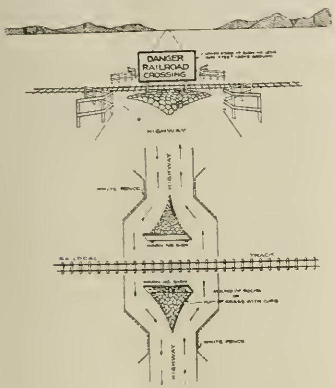


FIG. 5.

the tracks. The island in the center forces the driver to turn and thus provides him with the fraction of a moment to size up the situation and if need be he can run parallel to the tracks and so avoid a collision.

These various devices have as an aim the compelling of some action. They force a driver to make appropriate movement or deflection in order to get past

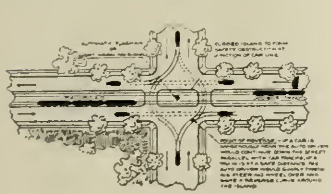


FIG. 6.

the track at all. These devices are at least a definite attempt to force not only the cognizance of outside conditions and to rouse the mind from their passive contemplation to the decisive and saving act of obedience to the call of rational and effectual common sense.

The Baker Valve Gear.

In the January, 1917, issue of Railway and Locomotive Engineering we were able to present to our readers some interesting facts concerning the Baker valve gear, and a table of the results of a test made by Mr. W. L. Kellogg, superintendent of motive power of the Missouri, Kansas & Texas Railway. This month we are able to present, through the courtesy of Mr. Wm. Schlafge, general mechanical superintendent of the Erie, a very close analysis of the performance of engine No. 1690 with the Stephenson gear, and subsequently as fitted up with the Baker valve gear.

The twenty-two items for each gear have been most carefully prepared and averages set down so that comparison is facilitated. In many cases there is not much to choose between the performance of each of the gears tested, but the total number of pounds of water supplied to the boiler (average) shows 109,959.5 with the Stephenson gear, and 98,905.25 lbs. with the Baker gear. This represents a saving of water in favor of the Baker mechanism of 11,054.25 lbs., which is over five tons of water. This is not an insignificant saving by any means.

The steam delivered to the cylinders per million foot-pounds of work, stated as pounds of steam, shows that the Stephenson gear (average) supplied 16.1 lbs. and the Baker 14.8 lbs., or a saving of 1.3 in favor of the latter. This saving, it must be remembered, is effected on less water used, so that as appears in the table the total per cent saving of steam per thousand foot-pounds of work amounts to 8.07. A persual of the various items will be found instructive.

Pennsylvania's Record.

Much comment has been made in the daily press throughout the country on the excellent record made by the Pennsylvania during the year, when more than nine million passenger and freight trains were operated over twenty-seven thousand miles of track, and the record shows that no passenger fatality occurred. As a matter of fact, for three successive years there has been no passenger fatality on the Pennsylvania, and the passenger traffic during that period approached six hundred millions.

Masks in Locomotive Cabs.

The Canadian Pacific is introducing a mask in locomotive cabs which was described and illustrated in our pages Oct., 1915, whereby the engineers have a clear vision ahead in all kinds of stormy weather. It is attached to the window frame of the engine cab and contains no glass, its principle being based on the deflection of wind currents by flanges. Between the upper plates of metal and an air chute is a broad slit through which the engineer surveys the track ahead.

Japan Widening the Railway Gauge.

The present railway gauge in Japan is 3 ft. 6 ins., and was adopted when the first railway was built in Japan. A change is desired, especially in the interest of a greater development of commerce and industry. The task is a large one, and it is planned to inaugurate the work by widening the gauge on the main trunk line connecting Tokio with Shimonoseki, which are 800 miles apart. This is the line which connects with Corea and the Siberian railway.

Pneumatic Tampers.

The Lehigh Valley R. R. has added pneumatic tamping machines to the maintenance of way equipment of each of its main line divisions, and pronounces the innovation a great improvement over the old method. One man with a pneumatic tamper can do as much work as two men tamping by hand. In addition, the results to the track are better and more permanent. Each pneumatic outfit consists of an air compressor and four tampers.

COMPARISON OF ERIE ENGINE NO. 1690, WITH STEPHENSON AND WITH BAKER GEARS.

	Stephenson Gear Engine No. 1690			Baker Pilliod Gear Engine No. 1690		
	East Bound	West Bound	Average	East Bound	West Bound	Average
Total length of run, miles	86.5	92.25	89.375	86.5	92.00	89.25
Time on road, hrs	6.17	7.71	6.94	6.87	7.65	7.26
Detentions, hrs.	1.85	2.90	2.37	2.71	2.65	2.68
Running time, hrs	4.32	4.81	4.57	4.16	5.00	4.58
Actual train load (including engine and tender)	2,859	2,784	2,821.5	3,022.6	2,921.2	2,971.9
Total average drawbar pull	13,650	11,890	12,770	12,454	13,004	12,729
Total average speed	20	19.2	19.6	20.8	18.4	19.6
Total average D.B.H.P	728	609	668.5	691	638	664.5
Million ft. lbs. work	6,234	5,791	6,012	5,688	6,317	6,002.5
Average steam pressure at mile posts	194.5	194	194.25	196.2	195.75	195.97
Average drawbar pull at mile posts	18,091	16,033	17,062	17,151	17,722	17,436.5
Average speed at mile posts	16.8	19.2	18	18.1	16.7	17.4
Average I.H.P. at mile posts	959.2	931.2	945.2	962.8	896.7	929.75
Average D.B.H.P. at mile posts	810	821	815.5	828	788.2	808.1
Mechanical efficiency of engine, %	84.5	88.2	86.35	86	87.9	86.95
Total water to boiler, lbs	110,325	109,594	109,959.5	95,603	1,022,075	98,905.25
Total water used on detentions, lbs.	3,567	3,785	3,676	2,053	2,567.5	2,310.5
Total water loss, to air pump and pops, lbs.	6,713	6,870	6,791.5	5,188	5,404	5,296
Steam quality, %	97.2	97.2	97.2	97.2	97.2	97.2
Total steam to cylinders, lbs.	97,244	96,159	96,702	85,887	91,597	88,742
Steam to cylinders per D.B.H.P. per hr., lbs	30.9	32.9	31.9	29.9	28.7	29.3
Steam to cylinders per million ft. lbs. works, lbs.	15.6	16.6	16.1	15.1	14.5	14.8
Per cent. saving in steam per million ft. lbs. work	.....	.....	.....	.....	.....	8.07

The Veco Flush Car Door

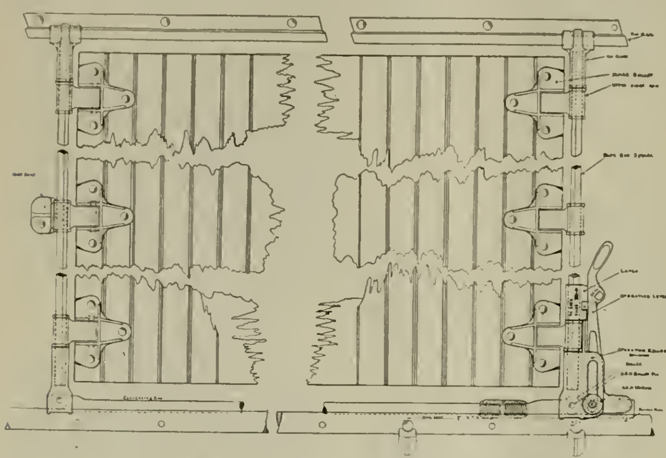
New Application of Mechanical Motion—Door Moved to Position by Hand, Made a Flush Door by Mechanical Action—Tight and Always Under Inward Pressure When Closed—Becomes Practically Part of the Car Side.

"Action and reaction are equal and opposite." This is Newton's third law of motion and it has a very practical application in combination with the simple mechanism which makes the "Veco" car door a tight flush door, applicable to box cars and to refrigerator cars. This door runs and its weight is carried on a bottom rail, formed by a bar of flat steel, which is amply supported so as to prevent displacement or bending; the upper rail is in the form of a Z-bar, and it acts simply as a guide to prevent the door from falling away from its intended location.

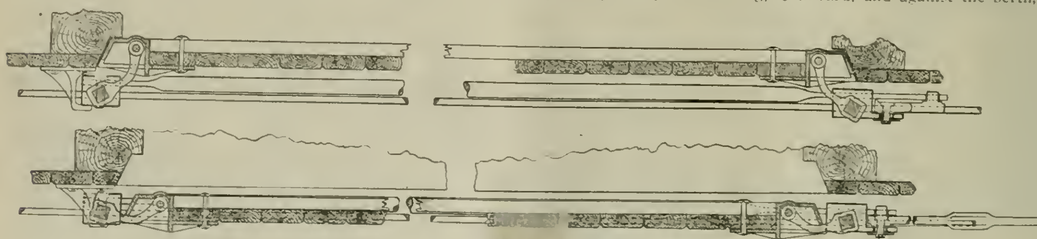
Two upright square steel bars (known as side rods), with malleable castings (known as guides) are placed at the top, near the top corners of the door so as to slide on the Z-bar; and two suitable malleable castings (known as roller housing at the left, and operating roller housing at the right hand side), are placed at the bottom of the side rods, near the bottom corners of the door, each containing a small roller to facilitate the movement of the door to and from the door opening. These side rods are placed, one at each side of the door and parallel with its vertical edges. A steel rod (known as a connecting rod) is placed parallel with the bottom rail so as to co-act with the malleable housing (in which the small rollers work) and which so operate that upon closing the door, the side rods approach each other to the extent of about 3 ins., which distance can be increased or decreased and thereby govern the pressure against the door through the hinges, as may be required. Likewise they recede from one another upon opening the door. This very simple opposing motion is produced by the operation of a bell-crank lever (known as the operating lever) located near the lo[illegible] hand corner of the door. The [illegible]r lever has two round raised fu[illegible]ints. One fulcrum point oper[illegible] vertical slot in the operating r[illegible]sing; the other registers and op[illegible] a round hole in the connecting rod. This is the only example that we know of, where opposing motion or the "to and from" movement of a pair of rods, maintaining their parallelism, closes and opens a door, and in this movement "action and reaction are equal and opposite."

In order that the approach of the two side rods may affect the door in the way desired, three malleable castings (known as hinge arms) with square openings, or sleeves at the large ends, are slipped over each of the two square side rods and are respectively positioned, one near the top of door, one at the center, and one near the bottom along the two vertical edges of the door. The small ends of the hinge arms, carry round openings or sleeves which engage with malleable castings (known as hinge-sockets) by means of steel pins or axles, thereby forming a hinge of which the hinge-socket members are permanently fastened to body of the door on its vertical edges. These ends are offset and lie inside the line of approach of the side rods.

The approach of the side rods toward each other would carry the hinges directly toward each other, but for the offset position of the hinge-socket members, which necessitate their pushing the door inward and toward the door opening or berth. The square sleeves of the hinge arm members cause the square side rods to rotate, and thereby intensify the inward push on the door. The door thus urged, moves perpendicular to its face and is thereby tightly seated in its berth. The motion of the side rods, upon closing the door, is toward each other and upon opening is away from each other, parallel to the side of the car. The motion of the door through pressure of the hinge upon closing, is inward, and against the berth, and upon opening, it is outward and away from the berth in a direction parallel to the ties of the track. The motion imparted to the operating lever by a car man, gives it, say a westward movement in closing and an eastward movement in



ELEVATION OF "VECO" CAR DOOR, SHOWING DETAILS.



SECTION OF "VECO" C[illegible] CLOSED, AND OPEN.

opening, which through the connecting rod and operating roller housing, causes the side rods and hinges to move the door northward upon closing, and southward upon opening. When seated in its berth, the result is a "flush door," with the sides and bottom edges beveled, while the top is square, forming a tight joint which will not admit any foreign matter into the car through the door opening.

The mechanism contains a gravity latch, similar to that of an ordinary gate, and, when the lever is in place, brings one ample latch hole in line with two similar holes in the lever, and a seal may be put through these holes even in the dark if the seal man does not have a lantern, by his feeling for the holes, as they are located so low down that the man sealing the car does not have to carry a ladder or look around for a soap box to stand on.

The whole of the mechanical action of the "Veco" mechanism is intended to put the door in its berth and to retain it securely with holding pressure, also to remove it from its berth, thereby freeing any outward pressure or binding that may exist. One marked advantage of this motion in and out of the berth, produced by the combined "Veco" mechanism is this. In the event that the load has shifted and is resting against the door, then to open an ordinary door in the usual sliding fashion when bound on account of the shifted load pressure, or sharp box corners, against the door, would be most difficult if not impossible. When opening the "Veco Flush Door" it first steps back and away from the load about 2½ ins. and thus frees itself entirely before a man moves it away from the door opening. The Veco flush door is provided with an appliance which operates when the door is away from the opening, so as to hold it in an open position, and thereby prevent it from whipping back and forward in transit, or during yard or terminal switching. This feature obviates the difficulty of doors banging against the door stops and destroying the mechanism. The door stays where it is put.

The "Veco Flush Door" when "home" in its berth is practically integral with the car, as it forms, for the time being, part of the side of the car and lends strength to the whole structure by reason of the close fit it makes. For the same reason, it is fireproof and weatherproof, for where no opening exists, cinders, sparks and weather conditions are effectually barred out and cannot enter the car through the tightly closed opening. It is also proof against pilfering, or the efforts of the sneak thief, because the door cannot be opened, or the car entered through the door opening, without first removing the seal. The door is mechanically all that could be desired, being strong, durable and simple. It cannot fall off or swing open on curves, or during yard or terminal operations, because the mechanism is so designed that the door cannot be dislodged from its berth by rough handling, or by severe car structure distortion, or from outward pressure caused by shifted load while engaged closely in its berth. This is due to the inward pressure exerted against the door through the "Veco" mechanism, nor will the door while disengaged, or away from the berth, fall off, on account of the mechanism being so designed that it cannot be dislodged from its intended location between the top and bottom rails.

The "Veco" mechanism is designed to be interchangeable with any size of door, on any style of car, new or old, on any road maintaining it as a standard. It is low in cost because of its simple construction and minimum variety of parts and during the process of evolution, fifty-seven different machining operations have been eliminated, until almost nothing is left to do but to clean the castings, provide the rods and rails (which are standard steel shapes) and put it all together. It has also a small maintenance cost, because wear has been brought to its lowest terms, all of the parts are made amply strong for the work they have to do and can be quickly and easily replaced.

When we come to consider its advantages as applied to refrigerator cars, it is a one-piece affair operating the same as the "Veco" box car door. It requires only a little more clearance at the loading platform because the refrigerator door is the thicker of the two. A car so equipped can be run in and placed opposite a warehouse which requires it to be left, the "Veco" door of the partly loaded car can be closed and locked without the services of a yard engine or crew to move the car clear of the loading platform. The refrigerator door has just to be moved along the bottom rail, which carries it; the operating lever is brought up to a vertical position and the door practically disappears as such, into its berth, and becomes part of the apparently unbroken side of the car, adding to its strength and rigidity at a place which is necessarily always a weak spot in any form of freight car construction.

It cannot swing open in transit, as the two-piece door can, the "Veco" door prevents accidents by sideswiping passing trains or striking persons who happen to be within its reach. It also prevents the loss and damage to freight loaded near the door opening. Further, it will at all times insure a tight joint on the four edges of the door.

Wrought Iron.

Mr. H. E. Blackburn, instructor of apprentices of the Erie Railroad, is noted for his scientific attainments and for diffusing the same among the apprentices and others. Mr. Blackburn recently, through the *Erie Magazine*, sent out the following sketch about WROUGHT IRON.

Wrought iron, which is made from pig-iron by a refining process, is not brittle but tough, because the carbon has been removed from the iron by a heat process called puddling; consequently, the wrought iron has fiber and it can be bent or forged into various shapes as well as welded together, a feature not found in pig or cast iron.

A furnace called a puddling furnace is used to convert the pig-iron into wrought iron. It consists mainly of a shallow hearth filled with enough pig iron to make a 400-pound charge. A coal fire is built in a chamber outside, the flame from this fire passes over a low fire wall, and is deflected down by the roof of the furnace on to the charge of pig-iron in the furnace hearth.

The man who runs the furnace is called a "puddler," because he puddles the iron as it melts with a long iron bar called a "rabler." Slag and cinder continually form by the chemical union of the impurities in the pigs and the sand on the surface of the pigs.

This cinder is really silicate of iron, and it protects the molten iron from oxidation or loss of metal.

The heat of the furnace is raised very high and the molten iron is constantly stirred until the phosphorus and sulphur is removed. The heat is then sufficiently lowered until the carbon is removed, when oxide of iron is added; then the metal begins to boil and in twenty minutes the metal begins to "stiffen up." The puddler quickly separates into two or three white hot balls the 400 pounds of spongy iron. They are removed from the furnace and reduced in size in a machine called a "squeezer." After this they are run through rolls and formed into flat bars called blooms. After they are cool they are cut into short lengths, and a bundle is made up called a "muck bar." This bundle is heated up to a welding heat and rolled into bars, rods, plates, etc.

If a higher grade of iron is desired the blooms are worked over again two or three times. This makes a more compact fiber.

Beginning of Electrification on Railroads Entering Chicago.

The beginning of what promises to be an extensive scheme of the electrification of the railroads entering Chicago, similar to the system already in operation on some of the leading railroads entering New York, seems assured. The first step is being taken by the Illinois Central, and a proposition has been made to the city authorities whereby the railroad proposes to adopt electric power on its suburban trains. It would take at least five years to complete the change, but it is believed that it would eventually effect a reduction in the cost of operation.

Electrical Department

Relation of Electrical Units to Mechanics—Ohm's Laws in Regard to Circuits.

In the preceding article we explained the meaning of several electrical terms, namely, the ampere, the unit of electric current; the volt, the unit of electrical pressure: the ohm, the unit of electrical resistance, and the watt, the unit of electrical power. We explained that electricity was analogous to water flowing through a pipe under a certain pressure or head.

We have referred to the volt as the electrical unit of pressure and have defined the unit in terms of the Clark standard cell. Now, the term pressure is measurable by the mechanical system and the question at once arises as to the relation between the electrical and mechanical units. Does the volt approximate the grain, the ounce or the pound? On first thought the volt appears as an electrical unit, not a mechanical one, and therefore it appears as if no comparison could be drawn.

The laws of pressure or force, however, belong strictly to the science of mechanics, and all questions of force therefore can and must be looked upon accordingly, if we are to arrive at a proper comprehension of such forces, as mechanics embraces all forms of force, whether at rest or in motion, as applied to matter. In other words, the means of obtaining pressure, or of setting matter in motion, is to be considered separately from the pressure or motion which is the result. Therefore, while the cause of pressure or motion may be electrical, the resulting force is mechanical. We may not know what electricity really is, in itself, but still we may have a clear knowledge of the results produced.

The whole system of electrical calculations as related to mechanics is based upon the Centimeter-Gramme-Second system; the unit of length or space is the centimeter, the unit of weight or mass is the gramme, and the unit of time is the second. This system is referred to as the C. G. S. system.

The force required to move one gramme at a velocity of one centimeter after having been applied for one second is called the unit of force and is known as *the Dyne*. It will be noticed that this is a purely mechanical definition, and therefore is parallel to the mechanical system of units, based upon the force of gravity and the laws of falling bodies.

The force of gravity varies slightly at different positions on the earth's surface, depending on the latitude, but for all practical purposes a constant 32.2 can be used. That is, the action of gravitation is such that a falling body will in one second reach a speed of 32.2 ft per second, or for a given number of seconds the speed will be a corresponding multiple of this speed. Here we are considering the unit of mass as the pound and the unit of distance as the foot. If we know the relation between the gramme and the pound, and between the centimeter and the foot we can express laws of gravity in terms of the dyne, and thus show the relation to the electrical units which, as we stated above, is based on the dyne.

One pound avoirdupois is equal approximately to 453.6 grammes and 32.2 feet is equal approximately to 981 centimeters, so that the force of gravity after one second is equal, approximately, to $453.6 \times 981 = 444{,}982$ dynes of force.

In a previous article we stated that the volt was the force which would cause one ampere to flow through a resistance of one ohm. The volt can be and is expressed in terms of the dyne. The volt is equivalent to 10^8 or 100,000,000 dynes. We have stated in the above paragraph that one pound acting under the force of gravity for one second has a force of 444,982 dynes. Dividing the value of the volt (100,000,000 dynes) by this number of dynes we obtain a value of 224.73 lbs., so that the volt represents the energy of 224.73 lbs. when acted on by gravity through one centimeter per second.

The unit of resistance is also expressed in dynes and is 10^9, so that the ohm is equal to 2,247.3 lbs. These magnitudes are so much greater than the general conception of the value of these units that a further comparison will be made. We know that electricity is closely related to heat and that current flowing through a conductor will generate heat. We also know that heat can be produced in metals by vibrations, or by moving of the metal. For instance, a wire when bent rapidly back and forth, generates heat, due to the movement of the particles of the wire against the force of cohesion. If we accept the theory that electricity acts similarly on the molecules, then we can see the reason for the heating and realize that the force or volt is of considerable magnitude, as shown in the preceding paragraph.

On the other hand, the unit of vibrations produced must necessarily be relatively small, and we find by Ohm's law that a volt of force impelling vibration upon an ohm of resistance which is ten times as great as itself produces an effect of one-tenth unit, which receives the name of an ampere. This term, therefore, which represents the result produced, may be looked upon either as a concrete amount or as a ratio.

The unit of force, one dyne, which we apply for one second to one gramme to produce a velocity of one centimeter per second, is absorbed by the mass and held as energy in the form of a dyne-centimeter or one "erg" per second, which is the statement of the matter in the form of "work." The ampere, therefore, is a concrete amount in that it is the effect produced by one volt of force upon one ohm of resistance, and it is equal to one-tenth of a dyne-centimeter. If, therefore, we multiply a volt in dynes by an ampere in dyne-centimeters we get a watt in dyne-centimeters, $100{,}000{,}000 \times 1\text{-}10$ 10,000,000, or 10^7. This value is 1-10 of the volt and therefore = 22,473 lbs. through one centimeter. If this amount of work were done in one second, it becomes a Joule or rate of doing work.

The watt is a parallel unit to the foot-pound, in that each is a unit of pressure or weight acting through a unit of space, and in neither case is the element of time introduced; that is, a watt of "work" will be the same amount no matter how long it may take to do it, exactly as a foot-pound is equal to one pound lifted one foot high without reference to the time occupied. If, however, the time of performing these amounts of work be limited to the unit of time, that is, to one second, we have in the former case one watt-second, or one "joule," which is a rate of doing work, or "power." We have no specific name for the foot-pound lifted in one second.

We may now institute a comparison between the joule and the foot-pound. If a joule is equal to 22.473 lbs., lifted through one centimeter per second, what amount is it equal to passing through one foot per second? As one foot is equal to 30.48 centimeters, the joule is obviously equal to $\frac{22.473 \times 1}{30.48} = .7373$ lbs. raised through one foot of space. If, therefore, 550 foot-pounds per second is equal to one horse-power, then $\frac{550}{.7373} = 746$ watts must be equal to one horse-power.

We have seen that there is a relation between the volt, the ampere and the ohm. The voltage or force tending to move the electricity is designated by E; the rate of flow or current is designated by I, and the resistance which the force must overcome to produce the flow of electricity is designated by R. The relation existing between these three factors was discovered and expressed by Ohm, and is known as Ohm's law of electrical resistance. The law is as follows:

"The current in a circuit is directly proportional to the electromotive force, E, and inversely proportional to the resistance, R, and may be written as an equation; thus, $I = \frac{E}{R}$ That is, if the electromotive force, E, is increased, the current will be increased in the same proportion; if the resistance, R, is increased the current will be decreased proportionally. Likewise a decrease in the resistance, R, causes a proportional increase in the current.

There are three factors involved in this equation, so that if any two of these factors are known the third can be determined. The following examples will illustrate this point:

Examples—

1. If 110 volts is applied to a circuit having a resistance of 20 ohms, how much current will flow?

Ans. $I = \frac{E}{R}$, $I = \frac{110}{20} = 5.5$ amperes.

2. What voltage is necessary to obtain 23 amperes through a resistance of 340 ohms?

Ans. $I = \frac{E}{R}$ or $E = I\,R$ or $E = 23 \times 340 = 7820$ volts.

3. If it is desired to obtain 7.5 amperes and the source of power is 110 volts, how much resistance will be necessary to place in the circuit?

Ans. $I = \frac{E}{R}$ or $R = \frac{E}{I}$ $R = \frac{110}{7.5} =$ 14.67 ohms.

The above examples illustrate problems encountered when dealing with a simple circuit, but the same principle or law applies to any direct current circuit no matter how complicated. Ohm's law is really the foundation for the solution of electrical problems and is used in nearly every problem which occurs.

There are both series and parallel circuits encountered in electrical work and it becomes necessary to determine the current flowings or perhaps to make an analysis of the voltage-drop throughout the circuit. In the series circuit the several parts are all joined together in series, as in Fig. 1. The total resistance is, in this case, the sum of the separate resistances, and this total resistance must be obtained in order to determine the amount of current flowing.

Example—

4. Referring to Fig. 1 with three coils in series, across 110 volts, of 10, 17 and 21 ohms, respectively, what current is flowing?

Ans. $I = \frac{E}{R}$ $I = \frac{E}{R_1 + R_2 + R_3}$.

$$I = \frac{110}{10 + 17 + 21} = \frac{110}{48} = 2.29 \text{ amperes.}$$

5. There is a circuit of 9 arc lamps in series, each lamp has a resistance of 5 ohms and 3.7 amperes is required to give the proper light. What voltage must be applied?

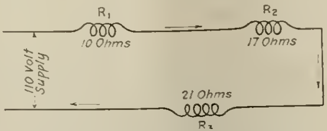


FIG. 1. SERIES CIRCUITS.

Ans. $I = \frac{E}{R}$. $E = IR$. $E =$ 3.7 $(9 \times 5) = 3.7 \times 45 = 166.5$ volts.

At times it is necessary to know the voltage-drop across any or each of the various parts which go to make up the circuit. For instance, referring to Fig. 1 it might be interesting to know what voltage drop exists across each of the three resistances. Ohm's law can be applied to any part of a circuit. In this particular problem we know from Example 4 that there is 2.29 + amperes flowing. The voltage-drop across each of the coils is then $E = I\,R$ and is as follows:

$E = 2.29 + \times 10 = 22.93$ volts drop across the 10 ohm coil.

$E = 2.29 + \times 17 = 38.95$ volts drop across the 17 ohm coil.

$E = 2.29 + \times 21 = 48.12$ volts drop across the 21 ohm coil.

An illustration of the parallel or divided circuits is shown by Fig. 2. The current on reaching point "a" divides, a certain amount passing through r_1 and the rest through r_2. The problem is to determine how much current passes through each branch. The amounts depend upon the relative resistance of the two circuits, the one with the lower resistance taking the greater amount of current.

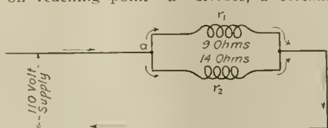


FIG. 2. PARALLEL OR DIVIDED CIRCUITS.

If both circuits were equal, the current in each would be equal. If one is twice the other then one-half would flow through the first and double the half, or one would flow through the second. In other words, the amount of current would depend upon the ability of the circuit to carry the current or upon its "conductance." Conductance may be said to be the inverse of resistance; in fact, it is the reciprocal of resistance. It may be defined as equal to $\frac{1}{R}$ Therefore, conductance becomes greater the less the resistance. For example, if the resistance of a circuit is 2 ohms the conductance is ½. If the resistance is ¼ the conductance is 4. In the case of the circuit, Fig. 2, the resistances are r_1 and r_2, so that the conductances are $\frac{1}{r_1}$ and $\frac{1}{r_2}$

It is obvious that the joint resistance of these two parallel circuits is less than either one. Now if we let R represent the joint resistance, then $\frac{1}{R}$ represents the joint conductance, and this joint conductance will, of course, equal the sum of the two conductances. We have then

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} = \frac{r_2 + r_1}{r_1\,r_2}$$

$$R = \frac{r_1\,r_2}{r_1 + r_2}$$

The resistance of a parallel circuit can be put into the form of a rule as follows: "The joint resistance of a divided circuit is equal to the product of the two separate resistances divided by their sum.

Example—

6. What is the joint resistance? Fig. 2. Also, what current will flow from the source of supply, and how will it divide?

$$R = \frac{r_1\,r_2}{r_1 + r_2} = \frac{9 \times 14}{9 + 14} = \frac{126}{23} = 5.48$$

ohms.

The total current will then be $I = \frac{E}{R}$ $= \frac{110}{5.48} = 20.07$ amperes. This current will divide in the ratio of 9 to 14, that is, $\frac{14}{9}$ will go through r_1 or 12.21 amperes and $\frac{9}{23}$ will go through r_2 or 7.86 amperes.

If there are more than two circuits the same rule is followed. Suppose, for instance, there are three circuits, r_1, r_2, r_3,

$$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} = \frac{r_2r_3 \times r_1r_3 \times r_1r_2}{r_1r_2r_3}$$

$$R = \frac{r_1r_2r_3}{r_2r_3 + r_1r_3 + r_1r_2}$$

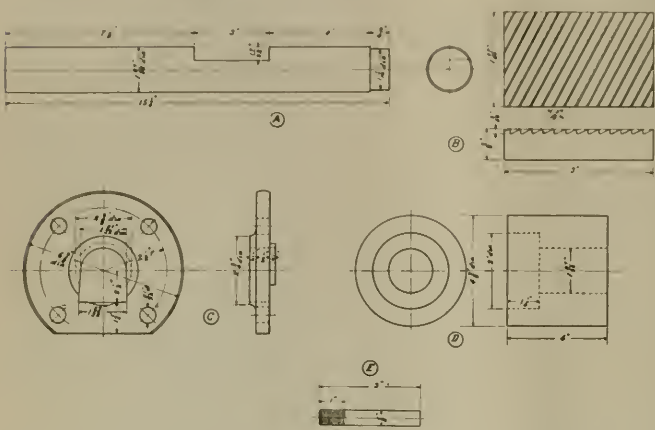
Conditions suggest that the railroads have come to understand that there is economy in doing more car-repairing themselves than by farming it out to private concerns. Orders placed for material prompt the opinion that they will undertake it on a greater scale than they ever have.

Air Brake Repair Work Tools Devised and Applied to Every Requirement

By GEORGE K. DORVART, Denver, Colo.

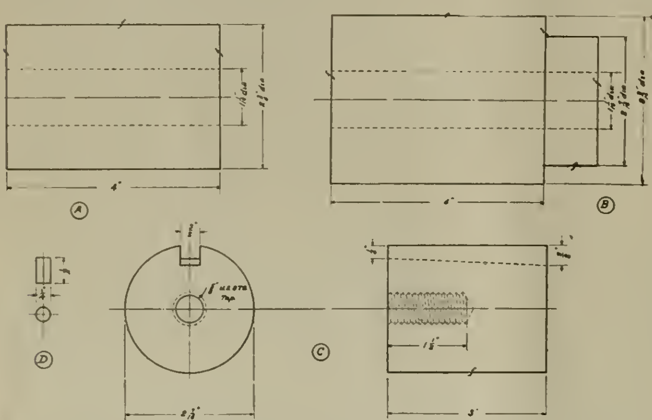
No. 3. Tools for Facing Slide Valve Seat in W. A. B. Steam Head.

The annexed drawing shows the details of tools designed for facing the slide valve seat of Westinghouse airbrake steam head. As is well known it is of



NO. 3. TOOLS FOR FACING SLIDE VALVE SEAT IN W. A. B. 9½ IN. STEAM HEAD.

importance that the slide valve seat of the steam head should be kept as nearly in perfect condition as possible. A shows steel bar to carry cutter; B shows seventeen cutter in face. This tool should be made of tool steel, hardened. C shows a jig adapted to bolt to steam head, PS. 5166, on the left hand side. D shows bushing guide for bar A, adapted for application to the right hand side of steam head. E shows dimensions of studs, of which there are four necessary, ⅝ in. in diameter, 11 thread used in bottom bolt holes of PC. 1876.



NO. 4. ANVIL BLOCK FOR RIVETING DOWLY IN P. C. 25848 C. WESTINGHOUSE CROSS COMPOUND PUMP.

No. 4. Anvil Block for Riveting Dowly in PC. 25848, C. Westinghouse 8½ ins. Cross Compound Pump.

The accompanying drawing shows details of construction of an anvil block for riveting dowly in P. C. 25848. C, Westinghouse 8½-in. cross compound pump. A shows block used in pressing out P. C. 25848. B shows a larger sized block used in pressing in P. C. 25848. D shows steel pin used in upsetting dowel in P. C. 25848. The parts are simple in construction and effective in operation.

Better Firing Methods.

By A. D. Carl, Salamanca, N. Y.

One of the greatest problems of the day on the railroads is, how can we save fuel? Stoker firms and others claim to save us so much coal per mile, and they do; but we cannot equip all our engines in a day, so we should turn our best efforts to hand firing in the meantime.

I fully agree with the writer who in a recent issue of your valuable journal said to get new firemen from the seat box on the left side of the engine, namely, the brakeman. He is the man who is best fitted for firing service, as he is in a position to watch the better firing methods of the better firemen, and if he knew he would be called to fill firing positions he would give more attention to the business and we would always have experienced men to select from.

The good fireman looks at the water first and then opens the blower slightly and looks at the crown sheet and fire box and fire. If the fire is in good shape he lets it go at that, but if not, he will take the rake and level his fire over and throw in a scoopful or so on the bright spots.

He never opens the blower wide open and puts the pops up so he can get what some firemen call "a heel in her." This so-called "heel" is the fireman's worst enemy. It consists of about 50 scoops of coal put in the back corners of the fire box and back section of grates, and is a waste of coal. What we need is a level fire, not 18 feet of coal in the back section of grates and nothing under the arch. Keep the fire level. The best way to keep the fire level is to fire with four or five scoopsful at a time. Two on each side and one through the center of the fire box, not 14 lbs. at a scoopful, but about eight pounds—just a nice level scoopful. You cannot place the 14 lbs. any place in the fire box, as you can the eight-pound scoopful. The steam does not drop back and you do not have to use the joy hook as often as you do with the large scoopful.

The man who carries the heavy fire is the one who never has steam when nearing the home terminal. That is because his fire is badly clinkered, caused by having his fire banked over in places. When the fire is banked over it makes a regular furnace under the banked part, and the air that should go up through the light bright fire is drawn to the light places where it can get through into the fire box. The heat generated under the banked places is intense, and as it moves over the ash on the grates and the refuse in the coal is melted and runs in with the ash on the grates and the clinker is thus formed.

If we keep our fire light and bright at all times during the trip we will never be bothered by clinker formation and the engine will steam just as well when the trip is about completed as it did when we started, because we can keep the ash shaken out and have a clean fire all the time. Another advantage gained is that you do not have to put the coal up under the arch by bodily strength as you do when the fire is banked at the door. The draft coming through the light fire and traveling to the flue sheet will help carry the coal to the front of the fire box if we use light scoopfuls and put it in with a spreading motion.

Another contributor to poor firing is poor tools, rakes especially. Generally they are too long, and with our high coal gates our room is limited and the fireman does not use the long rake when he should at times because it is so unhandy. Rakes of the proper length should be placed on engines, that is, the long rake should be the same length as the inside length of the fire box. My contention is that when a fire needs raking it needs it at that particular time, not after you have lost 10 or 15 lbs. of steam, and have filled the fire box with green coal in an effort to get the pointer to move in the right direction without the use of the rake. Another advantage of light firing is that when necessary to rake the fire it can be done in a moment without getting the rake red hot from one end to the other, because you do not have a thick bed of coals to break up, nor will the fire be torn full of holes if the engine happens to slip, for in this case the excessive draft will find the thin bright spots in a banked fire, and so the holes in the fire are formed and excessive raking is the result. Another saving is the free carbon, or most of it, being burned instead of being allowed to escape to the atmosphere in the form of black smoke. But best of all is the saving of labor for your fireman, and the smile worn by the engineer who handles the heavy tonnage trains and always has the maximum amount of steam.

Electrification of the London, Brighton & South Coast Railway, England.

By R. W. A. Salter, London, England.

The electrification of some of the suburban street railways in or near London, England, has had the effect of waking up the management of some of the leading steam railways running out of London to the necessity of keeping abreast of the times. The passenger traffic on the London, Brighton and South Coast Railway had fallen from 8,000,000 to 3,000,000 a year. The electric engineers were put to work and decided to employ the single phase system, with overhead contact wires, working at a pressure of 7,500 volts and 25 periods. The success was immediate, the number of passengers carried the first year being over 10,000,000. The length of the single track at present electrified is over 66 miles, while a contract just placed, and under construction, amounts to over 150 miles, which will make the length of line

TRAIN LEAVING LONDON BRIDGE.

electrified over 200 miles. Each motor car is being equipped with four 225 horse-power motors. So far 170 of these have been ordered, each able to handle two trailer coaches. At present 50 per cent more trains are handled daily in and out of the company's Victoria terminal station in London, than would have been practicable had steam been maintained, and when the remaining sections have been electrified, the number will be increased further. It is estimated that it will be possible to operate in and out of Victoria station from 1,500 to 1,800 trains a day.

Plans were begun before the war broke out, and have been carried on uninterruptedly, and ere long, it will be possible to make the journey from London to Brighton in 45 minutes, at a speed of about 70 miles an hour.

VICTORIA STATION, LONDON, ELECTRIFIED.

Working Both Injectors.

By C. Richardson.

A short time ago there was an order issued by the master mechanic alluding to the necessity of operating both injectors—not necessarily at once, but working one as much as the other. Some engines while undergoing repairs were found to have the injector on the left hand side so corroded that they were entirely useless. This not only meant the total loss of the injector, but if the other injector could not be used from any cause, the fire would have to be hauled, running the risk of scorching the crown sheet.

One would think after reading the order that every engineer would bear it in mind, but this is what happened in one instance: An express passenger locomotive came in with the right boiler cheek leaking badly, and when the left injector was tried it refused to work also, so there was nothing left to do but pull the fire and have the engine towed in. The left hand injector was found to be plastered up, as if a cement worker had been getting his fine work in on it, indicating that the injector had not been working for some time. No doubt the engineer will profit by the lesson, and those of your readers who are in charge of locomotives should all profit by this record of actual experience.

Items of Personal Interest

Mr. C. Gribbins has been appointed division master mechanic of the Canadian Pacific, with office at Smith's Falls, Ont.

Mr. H. J. Morgan has been appointed general storekeeper of the St. Louis, Brownsville & Mexico, with office at Kingsville, Tex.

Mr. Burton W. Mudge, president of Mudge & Co., has been elected vice-president of the Pilliod Company, in charge of the western territory.

Mr. H. C. Allen has been appointed road foreman of engines on the Rocky Mountain division of the Northern Pacific, with office at Missoula, Mont.

Mr. W. H. Sample, formerly master mechanic of the Grand Trunk at Battle Creek, Mich., has been appointed master mechanic on the same road at Montreal, Que.

Mr. N. H. Eaken, formerly supervisor of fuel economy of the Chesapeake & Ohio, has been appointed road foreman of engines on the same road, with office at Clifton Forge, Va.

Mr. J. W. Surles, formerly general foreman of the Southern Pacific at Houston, Tex., has been appointed superintendent of shops at that place, succeeding Mr. J. A. Power, promoted.

Mr. B. Petrusich, formerly air brake inspector for the Southern Pacific at Rosebury, Ore., has been transferred to Portland, Ore., in charge of the air brake equipment on the electric system.

Mr. G. C. Nichols, formerly master mechanic of the Alabama, Tennessee & Northern at York, Ala., has been appointed superintendent of motive power and equipment with offices at York.

Mr. W. Leighty, formerly mechanical engineer of the Frisco system at Springfield, Mo., has resigned to accept a position as chief engineer of the Oxweld Railroad Service Company, Chicago, Ill.

Mr. C. E. Jones has been appointed supervisor of fuel of the Canadian Northern, having charge of all fuel for shops, stations, water stations as well as locomotives, with headquarters at Toronto, Ont.

Mr. O. P. Reese, formerly assistant engineer of motive power of the Pennsylvania Lines West, at Pittsburgh, Pa., has been appointed superintendent of motive power of the Central System of the Lines West.

Mr. B. F. Dickinson, formerly supervisor of signals of the West Jersey & Sea Shore at Camden, N. J., has been appointed supervisor of signals on the Philadelphia division of the Pennsylvania Railroad.

Mr. J. A. Jones has been appointed superintendent of telegraph of the Southern, with headquarters at Washington, D. C., and Mr. W. A. Beauprie has been appointed assistant superintendent of telegraph, also with office at Washington.

Mr. Eugene E. Reed, of New Hampshire, who was nominated a member of the Philippine Commission last year, has been elected president of the Manila Railway, which recently was purchased by the government.

Mr. Louis E. Thomas, formerly passenger car inspector of the Illinois Central, has been appointed traveling steam heat and air brake inspector of the northern lines on the same road, with office at Chicago, Ill.

Mr. Fairfax Harrison, president of the Southern, has been elected president of the New Orleans & Northeastern, which has recently been acquired by the Southern. Mr. Harrison's headquarters are at Washington, D. C.

J. G. BLUNT.

Mr. T. K. Faherty, formerly road foreman of engines of the Baltimore & Ohio at Grafton, W. Va., has been appointed supervisor of locomotive operation of the West Virginia district of the same road, with office at Wheeling, W. Va.

Mr. James R. Sutton has been appointed assistant road foreman of engines of the West Iowa division of the Northern Iowa, succeeding Mr. Hiram Williams, promoted to position of road foreman of engines of the West Iowa division.

Mr. Ralph G. Coburn, formerly eastern sales manager of the Franklin Railway Supply Company, will henceforth devote his entire time to the management of the electrical department and exploitation of the Stone-Franklin Lighting Equipment.

Mr. Robert C. Shaal has been appointed eastern representative of the Pyle-National Company, with office in New York; Mr. N. S. Kenney, representative, Munsey building, Baltimore, Md., and Mr. W. L. Jeffers, Jr., representative, Mutual building, Richmond, Va.

Mr Waldo H. Marshall, whose resignation as president of the American Locomotive Company a month age was recorded in our pages, has become associated with J. P. Morgan & Company. In his new position Mr. Marshall is attached to the export department.

Mr. L. B. Jones has been appointed master mechanic of the Pennsylvania, with office at Verona, Pa., succeeding Mr. J. C. Glass, transferred, and Mr. G. J. Riches has been appointed master mechanic on the same division, succeeding Mr. D. E. Cassidy, transferred.

Mr. George H. Groce has been appointed sales representative in the railroad department of the U. S. Light & Heat Corporation of Niagara Falls, N. Y., with office at 1402 Railway Exchange, Chicago, Ill. Mr. Groce has had a wide experience in the mechanical department of railways.

Mr. R. S. Claar, formerly assistant engineer of the Duluth South Shore & Atlantic, and the Mineral Range, has been appointed office engineer; and Mr. George Mercer, formerly general foreman, has been appointed superintendent of bridges and buildings, with headquarters at Marquette, Mich.

Mr. J. A. Power, formerly superintendent of shops of the Southern Pacific, Texas Lines, at Houston, Tex., has been appointed assistant general manager succeeding Mr. George McCormick, whose appointment as general superintendent of motive power of the same was announced in our paper last month.

Mr. H. T. Armstrong, for the past three years connected with the sales department of the American Locomotive Company at Montreal, Canada, has been assigned to the sales department of the company's Chicago office, calling on all railroads and industrial concerns using locomotives in the western territory.

Mr. James Russell has been elected vice-president and general manager of the Minneapolis & St. Paul, with offices at Minneapolis, Minn. Mr. Russell has had a wide railway experience both in Canada and the United States. Previous to his present appointment he was general manager on the Denver & Rio Grande.

Mr. J. G. Blunt, formerly superintendent of the drawing room of the American Locomotive Company, has been appointed mechanical engineer of that company, with headquarters at Schenectady, N. Y. Mr. Blunt has had over twenty years' experience in railroad engineering work, chiefly with the American Locomotive Company.

Mr. H. H. Westinghouse, of the Westinghouse Air Brake Company, has been elected to the newly created position of

Chairman of the Board, and Mr. John F. Miller elected president, and Mr. A. L. Humphrey, formerly second vice-president and general manager, was elected first vice-president in addition to the general managership.

Mr. E. F. Allard, formerly road foreman of engines on the Northern Iowa division out of Eagle Grove, Ia., has been promoted to the position of road foreman of engines on the West Iowa division, with headquarters at Boone, Ia. Mr. Allard had the honor of a banquet tendered to him on leaving the Northern division, and a diamond ring by way of remembrance.

Mr. Andrew Fletcher has been elected president of the American Locomotive Company. Mr. Fletcher is also president of the W. & A. Fletcher Company, manufacturers of marine engines, with extensive works in Hoboken, New Jersey. He is also a director of the William Cramp & Sons Ship and Engine Building Company, and president of the Consolidated Iron Works and the North River Derrick Company.

D. F. CRAWFORD.

Mr. P. F. Smith, Jr., formerly superintendent of the Pennsylvania Lines West, with office at Toledo, Ohio, has been appointed general superintendent of motive power of the Lines West, with offices at Pittsburgh, Pa., succeeding Mr. D. F. Crawford, promoted. Mr. Smith entered the service of the Pennsylvania in 1887 as special apprentice at the Altoona shops, and has passed through nearly all of the positions in the mechanical department with credit and ability.

Mr. H. D. Savage, vice-president of the American Arch Company, has been appointed manager of sales of the industrial department of the Locomotive Pulverized Fuel Company, with office at 30 Church Street. Mr. Savage is a graduate of the Kenyon Military Academy. From 1897 to 1904 he served in various capacities in the manufacturing department of the Ashland Fire Brick Company, and in 1914 was elected vice-president of the American Arch Company, which position he still holds in addition to his new appointment.

Mr. Harry M. Evans has been appointed eastern sales manager of the Franklin Railway Supply Company, with office at 30 Church street, New York. He began railroad work as a callboy on the Erie, and served in various positions in the mechanical, transportation and traffic departments of that road. He entered the mechanical department of the Franklin Railway Supply Company October 1, 1908, as traveling representative, and was promoted to assistant western sales manager in August, 1916, which position he held at the time of recent appointment.

Mr. Grover C. Nichols has been appointed superintendent of motive power of the Alabama, Tennessee & Northern, with offices at York, Ala. Mr. Nichols is from Arkansas and began his railroad career in 1902 on the St. Louis Southwestern serving an apprenticeship as a machinist on that road. In a short time he was master mechanic of the Jonesboro, Lake City & Eastern, at Jonesboro, Ark. In 1913 he accepted an appointment in the Alabama, Tennessee & Northern, which position he held until his recent appointment as superintendent of motive power and equipment.

Mr. Orville C. Wright, formerly assistant engineer of motive power of the Northwest system of the Pennsylvania Lines West at Fort Wayne, Ind., has been appointed assistant engineer of motive power of the Lines West, with offices at Pittsburgh, Pa.

Mr. D. F. Crawford, formerly general superintendent of motive power of the Pennsylvania Lines West, at Pittsburgh, Pa., has been appointed general manager. Mr. Crawford was educated at the Pennsylvania Military Academy, and entered the service of the Pennsylvania as an apprentice in the Altoona shops in 1885. He rose through the various positions of inspector in the test department, assistant master mechanic, assistant to the superintendent of motive power, superintendent of motive power, and in 1903 was appointed general superintendent of motive power of the Pennsylvania Lines west of Pittsburgh, which position he held until appointed general manager. He is the inventor of the Crawford underfeed mechanical locomotive stoker and other devices, and is generally acknowledged as among the leading mechanical engineers of our time.

Mr. J. L. Randolph has been elected vice-president of the Economy Devices Corporation, with office at 30 Church Street, New York. Mr. Randolph is from New England, with an extensive railroad and also other experience, beginning his railroad career as a machinist apprentice in the Concord (N. H.) shops of the Northern Railroad, now a part of the Boston and Maine. Subsequently he served this road in the capacity of machinist, gang foreman, general foreman, master mechanic and superintendent of shops at Keene, N. H. In April, 1911, he accepted a position with the Franklin Railway Supply Company in the mechanical department. In February, 1914, he was appointed eastern sales manager of the Economy Devices Corporation, which position he held at the time of his recent appointment.

Mr. Arthur L. Humphrey, First Vice-President and General Manager of the Westinghouse Air Brake Company, has been elected President of the Union Switch & Signal Company, in accordance with merger proceedings of the two companies, and will hereafter assume the executive responsibility of both offices. Mr. Humphrey was born in Erie County, New York State. Before the year was out he and the others of the family found themselves pioneers in a new home in Iowa. At the age of 14, after the usual amount of country schooling, he struck out for himself, passing successively through positions of store-hand, cowboy, substitute cook, machinist apprentice, gang boss, mining engineer and general contractor—all in the new pioneer territory lying between the Missouri River and the Pacific Coast. At the age of 22 he organized a general machine shop and foundry at Seattle, which afterwards developed into the present extensive and well-known Moran Iron Works. Railroading again claimed him, and he became constructing division foreman of

ARTHUR L. HUMPHREY.

the Mojave Division of the Central Pacific, then master mechanic and later superintendent of motive power of the Colorado Midland. In 1892. Political urgency, due to Populistic activity, caused the business men of Colorado to combine and combat that influence in the Colorado Legislature by electing a business man to the State Legislature. Mr. Humphrey was chosen and elected, serving two active terms, one as Speaker of the House. Railroad lure, however, settled him on the Colorado Southern in 1899 and on the Alton in 1902, as superintendent of motive power. He became western manager of the Westinghouse Air Brake Company in 1893, general manager in 1905 and vice-president and general manager in 1910. Air brake and block signal development in the control of railroad train movement has become so inter-related from an engineering standpoint, that closer co-operation between these two Westinghouse interests has been inevitable for some years, and indeed was originally planned by the late George Westinghouse himself. Mr. Humphrey's broad experience as a railroad man qualifies him effectively for the new responsibilities assumed.

OBITUARY.

Harry C. Hooker.

Much regret is expressed at the death of Harry Chester Hooker, assistant to F. D. Underwood, president of the Erie Railroad Company, at the early age of 47. Mr. Hooker was from Milwaukee, Wis., and has been assistant to Mr. Underwood for sixteen years. Mr. Hooker's death occurred in this city on January 7th.

W. C. Nixon.

The death of W. C. Nixon, the recently elected president of the St. Louis & San Francisco railroad, is announced. He was 55 years of age, and had spent many years in various capacities on the Frisco system. Mr. Nixon was generally looked upon as one of the best railway executives in the Southwest, and his loss is very keenly felt.

Charles T. Turner.

Mr. Charles T. Turner, who was master mechanic at the Mount Clare shops, Baltimore, Md., of the Baltimore & Ohio, for many years, died on January 7 in Baltimore. Mr. Turner had been in the service of the company about 50 years, and for the last few years was on the company's pension roll.

Col. Herbert Hughes.

Cable advices announce the death of Colonel Herbert Hughes C. B., C. M. G. of Sheffield, England. He was a director of the well known steel firm of William Jessop & Sons, Sheffield, and prominent in all public matters having served as lord mayor of Sheffield, acting brigadier-general of volunteers, and member of the advisory board at the war office. Colonel Hughes represented the British government at the International Conference on trade marks held at Washington, D. C., a few years ago. He also acted in a similar capacity at conferences in Berlin and Madrid. As an eminent lawyer his services were much sought for, and he was in many ways a distinguished and admirable type of an English gentleman. He was sixty-four years of age.

Westinghouse Air Brake and Union Switch Merger.

The plan for the merger of the Union Switch & Signal Company into the Westinghouse Air Brake Company was formally declared effective January 12. The officers of the company as chosen are as follows: Chairman of the Board, W. D. Uptegraff, formerly president of the Union Switch & Signal Company; president, A. L. Humphrey, first vice-president and general manager of the Air Brake Company; vice-president, John F. Miller, president of the Air Brake Company; vice-president and treasurer, T. W. Siemon, formerly vice-president of the Signal Company; vice-president in charge of sales, G. A. Blackmore, formerly manager of sales of the Signal Company; acting vice-president and secretary, T. S. Grubbs, formerly secretary of the Signal Company; controller, C. A. Rowan, controller of the Air Brake Company; auditor, F. V. Shannon, formerly auditor of the Signal Company; assistant treasurer, M. K. Garrett, who was associated with George Westinghouse's private office in an accounting capacity for 25 years. The directors of the Air Brake Company have called a special meeting of stockholders for March 15, to ratify the merger and also to approve an increase in the capital of the company from $20,000,000 to $30,000,000 to finance the transaction. Out of the increased capital it is proposed to declare a stock dividend of 20 per cent to holders of Air Brake stock, including the shares exchanged for the stock of Union Switch & Signal Company.

General Foremen's Association.

The officers and executive committee of the International Railway General Foremen's Association met recently for the purpose of selecting a meeting place and time of holding the next annual convention, and other important matters pertaining to the welfare of the association. It was decided to again meet in the Sherman Hotel, Chicago, Ill., on September 4, 5, 6, 7, 1917. The following topics were selected for discussion: "Engine Failures, Causes and Responsibilities. What Constitutes a Failure?" W. R. Meeder, chairman, C. & E. I. Ry., Danville, Ill. "Methods of Meeting the Requirements of Federal Inspection Laws." J. B. Wright, chairman, Hocking Valley Ry., Columbus, O. "Alignment of Locomotive Parts, to Insure Maximum Service With Minimum Wear." B. F. Harris, chairman, So. Pac. Ry., Oakland, Cal. "What Interest Has the Locomtive Foreman With Car Department Matters?" Chas. Hobbs, chairman, Ann Arbor Ry., Owosso, Mich.

The Air Brake Association.

We have received from Mr. Nellis, Secretary of the Air Brake Association, a circular letter announcing that the next convention of that association will be held at Memphis, Tenn., on May 1-4. The Chisca hotel has been selected as headquarters, the rates ranging from $1.50 to $3.00 a day.

The announcement is made that Mr. Walter V. Turner will deliver one of his interesting addresses.

One afternoon will be devoted to informal, unreported discussions of Air Brake subjects, at which all members are invited to speak their minds freely and fully.

This is a very sensible innovation for many of the members are too diffident to speak freely when they expect to see their remarks in print.

The different railroad companies and the Pullman Company have displayed readiness to transport the railroad members of this association free of charge, or at reduced rates.

American Locomotive Company.

The annual report of the American Locomotive Company shows an increase in gross earnings in the last six months of 1916, as compared with the same period in 1915, of $23,464,735. At the present time the company has on its books unfilled orders amounting to $75,746,377.

At a meeting of the Board of Directors of the American Locomotive Company, held January 17, 1917, the following officers were appointed, effective February 1, 1917: Mr. Columbus K. Lassiter, vice-president in charge of manufacture; Mr. Harry B. Hunt, assistant vice-president in charge of manufacture; Mr. James D. Sawyer, vice-president in charge of sales; Mr. Joseph Davis, vice-president and comptroller.

Demand for Cars Abroad.

The orders coming to America for railroad equipment abroad continue to grow in volume. Inquiries for 40,000 cars for export are reported to be in the market, and inquiries for an additional 20,000 are expected. The latest inquiry was for 2,100 cars for Spanish railroads. The order includes 600 gondolas and 500 hopper cars.

RAILROAD NOTES.

The Illinois Central will expend about $40,000 in its shops at Louisville, Ky.

The Russian Government has placed orders in this country recently for 350 locomotives and 3,000 gondolas.

The Anaconda Copper Mining Company has ordered three locomotives from the Baldwin Locomotive Works.

The Seaboard Air Line has issued inquiries for 20 Santa Fe (2-10-2) and 10 Mallet (2-8-8-2) type locomotive.

The Northern Pacific proposes to erect extensive shops at Mandan, N. D., work on which is to begin early next spring.

The Santa Fe has plans for extensive shops at San Diego, Cal., to cost about $500,000, with machinery, equipment, etc.

The Union Pacific is reported as having placed an order with the Lima Locomotive Works for 10 Mikado (2-8-2) locomotives.

The Paris-Orleans Railway, of France, has placed orders in this country for 50 Mikados (2-8-2) to be delivered by November next.

The New York, New Haven & Hartford has ordered 40 Santa Fe (2-10-2) locomotives from the American Locomotive Company.

The Queen & Crescent will expend about $500,000 on its shops and yard facilities at Danville, Ky. A new roundhouse will also be built.

The British War Office is reported ordering 50 Consolidation (2-8-0) type and 75 Prairie (2-6-2) type locomotives from the Baldwin Locomotive Works.

The Lehigh Valley has placed orders for 149 gasolene motor-driven cars for track men to replace hand-cars. The company has 183 cars of this class in use now.

The Lehigh & New England has plans for installing automatic block signals at the Catasauqua tunnel, and for interlocking plants at Benders junction and Stockertown, Pa.

The American Locomotive Company will build a number of Mallet engines for the Virginian at a cost of $1,000,000. Each of them will weigh 335 tons, exclusive of their tenders of 70 tons.

The Texas & Pacific Ry. is inquiring for 100 steel underframe convertible ballast and 100 10,000-gallon tank cars. Some consideration is being given the purchase also of 400 50-ton gondola and 200 stock cars.

The Chicago, St. Paul, Minneapolis & Omaha has been getting prices on 50 machine tools for its car shops, and the Burlington has been getting prices on equipment for its new shops at West Burlington, Ia.

The Chicago, Terre Haute & Southeastern has ordered 2 Consolidation (2-8-0) type locomotives from the American Locomotive Co. Cylinders will be 25 by 32 inches; driving wheels 61 inches; total weight 244,000 lbs.

The Chicago, Milwaukee & St. Paul will build 1,000 gondola cars in its Tacoma (Wash.) shops. The cars will have wooden sides, and be equipped with steel center sills. The trucks will be let to the Griffith Wheel Works of South Tacoma, Wash.

The French Government, through J. P. Morgan & Company, has issued an inquiry accompanied by specifications for approximately 20,000 railroad cars of four types. It is understood, however, that 40,000 cars may be purchased and that the total purchases will be about $40,000,000.

The Buffalo, Rochester & Pittsburgh announces that as soon as the material can be secured automatic block signals will be extended from J. & B. Junction to Clarion Junction, Pa., just north of Johnsonburg, a distance of 20 miles. Forty signals will be required to protect this piece of track.

The Atchison, Topeka & Santa Fe advises that 28 Mikado (2-8-2) type locomotives ordered from the Baldwin Locomotive Works will have cylinders 27 by 32 inches and 63-inch driving wheels. Each engine will weigh 317,000 pounds, and will exert a maximum tractive power of 60,000 pounds.

The New York, New Haven & Hartford was reported in last week's issue as having ordered 40 Santa Fe type locomotives from the American Locomotive Company. This order has since been increased to 50. These locomotives will have 30 by 32 in. cylinders, 63 in. driving wheels, and a total weight in working order of 368,000 lbs.

On the recent order for freight cars placed by the Union Pacific with several car builders, Bettendorf steel underframes will be applied to 1,500 box and 1,000 automobile cars, and both steel underframes and trucks are specified for 400 box and 2,700 refrigerator cars. This makes a total of 5,600 steel underframes and 3,100 trucks furnished the Union Pacific by this company.

The Northern Pacific has ordered 20 Santa Fe and 5 Mallet type locomotives from the American Locomotive Company. The Santa Fe type locomotives will have 28 by 30 in. cylinders, 63 in. driving wheels and a total weight in working order of 320,000 lbs. The Mallet type locomotives will have 26 and 40 by 30 in. cylinders, 57 in. driving wheels, and a total weight in working order of 456,000 lbs.

The Southern Pacific has ordered 24 Santa Fe type locomotives from the American Locomotive Company, and 9 six-wheel switching locomotives from the Baldwin Locomotive Works. Of the Santa Fe engines, 23 will have 27½ by 32 in. cylinders, 63 in. driving wheels, and a total weight in working order of 344,000 lbs. The other will have 26½ by 32 in. cylinders, 57 in. driving wheels, and a total weight in working order of 341,000 lbs.

M. M. and M. C. B. Conventions.

The M. M. and M. C. B. Associations will hold their annual convention for 1917 at Atlantic City, June 13 to June 20. The conventions will be held in the convention hall on Young's Pier. The M. M. Association lead this year. The Railway Supply Manufacturers' Association will be present in full force, and will have an extensive exhibition of railroad appliances.

The R. S. M. A. dues are $15.00, and this entitles the member to all the privileges of the association and to one Ry. Sup. Mfg. Association badge. Badges for representatives or ladies $5.00 each. Arrangements have been made with the Philadelphia & Reading Railway for suitable accommodations for those desiring to exhibit rolling equipment. No charge, other than the association membership dues will be required, except for switching and demurrage. Track exhibits will be on a siding of the P. & R. Ry., at Mississippi avenue and Boardwalk, about 200 yards from the pier.

Improvement in the decorative features is planned for this year. The color scheme of green and white, which has proved so attractive in past years, will be preserved. The Annex at short end of building provides for additional exhibit space. This building being enclosed with glass, except where curtains will be used. The main building, booths surrounding the reception and dance floor, will be restricted to light, clean and noiseless exhibits, and so arranged that the floor may be used for reception purposes. The machinery hall extension will have a plastered ceiling, panel effect, and curtains hung on windows at backs of booths, ocean exposure. The floors of exhibit spaces will be stained and aisle-ways covered with new crex matting.

Additional facilities to provide power has been arranged for. Exhibitors will be furnished power as specified on the application blanks for space. All requirements for these facilities must be fully stated on the application blanks. Contract has been made with the Eldredge Express & Storage Warehouse Co., of Atlantic City, to deliver all freight shipments from the railroads to exhibitors' booth, to store all empty crates and boxes, and return them to exhibitor. The express company will return shipments to the railroad. J. J. Habermehl's Sons, Bellevue-Stratford Hotel, Philadelphia, Pa., have had the contract as official florists for the past seven years, have again been awarded this contract. C. M. Koury, of Atlantic City, N. J., will have the contract to provide for use of exhibitors on a rental basis, furnishings for booths, such as furniture, rugs, etc. Information concerning mechanics and electrical work, together with other detailed information, will be given in circular No. 2, which will be issued later.

The Railway Supply Mfg. Association's secretary announces that application for space, with blanks in duplicate, should be filled out with full detail information, and both original and duplicate blanks sent to him, 2136 Oliver Building, Pittsburgh, Pa., remittance by draft to accompany the application, covering the amount of space asked for at 40 cents per square foot and adding to this the membership fee of $15.00 and $5.00 for extra badges, if required. The assignment of space takes place on Friday, February 23, 1917, space being assigned at the office of the Association at Pittsburgh, Pa., at 2:30 p. m.

The Exhibit Committee are Messrs. J. G. Platt, Geo. R. Carr, C. W. Beaver.

J. D. Conway, Secretary-Treasurer.

Extensive Equipment Orders.

The railroads are certainly doing their part to keep money in circulation. They are spending money as fast as it is earned. Orders for equipment are being placed with a degree of magnitude hitherto unapproached, so much so that many of the orders being issued cannot be filled this year. This is particularly true of freight cars, over 60,000 of which are ordered, representing an expenditure of over $90,000,000.

American Locomotives in China.

Last month the steamship *Brinkburn* discharged 20 locomotives of American make for service on the Chinese railways. Ten of these are to be used on the railway from Wuchange to Changsha, which is expected to be in full operation early in March this year, and which is being built from funds provided by the Hukuang loan. The other ten locomotives are for the Peking-Hankow railway line.

Books, Bulletins, Catalogues, Etc.

Analyzing Character, by Katherine M. H. Blackford, M. D. and Arthur Newcomb. Published by the Review of Reviews Company, New York, 1916. Price $3.00.

Man with his god-like intellect—with all his exalted powers, still bears in his bodily frame the indelible stamp of his lowly origin. These words are a paraphrase of the concluding sentences in Darwin's "Descent of Man," and in a certain sense they are proved true in the interesting and most instructive book before us. Everything about a man indicates his character, it is only for the observer to read it aright.

The characteristics which go with color, form, size, structure, texture, consistentcy, proportion, expression and condition—these nine fundamental differences between men, have had a definite origin, and are in fact the results of climate, heredity, and the methods of getting a living which Nature forced upon the various races of men in the days when the earth was young.

These facts are apparent in modified form to the scientific observer. The fat man, possibly of dark color, which we see today comes of a tropical race where life was easy and comfortable as compared to the clear-faced and active blond whose lot was cast in the more northern and colder latitudes, where to live was a battle against the elements or with foes. The fat man desires comfort, but does not desire to work for it himself, so he appears at the present day (when rightly placed) as the head of some large enterprise where he directs the work of others. These and other explanations of bodily differences between men and the results which come from them are set forth in a fascinating and easily understandable way, which gives valuable information and instruction, while it holds the attention and interest as a good story, well told, would hold it.

Life stories of successful men are told with careful attention to essential details and in the same style of convincing narative, and the reasons for the failure of other men are brought out. Good illustrations of heads are given so that one is not only instructed in the meaning of the "long head," or the "concave face," but he sees it presented to him in the photograph of some living man to whom success or failure is rightly attributable. It is not too much to say that the authors have gone about their chosen theme with a thoroughness that leaves nothing to be desired, and throughout they have evinced a careful and penetrating judgment which inspires confidence and belief in the mind of the reader.

Hugh Miller has said that to recount the past is but prophecy turned about, and that the difficulty of correctly reading the past is not any harder than forecasting the future.

Our authors have looked back to the days when an inturned fold of skin became through the lapse of ages a specialized organ of sense, and they have shown how the texture of the skin of a living man has a significance hitherto little dreamed of in connection of character analysis of observation. After all, a man rightly placed, with work a pleasure, has a perpetual joy, and in a dim or shadowy way (whether or not he knows it), has gone back to some modification of a far-away ancestral occupation which now seems to come so "naturally" to him.

This book is a valuable contribution to the subject of character analysis by the observational method and its usefulness to the railroad man of today is that those who have the hiring of men, or the gathering together of a staff, will be materially helped in their selections of men, by an easily attained scientific view of applicants for positions. They will not have to trust to vague "intuitions" but will have a groundwork of fact to go upon in the diagnosis of probable failure or success in the men they employ.

Proceedings of the Master Car Builders' Association.

The report of the proceedings of the Fiftieth Annual Convention of the Master Car Builders' Association held at Atlantic City, N. J., June 14, 15 and 16, 1916, has just been issued from the press of the Henry O. Shepard Company, 632 Sherman Street, Chicago, Ill. The compilation and editing has been done by the Secretary, Jos. W. Taylor, Karpen Building, Chicago, from whom copies may be procured. The first volume extends to 544 pages and the second volume to 614 pages, in addition to which there are an unusually large number of folders making the largest volumes issued by the Association. In our July issue last year we published a detailed account of the subjects discussed, and it is not necessary to recapitulate the matter at this time. It is a noteworthy fact that the number and variety of subjects seems to grow with the growing years, and it is surprising that so much could be said and done in the three days allowed for the convention, and all of it with such a degree of thoroughness.

Publicity for Public Service Corporations.

Mr. Ivy Lee delivered an address recently before the American Electric Railway Association, on "Publicity for Public Service Corporations," the substance of which is now published and forms a valuable contribution to the railroad literature of our time. As is well known there was a time when railroad managers thought they were running a private business. This is all changed. The public has assumed control, and in dealing with the public Mr. Lee believes that the being and doing are far more than the saying, and that a man who goes into a policy of publicity must believe absolutely that he is right and that he can justify his policy upon the theme that truth loves open dealing, and that he can rely absolutely upon the refining and sterling value of the truth. Mr. Lee's deductions are admirable and copies of his valuable pamphlet should be perused by all who are influential in the conduct of railroads. Mr. Lee's offices are at 61 Broadway, New York.

McLaughlin Flexible Conduits.

The Franklin Railway Supply Company has issued Series C Bulletin 401, illustrating and describing the McLaughlin Flexible Conduits that are used between engine and tender or between units of Mallet articulated locomotives, providing flexible metallic connections for air, steam and oil, in place of rubber hose. The successful operation of metallic hose is applicable to any class of service, and is maintained at no expense except an occasional renewable gasket. The several joints are made of brass with sleeves of bronze to insure strength. A hard gasket is used for steam, soft rubber for air, and asbestos for oil. A spring, used for preventing vibration of parts, is also of brass, thus making the joints and attachments non-corrosive. A cotter pin is all that is necessary to lock the nut in place. The device has met with much favor, and is included in the standard specifications of a great many of the larger railroad systems. Those interested should secure a copy of the Bulletin referred to from the company's main office, 30 Church street, New York.

Correspondence School on C. & O.

There is a growing tendency among railroad companies to encourage their workmen to take a course in the International Correspondence School of Scranton, Pa., instead of encouraging special schools. In an extract from the Chesapeake & Ohio Employees Magazine we read:

"A feature of our educational work which should be encouraged by all who are mindful of the welfare of the employees and the success of the company is the training being given to many of our boys and men by the International Correspondence School of Scranton, Pa. It shows that employees of all kinds, from laborers to those occupying official positions, are developing the "study habit" and steadily accumulating specialized knowledge thereby, vastly increasing their efficiency and opening the doors that lead to high attainment.

Our employees appear to be taking advantage of the fine opportunity provided to qualify for higher positions. Beneficial results are certain, for sound training must produce a grade of railway men better able to render admirable service to the C. & O. than those who have no other knowledge than that picked up in the course of their every-day duties.

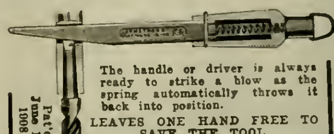
"When we stop to consider the possibilities ahead of the laborer, for instance, who devotes some of his spare time to studying and successfully passing Instruction Papers on Algebra, Trigonometry, and other mathematical subjects, we can take legitimate pride in the fact that we have many such men on the C. & O. They are not only building up success for themselves, but are also insuring the efficient operation and maintenance of our railway properties, and the safety of employees and the traveling public. We believe that this spare-time home study is most gratifying to the executive officers as well as to the management of the company, for it indicates the large caliber of many of our men and is a happy augury of the continued success of the road.

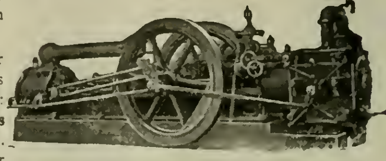
"Our advice to the employees of the C. & O. Railway who have a scholarship in the International Correspondence Schools is to take full advantage of the educational facilities provided by that institution. The man who devotes a portion of his spare time, if only one hour each week day, to acquiring the study habit and working on vocational lessons that are carefully prepared, accurate and practical, will soon realize the truth of the saying that "Efficiency is simply being qualified to do the right thing the first time."

President Underwood's Good Wishes.

President F. D. Underwood of the Erie Railroad has always been noted for the encouragement given to employees as there is a widespread desire manifested among the employees to look for a good word from the president when occasion offers.

In the Erie Railroad Magazine for January, President Underwood greets officers and employees of every grade: "The executive staff hereby extends its hearty good wishes for the ensuing year. You are seeing the property grow better each month. Let us see that the pleasant relations now existing continue, keeping alive our interest until the plans for the future improvement of the Erie bear full fruit."



Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXX. 114 Liberty Street, New York, March, 1917 No. 3

Triplex Articulated Compound Locomotive for the Virginian Railway

A triple articulated compound locomotive, with 2-8-8-8-4 wheel arrangement, has recently been built by the Baldwin Locomotive Works for the Virginian Railway. As far as the general principles of its design are concerned, this locomotive is similar to the Erie triples, which have now been in service a sufficient length of time to demonstrate the value of the type in heavy grade work. The Virginian locomotive exerts a maximum tractive force of 166,300 lbs., and was designed with a height limit of 16 ft. 10 ins. and a width limit of 12 ft. at a height of 2 ft. 3 ins. above the rail. The center line of the boiler is placed 10 ft. 9 ins. above the rail. Flanged tires are used throughout, the lateral play between rails and flanges being ⅞ in. on the front and back drivers of each group, and ⅝ in. on the main and intermediate pairs. The locomotive is turned on Ys, on which the curvature is 18 degs.

The boiler is of the wagon top type, with an outside diameter of 110 ins. at the third ring. Both the main and auxiliary domes are mounted on this ring, the latter being placed over a 15-in. opening in the shell. The longitudinal seams are all placed on the top center line. That on the dome ring is welded throughout its entire length, while the seams on the first and second rings are welded at the ends. The circumferential seam uniting the second and third rings, and the seams uniting the third ring with the throat and outside firebox sheets are triple riveted. The back tube-sheet is straight, and the tubes have a length of 25 ft. The furnace is of the Gaines type, and the arch is supported on five tubes.

As the fire-box is placed above the middle group of driving-wheels, the space available for the throat is exceedingly restricted. Sufficient depth of throat has been obtained by depressing the front bar of the mud ring between the wheels. Flexible Tate bolts stay the throat and back of the firebox, and are used in the breakage zones in the sides; and four rows of Baldwin expansion stays support the forward end of the crown. The mud ring is supported on vertical plates at the front and back, and at one intermediate point. Here the load is transferred to the plate through a transverse cast-steel brace, which is strongly ribbed, and supports the longitudinal grate bearers. Attention may be called to the ash pan, which, in spite of the limited space available, has two large hoppers with cast-steel bottoms and drop doors. The back receiver pipe and reach rod are run through the pan, which has a longitudinal duct running through it for this purpose. Provision is made for admitting air at the front of each hopper and near the top of the duct at each side, as well as under the mud ring.

The throttle is of the Rushton type, specially designed to suit restricted clearance limits. The dome is 10 ins. high and 36 ins. in diameter; and the dome opening in the shell measures 20 ins. longitudinally by 28 ins. transversely. The throttle valve is seated immediately over this opening, and the throttle pipe has cast on it a supporting bracket which is bolted to the boiler shell. The valve is lifted by a transverse rotating rod, which passes through a stuffing-box in the side of the boiler below the dome, and has an outside connection with the throttle lever. The latter is placed in a vertical position, and is designed to give maximum leverage and slowest valve movement when the valve is starting to lift.

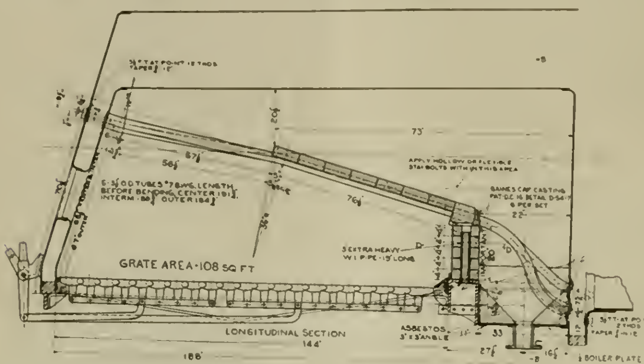
The superheater header is of cast iron, in one piece, and is designed for a 65-element superheater having 2,059 sq. ft. of surface. The superheated steam pipes leading back to the high pressure cylinders are fitted with slip joints, and the right hand pipe has a connection, through a suitable cast-steel elbow, with the Simplex starting valve. This valve is placed in the high pressure cylinder saddle.

When working compound, the two high-pressure cylinders exhaust into a common chamber, which communicates with the front and back receiver pipes. In starting, the intercepting valve is in such a position that live steam enters both the front and back receiver pipes as well as the high pressure cylinders; and the high-pressure exhaust is conveyed to the smoke-box through a separate pipe, which terminates in an annular nozzle surrounding the main nozzle. Both the main and aux-

TRIPLEX ENGINE 2-8-8-8-4 FOR THE VIRGINIAN RAILWAY.

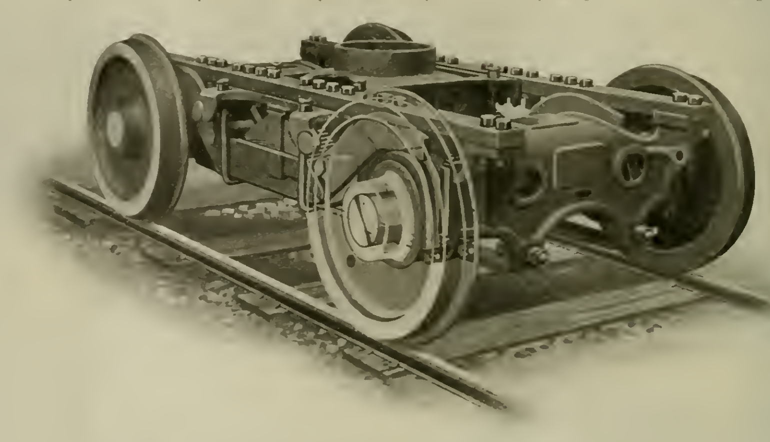
R. E. Jackson, Supt. Motive Power. Baldwin Loco Wks., Builders.

iliary nozzles have removable thimbles. The intercepting valve is so arranged that, by admitting steam through a pipe connection from the cab, the locomotive can be worked single expansion at any time. When drifting, saturated steam can be admitted to the high-pressure cylinders through a pipe connected with a lever valve placed in the cab.



FORM OF GAINES FURNACE WITH "SECURITY" BRICK ARCH.

The high-pressure cylinder saddle is made in two pieces, the upper of which is riveted to the boiler shell, while the lower is cored out for the intercepting valve and pipe connections. All six cylinders are cast from the same pattern: they are of vanadium iron, so designed that bushings ¾ in. thick can be subsequently applied if desired. The pistons have dished heads of forged steel, with cast-iron bull rings held in place by electrically welded retaining rings. The piston rods are of nikrome steel, without extensions. Vanadium cast steel is used for the cross-head bodies: they are of the Laird type, and are as light as is consistent with the strength required. The main crank-pins are of nikrome steel, hollow bored; while the main and side rods, and main driving axles, are of chrome-vanadium heat-treated steel. Vanadium steel is used for the driving tires and also for the springs. The valve motions are of the Baker type, controlled by the Ragonnet power reverse mechanism.


THE "ECONOMY" TRUCK SHOWING PEDESTAL TRANSOMS, EQUALIZERS AND AXLE BOXES.

An interesting table of valve gear tests made by the Erie Railroad appeared in our February, 1917, issue of Railway and Locomotive Engineering, on page 59. The tests were conducted so that a certain engine fitted with the Stephenson gear was run a number of trips and records of performance were kept. This same engine was then equipped with Baker valve gear and run on a series of similar trips, doing practically the same work and records were kept. A comparison of the records showed a superiority in favor of the Baker gear.

The Ragonnet reverse gear was also described in our last month's issue, in which the satisfactory results of this gear were shown for switching service. The rapidity, precision and directness of application were in favor of this type of reverse gear. The elimination of "reaction" time was mentioned, which is the time required for an engineman to cognize a signal in his mind and make the necessary muscular movement to operate the reverse handle. In placing this gear on a heavy engine, such as this for the Virginian Railway, where six sets of valve gear have to be moved at the same time, the railway have relieved the engineman of much heavy physical labor, and the advantage of such an arrangement is too obvious to need elaboration here.

This engine is equipped with the Street locomotive mechanical stoker. This type of engine not only requires mechanical firing, as the demand made upon a fireman would be too heavy for sustained physical work, and the deterioration in the quality of the service of a very strong man would be so rapid as to put economical operation out of the question. In fact, the mechanical stoker is here a necessity. In an interview by Dr. Sinclair with Mr. Samuel Vauclain, superintendent of the Baldwin Locomotive Works, published in our June, 1916, issue, page 232, Mr. Vauclain said in effect that the building of a locomotive of this class would have been a commercial impossibility if the mechanical stoker had not been available. The Street stoker is now used on about 1,245 engines on 24 railroads as the company's record up to January 1 of this year shows. A detailed description of its construction and operation are to be found in another column of this issue.

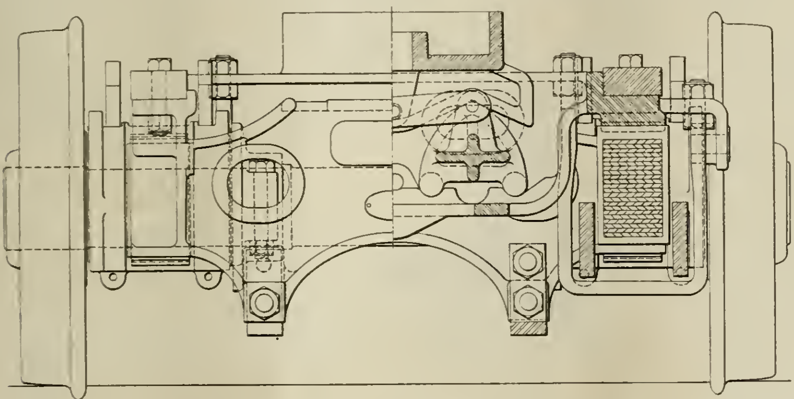
The frames are vanadium steel castings, 6 ins. in width. The radius bars at the two articulated frame connections are attached to horizontal transverse pins, and are fitted with case-hardened spherical bushings, which embrace the hinge pins. This construction has been used by the builders in a number of recent Mallet locomotives. It provides flexibility in a vertical as well as a horizontal plane, and prevents binding at the hinge-pins when passing over sudden changes in grade or poorly surfaced track. The structural details include a number of steel castings of unusual design. The waist bearers supporting the forward part of the boiler barrel, for example, and the three guide bearers, are all bolted to both the upper and lower frame rails, and constitute most effective transverse frame braces. The front bumper beam and deck plate are combined in a large steel casting, furnished by the Commonwealth Steel Co., and designed to house the Miner A-59 draft gear. This style of draft gear is used at the back end also.

The tank is of such length that it overhangs the rear driving-wheels by a considerable amount; and the weight of the overhang is carried by a four-wheeled, constant resistance engine truck of the Economy type. This truck has a total swing of 13¼ ins., and the load carried by it is equal to the total weight of an express passenger locomotive of 30 years ago. The leading truck, which is two-wheeled, is of the Economy type also.

The Economy truck has a number of interesting features, among which may be mentioned the guiding principle which has been here introduced. The pressure upon the flanges of the wheels when rounding a curve is in the end, transferred to the face of the pedestals. This pressure is never constant. It shifts from side to side, as right or left hand curves are encountered. This intermittent pressure has a tendency to permit the pedestal bolts to work loose. To obviate the result of this tendency, and at the same time to greatly increase the strength and rigidity whole structure of the Economy truck, a steel casting is put between the bar frames and is securely bolted to them; a tie rod, one on each side, connects the front to the back pedestal transoms, as these castings are called. This arrangement makes it only necessary to cut the truck frames to the required length, when building, long for a long truck, short for a short one. No lips or end forging is necessary. Cut the bar off square and the work is done.

The pedestal transom contains the pedestal, cast integral, so that each pedestal not only receives its holding effect from its own bolts, but it also has what holding power is derived from the pedestal bolts on the other side. In fact, to drive back one pedestal would require the dislocation of the other pedestal and the entire pedestal transom casting would have to be forced back, which would require the breakage of six bolts at the same time. Furthermore, the arrangement is such that a solid bearing is provided for equalizers on the boxes, and these equalizers are formed with an easy and smooth curve.

The springs and equalizers of standard form can be used. The journal boxes are not restricted as to depth because there is no fixed tie rod immediately below them, it being more advantageously placed in the Economy truck. This gives a railway company freedom to design the form of box and depth of packing cellar, which it may consider advisable. Axle collars are easily removable, and are made of cast iron to take up hub wear. The pedestal shoes are made of pressed steel. This truck has ample clearance, as it is made low so as to secure the maximum clearance below the engine frame.



OUTLINE OF THE "ECONOMY" TRUCK, SHOWING HEART-SHAPED SUPPORT FOR CRADLE AND PEDESTAL TRANSOM.

The bolster arrangement is such that hangers are not used, and what is called a "constant resistance" centering arrangement has been devised for this truck. It is applicable to the two, as well as the four, wheel truck. The cradle carrying the center casting is placed on heart-shaped supports resembling in form a heart or the top of a Gothic church door. The sides of the curved support are segments of circles and the "heart" thus made stands upon a wide base with point on top. When the cradle moves to the right (or the left, as the case may be), the notched underside of the cradle practically rolls upon one side of each support, and does this without raising the engine as high as the three-point suspension link does. The centering influence is supplied by the change of support from two to one lug on the corners of the heart-shaped support, and by the slight rise they give to the front end, and the inevitable return of the cradle to its normal position is assured.

This arrangement not only supplies a constant resistance to the side motion of the center pin, but it makes the initial resistance considerably greater than it is with other styles of trucks. In fact, the increased resistance augments the guiding influence, which is the thing desired, and it does this with little increased wear of the parts. In fact, the whole arrangement is, if one may say so, an approximation to a rigid wheel-base between truck and driving-wheels when on tangent track, yet this approximation to rigidity is not so strong as to prevent free lateral movement in curving. This approximation or tendency exists sufficiently to give a strong satisfactory guiding influence, without being too easy, and without being too stiff, to give the necessary flexibility for the exacting service it is designed to perform.

Attention should be called to the sanding arrangements used on this locomotive. There are four sand-boxes placed right and left over the boiler, two for the forward group of wheels and two for the middle group. Sand for the rear group is carried in a box which is placed on top of the tank. The pipes from this box are run to the bottom of the tank through two vertical pipes, 4½-in. diameter. In connection with the sanding equipment, rail washers are placed at each end of the locomotive; and a specially designed value in the cab controls the supply of sand and washing water simultaneously. When the handle of this valve is turned in one direction, sand is delivered under the front drivers of each group, and water is discharged through the washing pipes at the rear; while if the handle is turned in the opposite direction, sand is delivered under the rear drivers of each group, and water is discharged through the front washing pipes. Suitable nozzles are also provided for blowing out the sand traps and their pipe connections by means of compressed air. Flange oilers are applied to the front and rear driving-wheels in each group.

The exhaust steam from the rear cylinders passes through a feed-water heater, which is placed under the tank, and consists of a long drum 22 ins. in diameter. This drum is traversed by 31 tubes 2¼-in. diameter, providing 437 sq. ft. of heating surface. The exhaust steam passes through the tubes. The feed-water is handled by a Blake and Knowles piston pump, which is placed between the tank and the heater. The pump is placed under the tank and back of the rear driving-wheels. This arrangement requires a flexible connection in the steam line leading to the pump, but the latter handles only cold water, and is far more reliable in service than it would be if placed between the heater and the boiler, where hot water would have to be handled. The locomotive is equipped with two injectors also for use in cases of emergency.

The cab is roomy, and the fittings are conveniently arranged. The front wall of the cab is sloped to follow the inclination of the back-head, in order to provide ready access to the stay-bolts. The advantage of a power reverse mechanism, as far as simplifying the arrangement of the cab fittings is concerned, is most apparent in a locomotive of this size. The equipment includes a pyrometer and a low water alarm.

Where practicable, the railway company's standard details have been used in this locomotive. The driving tires and driving boxes interchange with those of the Class M-C Mikado type locomotives, which are used in heavy freight service on the low grade section of the line.

The tank has capacity for 13,000 gals.; it is 33 ft. 4 ins. long, 11 ft. 4 ins. wide, and 5 ft. 9 ins. deep inside. The top is rounded to a radius of 22 ft. 1 in., and the top and side sheets are joined by a piece of plate which is bent to a 3-in. radius. This provides a neat finish, and makes it impossible for water to accumulate on top of the tank. Supports for the tank are provided by the guide bearer of the rear engine, by two cast-steel bearers placed respectively between the second and third and the third and fourth pairs of wheels of the rear groups, and by three bearers composed of ½-in. plates, which are placed over the rear frame extensions.

Gauge, 4 ft. 8½ ins.; cylinders (6), 34 by 32 ins.; valves (piston), 14-in. diam.

Boiler.—Type, wagon top; diameter, 100 ins.; thickness of sheets, 31/32 ins., 1 1/32 ins., 1 1/16 ins.; working pressure, 215 lbs.; fuel, soft coal; staying, radial.

Fire Box.—Material, steel; length, 188 ins.; width, 108¼ ins.; depth, front, 93⅝ ins.; depth, back, 75⅞ ins.; thickness of sheets, sides, back, crown, tube, ⅝ ins; Gaines furnace, length of grate, 144 ins.

Water Space.—Front, 5½ ins.; sides and back, 5 ins.

Tubes.—Diameter, 5½ ins. and 2¼ ins.; material, steel; thickness, 5½ ins., No. 9 W. G.; 2¼ ins., No. 11 W. G.; number, 5½ ins., 65; 2¼ ins., 365; length, 25 ft.

Heating Surface.—Fire box, 359 sq. ft.; tubes, 7,689 sq. ft.; firebrick tubes, 72 sq. ft.; total, 8,120 sq. ft.; superheater, 2,059 sq. ft.; grate area, 108.2 sq. ft.

Driving Wheels.—Diameter, outside, 56 ins.; diameter, center, 49 ins.; journals, 11 ins. x 13 ins.

Engine and Truck Wheels.—Diameter, front, 30 ins.; journals, 6½ ins. x 14 ins.; diameter, back, 30 ins.; journals, 6½ ins. x 14 ins.

Wheel Base.—Driving, 67 ft. 7 ins., rigid, 15 ft. 3 ins.; total, 91 ft. 3 ins.

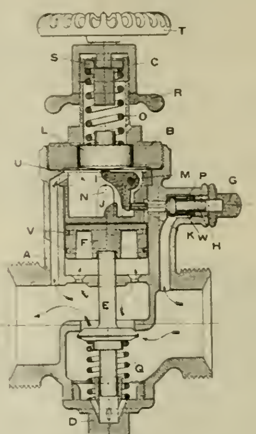
Weight, Estimated. — On driving wheels, 720,000 lbs.; on truck, front, 36,000 lbs.; on truck, back, 82,000 lbs.; total, 844,000 lbs.

Tank capacity, 13,000 U. S. gals.; fuel capacity, 12 tons; service, freight.

Automatic Pressure Regulator.

As the large modern steel passenger trains require a greater volume of steam than that formerly delivered, it has been found necessary to increase the size of the locomotive pressure regulating valve to take care of the pressure. The Gold Car Heating & Lighting Company, 17 Battery Place, New York, has put on the market their No. 1014 Regulator, which, besides delivering ample flow of steam for car heating, will deliver the necessary volume to take care of a Turbo-Generator in addition, if the train should be so equipped.

In our sectional illustration it will be



AUTOMATIC PRESSURE REGULATOR.

seen that by screwing down the handle "T" until the spring "O" is sufficiently compressed to move the diaphragm "U" and the bell crank "I," the control valve "H" is opened, allowing steam from inlet side to act on piston "F," which in turn opens the main valve "E," allowing full volume of steam to enter the low pressure outlet side of regulator. When this pressure, acting on other side of diaphragm "U" through small port from low pressure or outlet side, raises the diaphragm, it permits the control valve "H" to partially close and allow the piston "F" to raise sufficiently to also partially close the main valve "E," so as to maintain the desired pressure on outlet side.

The valve is simple in construction and easily got at in case of repairs. Both control valves and main valves can be extracted by removing their respective plugs. The whole mechanism can be removed without dismounting the valve. The apparatus is very sensitive and so balanced that when set for a desired pressure any change in pressure on either side of the regulator is quickly adjusted and pressure is uniformly maintained whether cars are added to or taken from the train.

Locomotive Headlights.

The apparently endless controversy on the subject of locomotive headlights has passed through another phase by the Interstate Commerce Commission adopting the 800-foot headlight, instead of the 1000-foot headlight order framed by Chief Inspector McManamy and the brotherhood chiefs, and which was approved by the commission last year. The order as now issued applies to all locomotives constructd after July 1, 1917, and for locomotives built prior to that date, the changes required shall be made when the engines are undergoing general repairs after July 1, 1917, and all locomotives must be equipped before July 1, 1920. The order is intended briefly to furnish such light after sunset as will afford sufficient illumination to see a man standing erect at a distance of 800 feet.

Copper Fireboxes with Bronze Staybolts.

The British Government has placed an order in this country for a number of locomotives to be built for the South African railroads. The fireboxes are to be of copper; the back flue sheets at the flue holes 1¼ in. in thickness, and around the flange to be milled off to ½ in. thick; the wrapper sheet and door sheets ⅜ in. thick. The staybolts are to be of bronze imported from England. They will be the most expensive locomotive boilers ever constructed at the Schenectady works of the American Locomotive Company. The Italian Government has also placed orders for 100 locomotives of similar construction and material, though the tenders are different from any ever before built in America.

Ex-President Taft on the Railroads.

At the annual commemoration day exercises of the Johns Hopkins University, Baltimore, Mr. Taft, speaking on the "Wise and Unwise Extensions of Federal Power," said: "The birthday of George Washington never comes without finding in our national affairs an issue and sometimes a crisis in meeting which we can derive aid from Washington's advice, his experience or his action. As we stand on the brink of hostilities with Germany and with Austria, his injunction to the American people that the best mode of securing peace is proper preparation for war comes home to us.

The Walschaerts Locomotive Valve Gear

Its Construction and Adjustment—Examples of Methods of Disconnecting in Case of Breakage in Service

The construction of the Walschaerts valve gear as originally applied by the inventor to the locomotives of the Belgian State Railways differed somewhat in detail from the forms in which it now appears on the twentieth century locomotives. The original means of causing the radial link to oscillate on its central suspension stud was by an eccentric, similar to what is still used on the Stephenson valve motion, and attached to the main axle, to which a rod was attached, one end of the rod being attached to the lower end of the radial link. This eccentric was set at right angles in advance of the main driving crank, that is, while the piston was at the extreme back end of the cylinder, and the main crank pin consequently on the back center, the extreme projection of the eccentric would be on the top center. The device was first applied at a time when the outside admission D-slide valve only was in use. In the case of a modern locomotive equipped with an inside admission piston valve the eccentric would be set at right angles behind or following the main crank. This change of position is made necessary as an inside admission valve must necessarily move in the opposite direction from that of the outside admission slide valve.

In addition to the change of position in the eccentric there is also a change necessary in the relative positions of the radius bar, that is, the connection between the link and valve rod, the outside admission valve requiring that the valve rod should be attached to the combination lever above the radius bar as in Walschaerts' original design, whereas with an inside admission valve, the valve rod attachment is made beneath that of the radius bar. Such are the chief changes in the construction of the valve gear, which are simply modifications of the same general principle.

In the oscillating link as now in use, there is an attachment extending beyond and underneath the bottom of the link. This attachment is variable in extent and is adapted to form a suitable connection for the eccentric rod. The exact location of the connecting point must be carefully calculated by the constructor on account of the relation of the amount of throw of the crank to the travel of the valve. In ordinary practice a locomotive with a piston stroke of 28 ins. would have a valve stroke of $5\frac{1}{2}$ ins., while the path of the eccentric crank would describe a circle 12 ins. in diameter. The center of the eccentric rod attachment to the link would thus be describing an arc 12 ins. in length in a straight line to its extremities, while the radius bar, being considerably nearer the center of the link, would move in a smaller arc, which would continue to grow smaller in its dimensions as the radius bar is moved towards the center of the link.

It will be readily noted that the motion of the valve is derived from two distinct sources—the eccentric crank by means of an eccentric rod attached to an oscillating link, and by a combination or lap and lead lever attached to a connection with the crosshead. The former gives the travel to the valve, the latter has a controlling effect on the position of the valve in regard to the requirements of the amount of lap and lead necessary to open and close the valve at the desired points necessary in the economical use of steam.

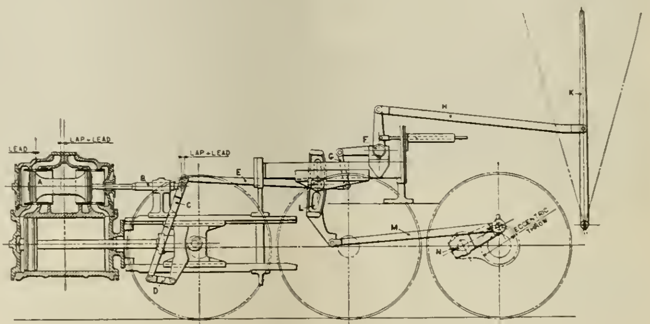


FIG. 2. WALSCHAERTS VALVE GEAR ADAPTED FOR INSIDE ADMISSION PISTON VALVES.

The link has the double quality common to all link motions of reversing the motion of the engine, and also graduating or varying the amount of travel of the valve. In the Walschaerts gear the general construction is so arranged that the engine will move forward when the link block is below the center of the pin on which the link oscillates, and will move backwards when the link block is above the central suspension point. The position of the valve is controlled by the radius bar which is attached to the link block at one end and to a connection with the valve rod at the other end, and the amount of lead or opening of the valve at the end of the piston stroke by the combination lever, as already described.

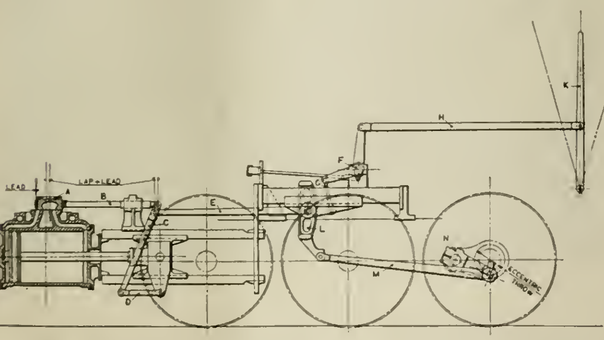


FIG. 1

FIG. 1. WALSCHAERTS VALVE GEAR ADAPTED FOR OUTSIDE ADMISSION SLIDE VALVES.

The accompanying diagrams show designs of the Walschaerts valve motion, Fig. 1 illustrating the design adapted for outside admission slide valves, and Fig. 2, a design used with inside admission piston valves. The lettering indicates the names of the various parts, A indicating the valve, B the valve stem, C the combination lever, D the crosshead link, E the radius rod, F the reverse shaft, G the lifting link, H the reach rod, K the reverse lever, L the oscillating or reverse link, M the eccentric rod, N the eccentric crank. The reverse lever is in the middle position, with the link block in the center of the link.

In the adjustment of the gear, when irregularities are noted in the opening of the valves when running ahead, if the eccentric rod is shortened the valve is moved ahead in a ratio corresponding to the throw of the eccentric to the travel of the valve, or in the figures referred to, 12 to 5½, so that the valve will be moved a little less than half of the variation made on the eccentric rod. If the eccentric rod is lengthened the valve is moved back. In the backward motion with the link block in the top of the link the opposite effect will be produced in lengthening or shortening the eccentric rod. In the case of alterations made on the radius rod the same variation will be made on the position of the valve, regardless of whether the link block is above or below the center of the link. Changes necessary will quickly suggest themselves to the experienced mechanic, but organic defects in the Walschaerts valve gear are not easily remedied, and some authorities claim that in case of any important variation from the exact action or position of the valves to adjust the parts as nearly correct as possible at the point of cut-off, where the locomotive will likely be doing its usually greatest amount of work. In high speed locomotives this point may be at one-third of the entire stroke of the piston, and the lever should be held at this point and the closing of the valve at both points of cut-off examined and rectified at this point, even if some slight sacrifice of the adjustment of the valve should be made at its full stroke.

With these general remarks on the construction and adjustment of the Walschaert valve gear, some reference might be made to the accidents incidental to service, which, although not more common to this kind of valve gear than others, are nevertheless inevitable to all mechanism involving rapid and strenuous operations. It may be remarked that while it would be impossible to lay down rules to cover every condition that might arise, the accidents may generally be divided into two classes: those in which it is not necessary, and those in which it is necessary to block the valve.

The first class of accidents includes only those cases in which it is not necessary to take down the main rod. The valve must

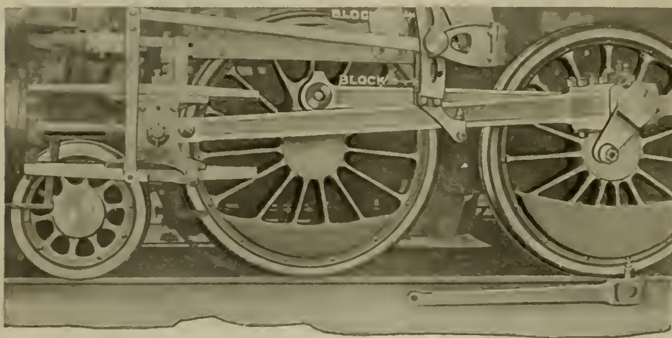


FIG. 3.

be blocked if the main rod is disconnected. In the second class of accidents, the damage may or may not make it necessary to take down the main rod. When it is possible to lubricate the cylinder and relieve compression, otherwise than by removing the cylinder cocks, the main rod may be left up if in a condition to ram. If there are relief or vacuum valves in the cylinder heads these may be removed. This will prevent compression and also permit of lubricating the cylinder.

As an illustration, assuming that an eccentric crank, eccentric rod or the foot of the link is broken, Fig. 3 shows how the valve gear may be disconnected in such cases. Remove the eccentric rod, disconnect the radius rod from the lifting shaft and secure the link block by pieces of wood fitted into both ends of the link slot, holding the link block securely in the center of the link. The valve on the side where the breakage has occurred then receives a motion from the lap and lead lever only. The travel of the valve will be equal to twice the total amount of the lap and lead, approximately about 2½ ins. This gives a port opening at the end of each piston stroke equal to the amount of the lead. The main rod need not be removed, as the cylinders will be lubricated. The supply of steam on the disabled side will be extremely limited, but a certain amount of work will be done by the steam admitted, and the engine may also be reversed in the usual way. In this illustration the radius rod is connected to the lift shaft arm by means of a link or hanger. In Fig. 4 the radius rod is directly connected to the lift shaft arm by means of a slip block, the reverse shaft being made in two pieces. To disconnect the radius rod it is necessary only to remove the outer section of the lift shaft arm and remove the slip block.

In the general class of accidents, where it is necessary to block the valve to cover the steam ports, these may be divided into two classes: first, cases where it is necessary to take down the main rod; and second, those in which the main rod is in condition to run. In the latter cases, the description already given is considered good practice as to leaving the main rod up or taking it down. Taking up these two kinds of accidents in their order, and assuming that the main rod is broken or the piston rod bent. In the case of the inside admission valves, the locomotive may be disconnected and blocked as

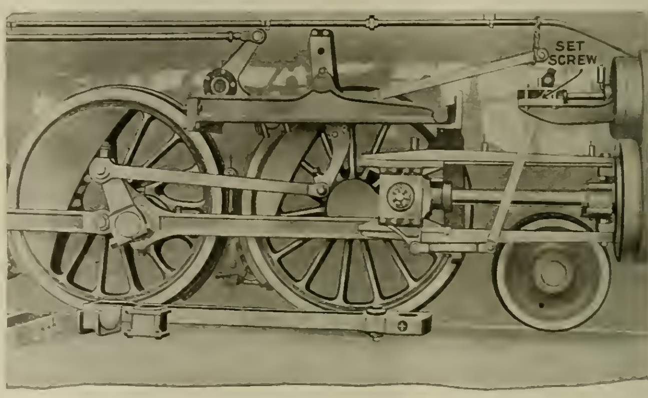


FIG. 4.

shown in Fig. 4. Disconnect the radius rod from the lap and lead lever. Suspend it clear of the latter. Secure the valve to cover the ports. There is usually a set screw or other device for this purpose. Clamp or block the crosshead at the back end of the guides as shown in the illustration. With the valve motion disconnected in this way, the reverse lever is free to operate the other side, and the locomotive may be run with one cylinder in operation. In the event of the crosshead arm, or combination lever being broken, the same method may be followed. All broken parts that would interfere with the running of the locomotive must, of course, be removed. In the case of outside admission valves, the same course may be followed as shown in Fig. 4, and already described, except that the combination lever must be taken down. If this was left in place, the radius rod would strike it in its motion with the movement of the link.

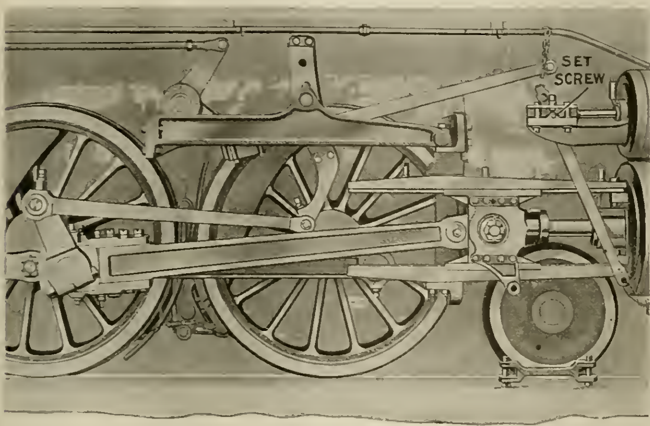


FIG. 5.

Again, if the valve has inside admission, the locomotive might be blocked as shown in Fig. 5. Suppose the combination lever, a connector to crosshead, or crosshead arm was broken. In such case disconnect the radius rod from the lap and lead lever. Suspend it clear of the latter. Fasten the lower end of the combining or lap arm lead lever ahead to clear the crosshead on the forward stroke. The locomotive can then be run in with one side working. With outside admission valves, under conditions similar to those assumed in Fig. 5, the combining lever must be removed from its place. When the radius rod is suspended a chain or wire should be used. Rope is readily cut by the action of the radius rod.

It would, as we have already stated, be beyond possibility to lay down rules in advance for every kind of breakage that may occur, as many accidents occur in practice that are not foreseen in imagination, and it may be again stated the Walschaerts valve gear is by no means uncommonly subject to breakages, but, as is well known, the unbreakable appliance, like the ideal in art, eludes, and ever will elude, the seeker after perfection.

The Chilled Iron Car Wheel in Railway Service

Nearly All Freight Cars Equipped With Them—Increase in Calling for Heavier Wheels and Increased Thickness in Tires

At a recent meeting of the Canadian Railway Club, Mr. George W. Lyndon, the President of the Association of Chilled Car Wheel Manufacturers, read a most interesting paper on the chilled iron car wheel. Below follows a brief account of the paper, in which extracts are made with a view of presenting a comprehensive digest of the subject. Among other things, Mr. Lyndon said: I am quite sure that the importance of the chilled iron wheel to the transportation world is not fully recognized by the general public. We manufacturers designate it "The wonderful single service chilled iron wheel" because it is today, and has been since its introduction in the year 1850, the standard vehicle of transportation.

Some statistics will indicate the magnitude of the chilled iron car wheel industry. The Interstate Commerce report of the United States for the year ended 1914, shows the following:

Total number of freight cars in commercial service	2,325,647
Total number of freight cars in company service..	124,709
Total	2,450,356
Add—Private car lines (approximated)	225,000
	2,675,356

Number of tons of freight carried, year ended 1914.	1,109,271,040
Tons of freight carried one mile, 54% of car capacity, exclusive of private car lines	288,319,890,210
Tons of car structure (estimated 18 tons per car) .	363,402,465,012
Total wheel burden carried one mile....tons.	651,722,355,222

An analysis of the rolling stock will show that 95 per cent. of all freight cars are equipped with the chilled iron wheel, therefore, we have in commercial freight car service and company service and private car lines in the United States alone about 20,332,705 chilled iron wheels. To this we must add the chilled iron wheels serving under passenger cars, engine tenders and street car lines, and we can safely and conservatively estimate the number of chilled iron wheels running today as about 25,000,000, taking into consideration those used in the Dominion of Canada, and the hundreds of thousands which have been shipped abroad and to Mexico and South America. Twenty-five million chilled iron wheels represent 8,000,000 tons of metal. The initial cost at $25 per ton, $200,000,000. The scrap value at $15 per ton, $120,000,000. Twenty-five million wheels placed on a single track would make a solid line of wheels 13,000 miles in length, over one-half of the circumference of the earth. If they were placed on a single track with treads 2-3/10 feet apart they would encircle the globe. If they could be piled on top of each other, hub to hub, they would reach a height of 2,760 miles. To replace 25,000,000 chilled iron wheels upon the basis of 2,500,000 annual renewals would require ten years. Eight hundred thousand tons of metal are used annually to provide for 2,500,000 wheel renewals. I speak for 25 manufacturers operating 50 foundries, scattered from the Atlantic to Pacific Oceans, located throughout the United States and Canada, and having a combined capacity of 20,000 car wheels per day.

The method of manufacture has not been materially changed and the pattern introduced in 1850 by Washburn is practically the same in outline as that in use today. By the joint action of our association and the committees with which we have had to deal, it will be found that the only thing that stands out prominently is that but little metal has been added to the wheel as the capacity of the car has been increased, but the increase in metal has been "grudgingly made" and never proportionate to the increase of duty required. Nevertheless the wheel manufacturers, in the face of restrictions in weight and flange dimensions, through improved foundry processes have been successful in maintaining the chilled iron wheel up to a high standard.

A 33-in., 525-lbs chilled iron wheel of the Washburn type became standard soon after the year of 1850 for 10-ton freight cars and also for passenger cars. Cars of this capacity remained standard for about thirty years. As late as 1875 there were only occasional cars having a capacity as high as 12 tons. The heaviest capacity passenger coaches weighed 18 tons. Sleeping and drawing room cars of 12 sections weighed 30 tons. Interchange of traffic as we now know it did not exist.

An official of a great railroad of those days charged another with running freight trains as fast as 12 miles an hour. "The wear and tear is something terrible," said he. "It is pounding the track to pieces. Every ton of freight handled at that speed is carried at a loss. The reduction of speed to eight miles an hour will lessen the cost more than $1,000 per day."

Such were the ideas of the foremost men in charge of transportation in the days of iron rails, hand brakes, link-and-pin couplers, and fragile cars. Under such conditions of light wheel loads, small flange pressures, slow speeds, low annual mileage, the wheels would last the entire life of the car. Wheel mileage obtained under such circumstances is sometimes erroneously used to indicate the superior service of wheels manufactured at that time. The ton mileage, which is the true basis for comparison, was extremely low as compared with wheel performance at the present time.

The introduction of the air brake, the automatic safety coupler, heavy steel rails, more rigid cars and interchange of traffic have brought an era of rapid transit of heavy capacity freight cars with time schedules almost equal to that of express trains. Daily runs averaging 30 miles per hour, including stops, with an occasional burst of speed as high as 50 to 60 miles per hour, to maintain the high average rate is not uncommon.

The 30-ton car introduced in 1885 was the heaviest capacity car on any railroad during the time of the World's Columbian Exposition at Chicago in 1893. It was strongly argued at that time that the wheel load of 11,000 lbs., which was required under cars of 30 tons capacity, was the maximum that could be carried on a 33 in. diameter wheel, because the area of contact between the wheel and rail was small, any greater load would cause injury to both wheel and rail by reason of the fact that the elastic limit in the metal would be exceeded, resulting in dents in the rail and flat spots in the wheel tread.

Not only was 11,000 lbs. per wheel considered the maximum wheel load, but there was a good deal of doubt as to whether this load was not in excess of good practice. The introduction of the 30-ton car was very rapid on all railroads. A chilled iron wheel weighing 600 lbs. was used under cars of this capacity and was recommended as standard in 1904 by the M. C. B. Association. It was later modified and the weight increased to 625 lbs. in the year 1909, upon the recommendation of our Association.

Notwithstanding the doubt expressed regarding the maximum wheel load, cars of 40 tons capacity were soon tried and found to be satisfactory and almost immediately thereafter the 50-ton car was developed for the coal-carrying trade and found to be satisfactory.

The 700 lbs. wheel was used under 50-ton cars and recommended as standard in 1904 by the M. C. B. Association, but afterwards, upon the recommendation of the Car Manufacturers' Association, this weight was changed to 725 lbs. and made standard in the year 1909. It will be noticed that in 1904 the first wheel made standard for the 50-ton cars weighed 700 lbs. In 1909 we succeeded in getting the weight increased 25 lbs. During the time intervening a new wheel was introduced of the rolled steel type and notwithstanding the alleged superiority of metal, the steel wheel, which was used instead of the 700 lbs. chilled iron wheel, weighed a minimum of 750 lbs.

The present indications are that the 50-ton car is likely to be superseded in the very near future by the 70-ton car for carrying coal, iron ore and heavy, rough freight. Cars of 70-ton capacity have already proved successful from every standpoint and are being built in comparatively large numbers at the present time. The marvelous increase since the year 1875 in the capacity of cars and the tremendous tonnage hauled has called for an increase in the weight of the car structure from 18,000 lbs. to 65,000 lbs., or 260 per cent. increase. An increase in the weight of rail from 50 lbs. to 125 lbs., or 150 per cent. increase. The axle, from 350 lbs. to 1,070 lbs., or 200 per cent. increase. The weight of the wheel 525 lbs. to 725 lbs., or 38 per cent. increase.

The percentage of increase in the wheel is much less than for any other part of the car, and while the carrying capacity has increased from 10-tons to 70-tons, or 600 per cent., the weight of the heaviest M. C. B. standard wheel has increased only 38 per cent. This is a good record for a wheel under adverse conditions with carrying capacity increased but the speeds of which trains increased 600 per cent.

While the chilled iron wheel has always met increased requirements by reason of the rapid increases in the capacity of the cars, there is one part of the wheel that has received scant consideration and that is the flange. During all the remarkable railroad development, one dimension in track structure has remained constant. The space between the running rail and guard rail has remained fixed at one and three-quarters ins.

The chilled iron wheel manufacturers have been trying for years to secure a stronger flange and have demonstrated the fact that three-sixteenths of an inch can be added to the thickness of the present M. C. B. flanges, compensation for the increase made in mounting each wheel three-thirty-seconds of an inch closer to the rail and still maintain the M. C. B. standard throat to back of flange dimension of 4 ft. 6-29/64 ins.

This insures that the relation of the back of the flange to guard rail remains the same as at present and no change in track clearance is required. There can, therefore, be no valid objection from a track standpoint, to making a liberal increase in the present flange thickness and we have received the approval of our plan from a special committee who were appointed for the purpose of investigation through the American Railway Engineering Association.

Under the 10-ton car whose weight was about equal to its capacity, the load carried per wheel was approximately 5,000 lbs., which would require about 4,000 lbs. flange pressure to change the direction of the truck when engaging curves. Under the 70-ton car the load per wheel has increased to 25,000 lbs., which requires almost 20,000 lbs. flange pressure to change the direction of the truck, therefore, the flange thrust has increased 400 per cent. on account of the increased load, which is further augmented by the high speed of modern freight trains. Under present conditions of increased load and speed, the thrust on the flange including impact, is at least 10 times greater than under the old 10-ton car and the increased duty has not been provided for.

The University of Illinois, under the direction of our Consulting Engineer, Mr. F. K. Vial, has been conducting a series of tests for the purpose of ascertaining the stresses to which the wheel is subjected in pressing the wheel onto the axle, and service conditions, with the following results:

(1). When a wheel is pressed on an axle a compressive stress is developed radially and a tensile stress circumferentially. These stresses are of large proportion and extend all the way from the hub to the tread.

(2). The plate of the wheel must carry the load which produces a combination of stresses resulting in a wheel slightly elliptical.

(3). On descending grades the heat generated by the brake shoe, which is a factor of load, grade and speed, causes a tensile stress in a radial direction in opposition to the compressive stress which was developed while pressing the wheel on the axle.

(4). The heavy flange thrust causes a

bending action in the plate which intensifies the tensile stress developed by the heat in the front plate and the compressive stress in the back plate developed while pressing on the axle. The ratio between these stresses developed in the 70-ton car as compared to the 10-ton car is much greater than that indicated by the mere increase in carrying capacity. The heaviest stress developed is probably that caused by the sudden rise in the temperature of the tread of the wheel from brake shoe application on descending grades. If we assume that trains are now operated at double the velocity they were 40 years ago and the load on the wheels five times as great, there will be 10 times the heat generated per unit of time on the tread of the present wheel as compared to the wheel under the 10-ton car. The flange thrust being from five to ten times greater indicates that we have ten times the force to deal with that we formerly had.

Our Association believes that due to the general conditions and considering the safety factor of operation that three designs of wheels of 675 lbs., 750 lbs., and 850 lbs. (with 3/16 of an inch increase in the flange) respectively, for 30-, 50-, and 70-ton cars, would in a great measure eliminate present troubles and our recommendations would be:

675 lbs. wheel for cars having a maximum gross load of 112,000 lbs.

750 lbs. wheel for cars having a maximum gross load of 161,000 lbs.

850 lbs. wheel for cars having a maximum gross load of 210,000 lbs.

The eight million tons of chilled iron wheels running today possess a higher relative market value when worn out, based upon their first cost, than is usual with other commodities purchased by the railroads. About 30 per cent. of all wheels sold are removed by foreign lines and the price paid for these removals is fixed by the printed interchange rules of the M. C. B. Association, as follows:

	Chilled Iron.	Steel.
New value, each	$9.00	$19.50
Scrap value, each	4.75	4.50
Net cost	$4.25	$15.00
Cost of removing from and replacing in trucks, per pair, $2.25, each	1.12	1.12
Cost under car, each	$5.37	$16.12
Cost of two turnings		3.25
Total cost of wheel service (each)	$5.37	$19.37

The total cost for wheel service for other types of wheels is about four times that of the chilled iron wheel and upon this basis of comparison any substitute must yield four times the mileage or time service in order to equalize the cost. As the M. C. B. Association fix the price of removals on 30 per cent. of the equipment, it must follow that the same relative basis of cost must apply on the 70 per cent. of removals on your own lines.

Chilled iron wheels sold at a differential of $10 per ton, makes the net cost of the three M. C. B. standards as follows:

625 lbs. M.C.B. Wheel for 30-ton cars.	$3.12
675 " " " " 40- " "	3.37
725 " " " " 50- " "	3.62

All chilled iron wheels, unlike other types, are guaranteed for a minimum service. Should any of these wheels fail in service through the fault of the manufacturer a new wheel is supplied without any cost to the user.

Maximum net cost of 625 lbs. M. C. B. wheel, guaranteed for 6 years, 52c. per year.

Maximum net cost of 675 lbs. M. C. B. wheel, guaranteed for 5 years, 67c. per year.

Maximum net cost of 25 lbs. M. C. B. wheel, guaranteed for 4 years, 90c. per year.

Any wheel that is sold for $20 will cost the railroad, in interest charges alone (figure at 5 per cent. per annum), more than the renewal charges of the chilled iron wheel, because while the guaranteed net cost to the railroads is based upon six, five and four years' service, respectively, the actual service is often twice as much. During the two years last past, the price of all commodities have reached their highest figures. Nevertheless, the price of the chilled iron car wheel has practically remained constant. Based upon the annual renewals of 2,500,000 wheels, any other substitute at a price of $20 per wheel will cost the railroads $50,000,000 initial investment the first year.

In summing up Mr. Lyndon said: (1) We have given you the material and if it is inadequate, its deficiency should have been discovered in 67 years of universal use.

(2) We have not yet reached the capacity of the chilled iron car wheel, and today we have in service wheels weighing 950 lbs., which are 225 lbs. heavier than the heaviest M. C. B. standard. These wheels are carrying a burden of 25,500 lbs. per wheel and they have given satisfactory service under engine tenders of 12,000 gallons capacity.

(3) Our Association was organized in the year 1908 for the purpose of improving the quality of the chilled iron wheel, and in the year of 1909 we succeeded in having three standard patterns adopted by the M. C. B. Association, and previous to that time there were as many patterns in use as there were manufacturers, and some railways used special patterns and manufactured the wheels themselves.

(4) Through a close study of the actual service conditions of the chilled iron wheel and through laboratory tests made by universities in this country, and our own tests, we have found some conditions of service that are not adequately provided for and our recommendations are the result of conclusions drawn from this research work.

(5) 25 lbs. per wheel would not appreciably increase our tonnage, but this addition of metal would materially increase the factor of safety. If all wheel renewals, based upon 2,500,000 annual renewals, were increased in weight 25 lbs. each, the total increased tonnage would be 31,250 tons at $10 per ton differential, making a total additional expenditure of $312,500 annually.

(6) I have shown how little has been done for the chilled iron wheel and how little needs to be done in order to increase the factor of safety.

(7) The chilled iron wheel has performed, and will still perform, all the functions required of it and its unimpaired usefulness for nearly three-quarters of a century is conclusive evidence that it possesses special advantageous qualities.

(8) Its principal characteristics are its graded hardness of structure and its ability to carry any load that may be imposed upon it. Chilled iron wheels will carry any load without crushing or flowing, and these special inherent qualities of chilled iron should assure us of your co-operation in any method by which the efficiency and safety of the chilled iron wheel can be improved.

Standard Type of Box Car.

The American railroads will eventually have a standard type of box car. The American Railway Association charged with the duty of bringing this about has decided on a "three-to-five standard" for a beginning for the double-sheathed, the steel frame, single-sheathed, and the all-steel cars. The first may be built for either 60,000 or 80,000 lbs. capacity, the second for 80,000 lbs., and the third for 80,000 or 100,000 lbs. capacity. Some of these are being built. Meanwhile there are about 1,100 types of box cars in operation.

Annealing Chains.

The strength of the weakest link is the strength of a chain. The structure of the metal composing the chain crystallizes rapidly, and more so in some places than in others. Hammered or rolled metal is of a stringy or fibrous formation. Left to itself it slowly resumes its original granular formation, and on being reheated it assumes an approach to the fibrous formation again. For this reason all chains should be periodically annealed and tested, the frequency of the annealing depending largely on the work which the chains have to do. The intervals should be short instead of long.

The Famous "999."

This locomotive, formerly on the Empire State Express, is now, in a changed condition, known as No. 1086, in service on Pennsylvania division trains 30 and 37, between Avis, N. Y., and Clearfield, Pa.

Experimental Refrigerator Cars on Pennsylvania R. R.

Statement of Past Experience by P. R. R.—Latest Form of Refrigerator Construction —Insulated Box Placed Inside Steel Receptacle—Easy to Get at for Repairs or Alterations

The Pennsylvania Railroad has just completed two types of refrigerator cars, for the purpose of experimenting as to the most suitable type of car for milk train service. The cars were built at Altoona, Pa., and although primarily designed for the carriage of milk, are of course expected to be available for transporting other commodities. The cars are primarily of the all-steel type, but the method of construction adopted is such that the superstructure is put together in sections, and can be taken apart in sections for repairs or alterations, if found necessary or desirable. In the designs used it was intended to utilize every available means regardless of past practices to provide a car that would furnish and maintain adequate refrigeration for milk and cream, either with ice placed in the ice bunkers or placed on top of the cans or boxes, and this car is also available for other shipments than milk and cream.

Past experience and past experiments indicated the basic requirements, which may be summarized as follows:

The car to be such as will fill requirements should have an inside lining that is watertight and keeps moisture away from the insulation. It should have adequate continuous insulation fully surrounding the inside lining. The amount of insulation under the roof, which is liable to be heated excessively by the direct rays of the sun, should be greater than that in the sides and bottom, and that the outside sheathing and roof should be weathertight, also the vertical air space around the ice baskets and through the ice should be adequate.

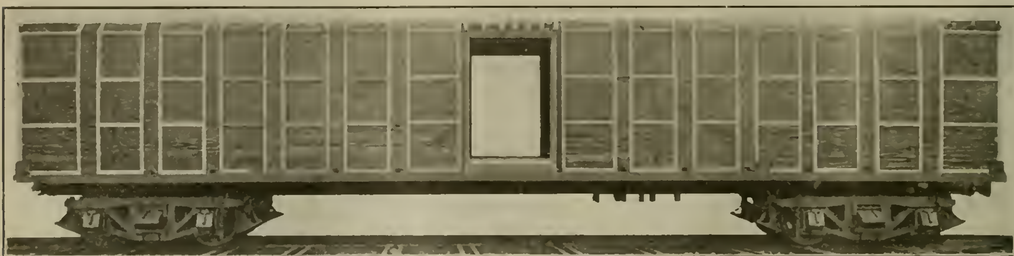
The bulkhead, in front of the ice chamber, should be solid, with an air inlet into the ice chamber, close to the ceiling, and an outlet into the car, close to the floor. The bulkhead should be made of non-conducting material, or should be insulated to promote dry refrigeration. The floor should be smooth to permit sliding the milk cans into place, and to provide a flat base for racks when the car is used for other shipments for which an air space under the lading is of advantage.

Two cars, differing slightly from each other, for experimental purposes, have have completed and turned out of the Altoona car shops of the P. R. R.

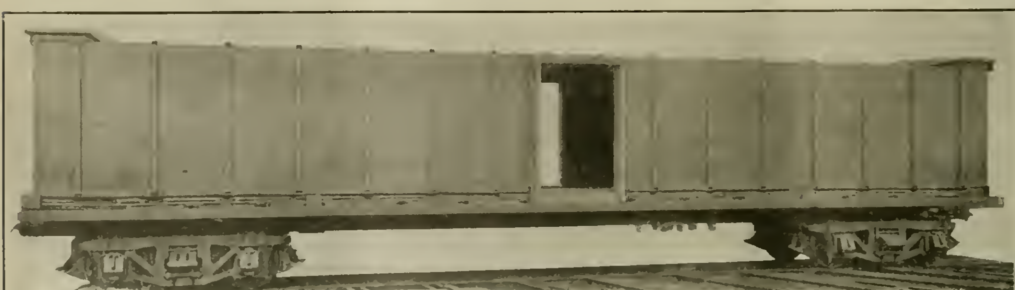
Car No. 2500 is not partitioned, and all of the space between ice baskets is in one compartment. The side doors are of the refrigerator type, and open outward.

Car No. 2550 has the space between the ice baskets divided into three compartments by means of two insulated wooden bulkheads. The middle compartment is 6 ft. 2½ ins. long, and is used for quick loading and unloading of cans and boxes from and to station platforms. The cans and boxes may be transferred to or from the other two compartments, which contain the refrigerating apparatus, while the train is in motion. In this car the side doors are of light construction, and the insulated refrigerator doors are in the two partitions. With the exception of the differences just mentioned, these two cars are exactly alike and may be described as follows:

The trucks are of special form. The side-frames are of cast steel. The side-frame center opening, the spring plank, and the 5 ft. 10-in. wheelbase are the same as in freight trucks. The elliptic springs and bolster are the same as are used on tenders. The ends of the frame are arranged for helical springs over the journal boxes, and the car has clasp brakes. The axles are of the passenger type, with 5x11-in. journals, and the wheels are rolled steel 33 ins. diameter. The journal boxes are the pedestal type

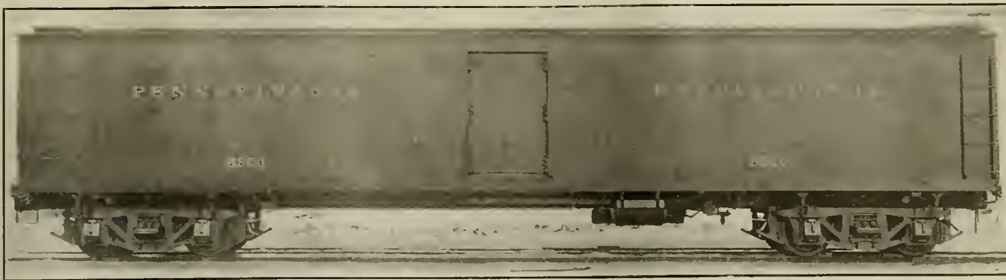


P R R REFRIGERATOR CAR INSIDE ON UNDERFRAME.



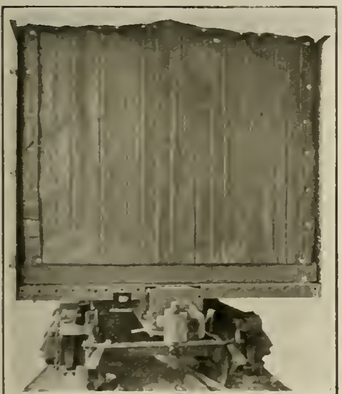
P. R. R. REFRIGERATOR CAR INSIDE ON UNDERFRAME.

passenger car boxes. From this it will be seen that the truck represents a combination of passenger and freight truck features, except the bolster side motion.



P. R. R. REFRIGERATOR CAR MADE WITH ONE COMPARTMENT.

The underframe also combines passenger and freight principles. Bolsters have been omitted, and cantilevers to support the side bearings have been substituted. The load is carried on the end sills and crossbearers, whence it is transferred to the center plate through the center sills. The center sill construction is of the box type, consisting of two 15-in., 40-lb. channels, spaced 12⅞ ins. apart, and two ½x20-in. cover-plates. The side sills are 3½x5x⅜-in. angles. The spaces between the center sill cover-plate and the side angles are covered with ⅛-in. steel plate, reinforced with U-shaped stiffeners, riveted on top. The back follower stop and front bumper castings are integral as used on freight cars. The center plates are drop-forged steel.

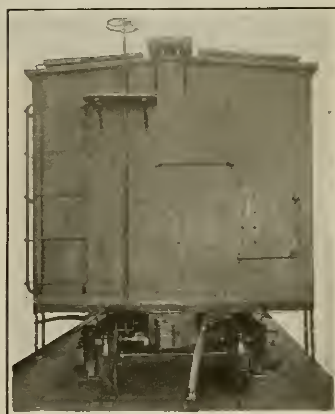


END VIEW P. R. R. REFRIGERATOR CAR—SIDE SHEATHING PLACED.

Oak blocks are placed on the end sills and cross-bearers to support the steel box forming the inside lining. The spaces between these blocks are filled with insulation, consisting of four layers of ¾-in. Keystone hair felt, separated by wooden grids to form air spaces. The inside lining consists of 3/16-in. floor plates, ⅛-in. side sheets and 3/32-in. ceiling sheets, all reinforced with U-shaped braces riveted to the outside. It forms a box which can be built up complete on the floor and then lifted to its proper location on the oak supports. The ¾-in. Keystone hair felt is of as great width as can conveniently be manufactured and cut to the proper length. It is lifted to the top of the lining box and unrolled to drop down the sides and so meet and join the insulation under the floor.

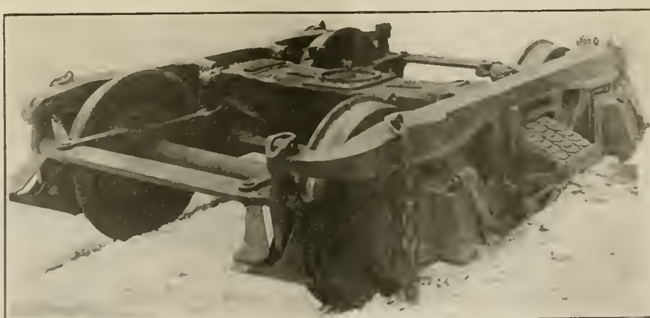
A continuous blanket is thus formed all round the inside box. There are four such blankets running transversely, separated with wooden grids, made of ½-in. strips of soft wood. Two additional layers, separated with wood grids, are placed longitudinally on the top of the box, and four layers are placed at the car ends to correspond with the sides. In this way a box insulated with hair felt and a surrounding air space is set inside a steel box, which forms the outside of the car, and of course stands the wear and tear of a car body, and is strong and properly proportioned.

The Keystone hair felt referred to consists of ¾-in. hair felt placed between two sheets of 90-lb. specification paper. and securely sewed together. After the insulation has been applied, the sides, ends and roof are attached. These parts are also reinforced with U-shaped braces, and are so designed that the riveting can all be done from the outside. This also permits removing a side, end or roof, for repairs, without disturbing any other part of the car. The connections between inside and outside steel shells are wood. The drains are made of indurated fibre. Hence there are no metal connections between the inside and outside steel shells.



END VIEW OF COMPLETED P. R. R. REFRIGERATOR CAR.

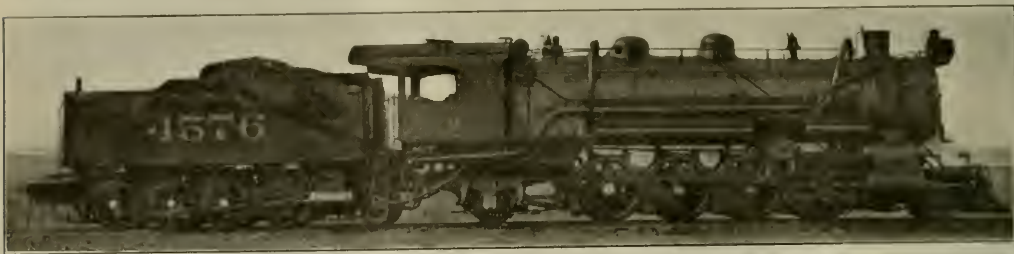
Height—Inside (average), 6 ft. 9¼ ins.; weight of car, empty, 78,000 lbs.; ice capacity in baskets, 10,000 lbs.; loading capacity, 50,000 lbs., 2,450 cb. ft.; distance between centers of trucks, 38 ft.; total wheelbase, 43 ft. 6 ins.



SIDE AND END VIEW OF P. R. R. REFRIGERATOR CAR TRUCK.

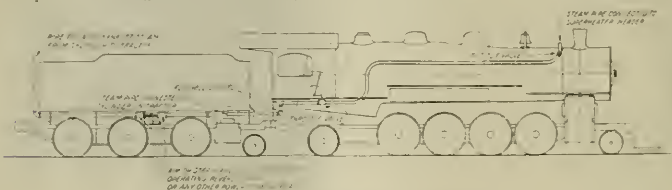
Duplex 2-8-2+2-8-0 on the Southern Railway

Novel Change in Locomotive Construction—Increased Tractive Effort—Few Changes Required—Larger and Heavier Trains Pulled on Lower Ton-Mile Pounds of Coal



DUPLEX 2-8-2 + 2-8-0 LOCOMOTIVE FOR THE SOUTHERN RAILWAY.

Between Asheville, N. C., and Hayne, S. C., there lies a stretch of track 69 miles long on the Southern Railroad, of which Mr. J. Hainen is general superintendent of motive power and equipment and assistant to the vice-president. This single track line had been much congested, until Mr. Hainen worked out a design of engine which has a much greater tractive power than the type of engine formerly employed. The plan is briefly the mounting of tender tanks upon the machinery of discarded locomotives. There is a 4 per cent grade 3 miles long on this division, and the new engines built by the Southern have to encounter this grade as part of the day's work.

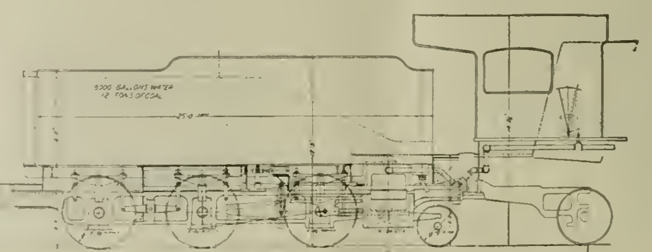


OUTLINE OF A SOUTHERN DUPLEX ENGINE.

The first of the new type of duplex engines was put upon the road about a year ago, and it proved to be so satisfactory that seven such locomotives have been turned out of the company's shops at Spencer, N. C. The number of trains has been reduced, though the total tonnage is considerably greater, and the speed of the train's run has been increased. To effect this satisfactory result it was not necessary to buy new cylinders, wheels or running gear. The parts used were taken from scrapped Mogul and Consolidation engines, so that the expense involved was reduced to its lowest terms.

The scrapped engines furnished the frames, cylinders, wheels, axles, side-rods and valve motion complete. By the use of specially designed carriers, the tanks of Mikado tenders were mounted where the boiler of the engines had formerly been. With 7,500 gallons of water and 12 tons of coal the auxiliary engine carries a weight of 176,000 lbs. as a maximum, the minimum being about 100,000 lbs. The mean is therefore 138,000 lbs. The cylinders are 18x24 in., as they have been bushed, being formerly 20 in. in diameter.

The Mikado engine proper has cylinders 26 in. in diameter being bushed down from 27 in. The Mikado drivers are 63 in. in diameter and those of the auxiliary are 50 in. diameter. The normal working pressure is 175 lbs. to the square inch. The duplex engine has a tractive effort of 64,000 lbs., while the tractive effort of the single engine formerly used did not go above 46,000 lbs. This is an increase of 39 per cent.



TENDER OF A SOUTHERN DUPLEX ENGINE, EQUIPPED WITH POWER.

The bushing of the cylinders was resorted to in order to have less tax on the boiler in supplying four cylinders. The new design includes flexible piping for carrying steam to the auxiliary cylinders and the arrangement of pipes for conveying the exhaust steam away. Steam is taken from the top of the superheater header and conducted in a jacketed pipe to the flexible elbow and steam pipe to the auxiliary cylinders. Live steam does not reach the auxiliary valve chambers in the ordinary way. In this engine these are blocked up and steam passes through a pipe tapped into the valve chamber on the outside. A special elbow has been designed for the exhaust steam and this is fitted to a pipe which passes under the tender and turns up at the back of the tender. These engines have been worked at full capacity for nearly an hour without any signs of trouble. The valve mechanism, which is the Stephenson link motion on the auxiliary engine, is moved by the reverse gear. The Walschaerts valve gear operates on the Mikado proper.

Saturated steam or superheated steam is supplied to the auxiliary engine, and superheated steam is used in the front or 2-8-2 engine. The cylinder saddle on the auxiliary engine was not cut or altered in any way, and the water bottom of the tank was cut into, so as to provide room for the saddle. This, however, does not substract much from the contents of the tank. It also affords room for the exhaust elbow.

The valves governing the supply of

superheated or saturated steam to the auxiliary engine are operated from the cab so that the engineman in charge may use what he considers best for the circumstances he may find himself in.

On the portion of the Southern Railway where the duplex engines operate, six passenger trains run daily and a number of freight trains are also moved. The grades are 1.5 and 1.7 per cent., and on this line the single, formerly used Mikado engine, had a maximum capacity over the first important grade, which is 22 miles long, of 1,100 tons. The duplex engine is now handling 1,400 tons over the same grade. The 46 miles which form the rest of the Asheville-Hayne division has grades on which the previously used Mikado could pull 1,150 tons, the duplex locomotives now haul each about 1,600 tons. This performance is the maximum of which the duplex is capable and it illustrates the economical results produced by the increased tractive effort gained by the combination of Mikado and auxiliary engines when made into the Southern Railway duplex locomotive.

The total ton-mile record of the formerly used Mikado showed 77,100 total ton-miles, at the rate of 0.18 lb. of coal per ton-mile. The duplex record amounts to 104,400 ton-miles with a consumption of 0.12 lb. of coal per ton-mile. The duplex engines have superheaters, brick arches and the air pump exhaust is used in heating the feed water for the boiler.

Master Blacksmiths' Convention.

The next convention of the Railroad Master Blacksmiths, to be held at Hotel Sherman, Chicago, Ill., on August 21, will see a change in the method of handling subjects. Instead of committees reporting on subjects, individual papers will be presented by members of the association. The following is the programme of topics:

1. The Fifth Anniversary, papers by W. W. McLellan and A. W. McCaslin.
2. Repairs to Locomotive Frames, by P. Lavender.
3. Drop Forging and Its Possibilities, by J. D. Boyle.
4. Heat Treatment of Iron and Steel —Purposes and Results, by George Hutton.
5. Why Railroads Should Adopt Specific Standard Safety Appliances to Comply with U. S. Standards, by J. E. Dugan.
6. Making and Repairing Springs, by J. W. Russell.
7. Up-to-date Smith Shops, by George Fraser.
8. Scrap Reclaiming by Use of the Oxy-Acetylene and Electric Welding Process, by Walter Constance.
9. Treatment and Results of Carbon, High Speed and Other Alloy Tool Steels for Tools, by J. H. DeArment.
10. A Modern Hammer and Hydraulic Forge Shop, by R. F. Scott.

Efficiency of Brake Shoes

Brake Shoe Action Analyzed—Many Unnecessary Losses of Cylinder Pressure by Poor Mechanism —Increasing Retardation Approaching a Stop Explained

At a meeting of the New York Railroad Club held a short time ago W. S. Dudley, chief engineer of the Westinghouse Air Brake Company, made some remarks on the efficiency of brake shoes, which are worthy of consideration. He said, when reading an interesting paper on developments in air brake engineering, that after the air brake mechanism has delivered compressed air to the brake cylinder sufficient to create a pressure say of 100 lbs. per square inch on its piston, much of this force may be frittered away by losses detracting from the pressure ultimately realized at the brake shoe.

There are losses due to friction at the brake cylinder piston packing leather, resistances of piston and truck release springs, friction at joints and supports, reactions on supports, pull in brake beam hangers, "false" piston travel, and other pressure losses. The sum of all the losses is, in per cent., but a fraction of what results from the use of such a device as a brake shoe to produce the desired retarding force.

For every 100 lbs. pressure on the brake shoe, not more than 10 or 12 lbs. average retarding force, i. e., tangential pull on the wheel, is obtained when stopping a modern train from 60 M. P. H. Ordinarily 8 lbs. or 10 lbs. would be fair average figures. With the present arrangement of brake shoe and wheel, we are doing work through the medium of an extremely inefficient mechanical process, viz., the force of friction between a stationary block of metal and a moving surface; the wheel tread.

The ratio which the normal pressure upon the brake shoe bears to the tangential frictional pull on the circumference of the wheels, is, therefore, a measure of the efficiency of the brake shoe in performing its function of transforming the brake shoe pressure into pull at the rim of the wheel. Ordinarily this efficiency is called the co-efficient of friction of the brake shoes. A statement that the mean coefficient of brake shoe friction is 10 per cent., conveys but little impression of what the real state of affairs is. But if we say that the brake shoe performs its function at the expense of 90 per cent. of the force delivered to it; or, in other words, has an efficiency of only 10 per cent. we see much more clearly the true relation of the forces acting.

Once the brake is installed, variations are uncontrollable. Consequently it is of the utmost importance that the installation be made in the first place, to secure, and maintain as nearly constant as may be, the most favorable brake shoe surface condition. The chief consideration in this connection, when using metal shoes, is the temperature of the rubbing surfaces of shoe and wheel during the stop. It must be realized that only a very thin film of the shoe and wheel metal are actually undergoing the abrasive action, offering the resistance we call friction, and the foot pounds of work being done is so great that extremely high temperatures are quickly developed at the working surfaces.

The Pennsylvania-Westinghouse Brake Tests revealed much important data. The performance of cast iron brake shoes varies between wide limits. The ordinarily-assigned causes for this variation (such as speed and time of action) become active chiefly as they affect the temperature of the working metal of the brake shoe and wheel.

The brake shoe bearing area and consequently the generation of heat in the working metal and the resultant coefficient of friction varies considerably during the progress of a single stop and to a greater degree as the fit of the shoe to the wheel may change, due to warping or continued rubbing. Due to this effect alone the emergency stopping distance from 60 M. P. H. may change by as much as 20 per cent.

The use of two shoes per wheel instead of one will result in a higher coefficient of friction and less wear per unit of work done, the durability under clasp brake conditions being about 40 per cent. greater than under single shoe conditions. Flanged shoes provide more available area than unflanged shoes and, when worn in, may shorten the stops about 12 per cent.

The use of two shoes per wheel permits a design of rigging which makes possible the use of flanged shoes without danger of pinching the flanges, thus eliminating excessive flange wear or non-uniform brake forces which result when flanged shoes are used with rigid beam connections. The wear of flanged shoes is about 20 per cent. less than unflanged shoes.

In brake tests previous to the Pennsylvania-Westinghouse Tests of 1913, the average of two, or at the most three, stops under a particular set of conditions was thought sufficient to establish the average performance of the train, but observations during those tests and a consideration of comparative records revealed many instances of variations in performance which could not be accounted for by any known differences in the equipment, adjustment or manipulation. A study of previous tests from this point of view led to the conclusion that variable factors existed, of which no accurate record had been obtained, nor indeed was sufficient data available to show definitely the extent of such variable performance as was indicated. The determination of the amount and cause of such variations in performance as might result under supposedly constant conditions was made the subject of special study in the 1913 tests. For this purpose a series of so-called check runs was scheduled, one test to be made at the beginning and another at the end of each day's work, all conditions for these check runs being kept the same as far as possible throughout the entire series of tests. These stops were all made from a speed of 60 M. P. H. with the complete train, standard braking conditions on the locomotive, electro pneumatic equipment, 150 per cent. braking ratio and plain shoes on cars. As anticipated, it was found that even when the tests were run under supposedly identical conditions, a wide variation in performance was obtained.

One series of these runs, made under identical conditions, as far as they could be controlled, affords a striking example of how brake shoe condition alone may affect the length of stop when other conditions are apparently constant. The average of the first five runs of this series was 1,310 ft. From the experience gained in previous tests it was evident that the shoe condition during the period when these tests were made, was not as good as could be expected after a further wearing in of the shoes. This shoe condition would not have attracted particular attention ordinarily; and, furthermore, the five tests under the same set of conditions would usually be considered ample to establish the average performance of the equipment without further question.

However, knowing the importance of what might be considered but a slight change in brake shoe condition, many more runs were made with the result that the shoe bearing was greatly improved and the average of the last five comparative check runs was 1,121 ft. Here, then, is a difference of nearly 200 ft. between the average of five tests made after the shoe condition was known to be good and the average of five other tests made some time before the shoes had been well worn in. This shows the necessity for checking by repeated tests, under as nearly as possible the same conditions, in order to detect influences which may not be apparent without such careful checking and yet would have an important effect on the value of the comparisons.

The "mean coefficient of friction," that is, the average coefficient of brake shoe friction during the stop is the factor usually mentioned in discussing stops. But it should always be borne in mind that this is a fictitious value, representing, as nearly as may be, the aggregate effect of the resistances which are varying more or less during the stopping of the train. These variations are quite consistent and characteristic in quality, although they vary considerably in quantity.

The Galton-Westinghouse tests were the first to establish the character of these variations. With constant brake cylinder pressure a fairly uniform retardation exists for a considerable portion of the time during which a train is being stopped from a high speed. But as the stopping point is approached and the speed becomes say 25 to 30 M. H. P., this uniform deceleration is replaced by a continually increasing retardation until a very high retardation is reached just as the train comes to a standstill. We now know that the fairly constant retardation during the middle portion of the stop, notwithstanding the continual decrease in speed, is due chiefly to the fact that the limit of the heat carrying capacity of the metal brake shoe is reached very shortly after the brakes become fully effective. For some time thereafter the work being done and the corresponding temperature being imparted to the metal particles in working or abrasive contact is so great per unit of time, that the shoe cannot conduct the heat away fast enough to prevent the contact particles becoming red or white hot, or even gasified, producing a substantially uniform, "molten metal" condition of the rubbing surfaces, the friction being still further reduced by the roller action of the particles torn off and being carried along by the surface of the wheel. This continues until as the speed is reduced until a point is reached where the generation of heat is no longer beyond the conductive capacity of the shoe metal.

The temperature of the rubbing surfaces then becomes lower, the abraided metal particles are ground off at a relatively low temperature, and therefore at a relatively higher tensile and crushing strength. Hence the rapid rise in retardation beginning at the point in the stop where the brake shoe ceases to throw off sparks and begins to discharge non-incandescent particles of metal.

When using high braking force to stop from relatively low speeds, the contact surfaces do not become so hot, and consequently there is an almost continuous rise in the retardation line due, first, to the effect of the increasing brake cylinder pressure, and thereafter, when the brake cylinder pressure becomes constant, to the decreasing temperature and better interlocking of the shoe and wheel metal at lower speeds.

Concluding this section of his paper, Mr. Dudley said: "The brake shoe, therefore, being a mechanical device, of inherently low efficiency, should be favored in every possible way, such as by advantageous location on the wheels, by a proper disposition of forces applied thereto, by the use of two shoes per wheel, or other means, so as to insure maximum area of working surface in order to maintain as high and as constant a coefficient of friction as can be secured. Where such precautions are not observed and where stops are made with brake shoes not well worn to the wheel, variations of 20 per cent. or more in length of stop may be expected, due to variations in brake shoe performance alone. The relatively light service pressures and slow speeds of every-day service braking, favor the production of a shoe surface well worn to the wheel and correspondingly better performance when an emergency arises."

Improved Car Flooring.

The problem of how to reduce the noise incident to train operation and make travel more pleasant, has engaged the attention of many car constructors. Some headway had been made recently, when the problem seems to have been solved after much experimenting by Mr. C. B. Young, chief mechanical engineer of the C. B. & Q. Railroad. He has devised a new system of car flooring, which with a number of other unusual features, has been embodied in a lot of new chair cars, coaches and smoking cars, just placed in service on the Burlington's through trains, and greatly appreciated by the travelling public.

The new method comprises a sub-floor, consisting of 1/16 in. steel plate at first applied, next a layer of insulating paper on top of which is laid a one-inch course of specially prepared hair felt, then comes a 9/16 in. air space over which is placed a specially constructed ½ in. metal flooring, so shaped as to provide an anchorage for the composition flooring which is spread over it. This flooring is in reality a magnesite cement, laid in a plastic state. It sets, after standing, but always remains more or less flexible, and is not, therefore, subject to disintegration due to the continual vibration. The aisles are laid with strips of interlocking rubber, placed flush with the composition flooring.

It is obvious, as Mr. Young claims, that a floor with a very high sound and weather insulation, which can be kept clean and in a sanitary condition, and at the same time posesses economical advantages and durable qualities, is the ideal flooring, and when to this is superadded a complete quieting of the noise and disagreeable vibrations incident to the older type of car floors, it must be admitted that the Burlington has made an important advance in the right direction, and one which is sure to come into popular favor.

Progress on the Alaskan Railways.

Plans for the coming season on the Alaskan railways include the construction of all bridges in the Seward division, and by next fall the old railroad between Seward and Mile 71 will be completed and ready for heavy traffic.

The Street Mechanical Stoker

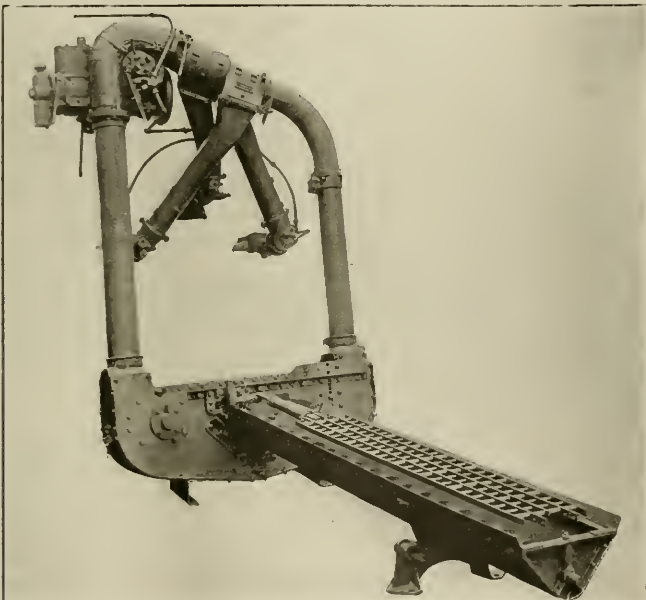
Design—Operation and Growth of Its Application

The Street Locomotive Stoker is what is known as the "scatter" type, that is, it spreads the coal over the surface of the fire. The Street machine is designed to take screened coal on the tank, and the tank is provided with a screen in the bottom of the coal space, through which the coal must pass before entering the stoker proper. Beneath this screen there is a screw conveyor, which carries the coal to the locomotive, where it falls into a hopper located below the conveyor deck. From this hopper it is, by means of an endless chain conveyor, carried to a point above the fire door, where it passes over a screen, and then falls through three openings in the back head (which are separate and independent of the fire door in the firebox) and through these openings it is blown into the firebox by a steam jet. One of these openings is placed directly above the center of the fire door, and one at each side thereof. The screen, referred to above, removes the finer particles from the coal, and delivers them to the center distributor, above the fire door. The coarser particles pass over the screen, and are divided between the right and left-hand tubes.

The screen is circular in form, and provided with openings of four different sizes, and the quantity of coal delivered to the center distributor depends upon the size of opening through which it is delivered. A convenient adjusting arrangement is provided to regulate this.

This feature of delivering the finer particles of coal through the center distributor is one of considerable value, as it prevents a large percentage of this material from going out of the stack and being lost.

One of the most important features of the Street Locomotive Stoker is the variable speed engine, which drives the mechanism. This engine is provided with seven different speeds, and the machine can be set at any one of these seven speeds, and will continue to run at that speed, regardless of the load which it has to carry. This enables the fireman to set the machine to feed a fixed and regular amount of coal into the firebox, and then, as the conditions require, to increase, or decrease, the rate of speed, and then come back to the original point. In other words, it gives him a fixed and known point at which he can set the stoker to feed, increase or decrease rate of speed, and then come back to original point.



MECHANISM OF THE STREET LOCOMOTIVE STOKER.

The first Street stoker was placed on a locomotive in 1909, and up to the present date over thirteen hundred of them have been delivered and are in regular service. About the first time that the machine could be considered as beyond the experimental stage was in 1912, and in that year 174 machines were shipped. In 1913 there were 196 placed in service, in 1914, 167; in 1915, 252, and in 1916, 450. This gives an idea of the rapid and regular growth of the Street stoker business.

Railway Gauges.

The Great Western railway of England was opened in 1838 with a gauge of 7 ft., and for some years all extensions were similar. The difficulties of transshipment from other roads having the 4 ft. 8½ in. gauge became intolerable, but, like everything else British, it lasted a long time. Finally in 1892 the change was made with a degree of rapidity that would be difficult to surpass. Many of the best authorities now agree that it would have been better if the narrow gauge had been changed to the wider one, but the overwhelming majority, as usual, right or wrong, carried the day.

Mount Royal Tunnel.

The Mount Royal tunnel of the Canadian Northern is completed with the exception of laying a double track. The excavations are in progress for the site of the company's permanent station, plans for which have been prepared by Warren & Wetmore, New York. Six electric locomotives are in course of construction and will shortly be engaged in conveying the rock through the tunnel to the Carterville yards.

Russian Railways.

The new line from Petrograd to Alexandroosk, extending to 930 miles, has been completed. It runs over 100 miles northeast to Kem, a small port on the western coast of the White sea. Turning to the northwest, it reaches the most westerly point of the White sea. The road then follows the western shore to Alexandroosk, in Katherine Harbor. Much of the new equipment was made in America.

New Shops on the Grand Trunk.

The construction of new repair shops on the Grand Trunk at Port Huron, Mich., has been begun to replace those recently destroyed by fire. The cost will be approximately $1,000,000. The site to be used for buildings and track will extend over 55 acres. The equipment will be the most modern.

Flat Cars for Automobiles.

The shortage of cars for conveying automobiles has induced some of the western railroads to supply flat cars for the purpose. The Los Angeles & Salt Lake recently sent 50 flat cars from Los Angeles, Cal., to the Buick Motor Company plant at Flint, Mich., where they were loaded with 150 machines, and at once moved in a special train to Los Angeles.

Railway and Locomotive Engineering

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Eliminating the Human Agency.

Some years ago when the feeling of sympathy among mankind was becoming a quality in which the public took an increasing interest, there grew up the idea that the protection of workmen was a matter of grave importance and manufacturers and railroads responded to the popular sentiment. One of the examples of this is the "dead man's handle" which is now very largely used on electric tramways and railroads. This handle shuts off the electric current from the motors and applies the brake in the emergency, if for any reason the motorman relaxes the pressure of his hand on the button in the controller handle. This does not require the motorman to drop dead, if he is incapacitated or faints, the mechanism acts for his own and the public safety.

The automatic stop signal, though not at present extensively adopted, is an appliance that is of the greatest possible value to train crew and to the public alike. It takes full cognizance of a hitherto unstudied phase of railroad operation, which has too long been kept out of sight or ignored. The stop signal deals with the railroad heresy that all men will act alike in a given set of circumstances. Accident investigations have revealed the fact that the mental makeup of a man is the determining factor in his behavior. Promulgating a rule or an order or showing a signal, does not guarantee safety nor does it insure its being obeyed.

Any one of these simply shows how safety may be easily and readily obtained. The stop signal not only shows this but it enforces its view of the case beyond the possibility of wavering or delay. The stop signal will one day be as commonplace as the air brake is today.

When the vertical plane coupler was introduced it eliminated much human suffering by the lessening of accidents. Previous to its coming a man had to go between approaching cars and in the brief interval allowed him, raise one end of a link so that it would enter the other drawbar. Between rapidly moving cars, this was almost equivalent to a man adjusting, by hand, a small piece of iron on an anvil, before a powerfully wielded sledge could be struck swiftly down on the iron. There was not even provision for automatically placing the pin of the drawbar, and the whole arrangement and procedure looks to us today as crude as it was barbarous.

The vertical plane coupler did away with all this, but the process of changing from the link-and-pin to the vertical plane, was comparatively slow, and the idea had to stand the well founded opposition that in car interchange trouble was to be experienced during the transition period. This trouble was met by having a pin-hole in the knuckle and a central slot in the knuckle for the link to enter, when a link was necessary. The walls of the knuckle around the pin-hole were quite thin and rules dealing with the cracks to be permitted were framed by the M. C. B. Association and a sort of railroad *modus vivendi*, was arrived at and worked very well until the gradual replacement of the link-and-pin drawbar by the vertical plane coupler was complete.

In the cases just given, the dead man's handle, the stop signal and the vertical plane coupler there is one principle, aside from safety considerations, that is clearly exemplified. It is the elimination, as far as possible, of the personal equation. Human agency, wherever it can be, is robbed of the dangerous element of choice. Want of skill, misunderstanding, and delay are removed, and a desire for "machine-made" conduct is apparent. Not only this but the reduction of human effort, bodily as well as mental, is also one of the ends in view.

If we go a step further and consider hose connectors between cars, we would find many conditions and advantages which would urge its adoption also. A connector in any desirable and efficient form, is the natural and logical sequence of the adoption of the vertical plane coupler. While its use would add to safety, its greatest advantages would be found in the making up and handling of trains. It would unquestionably save time by eliminating human agency, and this is in line with the trend of railway appliance-design and railroad operation today. The design of the connector, if correct, would reduce the right-angle bends in the train line and hence would reduce the friction to the flow of the air. It would cause less bending and kinking of the rubber hose and would provide an efficient train line whether or not the hose be frozen. Much time would, in any case, be saved.

The question of interchange might be raised as an argument against the connector, and in favor of leaving things as they are. If this view had prevailed when the vertical plane coupler was up for discussion we might still have the crude link-and-pin drawbar in use, today. Provision for the inconvenience to be experienced in the changing, was made and everyone accepted it and all ultimately profited by it. Profit is the inevitable concomitant of every progressive change in equipment on a railroad, especially if the change be in a desirable form of automatic equipment. There is no escape from it, and probable inconvenience during the transition period can never form a valid excuse for holding to a poor arrangement with a better one in sight. Provision can be made for connector interchange, and car men and all concerned can manage the transformation as they did with the vertical plane coupler.

The M. C. B. Association might with profit appoint a committee to consider this whole subject and by so doing, round out the work they begun by eliminating altogether human agency in the matter of car coupling on the railways of the country where conservation of time in handling is becoming a most important and pressing necessity.

Steel Substituted for Other Material.

At one of the regular mechanical department meetings of a prominent railway, where the good of the service is discussed in a sensible and very practical way, the subject of using cast steel top checks for locomotive boilers was taken up. It was thought that the boiler check might be made of this material instead of brass, and that thereby a saving would be effected. Some samples had been submitted at a previous meeting and it had been decided at the former gathering to have one tried on a branch line and one in the bad water district.

The reports of these trials were now submitted and were entirely satisfactory, indicating that one style of check, in the sizes required, was applicable to all engines. It was decided to put cast steel boiler checks on each engine that went through the shop, and that in time steel would become standard in this particular all over the line and the brass boiler checks would be scrapped. The bodies of these checks are to be of cast steel and the fittings are brass, as formerly; the patterns for bodies have been recalled from bronze metal companies and sent to cast steel foundries.

The subject of the breakages of driving shoes and wedges was also brought forward and the suggestion was made that cast steel in place of grey iron might be used for these parts. The patterns were to be sent to a firm of steel makers and cast steel will be used in future. At the meeting evidence was presented that a trial was not now necessary as the cast steel shoes and wedges had on a former occasion proved themselves efficient for the work required.

Picks for track men and others on this road had been previously purchased outside and for the year about 2,228 of them had been bought. At the company's shop a pick was developed made from an old steel tire at a cost of 15 cents each. The total cost of those picks bought outside had come to $690.68, while those made by the railway had reached a total cost of $289.64, making a clear saving of $401.04 for a year's consumption. This is a good example of how old material may be put to good use with thought and a little shop work.

Reports showed that track hand chisels were not, as a rule, sent into the mechanical department shop for repairs, many of the track men laying them aside and asking for new ones. It was shown at this meeting that if the rule requiring them to be sent in is followed a probable saving of 5¼ cents on each would be the probable result. Master mechanics and superintendents were notified of what the shop authorities were prepared to accomplish with the chisels when they were turned in so that greater quantities might be handled, and the promised saving would redound to the credit of the mechanical department and to the engineering staff on each division.

Second-hand steel tired wheels have been used under cabooses with great satisfaction. These second-hand steel tired wheels had also been applied to cinder cars and were found to be most serviceable under these cars. This is a case in which more mileage is obtainable out of old material by lessening the severity of the service to which it is put, as an old steam boiler which has its pressure reduced.

The Chilled Iron Car Wheel.

In another column of this issue will be found a digest of a paper recently read by Mr. Geo. W. Lyndon, president of the Association of Manufacturers of Chilled Car Wheels, before the Canadian Railway Club. In this paper Mr. Lyndon speaks of the growing requirements of railways for wheels to stand up under the enormous loads now hauled as compared with those of twenty years ago. He shows that the chilled car wheel may have its flange thickened by 3/16 of an inch, without altering the distance between the running rail and the guard rail at switches, frogs, bridges, or curves. No alteration in the track is required and the weight of the wheel would only be increased by about 25 pounds.

This seems to be a most desirable improvement, and it can be made with little or no trouble and at an exceedingly slight increase in cost. The necessity for a strong flange is something that no one will deny and this requirement is all the more urgent when we consider the increased flange pressure which modern loads have put upon it. Chilled iron is a particularly good material for ordinary freight car wheels, as the hardness of the tread is fully up to or exceeds that of high carbon tool steel. The distribution of the combined carbon varies in the chilled iron wheel when it is formed, and by the use of a chill mould the tread and hub are made to differ in composition. The melted metal holds carbon in solution, and the sudden cooling of the moulten mass at and near the chill mould, "sets" the chemically combined carbon and iron in the form of carbide of iron (Fe_3C). This alloy is very hard and yet the property of chilled iron permits its hardness to be shaded off by almost imperceptible degrees to the hub, where the iron is softer, owing to there being less combined carbon. This feature gives the wheel its gripping hold on the axle, when pressed on.

We have the chilled tread composed of what is called "cementite," having in it about 3½ per cent of combined carbon. At the hub there is about 3½ per cent of graphite but no combined carbon (cementite) but there is plenty of "ferrite" or pure soft iron. The chill action, as it were, automatically puts the hard cementite at the tread to resist wear, and the purer iron at the hub to hold firmly to, and without splitting at, the axle.

It is the hope of the chilled car wheel manufacturers that the total weights of the various wheels suitable for modern heavy loads will be made greater. A committee of the M. C. B. Association has this matter in hand now. The form of wheel and contour of the tread are to be taken up. The present form of tread, which has a slope of 1 in 20, has proved satisfactory in the past, and it adapts itself without alteration to the inclined rail, which is being introduced on a number of important railway systems. The whole subject is one of vital interest and merits the painstaking consideration which manufacturers and railway men are now taking in it.

Railroads and the Paper Shortage.

The example of the Lehigh Railroad in collecting waste paper is an excellent one, and as elsewhere reported steps are being taken by all of the railroads entering New York to utilize every scrap of paper hitherto burned at intervals to meet the mysterious paper shortage and probably aid in reducing the enormous increase in price to which the commodity has risen. The railroads are usually prompt enough to lend a helping hand in any good cause, and it is indeed puzzling to know why an article composed of such simple elements so easily found and manufactured in America should rise to such unwonted cost. The appalling war in Europe, of course, is given as the chief cause, but even a child knows that the belligerents are not firing paper bullets at each other. A good deal of paper is being used in the divergent notes issued by the belligerents, and some of our own officials and other neutrals have been using a good deal to little purpose. The subject is one into which a government inquiry is being made, and it is to be hoped that in the interest of the public generally and publishers particularly, a reasonable reduction will be made in the near future.

Liquid Fuel for Locomotives.

One of the earliest applications of oil fuel for steam raising was in locomotive practice, the pioneer in this work being Professor Urquhart, who utilized with great success the waste residuals of Russian petroleum, known as astatki and mazout, when he was engineer of Grazi-Tsaritsin Railway in Southeastern Russia.

In the year 1899 Professor Urquhart read a paper before the Institution of Mechanical Engineers, in which he stated that he had 143 locomotives burning this fuel oil, besides fifty stationary boilers and several furnaces. The burner used by this pioneer worker was a steam burner and it has been generally considered that the steam burner was the right apparatus for locomotive work. In later years, however, considerable progress has been made in the application of the pressure burner, it having been successfully applied to locomotives on South American railways.

New Westinghouse Plant.

The Westinghouse Electric & Manufacturing Company has purchased about 500 acres of ground at Essington, near Philadelphia, fronting the Delaware river, where it is being planned to rear a group of buildings with appliances for the construction of the larger kind of steam turbines, condensers and reduction gears. The initial development will cost about $6,000,000. The plant will give employment to several thousand people, and undoubtedly will in the future rival the company's East Pittsburgh plant.

Improvements on the Lehigh Valley.

The electrification of the main line of the Lehigh Valley through the Pennsylvania mountains, and the four-tracking of the main line from the coal fields to New York is under consideration.

Air Brake Department

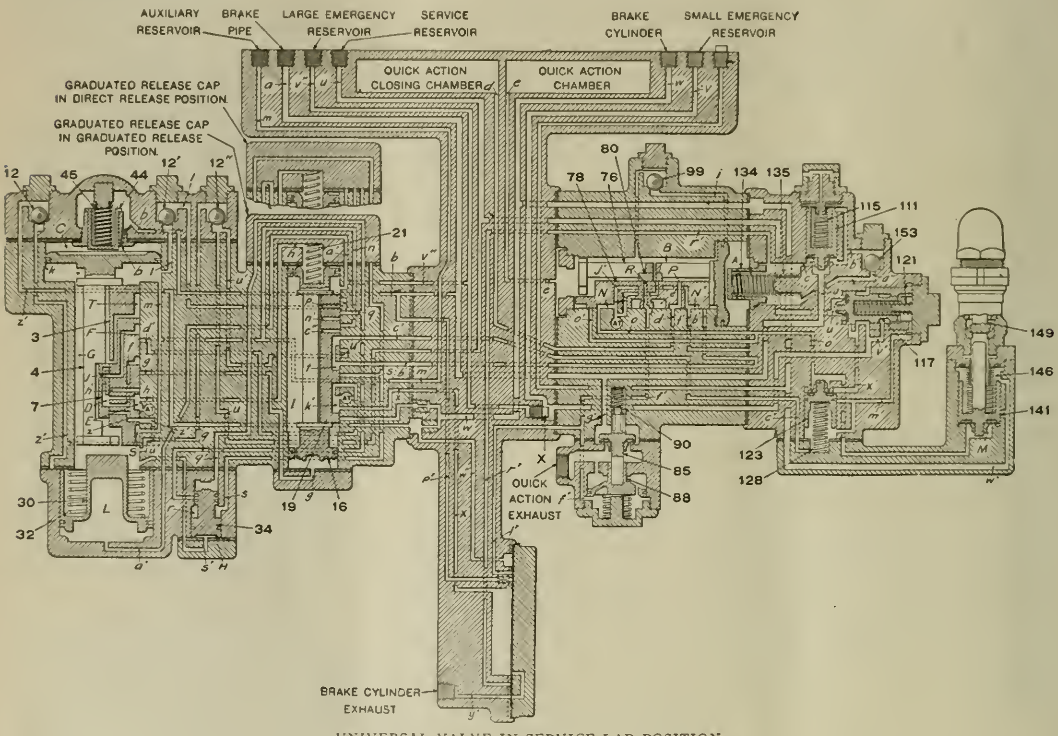
Operation of the Universal Valve in Emergency and Graduated Release Positions

In the description of the operation of the universal valve of the UC brake equipment, we have explained release and charging and service application positions, in last month's issue concluding with the statement that when a brake pipe reduction ceases the lowering of auxiliary and service reservoir pressures below that of the brake pipe pressure permits the brake pipe pressure to become higher and move the equalizing piston and graduating valve to what is known as lap position. This movement occurs provided that the brake pipe reduction ceases before the point of equalization between the auxiliary and service reservoirs and the brake cylinder is reached. In this event, the equalizing piston and graduating valve are moved just far enough downward to close the service port in the equalizing slide valve and stop the flow from the auxiliary and service reservoirs to the brake cylinder.

The emergency piston and graduating valve are affected in a similar manner, the emergency piston and graduating valve closing off the escape from the quick-action chamber and quick-action closing chamber pressures through the emergency slide valve and emergency slide valve exhaust port to the atmosphere. A further reduction in brake pipe pressure merely results in a movement of the pistons and graduating valves mentioned, permitting more auxiliary and service reservoir pressure to pass to the brake cylinders and permitting a further reduction from the quick action and quick-action closing chambers to escape to the atmosphere. The brake cylinder pressure is at such times limited to the adjustment of the safety valve, which opens at 62 lbs. and closes at 60 lbs.

There is no other movement of the portions of the universal valve unless the brake pipe reduction continues to a point where the auxiliary service reservoir and brake cylinder pressures become higher than the pressure remaining in the brake pipe, when the equalizing piston will travel its full stroke, leaving the service port in the equalizing slide valve open. It may be well to note at this time that the emergency piston will also keep the quick-action chamber and quick-action closing chambers reduced equally with the brake pipe pressure, until such time as the brake pipe pressure becomes weaker than the tension of the protection valve spring, when an emergency or quick-action application will occur.

A quick-action or emergency application of the brake is caused by the brake pipe pressure escaping at a faster rate than that at which the quick-action chamber and quick-action closing chamber pressures can escape through the emergency slide valve exhaust port to the atmosphere. When this occurs, the equalizing piston assumes the same position as in

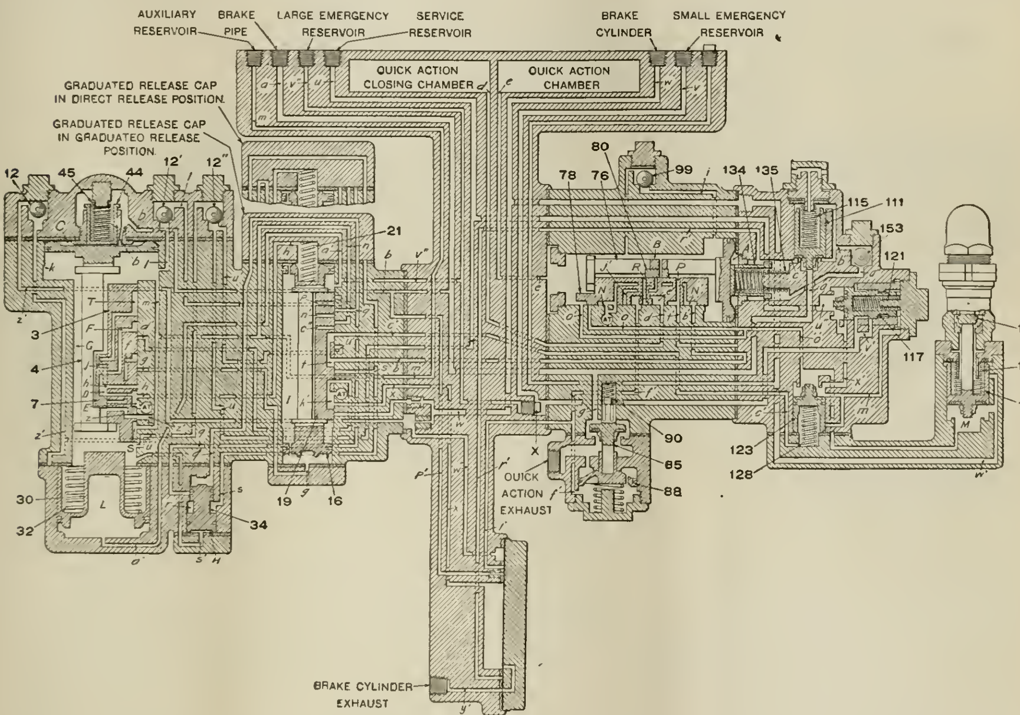


UNIVERSAL VALVE IN SERVICE LAP POSITION.

service, while the emergency slide valve travels its full stroke, opening the back of the intercepting valve and high pressure valves through the release slide valve to the atmosphere. At the same time the quick-action chamber and quick-action closing chambers are momentarily opened to quick-action piston chamber, but when the emergency piston has moved the emergency slide valve to its full stroke, the quick-action closing chamber drains away through a port in the quick-action piston at such a rate that normally the quick-action piston is held off its seat for a space of about 10 seconds, holding the quick-action valve off its seat and discharging the remainder of the brake pipe intercepting valve through the action of the high pressure valve, which serves as a pilot valve for the intercepting valve; then the intercepting valve spring promptly returns the intercepting valve to its original position, separating the brake cylinder and service reservoir pressure, and permits the emergency reservoir pressure to equalize with that pressure already obtained in the brake cylinder.

With the present arrangement the small emergency reservoir only equalizes with the brake cylinder in emergency, and the amount of brake cylinder pressure developed depends entirely upon the size of the small emergency reservoir. However, if desired, the large emergency reservoir brakes may be obtained at any time during or after a service brake application; it is only necessary for the rate of brake pipe reduction to exceed the capacity of the emergency slide valve port to discharge air from the quick action and quick-action closing chambers to the atmosphere.

If the brake pipe pressure reduces through leakage, or from any other cause, below the tension of the protection valve spring, this spring opens the emergency piston chamber to the atmosphere through the port holes in the protection valve cap nut, by moving the protection valve from its atmospheric seat to its brake pipe seat, and such a reduction exceeds the capacity



UNIVERSAL VALVE IN EMERGENCY POSITION.

pressure to the atmosphere. At this time the emergency slide valve has opened a communication from the brake cylinder to the quick-action chamber, keeping the quick-action chamber and the emergency slide valve bushing at brake cylinder pressure in order that the emergency slide valve may not become unseated.

The discharge of brake pipe pressure through the quick-action valve opening propagates quick action throughout the train, while the first movement of the intercepting valve instantly equalizes the pressure between the service and auxiliary reservoir and the brake cylinder and the same equalization is effective on the in- volume or any volume may be added to give any desired emergency brake cylinder pressure to produce the braking ratio for emergency applications. As this action occurs, the cut-off valve cuts the safety valve off from communication with the brake cylinder and the maximum pressure developed in the brake cylinder is retained to the point of stop. This higher emergency brake cylinder pressure is prevented by flowing back into the service and auxiliary reservoirs by the action of the intercepting valve and the service port ball check valve shown in the equalizing portion. It will be understood that the emergency or quick-action application of of the emergency slide valve to expand the pressure from the chambers in the bracket and the same quick action application occurs. The release after an emergency application is accomplished by increasing the brake pipe pressure a trifle above the pressure at which the service, auxiliary reservoir and the brake cylinder have equalized. Normally, with 110 lbs. brake pipe pressure this will be at some figure between 85 and 90 lbs., depending somewhat upon the brake cylinder piston travel.

As the brake pipe pressure has been discharged the quick-action valve will have been returned to its seat by the quick-action valve spring, and when the brake pipe pressure again exceeds the tension of the protection valve spring, the protection valve will be forced from its brake pipe seat to its atmospheric seat, the emergency piston and slide valve will be moved to their release position as the brake cylinder pressure reduces through the movement of the equalizing piston and slide valves and the consequent movement of the release slide valve structure and the opening of the brake cylinder exhaust port, the high pressure valve will be returned to its seat with the assistance of the high pressure valve spring, and the cut-off valve spring will return the cut-off valve to its original position, opening a communication between the brake cylinder and the safety valve.

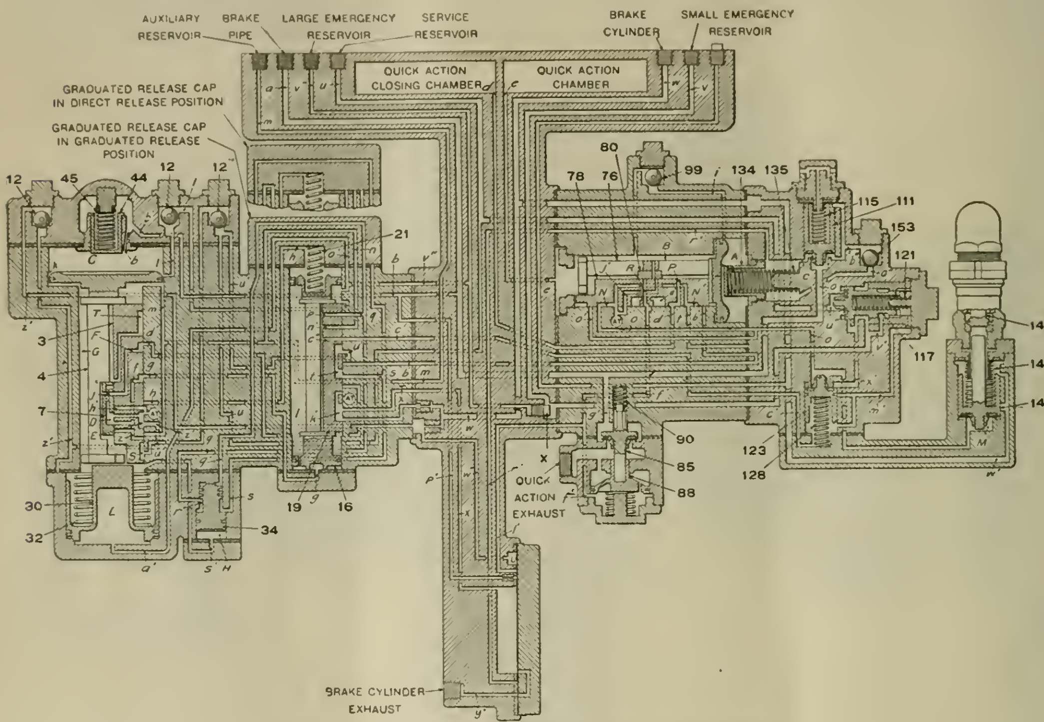
The various parts of the universal valve are then in the position shown for release and charging, and the charging of the reservoirs and chambers takes place as explained in the comments on this position.

It has been made clear that this description will have no reference to the electric operation of the valve until after the pneumatic operation has been fully explained. There is, however, another feature, of graduated release, that is not at the present time in use. In the drawings the valve is shown in graduated release, that is, the graduated release cap is shown in graduated release position, and to show the direct release it must be assumed that the graduated release cap is in the position as shown detached.

Assuming first a direct release, auxiliary reservoir pressure will at all times be effective on the lower side of the graduated release piston as the position of the release piston cylinder cover, or graduated release cap, will insure this. When the brake pipe pressure is then increased above that in the auxiliary reservoir the equalizing piston and slide valve will promptly move to release position, and the release piston and slide valve will follow in accordance with the port openings thus made. However, if the graduated release cap is in graduated release position, it will be observed that emergency reservoir pressure is effective on the under side of the graduated release piston, so that when the equalizing slide valve moves to service position, the graduated release piston follows to the limit of its travel.

In the first place, or in direct release, the present arrangement of universal valve provides for a prompt charging of the service reservoir through the service reservoir charging valve by maintaining service reservoir pressure on the top or the small end of the charging valve; therefore, as soon as auxiliary reservoir pressure exceeds that in the service reservoir the charging valve is opened and the service reservoir is promptly charged from the large emergency or as sometimes termed quick recharge reservoir. If the valve is being operated in graduated release position, the port openings in the graduated release cap will be such that large emergency reservoir pressure will be effective on the upper side of the charging valve piston and the charging valve cannot be lifted and the service reservoir charged until such time as the auxiliary reservoir pressure has been raised to a figure within 5 lbs. of that in the emergency reservoir.

In graduated release position, if the brake pipe pressure is promptly restored and maintained near the adjustment of the brake pipe feed valve, the release of the brake will be direct, that is, graduation will not be attempted and the brake pipe and emergency reservoir pressure becoming equal will permit the graduated release piston spring to return the valve to its normal position and the equalizing piston and slide valve can be moved to release position without hindrance. If the brake pipe increase ceases before the maximum is reached, that is, if the brake valve han-



UNIVERSAL VALVE IN RELEASE AND CHARGING POSITION.

dle is returned to lap position before full brake pipe pressure is obtained, the graduated release piston will stop the movement of the equalizing slide valve in what is known as graduated release position in which there is an inflow of pressure from the emergency reservoir through the release slide valve, and as a result the equalizing piston will be returned part way toward application position and far enough to reverse the movement of the graduating valve and the release piston structure will be moved to application position, retaining the pressure in the brake cylinder that has not escaped when the valve first started to release the brake cylinder pressure.

In this manner the pressure may be graduated out of the brake cylinders in any quantity desired and in proportion to the increase in brake pipe pressure. When desired to effect a complete release, the brake pipe pressure need only be maintained to the adjustment of the brake pipe feed valve.

The graduation merely involves a movement of the equalizing piston and graduating valve, which in turn results in the movement of the release piston structure to and from release position. Each time the movement of the equalizing piston and graduating valve reverses the release slide valve structure, the inflow of emergency reservoir pressure to the auxiliary reservoir ceases, so that the auxiliary reservoir is charged equally with the brake pipe regardless of the rate at which the brake pipe pressure is increased. If the equalizing portion is returned to release position and no graduation is desired, the auxiliary reservoir is promptly charged from the large emergency reservoir with the service reservoir cut off so that there is no drain whatever in the pressure in the brake pipe while the brakes on the train are releasing.

There are certain reasons for this action which will be explained in connection with defects that are likely to be encountered in the operation of the universal valve, and a more thorough understanding of the object of the design of the universal valve will be obtained from a study of a revised code of tests which will be printed in a future issue with illustrations of the test rack and will thus afford our readers much information.

Oils, Fats and Greases

Miscroscopic Conditions of Bearing Surfaces—The Theory of Lubrication—Friction and Other Losses Entailed by Motion—The Oil Film, Its Properties—The Surface Tension of Liquids—Lubricating Superheater Locomotive Cylinders

The consideration of lubricants of any kind is likely by the "law of association" in the mind to call up the idea of friction. There are two kinds of friction usually considered, the friction of rest or static friction; and kinetic friction of that of bodies in contact when moving relatively over one another.

The general theory of friction may be stated by saying that no matter how smooth the surfaces in contact may appear, they are relatively rough when seen through a microscope. A smooth surface, as we would call it, is a surface made up of innumerable scratches and the smaller and finer the scratches are, the smoother the surface is. A carefully bored cylinder, when worn as it becomes in time, has reduced the possibly perceptible tool marks to minute scratches, probably placed in line with the to and fro motion of the piston.

The condition of the two surfaces in contact would probably look, under a microscope, like a "bastard" file moving over the surface of a "smooth" file with this difference that the hills and hollows would not be regularly spaced as they are in a file but would be large and small on both files, and following no particular or settled direction.

It is easy to see that in order to move such surfaces, one over the other, the uppermost file would have to slide up the sides of the trough-like irregularities of the other, and would lift itself up so as to clear the crests of the ridges and then catch on the next series of crests. This lifting and falling of the uppermost or movable surface constitutes useless work, and the tearing away and breaking off of the crests of the scratch-ridges requires work to be done on them and this generates heat, all of which must be paid for by an enforced tax on the machine, the axle, the wheel, or the bearings as the case may be, and paid for in the form we call friction, which is represented by unproductive work and the wear of material.

If the scratches coincided sufficiently to produce a rhythmic rise and fall of the movable bearing, we would have a series of jolts or pulsations so timed as to produce a "musical" note, like that made by a grasshopper as he scrapes, with his roughened legs, on the edges of his wing cases, while he flies. This may account for the singing sound made by a very dry car journal when the car is moved about in the yard or the squeaking of a rusty hinge on a garden gate.

The function of a lubricant which destroys any sound of squeaking and reduces wear, is to bathe both contact surfaces in oil. The car journal and its bearing, iron and brass, the latter often filled with some anti-friction metal, are such that the tearing down of the high ridges of either is less violent in their case and so is accompanied with less friction than other metal surfaces would produce. The starting of any movement from a state of rest is greater than when motion has been established, because the inertia of the masses of matter resists motion, and the film of oil has reduced itself in thickness while standing so that the actual contact is more intimate, as the metals just beginning to move, have not acquired any momentum. Static friction or that from rest to motion is greater than kinetic friction where motion has been established and is continuous. A less amount of friction exists for these metals, iron and brass, and the value of the co-efficient for lubricated surfaces, varies with the velocity, pressure and temperature of the surfaces in contact.

Oil when applied between the contact surfaces fills the hollows or minute microscopic scratches of the metals, and tends to lift the upper bearing away from the crests of the small scratches, which are always present on the most highly polished surfaces. A thin film of oil exists between the bearings, so that the metallic contact is either very much reduced or disappears altogether. This is on the assumption that the lubricating film is split into two or more exceedingly thin layers. The split in the film is due to the adhesion of oil on top, to the upper bearing; while the lower part of film adheres to the lower bearing. The film itself is held together by the cohesive attraction of its own particles for one another. The movement of the contact surfaces drags the upper part of the oil film over the lower, and in so doing, overcomes the comparatively slight cohesion of the oil film particles, so that less friction exists.

This action may be said to transfer the harsh work of tearing off the metallic crests of the small scratches to the easier task of overcoming oil cohesion, even though the oil film is under pressure, as it undoubtedly is. The pressure in the oil has been found by experiment to be independent of the speed of the motion of the surfaces, and is directly proportional to the load upon the lubricated surfaces. This fact is of importance for the reason that when supplying oil to a bearing the pressure in the film must be overcome or the oil will not enter and maintain its form as a film. If the flow of oil to where it is required is tardy or the "head" from which it falls is too low, the lubrication will be faulty or will fail of its purpose altogether. If the pressure in the film is below the pressure of the atmosphere the "bearing" may even suck oil into the film.

Oil has another function in the matter of lubrication as well as providing a mobile film between the moving surfaces. Its constant flow carries away any metal particles which wear off, it removes any dirt or grit and supplies fresh lubricant all the time. Grease, on the other hand, is slower of "flow," and though it tends to remove metallic particles worn off and to keep the bearings clean, after it has done its work piles up as a ridge on the edges of the contact surfaces and forms a more or less effective barrier to dust, dirt, sand and grit entering and working in between the surfaces against the "flow," and the entrance of grit if it could thus take place, would render the lubrication less effective than otherwise.

When a rapidly revolving car wheel is braked, the shoe presses hard against the tread and one of the "problems" of wheel and shoe, if one may say so, is the disposal of the heat generated by the contact. Heat is of course rapidly radiated, but it is generated in such amount that it cannot be wholly disposed of in this way. The result is that the tread of the wheel and the surface of the shoe become hot enough to melt a thin portion of each and thus a molten film is interposed between the surfaces. This hot metal actually forms what amounts to a lubricant, the film being rolled along like oil, and wheel and shoe partially lose their grip on one another, until the slackening speed permits radiation to carry off all the heat generated, and the shoe grips tightly while the "wear" which had previously been melted is disposed of in bright scintillations, burnt up like iron filings in a flame, or is thrown down in an almost impalpable powder.

There is a property which oil shares with all liquids, which is believed to be of the utmost importance in preserving the film of oil between bearings and rubbing surfaces. This quality is known as the "surface tension of liquids." This surface tension is due to the cohesive action of the particles of the liquid. Cohesive force acts in all directions below the surface, and as there is no force tending to counteract it above the surface, this unbalanced condition where air and liquid meet is thought to produce a kind of tense "skin," like a drum-head, of almost inconceivable thinness, and this tenseness causes the surface of the oil to resist any tendency to tear it apart, so that the surface film or "skin" is, to a slight extent, stronger in the so-called "skin" or film form, than the other portions of the liquid below the surface.

The presence of a surface film may be easily demonstrated in the case of water. Dipping the hand into water, and watching it drain off until a drop or two remains at the end of the fingers is an easy experiment. These drops are nearly globular in shape and it is the action of the surface film which holds the small particles of water which adhere to the fingers, in the form of drops, which have the appearance of, and approximate to, the behavior of small sacks of water, like an infinitely thin rubber bottle such as is used in the sick room. Among insects, the surface film is made use of in many ingenious ways and the "pond skaters" stand upon, and move over, the surface film, their weight slightly depressing, but not breaking the surface, as a child might stand upon a sofa cushion and simply depress its surface. The larva of the mosquito has special apparatus for piercing the film from below, and hanging submerged from it while it breathes air before going down on another quest for food.

Returning to the consideration of oil, this surface film of oil tends to resist the breaking or tearing action of itself by the minute scratches or the "hills and valleys" on the contact surfaces. In the filling of the minute surface hollows with particles of oil, this tendency of the surface film to resist tearing, and the cooling effect of the oil, and the washing away of dirt and grit, and the sliding or rolling of the particles of oil one over another; may not individually be very great, but their combined action results in what we call lubrication, which reduces wear, and saves power in the moving of one surface over another, when in mechanical contact.

In considering the subject of oils and fats we may say that there is no sharply defined line of demarkation. Tallow is not solidified oil, it is an animal product containing ⅓ liquid fat or olein, and ⅔ solid palmitin or stearine. Those glycerides which are liquid below 20 degs. Centigrade are for convenience called oils, and those solid at or above that temperature are usually called fats. There is no oil or fat found in nature composed of a single chemical substance. There are generally two or three ingredients, and many impurities exist in the cleanest material, such as that which produces color, the remains of vegetable or animal matter, and resinous and mucilaginous material, and all these fats and oils are insoluble in water. Grease is simply animal fat in a soft state. Lard is a white animal product in a soft state, easily turned to oil by heat and contains about 40 per cent of palmitin and 60 per cent of the substance, olein.

The problem of lubricating superheater locomotives with oil unmixed with graphite or other similar substances, goes on apace. Oil with a comparatively high flashpoint is necessary, and a flashpoint of 525 degs. Fahr. has worked well, even under severe service conditions. When an engine is shut off, and the relief valves are open, allowing air to rush into the hot cylinders, the oil feed on the majority of the various types of locomotives is also shut off, and consequently there is not very much oil left in the cylinders under these circumstances.

We hope to deal more fully with superheater locomotive lubrication in a future issue, as the growing use of this type of engine appliance constantly raises the question in many minds of what are the essentials of the problem, and how have they, or how are they, being met today.

Exhibition of the National Railway Appliance Association.

The ninth annual exhibition of the National Railway Appliance Association will be held in the Coliseum, Chicago, March 19-22, 1917. Bulletins with full instructions are already issued and the entire exhibit space is already assigned. Arrangements are completed for handling the material and installing the exhibits so that the opening of the exhibition will be complete in every detail.

Transportation Club of Louisville, Ky.

At the annual election of officers and directors of the Transportation Club of Louisville, Ky., held at the Watterson hotel on February 12, George C. Devol, chief clerk general freight office, Louisville & Nashville, was elected president; Edward H. Bacon, division freight and passenger agent, Chicago, Indianapolis & Louisville, vice-president; W. T. Vandenburgh, commercial agent, Seaboard Air Line, secretary-treasurer; and the following as directors: Earl S. Gwin, president, American Southern National Bank; Samuel S. Riddle, superintendent of transportation, Louisville Railway; John S. Green, traffic manager H. Verhoeff & Co.; J. B. Wathan, Jr., president, Old Grandad Distillery Company.

Reducing the Cost of Train Operation.

Repeated experiments have demonstrated the fact that with the single-shoe type of brake on passenger cars 35 per cent of the tractive effort of the locomotive was consumed in pulling the train against the effect of the brake shoes dragging on the wheels after the brakes were released. With the new clasp type of brake with its increased shoe clearance this loss is entirely avoided, with a ratio of diminished cost.

Electrical Department

Inductance and Capacity—Density of Electric Charge—Details of Condenser

The two preceding articles have explained the meaning of several electrical terms such as the ampere, the volt, the ohm and the watt. Ohm's law has been explained and examples chosen to illustrate the use of this law. The relation of the electrical units to mechanics has also been pointed out. There are two other important factors which should be considered—namely, inductance and capacity.

As early as 1831, Faraday discovered that currents could be induced in a closed circuit by means of magnets; these magnets being moved close to the coil. Similar currents will be induced if the coil or closed circuit is moved across a magnetic field. Continuing further, after this discovery, he found that a current whose strength was changing—i. e., either increasing or decreasing—would induce a secondary current in a closed circuit near to it. Such currents whether generated by magnet or by other currents are known as Induction Currents. The modern electric generators, induction coils, transformers and other appliances are based upon this principle.

Since induction plays such an important part in the electric field, we must explain more or less in detail these discoveries of Faraday so that the principles will become entirely familiar to the reader and so that the priciples of the transformer, generator, etc., may be better understood when discussed in later articles.

Assume for instance that we had a spool on which is wound a large number of turns of insulated wire, the two ends of which are connected to an electrical measuring instrument which will indicate when electric current is induced in the wire and the direction of flow of this current. If the North Pole of a bar magnet is inserted inside of the spool, a momentary current is observed to flow during this time. When the bar magnet is held stationary no current is induced and when the magnet is pulled out the induced or, as electricians would say, the inducted current flows in the opposite direction. The magnet does not grow any weaker by being so used, for the real source of the electrical energy generated is the mechanical energy spent in the moving of the magnet in and out of the coil. If the ends of the wire are not connected, so that the coil is open-circuited, no currents are produced. However, an electro-magnetic force or a voltage will be set up tending to produce a current.

As another illustration, place two coils of wires with the centers on the same axis, adjacent to each other. In the first coil place a telegraph key in series with a current supply so that when the key is closed, electric current will flow through the coil. We will call this coil the primary coil. Connect the other coil to the electrical instrument for measuring current. We will call this coil the secondary coil. It will be found that whenever the current is allowed to flow in the primary coil, current will be induced in the secondary coil, but this current will only be induced momentarily while the current in the primary coil is building up from zero to its maximum value. When the current to the primary coil is broken, current is again induced in the other coil, but only while the current is falling off from maximum to zero. So long as a steady current traverses the primary circuit there are no induced currents in the secondary circuit.

Induction and induced current are generally associated with alternating current and are not necessarily considered in connection with direct current. The reason for this is obvious. Direct current is of a constant value, and as we have just seen currents are not induced when the primary current is constant. Alternating currents are not constant in value, but change rapidly from a maximum to zero, to a negative maximum, and back to zero, this cycle taking place in a fraction of a second. In the case of a 60-cycle current there are 60 of these cycles per second. We have seen that induced currents occur whenever the current changes in strength and the amount of the induced current depends on the rapidity of the rate of change. We should therefore expect a good deal of inductance when alternating current is flowing through circuits of various kinds, and this is so. Inductance is an important factor when dealing with alternating current and must be considered and allowance must be made for it, just as much as the resistance of the circuit. Many times the inductance of the circuit may be greater than its actual Ohmic resistance.

We have pointed out that when a current in one circuit is increasing or decreasing, there is an inductive effect upon any near-by circuit. This inductive effect is due to the change in the number of lines of force or magnetic field, as it is called, which surrounds the circuit carrying the variable current. This varying magnetic field extends outward from the primary coil or circuit and the secondary coil or circuit lies in this magnetic field so that the turns of wire are "cut" by the magnetic lines of force producing voltage and current.

It is obvious that the magnetic lines surrounding the primary circuit must "cut" across other parts of the same circuit as they move inward or outwards. Is there then a current and voltage created inductively in the primary circuit itself? Certainly there is and this "self-induction," as it is called, can be very great. For instance a coil of wire of a large number of turns will have a large self-induction, because the same lines of force "cut" the wire many times, the induction being cumulative.

Turning on the current in the "primary," will have the same effect as suddenly plunging the bar magnet into the coil, and turning off the current will have the same effect as suddenly withdrawing the magnet. The current induced by plunging a magnet into a coil is an inverse current tending to push the magnet out, while that induced by withdrawing the magnet is a direct current tending to draw it back. It therefore follows that the self-induced voltage, when current is turned on, will tend to oppose this current, and prevent the current from increasing as rapidly as it otherwise would. The voltage induced, on stopping the current, will tend to help the current to continue. The value of this self-induced voltage may be quite considerable. Especially will this be so as the rate of change from the maximum number of lines of force to the minimum is extremely rapid when the current is broken.

Nearly every one is familiar with the "kick" from a coil when the circuit is opened. This "kick," which is the self-induced voltage, may be several times as great as the supply voltage, and in many cases where circuits of considerable size and capacity are being handled it is extremely dangerous to open up the circuits unless adequate electrical apparatus is available.

The unit of induction is called the *Henry*. It is the induction in a circuit when the electromotive force induced in this circuit is one volt, while the current varies at the rate of one ampere per second. Since the henry is defined in terms of amperes and volts, it follows that it also can be expressed in terms of mechanical units, as was the ohm, the ampere and the watt in our preceding article.

We have learned that whenever certain materials are rubbed by other materials static electricity is produced. In other words, the non-conductor becomes charged. This charge of electricity resides only on the surface of conducting bodies. This is proved by the fact that whether the body be of solid metal or hollow, or even if it consists of wood, covered with tin foil, if the shape be similar, the charge will be distributed in the same manner over the surface, as if solid or hollow had been employed.

The density of this electric charge depends on the number of units of electricity which have been imparted to the insulated body and the area of the body. Only in the case of the sphere does the electric charge distribute itself uniformly over the whole surface. This charge has a certain "potential" or voltage in reference to other bodies. In order, therefore, to determine the capacity of any body, reference must be made to the voltage or potential which a certain charge will give. A large quantity of electricity imparted to a conductor or body of small capacity will electrify it up to a very high potential just as a large quantity of water poured into a vessel of narrow capacity will raise the surface of the water to a high level in the vessel. Capacity is also comparable to the capacity of a bottle containing air. The addition of a given amount of air will raise the pressure more or less, and the amount of air required to produce a certain pressure in the bottle may be taken as the measure of the capacity of the bottle.

A conductor that requires only one unit of electricity to raise its potential from zero to one will possess unit capacity. The capacity of conductor is increased by bringing near it a charge of an opposite kind and this principle is made use of in the construction of the condenser. In the consideration of various circuits, capacity plays an important part. In the case of alternating currents, it is often essential that additional capacity be connected or cut into the circuit either to produce certain conditions or else to offset certain conditions. This results in the use of the so-called condenser. The construction of the condenser is considered below.

The effect of capacity is very noticeable in the case of submarine cables. The cable acts as a condenser, the ocean forming the outer coating, and the internal wire the inner coating. When one end of a submerged cable is connected to the positive pole of a powerful battery, electricity will flow into it. Before any signal can be received at the other end, enough electricity must flow in, to charge the cable up to a comparatively high potential. In the case of long cables several seconds are required for current to pass, which is a serious obstacle to rapid signalling. When the current is disconnected, this charge of current returns. To obviate this retardation and increase the speed of signalling in cables, several devices are adopted. A delicate receiving instrument is used; in some cases a key is employed which after every signal immediately sends into the cable a charge of the opposite sign, to sweep out, as it were, the charge left behind. Often a condenser is interposed so as to make the signals shorter and sharper.

The manufactured condenser usually consists of a box of insulating material in which are placed a number of alternate layers of tin foil, separated by paraffine paper or mica as an insulator. All of the sheets of one set are connected to one terminal and all of the other sheets to another terminal.

Condensers are used in a great many electrical circuits where special results are required. The condenser serves as a momentary storage reservoir into which a sudden impulse or wave of current can go, and this excess of energy will be returned when the impulse has passed. It is analogous to a reservoir connected as a branch to a steam pipe line. When steam is first turned on to the system the reservoir fills up to the same pressure as the pipe line. If the pressure drops suddenly, for a moment, the steam in the reservoir discharges into the system, and so maintains the supply. The steam pressure now comes on again and the reservoir fills up and is again ready to supply the excess steam.

It is now apparent that capacity tends to oppose and neutralize inductance, and by proper proportioning of these quantities in any circuit the two can be counteracted and neutralize each other.

We have previously stated that the capacity of a conductor is measured by the quantity of electricity which must be imparted to it in order to raise its potential from zero to unity.

A conductor which required only one unit of electricity to raise its voltage from 0 to 1, would possess unit capacity. A sphere one centimeter in radius possesses unit capacity. The greater the sphere the greater the charge required to raise the potential to one, hence the greater capacity. It would be necessary to give a charge of 100 units to a sphere of 100 centimeters radius.

The unit of capacity adopted is termed the *Farad*. A condenser of one farad would have a capacity such that one coulomb of electricity would be required to raise the potential to one volt. A *Coulomb* is the quantity of electricity which is conveyed by one ampere, flowing for one second.

A condenser of one farad capacity is too enormous to be practically considered and the practical unit is the *Microfarad*, or one millionth of a farad. The earth itself has only a capacity of 7/10,000 of a farad.

In our next article we will begin with the generation of electric current. The principle will first be taken up and then the design of machines and electrical apparatus will follow.

Divisions of the Southern Railway.

For administration purposes of the various groups of the Southern Railway System the following is copied from the executive order issued by President Fairfax Harrison:

Lines East: The following operating divisions of Southern Railway Company, viz: Washington division, Danville division, Charlotte division, Richmond division, Norfolk division, Winston-Salem division, Columbia division, Charleston division, Spartanburg division, Knoxville division, Coster division, Appalachia division, Asheville division, Murphy division, Transylvania division.

Lines West: The Cincinnati, New Orleans & Texas Pacific Railway, Alabama Great Southern Railroad, New Orleans & Northeastern Railroad, Harriman & Northeastern Railroad, Cincinnati, Burnside & Cumberland River Railway, Northern Alabama Railway, and the following operating divisions of Southern Railway Company, viz.: St. Louis division, Louisville Division, Memphis Division, Atlanta division, Columbus division, Birmingham division and Mobile division.

The executive officers are as follows: T. C. Powell, vice-president, resident executive officer in the West and in charge of traffic lines west, office, Cincinnati, O.; H. B. Spencer, vice-president, in charge of construction, purchases, real estate, etc., office, Washington, D. C.; E. H. Coapman vice-president, in charge of operation, office, Washington, D. C.; H. W. Miller, vice-president, resident executive officer at Atlanta, office, Atlanta, Ga.; Lincoln Green, vice-president, in charge of traffic lines east, office, Washington, D. C.

Demand for Rails.

The unprecedented demand for rails continues to such an extent that many orders remain unfilled, among which is an order in the market from Great Britain for 50,000 tons. 12,000 tons is also wanted for Denmark, 10,000 tons for Cuba, and 2,000 tons for Porto Rico. Russia, also, remains a heavy buyer, and the French government is negotiating for an indefinite tonnage of rails.

Increase in Rates.

The New York State Public Service Commission has notified the New York, New Haven & Hartford that on March 20 local freight rates within the State of New York will be raised about 10 per cent. A similar increase will be made by the two New Haven subsidiaries, the Central New England and the New York, Westchester & Boston.

Freight Car Repairs

Varieties in Structural Details—Removing Defective Axles From Service

Not long ago Mr. L. K. Silcox read a paper on Points on Freight Car Repairs before the Car Foreman's Association of Chicago, in which, among other things he said, the subject of end frame reinforcement is now receiving a great deal of attention. One large eastern road is applying two pressed steel bellied U-shaped braces to the end sheathing over the end posts; a truss rod through the side and end plates and the angle plates at the belt rails, inside and outside the car in each corner. A 2½ x 2½ x ⅜-in. angle at the side and end plates is also used; a truss rod through the ends, just above the belt rail, and 1¾-in. flooring to the end lining, for about 3½ ft. up from the floor. The angle iron at the side and end plates is in one piece, extending up about 4½ ft. along each side plate. It spans each of the corners to avoid sharp ends and is bolted to the end and side plates.

Another road is applying 4 ins. (8.2 lbs.) Z-bars at each end post, 4 x 4 x 5/16 ins. angles at the end plates; and diagonal braces 3 x ⅜ in. at the corners in the roof, which are riveted to ¼-in. gusset plates at the side plate; and ⅜-in. gusset plates at the end plates. Generally speaking, a large number of roads are endeavoring to provide additional supports to the end plate. Another road favors the use of lateral straps, three at each end of the car, made of 4-in. scrap boiler flues, all of which can be applied at a cost of from $10 to $12 a car. For grain loading, some roads find it advantageous to apply metal bands to the outside of the sheathing, in the form of flattened flues, bar-iron or light channel sections. The cost of such applications would probably not exceed $4 a car. Flattened flues can also be punched into flat keys and washers or they can be used for corner bands; side door thresholds and stake pockets for coal cars.

The question of equipping all-steel coal cars, especially those of the flat bottom type, for extended service after the floor plates and the lower part of the side sheets have become corroded to the extent of impairing the strength of the car and causing the load to be lost through openings in the frame, is a serious problem. Its solution depends entirely upon the probable life of the car. Some roads, which operate under unfavorable climatic conditions and handle low-grade bituminous coal, rebuilding the car has been found necessary at the expiration of from nine to eleven years but where service conditions are not so severe, the period may be postponed to the fifteenth or even eighteenth year. One road makes a practice of splicing the bottom of the side sheet, thus saving 80 per cent. of the old material. The splice is required to transmit 6,200 lbs. when 80,000 lbs. is carried by one side. From a material standpoint, a good system to follow would be to have the center sill cover-plates 21 x ¼ ins. and the side sheet splices formed from the same size of material and flanged. In order to keep the sides from bulging, four braces, one placed at each cross-bearer and riveted directly to it, might be applied.

In connection with reinforcing the ends of steel coal cars, especially where they are used in lumber traffic, it is important to provide against bulging. One road has adopted a double row of pressed steel lateral braces with lipped ends engaging the entire surface of the corner post.

Two points in connection with the arch bar truck appear to be of considerable interest, so far as the actual performance of the bars are concerned. Two Eastern roads use cars of identical design; they are of the twin hopper all-steel type; in one case the trucks are fitted with 7 x 1¼-in. bars; the other has 5 x 1¾-in. sections. The net area with the wide bar is 6.27 sq. ins., while that of the narrow one is only 5.28 sq. ins. This is a difference of 19 per cent. with the same gross section. It was possible in the case of a 50-ton truck recently considered to reduce the stresses in the bottom arch-bar at the center of column bolt, from 21,000 lbs. per sq. in. to 5,000 lbs. per sq. in. (practically 400 per cent.) by applying a base casting under the columns. Several large roads have recently adopted this practice.

This does not mean that liability of failure would be reduced in this proportion, because the most destructive element, namely, crystallization, has been avoided by the reduction in the working fibre stresses mentioned above. Wrought iron should be used, because of its having a fibrous structure, while steel has not. For this reason, the latter material will crystallize very rapidly under vibration.

One of the refinements in the design of the average freight truck which seems seldom to receive definite attention is the position of the side bearings. There is a tendency in the practice of certain roads in some sections of the country, which makes it apparent that the subject is entirely misunderstood.

The real truth of the matter has been forced on some roads through their experience with the derailment of locomotive tenders, and it has become a live issue for this class of equipment because there is more liability of obtaining a higher center of gravity than is possible in the case of the usual freight car; the high center of gravity causing a great tendency for the equipment to roll dangerously. There is, generally speaking, only one remedy for such cases and that is to decrease the distance between the centers of side bearings, and this has been successful in largely reducing the difficulty mentioned.

The following practice card covers in very plain form a graphical method of presenting to the man on the line the subject of axle inspection. It is the result of very careful calculation and consideration. The great gain in its use appears in the fact that an inspector cannot misjudge the condition of an axle. This often occurs where the matter is left to each man's discretion.

Standard car axles are provided with 3¾ x 7 in., 4¼ x 8 in., 5 x 9 in., 5½ x 10 in., and 6 x 11 in. journals when new.

Axles must be removed from service if below the following limits:

FOR PASSENGER EQUIPMENT CARS.

Normal size of journal (Inches)	Journal diameter not less than (Inches)	Journal length not more than (Inches)	Collar thickness not less than (Inches)	Wheel fit not less than (Inches)
3¾ x 7	3 11/16	7¼	⅜	4⅞
4¼ x 8	4	8¼	⅜	5½
5 x 9	4¾	9¼	½	6¼
5½ x 10	5¼	10¼	½	6¾
6 x 11	5¾	11¼	9/16	7 3/16

FOR FREIGHT EQUIPMENT CARS.

Normal size of journal (Inches)	Journal diameter not less than (Inches)	Journal length not more than (Inches)	Collar thickness not less than (Inches)	Wheel fit not less than (Inches)
¾ x 7	3 9/16	7⅜	¼	4¾
4¼ x 8	3⅞	8⅜	¼	5½
5 x 9	4⅝	9⅜	5/16	6¼
5½ x 10	5⅛	10⅜	⅜	6¾
6 x 11	5⅝	11⅜	½	7⅜

Journals must be calipered to see if they are worn hollow or tapered. If the difference between the diameter of same journal measured at any two points is 1/22 in. or more, the journal must be turned.

Axles must be closely inspected for seams, cracks or flaws. Seamy journals may be returned to service if seams can be removed by turning, within the required limits. Cracked or flawed axles should be tested by painting doubtful part with whitewash and then holding flattener on one end of journal and striking with a sledge. Oil working through the paint will indicate flaw. Axles cracked, flawed or showing signs of excessive overheating or below limits in any respect, must be scrapped.

Defective axles likely to be held for inspection must have in addition to the car number and initials stenciled on axle, station symbol, date removed and defect symbol as follows. The station symbol is a letter. J—Broken between hubs; or Bent between wheel hubs; L—Fillet at back of journal below limit; M—Journal length beyond limit; N—Wheel fit below limit; O—Good for service; P—Journal diameter below limit; R—Cut journal; S—Burnt journal; T—Tapered journal; U—

bent journal; V—Broken journal; U—Seamy or flawed journal; Y—Collar below limit.

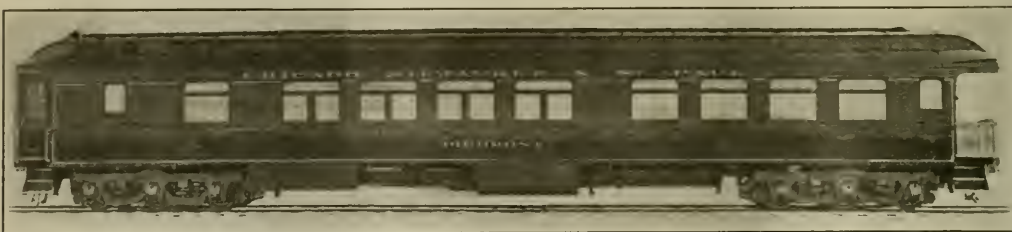
Scrapped axles should have a piece knocked off collar. Good judgment should be used in yards and at wheel mounting points in condemning axles. Axles in service should not be removed from cars until worn to limit, when otherwise in good order. Axles with one or more wheels pressed off must not be returned to service unless 1/16 or more above above limit of journal diameter. Wheel seats must not be turned down except they permit the smallest amount necessary to true up, if they require it. Axles must not be turned to fit wheels except when new axles are fitted to new wheels bored to standard dimensions.

Fillets on journals must be carefully tried, using standard fillet gauge, placing the gauge on the journal parallel with the center line of axle. If the vertical edge of the gauge touches the vertical part of the inside of the shoulder, axle must be scrapped. Use the corner of the gauge with ⅛-in. radius for axles having 3¼x7-in. journals and the corner with ¼-in. radius for axles having 4¼ x 8-in., 5 x 9-in., 5½ x 10-in. and 6 x 11-in. journals. M. C. B. limits must be closely followed in condemning axles under foreign cars in service.

Two Types of Passenger Cars for the Chicago, Milwaukee and St. Paul Railway

Some of the Many Details of Equipment

Two types of modern sleeping cars for the Chicago, Milwaukee & St. Paul Railway, built by the Barney and Smith Car Co. of Dayton, Ohio, embody some interesting features. One is an eight-section sleeper with observation smoking-room, and the other is an ordinary twelve-section sleeping car, with smoking-room as usual.



EXTERIOR OF SLEEPING CAR "PIEDMONT" ON THE C., M. & ST. P. RAILWAY

Both these cars are 72 ft. 6 in. long, having steel centre sills and the fish-belly type underframes. The sides, roof and end framing are made of metal, and the interior is of mahogany and walnut, the different types of wood being used in the different compartments.

The cars in general are equipped with Johns-Manville Salamander Keystone hair insulation. The Buckeye "Ohio" couplers; Chaffee centering device; Fowler upper vestibule buffer; Pullman wide-type of vestibule. The Rex vestibule curtain; Ajax diaphragms; National trap doors; Flexolith composition flooring on top of chanarch metal flooring; sides sheathed with ⅛ in. steel plate, butt riveted with welt plate over joint and button head rivets; upper deck of car inside ¼ in. Agasote; Imperial prismatic round cornered Gothic lights are applied to outside of car; Edwards window fixtures and weather strip; Blount door checks; window curtains of Pantasote; Curtain Supply Co.'s 88 ring fixtures at curtains.

TWELVE SECTION SLEEPER
C., M. & ST. P.

Seats, the Hale & Kilbourn; Duner hoppers; air pressure water system; Adams & Westlake lever type of wash stand faucets; Cook hot box cooler hooks; Chicago Car Heating Co.'s vapor system. Multiple regulation with independent regulators for all parts of the car; electric lights to work in connection with the head end system with pintsch gas for auxiliary lighting; Gibbs train connectors; Imperial window screens; Westinghouse high speed brake; American Slack Adjuster.

Trucks, 80-M lbs. capacity, Commonwealth cast steel frame, 36 in. rolled steel wheels, Railway Steel Spring Co.'s springs, P. C. Creco brake beams and side bearings; Pennsylvania type of sliding pipe clamps; all toilet rooms arranged to be locked from the outside so that in restricted territories, the toilet rooms may be locked without disturbing the occupants of a compartment or drawing room.

Everywhere the cars afford comfort to the patrons of the road and the vehicles themselves are elegant in appearance and have the substantial look of being able to give satisfactory service. The cars are used on the Overland trains of the C., M. & St. P. between Chicago and the Pacific coast.

OBSERVATION END OF SMOKER
C., M. & ST. P.

The Value of an Efficient Air Brake

By WALTER V. TURNER, Assistant Manager, Westinghouse Air Brake Co.

The comments made by me during the past year through this paper had reference largely to an efficient brake system for freight cars, and while that subject is at the present time very far from exhausted, I wish to digress for the time being and again mention the importance of an efficient passenger car brake, and not from a viewpoint of safety alone, which usually involves a great amount of matter concerning emergency stopping distances, but rather to call attention to the dividend earning or revenue producing phase of an efficient passenger car brake in congested districts.

The railroads carry the life blood of our society. They provide that circulation or communication between parts which is indispensable to the life of all organisms—physical, social and economic. If circulation ceases, life also ceases; and the life of an organism is healthful in the same degree that the circulation is free and active.

Railroads have an importance to the social body equivalent to that of the vascular system to the human body, and this should be enough to convince the public that it is as unwise to hamper and interfere with the operation of railroads as it is for a man to restrict the flow in his arteries.

It has been well said that time is the essence of railroading; that is, the fundamental purpose of a railroad is to save time. To increase traffic capacity involves operating at higher speeds and at more frequent intervals trains of a greater number of cars, with greater carrying capacity. Increased traffic capacity means a greater number of ton-miles and passenger-miles per unit of time.

It goes without saying that an increase in the number of tracks of a railroad will enlarge its capacity, and enlarge it in a greater proportion than the increase in the number of tracks, for additional tracks permit of the segregation of traffic according to its kind, and also prevent a tie-up on one track to tie up the whole line. Also grade and curve reductions enable the running of longer trains at higher speeds, so far as getting trains into motion and keeping them there is concerned.

But to get the maximum volume of traffic out of any set conditions of roadway it is necessary to employ the most improved means of train control; that is, there is a vital relation between train control and the service which railway properties can render, and this service is the measure of their value.

The relation of the wheel flange and the rail in providing lateral control to the movement of trains is commonplace, and crosses the threshold into consciousness only when a broken flange puts the train in the ditch, with great loss of life and property. Similarly the significance of longitudinal control, or, more simply stated, the ability to stop, does not receive the appreciation it merits. Naturally, were motion not imparted to a train, it would require no provision for control. To put a train into motion without adequate control would be more futile, not to mention the danger, than not to have moved the train at all.

Consider the congestion in modern traffic if it were necessary to remove all forms of brakes from existing equipment. Based on results of experiments conducted in the Illinois Central Railroad by Prof. E. C. Schmidt, and confirmed by tests we have made, a passenger train stop from a 60-mile per hour speed on level track due to internal friction alone would require a distance of over 30,000 ft., about 6 miles, as compared with 1,000 ft. the stop distance for a passenger train equipped with the most modern type of brake. The time necessary for the stop is about 14 minutes in the first case against about 20 seconds for the latter. Basing the headway upon the time required to run six times the stop distance, the modern trains with brakes could be operated at intervals of 1.14 minutes compared with 34.1 minutes for trains without brakes; that is, 30 trains can now run safely under a condition that but one train could be run without brakes.

In order to operate the two systems of trains with equal safety it would be necessary to run the train without brakes at a speed from which it could stop in the same distance as the train equipped with modern brakes. This speed would necessarily be about 9 miles per hour in order for the train to stop in a distance of 1,000 feet. This lower speed permits reduced headway amounting on the above to 7.6 minutes. If the velocity in miles per hour is multiplied by the number of trains per hour, for each system of trains, a comparison of train miles per hour can be made. This is 3,150 compared with 71 train miles per hour or a traffic capacity 44 times greater for the system of trains using air brakes, the increase being due to one thing alone, that is, the use of a modern brake equipment.

Without the use of brakes it would be impossible to operate trains over any grade exceeding 10 ft. to the mile. At this time a stop would be indefinitely prolonged and the time between trains correspondingly increased. Consider what it would mean to the railroad if it was necessary to carry the grade reduction to the point of having two-tenths of one per cent. as the maximum permissable grade.

Consider further the element of flexibility, or ability to apply any part of the total range of braking effort at the desired moment, and imagine the degree of skill required by an engineman in handling a train without brakes to "spot" cars for loading or to stop at a water tank or coal chute, involving, as it would, variations in grade, curves, train resistance, etc.

Picture in your mind the number of brakemen that would be required to handle our modern passenger and particularly our modern freight trains; also the lack of flexibility afforded the engineman in making stops at desired points, and in controlling a train down a mountain whereon it is necessary to make allowances for changes in grade curvature and other local conditions. There can be no team work equal to that possible in one player only—no co-ordination like that found in a single man; that is, the control of a train concentrated in one person, with the corresponding concentration of responsibility, is the ideal condition, due regard being given to any and all practical provisions for a watchman to "watch the watchman." The fireman in the cab, the "dead-man's" device for electric traction service, the conductor's valve on the train, and the automatic stop and cab signals, are some to be properly mentioned in this connection.

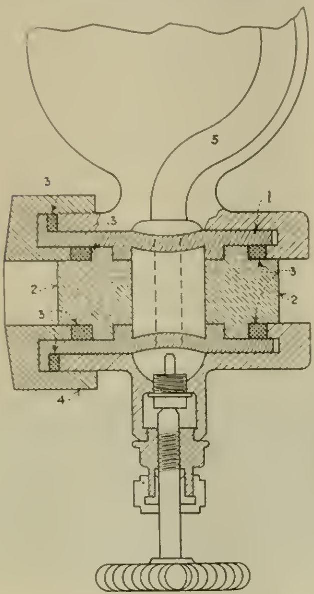
I have thus briefly attempted to sketch the tremendous importance of adequate control for the movement of trains, provided by the modern air brake, to the question of traffic capacity, which is of such pressing moment to every railroad manager, and in the near future, I propose to touch upon the financial phase of the matter, or in other words, is the money spent for modern brake apparatus a paying investment or does the return warrant the expenditure?

Improved Lubricator Glass Casing.

By H. Kreiss, Elizabeth, N. J.

In changing the glasses in lubricators, there is considerable difficulty in getting the rubber gaskets out that surround the glass. The cavity for the glass and the body of the lubricator are one casting, and there is no other way to get the gasket and glass out except by digging it out. The lubricators in use on the modern locomotive use glass casings with two nuts, one in the front and one in the back. The nut in the back is almost touching the boiler, and it is difficult to get at the nuts in the back while the lubricator is on the engine. In the device shown in the accompanying drawing I have perfected a method whereby the casing or tube has a glass in each end which are placed in position before they are put into the lubricator, and then fastened in place by one nut, which is on the front of the lubricator.

A triple feed lubricator has six glasses and six nuts, but with my casing three nuts are sufficient, thereby effecting con-



SECTION OF LUBRICATOR CASING.

siderable saving in material and labor in replacing and repairing. Referring to the drawing, Fig. 1 represents the casing; 2, the glass; 3, the rubber gaskets; 4, the nut; and 5, the oil passage to the tallow pipe. The drawing shows a section through the center of the glass.

Railways in Saskatchewan.

The annual report of the Saskatchewan Department of Railways for 1916 recently published contains several interesting statements indicating the growth of railway mileage in the province since its inception, also branch line equipment. The instalments indicate that for the period prior to the commencement of war very great expansion in railway construction took place. The total railway mileage in the province today is 6,101.46, divided as follows: C. P. R., 2,762.75; C. N. R., 2,206.78; G. T. P. R., 1,131.93.

Automatic Plate Valves.

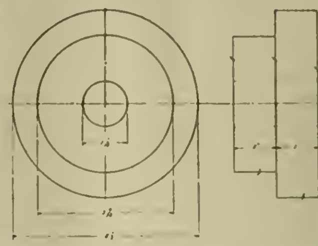
Bulletin "D" issued by the Mesta Machine Co., Pittsburgh, Pa., describing the Mesta automatic Plate valves (Iversen patent), which are being used in both new and re-built air and gas compressors, ammonia compressors, vacuum pumps and blowing engines.

Air Brake Repair Work Tools Devised and Applied to Every Requirement

By GEORGE K. DORWART, Denver, Colo.

No. 5. Tool for Removing Piston Bush.

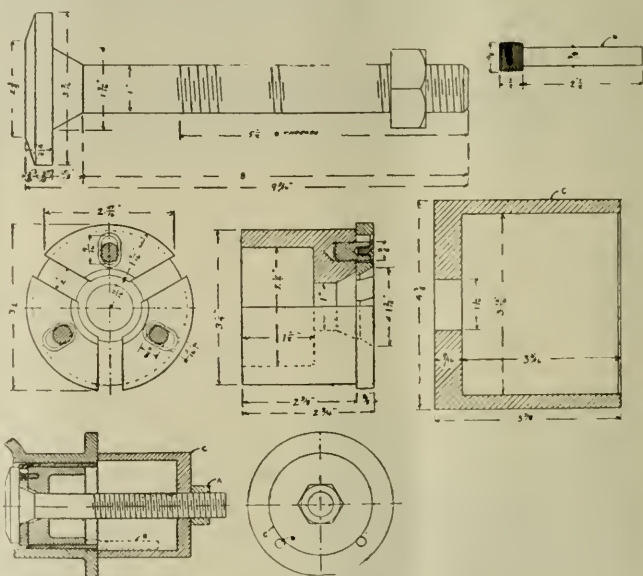
The accompanying reproduced drawing, No. 5, shows the details of the various parts of a substantial tool for removing piston bush Pc. 25,847, 8½ ins. cross compound pump. It will be noted that the studs marked B. are screwed into the two lower cylinder head cap screw holes for the purpose of supporting C. The illustration is self-explanatory, and its method of operation will be immediately apparent to those familiar with the construction of the cross compound pump. The tool has been found to be eminently reliable and expeditious in service.



NO. 6. TOOL FOR PRESSING IN PISTON BUSH.

No. 6. Tool for Pressing in Piston Bush.

As a companion tool for pressing Pc. 25,847 piston bush of the Westinghouse 8½ ins. cross compound pump, the drawing No. 6 furnishes details as to the various dimensions of the pressing tool, which is simple in detail and easily constructed. The two tools together furnish all that is necessary in removing the worn bush and inserting the new bushing.

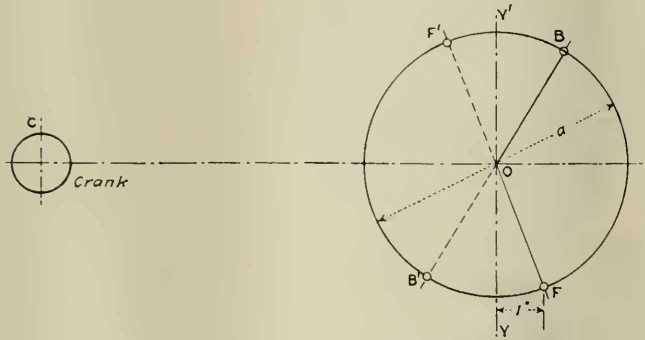


NO. 5. DETAILS OF TOOL FOR REMOVING PISTON BUSH.

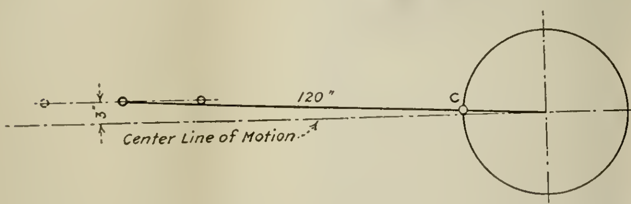
Angular Advance of Eccentrics

By ROGER ATKINSON, M. E.

To calculate accurately the angular advance of the eccentric when the lap and lead are known requires considerable mathematical knowledge and many dimensions of the motion must be known. If it is only required approximately it may be obtained as follows: Add together the lap, say 1 in., and the lead, say ⅛ in.; then 1⅛ ins. represents the linear advance of the valve. If the upper or valve arm of the rocker is greater than the lower or link arm then this amount must be reduced accordingly to get the linear advance of the eccentric. Let the upper arm be 9 ins. and the lower 8 ins.; then 9 : 8 : : 1⅛ : x from which x equals 1 in., the linear advance. This is the amount that the centre of the eccentric must be advanced beyond the right angle from the crank for a direct motion and vice versa for an indirect motion (a) throw of eccentric (F) and (B) indirect show position for direct; F and B′ show position for indirect. The angle FOY is the angular advance, and if OF is the radius of the eccentric, say 2¾ in. then



1-2¾ (i. e. linear advance radius) =.3636+ which is the natural sine of the angle FOY and is 21½ degs. nearly as may be found by any table of Natural Sines. Similarly the angle BOY′ will give the back eccentric and opposite centres F′ B′ give the eccentric positions for indirect motion. It should be observed that these angles F O Y and B O Y′ are



only equal when the "centre line of the motion," that is, a line from the driving axle to the bottom rocker pin coincides with the centre line from the driving axle to the middle position of crosshead pin, which is comparatively rare, as the crosshead pin is usually above the driving axle, and this angularity should be allowed for.

Thus suppose the main rod is 120 ins. long and the crosshead pin is 3 ins. above the normal position of the driving axle, then the crank pin is on the dead centre when it coincides with the main rod centre line, and is at an angle with the centre line of the motion. This angle has its sine=3-120=.025 which is the sine of an angle of 1½° (nearly). Thus for an indirect motion the angle C O F′ from the crank to the forward eccentric instead of being 90°—21½=68½° and the angle C O B′ for the back being 90°—21½°=68½° these become 68½°—1½°=67° forward eccentric and 68½+1½=70° back eccentric.

Buckeye File Sharpening Machine.

A file sharpening machine has just been placed on the market by the Macleod Company of Cincinnati, Ohio, which in point of simplicity and effectiveness is a marked advance in the right direction. It is adapted for either air or steam pressure of 80 or 100 lbs. pressure, the latter preferred. The abrasive used is a special flint, moderate in price, and is used over and over again as long as it retains any cutting action. The lighter particles flow away with the surplus water from the overflow, a water jet preventing the file from becoming overheated, and also preventing dust, the chimney taking the surplus air and exhaust steam.

The abrasive flint is directed against the file, the angle of the file being fixed by angle guides. A few strokes each way completes the recutting or re-sharpening of the file. The machine, as shown in the illustration is compact and contains no springs or complicated valves to get out of order. In the use of one hundred files the machine will pay at least 20 per cent., and even five hundred files would pay 100 per cent. As is well known, there is much time lost by using dull or dirty files. The loss in some of the larger shops would pay the cost of the machine in a single day. The machine can also be used as a sand blast of small castings, a hand hole being adapted for such articles. Send to the company's office, Rogen Street, Cincinnati, for a catalogue.

BUCKEYE FILE SHARPENING MACHINE.

The Locomotive Magazine.

London, England

The present issue completes the twenty-first year of The Locomotive, its first number having appeared in the early part of July, 1896, under the title (for the first year only) of "Moore's Monthly Magazine." From the beginning, the reception of the journal was of the most gratifying nature, the circulation continuing to increase steadily

Items of Personal Interest

Mr. William Darnall has been appointed round house foreman of the Santa Fe, with office at Barstow, Cal.

Mr. E. G. Goodwin has been appointed fuel agent of the Southern Lines East, with headquarters at Knoxville, Tenn.

Mr. Fred H. Linley has been appointed electrical engineer of the Duluth & Iron Range, with headquarters at Duluth, Minn.

Mr. T. N. Murphy has been appointed road foreman of engines on the middle division of the Santa Fe, with office at Newton, Kan.

Mr. W. Johnson has been appointed master mechanic of district No. 6, Intercolonial division of the Canadian Government railways, with office at Truro, N. S.

Mr. Arthur T. Kuehner, formerly district motive power inspector of the Baltimore & Ohio, has been appointed general foreman of the same road, with office at Riverside, Md.

Mr. J. C. Ramage, superintendent of tests of the Southern proper, has been appointed superintendent of tests of the entire Southern system, with headquarters at Alexandria, Va.

Mr. J. L. Jamieson has been appointed foreman of locomotives of the Medicine Hat division of the Canadian Pacific, with office at Medicine Hat, Alt., succeeding Mr. W. J. McLean, transferred.

Mr. W. W. Darrow, formerly secretary of the Camel Company, manufacturers of railway specialties and supplies, with offices at Chicago, Ill., has been appointed general manager of the company.

Mr. D. P. Sparks has been appointed machine shop foreman of the Rock Island, with office at Shawnee, Okla., and Mr. Richard Brown has been appointed erecting forman at the same place.

Mr. W. S. Murrian, superintendent of motive power of the Southern, at Knoxville, Tenn., has had his jurisdiction extended over both of the lines east and west, with headquarters at Knoxville.

Mr. F. W. Burch has been appointed roundhouse foreman of the Rock Island, with office at Herington, Kan., and Mr. C. Mitchell has been appointed night roundhouse foreman at the same place.

Mr. L. W. Duffee, formerly chief engineer of the Meridian & Memphis, at Mobile, Ala., has been appointed special engineer of the Gulf, Mobile & Northern, formerly the New Orleans, Mobile & Chicago.

Mr. A. Roesch, formerly acting master mechanic of the Colorado & Southern, at Denver, Colo., has been appointed master mechanic of the Santa Fe, with office at Denver, Colo., succeeding Mr. J. M. Davis.

Mr. W F. Zane, formerly inspector of signals of the Chicago, Burlington & Quincy, has been appointed assistant signal engineer on the same road, with headquarters at Lincoln, Neb., succeeding Mr. M. J. Fox, resigned.

Mr. E. C. Sasser, formerly superintendent of motive power of the Southern, with headquarters at Washington, D. C., has been appointed superintendent of motive power of the Lines East, with headquarters at Charlotte, N. C.

Mr. B. F. Hines, formerly signal engineer of the New Orleans & Northeastern, has been appointed signal engineer of the Alabama & Vicksburg, and the Vicksburg, Shreveport & Pacific, with headquarters at Vicksburg, Miss.

M. K. BARNUM.

Mr. O. R. Hale, formerly general master mechanic of the United Railways of Havana, at Havana, Cuba, has been appointed assistant superintendent of motive power of the Cuban Central railways, with offices at Sagua La Grange, Cuba.

Mr. D. C. Thomas, formerly superintendent of small supplies in the purchasing department of the Santa Fe, has been appointed sales representative of the Bareo Brass & Joint Company, in the Western territory, with headquarters at Kansas City, Mo.

Gen. George W. Goethals has opened offices in the Wall Street Exchange Building, 43 Exchange place, New York City, where he will engage in civil engineering, mechanical and hydraulic engineering. He has already secured a staff of special experts.

Mr. Hugh B. Holmes, formerly resident engineer of the Kansas City, Mexico & Orient, at Kansas City, Mo., has been appointed chief engineer, with headquarters at Kansas City. He has been engaged over twelve years in the engineering department of the road.

Mr. Harry Selfridge, formerly connected with the mechanical department of the Nevada Northern, has been appointed assistant to the general manager of the Pacific & Idaho Northern, at New Meadows, Ida., with general supervision over the mechanical department.

Mr. I. H. Drake, formerly master mechanic of the Pecos division of the Santa Fe at Clovis, N. M., has been transferred to La Junta, Colo., succeeding Mr. W. D. Deveny, and Mr. H. H. Stevens has been appointed master mechanic at Clovis, N. M., succeeding Mr. I. H. Drake.

Mr. Lloyd B. Jones, formerly assistant engineer of motive power of the Pennsylvania at Williamsport, Pa., has been appointed master mechanic, with office at Verona, Pa. Mr. Jones has been in the employ of the company over twelve years, having entered the service as special apprentice in 1904.

Mr. J. A. White, formerly manager of the Boston and Chicago branch offices of the U. S. Light & Heat Corporation, has recently been appointed manager of sales, battery department, with offices at Niagara Falls, N. Y. Mr. W. W. Halsey has been appointed manager of the New York sales office of the company.

Mr. W. D. Deveny, formerly master mechanic of the Arkansas river and Colorado divisions of the Santa Fe, at La Junta, Colo., has been appointed mechanical superintendent of the Southern district, with office at Amarillo, Tex., succeeding Mr. A. Dinan, who has been appointed master mechanic of the Panhandle division, with office at Wellington, Kan.

Mr. E. B. Merriam, formerly assistant engineer of the switchboard department of the General Electric Company, has been appointed as the head of the industrial service department recently organized by the company to supervise education, employment and provision of opportunities for advancement of employees of the Schenectady works of the company.

Mr. Robert Patterson, formerly master mechanic of the locomotive shops of the Grand Trunk, at Stratford, Ont., has been placed in charge of the General Car & Machinery Company's plant at Montgomery, Que. Mr. Patterson's duties in his new position will continue until the end of the war. Meanwhile Mr. Charles Kelso will act as master mechanic at Stratford.

Mr. W. L. Kellogg, formerly superintendent of motive power of the Missouri, Kansas & Texas, has been appointed superintendent of motive power of the Pere Marquette, with office at Detroit, Mich. Mr. Kellogg began his railway career as a machinist's apprentice in the the Missouri Pacific, and has filled nearly every position in the mechanical departments of several of the leading western railroads.

Mr. C. E. Goings, formerly supervisor of signals of the Pennsylvania, has been appointed inspector of signals, and Mr. E. L. Watson, formerly supervisor of signals in the Philadelphia division of the same road, succeeds Mr. Goings. Mr. W. I. Bell, formerly supervisor of signals in the signal engineer's office, has been transferred to the West Jersey & Sea Shore, as supervisor of signals, with headquarters at Camden, N. J.

Mr. Douglas I. Mackay and Mr. Sanger B. Steel have been elected vice-presidents of J. G. White & Company. Mr. Mackay was at one time Police Commissioner of New York City, and for the last two years served in the capacity of assistant to the president of the White Corporation. Mr. Steel will be occupied in connection with the handling and distribution of securities. The company transacts an extensive business in railway equipments all over the world.

Mr. M. K. Barnum, formerly superintendent of motive power of the Eastern lines of the Baltimore & Ohio, has been appointed assistant to Mr. J. M. Davis, vice-president, in charge of operation and maintenance. Mr. Barnum's long railroad experience, and more especially his close association with the handling and use of materials for operating purposes ably fits him for the work to which he has been assigned. From apprentice on the Erie railroad in 1884, he has filled almost every intervening position on many of the leading railroads in the West. He entered the service of the Baltimore & Ohio in 1913, as general mechanical inspector, and in 1914 was promoted to superintendent of motive power.

Mr. Columbus K. Lassiter, whose appointment as vice-president of the American Locomotive Company was announced last month, has been engaged in the service of the company for twenty-five years, beginning as clerk in the piece work department of the Richmond Locomotive Works in 1892. In two years he was chief clerk to the President of the Richmond Works. Latterly he was transferred to the Schenectady Works as chief clerk to the general manager, where he developed marked ability as a mechanical expert and was appointed in 1907 mechanical superintendent of all mechanical betterments for all the company's plants, with offices in New York. His services have been much sought for by many engineering establishments.

Dr. W. F. M. Goss, for many years associated with the Schools of Engineering, Purdue University, and since 1907, Dean of the College of Engineering of the University of Illinois, has resigned that

PROF. W. F. M. GOSS.

office, effective March 1, 1917, to assume the presidency of the Railway Car Manufacturers' Association, an office to which he was elected on February 1, subject to his release by the university authorities. The Railway Car Manufacturers' Association is of recent origin. It is made up of representatives of fifteen different organizations engaged in the manufacture of railway cars, freight and passenger. It will seek to establish co-operative relations with the purchasers of cars, and to aid especially in the matter of standardizing the design and specifications of cars.

PAUL JUDSON MYLER.

Mr. C. A. Gill has been appointed superintendent of motive power of the Eastern lines of the Baltimore & Ohio, with headquarters at Baltimore, Md. Mr. Gill has been over twenty years in the mechanical department of the road. Mr. A. K. Galloway, formerly general master mechanic of the Northwest district, succeeds Mr. Gill, at Baltimore, as general master mechanic. Mr. W. M. Malthaner, formerly superintendent of shops at Newark, O., becomes general master mechanic of the Northwest district. Mr. F. E. Cooper is appointed superintendent of shops at Newark. Mr. F. W. Rhuark is appointed master mechanic at Cleveland, succeeding Mr. J. F. Gethins. Mr. W. F. Moran succeeds Mr. Rhuark as master mechanic at Garrett, Ind., and Mr. A. E. McMillan is appointed master mechanic at Newark, succeeding Mr. Moran.

At the recent annual meeting of the board of directors, Mr. Paul Judson Myler was elected president of the Canadian Westinghouse Company, Limited, of Hamilton, Ontario, Canada, Mr. H. H. Westinghouse, retiring president, being elected chairman of the board. In 1886, Mr. Myler entered the employ of the Westinghouse Air Brake Company as bill clerk in their Allegheny shops, and advanced rapidly through the several bookkeeping and auditing positions of the company. In 1896 he was appointed secretary of the Westinghouse Manufacturing Company, a corporation then being organized with a capital of $500,000 to do a general manufacturing business in Canada, at Hamilton, Ontario. In 1897 he was made secretary-treasurer. In 1903 the company was reorganized as the Canadian Westinghouse Company, Limited, capital $5,000,000, to take over the Westinghouse Electric & Manufacturing Company's electric business and the air brake business of the Westinghouse Manufacturing Company. Mr. Myler was made vice-president and general manager in full charge of the Westinghouse interests in Canada. Apart from the extensive business affiliations, Mr. Myler is prominent in the social and economic life of the Dominion, being a leading member of various clubs, athletic, social and technical. Mr. Myler is also connected with a number of financial and manufacturing companies in the capacity of director.

Mr. M. C. M. Hatch, formerly superintendent of Fuel Service of the Delaware, Lackawanna & Western, has resigned to accept a position as assistant to the president of the Locomotive Pulverized Fuel Company of New York. Mr. Hatch spent two years in the Massachusetts Institute of Technology and two years at the University of California, in the latter institution taking the course in mechanical engineering as a member of the class of 1903. He then spent about 18 months in the shops of the Southern Pacific at West

Oakland and Sacramento, Cal., followed by 6 months in the test department and 6 months in the signal department of the same road. In June, 1905, he returned east and entered the mechanical department drafting room of the Boston & Maine. He remained with that company until October, 1911, serving during the last 5 years of that period as chief draftsman. From October, 1911, to April, 1912, he was engineer of tests of the New England lines, that is, of the New Haven, Boston & Maine and the Maine Central. In April, 1912, as above noted, he became superintendent of fuel service of the Delaware, Lackawanna & Western, which position he held up to the present time.

GEORGE H. HILL.

Obituary.

George H. Hill.

George H. Hill, for the last eight years assistant engineer of the railway and traction department of the General Electric Company, died at his home in Schenectady, N. Y., on January 31. He was a high authority in the electrification of railroads. He was in his forty-fifth year and gave promise of much usefulness. He directed the equipment of many electric railroads. He was a writer of marked ability, and an inventor of many important devices. His early death is greatly mourned by all who had the honor of his acquaintance.

Walter J. McBride.

Mr. Walter J. McBride, formerly president of the Haskell & Barker Car Company, Michigan City, Ind., died at his home in Chicago last month in his fifty-seventh year. He was closely identified with several of the leading car construction companies, and was for several years president of the American Car & Foundry Company.

Archibald Buchanan, Jr.

Mr. Archibald Buchanan, Jr., chief of the equipment division in the valuation department of the New York Central at New York, died on February 5. Mr. Buchanan came of a distinguished family of railway men and learned railway engineering in the shops of the New York Central at West Albany, and filled many positions in the mechanical department with credit and ability.

Charles Cyrus Ramsey.

Mr. Charles Cyrus Ramsey, for the last seven years president of the Crucible Steel Company, of America, died last month at Pittsburgh, Pa. He began his career as a railroad man in the employ of the Pennsylvania, and at an early age gave his attention to the manufacture of crucible steels, and rapidly rose to important positions in that industry. He was in his fifty-sixth year.

Charles T. Schoen.

Mr. Charles T. Schoen, an eminent engineer and inventor of the pressed steel car, died at Moylan, near Philadelphia, Pa., on February 4., aged 72 years. Mr. Schoen perfected many inventions, among others a solid forged and rolled steel car wheel, and was president of the Schoen Steel Wheel Company. He was also vice-president of the Colonial Trust Company of Philadelphia.

Railway Storekeepers' Association.

Mr. J. P. Murphy, Box C, Collinwood, Ohio, announces that the fourteenth annual convention of the Railway Storekeepers' Association will be held at Chicago, Ill., on May 21, 22 and 23, 1917. The principal subjects for discussion will be "Handling of Rails," "Handling of Cross Ties," "Reclamation of Scrap" and "Handling of Stationary." The Committee are actively engaged in preparing for a large and interesting convention, and special attention will be given by the local committee for the entertainment of the members and visitors.

Another Big Bridge.

The Paducah & Illinois is bridging the Ohio river at Paducah with a structure more than a mile long and 720 feet high, said to be the longest span of any railroad bridge in the world. It represents an expenditure of $6,000,000 and will be operated jointly by the Nashville, Chattanooga & St. Louis.

National Railway Appliance Company.

Announcement is made that the railroad department business of the U. S. Metal & Manufacturing Company has been taken over by the National Railway Appliance Company, a new concern incorporated for the purpose of selling railway supplies. The new company has opened temporary offices at 165 Broadway, New York City, and the officials elected to carry on the affairs of the concern are as follows: President, B. A. Hegeman, Jr.; first vice-president, Charles C. Castle; vice-president and treasurer, Harold A. Hegeman; assistant to president, F. C. Dunham; secretary and engineer, Edward D. Hillman. The company has established a branch office in the McCormick building, Chicago, under the immediate management of Walter H. Evans, and a branch office in the Munsey building, Washington, D. C., under the management of J. Turner Martyn. Both managers were formerly connected with the railroad department of the U. S. Metal & Manufacturing Company.

Du Pont Fabrikoid Company

The Du Pont Fabrikoid Company, with main offices at Wilmington, Delaware, has purchased the Marokene Company of Elizabeth, N. J. The Marokene Company manufactures a material similar to fabrikoid, which is used extensively by the automobile, carriage and upholstery industries. Mr. R. B. Heyward who has been assistant superintendent of the Fabrikoid Company's Newburgh plant will become superintendent of the Marokene plant at Elizabeth, N. J. No changes will be made to the present staff of employees. The purchaser will make thorough investigations in order to learn if any improvements can be made to the product, and if possible will better same, thus upholding the Du Pont standard. All the sales transactions of the Marokene Company will be under the direction of the Wilmington office, and the attention of Mr. J. K. Rodgers, sales manager of the Du Pont Fabrikoid Company..

Improved Methods of Production

No doubt nearly everybody is more or less familiar with the fact that improved methods and large-scale production, from the close of the Civil War down to the beginning of the present war, brought a great decline in the price of various manufactured articles. The same causes brought a decline quite as great in the cost of transportation.

Thus it is calculated that for government in all its divisions the people of the United States paid in 1910 six times as much as in 1870, for manufacturing five times as much, for mining seven times as much and for transportation less than four times as much—the latter absorbing a steadily declining proportion of the national income. Comparing our costs with those of other peoples, probably transportation is the cheapest thing in the United States today.

Railroad Equipment Notes.

The Interborough Rapid Transit Company is in the market for 310 subway cars.

The Rutland Railroad has completed plans for a new round house at Burlington, Vt.

The Northern Pacific has ordered 5,000 tons of 90-lb. rails from the Illinois Steel Company.

The Interstate Railroad has ordered 500 freight cars from the Pressed Steel Car Company.

The Delaware, Lackawanna & Western has ordered 10 coaches from the Pullman Company.

The Northern Railway of France has ordered 50 Mikado locomotives from the Baldwin Locomotive Works.

The Chicago, Burlington & Quincy has ordered 15 70-ft. coaches from the American Car & Foundry Company.

The Fort Smith & Western has ordered 2 Mikado (2-8-2) type locomotives from the Baldwin Locomotive Works.

The Sun Ning Railway (China) has ordered 2 Mogul type locomotives from the Baldwin Locomotive Works.

The French Government is negotiationg for 150,000 tons of heavy section rails, and 20,000 tons of medium section rails.

The Richmond, Fredericksburg & Potomac has ordered 200 steel-underframe box cars from the Pressed Steel Car Company.

The New York, Chicago & St. Louis has ordered 5,000 tons of rails from the Lackawanna Steel Company for delivery next year.

The Texas & Pacific has ordered 12 Santa Fe (2-10-2) type and 7 Pacific (4-6-2) type locomotives from the Baldwin Locomotive Works.

The Canadian Pacific has ordered 25 locomotives to be built in its Angus shops, which, it is said, will be the heaviest engines ever constructed in Canada.

The Louisville & Nashville has ordered 8 coaches, 6 baggage and mail cars, 4 chair cars and 3 dining cars from the American Car & Foundry Company.

The Southern Pacific Company has ordered 200 12,500-gallon oil tank cars and 126 50-ton steel drop bottom gondola cars from the Ralston Steel Car Company.

The Louisville & Nashville has ordered 1,000 underframes from the Bettendorf Company for 700 box, 200 stock and 100 refrigerator cars, which it will build in its own shops.

The Atchison, Topeka & Santa Fe will spend this year $500,000 on automatic signals in California, according to a notification made by the company to the state commission.

The signal installation by the Chicago & Eastern Illinois during the calendar year 1916 comprised 10 miles of automatic block on a single track between Fort Branch and Ingle, Ind.

The Illinois Central has ordered 20 Pacific (4-6-2) type and 20 six-wheel (0-6-0) type locomotives from the American Locomotive Company and 35 Mikado (2-8-2) type locomotives from the Baldwin Locomotive Works.

The Northern Railway of Spain has ordered 40 superheater Mikado locomotives from the American Locomotive Company. These locomotives will have 23 and 25¼-in. cylinders, and a total weight in working order of 196,000 lb.

The Yazoo & Mississippi Valley has given a contract to the Railroad Water & Coal Handling Company of Chicago for a 300-ton coaling station, to serve four tracks. This station is of the Holman type, of timber construction with a concrete foundation.

The Chicago & North Western has ordered 20 Mikado (2-8-2) type locomotives from the American Locomotive Company. The cylinders will be 27 by 32 inches; driving wheels 61 inches in diameter, and the total weight of each in working order, 302,000 pounds.

Advices from Petrograd state that the Russian minister of finance has accepted the tender made by American financiers to construct a railway system from the Moscow coal region to Donetsky, to advance 500,000,000 rubles for the work and to finish it in three and a half years.

The Elgin, Joliet & Eastern has ordered 8 Mikado (2-8-2) type and 8 eight-wheel (0-8-0) type locomotives from the American Locomotive Company. The former will weigh 312,000 pounds and have cylinders 28 by 30 inches and the latter will weigh 216,000 pounds and have cylinders 24 by 28 inches.

The Seaboard Air Line has ordered 16 Mallet type locomotives from the American Locomotive Company, and 10 Santa Fe (2-10-2) type locomotives from the Baldwin Locomotive Works. The former will have cylinders 26½ and 42 by 32 inches, 63-inch driving wheels and will weigh 497,000 pounds in working order.

The Missouri, Kansas & Texas has placed an order with the Union Switch & Signal Company to furnish the materials for the installation of automatic and interlocking signals at Parsons, Kan. This installation will include 70 three-position ground signals and 7 one-arm, three-position bridge signals.

The El Paso & Southwestern has recently placed a contract with the Union Switch & Signal Company to furnish the necessary material required for the new extension of their automatic block territory. This order will include 122 three-position upper quadrant signals and 3 two-arm, three-position signals.

The Baltimore & Ohio has placed orders with the Union Switch & Signal Company for 160 low-voltage, direct-current, style "T," one-arm, three-position signals, giving indication in the right-hand upper quadrant, together with approximately 400 direct-current relays of the Union model 13 neutral and model 12 polarized types.

The New York Central was recently reported as having ordered 60 locomotives from the American Locomotive Company and 90 from the Lima Locomotive Works. The 60 engines ordered from the American Locomotive Company include 45 Pacific and 5 Mikado locomotives for the New York Central itself, and 10 Pacific type locomotives for the Michigan Central.

The Pennsylvania Lines are building a 24-lever mechanical plant at West Effingham, Ill., controlling a yard junction, a 48-lever electro-mechanical plant near East St. Louis, Ill., at the grade crossing of the Alton & Southern, and a 32-lever mechanical plant at Smithboro, Ill., protecting a grade crossing with the Chicago, Burlington & Quincy. Two mechanical plants are to be installed, one of 12 levers at Gibson, Ind., and one of 8 levers at Reelsville, Ind., both protecting siding entrances.

One Aspect of Discipline

To many the word discipline calls up the idea of rules and penalties for their infraction, but this is not discipline in the broad or in the fullest sense. There have been men who have sat at a mahogany desk and written out a series of rules for the guidance of employes in shop or on the road and have empowered their subordinates to inflict penalties on those who came short or who failed to rigorously conform to those rules. Rules to be of value cannot be written down offhand, unless the writer of them has had experience in the matters he handles, and has gone through the actual work of which he writes.

Discipline, properly understood, is an atmosphere, and rules are evolved. The cultivation of this atmosphere is not the work of a day but is a systematic growth, and in the evolution of rules the employee may have something valuable to say.

Shop operation requires the existence of rules and regulations, and these should commend themselves to master and man alike. It is said that the street traffic in London depends on the respect which the public has for the policeman at the crossing, as the representative of law and authority; but there is something more than this. The public are interested in seeing the law carried out and would hamper and delay a law-breaker as far as possible, and if need be hand him over to the authorities, simply because his irregular behavior disarranged the system that all desire to have upheld and because he would inconvenience those who obeyed. Such rules have public support, and the policeman regulates the traffic which he does not need to control.

Applying the same principle to the shop, the inherent common sense of any rule will almost automatically produce obedience, but in order to bring about this state of affairs it is wise to let the men know the reason for each rule. The adage, "Like master, like man" has its most perfect fulfillment in any industrial organization, and the revealing of the purpose of a regulation gives the head of any institution a quiet but most subtly powerful influence for good, if he desires to use it.

When it comes to the imposing of some penalty, the greatest care must be taken to insure that the mere rule is not exalted so as to disgrace or humiliate the man concerned. Here personality counts. Tact is almost a determining factor, and justice and fair-play are indispensable requisites. Many a good man, making a slip, is saved for all time and to his company by a judicious word, possibly spoken in private, by the foreman or other person in authority. If a man ever actually requires to be loudly "called down" in public, it is almost proof positive that his undesirable presence in the shop should have been discovered previously. The voluble, excited, angry "call-down" reflects seriously upon the managing power of the man who does it, even if he is technically right as far as the rule goes. Managing men in a business has its commercial value, and a rule-and-penalty code can never be made to take the place of sympathetic common sense. A man with these desirable qualities can get good faithful work out of his men all the time, and he can get a strong business push from them in cases of emergency. Discipline is an atmosphere, not an army regulation.

Books, Bulletins, Catalogues, Etc.

Winter Track Work, by E. R. Lewis. Published by Railway Educational Press, 14 East Jackson Boulevard, Chicago, Ill. 157 pages, cloth, illustrated. Price $1.60.

Mr. Lewis, in his capacity as assistant to the general manager of the Duluth, South Shore & Atlantic Railway, has had exceptional advantages in observing the details of track work, especially during the severe winter weather experienced in the Northwest. The work before us shows how thoroughly Mr. Lewis has mastered the subject, and how minutely he has noted down his observations, the result being a notable addition to track work literature. The book has also the rare quality of growing in interest as it progresses, and the book is not only of great value to the trackman, but may also be perused with profit by the operating man, the traffic man and every one who is concerned with keeping railroad tracks in good condition at all seasons. The book is divided into ten chapters embracing the effects of climatic changes on all kinds of track structures, the tools and supplies necessary, snow handling equipment, floods and wash-outs, with a special chapter on ice, and a fine treatise on organization. The effect of such a work cannot fail to be of real value in raising the standard of track work generally and the readiness to meet emergencies particularly. The illustrations are excellent and the paper and presswork of the best.

Proceedings of the Master Mechanics' Association.

The annual report of the proceedings of the forty-ninth annual convention of the American Railway Master Mechanics' Association, held at Atlantic City, N. J., June 19-21, 1916, has been issued from the press of the Henry O. Shepard Company, Chicago, Ill., and extends to 846 pages of letterpress and 32 large folders. There are also numerous illustrations, the whole forming a very complete report of the proceedings. The volume also contains a reprint of the Constitution and By-laws, a list of members and an excellent opening address by the President. Of the number of reports of Committees on special subjects there are no less than 26, chiefly bearing upon the locomotive and allied subjects. The work as a whole bears the impress of a degree of thoroughness not surpassed by that of any other publication devoted to the work of any associated body. The reports and discussions all bear the stamp of careful consideration and a ready mastery that can only be acquired by men of close experience, and the discussions incident to the presentation of the reports are particularly marked by a degree of clearness that improves year by year and is the best proof that the master mechanic of today is not only accomplished in his high calling, which is to be expected, but is also scholarly in his attainments. The marshalling of facts and the purity of language are accomplishments that do not come in a day, but are the genuine marks of a thoughtful student graduated in the art of expression. The book is in every way another valuable addition to the railroad literature of our time. Enquiries for copies should be addressed to the Secretary, Jos. W. Taylor, 1112 Karpen Building, Chicago, Ill.

"National" Pipe Standards.

An appendix to the 1913 edition book of standards published by the National Tube Company has just been issued from the company's office, Pittsburgh, Pa. The purpose of the work, which extends to 200 pages, is to supply the latest information on the subjects contained in the 1913 edition. For the most part the information contained is supplmentary, but in several cases it replaces other data entirely. Where a conflict occurs the appendix is to be considered as the latest information. Practically all of the specifications appearing in the 1913 edition of the book of standards have been modified more or less and are now void. These constantly change with the progress of the art. Specifications covering products of the company are also printed in loose leaf form and may be had on request at the general office or any of the district offices. The index in the appendix contains both the appendix and original book of standards and should be used in place of the 1913 edition referred to. Copies may be had on application.

Graphite.

Vol. 19, No. 2, of Graphite, published by the Joseph Dixon Crucible Company, Jersey City, N. J., contains an unusually interesting article on removing scale from boilers. The danger of overheating and thus weakening the boiler by allowing scale to accumulate is well known. It may not be so well known, however, that this may be almost entirely prevented by the use of Dixon's Pioneer Boiler Graphite. Careful statistics show that it costs about 37 cents to clean each flue that is allowed to become incrusted with scale, whereas by the use of graphite as directed and which, by the way, costs little, the highest cost known in cleaning the flues is about 9 cents each. This does not take into account the saving in fuel. The effect of the graphite is such that any scale formation that does occur where graphite is used can readily be removed by a wire brush, thereby precluding the necessity of the everlasting hammering incidental to the older methods of flue cleaning. Time and expense is saved by the use of Dixon's boiler graphite Send for a copy of the issue to the company's office, and read the testimonials.

Federal Boiler Inspection.

The annual report issued from the office of Mr. Frank McManamy, chief inspector of locomotive boilers, presents a summary of the tabulated data for the fiscal year ending June 30, 1916, and includes inspection of all parts of locomotives or tenders and accidents resulting from failure. From the report it appears that the number of locomotives inspected were 52,630; number found defective, 24,685; number ordered out of service for repairs, 1,943; number of accidents, 537; number killed, 38; number injured, 599. Of the number killed, 33 were members of train crews; 4 were roundhouse and shop employees, and 1 non-employee. It is shown that there is a considerable decrease in the number of accidents, although unprecedented traffic conditions existed and every available locomotive was pressed into service. A larger majority of the carriers are reported as diligent in their efforts to comply with the requirements of the law.

Interborough Rapid Transit.

Not to be outdone by other railroads, the Interborough Rapid Transit Company has gone into the bulletin publication business. No. 2, just issued, shows that the company has something to boast about. Nearly three billions of people have been transported from place to place in the crowded city in the last ten years and only one passenger was killed in that period. Of course, the conditions for safety, especially in the subway lines, are ideal, but the alertness and intelligence of the employes generally, and the rare skill and ingenuity of the leading men, particularly in the mechanical departments, are of the highest and best, of which Mr. Frank Hedley, the general manager, is a shining example. The only drawback is that there are not more branches of the road in operation. This may be amended in the near future.

History of Railroads.

The Interstate Commerce Commission, in its wisdom, issued an order several years ago to all railroads to compile a written history, giving the chain of titles. The time limit has been several times extended and will likely have to be extended further. As an illustration, the Burlington system consists of some 225 small roads, and there are about 100 in the Rock Island system. This is a task involving labor, research and ingenuity. Doubtless such a work will be of value, and if it is to be done at all it will be better to do it now, as in the far future it would be as difficult to accomplish as to account for the ten lost tribes of Israel.

New Haven Railroad Company's Anti-Trespassing Campaign.

The New York, New Haven and Hartford Railway Company has just issued the third of a series of nine bulletins warning people of the danger of trespassing on the railroad tracks. 20,000 copies of each bulletin, 180,000 in all, are being distributed in factories, schools, stations, freight houses, cabooses, crossing cabins, section houses, work trains, shops, car inspection cabins, interlocking towers, telegraph poles, and all conspicuous places along the lines of the railroad. If people continue to be killed on the New Haven, it can hardly be called the fault of the railroad, if the people are trespassing.

Safeguarding Employees.

No less than fifty safety experts are working under the auspices of the National Safety Council on the problems involved in the maximum and minimum requirements in safeguarding employees in industrial plants. Special leaflets are being issued monthly bearing on some separate feature of the work. Those already published refer to "Ladders," "Stairs and Stairways" and "Boiler Rooms." The leaflets contain admirable suggestions looking towards safety. Copies of the leaflets may be had from the Secretary, W. H. Cameron, Continental and Commercial Bank Building, Chicago.

The Railway Signal and Permanent Way Engineer's Pocket Book.

This useful and handy volume is divided into three main sections, the first of which deals with signalling and the second with permanent way matters, while the third part contains pages of squared paper and tables of British measures with their metric equivalents; these latter are sure to be in demand, if we are to make any serious endeavor to capture foreign trade in the near future. In the first section practically all details of construction and their application in actual daily working are enumerated and explained in clear phraseology. The second part gives useful data and stresses for track and engineering works, durability of materials, and so forth. Prominent place is given to the more important Board of Trade regulations and restrictions that affect railway engineers. Published by the Locomotive Publishing Company, London, England. Price 75 cents. The book will be mailed to any address on receipt of price.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXX. 114 Liberty Street. New York. April, 1917 No. 4

Connaught Tunnel on the Canadian Pacific, Through the Selkirk Range of the Rocky Mountains

The Connaught tunnel on the Canadian Pacific railway is at the summit of the Selkirk range in British Columbia. It cuts through Mount Sir Donald at Rogers' Pass, and this part of the C. P. R. has been known by that name since the road was opened. It was thought appropriate to name the undertaking, just completed, after Canada's former Governor General, H. R. H., the Duke of Connaught, known as Prince Arthur in his younger days, brother of the late King Edward VII., and uncle of King George V.

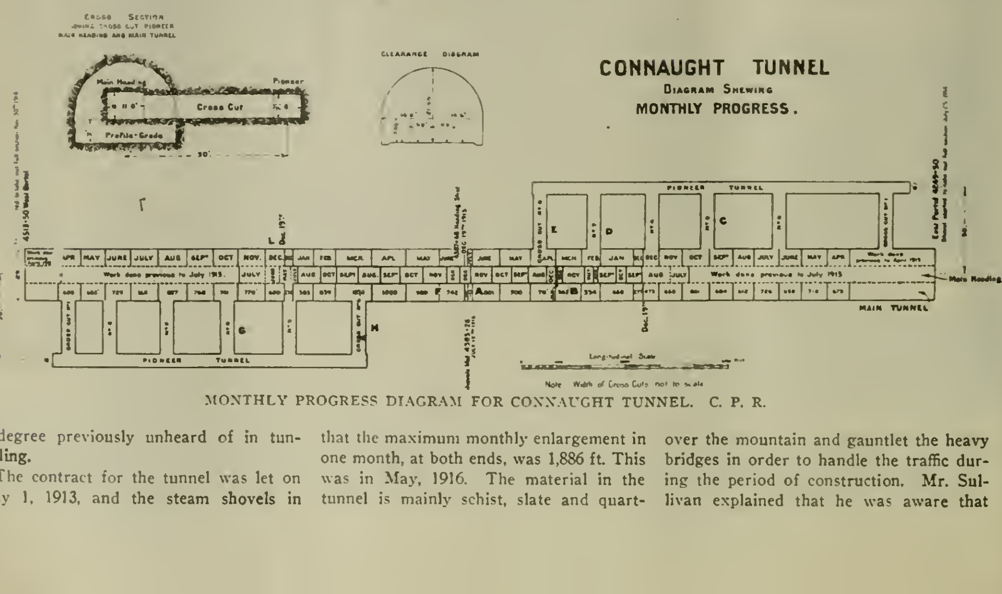
The former route of the railway across the Selkirk range was over Roger's Pass at an altitude 4,343 feet., which was approached by 2.2 per cent. grades. On account of the excessively heavy snowfall which is frequently over 40 ft. in a single winter in this range, difficulties were numerous and operation was costly and the building of long stretches of snow sheds had to be resorted to, and the sheds maintained over a large portion of the route.

The new double track tunnel line eliminates 4½ miles of snow shedding, reduces the summit elevation by 552 ft., eliminates about 2,400 degs. of curvature and shortens the line 4.3 miles. The tunnel is 5 miles long and is entirely on tangent, with a grade of 0.95 per cent. Some of the finest scenery in the Rocky Mountains is to be had in the Selkirk range, as the road passes along the side of the mountains at a considerable height above the tiny silver threads which are in reality rapidly moving streams and rivers. As a general thing one may say that the coast, or Pacific ocean side of these various mountain ranges comprising the Coast or Cascade range, the Gold range, the Selkirks, and the Rockies proper, is more precipitate than that on the eastern side, probably owing to the warm moist air derived from the Japan current as it floats inland being caught and precipitated in greater abundance on the west side than that which floats high in air above the lofty peaks and crags and flows eastward toward the prairies of the Northland.

PORTAL OF THE CONNAUGHT TUNNEL DURING CONSTRUCTION. CANADIAN PACIFIC RAILWAY.

The method of construction adopted at the Connaught tunnel was to drive a pioneer tunnel parallel with, and 50 ft. distant from the centre line of the main tunnel and to drive cross cuts from this

COMPLETED PORTAL OF THE CONNAUGHT TUNNEL. C. P. R.



MONTHLY PROGRESS DIAGRAM FOR CONNAUGHT TUNNEL. C. P. R.

pioneer to the main tunnel. In this manner a number of faces could be worked simultaneously and progress facilitated to a degree previously unheard of in tunnelling.

The contract for the tunnel was let on July 1, 1913, and the steam shovels in the large main tunnel met on July 7, 1916.

The monthly progress is illustrated in the diagram, from which it will be seen that the maximum monthly enlargement in one month, at both ends, was 1,886 ft. This was in May, 1916. The material in the tunnel is mainly schist, slate and quartzite, and approximately one and a half miles is lined with concrete.

The tunnel is ventilated by means of two multi-blade fans 12 ft. 5 ins. in diameter and 8 ft. 3 ins. wide. These fans are driven by two 4-cylinder, 4-cycle, 500 h. p. Diesel engines. The entire ventilating plant is housed at the west portal.

J. G. Sullivan is chief engineer for lines West, on the Canadian Pacific railway, and it was under his general supervision that the tunnel was driven. Frank Lee is principal assistant engineer of lines West on the C. P. R. The headquarters of the engineer's staff is at Winnipeg, Man. It is to the courtesy of the chief engineer that we are able to give this brief outline of this important and costly piece of railway engineering, which will in time pay back its cost to the railway by the lessened cost of passenger and freight haulage through this region in the Rocky mountains.

In giving a brief synopsis of the work, Mr. Sullivan when reading a paper before the Canadian Society of Civil Engineers' said, among other things:

The Rogers Pass tunnel is in the Selkirk mountains of British Columbia. It is double tracked, five miles long, lowers the summit of the former line, shortens the line, eliminates many degrees of curvature and avoids the expense and danger of maintaining and operating four and a half miles of snow sheds.

During the period from 1910 to 1913, the traffic of the Canadian Pacific Railway Company was increased so rapidly that it was evident that if the rate of increase continued, the road would have to be double tracked. A prominent consulting engineer, who reported favorably on the proposal to construct the tunnel, made a further suggestion that it might be necessary to double track the present line over the mountain and gauntlet the heavy bridges in order to handle the traffic during the period of construction. Mr. Sullivan explained that he was aware that tunnels in Europe had been driven at a rate two or three times as fast as any long tunnel had been driven on this continent, and he had, in a superficial way, an idea of the methods employed. In a circular letter sent to contractors dated April 8, 1913, the following statement appeared:

"The necessity for this tunnel is so great and the expenditure so large that it would be worth considering money to this company to have the tunnel completed as soon as possible. Therefore, everything else being equal, the party who will guarantee completion in the shortest time will be the party who will receive the work."

Prices on the European method of tunnelling were asked for. Tunnels in Europe have been driven at two or three times the speed that any tunnel was ever driven in the United States or Canada. Those who bid on the work were asked to state the amount per day that they would be willing to have inserted in a contract to be paid as a bonus for time saved over the agreed time, the same amount to be exacted as a penalty for the time lost, being the time between the fixed day of completion and the actual date of completion. This sum Mr. Sullivan thought should be about $750 per day.

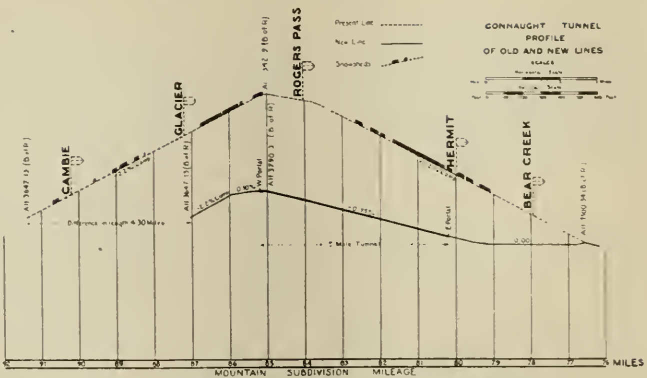
A railway engineer suggested driving a pioneer tunnel and taking out an upper heading through shafts into this tunnel, taking out the rest of the bench with steam shovels. It was pointed out to him that this was impracticable, for the reason that from an upper heading one cannot drill to the bottom of the tunnel, and therefore would have to clean up all the muck in the bench before a round of breast holes could be put in to break more rock. Plans showing a combination of Messrs. J. Sullivan and A. C. Dennis' ideas were prepared. The plan is to drive a small working pioneer tunnel, 8 ft. x 8 ft. underneath the main tunnel.

The contract for this work was let on July 1, 1913. The limit of time for completion was three and a half years, which would end on Jan. 1, 1917. There was an allowance in extension of time of one day for every ten feet of soft ground encountered, which would require immediate timbering. As there was some 1,660 ft. of such ground, the time limit of the contract was extended into June, 1917.

The work completed up to Dec. 19, 1915, was as follows: 19,610 ft. of pioneer tunnel, 24,612 ft. of centre heading, 1,660 ft. of earth tunnel and 14,342 ft. of tunnel enlargement in rock. At the same date there remained to be driven 288 ft. of centre heading, 10,398 ft. of tunnel enlargement.

A pioneer tunnel was driven entirely outside the regular section of the tunnel, and a centre heading was driven along the centre of the main tunnel. The functions of the pioneer tunnel were to provide a means of transporting the material from the heading to a point back of where the enlargement of the tunnel was being made, and to provide for the carrying of high pressure air pipes, water pipes, ventilating suction pipes, etc.

All expectations as to speed in the execution of the work have been more than realized. For rock tunnelling where the rock is of sufficient hardness to stand until the mucking has been completed, the method used here can be most successfully worked, an' a speed of three miles a year



PROFILE OF CONNAUGHT TUNNEL AND OLD LINE. C. P. R.

INTERIOR OF THE CONNAUGHT TUNNEL. C. P. R.

MAP SHOWING LOCATION OF THE CONNAUGHT TUNNEL IN THE SELKIRK MOUNTAINS. C. P. R. IN BRITISH COLUMBIA.

can be easily made at a much less cost than tunnels driven at the same speed by the European method. Furthermore, the practice of radial shooting has given a great deal less overbreak than would have resulted had the holes been drilled parallel to the axis of the tunnel.

The work was laid out and commenced under F. F. Busteed, engineer in charge of double tracking, with J. W. Sheppard as assistant engineer. It has recently been under the supervision of W. A. James, engineer of construction western lines, with H. G. Barber as assistant engineer, T. Martin, resident engineer at the west end and J. R. C. Macredie, resident engineer at the east end. The contractors are Messrs. Foley Brothers, Welch and Stewart. The construction work has been supervised for the contractors by Mr. A. C. Dennis.

Lubrication of Superheated Engines

Difference Between Saturated and Superheated Steam—The Action of High Temperatures—The Effect of Cold Air—The Effect of Smoke Box Gases—Catalysis Explained—What is Carbonization of Oil?

Some time ago Dr. P. H. Conradson, chief chemist of the Galena Signal Oil Company, of Franklin, Pa., gave to one or more of the Railway Clubs, what was, in each case, more than simply a lecture, for the reason that it contained a demonstration of what he sought to prove. The subject chosen by Dr. Conradson was "Locomotive Valve and Cylinder Lubrication in Connection with Saturated and Superheated Steam." Dealing with oil in superheated cylinders is simply the problem of getting the oil to do the work of lubrication under high temperatures. With saturated steam locomotives the temperatures encountered are not excessive, and the "wetness" of saturated steam has, in a sense, a lubricating quality, which is entirely absent in superheated steam, which is artificially dried and has to carry its lubrication along with it as a soldier would carry his day's ration into an unproductive enemy country.

An apparatus used by the lecturer consisted of several coils of glass pipe, into which oil and steam at high temperature could be introduced, in full view of the spectators. Steam at 400 degs. Fahr. was introduced into these glass coils and oil was also introduced by suitable means and in suitable quantity. A grey mist was seen to darken the coils of glass pipe. At about 700 degs. Fahr. the mist disappeared, though oil and superheated steam in the form of vapor was still entering the glass tubes. The demonstration was given when steam was shut off, the grey mist of oil again appeared and this condensed, so as to form a finely divided coating, made up of minute drops of oil which spread themselves over the interior surface of the glass tubes.

When the temperature is extremely high oil may go over in the form of vapor with the steam. The vapor aiding very materially in atomizing the oil, and lubricating the steam, which the speaker believes to be essential. Dr. Conradson found in the course of his investigations that it was of great importance, in gaining the best results to consider the form in which the oil introduction takes place. He discovered that oil when atomized did the best work, for it was then in a highly attenuated, emulsified, and so finely divided a condition, as to mingle easily, and if one may so say, impregnate the superheated steam.

The demonstration contained this further interesting and instructive fact, visible to all, by reason of the glass coils used. At the beginning of the stroke steam pressure and temperature are at their highest. As the piston moves forward in the cylinder, both these decrease. Then it is that the atomized oil, begins to separate from the steam and condense in a finely-divided coating of minute drops, on the cylinder walls. Up to this point the steam has been hot and clean and the oil has been practically pure, and carbonization has not taken place. The introduction of cold air, or the hot ash-laden, smoke-box gases, produce effects which were very clearly revealed in the demonstration of which we speak.

The apparatus when showing a temperature of about 800 degs. Fahr. without the oil carbonizing or burning, had the steam supply abruptly shut off and an air valve, communicating with the atmosphere, quickly opened, as would happen with a drifting locomotive. The admission of cold pure air where hot steam had previously been, produced a blue smoke in the apparatus. The smoke had a burnt odor, due to the fact the oil had carbonized or to speak plainly, had been burnt, because oil is so largely composed of carbon, and the conditions of high temperature and a liberal supply of oxygen, in the air, were present. The oil burned, and left a black residium which, having performed its part as cylinder oil, is now useless for lubrication.

The introduction of smoke box gases when drifting had been experimented within the oil company's laboratories and showed the resulting accumulation, to be burnt and useless, for even in the hot smoke box gases, sufficient oxygen was present to carbonize the oil. In addition to the carbonized oil, the residue in the cylinders was found to contain a large amount of cinders and ashes from the front end, and under the influence of the high temperatures of smoke box and cylinders, a cementing action had taken place where carbonized oil, ashes, soot and fine cinders were found to be more or less closely consolidated and that an excess of oil under these circumstances increases the cementation process, with anything but desirable results.

It is evident from a perusal of the various writings and sayings of Dr. Conradson that he believes in atomizing the oil for superheater locomotives and he also believes the practice to be very beneficial for saturated steam engines. The anatomized oil, lubricates the superheated steam so that wherever it touches, a finely-divided small bead-like deposition of oil is layed down. In the cylinder, as the piston progresses, and the pressure and temperature diminish, this fine mist-like oil condition automatically forms, and coats the wearing surfaces with a film sufficient to keep all running smoothly. The oil which is swept up by the piston as it moves in the cylinder, passes out, in large measure, by way of the exhaust. This loss is inevitable, but the oil passed out is laden with the products of wear, dirt or grit, and also with ashes, if the smoke box gases have been drawn in. In thus passing out of the cylinder and being practically lost, this oil performs a function similar to the feed from an oil cup on a butt-end strap, it keeps the bearing clean, as well as it provides a separating and moving film between the bearing surfaces.

Some curious facts have been brought out, as the work of investigation has proceeded. In the early days of the superheater in this country—Canada being the pioneer on the continent—some trouble was experienced with cracked and broken cylinders and other parts which came in contact with the superheated steam. The trouble was thought to be due to the valve and cylinder oils used. One road began its superheater experience with engines equipped with ordinary grey iron in steam chest and cylinder packing rings, which had given every satisfaction with its saturated steam locomotives. These rings wore out rapidly when subjected to superheated steam. The road subsequently adopted a dense, fine-grained, high-grade, air-furnace, iron. The new rings turned out to be such an improvement that the railway now uses them with their saturated steam engines. Railways have found out and will continue, from time to time, to find out, the composition of the metal best suited to their needs, and will succeed in securing oil capable of lubricating in whatever superheating conditions may be imposed. When one attempts to consider the whole subject of lubrication both for saturated and superheater locomotives, one has to go beyond a simple study of the oil itself.

The investigation of the behavior of oil under certain circumstances necessitated reproducing the conditions by mixing oil with various solid substances, which might find their way into the oil, or be put there by design. The unmixed oils were not acted on by superheated steam but those mixed with solid particles were found to have become oxidized, and the receptacles containing them were skinned over with a sort of stiff, rubbery cement. This condition was not due so much to chemical action as it was to what is called catalytic action. This word is Greek in origin and means the causing or accelerating a chemical change by contact or admixture with a substance which is itself not consumed nor permanently affected by the chemical change. A housewife might roughly illustrate the meaning of this word by telling you that in cooking green garden peas, a pinch of soda in the boiling water will prevent the peas from loosing their fresh green color, and so appear more appetizing. This is not catalysis, but an analogy therefrom, as the soda does not become part of the peas, it assists in producing an effect; just as soda makes vegetables soften quicker when boiling, than they otherwise would do. The soda helps to produce a result which has no effect upon itself.

The fact that the presence of air when admitted to the cylinders under certain conditions, was made apparent by the apparatus used. After superheated steam had been passed for a suitable length of time into the tubes, steam was shut off, and air admitted for a little while, as if the engine was drifting, and at temperatures of 400 to 500 degs. Fahr. no carbonizing took place. From about 550 to 600 and 700 degs. Fahr. when steam is shut off and air enters, the oil becomes sticky and gummy and finally carbonizes. The fact that the presence of foreign substances causes the oils to break up by catalytic action, and the experiment just referred to, would tend to emphasize the fact that pure oil, of suitable quality and the absence of air and front-end gases or foreign bodies at high cylinder temperatures, are extremely important factors in the problem.

When superheater locomotives began to be employed here, some railroads did not use any superheater valve oil. They have continued to use saturated engine valve oil with every satisfaction. Other roads believed that they must have special oil. That idea was probably imported from abroad, and many of these roads which originally believed this have come back to the oil of good quality that they formerly used.

The reason that oil with a flash point of 525 degs. Fahr. can exist in a steam atmosphere of 700 degs. Fahr. is the absence of the air necessary for combustion. If a moving locomotive is shut off tight a vacuum is at once created in the cylinders, which allows air to enter through the cylinder cocks, and smoke, gas and cinders to be drawn from the front end. Under these conditions, the oil in the cylinders will burn, and carbonization, which is an enemy to good lubrication, inevitably results. The remedy for this condition becomes apparent, namely, to admit sufficient steam into the steam chests and cylinders while drifting, to prevent the creation of a vacuum, with the result that good lubrication is maintained at all times.

Like many other things at and about railroads, the shroud of mystery which seems at first to enwrap the behavior of many familiar things, has clung for some time to the matter of locomotive lubrication, but the obscuring folds of doubt are giving way, as they are bound to give way, before the penetrating light of scientific investigations, which is really our only pathway to knowledge in the profession involving "steam and rail," which all love. We hope in a future issue to pursue the subject of lubrication somewhat farther. We invite our readers to contribute from their store of knowledge, and if there be any who have some words of authority to speak on the subject we will be glad to have them.

Rapid Replacing of the Omaha Bridge.

The four old spans of the Omaha double-track bridge across the Missouri river, having a total length of 1,000 ft. and weighing 1,950 tons, were replaced by four correspondingly stronger 250-ft. new spans, which were erected on false work parallel and adjacent to the old spans in service. The old spans were jacked up 2 ft. to correspond with the raised grade of the new bridge. The old spans were hauled out by a nine-part tackle to the ends of the pier extensions in 50 minutes. The tackles were then shifted to the new spans and moved to their positions in 3½ hours. The new spans weighed 3,580 tons. The spans were seated on their permanent bearings, the track restored and traffic resumed in 10½ hours after it had been diverted from the old spans. The members of the old spans are being removed by derricks operated on the new bridge.

Relieving Car Shortage.

Reports received up to date show that considerable progress is being made in forcing freight cars to those sections where car shortage is most acute. Railroads which have a large excess of equipment are being called upon for explanations as to why they have not taken steps to reduce the number of cars on their lines. As an illustration it may be stated that by the direction of the Commission on car service, the Seaboard Air Line has turned over 1,000 empty box cars to the Louisville & Nashville, the Mobile & Ohio and the Nashville, Chattanooga & St. Louis railroads. On these railroads there has been a shortage of cars.

A Double-Action Snow Plow.

A unique combination snow plow has been worked out by a railway official in Spokane, Wash., and is now in operation. It weighs 70,000 lbs., and is equipped with a plow at one end and a sheer at the other. It throws the snow to either side of the track by the plow, while the sheer, when in use, throws it to one side only. The plow is fitted up inside with electrical stoves and heating devices for the comfort of the crew in zero weather.

Steel Fireboxes for India.

Owing to the difficulty of obtaining copper plates in England for requirements unconnected with the war, railway administrations in India have been asked to consider the substitution of steel for copper fireboxes in preference to repairing the latter. New steel fireboxes can be made in England for existing engines, but must be especially designed for each engine.

New Coal Pier, Baltimore & Ohio.

The new coal pier on the Baltimore & Ohio at Curtis Bay has just been completed, and is the largest in the world, having a capacity of 7,000 tons an hour. The pier is of concrete and steel and is electrically operated. The pier is in two units, a car dumper, two loading towers and a trimming tower. Each dumper handles forty 100-ton cars an hour. In constructing the pier it was necessary to dredge a channel into the pier to a depth of 30 feet. The pier was constructed in a little over one year, and cost $2,500,000.

Varying Prices in Metals.

In the early days of iron mining in America pig iron sold as high as $40 a ton, and steel rails at $130 a ton. For some years before the present war boom the former ruled at $15 a ton, and the latter at $28 a ton. Improved methods of production and cheap transportation brought about the drop in prices, and it is to be hoped that the drop in prices will soon occur again.

New Tunnel Under the Hudson River.

A permit for building an $11,000,000-highway tunnel under the Hudson river from Canal street, New York, to Jersey City, has been granted by the War Department.

Compound Locomotive for the Madrid, Saragossa and Alicante Railway of Spain

The American Locomotive Company have recently completed twenty-five 4-8-0 type locomotives for the Madrid, Saragossa and Alicante Railway of Spain. These engines were built strictly in accordance with specifications and drawings furnished by the railway company, all the dimensions being given in the metric figures which the workmen used without translating them into the English equivalents.

This railway is one of the two largest railways in Spain and connects large cities such as Madrid, Zaragoza, Alicante, Barcelona, Valencia, Cordova and Seville. These locomotives are duplicates of existing locomotives used on this road and built in Germany. They were designed to haul, outside of the weight of engine and tender, a load of 280 tons at a speed of 50 km. or 31 miles an hour on 15 mm. grades of .015 per cent. over curves of 400 meters, 1.312 ft. radius; a load of 310 tons at a speed of 60 km., 37.28 miles, an hour on 10 mm. grades of .01 per cent. over curves of 400 meters, 1,312 ft., radius; a load of 340 tons at a speed of 100 km., 62.13 miles an hour, on level track over curves of 700 meters, 22.97 ft., radius.

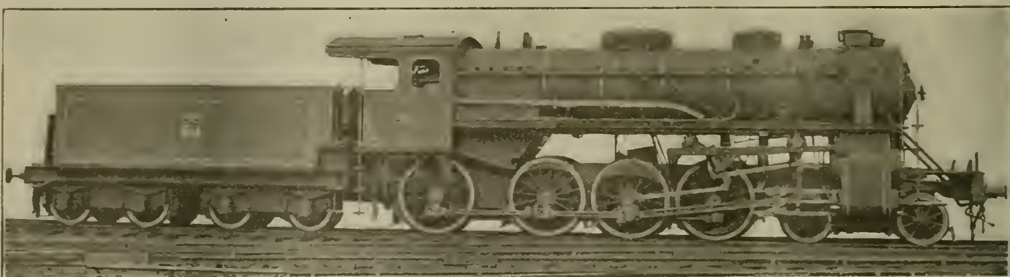
These engines are of the 4-cylinder, balanced compound type. The low pressure cylinders are between the frames underneath the smokebox and drive on the cranked axle of the leading driving wheels; while the high pressure cylinders, outside the frames, are connected with the second pair of driving wheels. The cylinders are cast in two pieces, each piece containing one high and one low pressure cylinder. Steam distribution is obtained by one set of valves driven by one set of valve gear. A screw reverse gear similar to American practice operates the valve gear.

Main frames are of steel plate 28 mm. or 1.102 ins. thick, with front rails of soft steel 100 mm. or 3.937 ins. thick. Front bumper and front plate are also of steel plate. All the axles are of forged steel, the crank axle being a single forging of basic open hearth steel having a minimum tensile strength of 55 kg. per sq. mm., 78,227 lbs. per sq. in., to 65 kg. per sq. mm., 92,450 lbs. per sq. in., and an elongation of not less than 18 per cent. in 150 mm. Under-hung springs are used as this arrangement is more suitable to plate frame design.

Contrary to American practice, these engines have what might be called a five-point system of equalization. The front truck first two pair of driving wheels, and the last two pair of driving wheels are all equalized with a separate system for each. Weight distribution is obtained by means of adjustable spring hangers. The engine truck is the railway company's design of four-wheel truck, all the weight being transferred to it by a spherical center-pin bearing. The smokebox has a high exhaust pipe fitted with an adjustable nozzle which is operated from the cab by a screw and hand wheel. The smokestack has a hood for checking the draft when the engine is standing or drifting. The use of these hoods is quite common on European locomotives and is said to be of considerable advantage while the locomotive is standing in sheds or passenger stations, more especially the latter.

The boiler is of the straight top type, the inside firebox being of copper. On 19 engines, the water-space stays are of manganese bronze. On the remaining 6 engines copper stays are applied to the throat and in the lower rows in the sides and backhead, manganese bronze being applied in the upper rows of the side and backhead. All the staybolts were drilled all the way through with a central hole 5 mm. diameter. This hole is stopped on the outside with a steel plug, being left open on the inside. Crown bars are used in the two front transverse rows. The barrel of the boiler has an outside diameter at the front end of 1,642 mm. or 64.65 ins. It contains 185 tubes 55 mm. or 1.97 ins. in diameter, and 24 flues 133 mm. or 5.24 ins. in diameter and 5,306 mm., 17 ft. 5 ins., long. The firebox is 2,100 mm. or 82.7 ins. long and 1,900 mm., 74.8 ins., wide. The total heating surface of the boiler is 222.5 sq. m., that is 2,395 sq. ft. of which the firebox contributes 15 sq. m., 161.5 sq. ft. The grate area is 4 sq. m., 43 sq. ft. The smokebox front is slightly conical in form. This is usual continental practice though it does not obtain in Great Britain. In this particular case the "Wind-splitter" is confined to the smokebox, but in France the front of the cab is often pointed in front extending out some distance toward the dome.

The tender tank is of the waterbottom type with a capacity of 25 cubic m. 6,600 U. S. gal., of water and 6,000 kilos or 6½ tons of fuel. The tender has a channel frame carried on two four-wheel trucks having plate frames and semi-elliptic springs over the top of each box.



4-8-0 LOCOMOTIVE, MADRID, SARAGOSSA AND ALICANTE RAILWAY OF SPAIN.
R. Andre, Assist. Loco. Supt., Madrid. Amer. Loco. Co., Builders.

Fuel—Bit. coal.

Piston valves. Factor of adhesion—4.63.

Weight in working order—87.5 tons, on drivers 62.1 tons, on engine truck 25.4 tons, engine and tender 143.3 tons.

Boiler—Type straight top.

Firebox—Type wide.

Crown staying—Radial.

Tubes—Lap welded steel.

Flues—Cold drawn seamless No. 24.

Wheels—Driving material, all, C. steel.

Wheels—Engine turck steel tired.

Boxes—Driving, all, C. steel.

Brake—Driver, railway company, truck vacuum; tender vacuum.

Engine truck—Plate frame cent. bearing

Exhaust pipe—Single, nozzles variable.

Grate—Stationary, wrought iron bars.

Piston packing Swedish iron.

Tender frame—Channel steel.

Tank—Style water bottom.

Counterbalancing the Reciprocating and Revolving Parts of Locomotives

Old and New Methods—Location of the Weights

The problem of counterbalancing the reciprocating parts of the locomotive is one, which after being reported upon by competent authorities from time to time, is still largely a matter where the methods used are designs peculiar to each railroad. This is not to be wondered at as the designs and weights and speeds of locomotives are as various as the conditions under which they operate. In spite of these variations there are, however, certain general principles evolved from experience that are universal in their application, and which a brief recapitulation may impress itself upon the minds of those who are interested in the subject, as well as those who occasionally call upon us for opinions on subjects relating to the mechanical appliances used on railways.

The latest report of the Master Mechanics' Association presented a series of diagrammatic illustrations, Figs. 1 to 4. The radius of the circle in each case represents the centrifugal force of the overbalance, or in other words, the centrifugal force of the weight added to partly counter-balance the reciprocating parts. It may be taken for granted that the revolving parts are correctly balanced, so that the weight added for that purpose need not be considered and is not represented in the diagrams. The weight added for partly balancing the reciprocating parts is the overbalance which distorts the otherwise perfectly balanced revolving parts. This overbalance is represented in the black parts of the diagram. Fig. 1, shows by shaded and unshaded portions, the total weight of the reciprocating parts, the shaded portion within the circle being balanced by the overbalance when the wheel is in the position shown. The portion within the circle is the unbalanced weight of reciprocating parts, which tends to cause a nosing on fore and aft irregular movement of the locomotive. Fig. 2, shows the position of the wheel after a quarter-turn, in which the effect of the unbalanced reciprocating parts is eliminated, and the distorting forces are caused by the centrifugal force of the overbalance acting in a downward direction, the resultant effect on the track being the static weight on the driving wheel plus the centrifugal force of the overbalance. This position gives the greatest weight on the rail. Fig. 3 is similar to Fig. 1 and shows the effect of unbalanced reciprocating parts in the opposite direction, after another quarter-turn. There are, however, slight differences in the effect shown in Figs. 1 and 3 due to angularity of connecting rods, and other causes, but these need not be considered. Fig. 4 shows the downward force on the track when the crank pin is down and overbalance is up, this force being the difference between the static weight on the driver and centrifugal force of the overbalance. This position gives the least weight on the rail, the proportions in this figure show the overbalance to neutralize about one-half the static weight on the wheel, leaving half the static weight as the downward force on the track for this position of the crank.

Fig. 1 Fig. 3

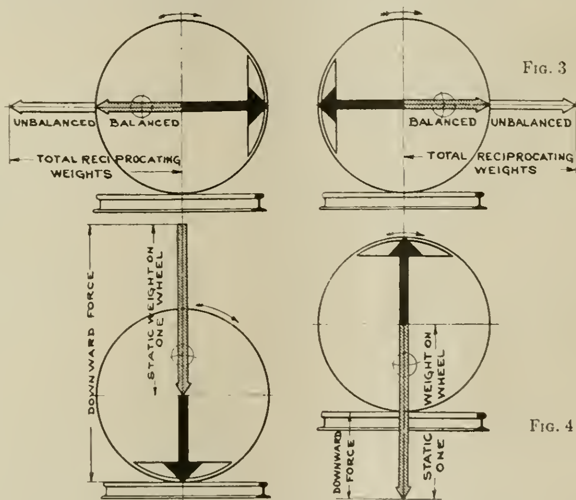


Fig. 2 Fig. 4

In counter-balancing, the parts to be considered are the piston head, rod and nut; the cross-head, cross-head key, pin and nuts; one half of the total weight of the main rod; also the arm and link fastened to cross-heads in the case of an outside valve gear. Each driving wheel should have sufficient weight added to counterbalance the weight of its revolving parts including the crank-pin, crank-pin nut, and the proportion of the weight of the side rods attached to the crank-pin. The main driving wheel should have added one-half the weight of the main rod, and two-thirds the weight of the eccentric arm for outside valve gear.

The amount of overbalance which is used to counteract the desired portion of the weight of the reciprocating parts should be distributed as nearly as possible among all driving wheels, adding to it the weight of the revolving parts for each wheel, this sum for each wheel, if placed at a distance from the driving wheel center equal to the length of the crank, or a proportionally less weight if at a greater distance, will be the counter-balance required.

In calculating centrifugal and reciprocating forces they are usually estimated at a speed in miles per hour equal to the diameter of the driving wheel in inches. This is generally referred to as diameter speed. At this speed the reciprocating parts, due to the laws of inertia, tend to continue their motion at the end of each stroke with a force about equal to forty times their weight. The overbalance also exerts a centrifugal force equal to about forty times its weight, and is at a maximum at the top and bottom position of the crank. This force is added to the static weight, in the lower position of the overbalance and is opposed to this weight in the upper position, as shown in Figs. 2 and 4. Approximately one-fortieth of the static weight on a wheel will, therefore, give the weight of the reciprocating parts which could be balanced without causing the wheel to rise from the track at diameter speed. This amount of balance would also double the load on the rail when the balance is down. It should be remembered that this dynamic augment varies with the length of the stroke.

For example, if the overbalance or excess weight at one half of a stroke of 18 ins., the dynamic augment at a diameter speed will be 29 times the weight. With 24 ins. stroke, the augment at diameter speed will be 38.5 multiplied by the weight. With a 30-in. stroke, the augment will be 48.4 times the weight, and so on with an equally increasing ratio all through.

The general practice in counterbalancing locomotives is to balance a portion of the total weight of the reciprocating parts, usually about two-thirds. A number of years ago a system was established to leave unbalanced on each side of the locomotive, a portion of the reciprocating parts equal to one-four-hundredth part of the weight of the locomotive. An exact

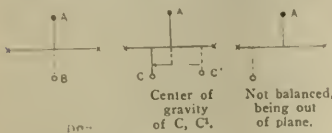


FIG. 5.

adherence to this rule has been found not always to produce the best results. It is advisable to obtain a ratio of the total weight of the reciprocating parts on each side of the locomotive to the total weight of the locomotive in working order, as many experiments have shown that at high speeds the riding of an engine can be very much improved by reducing the weight of the counterbalance. This may be done by increasing the amounts left unbalanced, or by reducing the total weight of the reciprocating parts. In view of the marked improvements in material, the latter practice is the best. It should also be borne in mind that in arranging for these advantageous variations, the calculations should be based on the speed at which the locomotive is usually expected to run. High speed locomotives with 30 per cent. of the reciprocating parts balanced, leaving 70 per cent. unbalanced, and with less than one-two-hundredth part of the locomotive unbalanced, the locomotive has no vibration at a high speed, but has considerable fore and aft movement at low speeds. Thus, when counterbalancing for very high speeds, a large portion of reciprocating parts may be left unbalanced.

The best practice shows, as we have already stated, that it is well to keep the total weight of the reciprocating parts on each side of the locomotive below one-one-hundred and sixtieth part of the total

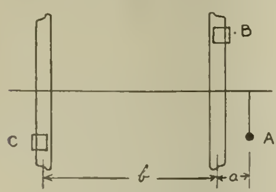


FIG. 6.

weight of the locomotive in working order, and the balance one-half of the reciprocating parts. This rule is based upon diameter speed. Where the normal speed is regularly considerably below the diameter speed, it may be desirable to increase the proportion of the reciprocating weights to be balanced to as much as 60 or 65 per cent.

It is interesting to note the progress made on the subject of counterbalancing during the last twenty years. At the Master Mechanics' convention in 1896, and again in 1897, while much serious attention was given to the whole subject, a general rule was adopted which will be of interest to quote: "Divide the total weight of the engine by 400; subtract the quotient from the weight of the reciprocating parts on one side, including the front end of the main rod. Distribute the remainder equally among all driving wheels, adding to it the weight of the revolving parts for each wheel. The sum will be the counterbalance required if placed at a distance equal to the length of the crank."

There is little reference to the weights of engines at that time and it is safe to assume that the above rule was framed for locomotives weighing less than 150,000 lbs., or what were known as the American or eight wheel engine. No particular variation from the above rule was given on account of variable speeds, and the progress that has been made may fairly

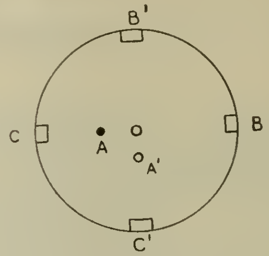


FIG. 7.

be said to be a development arising from increased weights of locomotives of more complex designs, together with a very marked improvement in the quality of material, making it possible to introduce special designs of piston heads, crossheads, hollow piston rods, and the use of heat-treated and alloy steel, aluminum, etc., making it possible to construct very light parts, so that one-two hundred and fortieth part of the total weight of the locomotive in working order instead of one-one hundredth and sixtieth part, as already expressed in representing a fair average.

The subject of cross-counterbalancing, that is a placing of the counter-weights at some point varying from the exact center of the crank pin, has been much discussed with a view to correct the disturbances caused by the parts revolving in different planes, the consensus of opinion being that it is deemed unnecessary in the case of outside cylinders, on account of the disturbing forces being slight when compared to the principal reciprocating and centrifugal forces.

Among other eminent engineers who have given this subject much attention, Mr. Roger Atkinson, formerly superintendent of motive power of the Canadian Pacific, has furnished us with his views on the subject which we take the opportunity of appending for the consideration of that large class of our readers whose life work is more or less devoted to the further im-

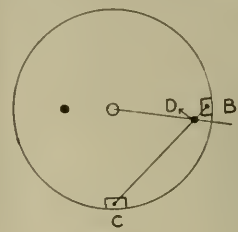


FIG. 8.

provement of the details of the modern locomotive.

A weight A revolving round an axis in a certain plane can only be counterbalanced by a weight B or weights C C¹, whose momentum is equal to the disturbing weight and whose center of gravity revolves in the same plane and at the opposite side of the same axis, Figs. 5, 6, 7, 8. Thus, in the locomotive, especially with side cylinders the balance weights being in the wheels are a long way out of the plane of the cranks or disturbing weight and have, therefore, to be adjusted accordingly, and the same applies to outside cylinders, but in a less degree. We have, therefore, the following conditions. The disturbing weight A cannot be balanced by a weight in the *same* plane and we can only make it the resultant of two other weights B and C, the one B in the rear wheel being equal in the momentum to the sum of the other two A and C, and C is of such mass that the center of gravity of A and C are in the same plane as B. Thus assuming the distance *a* equals one foot and *b* equals four feet then C equals one-quarter A or A ÷ C equals 4 ÷ 1, and, therefore, B equals 5 the sum of the others.

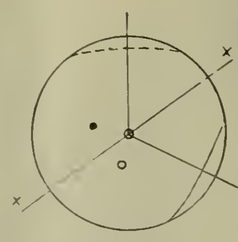


FIG. 9.

We should then have two balance weights in each driving wheel thus, Fig. 8. C being dotted in the far wheel and C¹ being the component in the near side wheel of the system of counterbalancing of the opposite side shown as A¹, B¹, C¹. It would be absurd to put two weights in one wheel when one equivalent weight at their common center of gravity will have the same effect. We, therefore, join the centers of gravity of the two weights and find the common C. G. B being equal 5, and C equal 1, the C. G. is 1/6 from B viz at D and we, therefore, know that a line from the center through D should be the center of the counterweight which is equal in momentum to the sum of B and C at whatever radius we might put it.

The wheels, therefore, are thus made, and the same pattern is good for both as it reverses by revolving about the line shown in Fig. 9.

Chilled Iron Wheels for Engine Tender Service

By F. K. VIAL, Chief Engineer, Griffin Wheel Company, Chicago

A review of the performance of wheels in engine tender service indicates that the burden imposed upon the wheel is much greater than in freight service for similar wheel loads. The life of the wheel in terms of mileage is very much reduced and the causes for removal are often very different from those found in freight service. These differences are sufficient to warrant a careful study of the whole problem of the relation of chilled iron wheels to service conditions. Special consideration must be given to standards for engine tender service that shall have an adequate factor of safety and render a maximum service at a minimum cost.

In the early days of railroading, loads and speeds were so low that the strains developed in the wheel and rail were well within the limits of the materials and sections used and practically no consideration was required or given to the relation between wheel design and various operating conditions. It was during this period that foundry practice was developed to a high degree insuring uniformity of product which made the chilled iron wheel the standard for railway service.

The 60,000 lbs. capacity car was introduced about 1887 and it was thought by most engineers that the load of 11,000 lbs., which each wheel must carry, caused a pressure over the small area of contact between wheel and rail which was greater than the metal could sustain without crushing. It was only a few years before this that 11,000 lbs. was considered a normal load for an engine driver.

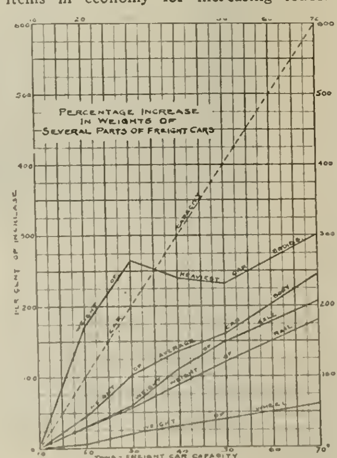
Notwithstanding these adverse opinions, the 80,000 lbs. capacity car, and soon afterwards the 100,000 lbs. capacity car, were introduced to general service, and recently cars of 140,000 lbs. capacity having a wheel load of 26,000 lbs. have come into general use. During the same period the size and weight of locomotive tenders have increased in similar proportion.

Although the chilled iron wheel has been standard for freight cars since the first railroads were established, it is only recently that any attention has been given to a clear study of the stresses developed in various parts of the wheel from varying service conditions, such as gross load, descending grade, flange pressure, etc. The increases in weight have been grudgingly given without any reference to the increased requirement, and the only surprise is that the service of the chilled iron wheel has been so uniformly satisfactory when so little attention has been paid to the principles involved. The fact that the service is so satisfactory is the main obstacle to-day in the way of further improvement. Failures of individual wheels can usually be traced to the use of improper standards, rather than to find that the metal of which the wheel is composed, is unreliable.

The increase in the requirements and weight of various items entering into the car; the axle, the wheel and the rail to take care of the rapid increase in wheel loads is shown in the following table:

	1875	1917	Per Cent Increase
Weight of Rail—Maximum	45 lbs.	125 lbs.	178
Capacity of Car—Maximum	20,000	140,000	600
Gross Load	40,000	210,000	425
Average Tare Weight of Car	18,000	54,000	200
Weight of Heavy Cars	18,000	66,000	267
Weight of Body of Car	12,400	43,000	247
Weight of Axle	350	1,070	206
Number of Wheels	8	8	0
Vertical load per Wheel	5,000	26,250	425
Maximum Flange pressure in service	6,500	40,000	515
Area of Flange Section	2.18 sq. in.	3.60 sq. in.	61
Heat generated on tread of wheel in effecting a stop from 30 MPH (ignoring train resistance)	195 BTU	1,020 BTU	425
Area of Tread Surface	415 sq. in.	415 sq. in.	0
Area of Tread Section	6.64 sq. in.	11.50 sq. in.	73
Thickness of Single Plate	9/16 in.	1⅛ in.	111
Weight of Wheel	525 lbs.	850 lbs.	62

These items are represented graphically in the chart, in which it will be noted that the wheel outclasses all other items in economy for increasing loads.



Each 100 per cent. increase in car capacity requires the following:

34 per cent. increase in weight of axle.
30 " " " " " rail.
40 " " " " " car body.
10 " " " " " wheel.

In other words, the wheel requires about one third of the percentage of increase in weight that is required in other parts of the car for increasing capacities. Further, the cost per pound of the chilled iron wheel is far below that of any other metal used in freight car construction; hence its remarkable economy.

The modern concentrated wheel loads hauled at high velocities produce certain stresses in the wheel that cause defects that were not known in the early development of the chilled iron wheel. These consist of brake burning, shell out, comby spots, cracked plates and an occasional broken wheel. The sudden increase in temperature in the tread in connection with the relatively slow transmission of heat to the interior of the wheel produces a decided difference in temperature resulting in unequal expansion, and stresses that are sufficient at times to rupture the metal where wheels are not properly standardized.

Brake friction on long heavy descending grades is of course the origin of excessive heat in the wheel. The intensity of the shoe pressure is a direct factor of the degree of heating. Notwithstanding the common knowledge that overheating is the principal cause of wheel failures, no classification has ever been made of railway equipment with respect to irregularities in braking power, which represents the feature that develops the maximum stresses within the wheel.

The only item used by the M. C. B. Association in standardizing wheels has been the gross load. This is correct only in so far as braking power and gross load bear a constant relation to each other. A superficial review of railway equipment at once indicates wide variations in this respect as shown by the following table, which is reproduced here in order to emphasize this important view of the subject.

	Tare Weight	Braking Power Total	Braking Power Per Cent of Tare Weight	Braking Power Per Cent of Gross Load	Per Cent Cars Represented
4¼ x 8 JOURNAL AXLES—95,000 LBS. GROSS LOAD					
Freight Cars—60,000 lbs. capacity:					
Light Cars	22,000 lbs.	13,200 lbs.	60	13.9	4.
Average Cars	32,000 lbs.	19,200 lbs.	60	20.2	100.
Heavy Cars	52,000 lbs.	31,200 lbs.	60	32.9	1.
Engine Tenders:					
5,000 Gals.	35,000 lbs.	31,500 lbs.	90	33.2	..
5 x 9 JOURNAL AXLES—132,000 LBS. GROSS LOAD					
Freight Cars—80,000 lbs. capacity:					
Light Cars	27,000 lbs.	16,200 lbs.	60	12.3	4.
Average Cars	37,000 lbs.	22,200 lbs.	60	16.8	100.
Heavy Cars	50,000 lbs.	30,000 lbs.	60	22.7	1.
Engine Tenders:					
7,000 Gals.	49,000 lbs.	44,100 lbs.	90	33.4	..
5½ x 10 JOURNAL AXLES—161,000 LBS. GROSS LOAD					
Freight Cars—100,000 lbs. capacity:					
Light Cars	32,000 lbs.	19,200 lbs.	60	11.9	7.
Average Cars	41,000 lbs.	24,600 lbs.	60	15.3	100.
Heavy Cars	50,000 lbs.	30,000 lbs.	60	18.6	1.
Engine Tenders:					
9,000 Gals.	63,000 lbs.	56,700 lbs.	90	35.2	..
6 x 11 JOURNAL AXLES—210,000 LBS. GROSS LOAD					
Freight Cars—140,000 lbs. capacity:					
Average Cars	53,000 lbs.	31,800 lbs.	60	15.1	100.
Engine Tenders:					
12,000 Gals.	75,000 lbs.	67,500 lbs.	90	32.2	..

The M. C. B. Association recommended standard for chilled iron wheels, for all the above varying conditions, consists of the 625 lb. wheel for cars of maximum gross weight not to exceed 95,000 lbs., the 675 lb. wheel for cars of maximum gross weight not to exceed 132,000 lbs. and the 725 lb. wheel for cars of maximum gross weight not to exceed 161,000 lbs.

These standards, which were developed for gondola freight service without reference to temperature stresses, have been applied equally to passenger service and have also been adopted by the American Railway Master Mechanics' Association as applicable to engine tender service for equivalent wheel loads. This is an erroneous practice.

With the proposition that the heaviest stresses developed in the wheel are temperature stresses which originate from brake friction, and that the heating of the wheel is proportional to the braking power, it follows directly that wheels which may be entirely satisfactory under freight equipment in which the braking power is 15 per cent. of the gross load are not at all suited for passenger service having braking power equal to 75 per cent. of the gross load, or for engine tender service with braking power 33 per cent. of the gross load, which is twice that encountered in freight service under the same operating conditions.

The limitation for the M. C. B. wheel designs, which apply to average freight service, are shown in the following summary which also shows the entire disregard of the factor of safety with reference to temperature stresses in M. C. B. standards applied to engine tender service, which are of more importance than those originating from gross loads.

	M. C. B. Standards.				Engine Tender Requirements.		
Size of Journal	Wt. of Wheel, Lbs.	Gross Load, Lbs.	Braking Power, Lbs.	Per Cent. Gross Load.	Braking Power for Equivalent Gross Load.	Per Cent. Gross Load.	Excess Braking Power Over M. C. B. Std.
4¼ x 8	625	95,000	19,200	20.2	31,500	33.2	65%
5 x 9	675	132,000	22,200	16.8	44,100	33.4	100%
5½ x 10	725	161,000	24,600	15.3	56,700	35.2	130%
6 x 11	850*	210,000	31,800	15.1	67,500	32.2	112%

*Recommended by the Association of Manufacturers of Chilled Car Wheels for Freight Equipment.

In the above table it will be seen that in heavy freight service the braking power of each car is from 15 to 17 per cent. of the gross load, whereas in engine tender service, the braking power is 33 per cent. of the gross load. This indicates that the heating effect in the wheel is twice as great in engine tender as in freight service, and this fact must be considered when establishing standards for engine tender service.

It is understood that the heating referred to occurs only on long continuous grades and not through the short application of brakes required for stopping trains. It is well known that aside from the very different condition with respect to the heating of wheels, engine tender service is especially severe on account of the high center of gravity, short wheel base, shifting load and jerks from the draw bar.

Taking into consideration the conditions stated above, without going into the theory of the relation of stresses in the wheel to increased braking power which has been quite definitely established, suffice it to say that in order to produce the proper factor of safety for various classes of service, the following wheel weights are what should be used and eventually will be required.

FIG. 1. EXCESSIVE BRAKE BURNING AND COMBY TREAD.

Size of Journal, Inches.	Present Standard Freight, Engine Tender and Pass. Service, Lbs.	Proposed Standard for Heavy Service. Freight. Lbs.	Proposed Standard for Heavy Service. Eng. Tdr. Lbs.
4¼ x 8	625	675	725
5 x 9	675	725	775
5½ x 10	725	775	825
6 x 11	...	875	950

While the Am. Ry., and the M. M. Assns. have never, in their recommended practice, considered any standard differing from the M. C. B. designs for equivalent wheel loads, many individual railroads have developed the standards given above, and find them entirely satisfactory for the heaviest engine tenders on divisions having maximum grades and curvature. The increased weights are used entirely to secure an adequate factor of safety and not to secure increased mileage.

In various classes of service, it is found in general that the chilled iron wheel will give an average of 350,000 ton miles. On this basis the net cost per 100,000 ton miles, also the cost per annum (after deducting scrap value) for the various weights of wheels will be as follows:

	Avg. Load Per Wheel Tons	Avg. Mileage Per Year Miles	Avg. Ton Miles Per Year	Wt. of Wheel	Cost Per 100,000 Ton Miles	Cost Per Wheel Per Year
FREIGHT CARS						
60,000 Lb. Cap.	4	8,000	32,000	625	1.07	.34
80,000 " "	5	8,000	40,000	675	1.16	.46
100,000 " "	6¼	8,000	50,000	725	1.24	.62
140,000 " "	8	8,000	64,000	850	1.46	.93
ENGINE TENDERS						
4,000 Gal. Cap.	4	30,000	120,000	725	1.24	1.49
6,000 " "	6	30,000	180,000	775	1.33	2.39
8,000 " "	8	30,000	240,000	850	1.46	3.50
10,000 " "	10	30,000	300,000	950	1.63	4.89

The above mentioned costs are lower than can be secured through the use of any other type of wheel.

In substantiation of the facts given above concerning wheel service under the heaviest modern tenders, the following test of four hundred 33-in. 925-lb. chilled iron wheels under engine tenders, having gross load of 203,000 lbs. and tare weight 91,840 lbs., is here submitted. The maximum wheel loads were approximately 13 tons with an average load of 10 tons. The total average mileage was 36,000 or 360,000 ton miles. Maximum mileage with 32 wheels still running, 55,000 miles. The average mileage was reduced on account of shell outs in 11 per cent. of the wheels, which gave an average mileage of 30,000 miles or 300,000 ton miles. Worn flanges, 28 per cent. of the total, averaged 34,000 miles. There were but two wheels removed for brake burning and no wheels removed for structural failure, nothwithstanding that the service was on heavy grades with a maximum amount of curvature in the Alleghany mountains.

This represents exceptionally well regulated braking power with reference to gross load, as compared with many other railroads operating under more favorable conditions where shelling out on the tread of the wheel is one of the chief defects which develop in service.

The illustration Fig. 1 shows excessive brake burning and comby tread caused by skidding on account of overheating in certain engine tender service. The other illustration, Fig. 2, shows a typical "shell out," which is also caused by excessive local heat developed in skidding short distances, not sufficient to produce typical flat spots.

The actual limitation of the chilled iron wheel is the abuse which occurs through improper brake adjustments resulting in excessive skidding, which produces the various manifestations of overheating commonly known as brake burning, shelling, comby tread, etc.

As far as sustaining the concentrated wheel load is concerned, there is no metal which is so well adapted to wheel service as chilled iron. No load has ever been applied in crane service or in laboratory tests that has left any indication of the load having reached the maximum that the metal can bear without permanent deformation and these loads have ranged from 100,000 lbs. to 200,000 lbs. per wheel. From the standpoint of reliability in the plate of the wheel, it is only necessary to use the metal in the proper proportion for the stresses developed in order to give absolute safety.

The flange, which often received a side thrust of 5,000 lbs. or 6,000 lbs. under the ten-ton car, has been accorded but scant consideration, although the pressures and impacts under the heaviest loads have today reached a magnitude of 40,000 lbs. It has been considered that the thickness of flange which was originally adopted in the early days of railroading cannot be increased without interfering with guard rails and track. This idea, it has been demonstrated, is not founded upon fact. Many railroads are using flanges under heavy equipment that exceed the M. C. B. maximum gauge in thickness, and further the question has been the subject of discussion by a sub-committee of the American Railway Engineering Association's track committee. All the discussions, and the sub-committee's verbal report, were entirely favorable to the proposition that the present M. C. B. flange can be increased 3/16 of an inch in thickness at the rail line without interfering with present track conditions. This increase in thickness can be provided for by mounting the wheels 3/32 of an inch closer to the rail. As the matter now stands it is only necessary for the M. C. B. wheel committee to say that an increased thickness of flange will add an element of safety to the wheel, and the American Railway Engineering Association will meet them more than half way.

FIG. 2. TYPICAL FORM OF SHELLED OUT SPOT.

Attempts to thicken the flange above the rail line without any change at the base line produces a wedge shape with respect to the guard rail which causes grooves to wear in the back of the flange and develops a greater pressure against the guard rail than would occur with flanges increased 3/16 of an inch at the base line, which is the recommendation of the Association of Manufacturers of Chilled Iron Wheels. This subject is being taken up actively by numerous railroads at the present time, and doubtless a new flange will ultimately be made standard with a large factor of safety above anything that is possible with the present flange. The way is absolutely clear for this improvement, which can be obtained for the asking.

When the relations between stresses, which are developed in service in each part of the wheel are analyzed, and the wheel designed in each part to meet these stresses, it will be found that the chilled iron wheel will give a maximum degree of safety together with a maximum mileage at the lowest unit cost of service for any load that can be carried on steel rails.

Steel Rails for the Pennsylvania.

The Pennsylvania has placed orders for 68,332 tons of steel rails for delivery in 1918. This compares with a total of 205,000 tons ordered for delivery in 1917. The reduction in the amount ordered for 1918 is the high price prevailing for steel rails. The 1918 order embraces 19,133 tons from the Bethlehem Steel Company, 15,033 tons from the Cambria Steel Company, 30,066 tons from the Lackawanna Steel Company, and the remainder from other companies.

Mosty Tunnel Opened.

The second Mosty tunnel, near Jablunkau, Austria, in the Carpathians, has been opened for traffic. The completion of this tunnel has created a double track railway connection from Breslau, Germany, through Hungary to the Balkan States.

Steel Hopper Cars for the Pennsylvania Railroad

Seventy-ton Cars Built by the Cambria Steel Co.—Eighty-five Ton Cars Built at Altoona by the P. R. R.

Our first illustration gives a general idea of the construction of a lot of new steel hopper cars for the Pennsylvania railroad, 3,000 of which have recently been built at the Steel Car Shops of the Cambria Steel Company, Johnstown, Pa. These cars in general were designed by the engineers of the Pennsylvania railroad, and as may be seen, each has four hoppers, provided with double doors, so that the contents can readily and quickly be discharged.

The details of the construction of the car doors, stiffeners and spreaders are of special design, the spreaders being of trough form, with outstanding flanges on the lower edges, the flanges and the connecting portion being thicker than the web portions, thereby providing a section of maximum stiffness and strength for a given weight. Heretofore these doors had been stiffened by the attachment to them of separate pieces of pressed steel or structural sections riveted thereto, and in addition a door spreader was connected with adjacent doors for the purpose of opening and closing them. The present construction obviates the necessity of using a separate stiffener, but the door spreader itself serves as a stiffener and spreader combined, and is attached directly to the doors, the side flanges of the doors being bent upwardly so that this can be done.

This construction materially reduces weight and cost of each car, and at the same time makes the work of building them more simple than previously. This particular detail, that is, the arrangement of the doors and the spreaders in connection with them, was designed by Mr. Ralph V. Sage, Contracting Car and Structural engineer and Mr. Ralph E. Wilder, car engineer of the Cambria Steel Company, and the method is covered by patent granted to them.

SEVENTY-TON STEEL GONDOLA BUILT FOR THE P. R. R. BY THE CAMBRIA STEEL COMPANY

The Pennsylvania Railroad has recently turned out of their shops at Altoona, Pa., a type of car which they term the H-24 hopper car. It differs from the type built by the Cambria Steel Company in that it has five hopper doors, while the Cambria car has four. The capacity of the cars ordered from the Cambria Company is 140,000 lbs; the P. R. R. cars, also illustrated in this article, have a capacity of 170,000 lbs.

In describing the cars built at Altoona no comparison is here instituted, as the outside company complied fully with the terms of their contract, and those built by the P. R. R. are of somewhat later date. The railway company believes that the past fifteen years have proved the steel car to be a good investment and recent development of the art tends toward the standardization of details and larger capacity equipment. Heavier rolling stock is being added by the railroads throughout the country as quickly as their road beds and motive power will permit. More especially is this true of the coal carrying roads delivering direct to tidewater. The P. R. R. anticipating rolling stock of greater capacity had just completed the construction of an 85-ton hopper car at their Altoona shops, the general dimensions of which are as follows:

Truck center, 38 ft. 4 ins.; length coupled, 50 ft. 4 ins.; length over end sills, 48 ft. 4 ins.; length inside, 46 ft. 6 ins.; width, extreme, 10 ft. 2 ins.; width inside, 9 ft. 4⅞ ins.; height from rail, 10 ft. 6 ins.; truck wheelbase, 5 ft. 10 ins.; light weight of car, 60,000 lbs.; capacity, 170,000 lbs., plus 10 per cent.; cubical capacity: box, 2,900 cu. ft.; heap, 328 cu. ft.; total, 3,228 cu. ft.

The new design, known as the Class H-24 car, is patterned after their quadruple hopper car, Class H-21/A, the details of which are interchangeable with it.

Increased volume is obtained by an additional bay, 6 ft. 4 ins. long, thus providing for five hoppers instead of four. The top and bottom members of the sides of the H-24 have been increased 50 per cent. in area over that of the H-21/A, to take care of the additional load.

The underframe is characteristic of former P. R. R. designs, having a well-balanced central member to absorb the buffing stresses, while the major portion of the load is carried by the side construction. The backbone of the car is composed of two 10-in. 30-lbs. per foot rolled channels, 48 ft. 0¾ ins. long, strengthened by spacers at the diaphragms, as well as by coverplates at either end. Cast steel striking plates join the end and center sills, and space the latter 12⅞ ins. apart. This reinforcement is further supplemented by two other steel castings, immediately over the center plates, commonly known as center plate reinforcing castings, which extend forward and backward a sufficient distance from the center line of the bolster to form a draft gear stop and act as a spacer for the center sills at the point where the body bolster is joined thereto. The center sill coverplate and bottom reinforcing angles are not continuous on account of the clearance required by the drop door operating device; therefore, the ⅜ x 18¾ ins.

cover plates, one at either end, are but 7 ft. 2½ ins. long, while the 4 x 4 x ¾ ins. reinforcing angles at the bottom of the center sills extend from the front face of the center plate reinforcing casting back 5 ft. 10¼ ins. beyond the center line of bolster and are 6 ft. 4¾ ins. long.

A U-shape ridge sheet, the four sections of which form a continuous member extending between end slope sheets, is substituted instead of a continuous coverplate, and is so attached to the center sill construction as to give the latter the value of at least 24 sq. ins. in buffing. The bottom member of the side construction is a 4 x 4 x ⅝ ins. angle, continuous between pressed Z-shape end sills, and is joined to the same by a cast steel push pole pocket.

The body bolster is composed of a ¼-in. vertical web plate, cut out over the center sills to permit the same to pass through, and which is secured at the top to the end slope sheets by means of two 5 x 3½ x ⅜ ins. angles, 8 ft. 10 ins. and 6 ft. 8½ ins. long; two 5 x 3½ x ⅜ ins. side sheets which connect the other three parts into a homogeneous member. Alternate posts in conjunction with inside butt strips join adjacent sheets.

The end construction consists of a top bulb angle 4½ x 5 in. by 19.3 lb. per foot, and a 3/16-in. end sheet connected to the sides by the cast steel corner casting and an angle corner post. The end sheet extends downward 2 ft. 9¾ ins. from the top of the bulb angle and is flanged inward at the bottom to support the floor slope sheet. The end floor sheets, ridge sheet and side hopper sheets all slope into the drop bottoms at a sufficient angle to discharge the load when doors are open.

Eight diamond-shape cross braces, located two above each intermediate diaphragm, tie the sides of the car together. These cross braces are located one above the other at a distance of 42 ins., the center line of the top one being 27 ins. below the top of car. A vertical ¼-in. gusset plate, 18 7/16 ins. wide at the top and 34 ins. wide at the bottom, is riveted between the lower flange of the upper, and a U-shape casting and T-bolt, the leg of the latter being threaded and screwed into the end of the link, thus forming a positive adjusting feature as the position of the T end of the bolt is fixed by the connecting casting, thus making a good job.

The car is carried on two cast steel side frame trucks, having a 5 ft. 10 ins. wheelbase, 6½ x 12 ins. journals, and wrought steel wheels. The side frames are of the box section type, 7 ins. wide, 2 ft. 2⅝ ins. high and 7 ft. 0½ in. over-all in length, in which the brake beam hanger supports, and bolster guides are cast integral. The cast steel journal boxes, secured at either end of the side frame with 1½-in. box bolts, are also tied at the bottom by ⅝ x 6 in. journal box tie bars, upon which rest two ½-in. shims which may be transferred to the top of the box.

The bolster opening at the center of the side frame is 17 ins. high and 20 ins. wide, the width being reduced to 17 ins. between the bolster guides. The top flange of the tension member below the opening is widened out to 13 ins. form-

EIGHTY-FIVE-TON, HIGH-SIDE, HOPPER-BOTTOM STEEL GONDOLA BUILT AT ALTOONA, PA., BY THE P. R. R.

reinforcing angles at the bottom extending from center to side sills, and a tie plate which passes under the center sills and is riveted to the web plate reinforcing angles on either side, as well as to the center sills, center sill reinforcing angles and casting. Against the bolster tie plate and immediately below the center plate reinforcing casting, a drop forged center plate is secured to the underframe, 25 ins. from the center line of car and riveted to the body bolster is a cast steel side bearing, while at either extremity is a roping and jacking casting. Four intermediate diaphragms situated between the five hoppers transfer the major portion of the load from the center to side construction.

The side construction is composed of four distinct members, viz.: a 5-in. 19.3 lb. per foot bulb angle, as top member extending the length of car and joined to the ends by a corner tie casting; a 4 x 4 x ⅝ ins. angle as bottom member, previously mentioned as part of the underframe, twenty-six vertical U-shape posts spaced 3 ft. 2 ins. and 3 ft. 3 ins. apart, as the details demand, and 3/16-in. the upper flange of the lower cross brace, as well as to the side sheets, thus adding materially to the stiffness of the superstructure.

The car has five hoppers which are divided by the ridge sheet which spans the center sills into two units each, each unit having a pair of drop doors which are operated by a mechanism controlled from the side of the car and when in release position have a maximum opening of 3 ft. 5½ ins. x 2 ft. 11 3/16 ins. per pair of doors.

The door operating device consists of a ratchet wheel, pawl, dog, an appropriate casting for holding it in position on the side of the car, a winding shaft, drum, a chain connecting the drum with a sheave directly above the center line of the doors and between the center sills, connecting links, T-bolts, T-bolt-connecting castings and drop door channels, mechanically arranged to open and close the doors holding them in any position from minimum to maximum opening. Simplicity and flexibility are the predominating features of this device, the door channels being connected directly to the links by means of ing a spring seat and spring plank anchorage, upon which a nest of six helical springs support the bolster. To the sides of the bolster opening and in the same vertical plane as the face, lugs are cast, to which the vertical legs of the U-shape spring plank are riveted. The spring plank is a pressed section ½-in thick and 16 ins. wide at the center, being spread at the ends to 20 ins., and is secured to the side frame at either end by eight ¾-in. rivets. The spring plank supports the third point suspension spring which is placed at the center and extends in either direction along the center line of car a sufficient distance to support the end of the brake beam strut. The bathtub type bolster is composed of a 15/16-in. plate which forms the body and a ⅜-in. coverplate riveted to the top flanges and supporting the drop forged center plate and side bearings. Cast steel bolster guides and center plate reinforcing castings complete the detail. The bolster is 7 ft. 8 ins. long, 17½ ins. wide and 14¼ ins. deep at the center, tapering to 7¼ ins. at either end. The weight of the truck is 13,050 lbs.

Fifty Mikado Type Locomotives for the Baltimore & Ohio Railroad

Equipped With Street Stokers, Superheaters, Brick Arches and Baker Valve Gear

The Baltimore & Ohio has recently placed in service fifty Mikado or 2-8-2 type of locomotives, which were built by the Baldwin Locomotive Works. The first Baldwin Mikados were built for this road in 1910, and including the new engines a total of 370 are now in service. These locomotives, although not among the heaviest of their type, constitute a most efficient group of modern power.

The new engines carry 222,100 lbs. on the driving wheels, and as the tractive force exerted is 54,600 lbs., the ratio of adhesion is 4.08. The driving wheels are 64 ins. in diameter, an unusually large size for a Mikado type locomotive. With these proportions, hauling and speed capacity are so combined as to fit the engines for both fast freight and heavy drag service. The steaming capacity is ample, and as the locomotives are equipped with mechanical stokers they can be worked at full capacity for sustained periods of time. The record made by the stoker on the Baltimore & Ohio is said to be very satisfactory. In the present instance the Street stoker is applied. A brief description of this appliance appeared in our last month's issue (March, 1917, page 87).

The boiler of each of these Mikado engines has an extended wagon-top, and is equipped with a brick arch and superheater. The arch is supported on four tubes, and the superheater consists of 34 elements. The boiler tubes are spaced with ⅞-in. bridges at the firebox end, and are kept well clear of the shell; while the water legs are 5 ins. wide at the bottom, increasing in width toward the top. This construction makes provision for free circulation, of hot water and steam, which is essential to satisfactory boiler performance, and it helps in low maintenance costs. At the same time the total equivalent heating surface (considering each square foot of superheating surface as equivalent to 1½ sq. ft. of water heating surface) is 5,293 sq. ft., or one square foot for each 10.3 lbs. of tractive force developed. This is a liberal ratio for a heavy freight locomotive

The frames are of 0.35 to 0.40 per cent. carbon steel, annealed. They are 5 ins. wide, and are spaced 42 ins. apart transversely. Running gear details include the Hodges design of trailing truck, Cole long main driving boxes, and Franklin adjustable shoes and wedges. The tires are all flanged, but the play between rails and flanges is sufficient to enable the locomotive to traverse 22 deg. curves. Flange lubricators are applied to the leading driving tires.

The Baker valve gear is used on these locomotives, and it is controlled by a hand reverse lever. Mention should be made of the pistons, which are of rolled steel with a dished section. This style of piston is, to a large extent, replacing the box form on heavy power, as it is lighter, stronger and in many ways more desirable.

The tender is of the Vanderbilt type, and has capacity for 10,000 gallons of water and 16 tons of coal. This style of tender has been in use for some time on the Baltimore & Ohio, behind locomotives of the 2-10-2 and Mallet types; and it has been applied to the new Mikados after having been thoroughly tried in service. The trucks are of the arch bar type, with "Standard" forged and rolled steel wheels.

These locomotives are specially fitted for meeting conditions peculiar to the Baltimore & Ohio, as the design is based on an extended experience with engines of this type previously built. This road was one of the first to introduce Mikado type locomotives on a large scale; and it is interesting to note that, in their principal features, the latest locomotives of this type are closely similar to the original design.

Some of the principal dimensions are here appended for reference.

Miscellaneous.—Gauge, 4 ft. 8½ ins.; cylinders, 26 x 32 ins.; valves, piston 14 ins. diam.

Boiler.—Type, wagon-top; diameter, 78 ins.; thickness of sheets, 11/16 and ¾ in.; working pressure, 190 lbs.; fuel, soft coal; staying, radial.

Firebox.—Material, steel; length, 120 ins.; width, 84 ins.; depth, front, 81 ins.; depth, back, 71½ ins.; thickness of sides, back and crown, ⅜ in.; thickness of tube, ½ in. Water Space.—Front, sides and back, 5 ins.

Tubes.—Diameter, 5½ and 2¼ ins.; material, steel; thickness, 5½ ins., No. 9 W. G. 2¼ ins., 0.125 in.; number, 5½ ins, 34; 2¼ ins., 218 ins.; length, 21 ft.

Heating Surface.—Firebox, 228 sq. ft.; tubes, 3,710 sq. ft.; firebrick tubes, 32 sq. ft.; total, 3,970 sq. ft.; superheater, 882 sq. ft.; grate area, 70 sq. ft.

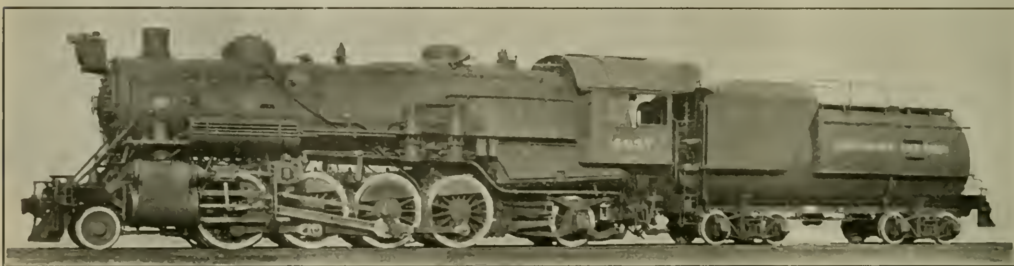
Driving Wheels.—Diameter, outside, 64 ins.; diameter, center, 56 ins.; journals, main, 11½ x 21 ins.; journals, others, 9½ x 13 ins.

Engine Truck Wheels. — Diameter, front, 33 ins.; journals, 6 x 10 ins.; diameter, back, 46 ins.; journals, 8 x 14 ins.

Wheel Base.—Driving, 16 ft. 9 ins.; rigid, 16 ft. 9 ins.; total engine, 35 ft. 0 ins.; total engine and tender, 72 ft. 0 ins.

Weight.—On driving wheels, 222,100 lbs.; on truck, front, 18,800 lbs.; on truck, back, 41,000 lbs.; total engine, 281,900 lbs.; total engine and tender, 463,000 lbs.

Tender.—Wheels, number, 8; wheel, diameter, 33 ins.; journals, 6 x 11 ins.; tank capacity, 10,000 U. S. gals.; fuel, 16 tons; service, freight.



2-8-2 LOCOMOTIVE FOR THE BALTIMORE & OHIO.

F. H. Clark, Genl. Supt. Motive Power. Baldwin Loco. Wks., Builders.

Opening of the Hell Gate Bridge and New York Connecting Railroad

The first train operated over the New York Connecting Railroad left the Pennsylvania station, New York, on March 9, and after passing through the East river tubes proceeded to the Sunnyside yards, Long Island, and traversed the line of the Connecting Railroad to the northern end of the Hell Gate bridge, where dedication ceremonies were performed by Mr. A. J. County, vice-president of the Pennsylvania Railroad Company; Mr. Gustav Lindenthall, the designer of the bridge and chief engineer of the East river bridge division; and Mr. Samuel Rea, president of the Pennsylvania Railroad. In the course of his remarks, Mr. Rea stated that the New York Connecting Railroad company was incorporated a quarter of a century ago, and its railroad and bridge had taken four years to construct. The railroad and bridge is transferred to the New York, New Haven & Hartford Railroad Company, for operation as a part of its system, to replace the river service over the Hudson and East rivers. It completes the direct rail connection, via New York City, between the Pennsylvania and New Haven systems, and between the New England states and the states lying west and south of the Hudson and East rivers.

PRESIDENT SAMUEL REA DEDICATING THE HELL GATE BRIDGE AND THE NEW YORK CONNECTING RAILROAD. GUSTAV LINDENTHAL, DESIGNER OF THE BRIDGE, ON THE LEFT.

Mr. E. G. Buckland, vice-president of the New York, New Haven & Hartford Railroad Company, acknowledged acceptance of the New York Connecting Railroad for the purpose of operation, and prophesied that it would open up for New England an era of greater prosperity than had ever been known before. At the close of the ceremonies, which were witnessed by 60 directors and officers of the Pennsylvania, the New York, New Haven & Hartford, and the Long Island railroads, the train proceeded to the junction with the New York, New Haven & Hartford Railroad, in the Bronx, and then returned to the Pennsylvania station.

The New York Connecting Railroad consists of a link of four-track elevated line, about 6 miles in length, and built of concrete and steel. Its most notable feature, the Hell Gate bridge, was described in the pages of RAILWAY AND LOCOMOTIVE ENGINEERING with the completion of the span in January, 1916, but may be briefly alluded to again now that it is opened for traffic. The bridge crosses the east channel of the East river in New York City, and is a part of the 2½ miles of bridge work which extends between 138th street to Lawrence street in Astoria, Long Island. The distance between the centers of skewbacks in the span is 977 ft. 6 ins. The distance between the near sides of the tower piers at the coping is 1,015 ft. In the center of the arch the top chord on its upper edge clears the river at high tide 307 ft. 6 ins., and on the lower side of the chord 265 ft.

The bottom of the floor or roadway system clears the river at high tide 135 ft. In addition to the four railroad tracks, there are two highway tracks suspended on brackets outside.

The span as shown in the illustration is divided into 23 panels of 42 ft. 6 ins. each, the bottom chord sections weighing 180 tons each and diminishing in proportion to 85 tons at the center. It exemplifies great engineering skill in its design and construction, and has cost over $27,000,000. Not only in its length of span but in its general outline of rugged strength and beauty, it is among the most notable structures of its kind. And as forming an enduring link between the leading eastern railway systems its importance cannot be overestimated. Not only is this bridge a useful, and one may say, a necessary structure, but the whole conception and design is highly artistic, not to say, ornate.

HELL GATE BRIDGE AND APPROACHES OF THE NEW YORK CONNECTING RAILROAD.

Completion of Russian Railway Bridge.

The railway bridge over the Amur River at Khabarovsk, Siberia, was opened to traffic on November 18, 1916. Its construction has taken five years and has cost $9,270,000. It is 7,593 feet long, one of the longest bridges in the world.

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Reclaiming Material

At a regular monthly mechanical department meeting on one of our leading railway systems, the subject of reclaiming air and signal and steam hose was taken up, and a full and instructive discussion of the question was had. A competent man had been selected for the purpose of inspecting air, signal and steam hose on the system in order to see if it might be possible to reclaim much of this material.

As a result of this man's work there were 13,275 air hose examined, and in this number the soap suds test was applied to 1,031 of them. Out of the total examined 301 hose were reclaimed, and this amounted to a saving of $195.30. Steam hose gave less definite results, and only 2,160 of them were examined. The signal hose, of which 375 hose were examined, required the soap suds test on 48, and out of the total 24 hose were reclaimed with a saving of $11.16.

When these results are brought together, it amounts to the inspection of 15,810 separate pieces of air, steam and signal hose. Soap suds test on 1,079 hose. A total reclamation of 325 hose was made at a money saving of $206.46. No attention had been paid during this inspection to the age of the hose, but in the discussion which followed it appeared to be desirable to do so.

It was decided that hose two years old and over should not be reclaimed as the cost of conducting the test exceeded the saving effected. All other hose that appeared good, and showed no signs of abrasion were to be tested, and if found in good condition, to be reclaimed.

Another test reported at the meeting disclosed the fact that a different batch of 14,035 air hose, carefully inspected, with soap suds test on 607, which were the total less than two years old in this batch, only 151 proved to be good.

From these tests it appeared to the meeting to be a waste of time, energy and money to attempt to reclaim air hose, as the cost of the work amounted to more than the saving.

Since this meeting was held, a better service from steam, air and signal hose appears to have been developed by the hose connector people, who guarantee hose to last three years or they will supply new. The best average service looked for on the railway of which we write was two years' service, and they were not absolutely sure of this service. With the guarantee of three years' service, a railway company is quite sure of the result from the beginning. If discarded two-year hose could be made to give a three-year service, there is a positive saving which is not experimental or doubtful.

Apprentice Schools.

The establishment of apprentice schools is one of the triumphs of the present century, and the dawn of a better day is full of hope, and doubtless the success of the training schools already established will induce others to follow in the same benignant path. Already the important element of natural selection is markedly active in many of the classes. Under careful instructors it is speedily recognized whether the young man has made the proper choice of a calling or not. The unfitted are weeded out and directed to other fields of human endeavor. The moral and intellectual tone of the student apprentice is elevated. Life becomes sweeter and higher and nobler when the difficulties of a calling are illumined by intelligent and kindly tuition. The burden of labor lies lightly on the shoulders of the studious youth who enjoys the gathered wisdom of a proficient instructor to his aid. To this is added another important factor—that the amount of work of the apprentice shows a marked increase where there is a special instructor. Hence the apprentices under the new system are being better paid, with the result that instead of being a burden to their parents during their apprenticeship, the young mechanics are self-supporting from the beginning, and when they graduate they have the proud consciousness of knowing that they are fitted to take their part in the world's work without fear or favor. Verily, the world moves onward and upward, and, in regard to a proper method of learning important mechanical occupations, it was high time.

The Chilled Iron Car Wheel.

In another column is printed an original paper written for Railway and Locomotive Engineering by F. K. Vial, chief engineer of the Griffin Wheel Company and consulting engineer for the Association of Manufacturers of Chilled Iron Wheels. The paper, while it deals specifically with chilled iron wheels used under tenders, yet lets in a flood of light upon the whole question of chilled iron wheels for freight car service as well. It is altogether an admirable addition to the stock of knowledge available for the use of the railroad world.

In the early days of railroading, the chilled iron car wheel may have been unwittingly made too strong for the work it was required then to do, or to put it another way, the factor of safety of the early wheel was greater than we would require it to be to-day. Loads have been added to, little by little, as time went on, and stresses have increased gradually and by small amounts at a time. The chilled iron wheel has met the more strenuous later day conditions with practically no failure. Little attention has so far been paid to several beneficial changes which are now definitely proposed for the wheel. The excellence of the material and the careful work of the manufacturers have been very largely relied upon rather than the specific working out of the engineering features of the problem or of obtaining facts by systematic tests. This does not say that individual railroads have been lax in the matter, many have been fully alive to the import of the problem, but the M. C. B. Association has not, if we read Mr. Vial aright, acted officially and authoritatively in the matter, as it was possible for it to have done, but it is still not too late to investigate and to act.

The proposed flange increase appears reasonable and is exceedingly easy to accomplish. It is eminently logical to increase the resistance, when the blow struck is known to be heavier than it was before, that is if the resisting material is not to ultimately succumb to attack. The action of brakes upon the chilled iron treads of car and tender wheels, is a most important item in railroad service. Numerous defects have their origin in the heating action of the brake shoe. In fact the energy of a moving train has to be dissipated in this way as heat, in order that the train may stop.

The ability to radiate heat rapidly may one day modify the form and the material of brake shoes. But that is in the future.

It is the endeavor of brake companies and others interested in train stopping, to secure powerful, rapid and smooth stops, and in all this the heat element is the salient feature and is the one thing at least which must be adequately handled. Form and material in the brake shoe may have to be changed in course of time, but the form of the wheel tread will probably remain as it is, and the wheel defects developed by heating are not by any means diminishing. The stand taken by the wheel manufacturers, and what they have said, is certainly as wise as it is timely.

The manufacturers have seen the gradual growth of wheel loads, and flange shocks, and have noted the brake heat defects in the wheels; and being keenly alive to all this from the very nature of their work, they have sounded a note of warning to the railroads which it is only the part of wisdom to hear and heed, to investigate conditions and to make the necessary provision for safety, and for prolonged wear, and for greater all-round reliability, and the M. C. B. Association is now begining to deal with the questions raised by the manufacturers in a scientific way which shall secure the best engineering and practical results. We commend Mr. Vial's facts and figures (page 117) to all who desire information on the subject or who are interested in hearing of the possible improvements in the wheel, its weight, its form, and its service.

Electrification in Chicago.

The Railway Terminal Commission of Chicago has presented their report calling upon the Illinois Central to electrify its lines for all train service within the city limits in ten years. The general demand for all of the other roads to electrify their equipment has been referred back to a sub-committee, the general opinion being that it would be ruinous to attempt such a gigantic undertaking at the present time. Since the publication of the report of the special committee of experts on smoke abatement, the people of Chicago realize that the smoke enveloping the city is not caused by the locomotives but by the many industrial concerns burning soft coal in their midst, and while electrification of transportation in densely populated districts has its advantages. it also has its first costs, and these are utterly beyond the reach of any railroad entering Chicago at the present time. When the population has doubled, then, and not till then, such expensive charges may be looked for.

Doubtless this is the reason that the Illinois Central has been allowed ten years' grace, but if the prices of material continue as at present, and no increase in rates are allowed, we doubt if the railroad referred to will be in a better position than it is to-day to proceed with the gigantic undertaking proposed. It has been said that all things come to them that wait, and there is some truth in this if the waiting is long enough. We would recommend to these far-seeing committees the advisability of going slow in their attempt to tie the hands of the next generation who may see more clearly than we do, especially in such cases where it has been clearly proved that the popular world has been misled as is shown in the smoke nuisance report. The railroads will take care of themselves if they are let alone, and we do not know of any better qualified than those who are entrusted with the future of the Illinois Central.

It may be added that railroads cannot cover their requirements and raise their rates to meet added costs without the sanction of the Interstate Commerce Commission. In spite of their apparent prosperity nearly all of the railroads are utterly unable to accumulate funds for the lean years that are sure to come. taxes in ten years have doubled, and if they double in the next few years it will be a receiver they will be looking for and not an electrician. Lines are not being extended as they should be and the clamor for local improvements brings into strong relief that vast portion of the country which still remains undeveloped.

The American Flexible Staybolt.

New devices must be developed toward perfection by service and one seldom or never hears of a new thing being perfect at the start. This is true of railroad specialties and particularly so of locomotive staybolts, which are subjected to stresses in service that cannot be approximated on any testing machine yet devised. The American Flexible Bolt Company started with a theory of a staybolt structure to overcome the troubles and expense due to use of the ordinary rigid staybolts and with some few months of shop experience in production, together with favorable opinions as to their theory from many railroad mechanical department officers.

The American Staybolt was first brought out in 1913, being made at that time of two pieces of half-round iron laid together, the ends being upset and welded and the body twisted. The use of this design, while it served to demonstrate the principle involved, also disclosed several points on which improvement could be made and accordingly, early in 1914, change was made to the use of round iron instead of half-rounds. The practice was and is to slot out the body and re-form it to a round, and twist it, in order to obtain the principle of relative body flexibility obtained in the original design.

The body slot now has all edges and ends worked and rounded so as to present no square or sharp edges for lateral vibration to affect. The fillets formerly used, joining the body to the threaded ends have been changed to long tapers, giving better lines for the flow of the material from the ends into the reduced diameter of the body. Both of these structural changes are in line with well known principles in machinery design where lateral stresses are involved.

The re-forming or forging down of the body was formerly done by hammering but the use of hammers has now been discontinued and the entire forming of the body, after slotting and working, including forming of the end tapers is done by rolling, the subsequent operations being twisting and then straightening in a press, at which time the square for application is formed. All of the forging operations are completed with one heating of the blank, the forged bolts being piled up still red hot for slow cooling before machining.

Laboratory tests prove that the working as now done to produce the body structure of these staybolts effects a material improvement in its strength and ability to withstand lateral stresses. The ratio of yield point or elastic limit to the tensile strength as shown by some sixty tests on six of the leading brands of staybolt iron was .676. The average ratio for the American Staybolt body as produced with the above described methods was .738, an increase of 9.17 per cent. or an indication of great gain in the ability of the structure to withstand service stresses and fulfill claims made for these staybolts. Vibratory tests also show great improvement over the record attainable with the former product.

The manufacturers of this type of staybolt inform us that close to a million and a half American staybolts have been marketed, about half of these being for 913 locomotives ordered prior to January 1, 1917, three-quarters of which are of the heaviest types of passenger and freight power. A number of roads have standardized it for their requirements in maintenance as well as for new power and the company states that it is doing a large business at the present time.

Readjusting the Valve Gear.

In readjusting the valve gear it is very common practice to use the original markings in the rim of the driving wheel in trying the valve trams on the valve rod to ascertain the exact location of the valves. This practice should be abolished. It is an error to suppose that while these markings, and it is time wel spent to be- time that they were originally made that they remain correct after the locomotive has had considerable service. Not only have the main and connecting rods loosened, but the frames in all cases are nearer the rails on account of the relaxation of the springs, while, of course, the wheels retain their original position. The main rod also will likely be lengthened. Those variations, however slight, affect the wheel markings, and it is time well spent to begin the operation of readjusting the valves from the beginning and make new marks on the wheels, and also prove that the markings are correct by moving the engine backward as well as forward and so obtain as nearly correct as possible an exact basis on which to conduct the investigation, and finally the readjustment of the gear. Valve gear mechanism is important, for the correct distribution of steam means economy of operation.

2-8-2 Type Locomotive for the Temiskaming and Northern Ontario Railway

Substituting a General Utility for a Special Engine—Increasing Freight Traffic to Be Handled—Many Locomotive Specialties Used

The Ontario Government have recently received for the Temiskaming & Northern Ontario Railway six Mikado or 2-8-2 type locomotives from the Canadian Locomotive Company, Limited, Kingston, Ontario. These locomotives were specially designed for the T. & N. O. Ry service under the supervision of Mr. H. L. Rodgers, Mechanical Engineer for the Ontario Government Railways.

These are the first engines of this type to go into service on this road, up to the present time, the ten-wheel and Pacific type having been used in handling their passenger trains, and ten-wheel and consolidation type being used for freight service. In purchasing these locomotives, the Commission, after careful consideration of the question, decided to secure a type equally adapted to both freight and passenger service, the latter having recently become somewhat too heavy at times for their previous heaviest type of passenger engine. In arranging the design care was taken to have as many parts as possible interchangeable with the railway's standard consolidation type engine.

The boiler is of the extended wagon-top type with sloping throat and back head and fire-box roof sheet, outside diameter at the front end 71 ins., and at the dome course 78 ins. There are 202, two-inch tubes and 32 superheater flues, the length being 20 ft. over tube sheets, and the bridges between the tubes are 7/8 ins. wide. The firebox is 96 ins. long by 75¼ ins. wide inside the sheets and the back tube sheet is 5/8 in. thick. Water space at the front of firebox is 5½ ins. wide and at the sides and back 4½ ins. The firebox is equipped with the American Arch Co.'s "Security" sectional brick arch supported on four-inch tubes. The total heating surface, including superheater, is 3,981 sq ft., and the grate area 50 sq. ft. The smoke boxes of four of the engines are equipped with the usual Master Mechanic's standard arrangement of front end, while the remaining two are fitted with the Mudge Slater arrangement, these latter being for test purposes. On account of the line of the T. & N. O. Ry. running for the greater part through forest country, it is the endeavor of the railway to provide the most modern devices obtainable for the elimination of danger of fires from engines throwing sparks.

The main frames are of vanadium steel 5 ins. wide throughout, spaced 43 in. centres, the front extensions being cast integral with the main frames. The rear frames are the Commonwealth Steel Co.'s design and the trailing truck is the same company's cast steel "Delta" type. The driving boxes are fitted with the Franklin Railway Supply Company's automatic adjustable driving box wedges, a description of which recently appeared in our columns. The equalization system divides between the second and third pair of driving wheels and the springs throughout are of vanadium steel, the driving springs being composed of 5 x 7/16 in. plates.

The cylinders are 25 ins. diameter, 30 ins. stroke, while the steam distribution is controlled by the Walschaerts valve gear with 14. in. piston valves on five of the engines, the sixth engine being equipped with the "Young" gear and valves. The driving wheels are 63 ins. diameter over tread, the tires being 3½ ins. thick and secured with Mansell retaining rings, as are also the engine truck wheels and tender truck wheels. The cabs of these engines are of a type new on the T. & N. O. Ry., and are an adaptation of the design used by the Russian Government on the engines built at the Canadian Locomotive Co.'s works for the Siberian railways. This design provides considerably more protection for the engine crew in winter, which is very necessary in this climate, and although enclosed all round should not be uncomfortably warm in summer as provision has been made for ample ventilation.

The tender frame is composed of steel channels, the centre sills being 13 ins. deep, while the tank is arranged with water bottom and has a capacity of 7,000 gals. (U. S.) of water and 12 tons coal. The tender trucks are of the equalized pedestal type, wheels 36 in. diameter.

Other specialties consist of Franklin automatic firebox doors (Butterfly type), and Franklin grate shakers, radial buffer between engine and tender, Pyle National Electric headlight type "E," Wilson pneumatic sanders, 8½ ins. cross-compound Westinghouse air pump, Detroit five feed lubricators, Babcock water gauge glass protectors, Oliver Boyer speed recorder. The engines included many special features, having the Locomotive Superheater Co.'s latest type A superheater; cab lights; American Arch Co. fire brick arch; vanadium steel frames, Commonwealth cast steel rear frame cradle, Delta trailing truck, Miner draft gear, Barber roller bearings on tender, Lewis & Kunzer metallic packing, Ohio No. 9 injectors, Coale safety valves, Detroit No. 42 lubricator, 5 feed; Babcock water gauge, cab, vestibule type, side doors with telescopic hood over tender completely closed in from the weather. Two of these engines are equipped with Mudge-Slater spark arresters, and one is equipped with the Young valve gear and Young steam chest valve, while the others have the Walschaerts valve gear with the builders' regular type of steam chest valve.

2-8-2 FOR THE TEMISKAMING & NORTHERN ONTARIO RAILWAY.

H. L. Rodgers, Mech. Eng. Ont. Govt. — Canadian Loco. Company, Builders.

With a maximum calculated tractive power of 45,000 lbs., these engines have a capacity, according to the railway company's rating, of 1,200 tons over the ruling grade, 1.25 per cent. combined with 6 deg. curves, on the North Bay and Englehart Division. These engines have been in service long enough to demonstrate that they are highly satisfactory and have fully exceeded the expected service for which they were built.

The Canadian Locomotive Company, Limited, are also completing an order for 50 Mikado locomotives for the Canadian Government Railways, which are of about the same class, but much heavier in weight. They have also closed an order with the British Government for 40 consolidation locomotives for use in France.

Some of the dimensions of these T. & N. O. are appended for reference:

Gauge, 4 ft. 8½ ins.; type of engine, Mikado 2-8-2 class; fuel, bituminous coal.

Weight in working order on drivers, 196,970 lbs.; weight on front truck, 29,550 lbs.; weight on trailer truck 31,520 lbs.; total, 258,040 lbs.; tender, 146,200 lbs.

Wheel base, driving, 16 ft. 6 ins.; wheel base, engine, 34 ft. 8 ins.; wheel base, engine and tender, 63 ft. 4¾ ins.

Tractive power, 45,500 lbs.; factor of adhesion, 4.32.

Cylinders, 25 x 30 ins.; driving wheels—diameter, 63 ins.; trailing wheels, 45 ins.; engine trailer wheels 33 ins.

Boiler, extended wagon top; boiler pressure, 180 lbs.; boiler diameter, 71 ins. and 78 ins.

Fire box, 96 x 75¼ ins.; tubes, number and diameter, 202 2-in. and 32 5⅜-in.; length, 20 ft.

Heating surface—Tubes, 2,102 sq. ft.; flues, 895.5 sq. ft.; water tubes, 30.5 sq. ft.; fire box, 191 sq. ft.; total, 3,220 sq. ft.; superheaters, 747 sq. ft.; equivalent, 4,340.5 sq. ft.; grate area, 50 sq. ft.

Tender frame, heavy steel channels; wheels, 36 ins. diameter; journals, 5½ x 10 ins.; truck, 4-wheeled equalized type.

Tank, water bottom; tank capacity, water, 7,000 U. S. gals.; coal, 12 tons.

Fitting Piston Rods

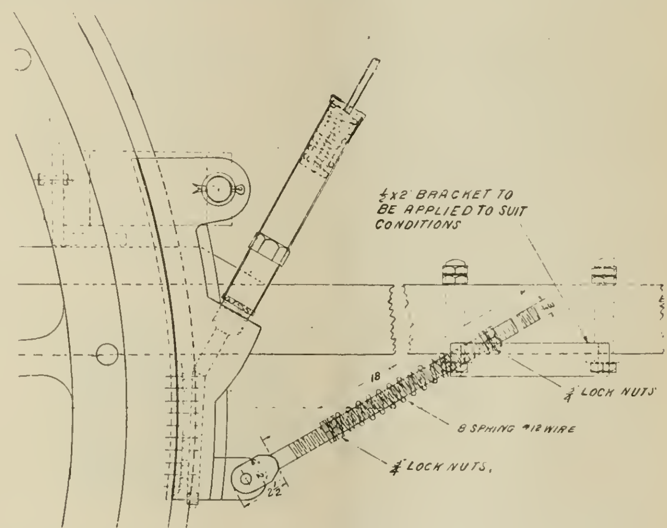
Of the two best known methods of attaching piston rod to crosshead, the design with the key is most generally used and weighs less than the one using nuts. The use of piston-valve cylinders has made necessary very secure fastening of the piston rod. It is the practice with some designers to make the end of the piston rod butt against a shoulder on the crosshead, in addition to the taper fit. The rod is very apt to be loose in the taper and bear altogether against the shoulder, or the taper may be too tight before reaching the shoulder. More uniformly satisfactory results can be obtained by omitting the shoulder and relying entirely upon the taper fit in one direction and the key in the other.

Black's Positive Flange Lubricator

Reclaimed Grease May Be Used

A flange lubricator has recently been perfected by Mr. W. F. Black and Mr. H. S. Rauch, Avis, Pa., and has already met the warm approval of many eminent engineering authorities. It is in the form of a brake shoe, with the tread portion removed, with a grease retainer and orifices to permit the flow of grease to the throat of the flange, the same being mounted on a bracket adjacent to and in contact with the wheel. This bracket is so arranged that the shoe will follow the lateral motion of the wheel, fitted up with springs on the bracket to keep the shoe in constant contact with the flange. In order to keep the shoe constantly against the wheel a rod is connected to the bottom portion of the shoe, one end of which is attached to any stationary part of the locomotive, a spring and jam nut fitted to this rod for the purpose of adjusting the pressure between the wheel and the foot of the shoe. This for the purpose of causing a sufficient friction to generate the necessary heat to soften the grease in the shoe, so that the same will flow through the orifice designed for that purpose. An important feature of this lubricator is the fact that reclaimed driving box compound, or hard grease, or reclaimed pin grease can be used for the purpose of flange lubrication, thus cutting down the cost of the same.

As is well known, there is a marked economy in the use of flange lubricaters, not only on wheel flanges, but on rails, frogs and switches. In actual mileage, made between the turnings, savings of over 300 per cent. are made, and the life of rail curves are increased from 25 to 400 per cent. by the adoption of flange lubrication. The loss of metal from tires due to sharp flanges, the weight of which would be between 500 lbs. and 1,100 lbs., per wheel turning, depending on the number of wheels on the engine, expressed in money value—the four-wheeled switcher would be from $50.00 to $55.00, six-wheel switcher from $55.00 to $65.00, consolidation type from $65.00 to $70.00 and a Mallet from $95.00 to $110.00. These figures, of course, are exclusive of the cost of laying up the power for tire turning when same might be in service, which in times like the present amounts to a very considerable item.



SECTIONAL VIEW OF BLACK'S FLANGE LUBRICATOR

Russian Railways.

The projected railways for construction during the period 1917-1922 comprise a total of 31,346 versts (20,779 miles), of which 2,000 versts (1,326 miles) are branch lines. The cost of constructing these lines is estimated at 600,000,000 rubles ($309,000,000 at the normal exchange rate of $0.515 to the ruble).

An act providing for setting clocks forward one hour will be laid before Congress, and it is declared it will be passed by a large majority.

Air Brake Department

Some Defects in the Universal Valve Variations in the Emergency Features

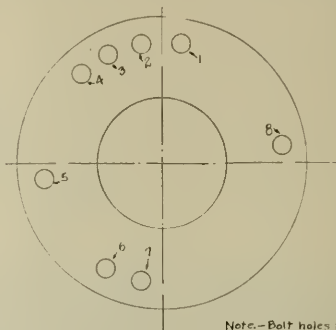
In connection with the description and operation of the universal valve of the UC brake equipment as applied to passenger equipment of the Pennsylvania Railroad, it may be well to again state that the reference will be to the valve as it is operated at the present time, that is, pneumatically and in direct release position. This particular installation has two, a small and a large emergency reservoir, the large one being used for a quick recharge of the auxiliary reservoir and the small one for a higher emergency brake cylinder pressure.

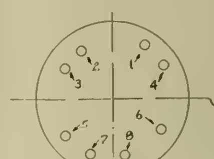
The difference between the two installations is, that where one large emergency reservoir is used for quick recharge and a very high emergency brake cylinder pressure the smaller reservoir is entirely omitted and where the two features are separated, the small reservoir is added and a port opening in the bracket is plugged for the purpose of separating the two pressures.

On some Pullman car arrangements two brake cylinders for both service and emergency operation are employed and operated by the universal valve.

We have printed the names of parts with a list of numbered indications, and explained the purpose of each part, and while the following list of disorders of the universal valve and the method of locating the sources of trouble are largely imaginary a study of the possibilities will lead to a more thorough understanding of the operation of the valve. We say possibilities, because these universal valves have been in service for several years operating under the same identical conditions as the triple valve equipments, and they manifest all the improvements over triple valve operation that is claimed for them and very seldom is there one found in which there is any symptom of disorder. With an ordinary inspection and cleaning to start with there appears to be several years' service, without any attention whatever in one of these valves, and so far the defects found, with one or two exceptions, are due entirely to careless or inaccurate repair work, or the excessive use of oil on the parts.

Like every other equipment, some undesired actions were encountered after the valves had been in service for some time and these have been promptly weeded out until at the present time practically no fault whatever can be found with the operation of the valve. As an example, some of the former types of valves were found to be working in undesired quick action, owing to bent emergency pistons and some failing to operate in quick action when desired for the same cause, but an additional ball check valve added to the high pressure cap restricts the flow or sudden inrush of pressure to the back of emergency piston and the consequent bending of these pistons has been eliminated. A failure to obtain the proper amount of brake cylinder pressure per pound of brake pipe reduction to correspond with other types of equipments, under certain conditions, has also been cases releasing ahead of triple valves during slow predetermined rises in brake pipe pressure. In fact, they improve triple valve operation in direct proportion to the amount of universal valves in the train. When a valve is found that requires over 2 lbs. increase in brake pipe pressure to effect a release it requires immediate attention. Such a valve will be found with so much resistance to movement, through an accumulation of dirt from oiling the valves when cleaned, that it will no doubt be necessary to drive the equalizing piston out of the bushing.





Note.—Bolt holes not shown.

Flange for Equalizing Cylinder Cap.	
List of Ports.	
1	Auxiliary Reservoir
2	Service Reservoir
3	Service
4	Brake Pipe
5	Charging Valve
6	Equalizing Piston Bushing
7	Emergency Reservoir
8	Brake Cylinder.

Face of Graduating Release Cap. U-12 U.C. Valve.	
List of Ports.	
1	Emergency Reservoir
2	Auxiliary Reservoir
3	Equalizing Slide Valve Seat
4	Lower Side of Charging Valve
5	Graduated Release Piston Chamber
6	Top of Charging Valve
7	Upper Side of Charging Valve
8	Emergency Reservoir

corrected by the action of an additional non-return or ball check valve between the service and auxiliary reservoirs, the latter being used to prevent a back flow from the auxiliary to the service reservoir during a graduated release of brakes.

It will at all times be remembered that the equalizing portion does only the work of a plain triple valve, although more efficiently, and the quick action portion and high pressure cap the work of the quick action portion of a triple valve.

This latter portion may be arranged with an elimination or substitution of parts to give practically any features of automatic brakes desired and with any system of single or two brake cylinder arrangements.

The valves release on a 1½ to 2 lb. increase in brake pipe pressure after ordinary servive brake applications, in all

If it is desired to cut out the brake for foundation brake gear trouble, a cut-out cock is provided in the brake cylinder pipe. This cock is also used when making a brake cylinder leakage test after cleaning or repairing the brake cylinder. The test gauge is attached to the elbow in the cut-out cock and when the cock is turned the brake cylinder pressure is opened to the gauge when the leakage in pounds per minute may be noted.

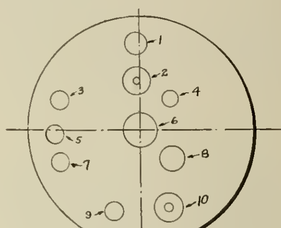
To cut out the brake for defects of the universal valve, the stop cock in the brake pipe branch is closed and the reservoirs drained.

To bleed off the brake, if such becomes necessary, the auxiliary reservoir bleeder cock is opened. These reservoirs or the brake itself should not be bled off by means of the emergency reservoir drain cock, which tends to unseat the release slide valve and cause a blow or waste of air from the release slide valve exhaust port.

Do not expect the brake to apply with less than a 5 lb. brake pipe reduction, but expect an emergency or quick action application of the brake if the brake pipe pressure is permitted to leak down to 35 lbs. or less.

Do not expect the universal valve to release upon the same increase in brake pipe pressure required to release a triple valve after an emergency application, as the P triple valve will release when 62 or 62½ lbs. pressure is obtained in the brake pipe, while the auxiliary reservoir pressure of the universal valve will remain as high as 85 or 90 lbs. when the valve is in emergency position. It will also be noticed that the universal valve applying the brake in emergency will also exhaust all the brake pipe pressure to the atmosphere, whether the quick action has originated in the universal valve or in some other triple valve in the train.

If there is a blow or waste of air from the brake cylinder and release slide valve exhaust ports when the system is charging, apply the brake once or twice and the blow will usually stop. Sometimes it will also stop if the finger is held tightly over the release slide valve exhaust port for a few seconds. In either case the disorder is due to an unseated release slide valve, probably from bleeding the emergency reservoir with the other reservoirs charged or from the valve having operated in quick action and the emergency reservoir pressure left the release slide valve chamber in advance of the pressure from the brake cylinder. If this does not stop the blow, expect to find some dirt on the seat of the release slide valve.



Note.—Bolt holes not shown.

Bolting Flange of Quick Action Portion of U.C. Valve.	
List of Ports.	
1	Service Reservoir
2	Emergency Switch
3	Quick Action Closing Chamber
4	Lug
5	Seat of Emergency Slide Valve
6	Quick Action Chamber
7	Emergency Brake Cylinder
8	Emergency Reservoir
9	Emergency Magnet
10	Emergency Valve
11	Brake cylinder
12	Brake Pipe

Ports in Flange of U.C. Valve, Equalizing portion	
List of Ports.	
1	Service Reservoir
2	Service Port (Choked)
3	Seat of Emergency Slide Valve
4	Service Magnet
5	Emergency Reservoir
6	Auxiliary Reservoir
7	Emergency Valve
8	Exhaust
9	Brake Pipe
10	Brake cylinder Port (Choked)

As the brake cylinder port and several other ones pass entirely through both portions of the valve, it follows that a leak through any of the body gaskets could cause a blow; hence the importance of knowing that all bolts and nuts are tight and gaskets in good condition before attempting to locate the source of a blow from the exhaust ports.

The source of these various leaks or blows at the exhaust ports will be taken up at a greater length when the code of tests for the universal valve is printed.

Do not confuse a short puff of air from the exhaust ports with a leak from some defective portion. There will be a short puff of air from the equalizing slide valve exhaust port as the brake starts to apply, this being from the application end of the release piston, and another exhaust of pressure from the quick action, and quick action closing chambers through the emergency slide valve exhaust port as the brake is applying. The latter exhaust will occur each time there is a brake pipe reduction.

As the brake starts to release there will be short puffs of air from both the equalizing and release slide valve exhaust ports, the former from the release end chamber of the release piston and the latter from the auxiliary reservoir reducing that pressure to insure a positive release of the brake.

There is also a slight escape of pressure from the friction increasing cavities in the face of the equalizing slide valve as the brake starts to apply, but the volume is so small as to be scarcely noticeable.

No defects in the service or equalizing portion can cause undesired quick action as the service features are positively separated and unaffected by the action of the equalizing piston and slide valve. The brake pipe reduction must be at a faster rate than that at which the quick action and quick closing chamber pressure can pass through the exhaust ports of the emergency slide valve before the emergency piston can be moved and an emergency application occur. If a valve is found that actually does work in undesired quick action the indications are that there is some restriction in the emergency slide valve exhaust passages or that the emergency piston spring is not standard (Emergency graduating spring) or that there is excessive friction encountered in the movement of the emergency piston. With former types of valve the latter was due to a bending of the emergency piston, the cause of which has been removed in the present type of valve.

Should the brake fail to apply when a service application is attempted first see that the brake cylinder pipe stop cock is open, then that the stop cock in the brake pipe branch is open and that all reservoirs are charged, even if it is necessary to use air gauges for the purpose, then expect to find a bad brake cylinder packing leather, a very bad equalizing piston packing ring, or an uncharged service reservoir due to a defective charging valve.

If the failure to apply is accompanied by a heavy blow from the brake cylinder exhaust port it indicates that the release piston for some reason has not moved to application position. This could be due to excessive friction or an almost impossible condition of tight release piston packing ring and a stopped up port through the release end of the release piston.

Should it require 10 or 12 lbs. or more brake pipe reduction to apply the universal valve it would point to excessive friction of the equalizing valve or to a stuck packing ring in the equalizing piston.

Should the brake apply in full after a light brake application it indicates a leak from the large emergency reservoir into the service reservoir, possibly past the seat of the intercepting valve, or to a leak from the large emergency reservoir the auxiliary reservoir past the ball charging port check valve to the emergency reservoir.

Cases are known where a defective emergency reservoir check valve in combination with an auxiliary reservoir leak, releasing the brake and thereafter the emergency reservoir check leaked emergency resevoir pressure into the brake pipe, forcing some other valves to release position, but with the present arrangement of ball check valve such an amount of back leakage is practically impossible even if the same combination did exist.

There are also some cases in which a valve fails to operate in quick action when desired, this being mainly due to a dirty condition of the emergency piston and emergency piston bushing. Other cases are known where the higher emergency brake cylinder pressure was not obtained through the failure of the intercepting valve to operate and an investigation disclosed the fact that the bolts holding the emergency portion of the valve to the bracket were drawn up unnecessarily tight, binding the intercepting valve in the bushing.

Should the brake fail to remain applied after a service reduction look first for a brake cylinder leak past the brake cylinder packing leather or past the safety valve or in the brake cylinder pipe.

If the brake releases through the exhaust port of the universal valve when the brake valve handle is on lap position, know first that the brake pipe pressure is not increasing from leakage from the main reservoir, then that there is no leakage in the auxiliary reservoir or its connections, then expect to find a leaky graduating valve in the equalizing slide valve. A leak in the service reservoir would not at this time affect the release of brakes, as the ball service reservoir check prevents any leakage or passage of air from the auxiliary to the service reservoirs. If the universal valve was operating in graduated release position, or with the graduated release cap in graduated release position, the auxiliary reservoir leak would only cause a graduation of the brake and it would not release as with a triple valve equipment.

Sometimes there are reports of brakes sticking and upon investigation it is found that the graduated release cap is in graduated position and this is accepted as a reasonable excuse for the sticking or failure of the brake to release, while at the same time the real cause is elsewhere, for if the brake pipe pressure is promptly increased to the maximum carried by the feed valve the brake will release straight away as a triple valve without reference to the position of the graduated release cap.

Cases have been known where the valve moved to release position after a brake pipe reduction, due to a badly distorted equalizing cylinder cover gasket which extended into the equalizing piston chamber and was compressed by the movement of the equalizing piston to its application position, and when the pressures surrounding the piston equalized, forced the equalizing piston far enough toward release position to result in the release of the brake. The possibilities of such an action has been eliminated in the late design of universal valves.

If the brake fails to release after an ordinary brake application, with full pressure in the brake pipe, notice first that the brake cylinder release spring is not broken or that the brake rigging has not fouled, then expect to find a stuck packing ring on the equalizing piston.

Failure to release might be due to excessive friction of the release piston and slide valve, or to a combination of tight piston packing ring and stopped up ports through the application portion of the release piston, but as stated these disorders are largely possibilities.

If it requires 100 lbs. or more brake pipe pressure to release a universal valve after an emergency application, expect to find a leaky service port check valve or a defective intercepting valve seat that has permitted emergency reservoir pressure to leak into the auxiliary reservoir.

When making an inspection of the brakes on a car equipped with a universal valve, it is well to examine all of the exhaust ports to see that the thread protectors and the small sheet metal discs have been removed from the port holes and that the tape wrapping has been removed from the safety valve.

There is really nothing complicated about the construction and operation of a universal valve, their performance in service is of such a character that very little attention is given them. They absolutely do not manifest the disorders of the triple valve, and there is no doubt but that if oil was not used for lubricating them, or if they were maintained dry, each valve would run indefinitely without any attention whatever. Practically the only incorrect operation ever found is due to oil on the pistons collecting dust from the brake system until the friction encountered is such that it requires 10 or 15 lbs. brake pipe reduction to apply the brake.

Where these valves are applied to Pullman cars there are two cylinders per car, and, as stated, both cylinders are used for service operation as well as both in emergency. This means doubling the reservoir volumes so that the auxiliary reservoir volumes are enlarged to a 12 x 33 for two 16-inch brake cylinder and to 14 x 33 for two 18-inch brake cylinders. For two 16-inch brake cylinders a 16 x 48 service reservoir and two 20½ x 48 emergency reservoirs are used. For two 18-inch brake cylinders the service reservoir is 18½ x 42, and there are two 22½ x 48 emergency reservoirs.

In the accompanying drawings, the port openings in the faces of the equalizing and quick action portions are shown, the bolt holes being omitted, these will be readily recognized from the outward appearance of the portions. The largest figure of the drawings shows the ports exposed when the equalizing cylinder cover has been removed. The smaller of the drawings shows the port openings exposed when the graduated release cap is removed.

The High Cost of Railroading.

The high cost of living is only one phase—and it is a distressing phase—of the high-price-for-everything, through which this country is passing during the great German war. Many people think the rise of food and other prices in the United States is not the result of any very marked shortage of commodities, but results from an extension of the get-rich-quick idea that is uppermost in many minds.

The evil, however, is here, and in the mechanical departments of our railways, the pinch of high prices for material has been severely felt. For example, the prices for car material were, say, about normal 1913-14, while this year they are more than double. An article purchasable for one dollar in 1914 would, in 1917, cost $2.19, and in the matter of locomotive parts, etc., a one dollar article in 1914 now brings $1.38.

This matter of high prices is not a matter beyond control, by any means. The Interstate Commerce Commission might have certain power concerning what railways must pay out, since the commission has the say as to the amount that may be earned on each specific item of service.

Years ago, in Great Britain, railways were, as a rule, equipped as huge manufacturing concerns, and even made their steel driving tires, wheels and other parts which, by common consent, have been given over to manufacturers. It is fair to say that railways have been better served by supply concerns than they would have been by making things themselves but it is quite possible for railways to effect many economies in small articles, reclamation of parts, guarantees of quality in very many lines, supplied from the open market, and insisting, wherever they can, not on haphazard, but on fair usage of equipment offered in interchange.

To Change the Meteorology.

The Hon. Albert Johnson is carrying on a crusade against the Fahrenheit thermometer which is used in all English-speaking countries and asks that the Centigrade thermometer be employed in its place. The Centigrade thermometer is used for nearly all scientific purposes and is decidedly superior to the Fahrenheit instrument, but the latter is in familiar use among the great mass of people who use heat measuring instruments. Practically all English-speaking people use the Fahrenheit scale, even with all its inconveniences, and people who imagine that they can effect a change by an act of Congress reckon without authority. Nothing is more difficult than to change the established habits of a people, a truth which will slowly dawn upon the enthusiast who undertakes to change the meteorology of a nation.

On the Southern Railway new car shops will be constructed at Spencer, N. C., including a steel car shed 109 ft. by 600 ft. The shop will be 50 ft. by 100 ft.

Rail Inclination and Wheel Tread Contour

Railroading in India may be just as progressive and wide-awake as it is in America. We here quote from *Indian Engineering* of a recent issue. This paper says: "It is somewhat remarkable that American railways have not yet fallen in with the European practice of giving rails the inclination required to correspond with the angle of the coning of wheel treads. . . . Considering the important purposes served by coning of wheels there can be no question of ever abondoning it. . . . The inclination of the rail is a corollary of the coning of the wheel tread. . . . The question of rail wear and rail breakage is nowhere more live than it is in America, and if only a small part of these losses is due to the maintenance of a vertical rail the change is worth making, remembering it will benefit a mileage in the United States alone of over one-sixth above the railway mileage of the whole of Europe."

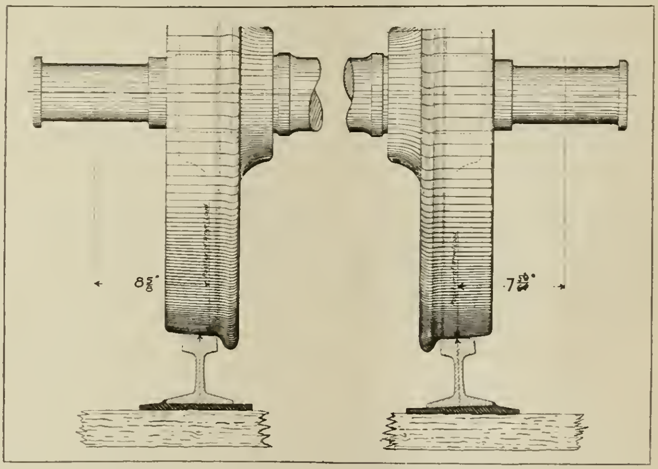
This quotation was sent to us by a gentleman who has taken a very intelligent and vital interest in the whole question of the relation of wheel to rail. We have recently published the opinion of Mr. George W. Lyndon, president of the Association of Manufacturers of chilled iron wheels, and in this issue there appears an article by Mr. F. K. Vial, the consulting engineer of the wheel makers' association.

It has been stated that the life of rail in the United States might be increased at least thirty per cent. by the judicious use of the inclined rail instead of the upright one. Whether this rather startling estimate of the prolongation of the life of rail, and corresponding reduction in the "rail" account, is a correct one or not, we cannot say. The whole matter can be proved by data from roads using the inclined rail, or verified or disproved by rational experiment.

Mr. Lyndon advocates the thickening of the flange of the chilled iron wheel by 3/16 of an inch. This he says can be done without altering the position of rail and guard rail, all over any system. To do this, however, each wheel would have to be mounted on the axle 3/32 of an inch nearer the rail. Let us for a moment glance at the effect of inclining the rail so as to bring wheel and rail into such relation as will reduce axle stresses as far as may be.

Our diagram indicates the conditions of contact between wheel and rail on both the upright rail and the inclined. The wear on the upright rail (left) is on the inside of the top of the head, while the wear on wheels is near the flange, producing in time the so-called double flanging. On the inclined rail (right) the wear is directly over the center of the rail, while on the wheel it is near the middle of the tread and parallel to the angle of the coning. It is only reasonable to estimate that wheel wear corresponds in some ratio to rail wear, as the surfaces of each perform work in the process of abrasion. It is perhaps unnecessary here to call attention to the well recognized fact that the present standard angle of coning (1 in 20) could not be much varied with any great advantage.

The saving of labor in turning worn steel wheels is not the only economy presented by the inclined rail in the equipment account; there is another, affecting journal bearings and axle stresses, which becomes apparent on consideration. It will be noted from our diagrams that in car wheels and their axles, the distance from the center of the journal bearing to the position of the wheel-load when the rail is inclined, is considerably less than it is with an upright rail.



LEVER ARM OF LEVEL (LEFT) AND INCLINED RAIL (RIGHT).

The diagrams show an 80-lb. rail of standard section. In the case of the upright rail, the distance from the center of the journal bearing to the position of bearing of the wheel on the rail is 8⅝ ins., while the corresponding lever-arm in the case of the inclined rail is 7 59/64 ins.; the difference, forty-five sixty-fourths of an inch (45/64), being in favor of the inclined rail. With a wheel load of 25,000 lbs. not an uncommon one nowadays, the reduction of bending moment in the axle, with the inclined rail, as compared with the upright rail, is therefore 45/64 in. x 25,000 lbs. = 17,578 inch-pounds. This reduction in bending moment in axles, where the stresses alternate every revolution, is surely worthy of the most careful consideration, not only by the mechanical men of a railroad company responsible for safety of train movement, but also by the higher executive officers.

If in order to thicken the flange of a chilled iron car wheel by 3/16 of an inch, it is, as Mr. Lyndon points out, only necessary to mount each wheel on the axle 3/32 of an inch nearer the rail. By this method we would shorten the lever-arm of today's practice, which is 8⅝ ins. on an upright rail, to 8 17/32 ins. This, if it be found to be in every way practicable, would reduce the axle stress considerably. Pushing the wheel over towards the rail would reduce the axle stress 2,344 inch-pounds.

As it is now with a level-arm of 8⅝ ins. from center of journal to wheel-on-rail position, this stress is 215,625 inch-pounds. When by the inclination of the rail the lever-arm becomes 7 59/64 ins., the axle stress sinks to 198,046 inch-pounds, or a reduction of the stress to 17,578 inch-pounds, and if the wheel position be pushed outward along the axle by 3/32 of an inch, the axle stress goes down another 2,344 inch-pounds. Mr. Lyndon's very practical proposal does not alter the arguments of those who believe we should go seriously into the question of inclining the rail.

As it is now, there is good reason to believe that the chilled iron car wheel can be improved and made stronger for the heavier work ahead of it, if future expectation can be measured by past achievement we have an excellent wheel tread contour. These other improvements appear to be so easily within our grasp that the time seems ripe for a joint consideration of wheel weight, and contour, together with rail inclination as has already been done in Europe.

Electrical Department

The Generation of the Electric Current

The few preceding articles have explained the meaning of several electrical terms, and we have discussed in detail Capacity and Inductance. In this article we will begin with the generation of electric current. Reference will be made to many, if not all, of the electrical terms previously discussed.

The electrical apparatus used for the generation of electricity is known as a Generator. The word "Dynamo" is found in a great many articles and refers to the same apparatus. The word Dynamo was used when electric machines were first built. It is derived from the Greek word, *dunamis*, meaning power, but later it has been very generally discontinued and the word "Generator" has been substitued.

All generators are based upon the discovery made by Faraday in 1831, that electric currents are generated in conductors by moving them in a magnetic field. Faraday's principle may be summed up as follows: "When a conductor is moved in a magnetic field, so as to cut the lines of force, there is an electro-motive force induced in the conductor, in a direction at right angles to the direction of the motion, and at right angles also to the direction of the lines of force."

A most useful rule for remembering this relation between motion, magnetism and induced current, is as follows: Hold the thumb, first and middle fingers of the right hand at right angles to each

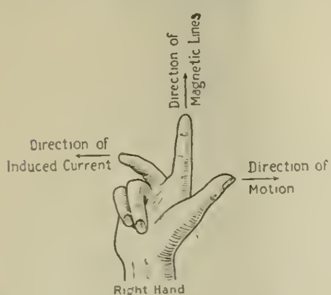


FIG. 1.

other, illustrated in Fig 1. If the thumb is pointing in the direction of the motion and the forefinger is pointing along the direction of the magnetic fields (the magnetic field is supposed to go from the north pole to the south pole), then the middle finger will point in the direction of the induced current. This rule is known as "Fleming's" rule. Another way of remembering the direction of the induced currents is to suppose a person swimming in a conductor and turning so as to look along the lines of magnetic force. If he and the conductor be moved towards his right hand he will be swimming with the induced current.

The induced electro-motive force or voltage is proportional to the number of magnetic lines cut per second. The magnetic lines in a generator radiate out from the pole pieces, around which are placed the field coils. It is a well-known principle that if a bar of iron has a number of turns of wire wound around it, and electric current is passed through these turns of wire, that the iron bar becomes a magnet with lines of force radiating from the ends. The greater the number of turns of wire, or with a given number of turns the larger amount of current passed through the wire, the greater will be the strength of the magnet so formed or, in other words, the larger will be the number of the lines of force.

We have stated that the voltage is proportional to the number of magnetic lines cut per second. With a constant speed of rotation, the induced voltage will increase in the strength of the field or, in other words, will increase with the number of lines of force radiating from the pole pieces. If the number of lines is kept constant, the voltage will increase with the increase in speed of rotation. In either case, the number of lines cut per second is increased.

In order to get some idea of the magnetic lines of force, we should conceive the whole of the space in the magnetic field to be traversed by lines. These lines can be used to specify the direction of the magnetic field and also the magnitude. The unit magnetic pole is one of such strength that when placed at a distance of one centimeter from a pole of equal strength it repels it with a force of one dyne. (For discussion of the dyne see February issue, page 62). If we imagine the number of lines per square centimeter of cross-section of the field equal to the number of dynes of force (on a unit pole), then we will have in the mind a sort of graphic representation of the strength of the magnetic field.

In order to understand Faraday's principle, we should have a clear conception of what a current of electricity really is as far as it is possible to know it. We know that a wire carrying an electric current looks in no way different from any other wire. No one knows what electricity is in itself, although we know about a great many things that it does. One thing is certain, however, and that is, that the energy does not flow in the wire itself but is transmitted along the outside and around the wire. We know that there is a magnetic field or magnetic lines for force surrounding a wire carrying electric current. The wire is surrounded by a sort of magnetic whirl as illustrated in Fig. 2. To set up this magnetic whirl requires an expenditure of energy and on breaking the circuit this

FIG. 2.

surrounding energy returns or flows back, tending to maintain the current and this causes the spark seen at the break of the circuit.

Referring to Fig. 3, we have a simple dynamo, the armature of which is represented by only one coil of wire but which serves as an illustration for the generality of electric generators. Consider the single rectangular loop of wire as rotating in a uniform magnetic field which exists between the poles of the large magnets, the direction of the lines of force, as we have stated previously, passing from the north pole to the south pole. If the loop be placed at first in a vertical plane, the number of lines that pass through it will be a maximum, but as it is gradually turned to the horizontal position, the number will be less and less until the minimum or zero is reached. Continuing the rotation, the lines begin again to penetrate the loop from the opposite side so that there will be a reversal in the direction of the flow of current induced in the coil. During the half revolution, the induced currents will be in the direction from back to front in the part of the loop which is rising on the left and in the opposite direction, namely from the front to the back, in that part which is descending on the right. If each end of the loop were separately attached to a metal collar on the shaft, and wires connected to springs were pressed on each of these collars an alternating current would be supplied to the circuit. All generator armatures are in principle as this simple one coil armature. There are, of course, many turns of wire but each turn is affected by the magnetic field as is this single turn.

There are, as we all know, direct current generators and alternating current generators. We have seen that there is a reversal of current in this single coil Fig. 3 as rotation takes place, and this reversal exists in all armatures whether of the direct or alternating current type. One might almost say that alternating current was the normal type and direct current a manufactured or derived type. In order to obtain direct current from any armature, it is necessary to make use of a commutator. This commutator consists of a series of copper bars, one

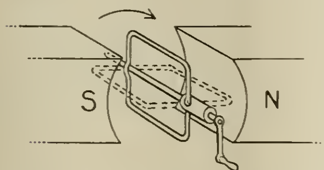


FIG. 3.

for each end of each coil on which are placed brushes. These brushes are set at such a location that the current is taken out of each coil in one direction only. The copper bar or commutator segment, as it is called, passes by the brush as the reversal of current takes place.

Referring back to the simple generator Fig. 3, the alternating current can be shown graphically by Fig. 4*A*. If a simple commutator was connected to this coil, then the reversed currents would be "rectified" and we would have a direct current which could be shown graphically by Fig. 4*B*. The current would be in one direction but not continuous. The continuous value is possible by means of a large number of coils on the armature. For instance, if one additional coil was used in this simple dynamo, placed at right angles to the one illustrated, and connected to the commutator, we would have a "rectified" current super-imposed on the other current and as shown by the dotted curves Fig. 4*B* since this coil would be 90 degs. from the other coil. The zero current value would occur in the second coil when the maximum occurs in the first coil. It may

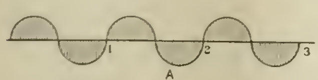


FIG. 4 A.

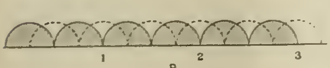


FIG. 4 B.

now readily be seen that, adding more and more coils, the variations become smaller and smaller and with a large number of coils, as in modern generators, these variations cannot be detected and the current is practically continuous, and of uniform value.

The direct current generator produces in the circuit a constant and steady voltage. This voltage exists even when no demand is made on the generator, that is, when no electric current is flowing. The situation is analogous to an air blower or fan. The office of the fan is to create a certain air pressure and the quantity of the resultant current of air is modified by the friction or resistance of the pipe or ducts through which the air flows. If this duct leading from the fan be entirely closed off, no air is carried away but nevertheless, the rotation of the fan maintains the air pressure inside of the fan casing. The energy of this air current when the duct is open, is directly proportional to the product of the pressure given by the fan and the quantity of the air flowing. A generator operating upon an open circuit has only to raise the electrical pressure or voltage between the brushes. As the circuit is open, no energy is expended in the circuit and the only energy required to keep up the rotation of the generator is that necessary to overcome the frictional resistances of the machine itself. If current is taken out of the generator, say for the burning of lights or the operation of electric motors, the energy delivered by the generator is directly proportional to the product of the current and the voltage. The energy therefore required to drive the generator under these conditions is proportional to the output.

The above conditions apply in general to alternating current generators. When operating upon an open circuit it raises the voltage between the brushes, but this voltage is not constant as in the case of the direct current generator but, as we have seen, varies from zero to its maximum (say 110) again back to zero, then to a negative maximum and back to zero. This variation is known as a "cycle" and many of these occur per second according to the "frequency" of the generator. On connecting the generator to a circuit of lights or to motors, a current will flow as in the case of the direct current machine. Since the voltage is not constant but varies, we would naturally expect that the current would vary, and this is true. The variations being of the same number as the voltage variations. The voltage and current go out in the form of waves. Some idea of how this electrical energy passes along the wire can be shown by a simple experiment. If one end of a long piece of rope is made fast to an object and so held stationary and the other end is moved rapidly up and down, the rope not being pulled tightly, a series of waves will progress along the rope from the moving end. It must not be supposed that the conductor carrying the electric energy moves and takes the form of waves as does the rope. It is the electrical energy itself which takes the wave form. It should also be remembered that although the wave form progresses along the rope, the particles of the rope only move up and down, proving that the wave motion is a propagation of form, not of matter.

Inductance and capacity exercise a most powerful influence on an alternating circuit. The lines of force in the case of the alternating current, are changing continually so that the inductance becomes an important factor. It is practically impossible to insert into an alternating circuit the right amount of capacity to completely neutralize the inductance or vice versa. However, when the inductance and capacity are approximately neutralized there is a condition set up which is analogous to a similar acoustic phenomenon and is spoken of as electrical resonance. We have mentioned that electrical transmission of energy is believed to take place by a series of waves; hence every circuit can have a natural period of vibration of its own as does a tuning fork. If a voltage be applied to a circuit for an instant, a wave moves along it, is reflected from the ends, and travels backwards and forwards. An analogous phenomenon can be observed by striking a long wooden rod with a hammer. A vibration will travel backward and forward along the rod being deflected from each end until the energy is dissipated in sound and heat. The period of vibration of the rod depends upon its elasticity and its density. The elasticity and density of the rod is represented by inductance and capacity of the electrical circuit. If the period of vibration or resonance of the circuit is in step with the applied voltage, then these waves will pass freely through the circuit.

The reason for employing alternating currents for electric lighting and power is to enable the cost of conductors to be reduced, as it is possible to use high voltages for transmission, reducing this high voltage to the suitable voltage for the lights, by transformers. The cross section of a wire necessary to transmit a given amount of electrical energy in watts with a given percentage loss in volts, is inversely proportional to the square of the voltage used, that is, if the voltage is raised from 500 volts to 1,000 volts, the size of wire can be reduced to one-quarter the cross section and weight. The great advantage thus obtained by the use of high voltage can be realized either by a saving in the weight of wire or by sending the current to a greater distance with the same size of wire.

New Shops on the Boston & Maine.

A new locomotive shop will be constructed for the Boston & Maine at East Deerfield, Mass. It will be of brick and steel construction 40 ft. in height, and 170 ft. wide, and 200 ft. long. The H. Wales Lines Company has secured the contract, and the work will be rapidly proceeded with.

You won't find half so much fault in me if you think of me in my forge dress, with my hammer in my hand, or even my pipe.—Great Expectations.

The Air Brake as an Insurance Against Accident

By WALTER V. TURNER, Assistant Manager, Westinghouse Air Brake Co.

Using American railway statistics for the year 1914, the average per diem mileage for each freight car is 24.5 and the average lead per car, involving empty and loaded car movements, is 13.9 tons. The revenue per ton mile, that is, the cost to the consumer of the railroad's product is the astonishingly low figure of 0.733 cents, a rate unequalled by any other nation on the face of the globe for transportation. The product of these three figures gives $2.50 as the daily revenue of a freight car. An annual depreciation and maintenance charge of 4 per cent. added to 6 per cent. for the interest on the investment, gives a total of 10 per cent. which, applied to an average cost of $40 for the air brake equipment per car, results in a daily charge of 1.095 cents for this equipment. This is but forty-four one-hundredths of one per cent. of the daily revenue which the brake makes possible, a revenue, which without the brake, would drop to five cents per day or less with the same ton-mile charge, instead of the above $2.50, due to the fact that the ton-mile per car would be cut 40 times; that is, it would take 40 cars without brakes, theoretically speaking, to do the work of one car equipped as at present. Practically considered, it is impossible to say how much the unit costs per ton mile would be raised if the brake were dispensed with, for the features of necessary grade reduction, lack of flexibility and safety, make it absurd to attempt an estimate.

However, using this same basis, it is found that an additional investment for the brakes of 4 per cent. of the value of the car, using 1,000 for the latter, increases its capacity forty fold. In other words, an investment of 40 dollars corresponds to an alternate investment of 39 times $1,000 or $39,000. Assuredly it requires no marked business acumen to choose between these alternatives.

It may be advanced that other countries, using brakes which do not even approximate ours in efficiency (to say nothing of cases where automatic brakes are not used at all) are getting along; are hauling freight every day, and are keeping trains in motion pretty well generally. I wonder if anyone advancing such an argument is aware of the fact, that despite greatly reduced labor costs, the ton-mile rates elsewhere are a number of times greater than ours. This is of great concern to us, for, in the last analysis, a difference in freight rate of one dollar per ton for a certain haul may mean two or three times this amount before the bill reaches the ultimate consumer, not the shipper, but the ultimate consumer of the article shipped. And after all the final economic burden always rests upon the commonwealth.

In a paper read before the Franklin Institute of Philadelphia, I quoted Mr. W. E. Symons in a previous discussion of Car Brake Installation, in which in estimating the value of a train with 200 passengers, on the usual legal estimate of passenges, the train and its contents would be worth $1,157,000 and the brakes on the train would be worth approximately $2,275, which is a little less than two-tenths of one per cent. (0.195).

Insurance has developed wonderfully within the past few years into an exact and indispensable science, an institution which wholesomely establishes more firmly every day that economic equity towards which we shall and must come some day. Did you ever consider the air brake in relation to insurance? Suppose that we assume that each full train equipment mentioned by Mr. Symons makes 150 trips per year between New York and Chicago. This is a very conservative estimate, providing ample time for terminal layovers. The average per diem value of the train must then be taken at 150/365 x $1,157,000 or 475,000, as it takes approximately one day for each trip. It is difficult to say where the line should be drawn between insurance charges for the air brake and the service or traffic charges, because the insurance rises in the potential or latent power of the brake to make an emergency stop when the necessity therefore arises, and therefore practically all the wear and tear comes in, and should be charged to ordinary service. Using the liberal allowance of an annual charge of 4 per cent. for depreciation and maintenance and 6 per cent. for the interest on the investment, the total daily charge on $2,275, the cost of the equipment (brake), of almost 62 cents. This is 13 one hundred thousands of one per cent. of the train value, quite a remarkable insurance rate. Even if multiplied one hundred times in order to include everything involved in the operation of the train, such as signal systems, etc., it still remains at an unusually low rate.

Of course, safety appliances are in the nature of preventive insurance, for in the event of a wreck there is no reimbursement for the damage. It is about as difficult to estimate the insurance value of the air brake to transportation by rail as it is to estimate that of the compass to transportation by water. It may seem startling to liken the worth of the air brake to that of the compass, but it is true that each is indispensable to its own service, and it may seem even more startling to say that the air brake is of even greater value than the compass. This is not so extreme however, when one reflects that all of the tonnage handled, or practically all of it, handled by water is also handled by rail, and that much tonnage is carried by rail which has nothing to do with water shipment. In other words, transportation by rail is the most important because there is more of it.

The hazard for transportation by rail calls for about a 1.25 per cent. rate in the insurance world. The better insurance comparison would then be this compared with the rate that would be demanded in the event that all railways would be stripped of their air brake apparatus. The rate would jump so high and to such an uncertain figure that in all likelihood no insurance company would be even willing to consider the proposition.

I have attempted to point out a contrast of the most extreme conditions in order that the present stage of railway science may be measured as nearly as possible on an absolute scale. All intermediate comparisons may be had according to the development stages which are compared. To provide for the making of comparisons of degrees or in greater detail and to facilitate an accurate analysis of all the factors and their limitations for maximum traffic capacity I have prepared the following outline:

TRAFFIC CAR CITY FACTORS AND THEIR LIMITATIONS FOR MAXIMUM TRAFFIC ON STEAM AND ELECTRIC RAILWAYS. RIGHT OF WAY CONDITIONS CONSTANT.

Factors. Car unit. Determined and limited by. Length of car. Clearances on curves. Width. Clearances. Height. Clearances.

Car Capacity.—Weight. Rails and road bed. Bridges. Contrast between empty and loaded weight. Dead weight per ton of lading. Volume of air for control. Brake shoe duty. Draft gear capacity.

Carl Loading (average percentage of possible capacity realized).—Cooperation on part of shippers. Reduction of empty hual. Grouping of l. c. l. lots.

Per Diem Mileage.—Terminal facilities for loading. Unloading. Maintenance. Demurrage.

Maintenance.—Organization. Cost.

Train Unit.—Locomotive capacity. Single shoe brake rigging. Length of sidings. Station platform length (electric railways).

Train Length—Number of Cars.—Train control. Slack action. Serial brake action. Electro pneumatic brake. Uniform braking ratio. Impact—slid flat wheels. Foundation brake gear. Brake cylinder pressure regulator. Grade service. Volume of air. Release of brakes. Draft gear capacity.

Time of Station Stops.—Car door arrangement and capacity for ingress and egress. Station arrangement. Local conditions as to number of passengers to load and unload. Picking up and setting out cars. Making up trains in rapid transit service. Automatic car, air and electric couplers.

Delays to Trains.—Terminal facilities. Trains getting out of or into yards. Defective or inadequate equipment.

Acceleration.—Locomotive equipment—steam railways. Motor equipment—electric railways. Line voltage regulator. Regenerative braking. Selective relays for empty and loaded condition of motor cars. Number of motors and trailers in train. Train resistances. Foundation brake gear. Grade.

Maximum Speed.—Acceleration. Station spacing. Retardation. Electro pneumatic brake. Grade. Running control. Stops. Curves.

Retardation.—Maximum speed. Weight of car. Volume of air. Brake shoe duty. Difference between empty and loaded condition. Foundation brake gear. Number of cars—shocks due to serial brake action. Air brake equipment. Rail conditions. Regenerative braking.

System of Trains.—Factors. Determined and limited by. Safety. Retardation. Maximum speed. Installation and characteristics of signal equipment.

Headway or Spacing of Trains.—Acceleration. Length of trains. Time of station stops. Speed control devices. Local roadway conditions. Station spacing. Curves. Grades. Interlocking plants. Bridges. Junctions, etc.

Air Brake Repair Work Tools Devised and Applied to Every Requirement

By GEORGE K. DORWART, Denver, Colo.

NO. 7. ANVIL BLOCK FOR REMOVING AND RIVETING SPRING RIVETS.

The annexed drawing shows the details of an anvil block, which when clamped in bench vise at the projection marked A, will be found very convenient for removing and riveting spring rivets on the following parts in connection with engine air brake repair work: Distributing valve, application valve spring pin, application piston spring pin, equalizing piston spring pin. F 1 and F 2, triple valves, slide valve spring pin.

This block may be readily adapted to include all types of passenger and freight triples by drilling suitable holes. The pin holes are scribed on block from the desired valves and, although there may be quite a number of holes, no confusion will arise owing to the fact that when the valve is placed in contact with the projecting rib the proper hole will register underneath pin.

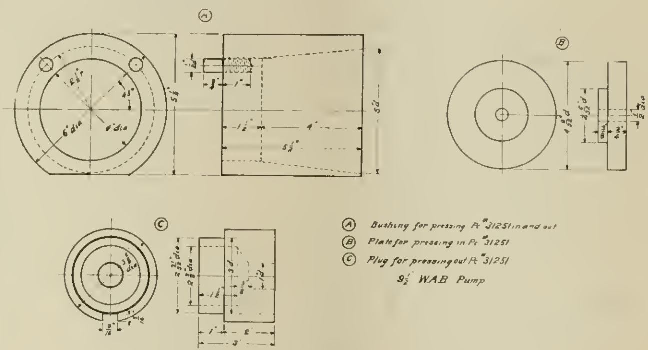


FIG. 8.

NO. 8. BUSHING, PLATE AND PLUG.

In the accompanying drawings A, B and C are furnished the details of three separate tools, easy of construction and well adapted for the purposes for which they are intended. A shows a bushing for pressing Pc. No. 31251 in and out of place. B illustrates plate for pressing in Pc. No. 31251. C gives details of a plug for pressing out Pc. No. 31251. The three tools are designed for use on the 9½-in. Westinghouse air brake pump and will be found to meet the requirements of the service.

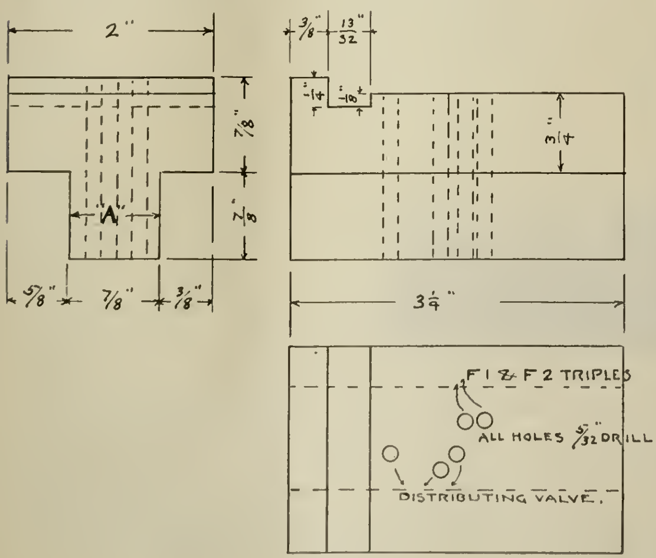


FIG. 7.

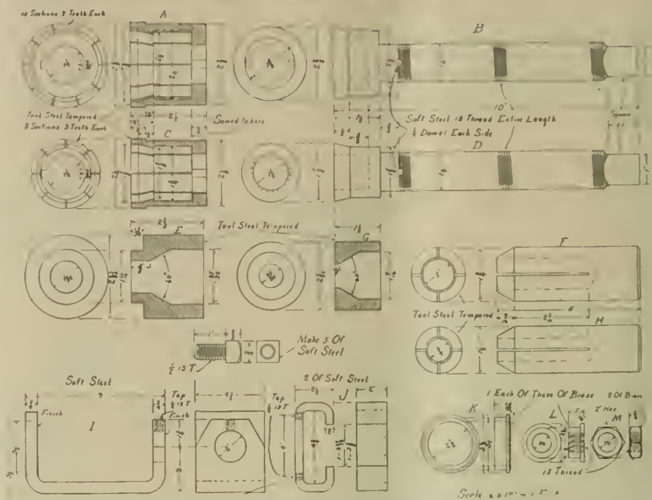
The American Railroads.

Since the first mile of railroad track was laid in the United States the country has bounded forward in population, production and political power until it now holds the most commanding position in the world. It has 45 per cent of all the railroads in the world. Three millions of square miles have been gridironed by 250,000 miles of railroads, contributing to the needs of over 100,000,000 people.

Reamers and Swages Used in the Repairing of Air Pump Governor Cylinders

By L. E. BOWEN, Air Brake Foreman, Illinois Central Railroad

The accompaning illustration shows a reproduction of a drawing of a set of reamers and swages adapted for repairing 1 in. and 1¼ in. air pump governor cylinders. The reamers, as shown, are of the expanding type, and if properly constructed and tempered will do excellent work, and can be readily made in the average railroad repair shop. Reamer A, frame I, and clamp J, are used to ream 1¼ in. cylinders. Reamer C is used to ream 1 in. cylinders. The pieces E and F are used to swage the inner portion of the 1¼ in. cylinders when the steam valve stem goes through so that the stem may be refitted and prevent the waste of steam. The pieces G and H are used for swaging the 1 in. cylinders. A reamer should be used for each stem about .008 in. smaller than the standard in order to insure a fine fit. Applying over size pistons and refitting steam valve stems reduces the cost of repairs and makes an excellent job. A couple of old cylinder caps should be bored out to fit the swages F and H, to act as guides.



DETAILS OF REAMERS AND SWAGES FOR REPAIRING AIR PUMP GOVERNOR CYLINDERS.

Type of Eight-Wheel Locomotive for the Northeastern Railway of England

By ROBERT W. A. SALTER, London, England

The accompanying reproduction of a photograph illustrates a type of eight-wheel superheated locomotive recently placed in freight service on the Northeastern railroad of England.

These engines, capable of taking 1,200 tons along the level at a speed of 20 miles per hour, are employed for mineral work. They are fitted with the Schmidt superheater (24 elements), and have Stephenson's link motion, with steam reversing gear. The following are the principal particulars:

Cylinders 20 in. diameter x 26 in. stroke; boiler 15 ft. long with diameter of 5 ft. 6 in.; firebox 8 ft. long. The capacity of the tanks is 3,375 gallons, and the well 565, which gives a total of 3,940. Coal space is 5 tons. The total weights of the engine in working order and light are, respectively, 65 tons 18 cwt. and 59 tons 1 cwt.; the tender weighs 41 tons 4 cwt. in working order and 20 tons light.

Heating surface is as follows: Water contact, 90 tubes 2 in. diameter 722.2 sq. ft., 24 tubes 5¼ in. diameter 504 sq. ft.; fire contact, superheater heating surface 544.8 sq. ft., heating surface in firebox 144 sq. ft. These give a total of 1915 sq. ft. Firegrate area is 23 sq. ft., and boiler pressure 160 lbs. per sq. in.

It is interesting to note that the Northeastern now includes as part of its system the famous line between Stockton and Darlington—the first railroad.

EIGHT-WHEEL LOCOMOTIVE FOR THE NORTHEASTERN RY. OF ENGLAND.

Better Than Really Required.

The advisability of substituting a cheaper grade of gasoline, known as "motor gasoline," for use in railway turntable motors and other similar machines, was taken up some time ago by the mechanical department officials of a large railway. The gasoline previously used was that specified by the railway company itself. This change in the quality of the gasoline used did not effect the service in any way, but exclusive of motors used outside the mechanical department, a saving per year of $4,000 can be credited to that department.

The matter of using this cheaper, but equally satisfactory "motor gasoline" for section men's motor cars was brought to the attention of the general manager of the railway and the mechanical department saving urged as a reason for the trial of the cheaper grade on track vehicles and on some McKeen motor cars owned and operated by this road. It is quite likely that a substantial saving will be effected in these two items, though we have not the figures before us at this writing and cannot give them to our readers. The gasoline question is quite a "live issue" with many concerns, and the satisfactory results obtained by the mechanical department of this road will no doubt stimulate investigation along these lines by others of the "common carriers," who desire economies in the smaller but constant expenditures.

Items of Personal Interest

Mr. H. F. Emerson has been apointed road foreman of engines of the Pennsylvania Lines West, with office at Crestline, Ohio.

Mr. W. F. Stoops has been appointed assistant road foreman of engines of the Pennsylvania Lines West, with office at Conway, Pa.

Mr. R. D. Quickel has been appointed fuel agent on the Southern Railway Lines West, with headquarters at Cincinnati, Ohio.

Mr. D. H. Varnell has been appointed fuel supervisor of the Louisiana division of the Texas & Pacific, with headquarters at Alexandria, La.

Mr. A. W. McLean has been appointed general foreman of the Rock Island shops at Haleyville, Okla., succeeding Mr. S. Jolley, resigned.

Mr. George L. Ernstrom has been appointed road foreman of the Yellowstone division of the Northern Pacific, with headquarters at Glendive, Mont.

Mr. J. E. McQuillen, mechanical superintendent of the Gulf, Colorado & Santa Fe, has had his headquarters changed from Cleburne to Galveston, Tex.

Mr. Irving Williams has been appointed master mechanic of the Cumberland Valley, with office at Chambersbburg, Pa., succeeding Mr. R. G. Bennett, resigned.

Mr. F. W. Board, formerly general mechanical inspector of the Texas & Pacific, has been appointed fuel agent on the same road, with office at Dallas, Tex.

Mr. N. F. Thompson, formerly assistant district engineer of the New York Central at New York, has been appointed district engineer, with headquarters at Albany, N. Y.

Mr. George H. Berry has been appointed general foreman of the Louisville & Nashville machine shops at Louisville, Ky., succeeding Mr. Paul C. Huber, deceased.

Mr. John Deifenbaker has been appointed roundhouse foreman of the Santa Fe at Moline, Kans., succeeding Mr. George Havener, retired under the pension system.

Mr. E. Tasker, formerly car foreman of the Canadian Pacific at Crowsnest, B. C., has been appointed car foreman at Field, B. C., succeeding Mr. M. J. Jordan, transferred.

Mr. C. E. White, formerly manager of the Detroit Battery Company, Detroit, Mich., has been appointed manager of the Chicago branch of the United States Light & Heat Company.

Mr. H. R. Pennington, formerly traveling electrical inspector of the Chicago, Rock Island & Pacific, has been appointed supervisor of electrical equipment, with headquarters at Chicago, Ill.

Mr. James T. Eagan has been appointed assistant road foreman of engines of the Buffalo, Rochester & Pittsburgh, in charge of the district between East Salamanca, N. Y., and Du Bois, Pa.

Mr. F. H. Hardin has been appointed master mechanic of the Adirondack division of the New York Central, with office at Utica, N. Y., succeeding Mr. C. F. Deaner, assigned to other duties.

Mr. O. F. Dalstrom, formerly chief draftsman in the bridge department of the Chicago & North Western, has been appointed bridge engineer on the same road, with headquarters at Chicago, Ill.

Mr. Frank E. Cooper, formerly general foreman of the Baltimore & Ohio, with office at Newark, Ohio, has been appointed superintendent of shops at the same place, succeeding Mr. W. Malthaner.

Mr. W. Y. Cherry, formerly enginehouse foreman of the Pennsylvania Lines West of Pittsburgh at Allegheny, Pa., has been appointed master mechanic of the Grand Rapids & Indiana, with office at Grand Rapids, Mich.

Mr. J. C. Roesch, formerly superintendent of the International & Great Northern at Mart, Tex., has been appointed chief engineer, with headquarters at Houston, Tex., succeeding Mr. O. H. Crittenden, deceased.

Mr. D. J. McQuaig, formerly general foreman of the Grand Trunk at Ottawa, Ont., has been appointed acting master mechanic of the Ontario lines, with office at Toronto, succeeding Mr. W. G. Sealy, assigned to other duties.

Mr. R. N. Kuhn, formerly roundhouse foreman of the Baltimore & Ohio at Flora, Ill., has been transferred to a similar position on the same road at Washington, Ind., and Mr. E. J. Dibble succeeds Mr. Kuhn at Flora.

Mr. H. A. Matthews, formerly manager of the railway sales department of the United States Light & Heat Corporation at Chicago, Ill., has transferred his headquarters to the company's general offices at Niagara Falls, N. Y.

Mr. F. T. Huston, formerly general car inspector of the Pennsylvania Lines West of Pittsburgh, at Fort Wayne, Ind., has been appointed assistant engineer of motive power on the same road, with headquarters at Fort Wayne.

Mr. E. Langham, purchasing agent of the Canadian Northern on the lines West of Port Arthur, has had his authority extended over the entire system, with the title of general purchasing agent, with headquarters at Toronto, Ont.

Mr. C. W. Hyde, formerly road foreman of equipment of the Chicago & Eastern Illinois, at Salem, Ill., has been appointed master mechanic of the Illinois division, with headquarters at Villa Grove, Ill., succeeding Mr. W. R. Meeder, resigned.

Mr. S. E. Westover has resigned his position as general boiler foreman of the Oregon-Washington Railroad and Navigation Company, and has accepted the position as superintendent of boiler construction of the Willamette Iron and Steel Company at Portland, Ore.

Mr. F. W. Douglas, chief engineer of the electrical department of the Atlanta Joint Terminals of the Louisville & Nashville, the Atlanta & West Point, and the Georgia Railroad at Atlanta, Ga., has been appointed master mechanic, in addition to his other duties, succeeding Mr. G. W. Eaves, resigned.

Mr. Charles Haines Williams, of the Chicago Railway Equipment Company, Chicago, has been elected first vice-president of the company. Mr. Williams has had a wide experience as a railroad man, and has been engaged for a number of years as mechanical inspector with the equipment company.

Mr. L. A. Mattimore has been appointed master mechanic of the Arizona division of the Atchison, Topeka & Santa Fe Coast Lines, with office at Needles, Cal., succeeding Mr. G. A. Armstrong, transferred as master mechanic to the Los Angeles division, with office at San Bernardino, succeeding Mr. J. C. Hicks, promoted.

Mr. F. Ronaldson, formerly district master mechanic of the Farnham division of the Quebec district of the Canadian Pacific at Farnham, Ont., has been appointed master mechanic of the Ontario district of the same road, with office at Toronto, succeeding Mr. A. H. Kendall, appointed Captain in the Canadian forces.

Mr. William Pollock has been appointed master boiler maker of the Baltimore & Ohio, at Pittsburgh, Pa., Glenwood shops, succeeding Mr. John Howe, transferred to a similar position at the Mt. Clare shops, Baltimore, Md., and Mr. M. C. Mickels has been appointed assistant boiler shop foreman at the Glenwood shops.

Mr. W. N. Ingram, formerly master mechanic, district No. 5, Intercolonial division of the Canadian Government Railways at Edmunton, N. B., has been appointed master mechanic, district No. 4, Intercolonial division, with office at Stellarton, N. S., succeeding Mr. H. D. Mackenzie, transferred from district No. 4 to district No. 5.

Mr. P. Alquist, formerly superintendent of the car department of the Missouri, Kansas & Texas, with headquarters at Denison, Tex., has been appointed to a similar position on the Pere Marquette, with office at Detroit, Mich., and Mr. T. P. Cleaver has been appointed foreman of the car department of the Missouri, Kansas & Texas, with office at Smithville, Tex.

Mr. J. J. Karibo has been appointed master mechanic of the eastern district of the Cleveland, Cincinnati, Chicago & St. Louis, with office at Bellefontaine, Ohio, succeeding Mr. W. J. Frauendiener, resigned; and Mr. E. J. Buckbee has been appointed master mechanic of the western district of the same road, with office at Mattoon, Ill., succeeding Mr. Karibo.

Mr. Amos Wilson, formerly special instructor in the motive power department of the Delaware, Lackawanna & Western at Scranton, Pa., has been appointed supervisor of fuel service, with headquarters at Scranton, succeeding Mr. M. C. M. Hatch, resigned; and Mr. J. R. Steed has been appointed assistant supervisor of fuel service, with headquarters at Scranton.

Mr. Arthur L. Jacobs, who for seventeen years was in charge of the Water and Electric Light Department of the city of St. Louis, has joined the Research Department of the Powdered Coal Engineering and Equipment Company of Chicago. This company is now preparing elaborate plans for many installations of their carburization process in the burning of powdered coal as fuel.

Mr. J. L. Bacon has been appointed mechanical representative of the Economy Devices Corporation, in charge of the Eastern territory, with headquarters in New York. Mr. Bacon is a graduate of Cornell University, and served four years as special apprentice in the General Electric Company's shops at Schenectady, N. Y., and was employed for some time in the operating department of the Interborough Rapid Transit Company, New York, and for the last few years was engaged in the mechanical department of the New York Central.

Mr. Henry Honaker, formerly master mechanic of the St. Louis-San Francisco, has been appointed assistant general superintendent of motive power on the same road, with headquarters at Springfield, Mo., and Mr. H. L. Worman, formerly traveling roundhouse inspector of the St. Louis-San Francisco, has been appointed master mechanic of the Southern division of the same road, with office at Memphis, Tenn., succeeding Mr. Honaker.

Mr. Edward E. Loomis, formerly vice-president of the Delaware, Lackawanna & Western, has been elected president of the Lehigh Valley Railroad. Mr. Loomis began his railroad career in the law offices of the Denver & Rio Grande in 1883. In 1884 he was appointed secretary to the general superintendent of the New York & Lake Erie, and was promoted to chief clerk in 1887, and chief clerk to the general manager in 1892. In 1894 he was appointed superintendent of the Tioga division of the same railroad, and in 1899 he was appointed superintendent of the New York, Susquehanna & Western, and the Wilkes-Barre & Eastern. In the same year he was appointed superintendent of the Lackawanna in charge of the mining department. Latterly he served as vice-president of the same road as above mentioned.

EDWARD E. LOOMIS

OBITUARY.

Frederick Charles Budden.

Frederick C. Budden, treasurer of the Hay-Budden Manufacturing Company, Brooklyn, N. Y., died at his home in Brooklyn on the 23rd of last month in the 62nd year of his age. Mr. Budden learned blacksmithing in Southampton, England, and came to America at an early age, and was employed for some time in the printing press works of R. Hoe & Company, New York. In 1886 he entered into partnership with Mr. James Hay, and the firm developed among other products the first anvil manufactory in America. Under their joint management the firm was very successful. Mr. Budden was active in promoting the welfare of the district where he lived, being prominently identified with building and other societies.

FREDERICK C. BUDDEN

Albert Clark Stebbins.

Mr. Albert C. Stebbins, a vice-president of Niles-Bement-Pond Company, 111 Broadway, New York, died on February 28, at Plainfield, N. J. He learned the machinist trade in New England, and in 1875 was appointed shop superintendent in the Pond shops at Worcester, Mass. Mr. Stebbins directed the construction of the extensive shops at Plainfield, N. J., and was elected vice-president of the company and manager of the Pond Works. He served as a member of the City Council and also as vice-president of the Dime Savings Bank of that city. Mr. Stebbins was 73 years of age.

Walter Katte.

Mr. Walter Katte, for many years chief engineer of the New York Central, died on March 4 in New York in his 87th year. He had a distinguished career as a railroad and bridge constructor. In the Civil War he was Colonel of an engineer regiment in the Union Army. He served as chief engineer of the Third and Ninth avenue elevated railways in New York, and also constructed the West Shore railroad and rebuilt the N. Y. C. Line in Park avenue, on the present elevated structure.

Oscar G. Murray.

Oscar G. Murray, chairman of the board of directors of the Baltimore & Ohio Railroad, and formerly one of the receivers and later first vice president in charge of traffic and the predecessor of Daniel Willard as president of the company, died in Baltimore, March 14, of a complication of diseases. The death of Mr. Murray removes from the railroad world one of the widest known executives of the last generation. Mr. Murray would have been 70 years of age on May 20, next, having been born at Bridgeport, Connecticut, in 1847.

John Hickey.

John Hickey, consulting engineer for the Salt Lake & Utah Railroad and regarded as one of the leading authorities on mechanical engineering in the West, died in Salt Lake City last month. Mr. Hickey filled many important positions in the Western railroads, among others that of superintendent of motive power of the Northern Pacific at St. Paul, Minn. He was president of the Master Mechanics' Association from 1891 to 1893.

Railroad Equipment Notes.

The Seaboard Air Line is in the market for 1,000 box and 1,000 flat cars.

The Pere Marquette is inquiring for six Santa Fe (2-10-2) type locomotives.

The Illinois Central is reported planning a shop and roundhouse at Palestine, Ill., to cost $100,000.

The Michigan Central has ordered 7,000 tons of rails from the Illinois Steel Company for 1918 delivery.

John D. Williams, New York, is inquiring for 100 steel box and 100 wooden-covered cars for China.

The Southern Railway is reported as having ordered 2,000 cars from the Pressed Steel Car Company.

The Philadelphia & Reading has ordered 20 Consolidation locomotives from the Baldwin Locomotive Works.

The Chicago Burlington & Quincy has ordered 125 12,000-gal. tank cars from the Standard Steel Car Company.

The Midvale Steel & Ordnance Company has ordered 1,000 steel coal cars from the Cambria Steel Company.

The Interborough Rapid Transit Company has ordered 477 cars, including trucks, from the Pullman Company.

The Union Tank Line has ordered 1,000 10,000-gal. capacity tank cars from the American Car & Foundry Company.

The Nashville Chattanooga & St. Louis has ordered 10 Mikado (2-8-2) type locomotives from the Baldwin Locomotive Works.

The Canadian Government Railways are reported as having ordered 20 locomotives from the Canadian Locomotive Company.

The Delaware & Hudson Company is expected to be in the market soon for equipment for its Colonie shops, Watervliet, N. Y.

The Belgian State Railways have put out an inquiry from Havre, France, for about 25,000 tons of steel rails of a weight approximating 85 lbs.

The French Government has placed an order for 50,000 tons of steel rails for delivery in 1918 with United States Steel Corporation subsidiaries.

The Belt Railway of Chicago has ordered five Santa Fe (2-10-2) type locomotives for hump yard service from the Baldwin Locomotive Works.

The Union Tank Line Company has ordered 1,000 tank cars from the American Car & Foundry Company, and 1,000 from the Standard Steel Car Company.

The Alaskan Engineering Commission has placed an order with the United States Steel Products Company for rails, angle bars, track bolts and spikes costing approximately $467,000.

The Canadian Government Railways has issued an inquiry for 1,830 tons of angle bars, 200 tons of track bolts with Harvey grip thread, and about 6,000 kegs of railroad spikes for delivery from June 15 to September 1, next.

The Grand Trunk has ordered 15 Mikado (2-8-2) type locomotives; five of which will be built by the American Locomotive Company and ten by the Canadian Locomotive Company. Each of these engines will weigh 276,000 lbs., exclusive of tender, which will have an additional weight of 165,800 lbs.

The Russian Government is expected to place additional orders for freight cars. Russia recently ordered 3,000 box cars of 1,200 poods capacity (approximately 43,200 lbs.) from the Eastern Car Company. Of these 600 will have air brakes and hand brake operated from the platform at one end of the car, and 2,400 will have air brakes but no hand brake or platform.

The Union Pacific system has ordered 68 locomotives from the Baldwin Locomotive Works. The order includes 25 six-wheel (0-6-0), 31 Mikado (2-8-2), 5 Santa Fe (2-10-2) and 7 Pacific (4-6-2) type engines. The Union Pacific also ordered 16 250-ton Mallet type locomotives from the American Locomotive Company. Cylinders will be 26 and 41 by 32 ins.

The Chicago, Rock Island & Pacific, already reported as being in the market for 20 Mikado and 10 Santa Fe type locomotives, has ordered these engines from the American Locomotive Company. The Mikado locomotives will have 28 by 30-in. cylinders, and a total weight in working order of 330,000 lbs. The Santa Fe type locomotives will have 30 by 32-in. cylinders, and a total weight of 380,000 lbs.

The Boston & Maine will install a 56-lever electro-mechanical interlocking plant at North Cambridge, Mass. The type "S-8" interlocking machine will be a combination of a 28-lever, S. & F. frame, having 9 levers for 9 signals, 6 levers for 8 switches and 7 levers for 8 facing point locks. The electrical section will comprise 7 levers for 18 signals and 21 spare spaces. The construction work will be performed by the regular signal forces of the railroad, the machine being furnished by the Union Switch & Signal Company.

Fifteen hundred 20-ton (metric) four-wheeled high-sided gondola cars, and 500 sets of steel work are being shipped from Montreal to France for the Paris-Orleans Railway. They have a light structural steel underframe, steel side frame, and end frame with wood lining, being of the regular Continental type. The cars are equipped with forged steel drawhooks, cast steel buffers with springs, forged screw couplings and safety chains. The brake arrangement is of the hand lever type, the brake being applied from the ground and operates on one wheel only. They have been built by the Canadian Car and Foundry Company, Ltd.

Additional Safety Methods on Railroads.

The American Railway Association has approved of an improved system of warnings to automobile drivers in crossing railroad tracks by adopting a uniform system of painting crossing gates with alternate stripes of black and white to make them more striking. Circled warning signs at points on the highway 300 feet on each side of the crossing are also approved. The signs have "R. R." painted in black on a white background together with a black cross. The adoption of a circular disc 16 inches in diameter with the word "Stop" painted in black upon a white background will be used by the crossing guards, instead of the red and green flags formerly used. The Chicago & Northwestern will be among the first in the country to witness the installation of these devices.

Manufacturers as Engineers.

It was formerly the rule for a manufacturer who was not an engineer to confine himself to the trade in which he was especially engaged, and, when necessity arose, to call in an engineer to advise him as to the purchase of a piece of equipment. It is now the custom for the manufacturer, to a considerable extent at least, to depend upon his own judgment, aided by those who would sell him the apparatus he is looking for.

New Roundhouse on the Lehigh Valley.

A new, reinforced-concrete engine house at East Buffalo, a fifteen-stall addition to the present engine house at Tifft Farm, together with new machine shops, power house, oil houses, etc., are improvements which the Lehigh Valley Railroad has begun building in this section of its territory. Contracts for their construction have been awarded to the Westinghouse-Church-Kerr Company. The East Buffalo engine house will be a model of its kind. It will contain twenty-two stalls. A 100-foot electrically operated turntable, with air auxiliary for emergency, and a 250-foot double-track water and ash pit, constructed of steel and concrete, are planned. A Gantry crane will be used to remove ashes. The boiler plant will be trebled in size. Special attention has been paid to the installation of electrically operated apparatus wherever possible.

Concrete Snowsheds on the Union Pacific.

The construction of permanent concrete snowsheds costing over $1,000,000, has been begun on the Union Pacific at some of the most frequently blockaded points between Wamsutter and Rawlins, Wyo., and the work will be rapidly proceeded with during the coming summer, so that by next winter the mountainous districts will be well provided for against the frequently recurring blockades from heavy snow slides.

New Equipment on the Lackawanna.

Last year the Lackawanna purchased 18 new locomotives, 10 steel express cars, 2 steel dining cars, 885 steel underframe box cars, 500 steel hopper cars, 350 steel gondola cars, 2 locomotive bucket cranes, the total costing $2,575,880. For replacement of equipment $357,219 was expended in applying steel underframes, heavy draft gear and safety appliances to freight cars, besides $54,376 for equipping locomotives with superheaters and other improvements.

Railway Signal Association.

The Railway Signal Association held a meeting at the Auditorium Hotel, Chicago, Ill., on March 19th. Committees reported on Signaling Practice, Mechanical Interlocking, Maintenance and Operation, Standard Designs, Direct Current Relays, Storage Battery and Charging Equipment, Lighting Protection, D. C. Automatic Block Signaling, Harmonizing of Specifications, and Electric Testing.

Block Signals.

There are 99,885 miles of trackage of railroads in the United States operated under the block signal system, an increase of 2,076 miles over that of 1915.

South American Railway Congress.

The Peruvian permanent commission of the South American Railway Congress has just been organized, the members of this commission being officials of railways and engineering societies. The first South American Railway Congress was held in Buenos Aires in 1910, and it is expected that the second will be held in Rio de Janeiro in 1918. The newly organized Peruvian commission will make efforts to have the third congress meet in Lima in 1921, the centenary of Peru's independence, when a celebration will also be held of the first trip of a locomotive in South America, which was in Lima in 1851.

Western Railway Club Meeting.

A paper on "Training Men for the Mechanical Department," was read by Mr. F. W. Thomas, supervisor of apprentices of the Santa Fe, before the members of the Western Railway Club, at the Hotel Sherman, Chicago, Ill., last month. The attendance was large, and the keenest interest was evinced in the reading of the paper. The prizes awarded to the apprentices under the admirable system are the best proof of its operation, as well as the number of promotions to those who have graduated under it, and shows how important a thing it is to train the human hand, mind and heart, to utilize to the limit the instruments placed in young hands.

Meeting of the N. Y. Railroad Club.

An interesting meeting of the New York Railroad Club was held on March 16, 1917. It is usual with the club at this season of the year to have an electrical night, and Mr. Edwin B. Katte, chief engineer electric traction of the New York Central. The chairman of the committee in charge, arranged an excellent programme. Mr. L. E. Johnston, president of the Norfolk & Western, delivered an able address on the "Economic and Operating features of the electrification of the Norfolk & Western," and Mr. R. Beeuwkes, electrical engineer of the Chicago, Milwaukee & St. Paul, presented an interesting paper on "The Peculiar Engineering and Structural Features of Electrification on the C. M. & St. P." Both speakers illustrated their addresses with moving pictures, which were very warmly appreciated.

Central Railway Club.

Major General George Goethals delivered an interesting address on "Some Phases of the Panama Canal" before the members of the Central Railway Club at their recent annual dinner at the Hotel Statler, Buffalo, N. Y. Over 50 railway and supply men made the trip from New York on special cars, and over 500 attended the dinner, making the occasion one of the most notable events of the season in the railway world. General Goethals is the acknowledged authority on all matters pertaining to the Panama Canal and his address was most timely.

Increased Prices of Railway Material.

The records of the purchasing department of the Pennsylvania railroad show that locomotives costing $28,500 in 1914 now cost $39,500. Steel passenger coaches in 1914 costing $15,000 now cost $20,000. The standard steel gondola freight car has in the same period increased in price from $1,184 to $2,569. Smaller supplies show even a larger increase in price; axles formerly 1.5c. per lb. are now 4.1 per lb., bridge steel from $1.83 per lb. to $4.71 per lb., and steel castings from a price range of 2.60c-6.10c per lb. to 5.50c-11c per lb.

Public Works in Switzerland.

Two projects of internal improvement are contemplated in Switzerland, the electrification of the Federal railroads, and the development of a waterways system. The abundant supply of water power for the generation of electricity will, when accomplished, largely free the country from dependence on outside fuel supplies and render impossible a recurrence of hardships attendant on its present conditions.

Pressed Steel Car Company.

The orders placed last year with the Pressed Steel Car Company were larger than any year since 1906, but many orders will not be filled for some months to come. The large orders for cars for Russia were completed and the cars are now doing excellent service. The company has purchased grounds adjacent to the McKees Rocks works, Pittsburgh, Pa., costing $68,524, and extensions are already in progress. There will be no delay in filling orders if the material can be secured.

Largest Private Telephone Switchboard on the Pacific Coast.

The largest private switchboard on the Pacific coast will shortly be installed in the railroad office buildings of the Southern Pacific in San Francisco, Calif. The Western Electric Company is busy completing the order which calls for an 8-position telephone switchboard, and will permit of additional sections being added in proportion as the company's service grows at that point.

Railroads in Operation.

There were 230,500 miles of railroads in operation in the United States in 1916, and it cost approximately $2,346,066,990 to run the railroads during the same period.

Books, Bulletins, Catalogues, Etc.

Proceedings of the Traveling Engineers' Association.

The proceedings of the Twenty-fourth Annual Convention of the Traveling Engineers' Association, held at Chicago, Ill., on October 24-27, 1916, has been compiled by the secretary, Mr. W. O. Thompson, Cleveland, Ohio, and issued in a substantial volume of 414 pages from the press of the J. A. Bell Company, Elkhart, Ind. The papers presented and discussions embrace the following subjects: "What effect does the mechanical placing of fuel in fire-boxes and lubricating of locomotives have on the cost of operation?" "The advantages of the use of superheaters, brick arches and other modern appliances on large engines, especially those of the Mallet type." "Difficulties accompanying the prevention of dense black smoke and its relation to cost of fuel and locomotive repairs." "Recommended practice and make-up and handling of modern freight trains on both level and steep grades to avoid danger to draft rigging and lading." "Assignment of power from the standpoint of efficient service and economy in fuel and maintenance." The book is finely printed and elegantly bound in flexible leather. Application for copies should be sent to the secretary, care of the general office, N. Y. C. R. R., Cleveland, Ohio.

Analyses of Coals.

The Government Printing Office has issued Bulletin No. 119, presenting analyses of coals purchased by the Government during the fiscal year 1908-15. Prior to 1906, the coal was purchased mainly on its reputation, or trade name, rather than on its heating value. All this is changed, and the methods of analyses and results are set forth with a complete degree of fulness that should be of special interest to railroad men looking for fuel economy. Congress has acted liberally in providing the means for carrying on a complete investigation to a degree beyond what is possible by private corporations, and the publication of this bulletin will be welcomed as one of the very few Government publications worth looking at the second time. This particular bulletin has an enduring quality which time cannot diminish. More than one copy cannot, under the law, be given to one person. The price of the publication is 15 cents.

The Locomotive Laboratory.

A very interesting illustrated pamphlet of 18 pages has been published by the University of Illinois showing the details of the locomotive laboratory which was erected in 1913, and provides means whereby the locomotive machinery may be run and the locomotive worked throughout its range of capacity, while the locomotive as a whole remains stationary; thus permitting all test measurements to be made with the degree of accuracy possible in a stationary power plant. The descriptive matter and illustrations show very clearly the details of the mechanism, all of which are of interest. The dynamometer is of the Emery type and is so constructed that it operates whether the locomotive is running backward or forward. Other details are equally ingenious, and all are important. Those interested in the bulletin or other university publications should address the Registrar, Urbana, Ill.

Proceedings of the Association of Transportation and Car Accounting Officers.

The proceedings of the twenty-sixth regular meeting of this association was held at Atlanta, Ga., Dec. 12-13, 1916, have now been issued by the Railway Equipment and Publication Company, 75 Church Street, New York, and embraces 274 pages of matter. Besides reports from the Executive and Arrangements Committees, other reports are published in full on car service, on conducting transportation, on continuous home route cards, on handling railroad business mail, and on office methods and accounting. A copy of the constitution and changes in the same are also published, together with discussions on the committees reports, and a list of the active, associate, and honorary members, and the per diem rules of the American Railway Association, which have just come into effect. The compact form in which many valuable statistics are presented shows how carefully the secretary has attended to the compilation of the work.

Weights and Measures.

The Department of Commerce, Washington, D. C., has issued a volume of 193 pages containing a report of the eleventh annual conference of representatives from various States held at the Bureau of Standards, Washington, May 23-26, 1916, to which is added an appendix on inspecting and testing and other related subjects. Many excellent illustrations illumine the volume, among others ten views of the details of the largest track scale in the country which has been recently installed at West Albany, N. Y. The conference, which was largely attended by representatives from all over America, showed that excellent work is being done by various manufacturers in perfecting the devices used in weighing and measuring, and also promulgating advanced methods in the inspection of testing the same. Copies of the volume may be secured from the Superintendent of Documents, Government Building, Washington, D. C. ,at 35 cents per copy.

Interborough Rapid Transit.

In May, 1915 RAILWAY AND LOCOMOTIVE ENGINEERING issued the first published illustrated article in reference to the important improvement on the elevated lines of the Interborough Rapid Transit Railroad of New York. At that time the work was not completed, and the work was largely experimental. Now the company has issued an illustrated pamphlet showing with full details how a twenty million dollar railroad was built in mid-air. As an engineering feat it was unique in many respects, a third track with occasional "humps" or raised parts for 17 double deck stations, and all was done without taking a train off the regular schedules. In one year the traffic has increased 13 per cent., the passengers carried in 1915 being 302 millions, and in 1916 about 340 millions.

Marking Progress.

The Southern Railway has issued a very handsome folder on the subject of "How Times Have Changed." It is an illuminated reproduction of an advertisement of the Orange and Alexandria Railroad in 1854, in comparison with a view on this same line, now part of the Southern's Washington division, showing one of the Southern's limited passenger trains on modern double track protected by the electric automatic block signal system. It is interesting at times to look back and get a bird's-eye view of the progress of railroad evolution in this country.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

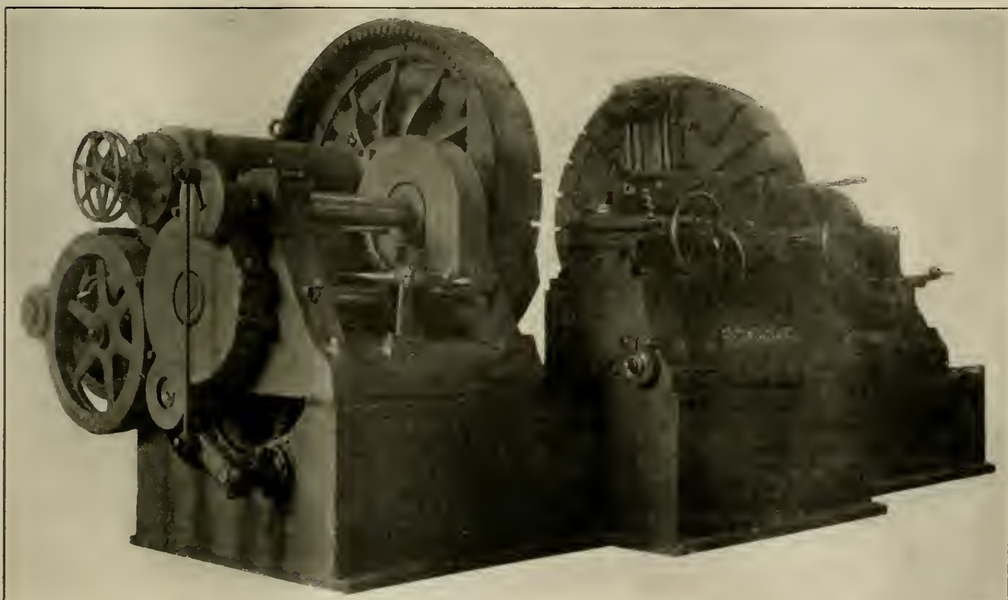
Vol. XXX. 114 Liberty Street, New York, May, 1917 No. 5

Description of Sellers' New Design of High Power Wheel Turning Lathe

The driving wheel lathe which we here illustrate was built and recently delivered to one of our leading railways. It was manufactured by William Sellers & Co., Inc., of Philadelphia, and is now in place in the railway repair shop.

In designing such high power double wheel lathes as we show here, the builders have made every effort to reduce the time and labor required for putting in and chucking the work; and in handling the tools for the various operations. The actual cutting time, per wheel, in such machines had been so reduced that the time lost in handling and setting the work and changing the tools had become relatively greater; and further improvements had to be sought for in the direction of reducing the time and the labor taken in performing these operations. Recognizing this, the manufacturers have endeavored to produce a wheel lathe having the necessary power and stiffness to take the heaviest cuts; and possessing, in addition, certain features which greatly facilitate the handling of the work and the tools.

One of the characteristic attachments of this lathe is a form of driver which will securely lock the wheels against the pressure of the heaviest cuts without side strain in the wheel rims. It is essential to hold the wheel with a resistance proportional to the cut; and which would also be self-contained and without loose parts to be removed or replaced in changing wheels. The arrangement shown in our illustration has these properties. They grasp the inner and outer faces of the tire without causing side strain. They may be each clamped by one set screw with an ordinary short wrench, and they automatically tighten as the pressure of the cut is increased and no loose bolts or clamps are needed. Each driver is mounted in a swing frame or plate secured to the face plate of the lathe for conveniently adjusting the driver to suit diameters of wheels, location of crank pins and number of spokes. What side motion there is in the clamp is utilized



HIGH POWER WHEEL TURNING LATHE.

in producing a toggle. This results in a driving power proportional to the resistance of the cut.

The set of tools required for roughing and finishing the rims are carried in two turret tool holders of special construction, so that each tool can be brought into position in its turn by simply rotating the turret by a hand lever. When the various working positions of the turret are reached, a spring latch holds it securely, while a further motion of the hand lever clamps the turret firmly. The turret is made of steel, and the center clamping bolt has a transverse opening for the roughing tool; thus permitting a long bar to be used, capable of frequent redressing. As the forming tools are not subject to frequent renewals, they are screwed directly to projections of the steel casting. The tools are thus very rigidly supported. As they are in the shape of flat cutters they may easily be removed. The turrets are made with the tools attached to projections from the body of the steel casting.

The turrets are mounted on slide rests which are very heavy and low, carried on a bench. These are easily adjusted by racks and pinions to suit the diameters of wheels. The base of the slide rest is arranged to swivel on the bench so as to suit the angle of the wheel tread. The slides are each provided with a feed ratchet, the connections for which are fitted with ball joints. A convenient micrometer screw and stop on the side of the cross slide enables the wheels to be rough turned to the same diameter without calipering. The stop can be swung aside when the operation of finishing is in progress.

The tool bench is broad and massive, thus making a solid support for the tools. The pinion shaft is provided with holding brakes, which permit the bench to slide back in cases of extraordinary strain, such as might be produced by the wedging of a broken tool between the tire and the rest. This is an important safety feature, but is not operative except in case of emergency, when it acts automatically. The bed is broad and of unusual depth, forming a very rigid base.

In addition to the special devices described, the lathe has many other features, some of which may be thus described. The first is the pinions for driving the face plates. These are placed in nearly the same horizontal plane as the tools, and on the same side of the center. The tool loads are thus transmitted directly through the face plate without imposing any pressure upon the spindle bearings.

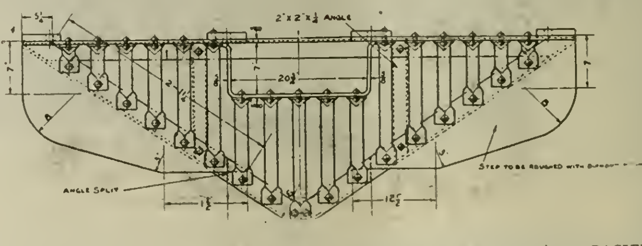
Second, the front of the openings in the turrets, for the forming tools, is made with a slight taper, to fit which a corresponding taper is provided on the tool sockets. The tools are thus accurately centered and securely held against side motion. This also permits a reduction in the size of the tool body without decreasing the broad bearing surface which supports the tool near the cutting edge and does not in any way impare its efficiency.

The next feature is the method of power transmission. Power is transmitted to the face plates from the long driving shaft through two gearing reductions, and not directly from the shaft itself. This arrangement, in connection with the large diameter of the shaft, produces a drive which is free from any tendency to chatter. The spindle caps on the heads are made in one continuous piece, producing a nearly solid support for the hardened steel step which is placed at the end of the spindle for taking end thrusts. Secured to the face plates are flanged bearings through which the sliding spindles pass, thus reducing their overhang when supporting the work. These bearings are supplied with split taper bushings for taking up wear, maintaining an easy fit without lost motion. When desired, these bushings may be closed tightly upon the spindle, thus forming an additional clamp. For driving the lathe a motor of ample size is provided, which has a speed range of 2 to 1, which, together with the mechanical changes, gives spindle speeds varying from ⅜ to 1½ turns per minute with numerous intermediate steps.

A suitable motor is used to move the tail-stock, so that this heavy part can be put in the desired position without any work on the part of the operator, except the moving of a controller handle. A great saving in time is effected by this means. Altogether this machine would be an up-to-date addition to any railway repair shop, where heavy work of this kind is regarded as a matter of importance.

New Steel Pilots for the C. P. R.

A new kind of steel pilot has been placed on a 4-6-2 type passenger locomotive on the Canadian Pacific Railway which has the double merit of being easily constructed and inexpensive in point of cost. As shown in our illustration it has a neat and substantial appearance. The bars of the pilot are made of old boiler tubes, which, after being put through a specially arranged set of rollers become triangular or three cornered in shape, so that they resemble the ordinary slat formation used on a wooden pilot. The tubes are passed through the rollers cold, and after being cut into the desired lengths they are flattened and bent at each end to the proper angle to suit their exact location in the pilot. The ends are riveted to the frame and nosing by ½-in. rivets. The nosing is made of 3-in. by 3-in. by 5/16 in. angle iron, and the frame is constructed of flat steel bars. A general adoption of locomotive pilots constructed in this way is expected to be established in the future on the road.



DETAILS OF PILOT ON 4-6-2 TYPE PASSENGER LOCOMOTIVE, CANADIAN PACIFIC RAILWAY.

Railroads Organizing Farm Hands.

The railroads are taking an active part in the organization of an agricultural army embracing the securing, distributing and handling of farm labor to the end that a solution of the food problem may be reached. This is a highly patriotic work, and there is only one solution which is that more food products will have to be planted and cultivated and gathered. The question resolves itself into the query—who is going to do all this? The officials of the Baltimore & Ohio railroad have made some excellent propositions which if carried out and taken up over the length and breadth of the land would add greatly to relieving the growing menace that faces the entire country. A survey is being made to ascertain the number of laborers needed in various sections. As public construction work will not likely be great during the year, the surplus labor can be utilized on the farms. The railroad will convey squads of workers, locating them where farm labor is demanded. The farmers will also be organized in groups, and a systematic plan of distribution of labor maintained. Efforts are also being made to enroll vacationists during the summer season to engage in such light farm work as may be agreeable to them. Groups of boys are also in course of getting ready on a six hours a day basis in farm work, and at such a remuneration as is equivalent to the kind and amount of work done. The scheme is full of promise, and the results will be watched with interest.

French Feed Water Heater

The Caille-Potonie System—Tests Made and Economies Claimed—Disadvantages Admitted—Extracts From a Foreign Publication

The French feed water heater, known as the Caille-Potonie system was described and explained in *Die Lokomotive* some time ago.

The Chemin de fer du Nord applied the Caille-Potonie feed water heater to some of their tank engines used in fast local service. The economical results obtained were so satisfactory that the company equipped quite a number of engines with this apparatus.

Exhaust steam while passing up the blast pipe encounters a deflecting plate, operated from the outside, which with hinge above, and deflecting edge below, in the blast pipe, draws off a certain amount of exhaust steam without interposing an obstacle to the steam, sufficient to produce any appreciable back pressure. Steam drawn from the blast pipe passes back through a pipe in which a regulating valve is placed. This regulating valve is for the purpose of admitting to the feed water heater only the amount of steam necessary to raise the feed water to approximately 212 degs. Fahr. When the supply of steam is properly regulated it gives up almost all its heat and condenses to water which is automatically drawn off and falls to the ground. The necessity for this is the fact that the exhaust steam used for heating the feed water carries oil and could not be allowed to mingle with the water entering the boiler.

The heater itself is a cylindrical chamber made of 5-32 in. steel plate with two round heads inside, a few inches from each of the heater end sheets. Between the inside round heads a bundle of copper tubes is placed, opening at each end into the space between the round heads and the heater end sheets. The tubes are ¾ in. in diameter, and .079 in. thick, through which the heating exhaust steam flows without coming in actual contact or mingling with the feed water.

The feed water is drawn from the tender, passed through the heater, and is delivered to the boiler by the movement of a double-acting steam pump, which closely resembles the Westinghouse air pump The steam cylinder of the pump is of similar construction to the air pump, but the lower or water cylinder is made so that the feed water enters the bottom pump chamber, and is delivered during the down stroke to the heater, through which it passes, abstracting heat of the exhaust steam, and it is delivered to the boiler during the up stroke of the piston. The feed water is below the pump-piston when being drawn into the heater, and above the pump-piston when on its way to the boiler.

If a double-acting pump is used, it may be located in any convenient place, as it is independent of the height or position of the heater. If, however, a single-acting pump be employed it is necessary to put the pump in such a position that the water from the tender will flow to it by gravity, because water at a temperature of nearly 212 degs. Fahr. cannot be "sucked."

When the engine is standing or drifting or is in the round house, when the throttle is closed, provision is made to maintain steam heat in the apparatus, by turning the exhaust steam of the feed pump and that of air pump into heater.

In order that the heater may always be kept full of water, and so prevent any gathering of steam, should any tend to form, the steam which would fill the space above the heater tubes can escape through a "float" valve, and pass to the atmosphere.

The advantages claimed for the use of the Caille-Potonie equipment is that no live steam is used to heat the feed water, and high temperature may be reached. The amount of feed water delivered to the boiler is claimed to be most easily regulated, and made to conform to the consumption of water according to the work done.

A calculation of the calorific efficiency of such a feed water heater as this, is given in this foreign publication as follows: "The engine in question is said to evaporate 17,600 lbs. of water per hour, at a steam pressure of 170 lbs. Assuming an overpressure of 10.6 lbs. every pound of steam delivers almost exactly 900 B. T. U. to the feed water heater. In order to heat 17,600 lbs. of water per hour from 32 degs. Fahr. to 212 degs. Fahr. 3,174,400 B. T. U., are wanted, and are supplied by 3,174,400 ÷ 900 = 3,520 lbs. of exhaust steam. This amounts to

$$\frac{3520}{9 \times 17600} = \frac{1}{4.5}$$

or 22 per cent. of the exhaust steam, if we assume that about 10 per cent. of the total amount of steam is condensed in the cylinders, and is lost elsewhere."

The deflecting plate in the blast pipe has to be opened to a position which covers one-eighth of the area of the pipe, in order to draw off sufficient steam for use in the feed water heater.

The Chemin de Fer du Nord, we are told, ascertained that on seven of their engines, equipped with the Caille-Potonie feed water heater, kept in service for seven months, an average coal saving of 12 per cent. was secured. There was, however, considerable variation above and below the average in the figures for this economy.

Some of the disadvantages incident to the use of this apparatus are stated in the article from which we quote. There are the large number of parts comprising the whole. These parts demand constant attention, and, of course, with them goes a maintenance charge. The apparatus takes up a good deal of room and may not always be applicable to some classes of locomotives. The weight of the whole outfit is about 13,200 lbs.* and it cannot, therefore, be always advantageously applied to any locomotive on account of weight limitations on axles.

The economy it secured when the device properly applied, and the reduction of stresses in the boiler, due to regular and evenly supplied feed water at a practically uniform temperature, and the consequent effective boiler performance, have an attraction for railroad mechanical men. The question of feed water heating is being taken up scientifically in the United States, based upon a somewhat different principle, but the ends sought are the same on both sides of the Atlantic, and later on we will have the opportunity of explaining what has been done in this country in order to make this important locomotive economy, our own.

The work already done in the United States, which will shortly be made public, embraces an apparatus that is much more compact than the Caille-Potonie system, and is about one-quarter of the weight as given by the foreign paper. The American design not only produces results superior to those quoted, but it is more easily got at for cleaning or repair, and both these operations can be effected with a minimum disturbance of parts. The whole subject of feed water heating opens up an opportunity to use a device for economical locomotive operation which bids fair, in the future, to be one of the indispensable requisites of locomotive equipment. The treatment of this important question has been gone into in this country, by a company fully equipped for investigation, and possessed of the ability to turn facts as they are disclosed, to practical utility, and to supply the demand which is likely to follow orderly and painstaking work directed to the exploitation of a reliable and efficient means of reducing coal consumption. The scientific use of otherwise waste heat is based on the principle of employing a by-product with advantage to the work of producing economy of operation, and is thus a money saver.

*We have not been able to verify this figure. It is probably somewhat in excess of the correct weight.

Locomotives of the 4-6-2 and the 2-10-2 Type for the Lehigh Valley Railroad

The Lehigh Valley has recently placed in service 70 locomotives which were built by the Baldwin Locomotive Works. Of these 30 are of the Pacific (4-6-2) type and 40 of the Santa Fe (2-10-2) type. The Pacifics are designated as Class K-5, and the Santa Fe types as Class R-1. The construction of these engines represents part of a systematic program for increasing the efficiency of the motive power and so distributing the locomotives that heavy trains can be moved over consecutive divisions without reducing tonnage on account of grade conditions. The new engines incorporate existing Lehigh Valley standards as far as is practicable, and resemble in many respects the latest design of Class N-3 Mikado type locomotives, 20 of which were built for this road by the Baldwin Locomotive Works in 1916.

The Pacific type locomotives were specially designed to handle fast freight trains weighing about 2,000-2,400 tons on the low grade sections of the line, but they are also fitted for heavy express passenger traffic, and are being used for such work on the Wyoming Division, where grades are heavy. In this respect they may be compared to the Class J-55 Ten-wheeled locomotives which, for some years, have been doing exceptionally good work on this road. The Pacifics are among the most powerful of their type, exerting a tractive force of 48,700 lbs., or 55 per cent., in excess of the tractive force of Class J-55. They are specially designed for burning bituminous coal, and differ in this respect from the greater part of the motive power on the Lehigh Valley.

The boilers of Class N-3, K-5, and R-1, are all of the same diameter at the front end, and the same number and diameter of tubes is used in each case. Classes N-3 and K-5 have tubes of equal length, but the fireboxes are different, as Class N-3 uses a mixture of anthracite and soft coal, and has 100 sq ft. of grate area as compared with 75 sq. ft. for Class K-5.

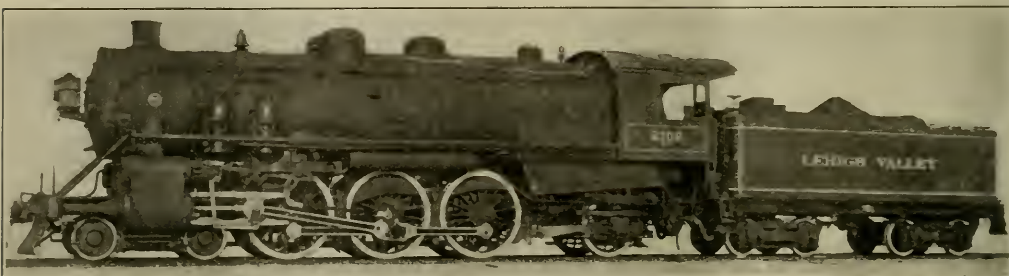
The boiler of Class K-5 has a conical ring in the middle of the barrel, increasing the shell diameter from 83¼ ins. at the front end to 94⅞ ins. at the dome ring. "Diamond" longitudinal seams are used, and they "break joint," that on the first ring being placed on the left side center, while the gusset seam is on the top center; and in the case of the third ring, the seam is on the left side under the dome flange. All the seams in the firebox and combustion chamber are welded, as is also the seam around the fire-door opening; and the tubes are welded at the firebox end. The furnace equipment includes an arch, supported on five water tubes; and a Street mechanical stoker is applied. The firedoor opening measures 14x26 ins. and the door is pneumatically operated. The combustion chamber is 48 ins. long.

The cylinders are bushed, and are designed with outside steam pipe connections, and with exhaust passages of liberal cross sectional area, free from abrupt bends. The steam chests are fitted with vacuum relief valves. When drifting, saturated steam can be admitted to the cylinders through a small pipe which leads from a shut-off valve tapped into the steam turret. This pipe is provided with a line valve conveniently placed in the cab.

Careful attention has been given to the design of the machinery in order to lighten the parts as far as is consistent with the strength required. The piston-heads are rolled steel, of light section and are fitted with bull-rings of cast iron, which are held in place by welded retaining rings. Hunt-Spiller metal is used for the piston and valve packing rings, cylinder and steam chest bushings, and crosshead shoes. The piston-rods are extended at the front, and are hollow throughout their length; and they, together with the crank-pins, connecting rods, and stub straps are made of Nikrome steel.

Walschaerts valve gear is used on 20 of these locomotives and Baker gear on the remaining ten. The Ragonnet power reverse mechanism is applied. The valves are set with a travel of 6 ins. and a lead of 5/16 in. The steam lap is 1 3/16 ins. and the exhaust clearance ⅛ in.

The Class R-1 locomotives exert a tractive force of 72,800 lbs., and burn a mixture of fine anthracite and soft coal. The boilers are similar in many respects to those of Class K-5, except that they are longer and the fireboxes are considerably wider. The combustion chamber is 60 ins. long, and the tube length is 21 ft. The grate area is 100 sq. ft., and in consideration of the large size of the firebox it is interesting to note that the seams are welded throughout, as in the Pacific type.



CLASS K.5.—PACIFIC (4-6-2) FOR THE LEHIGH VALLEY.
H. C. May, Supt. Motive Power. Baldwin Loco. Works, Builders.

Brick arches have been used, with marked success, in the Class N-3 locomotives, which have the same grate area as Class R-1. In the new engines the arch is supported on six water tubes and the Street stoker is applied.

Thirty of these locomotives are fitted with Walschaerts valve gear, while the remaining ten have the Baker gear. The piston valves interchange with those of the Pacific type locomotives, and the valve setting is the same, except that in the Class R-1 engines the exhaust clearance is reduced from ⅛-in. to 1/32-in. The advantages of using the Ragonnet power reverse mechanism are especially apparent on a locomotive like this one, where, on account of the unusually wide firebox, the room available in the cab is limited. It has been the practice, on all road engines recently built for the Lehigh Valley, to place the cab at the rear, regardless of the width of the firebox.

The Economy front truck is used in this design, in combination with the Economy lateral motion front driving-box. These features have been described in previous locomotive descriptions appearing in Railway and Locomotive Engineering.

The rear truck is of the Rushton type, with inside journals. This design of truck has been applied to all the Baldwin Mikado type locomotives built for the Lehigh Valley. The arrangement of Rushton truck, with inside journals, was patented in 1900, and has been applied to a large number of locomotives. A swing-beam is mounted on top of each journal box, and from the ends of this beam are suspended swing links. These in turn support two parallel yokes, which form part of the equalization system. The yokes are placed, respectively, on the inside and outside of the engine frame, and can therefore have no lateral movement; but the journal boxes, and consequently the wheels and axle, can move laterally, the swing links then assuming an inclined position. The journal boxes are held in alinement by transverse braces, and are made with suitable lugs to which the radius bar is bolted. The yokes, while they cannot move laterally, are free to move vertically with reference to the frames. Leaf springs support the frames back of the trucks; an arrangement which promotes easy riding.

The reciprocating parts are similar in design to those of the Class K-5 Pacific type locomotives, and the cross-heads are duplicates with the exception of the cross-head pins, which are larger in the Class R-1 engines.

The tenders are carried on Standard Steel Works Company's rolled steel wheels, and are equipped with equalized pedestal trucks. In general design they are similar, although the capacity of the tenders used with the Class R-1 locomotives is greater than those used with Class K-5.

These locomotives, built in conformity with the existing standards of the railroad, and designed for specific operating conditions, constitute a notable group of modern heavy power. Their principal dimensions are given in the tables. It may be noted that 20 additional Pacifics and thirty-six 2-10-2 type locomotives have been ordered for delivery in the fall of the present year.

Pacific type engine—Cylinders, 27 x 28 ins.; valves, piston, 14 ins. diameter.

Boiler.—Diameter, 83¾ ins.; thickness of sheets, ¾ and 13/16 in.; working pressure, 205 lbs.; fuel, soft coal; staying, radial.

Fire box—Length, 120 1/16 ins.; width, 90 ins.; depth, front, 88½ ins.; depth, back, 74 ins.; thickness of sides, back, and crown, ⅜ in.; thickness of tube, ½ in.

Water space—Front, 5 ins.; sides, 4 ins.; back, 4½ ins.

Tubes—Diameter, 5½ and 2¼ ins.; thickness, the 5½ ins., No. 9 W. G., and the 2¼ ins., No. 11 W. G.; number, the 5½ ins., 45; the 2¼ ins., 254; length, 17 ft., 6 ins.

Heating surface—Fire box, 229 sq. ft.; combustion chamber, 100 sq. ft.; tubes, 3,724 sq. ft.; firebrick tubes, 40 sq. ft.; total, 4,103 sq. ft.; superheater, 980 sq. ft.; grate area, 75 sq. ft.

Driving wheels—Diameter, 73 ins.

Engine truck wheels—Diameter, front, 33 ins.; journals, 7 ft. x 12 ins.

Wheel base—Driving, 13 ft. 8 ins.; total engine, 36 ft. 1 in.; total engine and tender, 68 ft. 10⅜ ins.

Weght—On driving wheels, 197,200 lbs.; on truck, front, 51,000 lbs.; on truck, back, 53,300 lbs.; total engine, 301,500 lbs.; total engine and tender, 458,700 lbs.

Tender—Wheels, diameter, 36 ins.; tank capacity, 8,000 U. S. gals.; fuel, capacity, 25,000 lbs.; service, fast freight and heavy passenger.

Santa Fé type engine—Cylinders, 29 x 32 ins.; valves, piston, 14 ins. diameter.

Boiler—Type, Wagon-top; diameter, 83¾ ins.; thickness of sheets, ¾ and 13/16 in.; working pressure, 200 lbs.; fuel, hard and soft coal mixed; staying, radial.

Fire box—Length, 126⅛ ins.; width, 114¼ ins.; depth, front, 88¾ ins.; depth, back, 73 ins.; thickness of sides, back and crown, ⅜ in.; thickness of tube, ½ in.

Water space—Front, 5 ins.; sides and back, 4½ ins.

Tubes—Diameter, 5½ ins. and 2¼ ins.; thickness, the 5½ ins., No. 9 W. G., and the 2¼ ins., No. 11 W. G.; number, the 5½ ins., 45; the 2¼ ins., 254; length, 21 ft.

Heating surface—Fire box, 263 sq. ft.; combustion chamber, 116 sq. ft.; tubes, 4,485 sq. ft.; firebrick tubes, 59 sq. ft.; total, 4,923 sq. ft.; superheater, 1,179 sq. ft.; Grate area, 100 sq. ft.

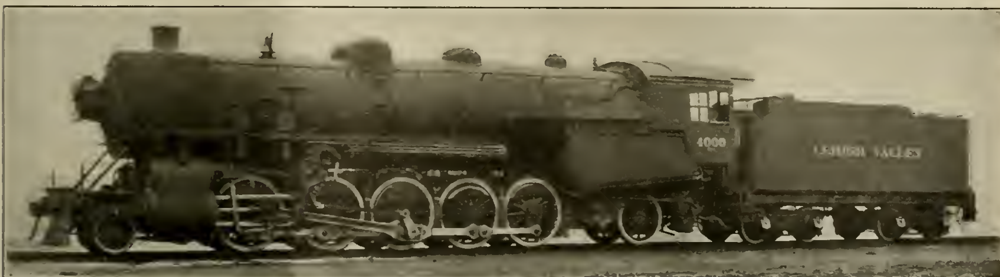
Driving wheels—Diameter, outside, 63 ins.; journals, main, 13 x 20 ins.

Engine truck wheels—Diameter, front, 33 ins.; journals, 7 x 12 ins.

Wheel base—Driving, 22 ft. 6 ins.; total engine, 41 ft. 8 ins.; total engine and tender, 74 ft. 6 ins.

Weight—On driving wheels, 289,000 lbs.; on truck, front, 29,000 lbs.; on truck, back, 52,000 lbs.; total engine, 370,000 lbs.; total engine and tender about 540,000 lbs.

Tender—Wheels, diameter, 36 ins.; journals, 6 x 11 ins.; tank capacity, 9,000 U. S. gals.; fuel capacity, 15 tons; service, freight.



CLASS R.1.—HEAVY 2-10-2 FOR THE LEHIGH VALLEY RAILROAD.
H. C. May, Supt. of Motive Power. Baldwin Loco. Works, Builders.

Increase in Railroad Freight Cars.

In 1906 the railroads had 1,840,000 freight cars: on December 31, 1916, the number had grown to 2,518,855, an increase of 678,000 cars. The railroads were not only ordering additional equipment; they were constantly replacing old equipment with new cars of greater carrying capacity than the old. So that while the number of cars in ten years increased 37 per cent, the load-carrying capacity provided by the railroads increased 60 per cent. During this same period the railroads have been adding new tracks, terminals, yards, etc., as well as improving grades and increasing the hauling power of engines. All of this has made it possible to get increased service out of each car.

Fire Losses.

Fire losses and the cost of fire prevention in the United States amount annually to $450,000,000 or more than the total American production of gold, silver, copper and petroleum in a year. The losses attributed to the railroads are rapidly diminishing.

Wooding Automatic Stop Signal and Speed Control

Description of the Apparatus—What It is Designed to Do—The Contact Features and How They Operate—The Speed Control and the Automatic Stop—Trial Installation on the Lackawanna

The track ramps for the Wooding device are about 25 ft. long, made out of angle iron. Two of these angles are used for each contact, one overlapping the other to protect from snow and sleet, and to make a knife-blade electrical connection when engaging the train contact blade. The two angles are held in their relation to each other by a number of broad, flat, U-shaped springs, which also force a firm continuous gripping connection on the train contact or the knife blade as the latter forces its way between the edges of the two angles, prying the lower one out from under its cover.

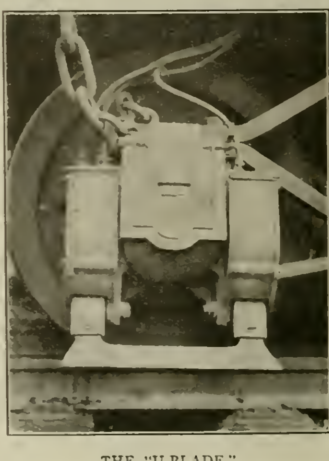
These contacts, two or more to the block, are supported on flexible or rigid brackets connected to the track rail or to the ties, parallel to the former, outside, and from 2 to 4 inches above. The two members of the contact, which we may call the "split-ramp," are spread apart at the ends to allow the engine "U-blade" contact to enter, and the angles are curved just back of the entrance toward the track rail, 4 inches, so as to deflect the train contact, or U-blade, and break the controlling circuit on the engine as it passes through. Incidentally the length of this curve also regulates and operates the permissive speed control.

When the U-blade, which normally stands at an angle of about 45 degrees, with its lower edge away from the tender and supported on the journal box, enters the split-ramp the curve in the angle bars toward the track carries the U-blade to practically a vertical position and thus moves it inward toward the wheel. This movement breaks the automatic train stop circuit and turns a disc housed in the closed receptacle at the axle box that houses the U-blade hinge. The rotation of the disc makes, or makes and breaks, the permissive speed control circuit on the engine and when a train exceeds the speed limit, with danger ahead, the electrically-operated brake-valve at once flies open and applies the brakes by reason of the escape of air from the train line. The automatic train stop circuit is normally closed and supplied by the battery on the engine. The permissive speed control circuit is normally open, but when closed it is supplied by the engine battery. The former circuit is designed to co-operate with the line wire circuits and electrical supply of the semaphore signalling system on the road.

If the signals are at "clear" and the electrical circuits along the track operative, as they would be, the breaking of the engine circuit by reason of the U-blade passing through the split-ramp, would not apply the brakes for the reason that the line wire current would maintain the energization of the supplementary engine circuit and keep the electrically-governed-air-valve on its seat, and no escape of the train line air could take place.

THE "SPLIT-RAMP."

In the case of danger (for operative purposes) this circuit is maintained by the rotation of the disc from its normal to middle position when the rate of the train movement conforms to the pre-determined safe speed. The movement of the U-blade under such circumstances only brings the disc to the central position and permits the engineer to complete the circuit by pressing a push button in the cab, or this circuit becomes closed automatically if preferred, and supplies the engine apparatus. If the speed is higher, the deflection of the U-blade by the split-ramp will be more sudden and this sharper movement of the U-blade will carry the disc to its extreme position and break the permissive circuit and a positive stop is at once made by the mechanism.



THE "U-BLADE."

It may here be stated that in the Wooding apparatus the permissive circuit is only completed and operative when the disc is in the middle position and the engineer presses the push button, or by being automatically closed through the battery and apparatus on the engine, to permit the train to proceed independent of the interrupted line wire circuit caused by danger ahead. It is optional with the railroads installing this appliance to select the semi-automatic push button plan, or the purely automatic. The former will not allow an engineer to pass his train by a caution or home signal without being conscious of the fact and he therefore must press the button.

When the signals at the entrance of a block are at "caution," the current in the line wire and split-ramps in the block back of the signal is reversed and the track rail connection broken by the stop signal relay in the next block. This condition forces the engineer to bring his train under control and meet the speed limit requirements or the brakes will be applied by an instant, efficient, service application that will stop the train before it reaches the danger zone.

A brief description of the parts of the apparatus is here in order, beginning with the engine equipment. This consists of a battery, one or two U-shaped blades the legs of which are hinged inside of two auxiliary iron boxes attached to the sides of (but insulated from) the second journal box on both sides of the tender. A circuit-breaker, to break the controlling circuit on the train, and the permissive speed control mechanism are housed in one of a pair of these auxiliary boxes. In the cab there is a magnet-controlled air-valve, a whistle and a push-button. The permissive speed control is a small semi-circular iron disc with an electrical contact; pivoted inside of the box just described, and made to rotate when acted on by the movement of the U-blade.

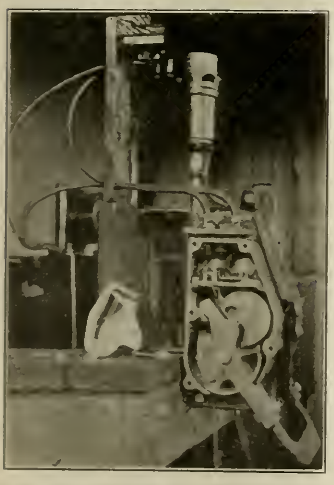
The track circuits, the relays and the electrical supplies are practically the same as those now used in the ordinary automatic block signalling system: Two line wires for double track roads, and four line wires for single track roads. One wire in each pair includes the track contacts in completing a circuit with its companion, to operate the appliance and the signal lights.

In the locomotive circuits, one side of a small battery is grounded to the iron parts of the locomotive or tender, the other passes through a wire to the circuit-breaker in the auxiliary box, previously described, down through one leg of the U-blade, and through it to the other leg, back through a wire to one side of the magnet-controlled air valve, and through it to the ground or iron parts of the locomotive and on to the battery.

The permissive speed control circuit may be described by saying, beginning at the side of the engine battery, not grounded, a wire connects it with the open point of a push button, thence to an open contact in the auxiliary box, to contact on the speed control disc, to the U-blade and through the U-blade "magnet" as already described in the locomotive circuit. It will be noted that this circuit is open in two places and to become operative, it can be closed automatically or by the engineman pushing the push-button at the time the permissive speed control mechanism forms its electrical connection while the U-blade is engaging the split-ramp.

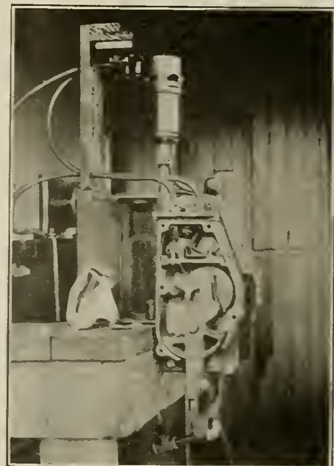
This automatic or semi-automatic operating feature is a matter of choice with any railway installing the Wooding apparatus.

When the blocks are clear, the track relays are energized by the track batteries and hold all circuits closed. This supplies the split-ramps with current from the line wire circuit battery to energize the magnet-controlled air-valve in the cab and it holds the brakes from being applied while the controlling circuit is broken by the deflection of the U-blade as it passes



NORMAL POSITION—STOP CIRCUIT CLOSED SPEED CONTROL CIRCUIT OPEN.

through the split-ramp. Before the controlling circuit is broken on the engine, the current from the line wire battery passes through the track relay, out through the line wire into the split-ramps up through the U-blade to the magnet-controlled air-valve, through it to the ground or iron parts of the locomotive



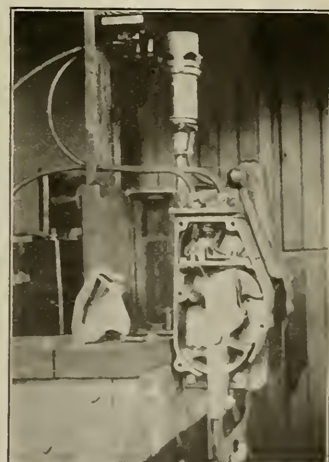
MIDDLE POSITION—STOP CIRCUIT OPEN SPEED CONTROL CIRCUIT CLOSED.

and into the track rail, back through it to the track relay, and through it to the opposite side of the battery from which it started. The curve at the outgoing end of the split-ramp restores the circuit carried on the train, by closing the circuit-breaker in bringing the U-blade back to its normal position, while the current is still flowing from the line wire battery. In this way the current from the battery on board the train overlaps the current from the line wire batteries to hold and maintain the energizing of the magnet-controlled air-valve on board the train, as long as the blocks are clear. On the other hand, should a block be occupied by a train, or have a switch, or a bridge be open, or a broken rail or any other dangerous condition that would break the track circuit, it would de-energize the track relay which would fall open and break or reverse all the circuits. This would reverse the current in the split-ramp and cut it out from the track rail, and when the approaching U-blade engaged the split-ramp and broke the controlling circuit on board the train there would be no current to take its place, and instantly the magnet-controlled air-valve would be de-energized, releasing the air and applying the brakes, and at the same time the released air would blow an air whistle in the cab.

During these operations the same wires, relays and battery supplies are operating the main signal lights beside the track. Under double track operation a red light shows at the back of the block occupied, a caution signal at the back of the second block, and clear signals in the other blocks. On single track roads the signals are produced in the blocks ahead also. For economy, the signal system can be installed so that no signals are operated except when a train is present and causes the clear signal to appear in the block ahead, providing they are clear for two blocks ahead. If not clear, either a caution or a red signal will appear instead, depending on whether the danger is just in the first or in the second block ahead, and displays a red and a caution signal back of the trains as described under double track operation.

The permissive speed control is to save time, by allowing an engineman to run his train safely up to another train or dangerous point without being stopped by the automatic train stop. The engineman may do this at the reduced speed, predetermined by the operating officials, as a safe speed. This is done both by the engineman and the speed regulating mechanism, or automatically.

The semi-circular speed control disc is rotated by the U-shaped blade as it passes through the curve in the split-ramp. If the curve is twice as long in the one case as in the other, the longer curve will properly deflect the U-blade and rotate the disc half as fast as in the shorter split-ramp or it will allow the train to move twice as fast in order to produce the same result, such as causing the disc to assume the middle position. A train can run faster with safety entering a block than it can on leaving the block to enter one in danger, so the split-ramps are permanently installed with the long curves near the



EXTREME POSITION—BOTH STOP AND SPEED CONTROL CIRCUITS OPEN.

entrance of a block and the short curves near the outgoing end.

As long as the track is clear and the signals show clear, the appliance automatically holds itself from operating the brake, but when a caution signal is approached the engineman must recognize it and reduce the speed of his train to that predetermined as safe. The touching of the push button is a practical acknowledgment that he cognizes the condition of affairs. The engineman also knows that he must further reduce the speed of his train to a minimum as he passes the next split-ramp. If he fails to recognize the caution signal, which is of vital importance, the brakes will be applied in time to stop the train in safety, regardless of the speed it is traveling at.

This appliance is said to meet all the requirements set forth by the American Railway Association. It not only protects the trains from the dangers described without interfering with the engineman in his control of the train, except when he fails, but it is also self detecting and no part of the appliance along the track or on board the locomotive can become inoperative without setting the signals at danger and stopping the train.

Railroad men are aware of the fact that notwithstanding the great value of the automatic signals, that they lack a vitally important and useful purpose, which is the power to reach out and stop a train that is running blindly to destruction while the signals stand helpless beside the track, having performed the full service for which they are at present designed.

This invention has been produced in a simple and practical form, and through the courtesy of the Lackawanna Railroad, a demonstrating section has been installed on the company's heaviest trunk line within seven miles of New York City. The parts of this appliance have been especially designed to perform their function in the simplest and best way known. Its simplicity and practicability is open to the investigation of any one who will give it consideration.

The Laying Out and Maintenance of Shoes and Wedges

Recent Important Improvement in Wedge Design

As is well known, the severe strain on the driving shoes and wedges of a locomotive is such that their replacement is one of the items of expenditure at regular intervals, while their proper adjustment is a constant necessity in locomotive running. In locomotive construction or general repairing, the work of fitting and laying out the shoes and wedges may be said to be comparatively easy of accomplishment. The object to be aimed at is to have the centers of the axles of the driving wheels at right angles to the frames, the main drivers being at a certain fixed distance from the cylinders, and the other axle or axles at equal distances. When the driving boxes have become worn and the wedges require refitting or replacing, it becomes a more involved mechanical problem, and a brief statement of the methods of operation cannot fail to be of interest to many of our readers.

To begin with, a center line on the frames between the two main driving pedestals on both frames, showing exactly where the center of the axle should be, is a prime necessity. The drawings will show the required distance from the center or back of the cylinder to the center of the axle. In either case the measurements from the cylinder are not always reliable, and should not be taken as a basis of new construction or repair work. A more reliable method is to start from a center punch mark on the saddle, and centrally located between the frames and about the same height as the top of the frames. An adjustable tram may be stretched from this point to the center of the pedestals, where a temporary mark may be made on the top of the frames. The center of the frame, longitudinally, can readily be ascertained by calipers. A straight edge laid across the frames at these points should be at right angles to the line of the frames, and measuring the distance to the cylinders, the central line of the pedestals can readily be located, taking care to maintain the exact right angle of the straight edge to the frames whatever slight variation there may be in the location of the cylinders. A distinct mark should then be scribed on the top and sides of the frames. When this line is correctly established, it should form the basis of every other operation.

Lines stretched through the centers of the cylinders should square exactly with this line, but it will be found that there are not infrequently slight variations in the cylinder lines; that they are not always exactly square to each other, and that the central lines of the cylinders may vary slightly from the line of the frames. These variations may be insignificant, but it is well that the line of the frames, if they are exactly parallel to each other, should be adhered to.

It need hardly be stated that in repair work the faces of the pedestal jaws should be carefully straightened to a face plate, and should also be tried by a long straight edge crosswise, so that the faces of both pedestal jaws on both frames should be true to each other. In fitting the binders or bottom braces they should fit perfectly tight before being quite drawn up to the frames; in other words, an allowance should be made for the subsequent loosening and tightening of the binders. The shoes should also be a little longer than the exact distance between the binder and the lower side of the top of the frames. The shoes should be carefully fitted to the rounded top of the pedestal jaw. This careful fitting of the shoes is of the utmost importance. When the shoes and wedges and binders are in place, before beginning to mark off the amount to be planed, or the amount to be filled with liners, as the case may be, the wedges should be raised about five-sixteenths of an inch from the binders, allowing sufficient space for loosening the wedges if necessary. A spreader, consisting of a piece of pipe with adjustable bolt, can be placed, one near the bottom and another near the top, holding the shoes and wedges securely in their places, and a straight edge can be rested upon the upper or lower spreader and held in place by small screw clamps.

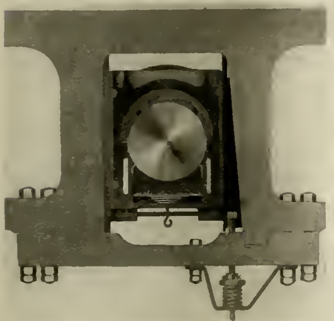
The sizes of the driving boxes, that is, the distance from their faces bearing against the wedges having been ascertained, we are now ready to lay off or adjust the front shoes. The central line of the pedestal being the chief factor in the operation, all measurements must be carefully started from this line. The shoes should be marked at three different points, the points running square to the top of the frames, the markings on the inside of the shoes agreeing exactly with the marks on the outside, and from these three points, or center punch marks, all of the other shoes and wedges may be marked by a suitable tram corresponding to the distance between the axles, and, of course, agreeing with the length of the connecting rods, taking care in the case of repair work to add to the markings, as the varying sizes of the boxes may require, if there be any variation.

It should be observed whether the driving boxes are bored exactly central, as the incidental wear sometimes compels a variation from the true center. This is not infrequently the case with the main drivers where the tendency to wear irregularly is the greatest, and where the planing of the box bearing on the wedges or the boring out of the new brass may have caused a deviation from the original center of the box bearing.

When the shoes and wedges are planed or lined to their proper thicknesses they should be carefully fitted to a straight edge reaching across the frames and filed till they are perfectly parallel to each other.

Such in brief is the general method of operations, but not infrequently special tools are used by mechanics in order to insure a greater degree of accuracy. And it is certain that too much care cannot be taken in securing a perfect alignment both in regard to the important feature of having the axles exactly square to the frames, as well as having the centers of the other axles equidistant to each other. In the newer forms of locomotive valve gears the exact location of the main axle is of importance in making it possible to maintain that degree of accuracy and adjustment of the action of the valve gear that aids in the perfect control and distribution of steam in the cylinders.

In the adjustment of driving-box wedges while running a locomotive, it might be said in a general way that there is a tendency, especially among the younger engineers, to meddle too much with the wedges. In the event of a driving box becoming heated it is very necessary that the wedge should be loosened, otherwise they should be let alone. In setting up wedges the position of the cranks is an important factor. The best practice is to have the cranks in the upper forward eighth position. At that point the driving box is readily held hard against the shoe, that is, when moving the engine forward, and the wedge may be readily screwed up tight, and then drawn down a sufficient distance, less than one-eighth of an inch, to allow the driving box that degree of freedom of movement essential to safe running. If the wedge bolt or bolts be loose in the wedge they should be screwed upwards the amount of the slack, so that the bolts will not permit of a further lowering of the wedge, the loosening and pounding of the driving boxes in the shoes and wedges being the chief cause in the wear and tear of the frames and running parts of the locomotive.

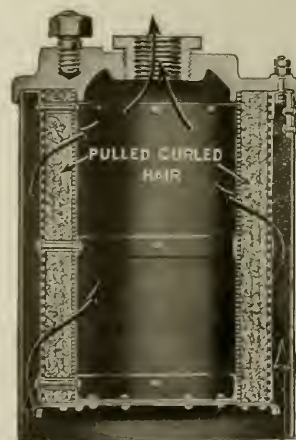


FRANKLIN AUTOMATIC ADJUSTABLE DRIVING BOX WEDGE.

In this regard a most important improvement has recently been made in maintaining the correct adjustment of the movable wedge by what is known as the Franklin automatic adjustable driving-box wedge. As shown in our half-tone illustration, it consists of an adjusting and a floating wedge held in place by a coil spring. The adjusting wedge is tapered on one side to suit the taper of the pedestal jaw and on the opposite side to accommodate the lesser taper of the floating wedge. The wedge bolt passes down through the pedestal binder, but instead of being held in place by adjustable nuts, a spring cap and coil spring is mounted on the bolt, the lower end of the spring resting on a bracket. The tension of the spring holds the adjusting wedge in position and automatically maintains the wedge in its proper adjustment to the driving box. The floating wedge being slightly shorter than the distance between the binder and top of the pedestal jaw, the effect is that the floating wedge will slightly relieve the adjusting wedge, completely preventing any tendency to sticking or seizing of the driving box, thereby eliminating any need of adjustment while the locomotive is running, and, consequently, reducing to a minimum the wear and tear of the working parts of the locomotive.

The New Special Westinghouse "Fifty-Four" Air Strainer.

The new special "Fifty-Four" air compressor strainer recently brought out by the Westinghouse Air Brake Company embodies features called for by modern service conditions that were not existent nor necessary in the older type. Demands of the modern heavy locomotive and car equipment, also longer trains, require a much greater air supply in the same time than formerly. This has been adequately met by the greater size and capacity of the compressor, also by increased efficiency at each step of compressor development, and the development and modification of the air strainer to keep pace with the heavier demands of the modern conditions now naturally follows. Earlier efforts were made from time to time in this direction, but they did not result in securing in full measure the improvement deserved and the new "Fifty-Four" is presented to meet the demands of heavy compressor service.



WESTINGHOUSE AIR STRAINER.

The prime requirements of such a compressor strainer are, proper capacity to present to the compressor a large volume of air at low vacuum and easy suction, also to deliver air to the compressor free from dust, grit and other foreign substance, thus providing positive assurance of freedom from unnatural wear of the air cylinder parts, heating, due to choked air passages and from worn packing rings, and derangement of regulation portions of the valvular parts of the air brake system on the locomotive. The Westinghouse "Fifty-Four" contains efficiently this important double function. The fifty-four square inches of suction screen area permits and provides a soft and gentle suction, or low vacuum line, at the intake port. The same large screen area and unusually liberal volume of curled hair filter material assures delivery of purified air and long periods between cleaning of the hair filter itself.

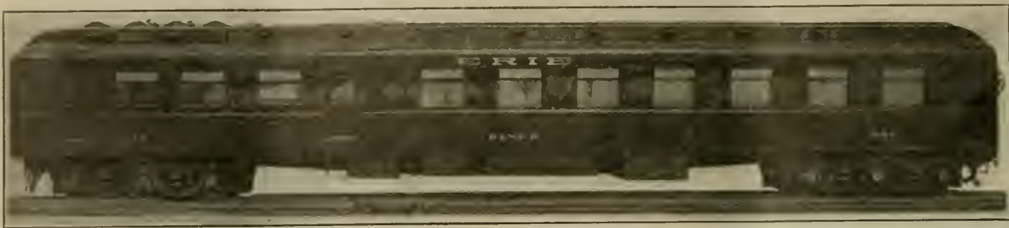
VIEW OF WESTINGHOUSE AIR STRAINER AS APPLIED TO AIR COMPRESSOR.

While primarily planned for the 8½-inch cross compound compressor, for which a manifold attachment has been designed to require but one strainer, the "Fifty-Four" may be used with material advantage on the 9½-inch and 11-inch compressors, the piping for same being arranged for close connection, or, if desired, it may be run off to an isolated and more protected location. The strainer is tapped for a two-inch pipe for the 8½-inch cross compound, but the piping may be reduced for the smaller size compressors.

Compartment Dining Car on the Erie Railroad

Unique Design—Two Aisles, One on Each Side of the Dining Tables—Tables Centrally Placed for Parties of Six, Four or Two

The dining-car service on Erie trains is planned for efficiency. In providing for 260,000 meals annually, an immensity of detail is necessary. The larder must be kept fully stocked so that patrons may secure what they desire. Supplies must be carefully inspected to secure freshness; the food well-cooked and properly served, although the kitchen facilities are necessarily limited.



ERIE DINER WITH UNIQUE DESIGN OF PRACTICALLY PRIVATE TABLES.

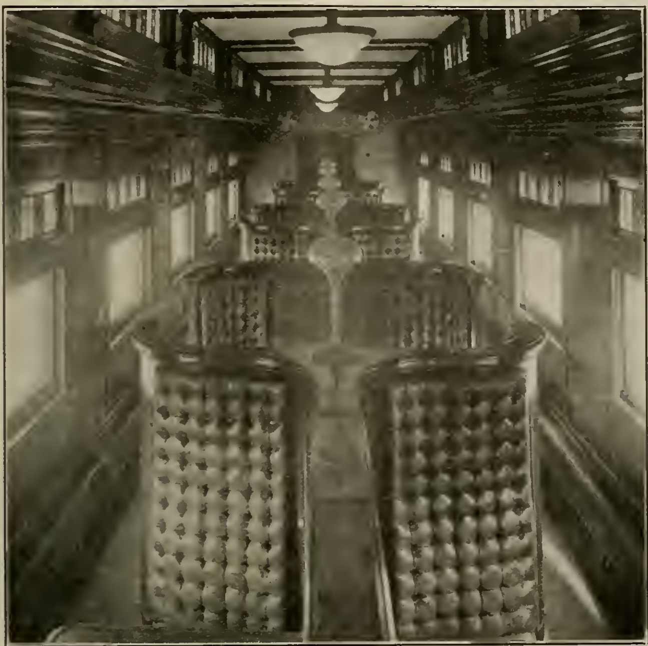
The Barney & Smith Company has recently delivered to the Erie Railroad two dining cars of all-steel frame construction which represent the latest development in coach design. They are now in service on through express trains. The design which is certainly unique, must be credited to Mr. F. D. Underwood, president of the road, and the builders, whose work has been supervised by Mr. William Schlafge, the general mechanical superintendent, and his staff, have carried out the work in a way that is highly creditable to them and to the Erie Railroad.

A radical departure has been made over the seating arrangement that is commonly employed, as in these cars the tables are in the center of the car and the partitions make partly enclosed compartments, leaving two aisles, one on each side, instead of being placed at the sides. They are so arranged that four persons may be seated at each of four tables and two persons seated at each of six tables, making a total seating capacity of 28. It is possible to accommodate six persons at the round tables. This arrangement provides maximum convenience to the patrons, greatly improves the conditions required for prompt and satisfactory service, and affords a desirable degree of privacy.

The ground plan of tables, seats and partitions are in outline like the steel sheet piling used at the ferry slips of some railroads. These are, in fact, I-beams with the top and bottom flanges curved downward and away from each other; the curved flange of the pile representing the partition, making the backs for three seats, and partly encircling a round table, and the curve of the next "pile" representing three other seats at the other side of the round table. This arrangement can be seen in our third illustration, the photograph for which was taken over the top of the partitions. These are too high for a seated passenger to look directly over the partitions, yet a general view through the car can be had. Referring again to the sheet pile, as a sort of approximate description of the table and seat plan, one may say that the web of the pile represents the centre partition between round tables and on each side of this central partition, two square tables are placed, provided each with two seats. At the table level, the partition is practically a window of opaque art glass, which can be let down into the wooden base of the partition, so that if a party of four desire to sit together the lowered glass partition makes both tables practically into one, and the four passengers may converse with all the sociability to be found at the round tables. If the pairs of passengers do not know each other, the raised glass partition secures the desired privacy for each table. Our second illustration shows this arrangement with the glass partition drawn up.

ERIE DINER WITH SQUARE TABLES, GLASS PARTITION CAN BE LET DOWN.

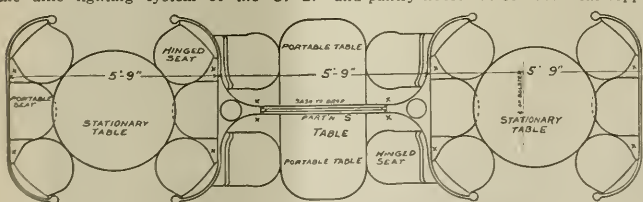
The underframes of these dining cars are of the built-up type having center sills of the deep girder type, while the side and end frames are of pressed steel, riveted to the roof construction through the medium of continuous rolled steel carlines. The exterior is covered with



INTERIOR OF ERIE DINER SHOWING ROUND TABLE.

sheet steel riveted to the frame. The trucks were designed by the Standard Car Truck Company and are of the six-wheel built-up steel type, and have the Standard Steel Car Company's design of clasp brakes.

The cars are lighted with electric lights placed on the ceiling, the current for which is supplied by storage battery and the axle lighting system of the U. S.



SECTION SHOWING TABLE ARRANGEMENT ERIE DINER.

Heat and Light Corporation of Niagara Falls, N. Y. Current is thus always available. The lamps in the dining room are all of the semi-indirect type affording a flood of illumination without any unpleasant glare. In the passageway and at the ends of the car pendant lights are located at suitable intervals. On top of the table partitions a number of lamps of art glass stand on ornamental metal bases and produce a pleasing effect, which breaks the dead level of top of the table partitions by an elegant and highly decorative arrangement.

The interior finish of the dining room in front of the buffet and the passageway is of light Cuban mahogany, the larger panels in the dining room being relieved by a narrow inlay of boxwood. The floor covering in the dining room is of maroon flexolite, while that in the passageway in front of the buffet and end of the car is a ¼ inch inlaid rubber. The kitchen and pantry floors are covered with copper upon which is a series of wooden racks, which prevent those in the kitchen from slipping. The cars are insulated throughout against changes of temperatures with ¾ ins. flaxinum.

Some of the principal dimensions of these cars are as follows: Length over end posts, 78 ft. 10 ins.; length center to center of tracks, 60 ft. 4 ins.; width over side sills, 10 ft.; height from top of rail to top of roof, 14 ft. 3 ins.; height from top of rail to bottom of side sill, 3 ft. 7½ ins. The weight of the car is about 155,400 lbs. One of these cars will leave New York on the day train, while the other will leave Buffalo, also on the daylight run.

New G-E Illuminating Fixture Throws Light Downward.

The city of Buffalo recently installed a new type of ornamental street lighting unit in one of its suburbs. The unit is also efficient and economical.

This type is equally suitable for lighting large open spaces, as docks, lumber and railroad yards, platforms at railroad and interurban street railway stations and the streets and open places in industrial plants. Where it is desirable a pendant form, as illustrated, of the same type unit is used.

In the old type a large proportion of the rays are thrown upward and lost, while those of the new unit are all redirected at a downward angle to the surface where illumination is needed.

An artistic fixture contains a prismatic refractor used to collect the up-

NEW DESIGN OF LIGHTING FIXTURE.

ward rays of the 100 candle-power Mazda C lamp in this case, and redirects the upward light at a slight downward angle, illuminating the surfaces used for traffic. This saves and applies to a useful purpose the light thrown upward and wasted with the average installation. The candle-power of the light used with this unit may vary, but the Mazda C lamp should be used without exception. This unit is the latest addition to the General Electric Company's many types of out-of-door lighting fixtures.

The application of the improved lamp, where it is already in service, is being warmly appreciated by the traveling public.

Fifty-Ton Box Cars on the Intercolonial Railway

Car Height Limited by Overhead Bridges and Other Restrictions—Interior Marks Showing the Loading Height for Various Commodities

The Intercolonial Railway of Canada have recently bought one thousand box cars for use on that road. The cars are made with steel frames, and 500 have been turned out by the Canadian Car & Foundry Company of Montreal and 500 by the Eastern Car Company of New Glasgow, N. S.

The superintendent of rolling stock of the Canadian Government Railways says of these cars:

"We think that these are a little better proportioned than other box cars, so far as the general dimensions are concerned, as we had to get the total height as low as possible and the effect of doing so seems to be a car that does not look top-heavy. About the only special design that we might point out is the small end door, located 16½ ins. from the floor and which is used for loading the car with rails at the steel mills. We have used such an opening for many years and find it of much advantage. We also reinforced the ends by heavy inside double lining, as shown, with very satisfactory results and it is a very rare occasion on which the end is bulged out."

The center sills of these cars consist of two 15 ins. x 35 lb. channels reinforced at top with 5 x 4 x ⅝ ins. angles and at bottom with 4 x 4 x ⅝ ins. angles. The top angles run the full length of the car and the bottom angles run through the bolster and stop at back of draft gear plates.

Bolsters are built up of 5/16 in. web plates. The bottom of bolster is reinforced with ¼ in. plate 19½ ins. wide and about 5 ft. long, securely riveted to the bottom of center sill. Top and bottom bolster cover plates ½ x 15 ins. Bolster center brace is of malleable iron or cast steel. All rivets used in the bolster construction are ¾ in.

Two pressed cross bearers are used per car of ¼ in. thick plate with 5/16 in. pressed center stiffener securely tied at top and bottom with 6 x ½ ins. plates.

Five cross ties per car of 5 x 3 x 5/16 ins. angles with ¼ in. pressed center stiffener are employed and center sill ties of 6 x ¼ ins.; two at bottom and four at top between bolsters. Side sills and end sills are of 10 ins. x 15 lb. channels and floor stringers of 3 ins. x 6.7 lb. Z-bars are run the full length of car. End sills to have a 12 x ¼ ins. cover plate. Diagonal braces at ends are of 5 x 3½ x ⅜ ins. with angles or channels of equal strength.

The design of underframe conforms to the M. C. B. requirements. It is guaranteed by the builder to be of ample strength to carry the load designated (100,000 lbs.) plus an overload of 10 per cent., in addition to the total weight of car complete with all fittings attached, without taking any permanent set. The framing is entirely of steel throughout.

The end plates are tied to the side plates with ⅜ x 6 ins. plates diagonally across each corner, placed near center of end plate and extending to side plate at an angle of 45 degs. secured with two ⅝ in. rivets at each end.

Gusset plates for side posts and braces are 5/16 in. thick pressed to shape with closed corners, four ⅝ in. rivets in posts and braces and three ¾ in. rivets in side plate.

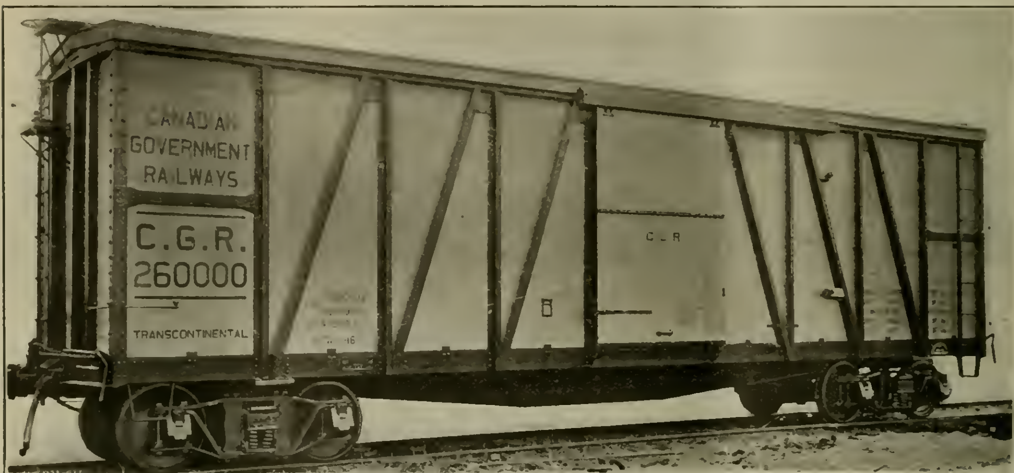
The flooring is built-up, combined with underframe, ends trimmed straight and corners cut off. Bolster center braces are of malleable iron, or cast steel, securely riveted in place with ¾ in. rivets. Center plates are made of cast steel securely riveted in place. Pressed steel side bearing plates of suitable design are applied, riveted to the bolster.

The flooring is supported on each side sill, and on two steel Z-bar stringers and on wooden floor supports of pine, bolted to center sills. The Z-bar stringers are continuous, without a splice, for the full length of car.

Flooring is secured to Z-bar stringers with ⅜ in. button-head bolts, two in each board. The ends of the flooring boards at door openings are secured with ⅜ in. button-head bolts, the heads of bolts are on top, but do not project above the level of the floor. Grip nuts are applied to each bolt.

The side doors are arranged on each side of the car, are made spark and weatherproof. A hood of No. 14 gauge iron is applied over door track. Each door is fitted with Camel No. 30 door hangers and "Positive" door fastenings.

The door rails, braces and stiles are of pine. A 1¼ x 1¼ x ¼ ins. angle-iron brace is riveted or bolted across the face of the door about 13 ins. from top with



STEEL FRAME BOX CAR FOR CANADIAN GOVERNMENT RAILWAYS.

⅜ in. rivets to hold it securely in place.

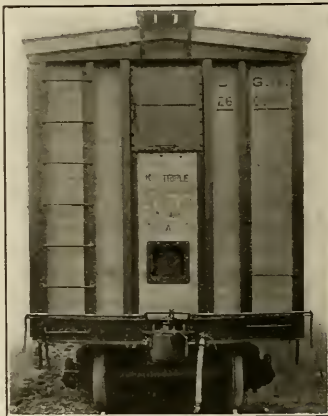
Door handles are cast iron, and are of the railway standard. The cars are equipped with Westinghouse standard automatic brake equipment, Schedule K. C. 1012. The general arrangement and details conform to M. C. B. requirements. Braking power is 60 per cent. of the light weight of car based on 50 lbs. cylinder pressure.

The drawgear is Miner Twin Spring Type, and is of the latest type casting applied in accordance with recommendations of company supplying them. Drawbar yokes are 1¼ x 5 ins. and are forged from solid billets of steel. The ends are not welded on. Cast steel buffing blocks of approved design are applied at each end.

The fish-belly underframes have 5/16 in. web plate, 2 ft. 4 ins. deep with outside top angles 3½ x 3 x 5/16 ins. and inside bottom angles 3½ x 3 x ⅜ in. and outside 3½ x 3 x 7/16 ins. Cover plate ¼ x 23 ins. run the full length of the web in one piece. Side channels are 9 ins. x 13.25 lbs. per foot. End channels are 10 ins. x 15 lbs. per foot.

Bolster web plates are 5/16 in. thick. Malleable iron bolster center braces are applied. The bolster cover plates top and bottom are ½ in. thick, 15 ins. wide. Channels 9 ins. x 15 lbs. per foot are riveted to the outside of the web plate at each end extending from within 12 ins. of the bolster to end sill. Outside bottom angles extend 12 ins. beyond the bolsters. The inside bottom angle extends to the draft gear castings. Floor supports 5 x 3 x 5/16 ins. angles, five on each side extend from center sill to side sill.

Some of the general dimensions are as follows: Capacity, 100,000 lbs.; length, inside lining, 40 ft. 6 ins.; width, inside, 9 ft. 0 ins.; height, floor to bottom of carline, 9 ft. 0 ins.; width, side door opening, 6 ft. 0 ins.; height, side door opening,



END DOOR FOR LOADING CAR WITH RAILS.

about 8 ft. 6 ins.; height, rail to center of drawbar, 2 ft. 10½ ins.; height, rail to floor, 3 ft. 10¼ ins.; center to center of bolsters, 31 ft.; height, rail to top of running board, 14 ft. ½ in.

INTERIOR OF CAR, SHOWING HEIGHTS TO WHICH VARIOUS COMMODITIES MAY BE LOADED.

The information concerning these cars has been put within our reach through the courtesy of Mr. George R. Joughins, superintendent of rolling stock of the Canadian Government Railways. The Dominion owns and operates not only the Intercolonial Railway, but also the International Railway, the New Brunswick & Prince Edward Island Railway, the Prince Edward Island Railway, the St. John & Quebec Railway and the National Transcontinental Railway.

How Smoke Box Gases Enter Cylinder.

We have been asked to say how it is that with throttle tightly closed and no relief valves used on an engine, that smoke-box gases enter the cylinders of superheater engines. Our enquirer practically answers his own question, where he says:

"Referring to the article in your April issue in regard to the lubricating of superheater locomotive cylinders in which you mention the presence of smoke-box gases in the cylinders when engine is drifting with throttle shut tight. We have had a little discussion in regard just how these gases gain admittance to the cylinders.

"With the reverse lever hooked up, would the valve not open the exhaust port before the piston had completed its stroke, and on account of the piston moving away from the exhaust port would this not account for the gases being drawn into the cylinder, also with piston valve when steam is shut off, the valve would naturally ride on the bottom of the valve cylinder, and the rings not being tight at the top would permit of gases being drawn over the top of the piston.

"We would appreciate your explanation in a subsequent issue of Railway and Locomotive Engineering."

It does not seem to us that any further explanation need be given, as Mr. Bowyer fully explains what does occur, and what he says does take place and accounts for smoke-box gases getting into the cylinders and interfering with the lubrication. This, of course, is governed to a greater or lesser extent by the speed at which engine is drifting, and particularly so if engine is not equipped with relief valves, for the reason that in the latter case no air can enter from the admission port to the cylinder, and it has to reach there from the smoke-box through exhaust port, as stated by our enquirer. Even with the small relief valves generally in use on locomotives, as compared with size of cylinders and area of the exhaust pipes and passages, it naturally stands to reason that even with the use of small relief valves, smoke-box gases will quite often find their way to the cylinders of the locomotive when drifting with throttle shut tight.

Success is a result of mental attitude and the right mental attitude will bring success in everything we undertake.

The Stephenson Locomotive Valve Gear

Shifting Link Still an Important Factor on the Lighter Type of Locomotives—Details of Its Construction—Approved Methods of Adjustment—Name of Original Inventor

The general introduction of outside forms of valve gearing for controlling the admission of steam to the cylinders of the modern high-powered locomotive, and the greater convenience in adjustment and repair when compared with the older forms of valve gear, has given an impetus to the spirit of further improvement which is in every way laudable. The shifting link motion or Stephenson valve gear, as it is generally called, is, however, still an important factor in locomotive construction, and our series of articles on the subject of locomotive valve gears would not be complete without a brief description of its construction and adjustment. To the young engineer or machinist the combination of levers and rods and eccentrics and sliding links as shown on Fig. 1 may be involved in mystery, but a little attention to the separate details of the device and the arrangement of the mechanism is not difficult to understand.

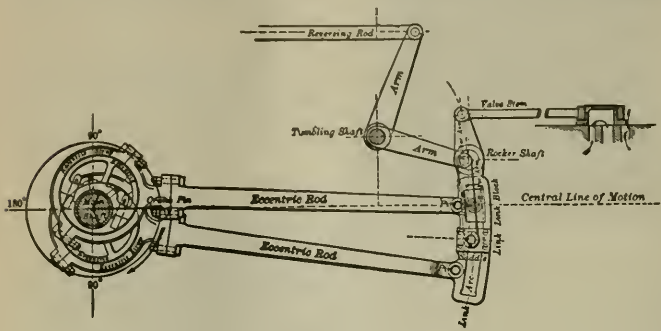


FIG. 1.

Beginning with the valve, which is usually of the D pattern, a valve stem and rod are attached to the upper arm of a rocker shaft, the lower arm of the rocker in turn being attached to a slidable radial link. The link is suspended by a hanger attached to the arm of a tumbling or lifting shaft, the upper arm of which in turn is coupled to a reversing rod which is joined to the reversing lever. Attached to the link also are two eccentric rods which, in turn, are connected to two eccentric straps fitted to eccentrics attached usually to the main driving axle of the locomotive. Two eccentrics are provided for each cylinder, and they are so adjusted in their relation to the main driving crank that one of each pair will run the locomotive in one direction, and the other two in the reverse direction. It will be readily noted that by assuming that the reversing lever has been moved forward on the quadrant, the link is dropped downward until the upper eccentric rod is in line with the center of the link block attached to the lower end of the rocker. With the parts of the proper length and location this position of the link would have the effect of placing the rocker so that the valve would be opened admitting steam to the front end of the cylinder, the presumption being that the piston would then be at the extreme end of its stroke on the forward center.

Assuming that the condition referred to is on the right side of the locomotive, the main crank pin on the left side would be on the top center, and the link on that side would be at its longest angle of inclination with a full opening of the valve port admitting steam to the back of the cylinder and so pressing the piston forward and consequently moving the engine forward.

Fig 2

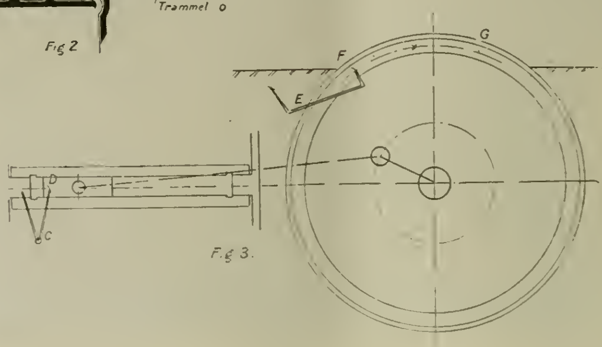


Fig 3.

With these elementary parts in mind, suppose we proceed to the adjustment of the valve gear. It may be said at the outset that there are degrees of proficiency required from the assembling of the parts of the valve gear to the simple matter of squaring the eccentric rods in a quick roundhouse readjustment. It is safe to assume that the designer's work is correct and we can safely proceed with the adjustment of the valve gear, which is generally the last operation in the construction or repairing of a locomotive.

Assuming that the four eccentrics are loose on the driving axle of a locomotive, move the driving wheels until one of the main crank pins is on the dead center—say the left forward. If the eccentric which is designed to move the engine in a forward direction is intended to be next to the frame, the eccentric may be temporarily put in place about 80 degrees above the line of the crank pin, the larger part of the eccentric inclining toward the crank pin. The eccentric intended for the backward motion should be placed a similar distance below the crank pin or center line of the axle. The eccentrics on the other side of the locomotive can be similarly attached after moving the crank to the suitable dead center, and all four eccentrics held in place by adjustable set screws.

Assuming again that the links have been attached to the rockers and the link hangers adjusted to the arms of the reversing shaft, the forward eccentric rod should be adjusted to the top of the link, and the back eccentric rod to the bottom of the link. The length of the valve rod should be correctly fitted so that when the rocker is plumb the valve will rest exactly on the center of the valve seat, that is, the amount of lap over the front and back ports should be identical. Any variation from this is the beginning of involved troubles that are beyond remedy. In adjusting the valve rod it should be seen that the engine is level.

There are various devices for revolving the wheels, the older method of moving the locomotive with pinch bars has disappeared, and rollers mounted in suitable chairs, which, by means of long screwed bolts, can be drawn under the driving wheels, thus raising the latter clear of the rails and thus enabling them to be slowly revolved by such means as may be most available. It is also desirable to have some convenient way of ascertaining the exact moment at which the outside edges of the valve close the front and back steam ports without having to refer each time to the valve itself. In Fig. 2 it is shown how this may be done with a trammel *o*, and scribing two lines *a* and *b* on the valve rod corresponding to the closing position of the front and back ports. The figure shows the trammel *o* in position. A strip of tin held between the port and the valve serves as a gauge to insure the edges of the port and valve being in line with one another. The trammel is a bent one in the form shown in the figure, the straight end being placed in a center pop mark made at a convenient fixed part of the cylinder casting. The steam chest may then be closed.

Fig. 3 shows how the dead center position of the crank may be found. Revolve the driving wheel until the crank approaches the dead center, then with a pair of dividers or short trammel *c* describe a line *d* on the crosshead, using the trammel from a fixed center pop mark on the guides or cylinder, also with a suitable trammel *e* used from a center pop mark on the frame or wheel guard describe an arc *f* on the edge of the wheel rim. Revolve the wheel slowly past the center until the crosshead again reaches the same position as above, but on the return stroke found by using the trammel *c*. Another arc *g* is described on the edge of the wheel with the same trammel as for line *f*, and used from the same center pop mark on frame. Bisect the space between the arcs *f* and *g* at *x* and revolve wheel until trammel intersects at *x*. The engine will then be exactly on the dead center. The same process is gone through for finding the opposite dead center.

Supposing that we begin by examining the position of the valve on the right forward center. Place the reversing lever in the extreme forward notch and revolve the wheels until the trammel touches the dead center point, then we proceed to scribe a mark with the valve trammel on the valve rod. Move the wheels again until you reach the other end of the crosshead or piston stroke where it is presumed marks have been made on the wheel rim in the manner already described, and again mark the valve rod. We will suppose that Fig. 4 shows the opening marks. It will be seen that the valve opening at the front end is about three-sixteenths of an inch, while at the back there is about one-sixteenth of an inch of lap, or in other words there is no opening until the valve rod has moved one sixteenth forward.

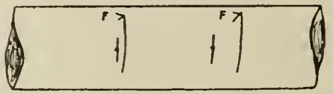


FIG. 4. FIRST MARKING.

In this case the valve rod must be moved one-eighth of an inch ahead in order to equalize the opening at both ends of the stroke. To do this the right forward eccentric rod must be shortened one eighth of an inch. Another trial of the trammel should show both marks as in Fig. 5.

The eccentric rod is now squarely adjusted, but supposing that the amount of valve opening or lead desired should be one-sixteenth of an inch, to obtain this change the right forward eccentric should

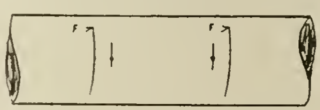


FIG. 5. ECCENTRIC ROD ADJUSTED.

be moved further away from the crank, and while the eccentric is being moved, the valve rod should be carefully observed by holding the valve trammel in position and the eccentric secured at the desired point, and after again experimentally revolving the wheels and marking the valve rod, when the engine is on the dead centers, the marking should show as in Fig. 6.

It is hardly necessary to state that the backward motion, with the reversing

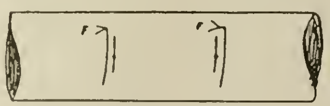


FIG. 6. ECCENTRIC ADJUSTED.

lever in the back notch, may be adjusted in the same way, and so on with the left side of the locomotive. Other details, such as the length of the reversing or reach rod, should be observed, and it is good practice to leave a larger clearance between the link block and the top of the link slot than at the bottom, as the tendency of the link to drop slightly after the parts are beginning to wear is inevitable. It is also necessary to examine the amount of valve travel at the point of cut-off, necessarily with the reversing lever nearer the center of the quadrant. In the event of any important variation this point of cut-off may also be correctly adjusted if the link saddle is movable, otherwise the exact adjustment of the valves at the extreme travel may be slightly sacrificed in favor of a correct adjustment at the point where the locomotive may be required to do its regular amount of work.

But enough has been said to start the intelligent mechanic in the right direction, and it may be remarked in closing that this link motion may see much service in the years that are to be in spite of the improvements essential to the heavier types of locomotives and to which we have already referred. As a masterly contrivance it perfected Stephenson's locomotive. The inventor, William Williams, a young Welsh draughtsman, in the employ of the Stephenson Locomotive Works at Newcastle, England, submitted a sketch showing the idea. It was applied by Robert Stephenson to the new locomotives in 1842. It was never patented. It is rarely that the young inventor's name is ever associated with it. It is doubtful if he ever had any substantial reward for his master stroke of surpassing ingenuity, but in the memory of many whose opinions are worth regarding, his name is folded deep as a genius in invention, fortunate in one particular that his idea was immediately applied.

Extracting a Broken Set Screw.

Among the various vexing problems that constantly arise in railroad repair work generally, and roundhouse work particularly, one of the most serious aggravations is that of a broken set screw, the renewal of which is sometimes a very tedious operation, to be taken care of at once to the sacrifice of all else.

Matters of this kind are now performed expeditiously by means of an extracting tool which has been designed for the purpose. It resembles a drill with a coarse left-handed thread, and to remove a broken set screw, cap screw, stay bolt or stud, a hole is drilled in the remaining portion into which the extractor is slipped. As it is turned it exerts a reverse influence on the broken set screw and the latter is backed out on its own thread. The new tools are made in three different sizes covering practically all machine shop requirements. They are sold in sets.

Rolling Stock Construction.

It is estimated that 7,500 locomotives and 300,000 cars have been constructed in the United States in twelve months. This could be nearly doubled if material and labor could be mobilized, and the manufacturers are not hampered by other difficulties besides perfecting organization and enlarging their factories.

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Dealing with Contingencies

A contingency may be defined as the possibility that that which happens might not have happened; that which does not involve necessity. It is in fact a possibility, and many appliances used on railroads are designed to obviate the results of a contingency, though it may not prevent the happening. An example of this is the dead man's handle on electric trains. Motormen do not habitually drop dead while at work. Such an occurrence may not take place once in a dozen years, yet the appliance operates if that remote contingency does take place.

White lights for "clear" signals have been eliminated for fear that enginemen might mistake a white, town or city light for a railway signal. Enginemen do not mistake such lights every night, but they might do so, and to guard against this chance the green color for "clear" has been adopted.

The interlocking signal system was devised so that a route having been "set up" could not be falsely indicated. All tower men would not make this mistake, but there is a possibility that a few would, and it is the uncertainy of the man's behavior which gives the interlocking system its greatest value. The time-lock, used at interlocked diamond crossings, prevents a towerman from changing his mind for a certain period of time when he has made, say the north and south bound route "clear" and has blocked the east and west track. Towermen do not all feel the impulse to alter the route in the face of an oncoming train, but there is the chance that some towerman may, and it is to prevent him from so doing for a definite period of time after he has "set up" a route, that the time-lock destroys his free-will until a moving clock-like mechanism has run down.

All these show the possibilties for mistakes, misunderstandings, sudden impulses, failures and perverted intention and judgment, and the mechanism in each case is designed to operate so as to thwart the results of these contingencies. In all these instances the real faulty mechanism is the living man, apparently normal, yet with a mental make-up which cannot be absolutely relied upon to remain normal in all cases. Good intentions have little or perhaps nothing to do with it. In some cases it is practically impossible for a man obsessed by a dominant thought to obey or take the normal and safe course.

These appliances show that the railroad world is slowly coming to abandon the fallacy that all men will act alike under similar circumstances. Suppose a street car collides with a cart on the street. The few short seconds after the passengers realize that a collision is inevitable tell the tale of manifold action and reckless impulse. A few of the passengers remain calm and quiet, others rush for the door, some shout and yell, some try to escape by the windows, some rush to apply the brake at the conductor's end, some ring the bell, some break the seats or injure themselves in their frantic haste, many foolish and useless acts are performed; and yet the cause of the pell-mell rush, confusion and agitation is the same for all. The stimulus which produces abject fear or wild and meaningless excitement does not differ for each man, it is a single cause.

The reason for this heterogeneous jumble of strange actions is not so much to be found in the prospect of collision, but is directly traceable to the differing mental make-up of the different passengers. The stimulus is the same for all; the results are multiform, and foolish.

In another column of this issue will be found an account of an automatic stop signal, which is a legitimate attempt to deal with a real contingency, just as much as the dead man's handle deals with a contingency or the signal time-lock restrains untoward impulse. We are not concerned in the success of the Wooding device, nor in any other form of stop signal, but we believe the principle involved to be right, and in time some such apparatus will be universally adopted. The contingency involved in mental failure is as real and as pressing as the possibility of a man being stricken by some sudden physical ailment, or even death. One may think it is remote, but it is there as surely as if marked by a bodily deformity.

One of the laws of psychology is that if two objects or two ideas are presented to the brain of a man, the mind inclines to the one which seems to it to be the more interesting of the two. As interest deepens, attention becomes stronger and in time the less attractive thing will fade from the mind, and if it be intrinsically important a positive effort of attention is all that prevents it from sinking below the level of consciousness. A hot driving crank pin requiring attention or a pleasant conversation thought over again, a word of praise revived in the memory, divides the attention with surrounding objects, and a signal with its imperative warning may even fail to awake a quick and understanding cognizance, and the time for action, on a rapidly moving train, may be short enough to suffer its practical obliteration from the mind of the beholder until it is too late.

All men do not fail in this way, but some have so failed; perhaps there have been long intervals between the lapse of A and the failure of B, but it is impossible, with the human mind constituted as it is, to entirely eliminate this form of mental miscarriage, and the only rational course left is to face the contingency, acknowledge its existence and provide means for preventing the consequences, be they slight mishap or dire disaster, just as the chance of sudden death of a man on duty, would otherwise cause a serious accident, if the danger was less remote than it is. It is there however and the mental failure is a contingency which must be reckoned with, if safety is to be secured.

Special Apprentices

It has been said that all wisdom cometh from the East. This may have been true at some remote period of the world's history, but it is not true now. The system of educational training of mechanics was a reproach to European civilization, and it was not much better in America before the dawn of the twentieth century, and while it would be invidious to make comparisons between the East or West of America, it is generally admitted that the West has blazed the way in the special training of apprentices for positions of responsibility. As the apprentices approach the completion of their period of apprenticeship particular selections are made and the boys are started on a course designed for junior mechanical officers. This special course extends over one year, and assuming that three years and a half have been already taken up in a thorough training in the railroad machine shop, the additional year is divided as follows: four months in the roundhouse, two months in the boiler shop, two months in the freight car shop, two months with a traveling engineer and two months inspecting incoming and outgoing engines.

A course of reading accompanies the period in each department. Strict examinations must be passed. The course is exacting. There is no time for pleasure or diversion. A Spartan simplicity is maintained. They are not supposed to become master mechanics in all of these trades, but the young men are ready for division foremanships in some isolated places. It is remarkable how much information they obtain, and it is also remarkable how anxious they are to learn the details of the trades in such a short time. In addition to the course of reading and studying and the answering of hundreds of questions, they are required to write a letter once a month describing the work that they have done. When through with this latter course a man so equipped is fit to go anywhere. The results are said to be of the most satisfactory kind.

Nor is this all. Another batch of the best and brightest of these well-drilled graduates are sent to the best contract shops in the country to complete their studies. Six months more are spent in this way, ranking as assistant department foremen and given responsible work to do. The large manufacturing corporations act very liberal in the matter, and at the end of their period of finished training they return from whence they came and are immediately placed in positions which they can fill without fear or favor, alike a credit to themselves and to the railway company that has provided them with such opportunities. From such men loyalty may be expected, and efficiency comes natural, and thoroughness is a characteristic. Surely we live in an age of progress.

Gross Profits from "Littles."

At a general staff meeting of the mechanical department of one of our leading railways, the subject of headlinings for passenger cars was taken up. It was suggested that black or stove-pipe iron be substituted for composite board. The stove-pipe iron, it was stated, could be obtained in sizes suitable for the work, and that a strip of this material might be used over the joints. A report was to be drawn up by a competent officer dealing with the actual saving that would be effected. The matter would then take on a dollar and cent aspect, which appealed strongly to those present.

A statement was made by one of the staff to the effect that he believed from what experience he had had with black iron headlining that a saving of three-quarters of the cost of composite board lining would result in the systematic substituting of this material for that usually employed on this road. The stove-pipe iron would answer the purpose just as satisfactorily as the "board" did, and moreover it was cheaper than the composite board and it was more durable. The stove-pipe iron headlining could be painted or decorated in an artistic manner, and while it did not mar the appearance of the coach was less expensive and would last longer than the board, both of these characteristics made for economy. A member of the staff stated that as far as could be learned at the date of the meeting, a saving of $671 annually had been realized by the change.

At this meeting the proposal was also made that malleable iron be used instead of brass for car trimmings. The meeting favored this proposal and it was determined that the malleable iron should be "mahogany annealed." It was thought that if the work of making these malleable iron castings were plased in the hands of one concern, economy of patterns would result and that the single firm would be able to quote terms and prices which would be advantageous to the railway. At the time the meeting was held it had not been possible to put the scheme through entirely, and brass castings were authorized when a shortage of the amount occurred in the manufacturer's output took place, but any initial shortage would shortly disappear and the full economy anticipated by the railway would be realized.

Here are two instances—the headlinings and the trimmings—in which small but positive savings were effected. This procedure if adhered to would in time produce a substantial amount and it gives the thoughtful railroad man "food for thought," as to the far-reaching results which may be obtained on any railway willing to shake off the chains of mere custom and to look about for methods of substituting cheaper but quite as satisfactory material for that which is an inheritance from former and practically standard practice. In the long run small savings, introduced in a variety of ways, will reach an astonishingly high figure, and be on the right side of the ledger. It is analagous to the business maxim that small profits and quick returns in time brings forth a most desirable pecuniary reward to those who carry it out with steady determination.

The Metric System.

We thought that we had done with the metric system, but it seems that there is a revival of a propaganda for its adoption, and the American Institute of Weights and Measures has deemed it of sufficient importance to interpose objections to the proposition of establishing the metric system of measurement in America. As nothing new can be added by those who favor its adoption the subject is now unworthy of any further consideration. If there were any surpassing merit in the system as compared with the scale of measures now in use, and which are overwhelmingly the preponderating standard of the world, it would have come into use long ago. The metric system has not been adopted anywhere on account of its superiority. It was established in some countries by compulsion at a time when modern organized manufacture was only beginning, and if it has become suitable to them they have a right to be let alone. So have we.

Some years ago a few semi-literary reformers undertook to change the spelling of many words. If they had eyes to see and ears to hear they might have noted that no sudden change occurred in any age in regard to the spelling of the words in a language. The changes are gradual as conditions vary, and sweeping changes in orthography should not be looked for. The same law of natural selection applies to weights and measures, and it is because the world is already well provided with standard measures that any change is not only unnecessary but impracticable.

Legislation Hindering the Railroads.

It is universally conceded by press and public that with such widespread and pressing demand for larger terminals, greater facilities and more equipment, it is absolutely necessary that the railroads be granted the higher rates necessary to place them in a position to meet rising costs and give them the earning basis to attract new capital for the additional transportation facilities and services so urgently required. The lack of sufficient means for many years past has prevented the railroads from providing such facilities and betterments in advance of traffic demands, and while labor and material costs were reasonable. It would seem that the Government, instead of reflecting the will of the people in aiding in the development of the country, has resolutely determined to clog the wheels of progress along the only lines on which real progress can move.

Railroads in Russia.

The trouble with Russia has been the lack of railroads. If the fruit of the revolution in that country awakens the people to the development of that vast country, it will call for enormous quantities of steel. Famine in one district and surplus grain and meat in another are due to the lack of railroads. Russia should have over 200,000 miles of new railroads to meet the requirements of the public and this will be accomplished if a stable democratic government is reared on the wreck of the Romanoff dynasty. The United States quite is able to supply the demand which will come from the undeveloped regions of Asia, Africa and South America. There is sure to be an era of railroad building after the war.

Air Brake Department

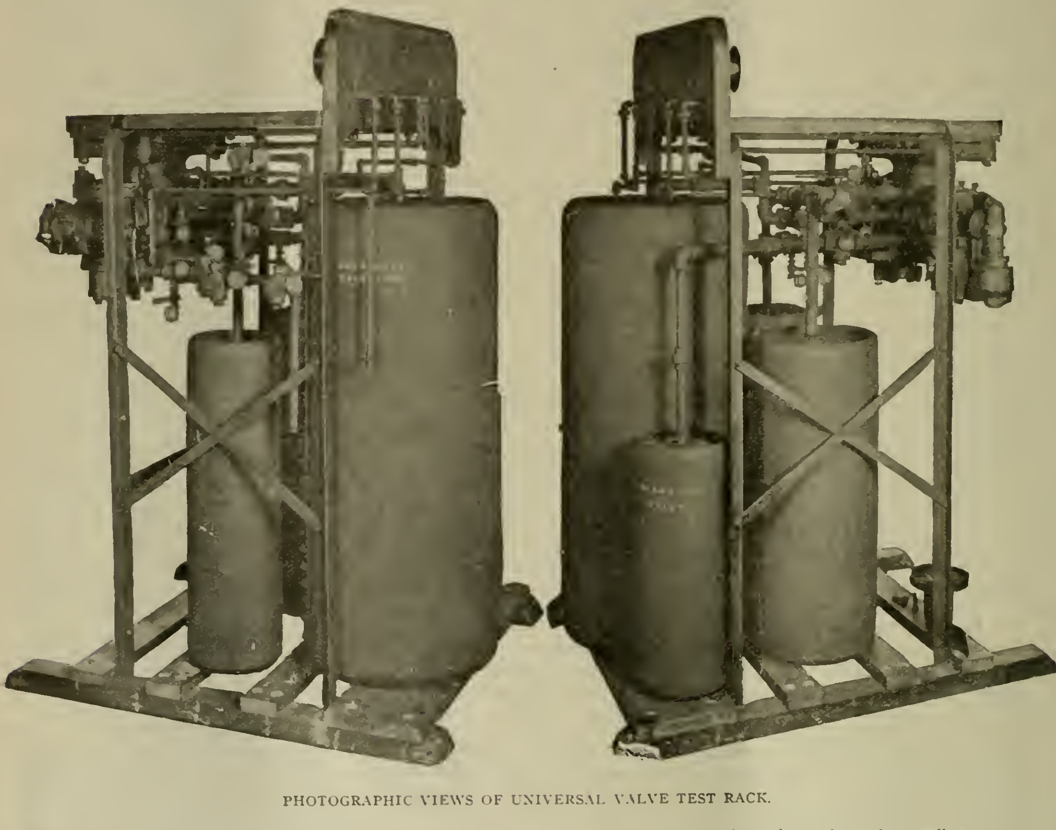
The Universal Valve Test Rack

The photographic views shown in this issue of RAILWAY LOCOMOTIVE ENGINEERING are of the universal valve test rack which is operated in conjunction with the standard triple valve test rack also a diagrammatic view of the combination is shown. We have a two-fold purpose in presenting this diagram and in printing a revised code of tests for the universal valve. The first is, that a study of the code of tests will lead to a more thorough understanding of the operation of the valve, and the second is, to formulate a code of tests that for practical purposes will very materially simplify the testing of universal valves and shorten the usual time required to test all portions of the valve.

The standard code deals with tests for each portion separately, and the printed matter in itself fills a pamphlet and it specifies that each portion should be tested separately, that is, an equalizing portion should be tested with a quick action portion and high pressure cap known by test to be in good condition and conversely when these portions are tested they should be operated with an equalizing portion that is known by test to be in perfect condition, this should be done for the purpose of preventing the confusion that would arise in attempting to locate the source of a disorder if each portion contained a defect. In every day practice, in cleaning and testing universal valves this will be found to be unnecessary, as very few defects are manifested, but in the event that some disorder is encountered, it is best to test the different portions separately or in combination with portions known to be in good condition.

It will be observed that but about 10 applications of the brake or applications of the universal valve are required to pass the valve through a complete test provided that no disorders are manifested, and it is best first to commit to memory just what tests the valve will be required to pass; thereafter the actual testing of the valve will be a comparatively simple operation.

When testing the universal valve a blanking flange is placed on the triple valve stand and the auxiliary reservoir volume is used as the small emergency reservoir volume, and the valve A, or brake valve of the triple valve rack is used to operate the universal valve. The only connections between the racks are the brake pipe, the auxiliary reservoir as stated and the connection between the auxiliary reservoir of the universal valve rack and the differential valve of the standard rack, this latter connection with the intent that the differential valve weights may be used in the friction tests in a similar manner that they are used with the triple valve test.



PHOTOGRAPHIC VIEWS OF UNIVERSAL VALVE TEST RACK.

The universal valve is to be placed on the test rack with the graduated release cap in direct release position, all reservoir cocks should be closed at this time and remain closed until such time as specified in the code of tests, which also applies to the cock in the pipe between the auxiliary reservoir of the universal valve test rack and the differential valve.

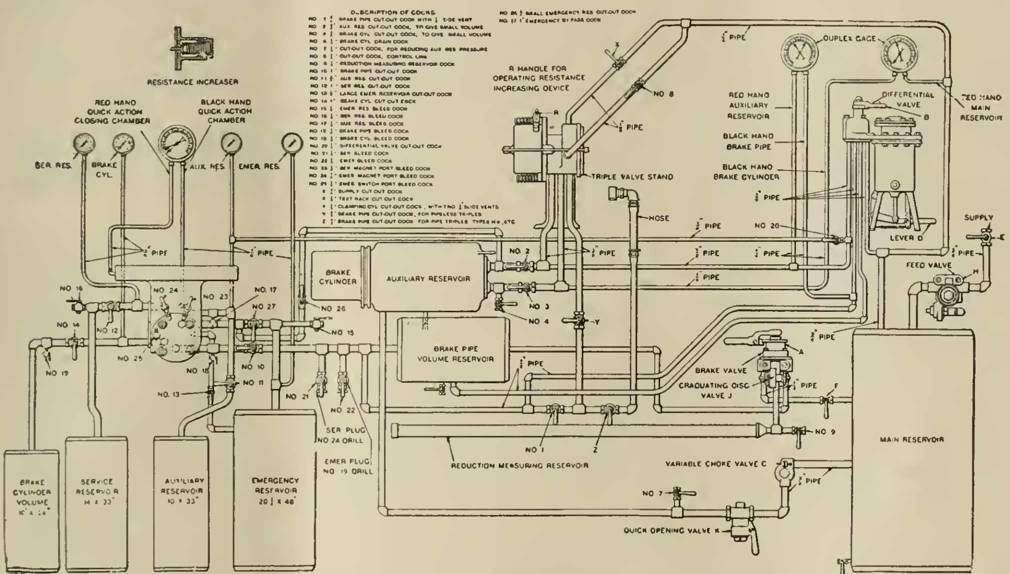
The following is an outline of the combined code of tests for the universal valve which should be committed to memory:

Protection Valve Opening.—Charging Quick Action and Quick Action Closing Chambers.—Preliminary Leakage Tests.—Charging Tests.—Leakage Tests.—Release Position: 1, Equalizing slide valve and graduating valve leakage; 2, Release slide valve leakage; 3, Release piston seal leakage; 4, Emergency or high pressure valve leakage; 5, Protection valve atmospheric seat; 6, Emergency slide valve or graduating valve leakage; 7, Emergency piston seat leakage.

Leakage Tests.—Emergency Position.

1, Equalizing slide valve leakage; 2, Release slide valve leakage; 3, Application end of release piston seal leakage; 4, Emergency valve seal leakage; 5, Upper seat of cut off valve; 6, Emergency slide valve; 7, Emergency piston seal.

Emergency reservoir check valve leakage.—Sensitiveness of emergency piston and graduating valve.—Quick action chamber charging port check.—Graduating valve leakage. — Safety valve leakage.—Cut off valve leakage.—Service reservoir check valve leakage.—Charging valve opening test.—Intercepting valve leakage.—Safety valve adjustment.—Charging valve leakage.—Intercepting valve test.—Blow down time for quick action closing chamber.—Service port check valve leakage.—Equalizing piston ring leakage.—Application test. Service sensitiveness.—Friction release test. Ring leakage check.—Graduated release test.—Charging valve sensitiveness test.—Service port capacity test.—Emergency slide valve exhaust port capacity.—Protection valve sensitiveness.—Equalizing piston stop leakage.—Sensitiveness to emergency.—Service magnet port opening.—Emergency magnet port opening.—Emergency switch piston port opening.



DIAGRAMMATIC VIEW OF COMBINED TRIPLE VALVE AND UNIVERSAL VALVE TEST RACK.

TESTS FOR UNIVERSAL VALVE GROUPED TO FORM A COMBINATION AVOIDING SEPARATE TESTS FOR EACH PORTION.

Protection valve opening. — Charging quick action and quick action closing chambers.—Preliminary leakage tests.

With a cleaned or repaired valve bolted to the test rack, auxiliary, service and both emergency reservoir cocks closed, with the blanking flange on the triple valve stand, brake valve in position No. 1 and the differential valve handle on lap, open the brake pipe cock and note that protection valve lifts from its brake pipe, to atmospheric seat, by the time 50 lbs. brake pipe pressure is shown on the brake pipe gage. The quick action chamber and quick action closing chamber should then start to charge and the time required is from 0 to 75 lbs. in from 14 to 18 seconds.

Test all gaskets and cap-nuts for leakage. If there is any blow of air from any of the exhaust ports, the charging test should be repeated after the blow or leakage from the exhaust ports is remedied. If the valve is apparently free from leakage the charging tests may be conducted.

Charging Tests.—Graduated Release Cap in Direct Release Position.

Open cut-out cock to auxiliary reservoir. With the auxiliary reservoir and bleed-cock closed; the auxiliary reservoir should charge from 0 to 70 lbs. in from 28 to 43 seconds. The pressure in the brake pipe being 80 lbs. Close emergency reservoir drain-cock and open stop cock in emergency reservoir pipe. Emergency reservoir should charge from 0 to 70 lbs. in from 65 to 80 seconds. Open cock leading to the small emergency reservoir which is the auxiliary reservoir of the triple valve test rack, this reservoir should charge from 0 to 70 lbs. in from 43 to 55 seconds. Close the service reservoir drain-cock and open the cock in the service reservoir pipe. This reservoir should charge from 0 to 70 lbs. in from 30 to 35 seconds.

Leakage tests.—Release position.

Close brake cylinder cut-out cock and brake cylinder exhaust port cock, and test at equalizing slide valve exhaust port, for leakage from the equalizing slide valve graduating valve or from the release piston seal. If no leakage is discovered, open brake cylinder exhaust port cock, and test at this point for release slide valve leakage, and also at the release slide valve exhaust port for release slide valve or equalizing slide valve leakage. Test for leakage at the quick action valve exhaust port, also for leakage from the protection valve vent ports. Test for leakage from the emergency slide valve or graduating valve through the emergency slide valve exhaust port and for leakage from the emergency valve seat. Leakage at the quick action valve exhaust port may be from the emergency slide valve or graduating valve and if in doubt as to the source of leakage, remove the quick action piston cap which will expose the port from the emergency slide valve.

Leakage tests.—Emergency position.

Close brake pipe cut out cock and open brake pipe drain cock, which will apply the brake and move the universal valve to the emergency position.

Test at equalizing slide valve exhaust port for equalizing slide valve, graduating valve or for application piston seal of release piston leakage. Close brake cylinder exhaust port cock and test at release slide valve exhaust port for leakage from the brake cylinder or from the emergency reservoir pressure. Leakage here at this time may also be from the equalizing slide valve. Test for leakage from the upper seat of the cut off valve by removing the safety valve. Test at quick action exhaust port for emergency slide valve leakage. Test at protection valve vent ports for leakage from the seal of the emergency piston on its leather gasket. Test at emergency slide valve exhaust port for leakage from the emergency slide valve or from the upper seat of the emergency or high pressure valve.

Emergency reservoir check valve leakage.—Sensitiveness of emergency piston and graduating valve.—Quick action chamber charging port check.—Graduating valve leakage.—Safety valve leakage.—Cut off valve leakage.—Service reservoir check valve leakage.—Charging valve opening test.

As these tests are largely a matter of observation, they can be made with one operation of the brake. With all stop cocks in reservoir pipes open and all reservoirs charged, the brake cylinder exhaust port cock open and the brake valve and differential valves in the positions used when starting triple valve tests. Close brake pipe cock and bleed the auxiliary reservoir down to 70 lbs. Note any building up of pressure on the auxiliary reservoir gauge which will indicate emergency reservoir check valve leakage. Leakage must not exceed 1 lb. in 30 seconds time.

Open auxiliary reservoir cock, make a 10 lb. brake pipe reduction with the brake valve in position No. 5. This should move the emergency piston and graduating valve and discharge quick action chamber pressure through the emergency slide valve exhaust port. Failure to do so will indicate excessive friction, piston ring leakage, or back leakage from the charging port check valve. Make a further reduction to obtain 30 lbs. pressure in the brake cylinder, close the brake cylinder cut out cock and note the brake cylinder gauge hand. Any increase in pressure will indicate graduating valve leakage which should not exceed 5 lbs. in 20 seconds. This test is for the equalizing slide valve graduating valve.

Test at safety valve exhaust ports for safety valve leakage. Test at emergency slide valve exhaust port for leakage from the cut off valve seat.

Open brake cylinder cock, bleed the service reservoir down to 50 lbs. and close service reservoir cut-out cock. An increase in pressure on the service reservoir gauge will indicate leakage past the service reservoir check valve. Such leakage must not exceed 2 lbs. in 20 seconds time. Re-open cock and return brake valve handle to release position the charging valve must lift and start to charge service reservoir at the same rate that auxiliary reservoir is charging.

Intercepting valve leakage. — Safety valve adjustment. — Charging valve leakage.

Make 10 lbs. brake pipe reduction and return valve handle to lap position, close auxiliary and service reservoir stop-cocks and brake cylinder stop-cock. An increase on the auxiliary reservoir gauge at this time will indicate leakage from the emergency reservoir past the seat of the intercepting valve and such leakage should not show 1 lb. in 20 seconds time. Re-open cocks and make a further reduction and note that 50 lbs. brake cylinder pressure is obtained for a 20 lb. brake pipe reduction. The safety valve should open at 62 lbs. and close at 60 lbs. brake cylinder pressure. After obtaining 50 lbs. in the brake cylinder, the brake cylinder exhaust port cock may be closed and the brake valve placed in release position and the reservoirs recharged when another brake pipe reduction will increase brake cylinder pressure to such an extent that the safety valve adjustment may be noted or corrected as required. At the completion of the safety valve adjustment, move the brake valve to release position and as the brake releases quickly, back to lap position. Under this condition leakage from the emergency reservoir past the small end of the charging valve will show on the service reservoir gauge and must not exceed 3 lbs. in 20 seconds. During this time the auxiliary reservoir pressure must not increase over 1 lb. in pressure.

Intercepting valve test.—Blow down time for quick action chamber.—Service port check valve leakage.

Close brake pipe stop cock and open brake pipe bleed-cock. The universal valve must apply in quick action and brake cylinder pressure build up from 0 to 60 lbs. in not more than 2 seconds and reach not less than 65 lbs. pressure. Failure to accumulate the specified pressure indicates too strong an intercepting valve spring, excessive leakage past the intercepting valve, or past a loose intercepting valve bushing, or a restricted emergency valveport. At this same time the quick action closing chamber should drain away from 80 to 10 lbs. in not over 10 seconds time. Close service and auxiliary reservoir stop cocks. Leakage from the brake cylinder into the auxiliary reservoir past the service port check valve, will, at this time, show on the auxiliary reservoir gauge, and such leakage must not exceed 1 lb. in 30 seconds at this time.

Equalizing piston ring leakage.—Application test.—Service sensitiveness.—Friction release test.—Ring leakage check.

With brake valve and differential-valve handles on lap position, close all reservoir stop-cocks, remove charging valve body and apply resistance increasing device. With brake valve in position No. 2 and valve J in position No. 2, and under this condition the brake pipe gauge hand should show an increase to 7 lbs. in one minute. A new valve should not, however, be condemned until the increase has been found to be less than 6 lbs. during three different tests. These figures are based on a perfect fitting ring and the valve J in position No. 2 increasing the brake pipe pressure from 0 to 8 lbs. in one minute. For condemning cleaned valves from further service the pressure should be less than 4 lbs. in one minute.

In order to obtain accurate results it is best to ascertain what the rate of increase in the brake pipe space is with valve J in position No. 2 and have the ring leakage test governed accordingly. If this should be found to be, say 9 lbs., the passing figure for new valves should be 8 lbs. or not less than 7 lbs. while the condemning test for cleaned valves would be less than 5 lbs. On the other hand if the increase in the brake pipe is 7 lbs., the passing figure for new valves is 6 lbs. and the checking figure 5 lbs., and for condemning cleaned valves 3½ lbs. At the completion of the test, remove friction increasing device, replace charging valve body and re-open the reservoir cut-out cocks. These cocks should be tested for leakage at specified periods, and be maintained free from leakage. If found to be leaking during a ring leakage test, the pressure must be bled from the reservoir in question to prevent interference with the ring leakage test.

With all reservoirs fully charged, the cock between the auxiliary reservoir and differential valve open, lever D in position No. 1, valve B in position No. 4, place brake valve in position No. 5. This rate of reduction should move the equalizing piston and graduating valve, closing the feed groove in the equalizing piston bushing and open the friction increasing cavities in the face of the slide valve, to the atmosphere. When 1½ lbs. differential between the brake pipe and auxiliary reservoir pressure is obtained, there should be a discharge of air from the vent port of the differential valve and then the valve B should be placed on lap position and the brake valve in position No. 4, changing the rate of brake pipe reduction under which condition the universal valve should apply when the proper difference between brake pipe and auxiliary reservoir is obtained. Failure to obtain the proper differential during this test indicates an enlarged feed groove and failure to obtain the application after the change in rate of brake pipe reduction indicates packing ring leakage.

After a 10 lb. reduction made in this manner, place valve B in position No. 1 lever D in position No. 2 and valve J in position No. 2. Then place brake valve in position No. 2 and with brake pipe pressure then under the diaphragm of the differential valve, the universal valve must release in one minute's time without causing a blow at the vent port of the differential valve. A discharge from the differential valve will indicate undue friction and failure to apply will indicate packing ring leakage past the equalizing piston.

Graduated release. — Charging valve sensitiveness test.

Change graduated release cap to graduated release position and charge reservoirs to 80 lbs. After a 25 lb. brake pipe reduction, graduate the release by alternating the brake valve handle between lap and release positions. It will be understood that all other valve handles and levers have been restored to their normal position after each test unless otherwise specified and as the valve handle of the brake valve is alternated from the positions mentioned, the pressure should be graduated out of the cylinder and at least 6 graduations should be obtained before the brake cylinder pressure is entirely exhausted. Less than the required number of graduations indicates excessive friction or a restriction in the flow from the emergency reservoir into the auxiliary.

At the end of the release note when charging valve lifts and starts to charge the service reservoir. Charging valve should lift before the auxiliary reservoir pressure reaches 80 lbs. Failure to do so indicates friction in the movement of the charging valve or leakage past the packing rings of the charging valve.

Service port capacity test. — Emergency slide valve exhaust port capacity. — Protection valve sensitiveness. — Equalizing piston stop leakage.—Sensitiveness to emergency.

After recharging reservoirs, place brake valve handle on lap position, and open the brake pipe exhaust cock with the smaller disc. Brake cylinder pressure must build up from 0 to 50 lbs. in from 4 to 5 seconds. The drop from 70 to 50 lbs. in the brake pipe should take place in 3 seconds time and this application must not produce quick action. Should quick action occur it indicates a weak emergency piston graduating spring or a restricted emergency slide valve exhaust port. If the valve passes the test, close cock and move brake valve handle to position No. 6, valve should apply in emergency when brake pipe pressure is between 25 and 35 lbs.

After valve moves to quick action position, close auxiliary and service reservoir cocks and note auxiliary reservoir gauge. The valve having passed all previous tests, any building up on the auxiliary reservoir gauge would at this time be from the equalizing piston stop seat or through a porous casting. Recharge reservoirs to 70 lbs. pressure, place brake valve handle on lap position and open the large disc brake pipe cock. The rate of drop in the brake pipe should be from 70 to 50 lbs. in 2½ seconds and should move the universal valve to emergency position. Failure to do so indicates an enlarged emergency slide valve exhaust port, excessive friction in the emergency portion, emergency piston spring too strong, or emergency piston packing ring leakage.

Service magnet port opening.—Emergency magnet port opening.—Emergency switch piston port opening.

When released and recharged, open right hand cock on electric portion blanking flange. This will show whether the service magnet port is open. Open left hand cock on electric blanking flange, which is the emergency switch piston port, then open middle cock of the blanking flange which must produce an emergency application and cause a blow at the emergency switch piston port. Failure to respond to these openings indicates restrictions in the ports leading to the cocks. **Return graduated release cap to direct release position before removing universal valve from test rack.**

Preventing Steel from Rusting.

Articles of steel may be protected from rust by a coating of cheap varnish diluted to two or three times its bulk with methylated spirits. Two drums, each open at one end; one, an ordinary five-gallon drum, 11 ins. in diameter, has ½-in. holes punched in the bottom and sides. The other may be a 10-gallon drum, 12 ins. in diameter. The larger vessel is filled about one-quarter full, and the articles to be treated are placed in the smaller vessel, which is lowered into the liquid, thus immersing them. When the vessel is withdrawn nearly all of the fluid drains back into the larger vessel. To harden the coating, the contents are spread on a wire draining surface, and in a short time are ready to be packed. It is claimed that articles so treated will keep free from rust for 12 months.

Railroad Mileage.

The mileage of American railroads aggregates 270,000, and forms 40 per cent. of the railways of the entire world. Russia comes next with 50,000 miles. The other countries and their respective mileages in order being Germany, 40,000; India, 35,000; France, 32,000; Canada, 30,000; Austria-Hungary, 29,000; Great Britain, 25,000; Argentina, 21,000; Australia, 20,000; Mexico, 16,000; Brazil, 16,000; Italy, 11,000; British South Africa, 11,000; Spain, 10,000; Sweden, 9,000; Japan (including Corea), 7,000; China, 6,000; Belgium, 6,000, and Chile, 4,000.

Of the world's railways outside the United States slightly more than one-half are government owned or controlled; of the telegraphs outside this country approximately two-thirds are government owned and operated.

Canada's Railway Problem.

Mr. W. F. Tye, C. E., speaking before the Canadian Society of Engineers, said that they had a railway problem, and a weighty one, which must be obvious to every intelligent Canadian. Not only have enormous sums of money been sunk in the past in extravagant railway construction, but the country is confronted with still more capital outlay, while immense sums are being handed over annually by the people of Canada to make up deficits in operation, and to meet fixed charges. The country is over-railroaded. It has thousands of miles of lines through territory that is not and may never be productive.

University of Illinois.

Professor C. R. Richards, professor of mechanical engineering and head of the department since 1911, has been appointed dean of the College of Engineering and director of the engineering experiment station of the University of Illinois to succeed Dr. W. F. M. Goss, who has resigned to become president of the Railway Car Manufacturers' Association of New York.

Electrical Department

The Generation of Electricity in Various Types of Machines

In the preceding article we discussed the generation of electricity, and pointed out that the generation of current is based upon Faraday's discovery which is that electric currents are generated in conductors by moving them in a magnetic field. We then explained the relation between motion, magnetism and induced current. A most useful rule for remembering this relation was shown by an illustration of the right hand with the thumb, forefinger and middle at right

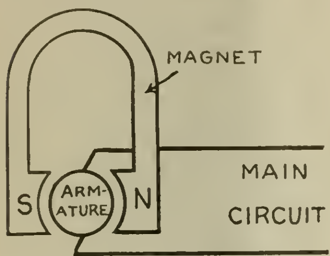


FIG. 1. MAGNETO GENERATOR.

angles. The simple dynamo was illustrated and explained and the difference between direct current and alternating current was discussed. With these facts and principles in mind, we will consider the electric generator more in detail and make mention of the various types.

As has already been pointed out, the function of the field magnet is to provide a large number of magnetic lines of force and the function of the armature is to cut (electrically) these lines of force.

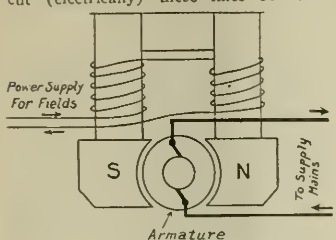


FIG. 2. SEPARATELY EXCITED GENERATOR.

The wires on the armature are wound on an iron core which contains slots of sufficient width and depth to receive the coils. When the coils are in place they are slightly below the surface of the core. This iron core may be regarded as belonging to the magnetic circuit. It forms a ready receiver for the magnetic lines leaving the pole pieces or fields, and keeps these lines of force concentrated and in the most effective position. The true armature would consist only of the copper conductors electrically, it is not necessary for the iron core to rotate, only the copper conductors, but mechanically, it is necessary as the coils must be supported tightly and securely against the centrifugal force due to the rotation at high speed and against the electric attraction and repulsion which exists between the conductors and field magnets.

In all generators, the voltage or electromotive force is proportional at all times to the rate of cutting of the lines of force. The rate of cutting depends on three quantities: (1) The number of magnetic lines provided by the field magnet. (2) The number of copper conductors connected together upon the armature. (3) The speed at which the conductors are rotating.

This voltage exists while the generator is being driven, i. e., while the armature is revolving. The current depends upon the resistance of the main circuit. When the main circuit is open and there is no current flowing, the only force required to drive the generator is that necessary to overcome bearing and windage friction. When current is flowing through the armature conductors, forces are set up between the windings and the fields so that additional power is required to keep the armature rotating, the tendency being for the armature to stop. That is, the work spent in revolving the armature maintains the current in the armature conductors. There are certain losses in all machines so that the power required for the generation of electricity which is termed the "input" is greater than the power received from the generator or the "output."

There are five simple methods of obtaining the magnetism for electric generators and can be divided into two groups or classifications according to whether the generator itself supplies current for its own magnetism or whether the magnetism is provided from some other source.

In the very oldest machines there was no attempt to have the generators excite their own fields and use was made of permanent steel magnets. It was difficult to build magnets which would maintain a sufficient magnetic strength. Shocks and vibration to which machines were subjected, would cause the magnets to gradually decrease in strength. A diagram of a machine of this type is shown in Fig. 1. This method of excitation has been entirely discontinued except in very small machines known in the present day as "magnetos." Due to better facilities and greater experience it is possible to "age" magnets so that there is practically no decrease in magnetism over a long period of time.

The next step in advance was to substitute for the steel magnets electromagnets excited by means of electric current from some independent source, such as a battery. This type of generator was used by Faraday in some of his experiments, but it did not come into acceptance until several years after. A circuit diagram of a separately excited generator

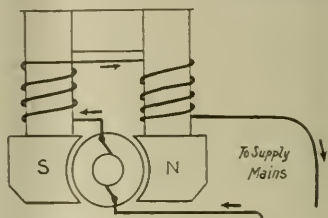


FIG. 3. SERIES GENERATOR.

is shown in Fig. 2. Obviously it is necessary to use direct current. This method of excitation is used with alternating current machines. Direct current machines are usually self-excited.

In the case of the self-excited generators there are three possible methods: (1) The whole current from the armature may be carried through the field coils

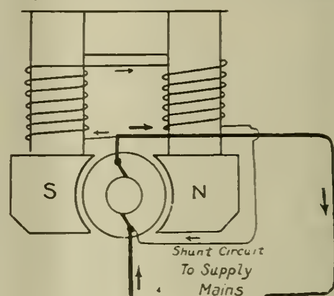


FIG. 4. SHUNT GENERATOR.

which are connected in series with the main circuit. A machine connected in this way is known as a Series Generator. (2) Part of the current from the armature may be diverted from the main circuit and pass through the field coils. A machine connected in this manner is known as a Shunt Generator. (3) The fields may be supplied from a combination of the above mentioned two types. A machine connected in this manner is known as a Compound Generator.

The Series Generator consists of but

one circuit—the circuit diagram is shown in Fig. 3. The winding on the field magnets consist of a few turns of heavy wire through which passes all of the current generated in the armature, except that which may pass through a rheostat connected around the series field. This rheostat is nothing but a resistance box or a strip of German silver and provides a means of adjusting the field strength to obtain a given current output.

In the shunt-wound generator, the ampere turns requisite for excitation is obtained by passing a small current through a large number of turns of fine wire. The circuit diagram is shown in Fig. 4. It is to be noted that the shunt field is connected across the armature so that the field winding is in parallel to the main circuit and the adjustable rheostat is always connected in series with the shunt field so that the amount of current, hence the field strength, can be adjusted so as to obtain adjustment in the voltage.

Combining the principle of the series and shunt generator, we have the compound generator. Circuit diagrams are shown in Figs. 5 and 6. The field coils consist of two parts. One part is of fine wire connected across the main circuit (long shunt connections) or across the armature (short shunt connections) and the other part consists of a few turns of heavy wire through which passes the main circuit current. Each of the above main types—namely, series, shunt and compound generators, have each their proper application.

The series generator, as it is called, is primarily a constant current machine. When there are a large number of lamps

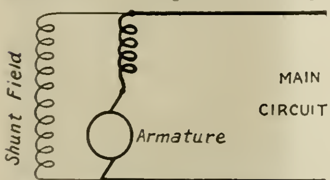


FIG. 5. COMPOUND GENERATOR—LONG SHUNT.

in series it is necessary to maintain the current constant. Electric arc lamps are usually so connected, many of these arc lamps being connected in series on each circuit. The ordinary lamp requires from 45 to 50 volts and approximately 10 amperes. With 40 of these lamps in series a voltage of from 1,800 to 2,000 will be required to maintin this constant current. The series generator is best adapted for high voltage circuits of this kind as it is comparatively easy to insulate and wind the field coils for this high voltage. Theoretically, the shunt machine would be satisfactory but it would be difficult to build the field coils. A very large amount of highly insulated wire would be necessary.

Shunt and compound generators are used for lighting and power purposes where constant voltage is necessary. For instance, in shops and factories where lamps and motors are connected in parallel to the supply mains, it is necessary to maintain a constant voltage so that motors may operate independently of each other. When a shunt or compound machine is supplying a circuit of this kind, the voltage remains constant, but the current increases or decreases according to the number of lights or motors cut in or out of the circuit. The current delivered is inversely proportional to the

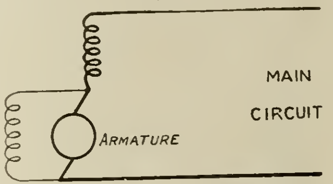


FIG. 6. COMPOUND GENERATOR—SHORT SHUNT.

resistance of the receiving circuit. Apparently, it is possible to obtain any amount of power from machines of this kind. This is generally true, but not practicable, due to the heat formed in the generator and to the sparking which may exist on the commutator. The electric current heats up the armature conductors and every machine is limited to the safe amount of power which can be used.

There are two or three interesting facts in connection with electric generators. One is that of "leakage." The air is not an insulator of magnetism. It is, however, less permeable than iron. In other words, iron will collect the magnetic lines of force and group them together, so to speak. That is, the density of the lines of force through the iron will be much greater than in air. In all generators, therefore, there will be some lines of force which will not pass from the pole pieces through the iron of the armature but will leak away through the air. We are all probably acquainted with the advisability of not approaching close to an electric generator with a good watch in the pocket as the hair spring of the same will become magnetized, which condition interfers with its reliability as a time keeper. The magnetism of the watch is due to the stray magnetic lines of force.

Another very interesting feature is that of "Eddy Currents." Whenever iron is magnetized and de-magnetized, the changes of flux induce an electro-motive force in the iron, producing current and these are termed "Eddy Currents." These Eddy Currents heat up the iron and unless provision is made to prevent this, the iron may become excessively heated and this interferes with the capacity and operation of the generator. Those parts subjected to the changes of magnetism as is the armature core, are built up of thin sheets of iron. These thin sheets are so assembled as to leave the iron as continuous in the direction of magnetism, but discontinuous in the direction of the eddy currents. In the case of the armature core. these laminations are at right angles to the axis of revolution. The laminations are made extremely thin, they are only a few hundredths of on inch in thickness, and are Japanned, thus being insulated from each other.

It is obvious that the iron forming the field magnets, around which the field coils are wound, should be of such a character that the magnets will be formed with the least expenditure of energy. There are three types of iron which may be considered, namely, cast iron; wrought iron, and cast steel.

Cast iron is cheap, but very heavy and is poor magnetically, hence in order to get a certain strength of field, it is necessary to have large proportions. This makes the machine large and clumsy. Moreover, with the larger size of pole pieces, it takes more copper to get the necessary number of ampere turns and the costs run up rapidly.

Wrought iron is the very best magnetic material. It is expensive but is used in machines of special design. Cast steel lies between the above mentioned metals, both magnetically and in cost, as it is used almost universally.

Usually the voltage of a shunt or compound machine is under the control of an

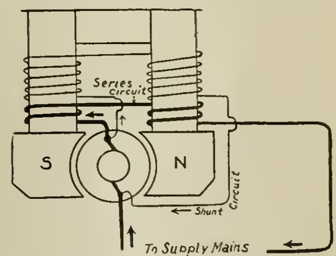


FIG. 7. COMPOUND WOUND.

attendant who, by manipulating the field rheostat, may keep the voltage as nearly constant as is desired. The shunt generator when driven at a constant speed has nearly a constant voltage over a large range of current. It is true that the voltage drops slightly. In order keep up a voltage to practically a constant value, or even to increase the voltage with increase of load, a few series turns (forming the compound generator) is placed around the field pole. These series-turns carry the main current, as may be noticed in Figs. 5 and 6 and as the ampere load increases, there is a corresponding increase in the number of lines of force due to the increase in the ampere turns, and the loss in voltage in shunt machine.

Traffic Capacity Factors and Their Limitations for Maximum Traffic on Steam and Electric Railways

By WALTER V. TURNER, Assistant Manager, Westinghouse Air Brake Co.

In last month's issue of this paper, I had an outline of traffic capacity factors and what they were determined and limited by, with the object of pointing out the value of an efficient air brake, such as the Amue electro-pneumatic empty and load passenger car brake, which has become a necessity on certain electric railway systems in this country. At the present time I am merely dealing with the transportation problem which demands a solution, and the most important consideration is an efficient brake.

The outline mentioned begins with the car unit and the part this has in deciding maximum traffic capacity for a railway system. The capacity of a road depends upon what it can carry, the extent to which the total loading is realized during all movements, the daily mileage the car makes, and the condition in which it is maintained. The length, width and height of the car govern the load it can transport, and these in turn combine to establish the total weight of the car, while right-of-way clearances limit all of these dimensions.

Clearance limitations on curves dictate as to the length of the car, if the clearance between the truck center plates is increased the center of the car on the inside of the curve approaches the clearance limit set for way structures. If the length or overhang beyond the center plates is added to, the fouling line comes on the outside of curves and the additional requirement arises that the couplers must have increased swing. This in turn means that new equipment will not couple satisfactorily with old, so far as operation on curves is concerned. The new 67 ft. cars of the New York Municipal Railways probably represent the maximum length of cars for electric traction service, while, on account of sharp curves on industrial sidings, 44 ft. is probably the maximum length of freight cars that may be advantageously used.

The height and width of all vehicles must, of course, conform to tunnels, bridges and various road structures. How simple many problems would be if it were only possible to start anew without the necessity for conforming to old limitations, such as ample clearance to provide for future development, the 6-ft. gauge or over and all other things to correspond. The most difficult problem the railway engineer has to solve is the one of interchange and conformity with existing equipment and conditions.

The weight of rolling stock can be no greater than what can be safely carried by the rails and roadbed and bridges. The advent of heavy motive power has brought about the strengthening and replacement of bridges and the laying of heavier rail. The tax an axle load imposes depends upon the number of axles, and therefore it is to be expected that a train of heavy axle loads would more severely burden the rail than a train with a great axle load on the locomotive only. The rail is the principal limiting factor for wheel loads, and it has been nip and tuck for the makers of steel rails to keep the pace with the recent increases in the wheel loads. The bridge is the limiting factor for total weight of vehicle and it must be remembered that a bridge strengthened to successfully withstand or sustain a single Mallet locomotive and cars of the usual weight might not be able to handle two or three locomotives together, or a locomotive and train of cars each of which approaches the weight of the locomotive.

Certain of the large freight cars of today weigh about 315,000 lbs. when loaded, the lading capacity is to be 245,000 lbs., which makes the ratio between empty and loaded weights 4.5, or, viewed in another way, the dead weight per ton of lading is 571 lbs. This decrease in dead weight with relation to lading capacity and also the greatly increased total capacity of the modern freight car display a significant trend toward reduction of unit costs on the part of the more and more efficient American railways. It also displays an operating condition correspondingly difficult, for the contrast between the empty and loaded weight has become so great that former brake apparatus, fully able to care for the wide range of operation through which it has served so long, has now become quite inadequate. A curious inconsistency is encountered in the expectations of some people concerning the permanence and range of brake equipment designed for operating conditions of 20 years ago to continue with unchanging efficiency and at the same time unquestioningly discard for all time the wooden underframe and the draft gear of archaic capacity.

The braking ratio for a brake installation is defined as the nominal relation between the brake shoe pressure, equal on each wheel, and the weight each wheel imposes on the rail. If all wheels are not braked, or not braked equally, it is taken as the relation between the sum of all brake shoe pressures and the total weight of the car.

The single capacity brake is the one most generally found in railroad service today. It is one in which a constant braking force is used for all conditions of car loading, which results in a widely varying braking ratio. If a freight car is braked at 60 per cent. of its empty weight, as explained in these columns in the past on a cylinder pressure of 50 pounds, and the ratio of loaded to empty weight is three to one, the braking ratio for the loaded car becomes 60/3, or 20 per cent., the cylinder pressure basis still remaining 50 pounds. With a loaded to empty car weight ratio of 4.5 to 1, the loaded car braking ratio drops to 60/4.5, or 13.3 per cent. The brake installation must base the braking ratio on the empty weight of the car, and not higher than 60 per cent., otherwise if this 60 per cent. was based on the loaded weight of the car the empty car braking ratio would be raised to a prohibitive point because of the far more violent running of slack and the slid flat wheels that it would produce in long trains.

Many ask why it is that today shocks in train operation occur with a magnitude and frequency unknown a few years ago. For the same velocity differences between two cars in a train are bound to exist. The severity of the impact depends directly upon the car weights, the heavier the cars the greater the force of impact. Other things being equal, the 70,000-pound car will give almost twice the shock obtained with the 40,000-pound car, and this is a partial answer to the question and will be referred to later on.

The new types of motor cars for the New York Municipal Railways are built to accommodate 260 passengers, making a load of about 35,000 pounds, the empty weight being 85,000 pounds and about 120,000 pounds when loaded. This represents an empty to loaded weight ratio of 1.41, quite insignificant when compared with the different ratios found in freight service, but in the electric systems in New York trains are run "on the second" and it is essential, for the sake of maximum traffic volume, to have retardation at all times being independent of the condition of car loading, and, of course, an empty and load brake is required. This is quite apart from the questions of control on grades and slack action in trains, because the weight ratio is so small as to render the former negligible and the electro-pneumatic brake circumvents any difficulty from the latter.

The empty and load brake for these motor cars is so arranged that a constant braking ratio is obtained for all conditions of car loading, and brake flexibility is at the same time maintained; and this latter is the ability to graduate braking effort on or off in any desired series of steps from maximum to minimum. This is the ideal brake operation, but the apparatus necessary to obtain this highly desirable result is, at the present stage of the air brake art, a refinement quite out of keeping with the features of modern freight service. The differences between empty and loaded weights of steam road passenger cars are so comparatively slight that the demands encountered are not similar to those of very dense interurban traffic.

In the passenger empty and load brake the selective mechanism is thrown into engagement by the opening of the car doors. Before the car doors are shut the passengers have been discharged and taken on, and the car loading is that under which brake operation will take place until the next stop is made. Closing the car doors disengages the selective mechanism to save it from wear and tear and from cutting in and out from inequalities of track. One portion of this device is attached to that part of the trucks which keep it at a constant distance from the rail, the other portions are connected to the car body, and the relative motion between the two—a function of the movement of the truck springs and therefore of the car weight—provides that base for the variation of the volumes and valves which give the desired results. This device also operates selective relays which provide a current supply to the motors, so proportioned to the weight of the car that acceleration, as well as retardation, is constant, irrespective of conditions of car loading. Without this means for providing uniform retardation the headway and schedule of trains, to the extent that they are dependent upon retardation, would be impaired 40 per cent. during loaded car movements, which, of course, constitute the critical phase of train operation.

In past articles I have called attention to the advantages of the empty and load brake in freight service, showing how the correct braking ratio provided does away with the slack action effects due to differences in braking ratio through the train that are always encountered with the single capacity brake and I have also pointed out the importance of considering the increased volumes of compressed air necessary for operating the larger brake cylinders made necessary by increased car weights.

These volumes in turn have taxed the ability of the air handling devices to conform to the time limits required for proper train operation. As an example, the 10-inch brake cylinder of the 50,000-pound car requires an auxiliary reservoir volume of about 2,500 cu. ins. of compressed air while the modern Pullman car, requiring two auxiliary and two supplementary reservoirs for proper control, store a volume of about 50,000 cu. ins. of compressed air. The brake pipe connecting such cars has not been increased in size, hence the need for air brake devices of a design that will not overtax the capacity of the brake pipe to supply air from the locomotive. The empty and load brake for freight service reduces the amount of compressed air volume required for train control down to about one-half that required by a single capacity brake, which in comparison is equivalent to a valve gear on a locomotive which would do the same work as the existing type with a demand upon the boiler for steam supply which would be but one-half of that now required.

The eight-wheel coach of the year 1880 had as many brake shoes through which to dissipate the kinetic energy of the moving trains of that time as the eight wheel coach of the present time, but the weight of the coach has more than doubled, thereby doubling the horse power or duty of each brake shoe. Speeds have also increased, which means that the brake shoe duty has increased as the square of the speed. Contrasting the two cars mentioned running at a speed of 35 miles per hour for the older type of car, the speeds averaged years ago, and the 150,000-pound Pullman car of today running at a speed of 65 miles per hour. The horse power required to effect a stop from these respective speeds in 25 seconds time is 149, as compared with 1,540, or dividing this total by the number of shoes in each case, the duty for each shoe is 18.6 horse power for the lighter car and 128.3 for the modern car, or the work for the shoe for modern conditions of service is 6.9 times greater for the heavy car.

This necessitates an efficient type of clasp foundation brake gear, which among other advantages has two brake shoes per wheel, thereby halving the load per shoe, and returning the shoe more nearly to the temperature at which it can do its most efficient work. Where a set of shoes in a certain service lasts but 10 days with the single shoe type of brake gear, a full set of shoes will last the clasp brake 28 days in the same identical service. If worn to the thinness that halving the work of the brake shoe permits, a set of shoes will last 33 days as compared with 10 for the single shoe per wheel gear.

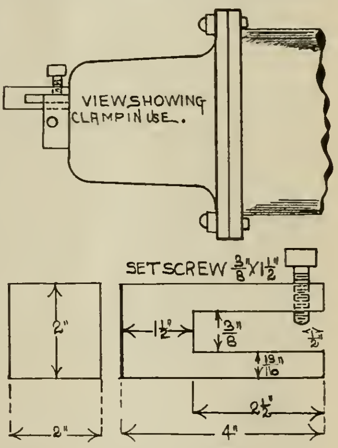
This points to a great possibility in saving, both in brake shoe material and the cost of replacement.

All of these matters bear a vital relation to car capacity, and this will also be affected by the capacity of the draft gear to absorb shocks. Naturally as the weight of the car increases the draft gear will be called upon to perform greater service when the same velocity differences are set up between cars in stopping with brake equipment of outdistanced capacity, and, in starting with locomotives of greatly increased tractive effort. Of course, all the punishment in mixed trains will be on the draft gear of relatively small capacity cars, and if these are to be spared during the transition period it will be necessary to employ the most modern train control equipment.

Brake Cylinder Piston Rod Clamp.

By J. H. Hahn, Machinist, Norfolk & Western Railway, Bluefield, W. Va.

In removing pistons from brake cylinders a variety of devices more or less insecure are used by air brake repair machinists, and the annexed sketch shows the details of a piston rod clamp that will



DETAILS OF BRAKE CYLINDER PISTON ROD CLAMP.

be found very reliable for holding the spring securely in place in the brake cylinder where the plain piston sleeves are used. This clamp is easily constructed and quickly applied and held in place by a set screw, as shown, and prevents the piston springs from jumping out while the piston is being removed for cleaning or renewing the packing leather.

Developing Engine Failures.

By Harvey De Witt Holcombe, Meadville, Pa.

There are a great variety of opinions as to the effects of engine failures; some roads figure their failures on the dollar and cents cost basis as money lost, while other roads base their reputation on the high percentage of trains handled on time, and there are really only a small number of roads which look on the failure record in its true light—that is, as a means of education to show up weakness or poor design of equipment and to check up poor workmanship.

In the past theory has been our safest guide to success, for is it not a fact that theory had figured to a nicety the remarkable savings that were later proved by the introduction of the Mallett type locomotive and the application of superheated steam, but on the other hand, this same theory may go astray and it becomes necessary to apply actual service tests to bring out every day practicability. Successful manufacturing concerns will invite criticisms of their product for the purpose of increasing or bettering machines, while on a large railroad some glaring example of poor design will be "written" up so as to place the blame of whatever failure has occurred on the fellow who cannot in turn put it up to some other fellow. As an example of this point, there happened to be several hot truck journal failures on a certain class of engine. Of course, the first question raised was that the roundhouse force was not giving the proper attention to this work. After several failures and subsequent "call downs," the roundhouse foreman dug into the matter and reported that the wool packing was not up to standard. This packing was examined, and it was found that the packing was even better than the ordinary. The next excuse offered was the quality of oil being used and even this was proved to be quite good, so after there was no let up in the hot truck failures, the matter was "developed" as it should have been in the first place, and it was found that the size of the axle was altogether too small for the weight it was required to carry. "Developing" this case in the proper way would have saved much expense and lost time to the company, for the matter should have been given prompt attention after the first failure.

The question has often been raised as to just what constituted a failure, and the best answer to this should be: on a road where any detention is used as a means of developing the reasons thereof for the purpose of applying the proper remedies to prevent a re-occurrence, a failure should only be classed as a failure when it is caused by a broken part that could not have been discovered by inspection. While on a road where one department is trying to "put it up" to the other fellow, anything which causes a train to be late, should be classed as an engine failure. If an engine is rated to take so many passenger cars over the division in a stated time and the transportation adds another heavy coach to the train so that the engine does not maintain her running time, this would not be considered as an engine failure for even an engine is limited in what it can efficiently do; but if this should happen on the road which classes everything as a failure, there is no doubt but that the mechanical department would have to stand another unjust record on their failure sheet. In a case where an engineer could prevent the cutting of a driving wheel journal by giving it proper attention at the critical time, and by so doing bring his train to the terminal a few minutes late, he should be commended rather than suspended. This should not be classed as a failure but as a detention.

On a road where they measure their success by the few engine failures they have, it is almost similar to the boasts of a man who claims he never makes mistakes. We all make mistakes, but it is the successful man who seldom makes the same mistake twice. Beware of the road which claims to be perfect, also believe just about half what you hear of the road which has a great number of failures, for this latter, if they handle their failures in the nature of experience, will soon be better than the man who does not know how to handle a failure.

On a large road, where it was almost impossible to get a train over the road on time, it became necessary to appoint a new master mechanic, and the man who was selected was advised not to take the appointment because of the "raw-hiding" a man in his position was sure to get. His predecessor had been a man with a strong constitution who had ruled his division by brute strength, so when the new master mechanic took charge he found a "one man" organization, that is an organization where every one looked on the master mechanic as the one and only authority. The very first morning the new man arrived, he was confronted with an engine being off the turn table during the worst and most trying rush period of the day, but simply went into his office and smoked a cigar. This was such an unheard of action for a master mechanic to do that the foremen seemed lost. After looking over the place a few days, the new man called his foremen into his office and told them frankly that he was turning the place over to them to handle, for he would be busy working up means to prevent their failures. From that time on he would like to keep in touch with the work, but he could not give very much personal attention to any details. After going over the records for the past year or two at that point, the new master mechanic began to order certain classes of engines into the back shops for new fire boxes, although the entire boiler force swore that the life of the old box was good for another year or so. However, the master mechanic had his way, and the engines began to receive new fire boxes. Not only new fire boxes were given, but he also ordered new side rods, scrapping apparently good rods, and the erecting shop put up a big kick, but to no avail. Slowly but surely, the failures began to stop on that division and it soon began to be a model for the other divisions to look up to. The real secret of success was due to the fact that the new master mechanic made a careful study of all the past failures and adopted such measures as to prevent a re-occurence. He found by making a careful study of the entire situation where certain engines would suddenly fail although their fire boxes were marked up as being good for several months. It was the same with side rods, motion work, guides, crossheads, etc., and after he assembled all the failure information, he simply worked out a schedule covering how long each part could be used before it was liable to fail. Was not this a case where "developing engine failures" was the actual means of protection to the company?

With the present equipment on the roads, it is almost impossible to secure mechanics who have become efficient in the repairs of all the many specialities now used, therefore we must profit by failures when they do occur and build up our forces to prevent a re-occurence. If the mechanics are not educated to the point where they catch on quickly to some special type of stoker, fire door, reversing mechanism of special valve motion, do not let us condemn this equipment till the matter has been thoroughly "developed." Cases of where the shop forces did not understand some special attachment has resulted in the removal of that attachment due to the fact of the prohibitive cost of maintenance. "Developing" of this case would soon bring to light the exact cause and proper steps could be taken to prevent future failures.

The day for the roundhouse force to guess at the cause of failures is past and it becomes necessary to go thoroughly into any case before deciding what or who is to blame. The day of the old excuse "poor coal" has passed for nearly all coal is analyzed and tested very carefully before being assigned to any type of engine, and when the division or the master mechanic or the roundhouse foreman claims a failure is due to poor coal, the chances are that he is trying to hide some of his own short-comings, but as there is no coal testing outfit on the road, the matter will end there.

To prevent engine failures let the reasons be thoroughly analyzed and the blame placed where it properly belongs, then if anyone gets angry because he is criticised he does not have the right kind of backbone to get results by learning from past mistakes.

Railway Business Association.

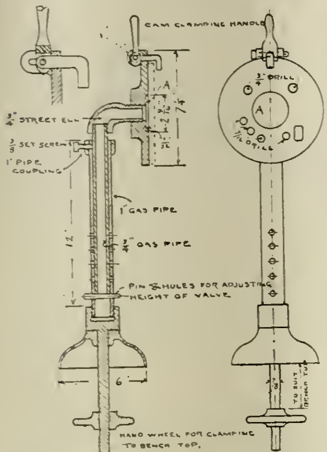
On April 18 the general executive committee of the Railway Business Association met in New York, to consider plans for the railway supply industry co-operating with the Council of National Defense. The committee will meet from time to time, and the perfected plans will be made known at an early date.

Air Brake Repair Work Tools Devised and Applied to Every Requirement

By GEORGE K. DORWART, Denver, Colo.

No. 9. Revolving Bench Stand for Holding Distributing Valve While Making Repairs.

The annexed drawing illustrates a revolving bench stand for holding the Westinghouse distributing valve while making repairs. The stand can be quickly adjusted to convenient height by revolving the tapered pin and placing it in the suitable hole. The distributing valve, when clamped to the face plate, can be revolved to stand at any suitable angle and firmly held by the set screw shown at the top of the outer tube of the stand. It will be observed that no bolts are used in clamping the distributing valve to the face plate. The projection in the center of the valve enters a recess in the face plate at A, and is securely held by the cam clamp at the top of the face plate, engaging the flange of the distributing valve.

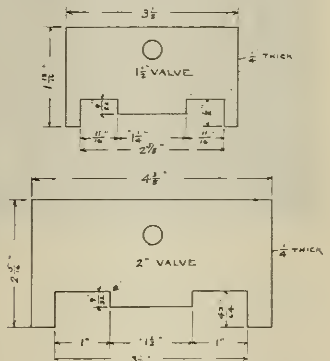


DEVICE FOR HOLDING DISTRIBUTING VALVE WHILE MAKING REPAIRS.

Holes, as indicated, are drilled through the face plate for the purpose of inserting the nozzle of air hose for blowing out the ports. These holes may be scribed from distributing valve gasket—Piece number 16,943. The 1 in., or outer pipe, is screwed permanently into the base, and this in turn clamped firmly to the bench by hand wheel or large nut and washer. The ¾-in., or inner pipe, revolves, and is supported at different heights by a taper pin.

No. 10. Gauges for Air Valve Caps.

This drawing shows details of gauges for air valve caps of 9½ ins. and 11 ins., and C.C. pumps Pc. Nos. 1906 and 1697. When made of steel ¼ in. in thickness and hardened they are good for many years of reliable service. A hole is drilled in the body of the plate so that the gauges may be suspended on a pin or hook when not in service.



DETAILS OF GAUGES FOR AIR VALVE CAPS.

Panama Builds Its First Railroad—The Chiriqui National Railroad

By W. F. SCHAPHORST, New York.

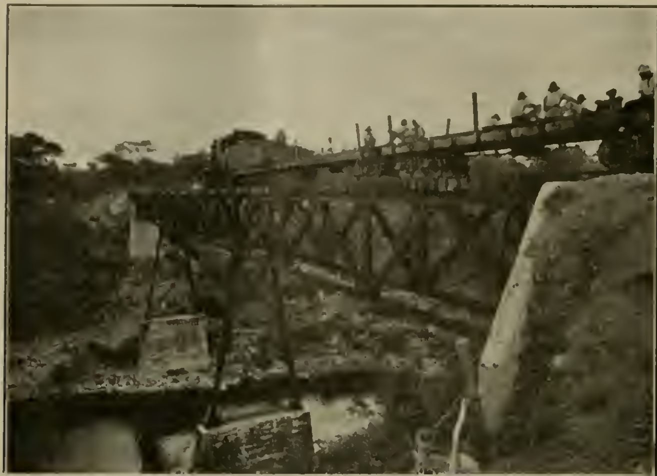
The population of the Republic of Panama is for the most part concentrated in the Canal Zone, especially at the terminal cities of the canal. The western part of Panama is a cattle raising country and its people have felt the need of a railway to bring the ranches in touch with the seacoast. This want has now been satisfied by the completion of the Chiriqui National Railroad which has been built by American engineers and officially inaugurated for public service by the President of the Republic of Panama. On that occasion the Cabinet and about 100 invited guests from the cities of Panama and Colon were present at the ceremonies.

The new line extends from the port of Pedregal on the Pacific, passing through the city of David and terminating at El Boquete, which is 3,300 feet above the sea level. Branches to La Concepcion and Potrerillos bring the total trackage up to sixty miles. The railroad is notable in

CHIRIQUI NATIONAL RAILWAY, PANAMA CANAL ZONE, RIO DAVID VALLEY.

the respect that to reach Boquete, 10 miles of 4½ to 5 per cent. continuous grade is resorted to.

The locomotives used are consolidation type or 2-8-0, with 120,000 lbs. on the driving wheels. These engines are capable of hauling trains weighing 125 tons, at a speed of 10 miles an hour on the maximum grade of 5 per cent. The railroad is now commercially operated. R. W. Hebard & Co. are the American engineers and they have, temporarily, assumed the management of the property.



RIO MAJAGUA BRIDGE—CHIRIQUI NATIONAL RAILROAD.

Pulverized Fuel for Locomotives.

Recently the American Society of Mechanical Engineers listened to a very interesting and instructive paper presented by Mr. John E. Muhlfeld, president of the Locomotive Pulverized Fuel Company, 30 Church St., New York. The paper dealt with the experiments and results obtained by the company in the burning, in locomotives, of fine, powdered coal. Practical tests were made on the engines of the New York Central Railroad, the Atchison, Topeka & Santa Fe Railway, the Delaware & Hudson Company, the Missouri, Kansas & Texas Railway, and the Central Railway of Brazil. The results of locomotive performance on these roads were set forth in the paper as well as a full description of the apparatus and the chemistry of coal combustion. This paper has now been issued in pamphlet form.

Steam railways in the United States are now expending about $300,000,000 annually for locomotive fuel. Of this total from $75,000,000 to $100,000,000 represents the proportion that performs no service in the way of developing tractive power. With the existing domestic and foreign demand for almost more fuel than the mines can produce, the probability is that the current year will find the railway fuel prices increasing in such a way as will produce a serious increase in railway expense.

Oil, packing houses, sugar refineries and like companies look to their by-products for a goodly part of their profits. Why should not the mine operators adjacent to railways utilize the waste and inferior fuels for producing their light, heat and power and thereby release the better and more costly fuel for the domestic and foreign use and in order to secure a cheaper revenue haul on railways?

One of the surest, and at the same time the most scientific methods of production, is the utilization of what has hitherto been a waste, by transforming it into a source of revenue. This is the principle made use of by the superheater, the feed water heater, the brick arch and the pulverized fuel burner. The pamphlet issued by those engaged in carrying on this work is well worthy of careful reading. It tells how the use of a by-product of the mine, such as the inferior grades of anthracite and bituminous coal, lignite and peat can be effectively and economically utilized in the pulverized form for locomotive and stationary boiler purposes by burning it in suspension, instead of on grates or in retorts, and in a manner that has been finally and successfully developed and is now on the market as a practical success. The company will send this pamphlet to anyone interested, on request.

Vapor Car Heating Company.

The Vapor Car Heating Company has taken over all of the heating and ventilating business of the Chicago Car Heating Company, and the Standard Heat & Ventilation Company. The main office and headquarters of the business will be in the Railway Exchange, Chicago. The officers of the company are as follows: Egbert H. Gold, president; J. E. Baker, vice-president; J. Allan Smith, vice-president; Samuel Higgins, vice-president and treasurer; Winthrop Gold, assistant treasurer; Edward A. Schreiber, general manager; Arthur P. Harper, secretary and comptroller; Otto R. Barnett, general counsel. Those in charge of the branch offices are as follows: Samuel Higgins and George T. Cooke at New York City; Frank F. Coggin at Boston, Mass.; F. A. Purdy and S. P. Harriman at Montreal, Canada; Harry F. Lowman at Washington, D. C.; Lewis B. Rhodes at Atlanta, Ga.

The Association of Railway Supply Men.

The Association of Railway Supply Men are arranging for an extensive exhibit during the thirteenth annual convention of the International Railway General Foremen's Association, which will be held in Chicago, September 4 to September 7, inclusive. The growing importance of the convention is such that exhibition spaces are being rapidly arranged for among the members of the supply men's association. The membership includes the leading manufacturers and others interested in the railway supply business, and there is every indication of the largest convention in the history of the general foremen's association. Mr. H. A. Varney, 122 South Michigan avenue, Chicago, Ill., is secretary and treasurer of the Association of Railway Supply Men.

Changes on the New Haven.

At a meeting of the board of directors of the New York, New Haven & Hartford Railroad Company, held on April 24, the resignation of Mr. Howard Elliott as president was accepted. Mr. E. J. Pearson, vice-president since March, 1916, was elected president, to succeed Mr. Elliott. The board of directors created a committee of inter-corporate relations, which is to consist of the presidents and vice-presidents of the various companies comprising the New Haven system. Mr. Elliott is to be chairman of this committee, and will work with the various presidents to co-ordinate and harmonize the activities of the companies.

New Detroit Company.

A new company has been formed at Detroit under the name of the Oxy-Acetylene Equipment Company, to handle welding apparatus and equipment of all kinds. The company is under the management of C. H. Dockson, one of the oldest and best known apparatus salesmen in the country.

New Design of Plate Fulcrum Scales

Longer Service Without Repairs—Massive Plates More Durable Than Knife Edge Bearings.

What is claimed to be an improvement in heavy track scale construction has recently been established on the Pennsylvania Railroad and bids fair to meet with popular approval on railroads generally. As is well known, a degree of perfection has been reached and approved by the American Railway Association in regard to the material and amount of stresses corresponding to the dimensions of the knife-edge method of balancing the extension levers in track scales generally. The bearing pressure of 7,000 lbs. per linear inch of knife edge bearing recommended has been found to be a conservative estimate capable of sustaining and registering very correctly the weights of locomotives and cars for a limited time, and while the repairs incident to intermittent stresses resting on such delicately balanced appliances are neither frequently necessary nor difficult of accomplishment, the need for a track scale, which will meet the weighing conditions on a busy railroad and maintain its accuracy and sensitiveness for a long period of years without repairs having to be made has led to the development of the plate fulcrum type, wherein knife edges are entirely eliminated and the loads are carried by these plates of steel. With this construction the vital parts of the scale are not excessively worn, hence a means is provided for retaining the accuracy of the scale almost indefinitely.

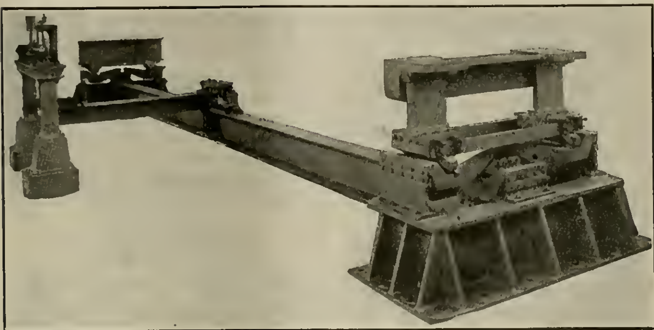


FIG. 1. VIEW OF PLATE FULCRUM SCALE.

Fig. 1 shows a plate fulcrum track scale recently built for the Pennsylvania Railroad.

This scale has a weighing rail 52 ft. in length, and in order to eliminate complications the scale is made in two sections. The supports for the main levers and the longitudinal extension levers are formed by means of massive base plates which are securely anchored to the concrete foundation.

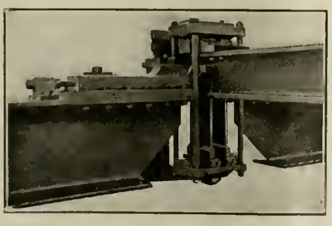


FIG. 2. CONNECTION BETWEEN END EXTENSION LEVER AND TRANSVERSE EXTENSION LEVERS.

In designing the scale a load of 400,000 lbs. is considered concentrated at each section, and the plate fulcrums throughout the scale are designed to successfully withstand this load for an indefinite period. The load from the main girders is transmitted to the plate fulcrums through massive bearing blocks engaging with the upper portion. These bearing blocks are securely tied together by means of transverse bracing so that the load is transmitted through true vertical center lines. Where the end-extension levers connect to the transverse extension lever a refined construction is adopted so as to make provision for expansion and contraction of the longitudinal extension levers. Fig. 2 illustrates this construction.

The lower portion of the struts engaging with the plate fulcrums in the tips of the longitudinal extension levers is ground to a radius and engages with a hardened steel plate, thus providing freedom of action without disturbance of the transverse extension lever when expansion or contraction takes place. The transverse extension lever is directly connected to the weighing beam.

Fig. 3 shows the beam outfit. Metal bases, pillars and shelf are used, and a means is provided for transverse adjustment so as to maintain the connection from the tip of transverse extension lever to the butt of the beam in a vertical position when the nose iron of the transverse extension lever is moved. The beam is graduated to 300,000 lbs. by 50 lbs., and an auxiliary weight of 100,000 lbs. capacity is provided, thus giving a total weighing capacity for the scale of 400,000 lbs. An indicator moving over a graduated arc is also provided, thus furnishing a very accurate means for balancing the beam. The main poise is provided with ball bearings so as to eliminate friction to as great an extent as possible.

The plate fulcrum track scale has been developed jointly by E. & T. Fairbanks & Company, A. N. Emery and the Pennsylvania Railroad, and this type of construction for track scales, as we have already stated, is being adopted as a standard by the Pennsylvania Railroad Company.

Vanadium-Alloys Steel Co.'s Agencies.

The following firms have completed arrangements whereby they will become agents for the sale of the products of the Vanadium-Alloys Steel Company of Pittsburgh, Pa.: E. T. Ward's Sons, Boston, Mass.; George Nash Company, New York and Chicago; Field & Co., Inc., Philadelphia, Pa. A full stock of high speed steel, alloy and carbon steel will be on hand at the various agencies as well as at the Vanadium-Alloys Steel Company's warehouses at Pittsburgh, Pa.

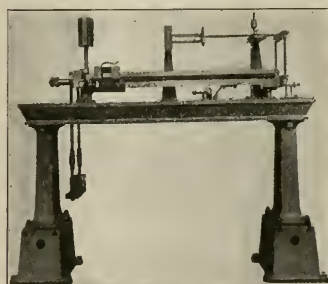


FIG. 3. BEAM OF PLATE FULCRUM SCALE.

Items of Personal Interest

Mr. T. H. Roomey has been appointed fuel superviser of the Eastern division of the Texas & Pacific, with headquarters at Marshall, Tex.

Mr. Henry B. Oatley, chief engineer of the Locomotive Superheater Company, has been called to active duty as a lieutenant in the New York naval reserve.

Mr. George Moth has been appointed division master mechanic of the Canadian Pacific, with office at Edmonton, Alta., succeeding Mr. A. E. Dales, transferred.

Mr. G. P. Trachta has been appointed master mechanic of the Casper division of the Chicago, Burlington & Quincy, with office at Casper, Wyo., succeeding Mr. J. O. McArthur, transferred.

Mr. E. F. Thomson, formerly chief clerk to the president of the Chicago, Indianapolis & Louisville at Chicago, Ill., has been appointed assistant to the superintendent of motive power at Lafayette, Ind.

Mr. H. A. Lane, formerly assistant to the chief engineer of the Baltimore & Ohio Railroad, has been appointed chief engineer, with office at Baltimore, Md., succeeding Mr. R. N. Begien, appointed general manager of the eastern lines.

Mr. J. W. Cuyler, formerly master mechanic of the Chicago, Rock Island & Pacific at Armourdale, Kans., has been transferred to Herington, Kans., as master mechanic of the Kansas division, succeeding Mr. R. J. McQuade, transferred.

Mr. James Hall, formerly master car repairer, coast division of the Southern Pacific, with headquarters at San Francisco, Cal., has been appointed general car foreman in charge of the passenger car department, with office at Sacramento, Cal.

Mr. D. P. Kellogg, formerly superintendent of shops of the Southern Pacific at Los Angeles, Cal., has been appointed superintendent of motive power on the same road, with headquarters at Sacramento, Cal., succeeding Mr. T. W. Younger, resigned.

Mr. C. L. Sharp, formerly general foreman of locomotives, Chicago, Rock Island & Pacific, at Shawnee, Okla., has been appointed master mechanic of the Louisiana division at Eldorado, Ark., succeeding Mr. W. F. Eddy, who has been appointed superintendent of fuel economy.

Mr. A. R. Ruiter, formerly general foreman of locomotives on the Chicago, Rock Island & Pacific, at Chicago, Ill., has been appointed master mechanic of the Kansas City Terminal, and St. Louis divisions, with headquarters at Armourdale, Kans., succeeding Mr. J. W. Cuyler, transferred.

General Charles Miller has been elected president of the Galena-Signal Oil Company, succeeding Mr. S. A. Megeath, who has resigned to take charge of the refining and foreign business of the company with headquarters at 17 Battery Place, New York. General Miller's headquarters will be at Franklin, Pa.

W. F. Schaphorst, M. E., advertising engineer, and author of technical articles that have been published in Railway and Locomotive Engineering, has established an engineering advertising service office in the Woolworth Building, New York City. He solicits business with manufacturers of high grade engineering products.

Mr. R. N. Begien has been appointed general manager of the eastern lines of the Baltimore & Ohio Railroad. Mr. Begien graduated from Harvard University in 1897, and after several years' engineering service in Central America, entered the service of the Baltimore & Ohio in 1902 as assistant engineer and advanced to the position of chief engineer, which position he held until appointed general manager.

Mr. J. H. McGoff, formerly mechanical superintendent of the Atchison, Topeka & Santa Fe Railway, at Topeka, Kans., has been appointed mechanical superintendent of the eastern division of the eastern lines, with headquarters at Fort Madison, Iowa; and Mr. I. C. Hicks, formerly master mechanic at San Bernardino, Cal., has been appointed mechanical superintendent of the western district of the eastern lines, with headquarters at Topeka.

Mr. J. W. Kelker, formerly in the engineering department of the American Locomotive Company, has been appointed mechanical engineer of the Pilliod Company, succeeding Mr. Ross G. Graham, resigned; and Mr. K. J. Eklund, assistant to the president of the Pilliod Company, has been transferred from New York to Chicago as assistant to Mr. Burton W. Mudge, president of Mudge & Company, and vice-president of the Pilliod Company.

Mr. Elisha Lee has been appointed general manager of the Pennsylvania Railroad lines east of Pittsburgh, succeeding Mr. Simon C. Long, who died last month after five years' service as general manager. Mr. Lee is from Illinois and a graduate of the Massachusetts Institute of Technology. He entered the service of the Pennsylvania Railroad in the engineering depatment in 1892, and has filled many positions in the engineering and transportation departments. In 1911 he was appointed assistant to the general manager of the Pennsylvania lines east of Pittsburgh, which office he filled until his appointment last month as general manager.

Mr. Harvey B. Slaybaugh, formerly assistant secretary of the American Arch Company, has been elected secretary, with offices at 30 Church St., New York. Mr. Slaybaugh is a graduate of Oberlin College and entered railway service in 1893. He served as timekeeper, stenographer, accountant and storekeeper in the locomotive department of the Lake Shore & Michigan Southern, and in 1899 he was transferred to the office of the superintendent of motive power. In 1908 he was appointed chief motive power clerk. In July, 1910, he left the railway service to become assistant secretary of the American Arch Company as stated above, which position he held until elected secretary of that company.

OBITUARY

James B. Brady

James B. Brady, vice-president of the Standard Steel Car Company, died at Atlantic City, N. J., on April 13, after a long illness. Mr. Brady was a unique and popular character among railway men generally and railway supply men particularly for many years. He was associated with a number of the leading railway supply firms and amassed a considerable fortune.

George Henry Frost.

George Henry Frost, for many years publisher of the *Engineering News*, died at Plainfield, N. J., last month in his eightieth year. He was a native of Canada and graduated from McGill University, Montreal, in 1860. He was for several years in the service of the Chicago & North Western Railway. He founded the *Engineering News* in 1874 and continued its publication until 1911. He was a member of several engineering societies in the United States and Canada.

Simon Cameron Long.

Simon Cameron Long, for the last five years general manager of the Pennsylvania lines east of Pittsburgh, died on March 25, while traveling on a train to his home at Merwin, Pa. He was born near Harrisburg, Pa., in 1857, and graduated with the degree of civil engineer from Lafayette College in 1877. He entered the service of the Pennsylvania in 1881, and was promoted supervisor in 1885, assistant engineer 1889, superintendent 1902 and was appointed general manager of the eastern lines in 1911, which position he held at the time of his death. Mr. Long was in his sixty-first year.

Railroad Equipment Notes.

The Carnegie Steel Company has ordered 20 70-ton dump cars from the Standard Steel Car Company.

The Atchison, Topeka & Santa Fe has ordered 800 refrigerator cars from the American Car & Foundry Company.

The Carolina, Clinchfield & Ohio has ordered 9 Mikado and 7 Mallet locomotives from the Baldwin Locomotive Works.

The Chicago & North Western has ordered 2,000 50-ton steel frame gondola cars from the American Car & Foundry Company.

The Chicago & Eastern Illinois has ordered 7 Santa Fe (2-10-2) type locomotives from the Baldwin Locomotive Works for delivery in January, 1918.

The Blue Ridge will rebuild its round house and shops at Anderson, S. C., which were recently burned at a loss of $25,000. The new structure will be of brick.

The San Antonio, Uvalde & Gulf proposes to construct a new machine shop at North Pleasanton, Tex., at an estimated cost of $87,000 for structure and new equipment.

The El Paso & Southwestern system has placed an order with the American Locomotive Company for 5 Mikado (2-8-2) type locomotives, each weighing 321,000 lbs. and having cylinders 29 by 30 ins.

The Los Angeles & Salt Lake is reported contemplating improvements at Provo, Utah. A new round house, machine shops and coal chutes are to be built and yards rearranged and extended.

The Chicago & North Western has ordered 50 Mikado (2-8-2) type locomotives from the American Locomotive Company. These engines will each weigh 303,000 lbs. and will have cylinders 27 by 32 ins.

The Union Pacific has let the contract for the erection of a brick and steel power house, 76 by 209 ft., at Omaha, Neb., at $450,000; also for the erection of its new brick and stone passenger station at North Platte, Neb., at $120,000.

The South African Railways have ordered 8 Mallet type locomotives from the American Locomotive Company. These locomotives will have 16½ and 26 by 24-ins. cylinders, and a total weight in working order of 194,000 lbs.

The Buffalo, Rochester & Pittsburgh has planned a machine shop and erecting shop and an addition to its round house at Salamanca, N. Y. Westinghouse Church Kerr & Company, New York, is reported to have the contract.

The Indian Refining Company has ordered 9 6,000-gallon, 30-ton tank cars from the Chicago Steel Car Company, Chicago, and 15 6,000-gallon, 40-ton and 60 8,000-gallon, 50-ton tank cars from the Standard Car Construction Company, Sharon, Pa.

The Philadelphia & Reading has ordered 500 box cars from the Pullman Company, 500 box cars from the American Car & Foundry Company, 500 gondola cars from the Pressed Steel Car Company and 500 gondola cars from the Standard Steel Car Company.

The Norfolk Southern is having 500 wooden underframe gondola cars reconstructed into 40-ton box cars. Steel center sills will be applied and ends of cars reinforced with "Z" bars. The American Car & Foundry Company will rebuild 250 cars and Mt. Vernon Car & Manufacturing Company 250 cars.

The Western Pacific, it is said, will consolidate its shops at Stockton with those at Oroville, Cal., and will enlarge the capacity of the latter and install additional machinery. The shops at Sacramento, Cal., will hereafter be used for new construction, all the repair work being done at Oroville.

The Union Pacific is to install automatic block signals on its line from Point of Rocks, Wyo., to Wamsutter, 53 miles; from Hermosa, Wyo., to Buford, 12 miles, and from Archer, Wyo., to Pine Bluffs, 35 miles. These signals are model 2A, base-of-mast, furnished by the General Railway Signal Company.

The Chicago, Burlington & Quincy will make an expenditure of $150,000 during the next few months to improve its terminal facilities at this point. Among the improvements contemplated are extensions to the present roundhouse, a few minor shop buildings and additional track facilities. The work will be done by company forces.

The Pennsylvania Lines West of Pittsburgh have awarded a contract to the Roberts & Schaefer Company, Chicago, for the designing and building of a reinforced concrete, three-track automatic electric locomotive coaling plant, and also a reinforced concrete "Rands" gravity sand plant, which will be built at the new terminal now under construction at Akron, Ohio.

The Southern Pacific has completed plans for the reconstruction of car shop No. 3 at Sacramento, Cal., which was burned last fall. Car shop No. 9 at the Sacramento plant is being enlarged and additional tracks, air lines and steam lines are to be placed in the building. A new 50-ton, 64-foot span crane is being installed in the boiler house and two 1,500 lb. forging hammers in the blacksmith shop.

The June Conventions.

After discussing very thoroughly the advisability of holding the annual mechanical conventions in June of this year, the leaders of the Master Car Builders and of the American Railway Master Mechanics' Associations have decided that no conventions shall be held.

The principal reasons given for this decision are that the war conditions existing in the United States demand that all important mechanical officials should be at their headquarters attending to the duties likely to be arduous while the war excitement lasts. The train movements are likely to be unusually heavy this summer and will entail energy and management by every official to keep the trains moving promptly. Anything calculated to interfere with this regular movement would be detrimental to the railroads generally, and to the country at large. For this reason the executive committees of both associations decided to postpone the conventions till the advent of more peaceful times.

The Executive Committee of the Railway Supply Men's Association took action similar to Master Car Builders' and Railway Master Mechanics' Associations.

Organization of Gear Manufacturers.

The American Gear Manufacturers has organized for the purpose of advancing and improving the gear industry in a general way by standardization of gear design manufacture and application. The association includes in its membership the leading manufacturers of gears. The officers elected are the following: President, F. W. Sinran; vice-president, H. E. Eberhardt; secretary, F. D. Hamlin; treasurer, Frank Horsburgh. The Executive Committee is composed as follows: F. W. Sinran, Van Dorn & Dulten Co., Cleveland, Ohio; H. E. Eberhardt, Newark Gear Cutting Machine Co., Newark, N. J.; F. D. Hamlin, Earle Gear & Machine Co., Philadelphia, Pa.; Frank Horsburgh, Horsburgh & Scott, Cleveland, Ohio; Biddle Arthur, Simonds Manufacturing Co., Pittsburgh, Pa.; George L. Markland, Philadelphia Gear Works, Philadelphia, Pa.; Milton Rupert, R. D. Nuttall Co., Pittsburgh, Pa.

Safety Suggestions on the Baltimore & Ohio.

On the various divisions of the Baltimore & Ohio there were held 198 meetings in 12 months, at which 8,268 suggestions were made by employees. Of these 7,854, or 91 per cent., were adopted. The decrease in the number of suggestions as compared with that of the previous year amounted to 49 per cent., showing evidently that the management is placing every available safeguard around the employees.

Meeting of Mechanical Engineers.

The American Society of Mechanical Engineers will hold its next meeting at Cincinnati, Ohio, May 21 to 24, 1917. The meeting is being held coincident with the meeting of the National Machine Tool Builders' Association. Among other papers there will be a discussion of problems arising from the manufacture of munitions, such as specifications, materials, limits, special machines, and training the working force. A largely attended meeting is expected.

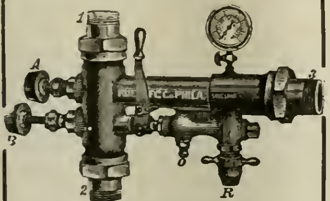
Changes in Supply Organization.

The National Railway Appliance Company announces that it has taken over the railroad department business of the United States Metal and Manufacturing Company and have established headquarters at 50 East 42d street, New York. Mr. B. A. Hegeman, Jr., is president; Mr. Charles C. Castle, first vice-president; Mr. Harold A. Hegeman, vice-president and treasurer; Mr. F. C. Dunham, assistant to the president, and Mr. Edward D. Hillman, secretary and engineer. Branch offices have been established in the McCormick Building, Chicago, Ill., under the management of Mr. Walter H. Evans, and at the Munsey Building, Washington, D. C., under the management of Mr. J. Turner Martyn.

Honors for Safety Awarded.

The American Museum of Safety announce the award of the Harriman Memorial Medals for the year 1916, for the highest possible degree of safety effort on American steam railroads. The gold medal is awarded to the Alabama Southern railway company whose record is remarkable, no fatality occuring either to passengers or employees. Among 2,000 industrial workers only two were injured. The silver medal is awarded to the Illinois Central with an equally excellent record. The bronze medal is warded to the individual considered most conspicuous in safety promotion, and Mr. James A. McCrea, general manager of the Long Island, whose unceasing activity in safeguarding human life has had far-reaching results, was awarded the special bronze medal.

Adversity sometimes gives a man courage; prosperity too often takes it out of him.



Books, Bulletins, Catalogues, Etc.

A Practical Manual on Oxy-Acetylene Welding and Cutting, With a Treatise on Acetylene and Oxygen. By P. F. Willis, St. Louis, Mo. 180 pages, flexible covers. Price, 50 cents.

This illustrated handbook furnishes a very complete and interesting educational course in oxy-acetylene welding and cutting, and is divided into eight chapters embracing a department in the question and answer form, followed by a full description of apparatus and installation, and the best methods of preparing for welding of different materials, with many examples of actual experience by the author. While the book may be said to be primarily adapted for the instruction of beginners, there is much matter that will be found useful to practised hands, and the handy form and popular price of the book is such that it cannot fail to meet with a ready sale.

How to Run an Automobile. By Victor W. Page. The Norman W. Henley Publishing Co., 2 West 45th street, New York. 178 pages, 72 special engravings. Price One Dollar.

Mr. Page is already well known as an engineering writer of ability, and his latest book is sure of a popular reception. The work treats in a concise and clear way of all of the best known automobiles, and furnishes full instructions for starting and running, as well as caring for them. It is divided into four chapters, embracing automobile parts and their functions; general starting and driving instructions; typical 1917 control systems; care of automobiles. The book is the work of one who has thoroughly mastered the subject in all its details, and who has the fine faculty of imparting information to others. All the problems possible in automobile running are solved, and a careful perusal of the book furnishes the mental equipment necessary.

The Locomotive Engineer's Pocket Book and Diary, 1917. The Locomotive Publishing Company, 3 Amen Corner, London, E. C. Angus Sinclair Company, New York. 340 pages, flexible covers. Price One Dollar.

The 1917 edition of this popular diary, primarily intended for British or Colonial engineers contains a mass of information that will be found useful to mechanical railway men in every section of the globe. There is no problem in connection with the construction and running and repairing of locomotives but is treated concisely and clearly in its pages, together with tables simplifying calculations, recipes, alloys, feed water heating, lubrication and kindred subjects. In brief, its high character earned through many years of improvement is well sustained.

"National" Preparedness.

The National Tube Company, Frick Building, Pittsburgh, Pa., has published a unique calendar, setting forth in melodious and stirring verse, the various uses and surpassing merits of "National" pipe. The verses are by Berton Braley, and it would be well if many of our magazine versifiers would take a lesson from his masterly production. His ear is faultless. The verses are illumined by thirteen colored illustrations. There is a grace and dignity about the production which stamps it at once as a gem in advertising that is unrivalled in our memory. We understand that copies may be had on application to the company's main office at Pittsburgh.

The Six Metric Myths.

The American Institute of Weights and Measures has issued Bulletin No. 1, setting forth with convincing logic the undesirability of changing the standard of measures now in use in America to the metric system. The six metric myths, so called, are a condensed classification of the arguments that have been advanced in favor of the metric system, and while there is nothing particularly new in these metric myths, they are all taken up and disposed with a degree of fairness and force that leaves nothing further to be desired. Copies of the Bulletin will be sent free to any address on request to the Commissioner, 20 Vesey street, New York.

Graphite.

The latest issue of *Graphite,* the organ of the Joseph Dixon Crucible Company, Jersey City, N. J., furnishes interesting data in regard to the graphite lubrication of locomotives, laying particular stress on the saving of cylinder packing in superheated locomotives. Many eminent authorities agree that with the use of graphite there is less of bypass of steam past the packing rings, which, of course, means a saving of fuel. As cylinder packing is a source of considerable trouble in high-powered locomotives when there is superheat, the proper use of graphite is a distinct advantage.

Staybolts.

The latest issue of "Staybolts" published by the Flannery Bolt Company, Pittsburgh, Pa., presents interesting details showing that step by step the use of the Tate flexible bolt has been gradually extended in recent years to cover the breaking zone of the rigid staybolt, and it has clearly demonstrated that the greater use of the flexible bolt to cover larger sheet areas has been fully justified.

It is also gratifying to observe that in spite of the rapidly increasing demand the company has been able to fill all orders as promptly as formerly.

Safety Engineering.

The latest issue of *Safety Engineering* has, among other interesting matter, an able article "About Boiler Safety," from the pen of R. L. Hemingway, safety engineer, Industrial Accident Commission, California. The article calls particular attention to the pernicious effects of small leaks in boilers, which, the writer claims, have much more serious effects than is generally believed, and such leaks should be stopped as soon as they are discovered. The publication is full of valuable matter in the interest of safety and is well worthy of perusal.

The Pennsylvania Railroad System.

The Pennsylvania Railroad System has issued, in booklet form, a historical and descriptive treatise covering the territory traversed by its lines. The principal object of the booklet is to point out the most interesting and picturesque incidents connected with the settlement and subsequent development of this region, which has become the richest and most thickly populated in the United States; also to set forth the present character of the various portions of the territory with reference to industry, mining, agriculture and commerce. The book is profusely illustrated, and is accompanied by a large folding map of the territory served by the Pennsylvania system.

Pipe Fittings for Air Brake Service.

The Westinghouse Air Brake Company has issued their Special Publication No. 9021, on "Extra Quality Pipe Fittings for Railroad Air Brake Service." This is a high grade, carefully prepared booklet, which emphasizes the better air brake service and saving of money made possible to railroads by the use of reliable pipe fittings in all air brake work on locomotives and cars.

Safety Posters on the New Haven.

In furthering its campaign to prevent accidents due to trespassing upon its tracks, the New York, New Haven & Hartford Railroad Company is issuing several thousand posters in Italian, Polish, Hungarian and Greek, calling attention to the perils of using railway property as a highway. At frequent intervals 180,000 trespassing posters in English have been placed in factories, schools, stations, freight houses, cabooses, crossing cabins, section houses, work trains, shops, car inspection cabins, interlocking towers, telegraph poles and various other places. The foreign language posters will be distributed in appropriate places where there are large numbers of Italians, Poles, Hungarians and Greeks.

A Little Story of the Boston & Providence Railroad Company.

Mr. Charles E. Fisher, 3309 Arch Street, Philadelphia, Pa., has published a pamphlet giving a brief history of the Boston & Providence Railroad. It is illuminated with illustrations of early locomotives, buildings and viaducts, and furnishes much interesting data in regard to the early motive power of the road before it became leased to the Old Colony Railroad in 1888. The pamphlet is one of those rare publications that becomes more valuable with the lapse of time. The author shows an enthusiastic interest in the work, and has many good words to say about the early pioneers in locomotive construction in New England.

Fuel Combustion.

The Bureau of Mines has issued Technical Paper No. 137, dealing very fully with the subject of "Combustion in the Fuel Bed of Hand-filled Furnaces." Especially in the matter of furnace design and results of tests, the publication is worthy the attention of all interested in this important subject. The work is the joint production of W. Kreisinger, F. K. Ovitz and C. E. Augustine. Copies may be had from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price of this publication is 15 cents.

The President Urges Efficiency.

The President of the United States in a recent statement, said:

"To the men who run the railways of the country, whether they be managers or operative employes, let me say that the railways are the arteries of the nation's life and that upon them rests the immense responsibility of seeing to it that those arteries suffer no obstruction of any kind, no inefficiency nor slackened power."

Might of the roaring boiler,
  Force of the engine's thrust,
Strength of the sweating toiler,
  Greatly in these we trust.
But back of them stands the schemer,
  The Thinker who drives things through;
Back of the Job—the Dreamer,
  Who's making the dream come true!

—*Berton Braley.*

Read all the Books on every Shelf—
But do your Thinking for yourself.

Statement of the ownership, management, etc., required by the act of Congress of August 24, 1912, of Railway and Locomotive Engineering *published monthly at New York, N. Y., for April 1, 1917.*

State of New York }
County of New York } *ss.*

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Harry A. Kenney, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Railway and Locomotive Engineering, *and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act. of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:*

1. That the names and addresses of the publisher, editor, managing editor and business managers are: Publisher, Angus Sinclair Co., Inc., 114 Liberty St., New York, N. Y.; Editor, Angus Sinclair, 114 Liberty St., New York, N. Y.; Managing Editor, James Kennedy, 114 Liberty St., New York, N. Y.; Business Manager, Harry A. Kenney, 114 Liberty St., New York, N. Y.

2. That the owners are: Angus Sinclair Co., Inc., 114 Liberty St., New York, N. Y. Stockholders owning 1 per cent. of the total amount of stock: Angus Sinclair, 114 Liberty St., New York, N. Y.; James Kennedy, 114 Liberty St., New York, N. Y.; Harry A. Kenney, 114 Liberty St., New York, N. Y.; Mrs. O. J. Schanbacher, 40 Heddon Terrace, Newark, N. J.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent. or more of the total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the Company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and that this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

[SEAL] Harry A. Kenney,
Business Manager.

Sworn to and subscribed before me this twelfth day of April, 1917.

Oliver R. Grant.
Notary Public.

My commission expires March 30, 1919.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXX. 114 Liberty Street, New York, June, 1917 No. 6

Efficient Type of Bottom for Railway Water Tank

Comparison With the Wooden Tank and Wooden Bottom—Increased Storage Capacity of Elliptical Bottom—Advantages of Steel Construction—Building and Maintenance Charges

Among the various changes in railway equipment which are constantly taking place, there are probably none more conspicuous at the present time than the abandonment of the wooden water tank for the all steel structures on most of our big lines; and, aside from the differences in the various materials used, there is no single factor more closely allied with this improvement than the change in the form of the tank bottom.

The first tanks built for railway service were naturally modeled after those used for various kinds of industrial service at the time, and were, of course, made of wood with flat wooden bottoms. The sub-structures for these tanks were also made of wood, topped by a grillage of wooden beams supporting the tank bottom. In time, this form of construction became obsolete, and both the sub-structure and the wooden grillage, on account of their temporary character and their frequent failure, were replaced by a steel tower with a grillage of steel I-beams.

The same theory was not, however, applied to the super-structure, and we find the wooden tank of today built essentially as it was several decades ago with its wooden staves held against each other and against the edges of the flat bottom by metal hoops which bind it together, and are placed around the outside.

The present day steel tank is, however, a marked departure from its wooden predecessor in every phase of its construction. There are two general types used for railway service, known as the elliptical, and the conical bottom, tank, both of which have the tower posts directly connected to the shell-plates, and the bottom plates joining the shell-plates on the line of a true tangent.

The elliptical type has a bottom whose cross section approximates to a semi-ellipse, while the conical bottom is made up of a straight conical section connected to the tank-shell by a circular arc tangent to

CONICAL TANK BOTTOM, L. & E. RY.

CONICAL BOTTOM TANK, ILL. CENT. R. R.

both the inclined bottom and to the cylindrical shell. Both types have large diameter, riveted steel riser pipes directly connected to the tank bottoms.

Among the numerous advantages which these types of bottom construction have over the flat bottom of the wooden tank, none are more apparent than the economy of material effected. The wooden tank bottom, being perfectly flat, must of necessity be supported from underneath, and this requires the grillage of I-beams, above referred to. This grillage, which may, in point of fact, be said to serve no useful purpose whatever, as an actual container for the stored water, weighs nevertheless a very considerable amount, in some cases, a large percentage of what a superimposed steel tank would weigh.

The steel tank bottom, on the other hand, is entirely self-supporting; no grillage, bracing or stays of any kind are required; while the induced stresses, which are readily determinable, are less than those in the lowest course of the tank shell.

In close connection with its self-supporting properties, the steel bottom has the added advantage that its chances of permanency are much greater, and its rate of depreciation much less, than in the case of the wooden bottom with its grillage construction. Every part of the steel bottom is clear and open to the air; it has no points of contact with other surfaces tending to harbor dirt and moisture and so induce corrosion. It is completely accessible for inspection and painting. The same cannot be said for the plank and grillage bottom, as the area of contact between the bottom planks and the upper flanges of the grillage beams is entirely inaccessible; it can neither be seen, nor painted, and, having a natural tendency to hold moisture, it becomes a frequent cause for the corrosion of the beams underneath and the rotting of the planks above.

In the case of steel tanks where the posts have a batter so as to give a wide base, as in the case of tanks having a considerable elevation, such as are used at railway repair shops, the tops of the posts are joined to a steel ring which encircles the tank and the inward pressure at the top of the posts is not permitted to bear upon the tank itself.

There is, however, still another economy effected by the steel bottom which may be called an economy of volume, rather than one of material. When we consider a wooden tank bottom we have a bottom and a bottom only; when we consider a steel tank bottom, we have not only a bottom, but, at once, a tank, complete in itself, and possessed of a very considerable storage capacity. This extra capacity in most cases makes a very noticeable addition to the cylindrical portion of the tank above. Taking as an illustration a flat bottom tank twenty feet in diameter by twenty feet in depth, we find that it contains approximately forty-seven thousand gallons; while the addition of a hemispherical bottom will increase its capacity fifteen thousand seven hundred gallons, or 33 1-3 per cent. This increase in volume is accompanied by a saving of material which is an economy well worth while.

Viewing the subject from the broad standpoint of total cost, covering both initial cost and maintenance charges, the steel bottom tank is found to play an important part in reducing the latter. As stated above, both the elliptical and conical types have large riveted steel risers riveted directly to the tank bottoms. These are made from four to eight feet in diameter and serve as settling basins for all foreign material and sediment contained in the water, and are equipped with wash-out valves at the bottom.

Where the water is especially muddy the conical type is generally used. In this case the mud which is deposited on the sloping sides of the bottom is precipitated into the large riser, where a considerable amount may accumulate before it interferes with the inlet or outlet pipes which extend several feet above the bottom. When it is desired to clean the tank, it is only necessary to turn the rod controlling the wash-out valve and projecting through the side of the riser. This automatically flushes out all the sediment without interrupting the service of the tank, and the operation practically costs nothing. In marked contrast to this we find that when a flat-bottom tank is to be cleaned, it is necessary to draw off all the water, and shovel or scrape out the dirt. The difference in the amount of work done and the cost, as compared with the other system, is very apparent.

From a constructional viewpoint, the steel bottom again shows its superiority to the wooden bottom. The wooden planks of the flat bottom tank, should, of course, fit very tightly into the staves at their lower ends. To make this joint, a deep groove is cut into the inside surfaces of the staves into which the bottom planks may or may not fit snugly. In any event, this joint, which is at the point of greatest pressure in the tank, must be kept tight by the holding pressure of the hoops alone, as the water pressure tends to continually force the joint open. Furthermore, this cut, or groove, in the staves, which is made across the grain of the wood, serves as a place for the entrance of water, as indicated by the many cases of early decay at this point.

ORDINARY WOODEN TANK AND HEMISPHERICAL BOTTOM STEEL TANK WITH CAPACITY OF 200,000 GALLS. 51 FT. 6 INS. HIGH.

In the steel bottom tank there is no right angle joint between the bottom and the shell; they join tangentially with no tendency for one to spring away from the other. Moreover, there is no probability of the water entering the joints, as they are made tight by calking only, making a "metal to metal" joint without the use of any foreign material. This is then painted, leaving nothing to decay or cause trouble.

The total result of the correct design and construction of the steel bottom is, that it is free from repairs, it does not leak, it does not fail and is always open to inspection. By the use of this type of bottom, it is possible to make the tank and tower an integral unit of very pleasing proportions and good appearance, which item, in itself, is worthy of some consideration.

The above-mentioned qualities, it would seem, have met with the approval of many of our railway executives, as indicated by the adoption of the all-steel structure by a large proportion of our leading roads. This change has been made in most cases only after very careful investigation into the construction, length of life, class of service and cost per year of tank service of each tank, and appears to be a sound endorsement of the newer type of structure.

Modernizing Locomotives.

About 1890-5 there were locomotives of the 4-4-0 class. One of them weighed about 116,000 lbs. and had a load of 74,500 lbs. on the driving wheels. This engine developed a tractive effort of 21,290 lbs. To-day a locomotive, recently built, with two cylinders, a single group of driving wheels, develops a tractive power of 84,500 lbs. That is about 3½ times as much as the 4-4-0 engine. Thus is progress exemplified. In Europe the high cost of fuel directed attention to the possibility of greater efficiency and the various savings which might be effected. This viewpoint was sooner reached in the older countries than it was here, and led to many improvements, but our progress has been substantial and rapid when once it had got under way.

Among the various things which have been done in the United States was the introduction of the superheater. This appliance has added greatly to the efficiency of the locomotive, and by that we mean that it is enabled to make more ton-miles and make them faster than the same engine would if not equipped with a superheater. The steam that is generated is heated, so that cylinder condensation is not permitted to restrict the good use that is made of the steam supplied to the cylinders; and when to the advantage gained by the employment of superheated steam, there is added a carefully worked-out design of valve gear; a very long step toward the desired end, has been taken.

Formerly the capacity of an engine was, as mathematicians would say, a function of the physical power and endurance of the fireman. The mechanical stoker, however, has altered all that. Take for example the Street automatic stoker, by test it was found that a good fireman was able to shovel from 2½ to 3 tons of coal an hour, while the mechanical stoker was almost without limit, though in practice, from 5 to 6 tons an hour is usually satisfactory. The use of the mechanical stoker proved that even the restricted area of the grate, often not larger than a good sized dining room table, had not been used to its full value.

Pulverized fuel has lately been shown as a very valuable steam producer, and a company having the matter in hand has by the design of a thoroughly workable appliance, shown that what gave excellent results in stationary practice, was not only available for locomotive use, but was an economical steam producer of exceptional value. In this connection one is led to regard the firebrick arch, which is required where cheap, otherwise waste coal, is used. This arch appliance has a wide and beneficial function to perform in the firebox of any engine. It prevents waste of coal by combining the oxygen of the air with the carbon of the coal, in the flame surging in the firebox, and so brings about better combustion. In fact the brick arch produces combustion so thoroughly that the powerful draft created by the exhaust steam does not draw through the flues a dense black cloud of unburned gas, but the carbon is thoroughly consumed in the white-hot hurricane of flame that the blast produces. The rapid escape of particles of unburned carbon is checked, and the baffled gases give up much more heat than can be extracted from the coal on the grate, when burned in the usual way. A definite quantity of coal, giving out a definite quantity of heat, when burned with the arch in place means more water turned to steam with a larger liberation of heat, from the definite supply of coal.

Just here the use of the automatic fire door may be made to add its quota to the general economy so far attained. The opening of the fire door for however brief a time produces an undesirable result. It allows cold air to enter above the grates and reduces the flow of air through the layers of coal lying on the grates. This has the result of directly checking some part of the advantage gained in other ways and militates against the economies of good hand firing and the effect of the brick arch. It does not by any means destroy these advantages, but it has a tendency to reduce them, and the longer the door is kept open the worse it will be. A fireman doing his best to close the door quickly nevertheless nullifies part of the economy he has produced by his good firing. The automatic door closer does that work far better and quicker than he can do it, and so reduces to a minimum what there is of waste by the comparatively tardy operation of the door. Steam operated grate shakers are, in a sense, in the same class. A grate can be quickly shaken on the road and any desired amount of shaking can be had, and any section of the grate can be shaken independently of the others. This appliance does its work well, and incidentally relieves the fireman of much physical exertion; while at the round house the quick and thorough shaking out of the fire that can be had by the steam operated grate shaker is inestimable. It permits quick turning of an engine and easily and satisfactorily assists in getting the engine ready for a return trip. An engine on the road is worth far more as a money earning machine than two in the shop.

The feed water heater is an important revenue producer for very obvious reasons. Water open or free to the air boils at 212 degs. Fahr., and if water is heated by otherwise waste steam, a corresponding reduction of the heat required to boil it, under pressure, is a manifest economy, just as painting a house already primed must use up less material than if the priming coat had to be bought and applied. The feed water heater is efficacious on the well-known economic truth that the use of a by-product is the surest way to wealth. The heat-containing steam, which would otherwise escape as an unused by-product of locomotive operation, when turned to account is made to yield its heat to cold water, and insofar as it accomplishes this, it reduces the amount of coal burned in the firebox to produce a given result.

Force feed lubricators ensure positive lubrication. With their use there is no doubt that the lubricant gets to the place where it will do most good. Any pressure of steam getting into the oil pipes, from whatever cause, does not hold back the oil which is forced to flow in one direction only. Pockets in the pipes offer no permanent obstacle to the flow of oil. The work the oil is sent to do, it must do, and its reliability and its steady flow leave little to be desired. Flange lubricators reduce friction on curves especially. They reduce wear of flanges and though seemingly of small importance, as far as any one curve is concerned, they are beneficial, and the effect of the oil is cumulative and the action of the force feed lubricator when spread over a period of time brings down the power required to drive an engine round a curve, and as this power is derived from steam, and the steam requires the burning of coal, a positive and at least measurable amount of fuel saving must be placed to the credit of the lubricator.

(Continued on page 210.)

Mallet Articulated Locomotives for the Philadelphia & Reading Railway

The Philadelphia & Reading have recently received, from the Baldwin Locomotive Works, six Mallet locomotives of the 2-8-8-2 type, which develop a tractive force of 98,400 lbs. each and are used in heavy freight and pushing service on 3 per cent. grades. These locomotives are of special interest, because of the restricted clearance limits imposed. The height limit is 15 ft., and the width limit over the low pressure cylinders is 11 ft, while the width over the running boards does not exceed 10 ft. 8 ins. The boiler center is placed 9 ft. 9 ins. above the rail, and this comparatively low elevation has increased the difficulty of working out some of the details of the design.

The boiler is of the Wootten type, which is standard on this road, and it is one of the largest Wootten boilers thus far built, as it has a diameter at the throat of 102 ins., and a grate area of 108 sq. ft. It is designed for a pressure of 225 lbs., but in service the safety-valves are set at 210 lbs. The total equivalent heating surface is 7,901 sq. ft. The designer incorporates a combustion chamber 46 ins. long, and a brick wall, 26 ins. high, is built across the throat of this chamber. The equipment includes a Street locomotive stoker and Franklin power-operated fire-door and grate shaker. The grate is divided into three sections by two longitudinal bearers. The bars in each side section are connected so as to shake in three groups. In the central section, there are drop plates at the front and back, and the bars between the drop plates are connected to shake in two groups. The ash-pan has three hoppers, two of which are placed outside the frames, between the rear driving-wheels and the trailing truck. The fire-door opening is single, and has a width of 35 ins. The dies used in flanging the firebox sheets and back-head are the same as those used for the Mikado type locomotives now on this road.

Owing to the restricted clearance limits, it was necessary to mount the safety-valves in a specially designed casting, which projects downward into a 26-in. circular opening in the boiler shell. This opening is placed just ahead of the combustion chamber. The main dome is of pressed steel and is 10½ in. high. The whistle is placed in a horizontal position, and its connection is tapped directly into the boiler shell.

The throttle is of the Rushton type, with auxiliary drifting valve. The throttle lever is placed in a vertical position on the right-hand side of the cab, and is connected to the throttle stem through a transverse rotating shaft. Piston valves, 14 ins. in diameter, control the steam distribution to all the cylinders, and the valve gears are of the Walschaerts type. The front and back reverse shafts are supported on the guide bearers, and are bent to clear the boiler. A single reach rod, placed on the center line of the locomotive, connects the front and back reverse shafts. This arrangement, which is regularly used on Baldwin Mallet locomotives, occupies but little room, and is particularly convenient on an engine where the clearance is restricted, as it is in this case. The Ragonnet reverse gear is used.

The high pressure pistons are of box form, while the low pressure pistons have cast steel dished centers, with cast iron bull rings, bolted on. The bull rings are widened at the bottom, to give ample bearing area, and no extension piston rods are used.

The forward frames are stopped just ahead of the leading driving pedestals, and are bolted and keyed to a large steel casting, which supports the low pressure cylinders. The forward equalizing beam is fulcrumed underneath this casting. The forward equalization system divides between the second and third pairs of driving-wheels. As there is not room to place springs over the boxes of the first and second pairs of wheels, beams are mounted over these boxes and the frames are supported on inverted leaf springs suspended from the beams. The forward, central equalizer is connected to the beams over the front boxes through a half-elliptic spring which is placed in a transverse position. This arrangement was adopted instead of using springs over the front driving boxes.

The radius bar, which connects the front and rear frames, is attached to a horizontal pin secured to the front frames, and has a ball-jointed connection with the hinge pin. This arrangement, which is covered by a patent, has been applied by the builders to a number of articulated locomotives recently built by them. In the engines now under review, the frames are not interlocked in any way; so that the articulated joint has maximum flexibility in both horizontal and vertical directions.

There are four sand boxes, two for the front group of wheels and two for the back group. The boxes are placed right and left on the round of the boiler, and the bell is similarly situated on the right-hand side. Front bumper steps are provided instead of a pilot, and the equipment in this respect is in accordance with the requirements for switching service.

The detail parts of these locomotives are designed to interchange, where practicable, with those of the Mikado type engines on the Reading. The following parts were furnished by the Standard Steel Works Company: Connecting rods, driving axles, piston rods, stub straps, crank pins, driving tires, smoke-box rings, springs, tender wheels. The dimensions are given in the table:

General—Guage of track, 4 ft. 8½ ins.; cylinders, 26 ins. x 40 ins. x 32 ins.; valves, piston, 14 ins. diam.

Boiler—Type, Wootten, conical; diameter, 90 ins.; thickness of sheets, 15/16 in.; working pressure, 210 lbs.; fuel, hard and soft coal mixed; staying, radial.

Fire Box—Material, steel; length, 144¼ ins.; width, 108¼ ins.; depth, front,

2-8-8-2 TYPE LOCOMOTIVES FOR THE PHILADELPHIA & READING RAILWAY.

I. A. Seiders, Supt. of Motive Power. Baldwin Locomotive Works, Builders.

84½ ins.; back, 65½ ins.; thickness of sheets, sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ⅝ in.

Water space—Front, 5 ins.; sides, back, 4 ins.

Tubes—Diameter, 5½ and 2¼ ins.; material, 5½ ins., steel; 2¼ ins. iron; thickness, 5½ ins. No. 9 W. G.; 2¼ ins. No. 11 W. G.; number, 5½ ins., 50; 2¼ ins., 277; length, 23 ft. 0 ins.

Heating surface—Fire box, 264 sq. ft.; combustion chamber, 94 sq. ft.; tubes, 5,389 sq. ft.; total 5,747 sq. ft.; superheater, 1,436 sq. ft.; grate area, 108 sq. ft.

Driving wheels—Diameter, outside, 55½ ins.; journals, main and others, 11 x 13 ins.

Engine truck wheels—Diameter, front, 33 ins.; journals, 7 ins. x 11 ins.; diameter, back, 33 ins.

Wheel base—Driving, 39 ft. 8 ins.; rigid, 15 ft. 0 ins.; total engine, 55 ft. 10 ins.; total engine and tender, 83 ft. 2½ ins.

Weight—On driving wheels, 435,200 lbs.; on truck, front, 23,000 lbs.; on truck, back, 20,300 lbs.; total engine, 478,500 lbs.; total engine and tender, about 630,000 lbs.

Tender—Wheels, number, 8; diameter, 36 ins.; journals, 6 ins. x 11 ins.; tank capacity, 8,000 gals.; fuel, 13 tons; service, freight.

Practical Elimination of Corrosion in Hot Water Supply Pipe

Mr. F. N. Speller, Metallurgical Engineer, National Tube Co., recently read a paper before the American Society of Heating and Ventilating Engineers. He said, among other things:

In discussing the general principles of the mechanism of corrosion, the writer pointed out on a previous occasion the wide difference in durability found with the same kind of pipe in different kinds of service, and how this difference had been noticed in the same class of service by varying the conditions of heating so as to remove more or less of the free oxygen from the water. Free oxygen and carbonic acid in water have been proved to be the cause of practically all the trouble with hot water supply lines, as these gases are retained in the water with the closed systems of heating used almost universally in this country. Two methods of removing these gases from water, giving the percentage removed under various conditions, were: (1) by reducing the pressure of the heated water—for example, by the use of an efficient "open" type heater under atmospheric pressure, or partial vacuum, and (2) by keeping the hot water in contact with a large surface of iron under pressure for a sufficient length of time to remove and "fix" the oxygen and carbon dioxide.

The latter principle has been in use at two plants during the past year: at the Research Laboratory and Hospital Building, National Tube Company, McKeesport, Pa., and at the Irene Kaufmann Settlement, Pittsburgh, Pa. Both installations have demonstrated that the corrosion of iron or steel pipe can be arrested and practically eliminated by this process.

The course of the water circulating between the heater and storage tank and the temperature of the filter is maintained the same as the water in storage. Where circulation of hot water has to be maintained in buildings, the outlet line can be taken up through the filter bed and the return connected in at the bottom of the filter.

In one plant discs of "Cambridge" metal lath were used. Strips of this or other suitable form of sheet iron may be used provided it is spaced so as to fill the chamber and yet leave a cellular structure with openings not over one-quarter or three-eighth inch through which the water can freely circulate. Rust occupies a space several times that of metallic iron and this must be provided for.

The average daily consumption of treated hot water in the Kaufmann Settlement varied from 600 to 1,200 gals. In the other system using untreated water somewhat less was used. The normal temperature of the hot water is 170 deg. Fahr.

The original piping in this building was about worn out at the time the present system was installed; in fact, this was the main reason for selecting this location for these experiments. Once rust starts, the action is usually accelerated, so that the arresting of corrosion in old pipes is of great significance and promise.

It is, of course, necessary to filter the fine rust out of water so treated before use, and it is also necessary that the filter be so designed in connection with the heater as to be kept hot when no water is being drawn.

The Settlement was built in 1910, using wrought iron and steel pipe for the hot and cold water lines with storage tanks and gas heaters. All the hot water piping was showing signs of serious corrosion by 1915, a number of pieces having already been replaced with brass pipe. Every week or two replacements and repairs had to be made.

With the approval of the directors, a new hot-water heating system, to supply the residence and laundry alone, was put into use, December, 1915. This consisted of a storage tank filled with alternate pieces of corrugated and plain steel sheets, No. 26 gauge, arranged radially around a filter. The water was heated by a Stewart heater passed downward between these plates, being thereby deoxidized to a large extent. The water then flowed upwards through pipes to the top of the filter and downwards again through the filter and finally up through the central pipe to the system. The return with check was brought into the bottom of the chamber underneath the filter bed.

The Pittsburgh Testing Laboratory was employed to make tests at this time, December, 1915. The relative corrosion of pieces taken from the same length of pipe, with and without treatment, indicated the results obtained by eliminating this amount of oxygen from the water. The pipes carrying deoxidized water were in use a month longer and carried 50 per cent. more water but showed from 62 to 85 per cent. less corrosion, based on the deepest pitting in the pipe carrying untreated water. The best results were found with the steel pipe, which had the least amount of mill scale on the inside surface. There was no practical difference between the best grades of so-called "genuine" wrought iron and steel pipe under these conditions.

These Pittsburgh Testing Laboratory experiments also indicated that water, which has been in contact with the plates in the deoxidizer, still carried considerable gas in solution, but that this gas consisted mainly of hydrogen and nitrogen. The hydrogen frequently ran as high as 20 per cent. The oxygen in untreated water frequently runs as high as 26 to 30 per cent. of the volume of dissolved gases.

It is also of interest to note from the gas analyses and oxygen determinations made from time to time that the rate of removal of oxygen has not diminished with length of service. Plates which were removed from the McKeesport plant after eight months' service had a thick layer of rust over the surface, but the efficiency of the tank was even greater after use.

The question as to how long these plates will last often comes up. That depends on the quantity of water treated. Assuming the raw water contains 9 c.c. of free oxygen per liter and is completely deoxidized, from the analysis of the rust formed, about 220 lbs. of iron will be used up in treating 1,000,000 gals. of water. At this rate and figuring the cost of sheet iron scrap at 2c. per lb., the cost of material for deoxidization of water is well within the usual cost of chemicals for the treatment of boiler water.

Rebuilding French Railroads.

The pressing need for American engineers, railroad men and technical workmen to help rebuild the railroads, canals and highways of the devastated regions of France is emphasized in a report just made by Albert Claveille, Under Secretary of Transportation.

Railway Water Supply

Consumption and Cost—Lakes and Ponds Furnish the Best Water

Mr. C. R. Knowles, superintendent of water service on the Illinois Central Railroad, recently spoke on this subject to the members of the New York Railroad Club. Among other things he said: The estimated annual consumption of water by locomotives alone on the railroads of the United States is 450,000,000,000 gals. The cost of furnishing this water, not including maintenance, interest and depreciation of water stations, is over $16,000,000 per year. Water for other than locomotive supply is not included in these figures. Assuming the water stations to be spaced an average distance of 20 miles apart, it is necessary to maintain nearly 13,000 water stations to supply the water required by more than 60,000 locomotives hauling 1,000,000,000 passengers and 2,000,000,000 tons of freight annually. The twelve reservoirs in the Croton water shed, which supply New York City with water, with a storage capacity of 104,443,000,000 gals., would furnish our railroads with water for about two months.

The consumption of water by locomotives will vary greatly with existing conditions, such as the power and speed, the curvature, gradients and tonnage of trains, also condition of rolling stock and track and the ability of the engineer and fireman. A test made showed the following:

Consolidation Locomotives:
Water used per engine mile...219.6 gals.
Water used per 100 gross ton miles .... 17.3 gals.

Mallet Locomotives:
Water used per engine mile...257.6 gals.
Water used per 100 gross ton miles ....14.25 gals.

Mikado Locomotives:
Water used per engine mile...202.5 gals.
Water used per 100 gross ton miles .... 10.1 gals.

The Mikado engines were given the preference in fast freight runs and this service permitted of greater economy in fuel and water.

An analysis of the use of 4,550,000,000 gals. of water on 2,000 miles of road indicated that locomotives consumed 74 per cent. of this amount or 3,367,000,000 gals., washing and filling boilers at terminals used 16 per cent., amounting to 728,000,000 gals.

As an example of the enormous increase in the consumption of water by the railroads during the last quarter of a century, a compilation of the figures showing the water consumed at a railroad in central Illinois may be cited. The amount used at this point in 1895 was 72,000,000 gals., while in 1905 it had increased to 141,404,000 gals., and in 1915 to 238,630,000 gals. According to these figures, the consumption has practically doubled every ten years. It may be said in passing, that the consumption in 1915 was 42,000,000 gals. less than that of 1914 because of a campaign against water waste.

While water supply is among the most important requirements, it has perhaps received less consideration than almost any other department, many railroads being apparently indifferent to the necessity for more economical and serviceable installations. While many of the water stations constructed 20 years or more ago are still in use, the expense for maintenance and operation is often excessive and an adequate supply uncertain. With freight trains on important trunk lines of low gradients loaded with 2,000 to 5,000 tons and engine tender storage of 9,000 and 10,000 gals., the development of a water supply may certainly be classed among the most important features of modern railway operation.

In the selection of a railway water supply, two important features are to be considered: first, the water must be satisfactory as to quality, and, second, it must be available in sufficient quantity. To secure an ample supply of satisfactory water, it is often necessary to pipe it from a distance. If water from surface supplies is not available within a reasonable distance, consideration should be given to water from ground sources, or from impounding reservoirs, if a suitable location may be found.

Streams usually carry considerable matter in suspension and the problem of protecting the intake lines from mud, sand, leaves, etc., is quite important. The matter carried in suspension by the water of streams may be readily removed by settling basins or filtration and the water is usually of a good quality, except where the streams are polluted by sewage or industrial wastes. Smaller streams are often affected by organic and vegetable matter, especially after a prolonged dry period, followed by light rains, which bring the deleterious matter into the streams, but do not flood the streams so as to carry the impurities away. This condition accounts for a great deal of the trouble experienced from foaming and pitting by water that is usually considered good water.

The smaller lakes and ponds usually offer the most favorable conditions for establishing a pumping station, both as to construction and in quality of water. They are little affected by storms, and while the quality of the water of the large lakes is uniformly good, the effects of currents and storms sometimes cause a great deal of turbidity and sewage pollution, as well as stoppage of intake, if the intake is near the shore. Very few, if any, intakes of railway water stations are far away from shore or breakwater, and as the shores of lakes in the vicinity of cities are being constantly extended, chiefly through the dumping of rubbish, these intakes are a constant source of trouble and expense.

A well is not always the most satisfactory method of securing water, as where the head is far below the surface, the cost of raising the water is excessive, but surface conditions are often such that the only available water supply is secured from wells. Well waters, as a rule, are pure and clear, although many are very hard. A hard water is not objectionable for drinking purposes, but is unsatisfactory for boiler use.

The general tendency of railroads has been to attempt to standardize the pumping equipment, it being assumed in many instances that if certain equipment gave good results under certain conditions, that it should be adopted as standard and used in all cases, regardless of local conditions. While it is desirable to adopt certain standards as applying to water supply, such as tanks, pump houses, etc., it is a mistake to include the pumping equipment in such standardization. In the selection of pumping equipment, much is dependent upon the source of supply, local conditions, available fuel and existing facilities. While fuel consumption is the most important factor in pumping efficiency, it often represents only a small part of the cost of operation. In many instances, attendance and interest and depreciation charges may make up the greater part of the operating expense. Steam is most commonly used in pumping water and is economical or otherwise, according to whether the installation is near a source of fuel supply.

Gasoline engines, while not the most economical pumping units, are even less so with the increased cost of gasoline and the expense of operating these engines. Gasoline engines now in service may be converted into oil burning engines by the use of attachments for vaporizing the heavier oils before they enter the cylinder. Oil engines of the Semi-Diesel type are being used extensively in railway water service and are proving very economical power units. Oil engines are more restricted than steam pumps and their use is necessarily limited to a certain extent, particularly where there is a wide range of duty, as they will not operate successfully under an overload and providing excess power cuts down the efficiency. They are coming into greater favor as the centrifugal pump is being developed, as an oil engine and centrifugal pump make an ideal installation under favorable conditions.

Cast iron pipe is undoubtedly preferable to either wrought iron or steel pipe for underground water mains because of its greater resistance to corrosion. There are considerable data on the life of cast iron pipe, which go to show that it is good for 100 years under almost any ordinary soil conditions. Suction lines are subject to rapid decay and the increased life to be obtained from wrought iron pipe will fully justify its use for this purpose. Too much stress cannot be placed upon the maintenance of pipe lines. We are inclined to overlook this feature, for the reason that they are, for the most part, underground, but if they were brought to the surface and their true condition realized, it would doubtless prove an instructive but very unpleasant surprise.

Up to within the past few years, standard tanks rarely exceeded a capacity of 50,000 to 60,000 gals., while the tanks on many lines today include tanks holding 100,000 to 150,00 gals., and even 200,000 gals. While the tendency toward larger tanks has been marked, the development along this line has been all too slow and the efficiency of the water service impaired to a great extent by limited storage. The construction of large tanks has been retarded to some extent owing to permanent location, on account of the possibility of track changes and other construction features. By installing penstocks, it is possible to select a permanent location for a tank, remote from the track and out of the way of future construction. In addition to permitting a more satisfactory location of the tank, a penstock offers many other advantages, as it does not obstruct the view of signals, etc., offers better drainage and gives less trouble from soft track and ice in winter.

All natural waters contain more or less foreign matter, either in suspension or solution and the relative degree of purity is dependent on the locality in which they originate. It is unnecessary to detail here the disadvantages of a poor water, as they are only too apparent on our railroads. The American Railway Engineering Association estimates a saving of 7 cents per pound for incrusting matter kept from entering the boiler. In arriving at a cost of 7 cents for incrusting matter, the committee realized that the benefits derived from water treatment are numerous, but usually of an intangible nature However, valves were placed on four of them—loss of fuel resulting from the insulating effect of the scale, renewal of flues, repair work on flues and boilers in the roundhouse and the loss of engine time during repairs. On account of its intangible nature, the reduction of engine failures was not considered in determining this figure. It has been found that the average cost per engine failure, exclusive of labor and material for repairs, amounts to $17, and on one division the engine failures resulting from boiler troubles were cut down over 1,000 per year by the treatment of the water, thereby giving saving in this one item alone of $17,000. From this it is seen that 7 cents is very conservative.

There are two methods to be followed in the treatment of boiler water. It may either be purified by treating plants before it enters the boiler, or it may be treated inside the boiler by the use of compounds. Concerning interior treatment, while in the case of stationary boilers conditions are favorable for the use of compounds, the interior of a locomotive boiler is so small in proportion to the steaming capacity that there is a definite limit to the permissible viscosity of the water. Time for reaction is a factor also and as a general thing interior treatment would appear inadvisable. The proper treatment is by means of a purifying or softening plant before the water enters the boiler.

Water is generally considered as free as the air we breathe and much of the waste is due to carelessness on the part of employees who fail to realize its cost. This lack of co-operation, due to ignorance of the vàlue of water, sometimes aided and abetted by departmental views and jealousies, causes thousands of dollars expense. American railroads consume daily approximately 1,750,000,000 gals. of water, at a daily expense of about one hundred thousand dollars. These figures should be enough to convince almost anyone that water is not free, and that a saving in water is quite as important as a saving in coal, oil or other supplies. It is safe to say that 15 per cent. of all the water used by railroads is wasted. By waste is meant that quantity of water drawn in excess of the amount actually required.

Large quantities of water may be wasted in taking water at tanks and penstocks. A conservative estimate of the total cost of this waste per annum is $60 per tank or 5 per cent. on $1,200 and will pay the interest and depreciation on the cost of construction of a new 100,000 gallon tank at each station in five years.

One of the most expensive sources of water waste is at engine houses, in connection with the use of boiler washout hose and valves. The water used for washing locomotives invariably has to be handled twice to secure the high pressure necessary to properly wash locomotive boilers. The average cost for such water is in excess of 10 cents per 1,000 gals. A boiler washout hose, with a one-inch nozzle, at 100 lbs. pressure, will easily waste 12,000 gals. of water per hour at a cost of $1.20 to $1.50.

Laws prohibiting the use of public drinking cups have made the bubbling drinking fountain a necessity, but the makeshift affair commonly constructed of half-inch to one and one-half inch pipe and flowing constantly, is an abuse to this system of providing drinking water in a railroad shop and wastes from $150 to $350 per year for each fountain. A single bubbling fountain, with a quarter of an inch opening at 25 lbs. pressure, will deliver 425 gals. per hour, which would furnish ample drinking water for 10,000 men and allow 50 per cent. waste. The only satisfactory way to control this waste is to restrict the size of opening and equip all fixtures of this kind with self-closing valve.

Yard hydrants for sprinkling, filling car tanks and coach yard service also cause a heavy waste of water. A one-inch hydrant of this type will waste from 20 to 30 cents worth of water per hour, or $5 to $7 per day. Forty or fifty of these hydrants are often installed in a single coach yard and, as there are nearly always a number of them open and running, the loss is enormous.

Leaking or improperly adjusted valves in toilet flush tanks will waste from $3 to $50 per month for each battery, depending on the number of fixtures and cost of water. A case was found recently where toilet facilities at a large terminal were causing a loss of over $400 per month. In another instance, the loss was over $150 per month. The trouble was corrected by cutting down the waste of water and the saving at these two points alone amounts to $10,000 per year. Another source of waste is through leaks in underground mains. These underground leaks are not always easy to detect, for, if the pipe is laid in a porous formation or near sewers, the water finds a ready outlet without reaching the surface. The saving effected in handling cinders with modern cinder pit facilities is often destroyed by the waste of water by hose connections.

As an example of what may be accomplished by a campaign against water waste the Illinois Central System reduced the expense for city water by $34,573.79. The expense for city water was further reduced during the year ending June 30, 1916, to $174,101.31, showing a reduction in the cost of city water in two years of $85,695.42. This is a net saving, all of which has been accomplished by the elimination of water waste.

With the exception of a few of the larger railroad systems, no distinct water departments are maintained. On the majority of roads the development of water supply and design and construction of water stations is handled by someone in the Engineering Department in connection with other duties, while the maintenance and operation comes under the supervisor or foreman of bridges and buildings, whose principal duties are along other lines.

The investments necessary to provide improved facilities, together with the cost of pumping and properly treating the large quantities of water required, represent such heavy expenditures that more careful and extensive investigation should be given the subject of water supply, with a view of greater economy and more satisfactory service. To accomplish the desired results, a well organized water department is necessary. The organization of such a department does not necessarily mean a heavy additional expense for salaries, etc., but rather the reconstruction of the existing organization, placing the forces used in water service on a definite basis, with a supervising head directing the energies of the department in the proper channel. In fact reorganizing the water service forces as a distinct unit would, on many roads, effect an actual reduction of force. That there is an urgent necssity for such an organization has been proved by the results obtained by the roads which have established a department to handle this very important feature of railroad operation.

At the Mt. Clare Shops of the Baltimore & Ohio

Extensive Installation of Automatic Machines—Complete Modern Equipment—Able Personnel

An extensive installation of automatic machines has been made in the Mt. Clare shops of the Baltimore & Ohio Railroad, Baltimore, Md. These embrace 12 Potter & Johnston Machine Company's automatic chucking and turning machines, piston and piston ring machines, screw shaving machines. There are 7 single spindle and 4 four-spindle Gridley automatic and semi-automatic machines, furnished by the National-Acme Manufacturing Company, Windsor, Vt. There are also 2 New Britain automatic spindle chucking machines.

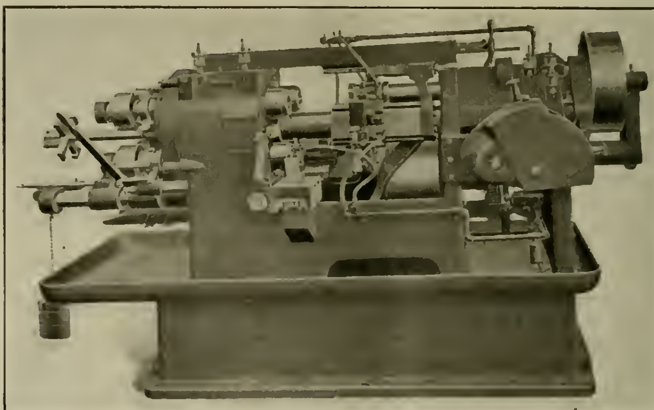
These machines are designed for the manufacture of many of the smaller appliances of the modern locomotive, and embrace such articles as air pump piston heads, piston packing rings, valve bull rings, link motion bushings and pins, globe valves, drain and cylinder cocks, wash-out plugs, oil cups and caps for link motion, side rod grease cups and similar appliances.

In observing the various processes through which any of these or other articles passed from the rough casting or forging to the finished product, the most striking feature of the operations was the almost complete absence, in nearly every instance, of manual labor. Then the degree of rapidity and the perfect finish of each part left nothing to be desired. In regard to Potter & Johnston machines, whose works are located at Pawtucket, R. I., one attendant was operating a battery of six machines, and the work done by hand was of the simplest kind—placing the piece in the chuck or on the arbor, and removing the finished product. A feed and speed table is attached to each machine, directing the proper speed and feed gears for any parts to be handled by the machines. The turret containing the stations upon which the tools are bolted, is advanced, revolved and returned automatically with a comparatively small loss of time, and when the turret slide has advanced to the cutting point of the tools, the feeding motion is automatically thrown in. On the machine shown in our illustration the turret travel is 9 inches, sufficient to permit of having all turret tools piloted in a bushing mounted in the chuck before the actual cutting operations commence. The machine is possessed of great rigidity. Either belt or motor drive is applied to these machines—a bracket being bolted upon the base of the larger machines, upon which the motor is mounted, substituting for the driving pulley a clutch gear, which meshes into the pinion on the motor shaft.

The Gridley piston and ring machines are semi-automatic, especially designed for making pistons and piston rings. They turn the outside of the ring's eccentric at the same time that the insides of the rings are being bored concentric. They are adapted for the smaller sizes of piston rings.

It can be seen at a glance the great advantage in the design of these machines over the earlier forms, as they not only control the absolute accuracy of the product, but also its adaptability to work that has heretofore to be made on hand-operated turret machines, but which can now be made by Gridley automatics. It may be added that the machines generally are made in three sizes, and are especially serviceable for the smallest as well as the largest kinds of locomotive work. A semi-automatic machine is one in which the rough piece of work is placed in the chuck by the operator and on which all of the various operations, such as turning, drilling, boring, tapping, facing, etc., are automatically performed, as well as the rotating of the turret; that is, the machines are fully automatic, except putting the unfinished piece of work into the chuck by the operator.

Special reference may be made to the New Britain machines and their superb structure and operations. In the machining of cylinder cocks on what was known as a Libby machine with five heads attached to the turret, the operator removed the finished part and inserted another rough casting in one head, while four operations were going on simultaneously, including boring, tapping, facing and cutting the valve seat at the rate of one per minute at a cost of about 75 cents per hundred. This machine was the product of the New Britain Machine Company, New Britain, Conn., and while it is not our purpose to make comparisons looking towards favoring any particular maker, which would, indeed, be difficult where all were so rapid in producing the finished product and so uniformly perfect in



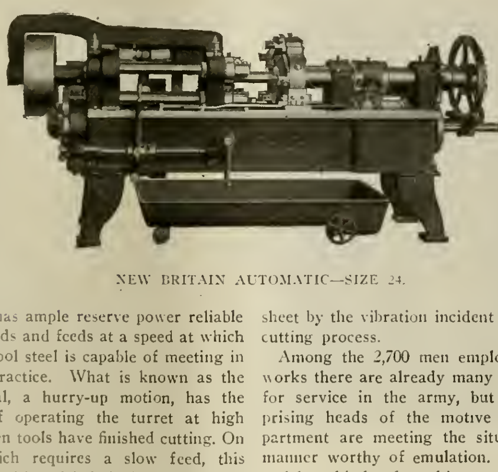
GRIDLEY MULTIPLE-SPINDLE AUTOMATIC.

finish, a marked peculiarity of the New Britain machines is their adaptability to an extensive variety of work. They are also adapted to engage a combination tap and die head, a very ingenious appliance that may be fitted to all machines for cutting internal and external threads of different diameters and pitches on the same end of a piece of work at the same time. The tap is fastened directly to the sliding spindle and threads according to the pitch. Both tap and die have their own starting levers and cams, so that they are entirely independent of each other, with the exception of driving.

The illustration showing the New Britain automatic, known as size 24, is of the single head type, with four working spindles and five chucking positions. This machine is adapted for service on an endless variety of parts, including air brake and general locomotive parts, nearly all kinds of valves, unions and steam fittings, up to and including 2-inch taper pipe sizes, as well as all the lighter appliances used on motors. It is rigid in construction and has ample reserve power reliable in all speeds and feeds at a speed at which the best tool steel is capable of meeting in modern practice. What is known as the differential, a hurry-up motion, has the quality of operating the turret at high speed when tools have finished cutting. On work which requires a slow feed, this hurry-up with quick indexing greatly increases the rate of production. In case the machine is used on brass work with a very coarse feed, the differential can be thrown out of action by removing the high-speed shifting dog. This fine machine is coming rapidly into popular favor.

The introduction of the new machines with their amazing output seemed infectious, so much so, that W. S. Eyerly, foreman of No. 2 machine shop in the Mt. Clare works, contrived a rapid method of turning out boiler wash-out plugs. By the old method of turning on lathe centers, they had cost about 4 cents each. By adjusting an appliance to hold the square head of the plug on the revolving end of an ordinary lathe and a moveable piston actuated by compressed air on the other end, the plug was held at once with sufficient degree of tightness, and the screw cutting tool passed rapidly along the outer face of the casting, the plug was completed without any centering or dog-fastening, and the price of product reduced to 75 cents per hundred.

The oxy-acetylene and electric welding processes were much in evidence. Broken and cracked cylinders had a brick arch built over them and submitted to a heating process that lasted for many hours, when the oxy-acetylene torch was applied with rapid and satisfactory results. The cylinders were rebored and machined and no further failure recorded. The electric torch was being used in welding the studs on smoke-box front ends, instead of drilling and tapping and applying nuts to the inner projecting ends of the studs. The oxy-acetylene seemed to be the favorite method of welding in general boiler repair work. We observed an improvement in cutting off the projecting ends of boiler studs by the use of the oxy-acetylene torch, instead of cutting with a chisel, which frequently had the effect of slightly damaging the thread in the sheet by the vibration incident to the cold cutting process.



NEW BRITAIN AUTOMATIC—SIZE 24.

Among the 2,700 men employed in the works there are already many enlistments for service in the army, but the enterprising heads of the motive power department are meeting the situation in a manner worthy of emulation. The latest and best kinds of machines are being installed and the most approved methods are adopted. Mr. F. H. Clark, general superintendent of motive power, is the right man in the right place, while Mr. L. Finegan, the shop superintendent, is possessed of the rare faculty of getting the best out of the skilled mechanics. Mr. R. Bowler, a young engineer of marked ability, had charge of the new machines and was familiar with every detail of their intricate construction, and has the fine quality of imparting his mastery of details to others. In brief, the Mt. Clare shops of the Baltimore & Ohio Railroad are not only models in structure and appliances, but examples of accomplishment that would be difficult to surpass, while the faces of the skilled mechanics were illumined with the joy of contentment.

The Railroads' Supreme Patriotic Duty

How the railroads can do more work with existing facilities is set forth in an eight-page official bulletin just issued to all the railroads of the United States by the Executive Committee of the American Railway Association's Special Committee on National Defense. The appeal is forcefully eloquent and eminently practical; rules are presented categorically how motive power may be conserved; the prompt repairing of cars is insisted upon; the importance of train-loading is pointed out, and the intelligent use of embargoes is explained, all looking towards meeting a great national emergency, calling for the best of which we are capable. The committee, of which Fairfax Harrison, president Southern Railway System, is chairman, together with the other members, including Howard Elliott, of the New Haven; Hale Holden, of the Burlington; Julius Kruttschnitt, of the Southern Pacific, and Samuel Rea, of the Pennsylvania, are doing an admirable work, and we know that their earnest appeals to the railroad men to rise to the full measure of their patriotic duty will not be made in vain.

Pulverized Fuel on Canadian Engines.

The Prairie Provinces of the Dominion have large deposits of coal, but much of it has hitherto been unsuitable for railway fuel for locomotives. During recent years experiments have been made respecting the use of pulverized fuel for locomotives. It has been used for several years in connection with certain kinds of metallurgical work and has been found of great economic importance. The tests made on locomotives show that the use of pulverized coal is as efficient if not more efficient than the ordinary method of burning coal, and, in addition it does not cause smoke, cinders, nor sparks. Its use is not only an economy, but would probably add to the comfort of the passengers.

The railway fuel problem in Central and Western Canada is an important one, and, considering the introduction of pulverized fuel on railways in the United States and the economy effected by its use, points to the time when engines equipped with the Locomotive Pulverized Fuel Company's apparatus may be used in Canada.

Safety Engineering.

The May issue of *Safety Engineering* is an exceptionally interesting number, containing among a large number of excellent articles, a paper on "Welded and Screwed Connections," wherein the relative strength of oxy-acetylene and screwed pipe connections as shown by hydraulic pressure tests are fully described.

The Operating Side of a Railroad

To Insure Promotion Requires Experience, Self-Confidence, Judgment, and an Assumption of Responsibility

By A. J. STONE, Vice-President of the Erie Railroad.

The Railroad Men's Improvement Society of New York have addresses of an improving character delivered periodically at their meetings. At the May meeting held in the Machinery Club rooms Mr. A. J. Stone, vice-president of the Erie Railroad, read the following address:

I have been asked to talk to you upon the subject of "The Operating Side of a Railroad," but as I reflect upon the net results of my own work during the past few months, as shown in the balance sheet, I am beginning to doubt the propriety of an attempt on my part to enlighten you, and I therefore ask for latitude in the premises.

You have favored me with the opportunity of addressing you, and I thank you very much for the privilege. I have kept in close touch with your Association through some of your members, and have had a genuine admiration for you all, because of your effort to improve your understanding of the conditions with which you are surrounded in your business. The many side lights which have been thrown upon the railroad work by those who have addressed you must be of great value to you, because each speaker has doubtless done his best to make his remarks interesting and instructive. Your organization is commendable and unique in that it is a self-supporting body with the single purpose of educational study, and the steady growth of your membership speaks volumes for the high character of the Association. I respect you for the effort which you are making, and if I am in a small degree able to say anything to you that will encourage you in your efforts or inspire you I shall be grateful for the opportunity.

Men need inspiration in their work. That does not apply to young men alone, but to both young and old. It seems to me the older I grow the more need I have for inspiration, and I have observed in my own case that as the years pass the enthusiasm of youth dulls to some extent and greater effort is required to shake off the tendency to become blasé.

The object of your society is self-improvement. Therefore, I have taken the liberty to speak of some of the principles which I have found valuable and which may be valuable to some of you in pointing the way in which your future success may be advanced. Edwin Markham, author of "The Man With the Hoe," says that "poor work breaks down character." That is a very true statement. A thing poorly done eats into one's self-respect and causes one to depreciate his own ability, and the cumulative effect of one poor job after another finally results in entire loss of confidence and unfits a man for the assumption of responsibility. Whatever the task at hand it should be done well, if for no other reason than to build up one's own character. We never know when a piece of good work may be taken notice of to our advantage, but we are almost certain that a job poorly done will attract attention and criticism.

Avoid giving an impression of being conceited. No man likes a conceited person, but conceit should not be confounded with self-confidence, as confidence is absolutely essential to success. A man must have convictions and then have the

A. J. STONE,
Vice-President, Erie Railroad.

courage to back those convictions. It is not immodest for a man of clear head and clean principles to fairly measure himself with his associates in his work. To constantly defer to other people's opinion brands a man as a weakling. On the other hand, a man must know when to defer and not permit his own convictions, no matter how strong, to render him non-amenable to properly constituted authority. A good soldier scrupulously obeys orders without the slightest indication of insubordination.

In the matter of promotion in the operating department, with few exceptional railroads, there is no established line of promotion. Men who have started in various branches of the service have reached the top—track laborers, station agents, yard clerks, firemen, brakemen, shopmen, switchmen, general office clerks, and many other; in fact, all other occupations of whatever nature have produced successful general managers who have passed on to executive office. Young men who have good character, good health, integrity, great energy and a well-balanced mind and disposition have developed their judgment to act, which is finally the key to successful work.

An important qualification which marks a man's work in the operating department is a willingness to assume responsibility. There is great difficulty in advancing men in the service who have not the self-confidence to take on responsibility or assume authority. Somewhere in the Good Book there is a statement to the effect that "To him that hath, shall be given." I do not believe that promise refers particularly to riches, but that it applies equally to the question of confidence to assume responsibility. A man who has good judgment and who knows he is right, and who is willing to back his knowledge with his action, will attract attention and will be given additional responsibility as fast as he is willing and shows his capacity for assuming it. Every official sooner or later finds it necessary to shift some of his responsibility and work to others, and if the man who shows capactiy for doing things is available he is pretty apt to get his share of the load. An example of this came to my notice some years ago. A good position was vacant in the general office of a railroad. The general superintendent wrote to each of his eight superintendents asking them to nominate a man for the place. Each superintendent looked over his men and picked out a man whom he felt he could recommend as competent. Each one had advanced himself in his individual work and seemed eligible for promotion. The general superintendent sent for each of them separately, sized them up, talked with them about their experience, etc., and finally asked them the question, if they thought they could handle the job. Seven out of eight either said they would try, they didn't know or they would think it over and let him know. They were evidently making an effort to be modest, believing this would be an evidence of merit. The eighth, although the youngest and least experienced of the lot, replied that he knew he could do the work satisfactorily and was anxious for the job. He got it and made a success of it, and some years afterward the general superintendent told him of the circumstances and why he had selected him for the place. This little narrative illustrates the value of self-confidence.

The railroads have been hampered by restrictions imposed by a hostile public through Congress, the various commissions and legislatures to the point where the business is in a precarious condition, and this condition is reflected in the comptroller's balance sheet. A business of the magnitude of ours, in which little new capital has been invested for the past several years, must necessarily have outgrown its facilities. Previous to the present period and for many years millions of dollars annually have been expended in additions and betterments to the railroads. This represented borrowed capital largely, although much of it came out of earnings. Of recent years the railroads' credit has been so impaired as to make it impossible to borrow capital with the result that the physical facilities have stood still while the country's business has constantly grown and is away beyond the railroads' ability to handle with efficiency or expedition.

The railroads are now before the Interstate Commerce Commission asking for an increase of 15 per cent. in rates. A few years ago a 10 per cent. increase was requested and flatly refused by the Commission. Later a more modest 5 per cent. increase was asked, and after many weeks of effort, during which manufacturers and business men supported the railroads' application, the Commission granted what amounted to between 3 and 4 per cent. increase. That was a mere drop in the bucket. Had the 10 per cent. originally asked been freely and quickly granted, a far different situation would have confronted the railroads and the public today. It would have been possible, out of the increased earnings, to have spent many millions of dollars in development work, and the facilities thus provided would have been available now to handle the business offered.

It is now a generally known fact that the reason the Germans did not reach Paris in August, 1914, was because the railroads failed to meet the military requirements. So with all the German efficiency in military matters, they failed in their railroad efficiency, and that failure has cost Germany dearly. Of course, it is probable that this country may never need railroad facilities as did Germany in 1914, but the lesson is there nevertheless, and our Government is now awakening to the importance of a better attitude towards this great industry. It may be that some of you do not fully understand to what extent the railroads are prepared to meet the military necessity of the Government. Let me first say that as badly as our railroads have been hampered they yet represent a most magnificent transportation machine, and one which is capable, under proper direction of meeting all military requirements. This would be accomplished at the sacrifice for a time of nearly all other business, but nevertheless it would be accomplished. It was freely predicted a few months ago that with the advent of war one of the first steps to be taken by the Government would be to take over control and operate the railroads, and it can be said to the credit of the railroad executives and directors of this country that they arose immediately to the necessities of the Government without the slightest coercion or threat of legislation. The railroads today stand ready to carry out the military and commercial requirements in time of war under a form of organization which is most satisfactory to the Government and to the public.

At a meeting of the presidents of the railroads of the United States in Washington, D. C., on April 11, 1917, the following resolution was adopted:

"Resolved: That the railroads of the United States, acting through their chief executive officers here and now assembled, and stirred by a high sense of their opportunity to be of the greatest service to their country in the present national crisis, do hereby pledge themselves, with the Government of the United States, with the Governments of the several States, and with one another, that during the present war they will co-ordinate their operations in a continental railway system, merging during such period all their merely individual and competitive activities in the effort to produce a maximum of national transportation efficiency. To this end they hereby agree to create an organization which shall have general authority to formulate in detail and from time to time a policy of operation of all or any of the railways, which policy, when and as announced by such temporary organization, shall be accepted and earnestly made effective by the several managements of the individual railroad companies here represented."

As a result of the above resolution there sits in Washington today a commission of five railroad presidents who have all of the authority of all of the boards of directors of all of the railroads in the United States so far as the use of the railroads may be required by the Government, not only as to the requirements for the movement of men and material engaged in warfare, but as to the commercial requirements for the transportation of material as best may meet the needs of warfare. This railroad organization which has been created in Washington, to which the railroads are pledged, makes it possible for a single board to utilize the freedom of all of the railroad mileage of the United States as though it were one system. The railroads have always, so far as has been in their power, responded to the needs ot the public in time of national crises, and in this instance the organization which has been developed is as complete as though Government ownership prevailed. There isn't a railroad executive in the United States who is not ready to salute and accept orders from this commission of his own creation. I have not heard a dissenting voice or opinion in regard to the wisdom of the course which has been followed. It must mean a great relief and satisfaction to the President of the United States, to Congress, and all those in authority, to know that by the spontaneous and united action of the railroad executives, the railroads of the country have been practically turned over to the Government with a satisfactory administrative organization, thus making it unnecessary for any of the energy of the President and of Congress to be devoted to the creation of a railroad organization to meet the requirements of the Government. If the manufacturers of material could muster themselves into so complete an organization as has been perfected by the railroads, a great load would be lifted from the shoulders of the Government at a time when every man in public life is overburdened with the responsibilities of office. We railroad men should all be inspired by the patriotic spirit which has actuated the organization of the railroads and the placing of same so completely at the service of the Government without the compulsion of legislation or the promise of reward. Every railroad officer feels keenly the responsibility of his present position, and the great army of two million railroad workers stand ready to meet all of the transportation requirements of the war.

In passing it should be stated that the railroad labor organizations have with magnificent patriotism pledged themselves to remain at industrial peace with the railroads during the continuance of the war. Of late years the activity of labor organizations on the railroads has grown most unbearable. The advent of the war found the railroads and the labor organizations on the point of a bitter strife with every indication of a general suspension of traffic. Upon the urgent request of the Government, the railroad managers agreed to the adoption of the eight-hour day and a peace contract was signed 24 hours before the Supreme Court had handed down its decision confirming the constitutionality of the Adamson law. A marked change has since occurred in the attitude of the men when it was found that the country must have a solidified organization to run the railroads during the war.

We have had strife with labor organizations in the past, and may have it in the future, but not during the war. A state of truce at present prevails which will not be broken by either side and it is hoped that the experience which is ahead of us may result in bringing the employes and their employers closer together for their mutual welfare.

The impression prevails in some quarters that the railroads have a desire to exterminate the labor organizations. Nothing is further from the truth. Labor unions, when properly organized and honestly administered are a help to the railroads instead of a hindrance. When improperly organized and administered they are a menace, not only to the railroads but to the public. One great evil which arises out of the concerted action of labor organizations in negotiating their demands with the railroads is the tendency on the part of the rank and file, who are not in close touch with their committee, to fall into the error of personal antagonism, thus impairing their efficiency and destroying the "espirit de corps" of the service and generally lowering the efficiency of the work. An agitation for a general strike throughout the United States, or a large section of the United States is naturally widely heralded in the newspapers, each contending side desiring to blame the other to the point where such a bitter feeling prevails as to render impossible anything like perfect service. It is not human nature to expect that a fight can be carried on with one hand while the other serves. Thus, even though a dispute ends in a settlement without resort to a strike, the service of the railroads is very seriously impaired by the cumulative effect of indifferent service. It is a relief to know that the differences have now been settled and that during the continuance of the war no industrial strife is likely or, according to agreement, can take place. "This is a consummation devoutly to be wished," as the Bard of Avon phrased it.

(*To be continued in the July issue.*)

Graphite as a Lubricant

Flake Graphite Used on the Long Island Railroad—Applied Direct to Cylinders of Saturated or Superheated Locomotives—Used on Air Cylinders of W. A. B. Pumps

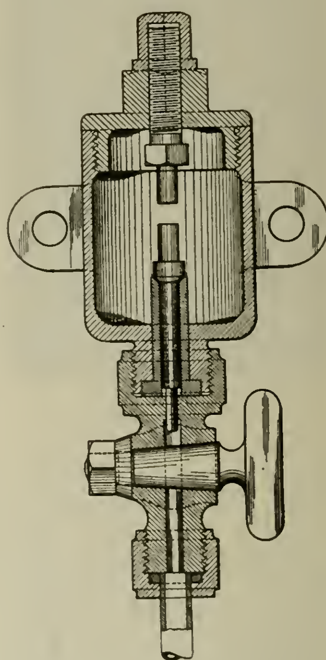
In winter a snowfall which coats the road with a fine, hard, white, glistening mass of snow crystals enables sleighs containing very considerable loads to be drawn over it with a minimum of resistance. where wheels would only be clogged. If, however, the snowfall should continue, the road would become impassable even for sleighs, simply because there was too much of it and not because the dry, hard, snow was not in itself quite satisfactorily "slippery."

This commonplace simile practically epitomizes the story of graphite as a lubricant. Little is good, too much clogs the machine.

As was remarked in one of our previous articles on "Oils, Fats and Greases" (March, 1917, page 93) the best machined or filed wearing surface is, under the microscope, found to be made up of exceedingly minute scratches, something resembling the markings of a phonograph disc, but in some instances the scratches would perhaps be finer and they would be without any design or any regularity, but would resemble miniature mountains and valleys with spurs here and deep declivities there.

Flake graphite, if judiciously applied, would fill up the valleys and depressions and would tend to bring the whole to a flat smooth surface. Flake graphite is almost, if not entirely, unaffected by heat, and tends to cling closely to the metallic surface with which it comes in contact. It has good wearing qualities, and when its use is understood, may be valuable in quite a large number of cases. It has been found of service when used with grease in lubricating switch and signal mechanism.

Up to the present no very conclusive series of tests exists, nor has been carried out on railways, for locomotive lubrication. The Long Island Railway has had some measure of success with graphite, the general foreman of locomotive repairs at Richmond Hill, L. I., has made some experiments which prove that the lubrication of steam engines with flake graphite is not an impossibility. Under the policy adopted by the railroad, the best results that can be had are, as far as possible, assured. This policy is not to adopt graphite as the "standard," or the "one-and-only," method of lubricating locomotive cylinders where saturated or superheated steam is used. The policy is to let it be known that a graphite cup is used on the road. No engineman is compelled to use it, nor is there any persuasive inducements offered. Graphite on the Long Island stands on its merits, and the railroad officials are not interested in securing a paper or any other record of success for graphite, or indeed for any other locomtive specialty.



GRAPHITE LUBRICATOR ON THE L. I. R. R.

If any engineman has the good of the company sufficiently before him, or if he desires by intelligent care to reduce his lubrication charge, he is free to apply for one of the company's graphite cups, and it is given to him with proper instructions as to its principle and the method of its successful manipulation. In thus leaving the matter practically optional with the engineman and others who may be able to use graphite, the Long Island has applied what evolutionists would call a kind of "natural selection," by which graphite lubrication is secured almost automatically to the more intelligent and painstaking type of man. This is practically Nature's method in the organic world applied on a railway at the present time to a subject which Dame Nature knows nothing of. This same method or mode of procedure here outlined may have other and as advantageous applications as that on the Long Island if the mechanical department officers of other roads would consider this method seriously.

A probable theory of how the Long Island graphite cup works may be briefly summarized as follows: The cup to begin with is clean and dry, that is, free from oil or grease, and contains a pin; or, more properly, a "pin-valve" which is made a "slip fit" for the guide bushing in which it works. Above this is a "stop," which is threaded and capable of adjustment, so that it governs the movement of the small spindle or pin-valve. When this cup is filled with flake graphite, on each pressure stroke a small amount of steam or air is trapped in the graphite cup; and as the plunger does not make a perfect seat owing to graphite under it. When the exhaust stroke takes place this little amount of trapped steam blows a small portion of the graphite out of the cup. It is a question whether the cup really performs its function as regularly as this, and it may be that the cup only works when some change in the working condition of the cylinder takes place, such as shutting off, changing the reverse lever notch, etc.

Flake graphite is a finely divided substance, and its distribution along the cylinder walls and up through the ports to the valve chamber takes place automatically and thoroughly, much as fine dust would sift in at a window in a room if the window was only half an inch open. Dust would be found in all parts of the room, after the process had gone on for some time. The important matter to be attended to, on pain of total failure, is that the least amount of graphite must be admitted, which will do the work, and no excess can be permitted, but all must pass out by the exhaust, when it has traversed the area to be lubricated. The beneficial effects of a moderate snow-fall, and the blocking and clogging effect of too much snow have to be remembered in this connection and this actual fact must never be forgotten. The graphite being free from oil does not form into balls or become a sticky mass, but is distributed by the flow of the steam and the back and forward sweep of the piston, the graphite passes out in due time, with the exhaust steam. Graphite is a solid substance and does not change its form and must be disposed of; that is why so little is requisite. While glancing over this brief résumé of what is actually being done on this road, the reader must bear in mind the kind of results which can be had, if the whole matter is put into the hands of men who have voluntarily expressed the wish to try it. It is said of those who thus use it that they find the handling of the reverse lever easier than it was formerly.

Graphite has been applied to the lubrication of the air cylinder of W. A. B. pumps on this road. Those who have used it are said to have noticed the more satisfactory and easy working of the engineers' brake valve, and the absence of heating of the pump. An idea of the amount of graphite used for air cylinder lubrication may be had when it is said to amount to half an ounce in 15 hours. Graphite for air cylinder lubrication is fed in by the same kind of cup as that used on the steam cylinders of locomotives. It appears at least to be a justifiable belief that the life of the air pump may be lengthened if sufficient care be taken by the engineman in the use of a trifling amount of graphite. The two engines using this form of lubrication are in the hands of exceptionally good enginemen. on the Long Island. The graphite being free from oil has no tendency to gum up, and the testimony of those who experienced the better working of the brake valve with graphite fed in small quantity to the air cylinder of the pump, looks like reliable evidence that everything is working satisfactorily. We do not hold any brief for graphite lubrication, any more than do the officials of the Long Island Railroad, but in the interest of our readers we have presented the facts as we found them on this railroad.

We are informed that this kind of graphite cup can be applied to stationary engines, and furthermore that two other styles of graphite feed cups are on the market as well as the one used on the Long Island Railroad, and that where graphite has been so applied the results have been satisfactory. Mr. Sweeley of the L. I. R. R. states that the graphite cup, which he has patented, works quite as well when applied to the steam pipe of a locomotive using saturated or superheated steam, and that a test and application has been made in the U. S. Navy.

The device is handled by the Nathan Manufacturing Company of New York.

Saving on Couplers

Experiments Have Shown Saving on Couplers and Knuckles

At the monthly meeting of the members of the mechanical department of one of our leading railways a report concerning the saving on couplers was brought up. When couplers are broken and the yokes are in good condition, the yokes are taken off and applied to new couplers. New couplers with yokes are supplied as usual. Cast steel couplers distorted or bent are straightened and put into service again. An accumulator for the riveter was ordered for one of the shops, so as to facilitate the applying of yokes to couplers. This is evidence of the importance of this work as viewed on the railway in question.

Some pilot couplers made of steel and used in connection with wooden pilots had to be modified to suit conditions by cutting off the stem and riveting on a band, and couplers with broken stems are worked over for use on pilots, and this plan had the beneficial effect of eliminating the purchase of new pilot couplers. It was stated that 329 pilot couplers had thus been reclaimed, and that the net saving effected amounted to $2,533, and that on a given date, as many as 1,441 defective car couplers had been rendered serviceable by building up the butt ends to standard size. The total saving thus brought about amounted to $4,740. The saving effected by the reclaiming of the knuckles was laid over for a subsequent meeting, but it is fair to suppose that the railway which has made such a marked reduction of cost on couplers will be able to accomplish some substantial results when the matter of knuckles is seriously taken in hand.

At the subsequent meeting it was also stated that the savings to date which had been effected by reclaiming couplers and knuckles had been very considerable. On couplers built up on the butt end, 11,010 had been handled, with a corresponding saving of $36,222. Pilot couplers, of which a total of 474 had been taken care of, produced a saving of $3,648. As many as 12,972 knuckles were reclaimed, and theer had been a saving of $17,492 as a result. These three items gave a total saving of $57,363. Still greater savings in these matters were confidently expected when the accumulator for the hydraulic riveter was installed as part of the riveting plant devoted to this work. A report of actual performance was looked for as soon as sufficient time had clapsed to collect data.

There is no doubt that much good work in the way of substantial economy can be had by the careful and intelligent pursuit of small and seemingly unimportant details. No one article when expeditiously repaired will yield any great return, but the constant and systematic attack on "littles" brings about a result which is cumulative and in the aggregate amounts to a very considerable sum. In these days, when new appliances are being devised and put in operation with such beneficial results the question of economies to be effected by not throwing away a good part because of the wearing out or failure of the part it is associated with, may become a source of indirect revenue which is well worthy of careful investigation.

Opportunity for Economy.

There is wide opportunity for economy in bringing railway men in general and shop employees in particular to realize that time and material which they can save in their personal work can have a direct and considerable bearing on the condition of the company's treasury and consequently on their own prosperity.

In the Southern Railway Shops at Alexandria, Va.

In Congress—At the Union Terminal, Washington, D. C.

While it is our policy to present prominently that which is new in relation to the mechanical appliances used on railways, it is occasionally interesting to glance briefly at places where the old and new seem to meet each other, and memories of the storied past commingle with the stirring present. The repair shops of the Southern Railway at Alexandria, Va., are a fine example of this kind. While the roundhouse is entirely modern in its complete details, the machine shops have seen little outward change since they were used by the Union forces in the Civil War time. The stationary engine that runs a part of the equipment bears testimony by the inscription on a brass plate on the cylinder: "Built at the Shops of the U. S. Military R. Rd., Dept. Alexandria, Va., 1864. W. H. McCafferty, M. M." Surely Mr. McCafferty builded better than he knew. The engine, about 75 horse-power, looked as if it would round out the century. It is in excellent condition, and has undergone little repair. It is of the horizontal, slide valve type, and in its burnished beauty looks as good as new.

In the roundhouse, the locomotives were of the latest and most powerful types and in excellent condition, and it is not too much to state that the engineers seem to take a particular pride in their engines. One engine, No. 1110, is a shining example. This ten-wheeler runs through the beautiful Shenandoah valley every day, and H. S. Brown, the engineer, is looked up to with the eyes of envy and admiration, as he sits in a gilded glory of burnished brass that runs around the back of the boiler head and surrounds every pipe, like the shining tracery of an alcove in Solomon's temple. One may be said to be climbing the golden stairs on entering the glorified cab or pacing the steps to the dazzling head-light, while the hand rails and jacket bands are too bright to be touched by common hands.

The records of many of these fine locomotives are noteworthy. S. R. Kelly, the general foreman, had No. 1349 run out for our special edification. It was a fine specimen of the Pacific type, equipped with superheater, brick arch, and Southern valve gear. The total weight of the engine is 232,000 pounds, 141,500 pounds on the drivers, 48,000 pounds on the front truck, and 42,500 pounds on the trailer. Tender, 132,000 pounds. Diameter of driving wheels, 72½ inches. Cylinders, 24 inches by 28 inches. Tractive effort rated at 35,000 pounds. The engine runs 159 miles every day, hauling ten heavy steel cars, and has been in constant service for the last three years, with a record in that period approaching 170,000 miles. The valve packing had just been changed last month for the first time, but this is not to be wondered at, as the rings were of Hunt-Spiller iron. The valve cylinders were not rebored. No failure of any kind had been recorded in regard to the operation of the locomotive. Running 106 miles without taking water in the fast-mail service from Alexandria to Charlottesville, and thence to Monroe. The cylinder packing had been renewed four times during the three years, but of other general repairs or renewals there were none. Mr. Kelly spoke warmly in favor of the flange oilers, and waxed eloquent on the Southern valve gear. The eight simple but massive bearings, through which the valve motion is transmitted, seemed in fine fitting condition. The link block remaining stationary on this type of gearing, except when the reverse lever is moved in reversing or changing the amount of valve stroke, there is little or no wear in the link, and if the link and link block are properly hardened, there is literally nothing on the gearing to wear with the exception of the eccentric crank bearing. The inevitable settling of the engine on account of the relaxing of the springs slightly affects the opening of the valves, but the variation is easily rectified by inserting a thin liner under each end of the link bearing. One sixteenth had been inserted in the three years' service. The reverse lever, though comparatively easy of movement, is equipped with power reverse gear on the larger types of locomotives, as E. C. Sasser, the superintendent of motive power, believes in the use of every modern device that has proved itself as aiding efficiency and relieving the physical strain incident to the handling of high-powered locomotives. Both Mr. Sasser and Mr. Fuller, the master mechanic, are mechanical engineers of marked ability, masters of detail, and polished by experience. H. C. Linn, engineer of locomotive No. 1349, holds the record for coal, that is for the economical use of coal.

Coming back to Mr. Kelly, his engaging personality is heightened by his wealth of reminiscences of the early railroad days. He described with a fine degree of fullness a locomotive valve gear applied to a locomotive on the Lehigh Valley railroad last century. According to his account, it must have had a resemblance to the Corliss gearing. It worked to perfection with four valves on each cylinder, opening and closing with all the exactness of the best automobile, motors of our own day. George Strong was the name of the inventor, but at that time there was no metal tough enough to remain in good condition with the strenuous service incident to the jumping-jack motion of the valves. They rattled themselves loose in a day or two, and the locomotive may truly be said to pass along the Lehigh Valley road in a pillar of cloud by day, as the valves would not remain tight, and after repeated and frantic efforts to furnish durable metal, the appliance passed to the scrap heap.

We regret we had not more time among such earnest men and such interesting surroundings, but we had promised to look into the halls of Congress and listen to the words of wisdom that fall from the lips of our legislators. The proposed increase in the postal rates on publications passing through the mails was being discussed. The interruptions were frequent and acrimonious. The lower House, so called, seemed to us to be over-worked, making little visible progress, the voices of the angry and passionate law-makers might be compared to the forceful exhaust of an overloaded freight engine making futile efforts to round a curve on a slippery track. Like a lobster, it seemed to move more easily backward than forward. It lacked momentum or sand or something to do the expected trick. It would be hardly fair to say that the legislative machine lacks power, but it lacks promptitude in accomplishment. Where there is so much smoke we should not look for a full head of steam.

Inventors are much in evidence in the marble corridors of Washington, their pockets stuffed with blue prints, and their thoughtful faces wrapped in gloom. Good men are quick to recognize the good qualities in others, but an inventor to be recognized in Washington is something hardly to be hoped for. The inventors may have world-moving wonders in their pockets, but nobody has time to bother with them. They can wait. Watt, Stephenson, Fulton and others of the illustrious dead had to wait until in the undiscovered future their dreams came true.

Things were clearer at the Union terminal, where a Pacific locomotive panoplied with the flags of the Allies, and a train of palatial cars were awaiting the foreign war missions about to pass over the Baltimore & Ohio railroad to New York. The heads of the mechanical department were there in force, and there was no guess work about the perfection of detail in the fine equipment. "Safety First" was emblazoned on the locomotive front end, and the motto seemed to be the watchword of the system. With the exception of the lower house of Congress "all is well on the Potomac."

Boston & Maine Steel Postal Car

Built for the Railway Service of the Post Office Department

A steel postal car used on the Boston & Maine Railroad, built by the Barney & Smith Car Company of Dayton, Ohio, is here illustrated. The cars are entirely of steel construction and were built in

BOSTON & MAINE RAILROAD STEEL POSTAL CAR.

conformity with the specifications issued by the Railway Mail Service Division of the Post Office Department for stresses, strains, buffing shocks, etc. The underframe was of the built-up type having body bolsters also of the built-up type, side sills consisting of a 6x4x½ ins. angle, and center sills of the fish-belly type 26 ins. deep at center. The superstructure consisted also of steel shapes. Sheathing for outside was ⅛ in. steel plates, while the interior finish for sides, ends and headlining was 1-16 in. flat steel plates.

INTERIOR OF B. & M. STEEL POSTAL CAR

The half-tone view which we give of the interior of the car shows the collapsible centre tables for sorting mail matter. The supports are made of ordinary pipe and suitable fittings. The car has an abundance of artificial light, supplied from Pintsch gas burners. The parcel racks are high above the floor, and are more or less out of the way, while the mail pouches and bags are hung from hooks immediately below them.

The length of the mail room is 60 ft. 5 13-16 ins. in the clear and the width inside between sheeting 9 ft. 1 5-16 ins. Height from the top of floor to the underside of the upper deck ceilings 9 ft. 1¼ ins.

The whole interior of the car has been laid out so as to facilitate the work that has to be done. This is not the result of haphazard guessing but is born of practical experience. The men can work with comfort without in any way interfering with one another, and the immense amount of work done in cars of this kind attest their usefulness and necessity in the present day when communication by mail is one of the recognized business activities of the country.

The car is carried on two 6-wheel trucks, and is equipped with the usual mail bag catchers, one on each side so that mail may be picked up en route without the train being compelled to stop. The mail bag for the station where the stop is omitted is dropped off from the post office car while the train is running.

Women on the Pennsylvania

General Manager Elisha Lee has directed the superintendents of the Pennsylvania Lines east of Pittsburgh to investigate and report in what capacities girls or women can be efficiently employed on all parts of the railroad; what numbers can be utilized, and to what extent they can perform the work now being done by men. A considerable depletion of the forces of male employees is expected on account of the war, and the experiment of employing women has been tried in Philadelphia with very successful results. In addition to clerical work, the lighter kinds of machine shop work, signalling, car cleaning, and other work is being experimented with, and the outlook is full of promise.

The movement has caused much discussion and promises an easier solution of a problem presented in connection with the present movement for organizing regiments of mechanics and construction experts to be sent to France as quickly as possible.

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Fitting Engines with "Staying Power."

Some of our principal railways have announced that they have reduced their passenger service so as to employ the locomotives hitherto hauling passenger trains, on freight trains. This means fewer pasenger trains and more freight trains. This is perhaps a necessary thing to do and it is patriotic, but the present conditions suggest another method of securing the prompt movement of freight. As a general thing passenger engines are not good freight engines though everyone knows that they can be used for freight service in an emergency.

Our article found on another page of this issue, on "Modernizing Locomotives," gives a brief outline of the possibilities now within the reach of the superintendent of motive power and the higher officials of the railways which are likely to be called upon to transport commodities necessary for daily life of large sections of the population and these commodities are not all foodstuffs. Many articles of commerce are practical necessities, and war material has first place on the list of goods to be moved.

The freight engines as they stand are capable of being made more efficient than they were by the addition of certain specialties which are built to be applied as the engines are now, and they do not require to be extensively or expensively altered in order to do better work and more of it than in their present condition. Many locomotives turned out by the builders have these appliances from the very first. It is not with this equipment of new engines, desirable as that certainly is, that we are now concerned, for as Rudyard Kipling would say, "That is another story."

It has been proved in the days of profound peace, and as a purely commercial proposition, that with a properly designed and properly operated superheater in switching service, that three superheater engines will do the work of four not so equipped. Extending this to road work, one can get an idea of the latent possibilities in the way of economy which the superheater holds out to those who are willing to employ it. This easily applied contrivance comes at once into the class of improvements by which more ton-miles can be made, and made with greater rapidity than is possible with engines lacking the superheater device.

The mechanical stoker is an appliance in the same class, that is, it enables an engine to do more work and do it quicker than an engine of large capacity can do without it. Efficient valve gear is in the same class for rapid and economical work. Automatic firedoors make for the same goal. Power reverse gear assists very materially in the same direction, as it enables an engineman to regulate the cutoff point more accurately than with the hand lever and the notched quadrant. This regulation of the valve gear is possible with the ordinary form of gear, but the exertion required has no doubt a deterrent effect on the engineman, which is entirely absent with the power gear. The easily worked power gear positively invites an engineman to make fine adjustments, while the knowledge that he can only do this by manipulating a heavy or hard-to-move lever has a tendency to make him take it easy at the expense of the engine, when he is not under the eye of an exacting superior.

Feed water heating puts an economy of the class we are considering right in the hands of the man at the throttle. Waste heat is reclaimed and made to work again. It is utilizing a by-product of locomotive operation and forcing waste heat to yield a substantial saving of coal, and with less of the fluctuations of temperature, which is detrimental to the boiler, while it enables the coal burned to attack its work of boiling water, with a large part of the work already done at little or no expense. The brick arch is easily a coal saver, and a ton-mileage increaser. The coal thrown into the firebox is by this appliance made to give out the full measure of heat obtainable in the hurricane of gas and flame that surges in the firebox and rushes through the flues.

Pulverized fuel offers a great advantage in the burning of fuel, for what would otherwise be thrown away is made to serve as a useful and cheap steam producer. This appliance used with the brick arch has much economy to its credit. It is a user of the by-product of the mine, and a locomotive fitted with it, the brick arch and the feed water heater, would be a consumer of by-products which would made such an engine *facile princeps* in the production of more ton-miles, cheaply and expeditiously made than is usually the case with ordinary engines built as they originally were.

When it comes to the savings in railway repair shops, the field is already "white unto the harvest." The use of lateral motion driving boxes permits of a long wheel base, and the introduction of another pair of drivers to carry more weight and so increase the tractive effort. Steam grate shakers, automatic firedoors, automatic wedges and hollow staybolts, are appliances for straight coal saving. Air operated ash pans and cylinder cocks, force-feed lubricators for big engines, flange lubricators, radial buffers, steam and air connectors, constant resistance and articulated trucks, lighter weight of reciprocating parts, made of Nicrome steel, all help forward the desirable work of reducing time at roundhouses, or give less maintenance costs or reduce wear, which means less friction and consequently less coal burned and longer life of parts and a general all round atmosphere of saving in the varieties of activities on the road and in the shop, filled with the spirit of scientific economy, where each appliance for each operation contributes its maximum quota to the work in hand and so materially increases the quantity of work that can be done, shortens the time in which it can be done, and keeps the cost within reasonable limits. In times of stress and strain like the present, the locomotive, as a war machine, must be fitted up so as to have a mechanical "staying power," and as far as may be, imitate that great moral factor making steadily for victory and peace, which distinguishes the British and French troops on the firing line to-day.

Air Brake Convention.

From our report of the proceedings of the Air Brake Convention, held last month in Memphis, Tenn., it will be observed that the subjects discussed were not only more than usually interesting but much new light was thrown upon several subjects of real importance, and reflects great credit on the various committees to which the subjects were submitted. It is a valuable proof, if proof were needed, of the growing importance of such meetings and an evidence of the quickening effect of men of experience coming together for a common purpose.

In times like the present perhaps it is well that some of the larger conventions should be suspended, more particularly those that might interfere in some way with the continued duties of department heads, but the added knowledge, to be gathered from a meeting like that of the air brake men does far more than make up for the brief absence from their work, to which they return with renewed zest and quickened intelligence.

In the increased volume of transportation which is sure to come in the moving of men and material, anything that adds to the approach toward perfection in the air brake is of importance, and the meeting to which we allude cannot fail to be far-reaching in its results.

Where the Heat Comes From.

A hot box is usually said to be caused by excessive friction due to some roughness in or on the brass, or to the fact that the lubrication is in some way defective. These are what philosophers would call proximate causes, for behind them there is another cause from which the others come. The proof of this is that if a hot box develops there are several ways of overcoming it. One is to repack the box, another is to put in a new brass or to cool the old one off with water or ice. These may remove the trouble, but there is another way, not often resorted to on railways, and that is to let the car stand still. If it is left on a siding a sufficient length of time the hot box cools.

This simple procedure brings us nearer to the "causing cause," as philosophers term it. It is, in fact, the motion of the car, which, meeting the secondary causes of rough brass or poor lubrication, produces the heat. This heat is due to the motion given to the car by the locomotive, and this motion of the locomotive is due to the burning of coal in the firebox, so that it is part of the heat of the burning coal thus appears at the journal of the troublesome car. The journal resists the motion of the train drawn by locomotive and its resistance or protest against motion is a hot box.

The motion of a train is the energy of the burning coal transformed into movement, and in order to bring the train to rest brakes are applied. The whole of the motion is turned into heat at the brake shoes and sparks and radiating scintillations of burning iron show as the train gradually comes to rest. If it were possible to measure the heat transferred from the burning coal in the firebox at the moment the brakes were applied, we would have just that amount of heat to dispose of before the train came to a stop.

The dissipation of heat at the brake shoe is a convenient way of doing the work, as the heat is ultimately radiated in large volume to the atmosphere after doing some incidental work of heating the cold wheel and shoe and burning off and wearing down the surface of each. If the train could be plunged into a soft yielding substance, the motion of the train could be made to do the work of compressing the yielding material and the train would gradually come to rest. If it were possible to run the train against a powerful spring the same effect would be produced, only that the spring would give back the energy imparted to it in a strong, steady back push which would move the train in the opposite direction.

Part of the higher temperature to be found in the New York subway, and which has to be, and is, disposed of, before it becomes excessive, is caused by the vast number of trains that are constantly stopped by brakes in the confined space underground. A volume of air from the outside, and a similar amount from the inside, equalling two tall "Empire" and three "Trinity" buildings on Broadway, has to be put into the subway, and taken out, once in about 25 minutes to properly ventilate this understreet thoroughfare. Stair openings, gratings and vents provide for the necessary in and outflow of air. The subway is, therefore, always cool and pleasant. There are other causes for what heat is liberated in the subway, but this is one of them, and its effects are promptly disposed of. Energy cannot be destroyed, though it may be transformed into motion, friction, light and heat. When dissipated in the air as heat, it is simply lost to us, but is never destroyed.

The Age of Machines.

There is no country in the world so well prepared to move large bodies of men and munitions as the United States is. The Civil War and the Cuban expedition furnished object lessons that have not been forgotten. In stating that the American railroads are ready for any emergency we are saying what is true. Germany has done somthing in railroading since the Franco-Prussian war, but they have a long way to go before they can catch up with this country. This marvel in transportation owes much of its possibility to the perfection of mechanical details developed in the machine shops. In the matter of standardization, and rapidity of constructive details a degree of perfection has been reached that it seems no idle boast to say that the age of perfection has almost been reached in mechanism to-day in America, just as the age of perfection in architecture was reached in Athens in the age of Pericles. A visit to any of the machine shops on the leading railways and an opportunity to observe the degree of accuracy and the speed of production in contrast with the methods of last century reveals a marvel in progress that has no parallel in the realm of human endeavor. The grosser elements of the earth seem to take shape without the aid of the human hand, and fall ready for use, as one might shake a ripened tree and gather the generously bestowed products to meet the common needs of every-day life. Improvement in material has done much, but improvement in mechanism has done more, and while the perfect end may not have been reached, it has surely been approached.

This has justly been called the "age of machines," and the mechanical excellence we have attained has a two-fold advantage for the community at large. Not only are the products of mechanical operation turned out rapidly, cheaply and accurately, but this work done by the unintelligent servant of man—the machine—has the effect of releasing the hands of workmen for other and more onerous tasks, but the inventive mental faculties of man are freed, to engage in the work of planning for further steps ahead and for analyzing the machines as they work so that betterment may be achieved and new methods may be evolved by those who are thus enabled to think as they work.

England and the Railroads.

Hon. Franklin K. Lane, Secretary of the Interior, in an address before the Committee of the Council of National Defense, said that "England, at the beginning of the war, was prepared in one respect at least; that is, in respect to her railroads. The minute war began the government took over the railroads, upon an extremely simple plan, viz., that they should be paid the amount of net revenue per annum that they had received in 1913. Then the railroads were tied together. Unnecessary terminals and yards were eliminated. Things were so disposed as to unite all the railroads of England into a single system. I was surprised, in talking to Mr. Thomas, a member of the British war delegation, a member of parliament and president of the Railroad Men's Union over there (and that is an organization of 400,000 men), to learn what has resulted. Mr. Thomas told me that, notwithstanding the fact that the government pays nothing for the transportation of troops, munitions, or actual war material, business had so increased, and the economies created were so great, that after paying the 1913 revenue to the railroads, the government was making money out of the operation of the roads."

8000 Locomotives Idle at Essen.

The Glasgow *Herald* states that in a case before the Prize Court, London, recently, in which the government was applying for the condemnation of cargoes of lubricating oils which were ultimately destined for Germany, an affidavit was read, stating that there was great shortage of fats and oils in Germany. The shortage was causing particularly serious embarrassment at the present time, the lubricating of locomotives and railway carriages being one of the gravest problems which the Germans had to face. In March there were 8,000 locomotives at Essen awaiting repairs, the wear and tear having been principally due to the shortage and bad quality of the lubricating oils.

Air Brake Department

Twenty-fourth Annual Convention of the Air Brake Association

The members of the Air Brake Association assembled for their 24th annual convention at the Hotel Chisca, Memphis, Tenn., Tuesday, a. m., May 1.

A welcoming address was delivered by the Mayor of the city, Mr. T. C. Ashcroft.

The president, Mr. T. W. Dow, Erie R. R., in his address called attention to the fact that the advisability of postponing the 1917 convention had been discussed by the Executive Committee, but in view of the excellent work done by some of the committees, its was decided to hold the meeting as scheduled.

It was unanimously decided to send to the President of the United States a telegram assuring him of the loyal support of the members in convention assembled, and by a unanimous vote it was decided that each member of the Air Brake Association present should be assessed one dollar as a contribution to the Red Cross Society.

In spite of previous indications to the contrary, the usual large attendance was present.

Much new business was brought before the association, particularly that of a recent decision of the Master Car Builders' Association to have three members of the Air Brake Association admitted to act with the Air Brake and Train Signal Committee of the former association, the object being to have the detailed work of this committee approved of by the Air Brake Association before it is discussed or adopted as a recommended or standard practice by the Master Car Builders' Association.

Obviously, this is a very commendable arrangement whereby the two associations may work in entire harmony and in view of this, both the president and secretary requested the members to co-operate through adhering strictly to the subject under consideration during discussion, and to refrain from making remarks of a radical nature that upon reflection would not appear logical to the minds of the members of the older association.

The afternoon session was devoted to an informal discussion of any topics suggested by the members, and of which no stenographic record was taken. At this time methods of efficient cleaning and testing of freight car brakes was touched upon, also the subject of condensation in locomotive air compressor steam cylinders and the prevention of moisture from entering the brake system. This led up to changes in the location of locomotive distributing valves for the purpose of preventing the entrance of moisture and freezing in cold weather, and finally the need of a retarded application type of distributing to assist in the smoother handling of freight trains.

The first paper on technical subjects presented was one continued from last year entitled "Slack action in long passenger trains. Its relation to triple valves of different types, and consequent results in the handling of passenger trains," by J. A. Burke and Wm. Holtzfield.

The authors of the paper pointed out that the troubles rising from slack action

T. W. DOW,
President Air Brake Association, 1915-16.

in long passenger trains is intensifying rather than diminishing, and that during the past year the progress made in an effort to correct such troubles has not attained a degree which the situation demands, in fact it appears that in spite of the attention given to the smooth handling of long passenger trains, the situation is growing worse.

The paper sets forth the conditions that produce the violent slack action and deals with it from a viewpoint of brake applications only. The principal factors that tend to produce undesirable slack action from brake applications in these trains is summed up as

(a) The percentage of braking ratio on the locomotive being lower, considering the total weight of engine and tender, than the braking ratio employed on the ordinary passenger car.

(b) Unbraked weight, or load on cars for which no additional braking effect is provided, at the head end of the train, tending to increase the shock due to slack action, in the form of jerks if this weight or portion of the train is brought to a sudden stop, such as might be the case if the slack was pushed back in the train and then jerked out again quickly, and may be produced during ordinary brake operations by quickly shutting off the engine throttle and then applying brakes somewhat heavily. This action is, of course, produced by the rear portion of the train, tending to stop in a shorter distance than the head end.

(c) Applying the engine brakes and then the train brakes (or where the distributing valve operates in advance of the car brakes).

(d) Trains with brake conditions that produce effective braking force on the engine and head cars in advance of the rear cars.

(e) Cars in trains having a lower percentage of braking ratio to their total weight than the balance of the cars. (From various causes.)

(f) The severity of any shock produced from the before mentioned will depend upon the degree in which any or all of the factors mentioned exist. The number and weight of cars, rate of speed and amount and rate of producing brake cylinder pressure.

The effects of unequal brake piston travel, differences in operation with different types of equipment is touched upon, along with the effects of increased weights of cars and locomotives, the latter necessarily resulting in the employment of larger air volumes, large air valves and heavy foundation brake gear.

While dealing with length of trains, the time element incident to brake operation and foundation brake gear problems, the paper does not clearly set forth any specific remedy for the existing conditions.

Our readers will understand that there have been numerous experiments made with new designs of brake gear and with new types of operating valves; in fact the inventions and attachments to triple valves intended to produce smooth handlings are so numerous as to confuse the entire subject.

Mr. P. J. Langan takes the stand that trains of ordinary length can be handled without serious shocks, but, however, that there should be a limit to the length of passenger trains so far as the viewpoint of brake operation is concerned, and that there is one particular qualification that the brakes after being moderately applied and slack adjusted, the reduction of brake pipe pressure may be continued, and if brakes are held on to the stop, that is, if two application stops are not attempted unless all brakes can be released entirely before being reapplied, no serious shocks will result.

Messrs. G. H. Wood and F. Van Bergen explained how brake applications should be made to avoid shocks to trains, touching upon the amount of skill and judgment demanded from the engineer, while Mr. Goff, inventor of the Goff system of air brakes, advances the opinion that where it is frankly admitted, as at the present time, that the amount of knowledge, skill and judgment required to handle modern trains is such that the human equation is the dividing line between rough and smooth handling of passenger trains, the inventor should be the logical person to solve the difficulty, by designing a brake that will make possible the desired results, inferring that it not only would be, but has been done.

A representative of the Interstate Commerce Commission, Mr. John Adair, safety appliance inspector, touched upon the inspection of locomotive brake equipment, explaining what was required by the Federal law, going into detail concerning the observations to be made with the brake valves in different positions, supplementing the standard . form of printed instructions.

These matters will be touched upon, beginning with the series of questions and answers to be started in the August issue of Railway and Locomotive Engineering which will cover all of the requirements of the Federal regulations.

The second paper entitled "What is the safe life of an air brake hose?" by a committee, M. E. Hamilton, J. W. Walker, M. S. Belk and G. W. Nowland was the result of a large number of tests made by various members of the association and was sub-divided into three questions; first, the safe life of an air brake hose; second, why is the length of service not greater? and third, what may be done to increase the life of the hose?

It is generally agreed that the life of an air brake hose is largely what it is made to be by conditions of service. After the examinations of hose, in service, and removed for various causes, the committee is of the opinion that results of the tabulation indicate that the average life of the best hose is 28.6 months, and that an air brake hose should not be allowed to continue in service after 28 months. These opinions are based upon the observations of conditions of thousands of hose from which average figures were obtained.

As to why the length of service is not greater is generally attributed to abuse or unfair usage of hose, where failure to uncouple hose by hand instead of pulling them apart by starting the locomotive, also through "cornering" cars or couplers passing as well as rapid changes in temperature of the hose, where they may be frozen hard and within a few seconds time be thawed out, all of which, in addition to a natural deterioration, results in the premature failure of many hose.

The removal of air hose at the end of 28 months service would no doubt increase the number of hose purchased and, therefore, increase the total cost of hose, therefore. any economy effected would not be apparent in the purchasing or first cost in the Storehouse Department, but would be reflected in the maintenance of equipment account and in the earning capacity of the various units of equipment.

As to the third question being, what may be done to increase the life of the hose in service, the committee agrees that, with hose of the present manufacture, the "life saving" should begin in the mounting room. Nipple ends should be rounded to present no cutting edge when inner lining is pressed against the nipple, either when mounting or when thereafter pulled apart. Hose clamps used should be flexible, and should not be used after they have elongated sufficiently to allow the clamp shoulders to come together when clamping the fittings on the hose.

Every effort should be made to stop the abuse of hose while shifting, and have hose couplings parted by hand, either by assigned men to uncouple them or by insisting that train or yard men, or both, do so.

Also an brake hose should be purchased from manufacturers whose products give the best general results, and a table showing this to be prepared without giving the names of manufacturers.

During the discussion of the paper, it was generally agreed that air hose should also be condemned largely upon their appearance. and that the life of hose in passenger service should be much less than that permitted in freight service, notwithstanding the fact that a hose failure or burst hose is much more preferable in passenger service from a viewpoint of possible damage to equipment or possibility of wrecks, hence, a hose removed from passenger service should not be transferred to freight service for further service.

In view of the constantly changing conditions and the enormous amount of money involved in the purchase of air brake hose, it was decided to continue the subject to the next meeting.

The third paper of the convention was "Handling heavy tonnage trains on grades with air brakes exclusively," by a committee composed of Messrs. C. H. Rawlings, J. E. Fitzgerald, S. S. Ayer and C. T. Goodwin.

The committee infers that, where railroads have heavy grades to descend, a convenient "dead line" should be established where equipment may be inspected and properly repaired before the descent is begun, and this point not necessarily being where the descent of the grade begins. Inspections at such points develops the fact that there are still many freight car brakes in poor condition and that the retaining valve and its piping are not receiving proper attention at all points. It is essential that retaining valves and piping, brake cylinders and piston travel receive careful consideration at such inspection points if trains descending mountain grades are to be controlled by air brakes exclusively.

The principal points brought out are, that after a brake test and necessary repairs at the summit of a grade, particular care is so exercised that the brake system is fully charged to the pressure desired, and that the engineer should have a knowledge of the tonnage to be handled and the number of cars in the train and that the brakes are in good condition.

During cold weather, it was considered advisable, where permissible, to promptly apply brakes at the beginning of the descent and work steam for a short distance for the removal of ice and snow from between shoes and wheels, retaining valve to be turned up before descent is begun.

After starting from the summit, a full application of brakes should be made as soon as practicable, without stalling, the object being to test the holding power or retarding effect of brakes and secure the use of the retaining valves.

The speed of the train for the first mile should be exceptionally low for the purpose of permitting the wheels to assume a gradual heat, to compensate for expansion of the metals. The speed thereafter should under no circumstances exceed the schedule rate as provided by the time table or special instructions.

Speed, on a 4 per cent. grade, should not exceed 10 miles per hour, if braking conditions are favorable, if unfavorable, this speed should not be permitted. Speed and air pressure are the most important factors and should be constantly observed at both ends of the train. The engineer will, of course, understand that the critical time in grade braking is during the time of recharge of brake pipe and auxiliary reservoirs, and that he should regulate the application of brakes to maintain, as nearly as possible, a uniform speed. To accomplish this a one reduction method must be followed, that is, making a brake pipe reduction sufficient to hold the train, and in recharging to keep the brake valve in release position until the brake pipe pressure is fully restored, before an attempt is made to return to running position. Where no time is permitted for running position, brake applications may be made from release position but then 2 seconds time should be allowed in running position for a partial equalization of pressure in the brake pipe to take place.

Where duplex retaining valves are

used, all valves should be turned to the high pressure position on heavily loaded cars, and if it is found that wheels are becoming overheated, the retaining valves on cars may be alternated or turned down temporarily.

On grades where places are designated for trains to stop to permit of the cooling of wheels, the first stop should not be more than from 5 to 7 miles from the point where heavy braking commences, and train should remain at such point for at least 10 minutes time to accomplish the desired result. If the train consists of loads and empties, and all the retaining valves are not required, it is advisable to turn up retaining valve handles on all loaded cars and every second or third one on the empty cars which should be alternated at intervals to avoid the liability of overheating the wheels. On a 2 per cent. grade with 75 to 80 heavily loaded cars, very good results are obtained by using 75 per cent. of the retainers in the high-pressure position, beginning at the head end of train and the remaining 25 per cent. to have retaining valve handle in low pressure position.

Should the train be composed of lighter loads, the low pressure position of retaining valve handles will be sufficient.

On long trains of empty cars it is advisable to use 50 per cent. of the retaining valves, alternating them every 10 miles.

On light grades, where low speeds are necessary, the use of from 20 to 25 per cent. of the retaining valves (for short distances), is found to be of great assistance in the control of slack action.

When handling long freight trains over undulating grades, or where the resistance of curvature is great, in different parts of the train, generally speaking, the slack of the entire train should be bunched before the train brake is applied, principally on account of the time element factor incident to serial action of brakes, the brakes applying at the head end first, thus tending to bunch the slack harshly. From such action the bunching of slack in advance of the brake application tends to avoid a rapid change in slack conditions.

There are several ways of bunching the train, but the important feature is to bunch it gently, and this can be successfully done with the independent engine and tender brake, but on account of the liability of bunching the slack too severely, the use of the independent or straight air brake for this purpose is generally condemned.

However, it has been proved by experience that the train slack can be gathered in gently with the use of the engine and tender brake alone.

After it has been determined that the slack is all in, after a graduated application of the brakes on the engine alone, a moderate brake pipe reduction can be made with no shock of any consequence to the rear of the train, but the driver brake must be permitted to work in conjunction with the train brakes.

The graduated use of the independent brake is recommended for cases where curvature sets up a retarding effect, tending to allow the engine to drift out the slack, and when slack conditions have thereafter changed the independent brake should in all cases be graduated off.

It is also pointed out that when trains are stopped on a grade, hand and not air brakes must be employed to prevent any undesired movement of the train, and that liability of wheel sliding is greatest when starting a train after a short stop where retaining valves are in use, and ample time should be permitted for the retaining valves to reduce the brake cylinder pressure before attempting to start, and after starting, speed of train should be slow for some distance so that trainmen may make inspections for wheel sliding or other disorders, from the ground.

Short movements with long heavy trains should be avoided, but where it is absolutely necessary to make them, a sufficient number of hand brakes to hold the slack should be applied throughout the train.

On Wednesday evening, May 2, Mr. W. V. Turner delivered an illustrated lecture on the "Manufacture of the Shrapnel Shell."

He mentioned the reasons for the Westinghouse Air Brake Company first starting the manufacture of these shells, during the business depression at the beginning of the European war, reviewing the difficulties at the start of manufacturing, and contrasted the complexity of the construction of the shells and fuses with that of the construction of air brake apparatus.

He explained in detail, by means of lantern slides, just how shrapnel and high explosive shells were constructed, stating that on some parts, 170 different gauges were used, and that over 10,000 different gauges were necessary before the work on the first contract for shells could be started.

He stated that the workmanship on such shells was required to be so accurate that when the finished product was inspected the measurements must conform to the one ten-thousandth part of an inch, and the weight must not vary more than 3 grammes in order that the place and distance of explosion may be accurately timed.

Mr. Turner displayed a considerable knowledge of modern methods of warfare, illustrating methods employed by the artillery corps of the French army in the use of high explosive and shrapnel shell in the barrage fire.

Mr. Turner concluded with a stirring appeal to the patriotism of the nation, urging everyone to "do their bit" and condemning the "passive" patriotism, stating that just what caused this nation to enter this world conflict was of no moment whatever, considering that we were now engaged in war.

He insisted that this conflict was one solely of autocracy against democracy, and while some citizens might prefer the laws as formulated by the German Empire, the majority favored the present form of government, and the lecture culminated in a patriotic demonstration during which a substantial sum of money was presented by Mrs. P. J. Langan, from the Air Brake Association, to the Red Cross Society through Miss Stone, a youthful Red Cross nurse whose father, a well-known Memphis physician and surgeon, is abandoning his practice and sailing for France for duty in the Red Cross service.

On Thursday morning, May 3, the discussion on handling heavy tonnage trains on mountain grades was continued, and one of the old-time association discussions was precipitated.

Messrs. Langan, Von Bergen, Hamilton, Wood, Smith, Remfry, Lyons contributed in an attempted solution of the problems as to air pump and main reservoir capacity, brake pipe pressures to be carried, speed and tonnage per brake, and fixed rules governing operation of trains on grades that should be employed.

A very spirited argument was finally broken up by Mr. Turner who stated that to him those factors mentioned meant nothing whatever; that pressures, air pump and main reservoir capacity were merely an incident to the subject or a matter of convenience to the main subject which as he sees it, is a matter of obtaining a retarding force in proportion to the per cent. of grade that it was necessary to descend, that is, on a 4 per cent. grade a retardation equal to 4 per cent. must be obtained to control the train, and pointed out that it was a matter now entirely out of the hands of the members when large capacity cars were considered, and that the matter was strictly up to a design of brake, in view of the fact that with the standard brake equipment it is impossible to obtain the necessary percentage of retarding effect for the loaded car on a heavy grade in order for it to be handled with air brakes exclusively, while due regard is being given to per cent. of braking ratio when the car is empty.

Our readers will, of course, understand that this problem has been solved with an efficient "empty and load" brake for modern large capacity freight cars.

Following the close of the discussion a paper entitled "The Functional Inter-Relation Between the Component Parts of the Air Brake System," by Mr. W. E. Dean, was read by the author in which he summed up various problems relating to the foundation brake rigging employed on cars. The paper contained several diagrams and charts of exceptional value and merit, and adds a chapter in reference to air brake literature.

Several of the charts show the critical point of wheel sliding as based upon the per cent. of forces acting on the revolving car wheel. The paper also sets forth in detail the faulty construction and undesirable effects found in the standard single shoe per wheel type of brake gear, and points out how the evils may be scientifically as well as practically corrected with the installation of a clasp or two shoes per wheel type of gear.

All of the information contained in the paper was obtained from a result of tests, there being very little room left for discussion. The conclusion of this paper was followed by the reading of what may be termed a preliminary report of a large committee investigation, the subject of "Slack Action in Long Passenger Trains" being in a measure a continuation of the first paper presented at the 1917 convention.

This committee is composed of Messrs. G. H. Wood, W. F. Peck, M. E. Hamilton, Mark Purcell, C. U. Joy, L. S. Ayer, T. F. Lyons, L. P. Streeter, M. S. Belk, W. J. Hatch, C. H. Rawlings, J. A. Burke, R. C. Burns, and Wm. Spencer.

This committee was appointed for the purpose of ascertaining the actual facts concerning the operation of brakes in passenger trains, and, if possible, to suggest or recommend remedies to the end that rough handling may be eliminated or reduced to a minimum.

This committee advises that through the prompt and generous response of the railroads throughout the country, they have been able to obtain considerable information regarding the subject, but are not as yet ready to submit a final or complete report.

An elaborate series of tests were conducted along with about 3,000 observations of train handling of trains of from four to eighteen cars. In the first phase or sections of the report, an effort was made to learn everything possible concerning conditions leading up to rough handling on trains throughout the entire country, that is, weights, make up and length of trains, type of brake equipments used, and maintenance of brake piston travel, type of brake gear, number of brake equipments per car, and what instructions governing train handling were recommended, also whether direct or graduated release was being used, amount of slack found between cars, type and strength of draft gear, air pressures, and reservoir proportions and capacity all received due consideration through an investigation that develops that many improvements are possible with instructions and close supervision.

It was also discovered that rough handling can occur through certain methods of brake application even where modern foundation brake gear and brake operating mechanism are in use.

In order to determine to just what extent rough handling could be eliminated through the proper proportion of auxiliary reservoir and brake cylinder volumes as constantly specified by the air brake companies, one railroad furnished an 18 car passenger train for test purposes, with the brake equipment of the cars so modified, by the use of a special device, that these proportions could be maintained very closely as specified by the manufacturers, that is, so that the brake cylinder pressure could be built up in proportion to the amount of brake pipe reduction made, regardless as to the inequality of the brake piston travel existing between the various cars.

Mr. G. H. Wood, of the Santa Fe System, was chiefly responsible for tests made with this modification, and as he read the portion of the paper setting forth the results, the diagrams of the brake performance with reference to slack action and shock were shown on a screen with lantern slides.

While it is generally believed that with modern equipment throughout, trains can be handled without shock, but the general desire of the committee was to develop, if possible, some method of handling equipment in use at the present time without serious shock or damage. It is well known that rough or unsatisfactory handling of passenger trains is universally prevalent, and attempts to compensate for conditions are being made by prolonging the time in which the train stop is made. With such a trend of manipulation it is possible to provide satisfactory handling, of course, at a sacrifice of time, and with the addition of the modification mentioned, an increased flexibility is obtained.

Having a satisfactory base upon which to work, the committee was retained to continue their investigations throughout the coming year, and make a further report at the next convention.

In the afternoon of May 3, Mr. W. V. Turner delivered an illustrated lecture on modern types of passenger car brake equipments which was supplemented by a moving picture of the operation of universal valve of the U. C. brake equipment, which was the same film shown at the Atlanta convention in 1916, repeated by request.

At the same time some slides were shown of freak inventions upon which patents had been obtained.

Mr. Turner explained that any novel idea was sufficient to obtain a patent under our present laws, but that the granting of the patent was merely a license to go into court and contest claims of infringement. This part of the lecture was very amusing, considering the absurdity of the ideas manifested by these patents.

On Friday morning, a paper by Mr. R. C. Burns, entitled "Suggested Practice for the Cleaning and Lubricating of Brake Cylinder Packing Leathers" was read.

The paper sets forth the practices at certain points on the Pennsylvania Railroad in cleaning and lubricating brake cylinders. Briefly, where track conditions are such that transportation facilities permit, the piston, spring and non-pressure head are removed from the brake cylinder to be cleaned and the piston and leather are brought to a repair room where a special installation of different sized brake cylinders are installed in which the cleaned piston and leather are placed and tested. This arrangement provides by means of yokes required piston travel for the leakage test and an accurate test is made through controlling the pressure to the test cylinders with a series of straight air brake valves, instead of the cut out cocks usually employed for such purposes.

If, during the test, the leakage from the brake cylinder does not exceed 5 lbs. per minute from an initial pressure of 50 lbs., it is assumed that the piston and leather are in a suitable condition to be replaced in the car cylinder.

If one fails to pass the required test, another piston and leather that are known to have passed a satisfactory test are substituted or placed in a container to be transported to the car, thus to the intent that leather will not be damaged while in transit and in this manner brake pistons and leathers are being cleaned and tested before replacement in a repair room, and in a similar manner that triple valves are being handled.

Photographic views in conjunction with the paper give an excellent idea as to how this work is quickly and efficiently done and at the same time an adjustable gage for the brake cylinder expander ring is shown, through the use of which all expander rings are gauged before being returned to service.

In connection with the maintenance of freight car brakes, it may be added that a brake test is being made on all cars arriving in yards where such repair work is done, and where a brake equipment is not due for any attention a brake cylinder leakage test is made, with a 6-in. brake piston travel and 50 lbs. cylinder pressure and if the leakage exceeds 12 lbs. per minute, the necessary repairs are made regardless as to last date of stencilling of cleaning. Packing leathers that fail on the test rack, after it has been determined that there is no leakage from follower plate studs, are returned to the manufacturers for re-treating where the leathers are thoroughly cleaned, the old filler withdrawn from the pores and a new filler forced into the pores, making the leathers practically as good as new.

This paper was followed by the reading of suggested changes in the Associations recommended practice, and a large number of additions were sanctioned.

These suggestions for changes to conform with improved practices and new types of equipment are received during the year by a committee composed of Messrs. S. G. Down, H. A. Wahlert, W. A. Campbell, J. R. Alexander and H. A. Clark.

The revision was followed by the election of officers for the ensuing year. Mr. T. W. Dow, retiring as president. Mr. C. H. Weaver, L. S. & M. S. R. R. is the president elect with C. W. Martin, P. R. R., first vice president; F. J. Barry, N. Y. O. & W. R. R., second vice president; T. F. Lyons, L. S. & M. S. R. R., third vice president.

The executive members are: L. P. Streeter, Ill. Cent. R. R.; Mark Purcell, Northern Pacific; G. H. Wood, Santa Fe R. R.; C. M. Kidd, Norfolk and Western and Mr. R. C. Burns, Penna. R. R., was elected as an executive member.

The following manufacturing firms had unusually large exhibits: Vapor Car Heating Co., New York Belting & Packing Co., Edna Brass Manufacturing Co., Chicago Railway Equipment Co., H. W. Johns-Manville Co., New York & New Jersey Lubricant Co., Jos. Dixon Crucible Co., Barco Brass and Joint Co., Detroit Lubricator Co., Ashton Valve Co., Garlock Packing Company, A. M. Beyers Co., Leslie Regulator Co. and the Simmons-Boardman Publishing Company.

The New York Air Brake Co., exhibiting the improved type P. S. equipment for passenger cars, and the type J brake pipe, feed valves and several other devices.

The Westinghouse Air Brake Co. exhibited the retarded application type of distributing valve and reservoir, quite a number of other devices recently brought out, among them the special "54" air strainer and the improved triple valve test rack.

This test rack will be mentioned in a future issue as it supersedes the standard type, is a great deal more simple in operation and efficient, and only occupies about one-half the space required by the standard rack.

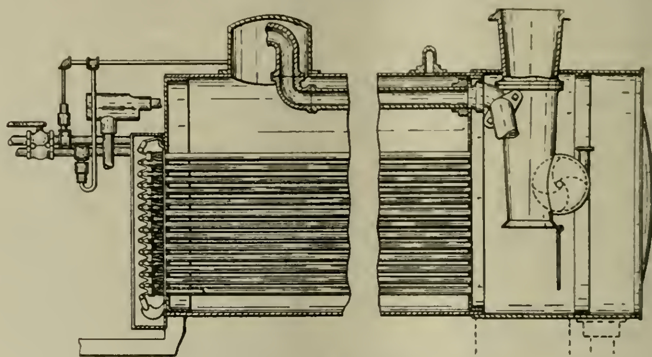
The close attention of the members throughout the entire proceedings was particularly marked; and it is not too much to state that the various papers were marked by a minuteness of detail that showed that the various committees had given that degree of thought which the importance of the subjects called for, and promises well for the future activity of the Association by constantly keeping before the membership the need of a complete mastery of the involved mechanism.

New and Unique Design of Steam Generating Plant

Among recent improvements in boiler construction and the application of means for a more economical use of fuel, the accompanying illustration shows a design of boiler which the inventor J. P. Spiegel, Toronto, claims will be smokeless in operation, efficient and economical, silent, and requiring a minimum of attention. The chief departure from the ordinary type of boilers is the absence of the fire box. A fluid burning apparatus is applied and a jet is located opposite each fire tube. The jets are provided with conical spreaders intended to produce a cylindrical jet of flame slightly smaller than the diameter of the tube. Each jet has a mixing chamber with alternating air and gas conduits supported by a burner frame close to the rear tube plate of the boiler. Compressed air appliances furnish the necessary pressure for feeding the jets. A control valve regulates the supply. A relighting appliance and other minor details are fully provided, as well as feed water heating and feeding appliances. The exhaust steam from the valve chests of the locomotive leads into the tender where a condensing chamber, drainage cocks, and safety valves are provided, and also pressure gauges adapted to the various receptacles into which the tank is divided.

Returning to the fire jets, which are enclosed in an air tight housing, the exhaust steam being no longer available to create a draft, a fire is projected into the draft pipe and driven by a steam turbine or other suitable motor supplied with steam from the boiler. A hinged damper is provided at the lower end of the draft pipe, and may be operated by any suitable mechanism.

It will thus be seen that the operation is simply started by extraneous means, after which steam will be supplied from the boiler that may be necessary to operate the appliances, the advantages claimed being that the gas generated is burnt under conditions which insure perfect combustion, the loss of heat by radiation in ordinary locomotive furnaces being almost entirely avoided. It is claimed that any grade of fuel used under such conditions may be used to advantage, perfect regulation of the firing being obtained automatically and manually, while the complete elimination of the fire box is not only more economical in point of construction and repair, but utilizes the heat immediately in proximity to the water surrounding the flues. A patent has been applied for, and the results of the experiments now in progress will be watched with interest.



SECTION VIEW OF NEW DESIGN OF BOILER.

Pulverized Fuel.

The use of pulverized fuel is meeting with considerable favor in various industries, and the Locomotive Pulverized Fuel Company, 30 Church Street, New York, have recently placed on the market an adaptation of a low pressure feeder for cement kilns that is meeting every requirement at a greatly reduced cost. The results are reflected in greater kiln capacity and less fuel consumption. The substitution of feed screws of different pitch is the only change necessary to increase or decrease capacity beyond the limits of the normal speed range. As an illustration approximately 165 horsepower is required to compress and deliver 1,000 cubic feet of free air per minute at 80 pounds pressure, as generally used in cement kiln pulverized fuel feeders, but to deliver the same amount of air at 8 ounces pressure, as successfully used in the locomotive pulverized fuel feeder, only 5 horsepower is required.

The degree of economy is thus particularly marked and in the near future an extensive use of pulverized fuel may be confidently looked for in operating plants.

Electrical Department

Reasons for Care in Inspection of Generators

In the preceding article the various types of electric generators were taken up. We explained how the first generator, or simple dynamo, did not include field coils but consisted of permanent steel magnets; how the next step in advance was to substitute electro-magnets for the steel magnets excited from some independent source; how the next step was to make the generator excite its own fields. Of the self-excited machines there are three types: the series, the shunt and the compound. These three types were dealt with and their electrical connections were shown by various diagrams. Of the three types the compound is the most common and is used almost universally. It was pointed out that the voltage of a shunt generator drops slightly as the load comes on, i. e., as the amount of current taken from the machine increases. In order to keep up the voltage to a constant value, or to increase the voltage with the load, which is often very desirable, series turns are placed on the field coils so that with the increase of load there is an increase of field strength, which in turn increases the voltage for the same speed of rotation as the conductors on the armature cut a greater number of lines of force. The loss of voltage of the shunt machine is therefore compensated for. The generator is "over-compounded." The over-compounding is usually given as percentage of no-load voltage. Thus a 9 per cent over-compounded 230-volt generator will have a full load voltage of approximately 250 volts. By putting on a number of more series-turns than is necessary to keep the voltage constant, it is possible to over-compensate, and the voltage is actually increased. This principle is used in a great many cases, especially where the power load is some little distance away from the generator and where it is necessary to maintain a constant voltage. We know from Ohm's law (explained in our issue of January, 1917, page 23) that the voltage drop in the wires from the generator to motors or lamps will increase with the increase in current. In order to keep a constant voltage at the motors, the generator voltage must increase with the load an amount equal to the decrease due to the voltage drop. Compound generators having this increase in voltage are spoken of as "over-compounded." This automatic adjustment of the voltage, due to the arrangement of windings of the generator, is know as "self-regulation." Over-compounded generators are used in connection with railway operations and similar conditions.

A compound generator always has a low resistance shunt usually of German silver connected across the terminals of its series field winding. It is easily understood that it would be impossible to wind the series field of the generator so that it would give exactly the voltages desired. Moreover, the generator might be used in other conditions and a different over-compounding would be necessary. By means of the German silver shunt, the amount of current passing through the series field can be adjusted to suit the voltage conditions.

When a self-excited generator is first started the slight residual magnetism left in the pole pieces induces a small amount of voltage in the armature. This small voltage, in turn, produces a small current in the field, which strengthens the residual magnetism. This increase in field

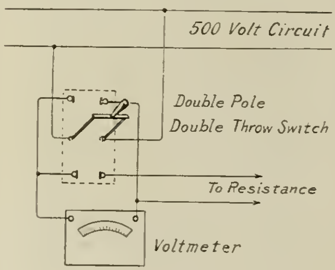


FIG. 1.

strength, increases the current and the generator builds up to its rated voltage.

"Voltage regulation" is often spoken of in connection with generators. It is the change of voltage from no load to full load expressed as the percentage of full load. Assuming that we have a shunt generator, which under full load will give 110 volts and at light loads will be 126.5 volts. The regulation is then

$$\frac{126.5 - 110}{110} = 0.15 \text{ or } 15 \text{ per cent.}$$

Electric generators are used by the thousand. Their application is almost universal. They are made in all sizes from 1 kilowatt to 50,000 kw. Many methods of drive are used. Some are arranged for belt drive. They have two or three bearings, shaft and pulley. Others are the "coupled self-contained" type. They have two bearings and a shaft for direct connection to a prime mover such as a steam engine, internal-combustion engine or water power.

Engine type generators consist of a complete field and armature without bearings or shaft, the armature arranged for mounting on the extended shaft of the prime mover.

Turbo-generators are built for steam turbine drive. This type is a very important one as a large percentage of new machines are turbine driven. The generators differ from the ordinary engine type mainly in the mechanical features required for the high speed of the turbines.

Of the three types of generators the most common for direct current work is the compound, with the shunt generator second. There are a few applications where the shunt machine is better adapted than the compound one. Usually generators for charging storage batteries are shunt wound, although this is not universal. A very large number of the generators are alternating current. As pointed out in the preceding article, the alternating current generators are separately excited and the voltage is controlled and regulated by the operator in charge.

The care and inspection of electric generators is very important. Successful operation depends on proper care being given to the electrical apparatus. We will outline in considerable detail what methods should be followed, what parts should be inspected, etc., and will show the reason for giving close attention to these parts. Much, which will be covered, concerns electrical apparatus in general and applies especially to electric motors.

The most important thing is to keep the generator clean. Accidents serious enough to put the electrical apparatus out of commission are liable to happen unless the apparatus is protected and is given careful inspection and care. It is extremely important that the insulation must be kept clean and dry. Oil and dirt in the insulation are as much out of place as grit or sand in a cylinder or a bearing. Voltage, as we know, is analogous to pressure and it is the electrical insulation which keeps this electrical pressure or voltage in the wires. A breakdown in the insulation allows the electric current to flow into the metal frame of the machine and the machine is no longer operative and is what is known as "grounded." Practically, every insulation used in the construction of electric generators is affected by the action of oil. In other words, oil has a harmful effect and gradually causes deterioration of the insulation. There are parts of the machine which are exposed and not covered by insulation. It is a well-known fact that electric current will travel over the surface of the insulation and in every machine where bare parts are exposed, there is a sufficient distance allowed between the iron framework and the bare parts, so that the electric current will not creep along over the surface and result in grounding the machine. These distances are so chosen that the "creepage" distance is sufficient under average conditions. That is, under normal conditions of moisture and dust. However, if oil and dirt are allowed to accumulate around the windings and parts of the generators and motors, the creepage distance will be reduced as the combination of dirt and oil is more or less a conductor. Distances which are satisfactory when dry and clean are no longer satisfactory if covered with dirt and oil. Neat and economical electrical generator design does not consider creepage distances sufficient to withstand the voltage when the insulation is covered with dirt and oil, but is designed for clean conditions.

When the electric apparatus is installed, care should be used not to handle it roughly by means of bars and hooks, as considerable damage may result. Particular care should be given to the armature as in machines of any size the weight of the armature is sufficient to crush the windings if allowed to come in contact with any projection. When unpacking cases of electrical apparatus, it is much better to do this work in the cool part of the day so as to prevent "sweating." The moisture which collects on the windings, coils, etc., providing they are much cooler than the surrounding atmosphere, would exist over the whole surface and might under certain conditions work into the insulation. The presence of moisture is very nearly, if not actually, as serious as oil, and machines must be protected at all times from moisture. It is true that there are special motors built to withstand severe moisture conditions. These machines, however, are specially treated with a varnish and thoroughly baked so that they are impervious to moisture.

If a machine has been exposed to moisture, the windings should be thoroughly dried before being put into service. This is particularly true of nearly all machines which have been in storage, especially in unheated warehouses, or machines that have been idle for sometime. Machines which have been in transit for some time will collect a great deal of moisture which must be thoroughly removed. After once being dried thoroughly and put into operation the machine will keep itself in condition, free from moisture due to the internal heat of the motor or generator which is formed by the pasasge of electric current.

Small motors can be baked in ovens to remove this moisture, and all sizes can be dried by passing an electric current through the windings of such a value that the temperature will be raised to a point not over 85 degs. Cent. The temperature must be raised very gradually, several hours being required in large size machines, and this temperature is maintained for several days. The length of time that this drying occupies is determined by taking measurements of the insulation resistance. In generators or motors which have been exposed to moisture, this insulation resistance may be about zero, which means that the insulation has practically no power to hold the electric current in the wires. As the moisture is driven out of the insulation by the heat in the windings, this insulation resistance becomes greater, and when all moisture is out the resistance is normal.

There is always danger of over-heating the windings of the machine when drying them with current as the inner parts which cannot quickly dissipate the heat and which cannot be examined, may get dangerously hot, while the more exposed and more easily cooled portions are still at a moderate temperature. It must be borne in mind that insulation is more easily injured by over-heating when damp than when dry. As mentioned above, the higher the insulation resistance, the better is the general condition of the insulating material. Even though the insulation is in exactly the same condition, the insulation resistance of any machine is much lower when hot than cool.

Some of our readers may have occasion to test an electric generator or motor for the condition of insulation and following is the method and procedure to follow: Refer to Fig. 1, which shows the connections. A 500-volt direct current circuit is used, and a 500-volt direct current voltmeter is connected to a double pole switch and to a pair of leads noted in the figure "to resistance." When this double pole switch is thrown into the upper position the 500-volt circuit is connected to the voltmeter so that the voltage of this circuit is shown. When the switch is thrown to the down position, the voltmeter will read the voltage across the insulation. The voltmeter, as can be seen by following out the circuit, is in series with the resistance to be measured.

The measured resistance can be readily calculated by using the following formula:

$$R = \frac{r\,(V-v)}{v};$$

where

V=voltage of the line.

v=voltage reading with insulation in series with the voltmeter.

r=resistance of voltmeter in Ohms (this is generally marked on a label in an instrument cover).

R=the resistance of insulation.

In addition to the above insulation test, the strength of the insulation is measured by what is known as a high voltage or breakdown test. It is made by subjecting the insulation to a voltage much greater than it will stand in actual service. It is exactly analogous to the tests which are made on steam boilers, where the pressure is raised to one, something above that which it will be subjected to in actual service. This high-voltage test is in the nature of an over-strain and must be applied with great caution. High voltage tests should not be made when the insulation resistance is low, and it must be borne in mind that the insulation is more easily broken down when hot than when cold.

The foundation on which the machine is to be placed must be solid enough to prevent vibration. There is nothing better than solid masonry or concrete, but it is perfectly feasible in the case of machines not exceeding 50 kw. capacity to use timber bases. In the case of concrete foundations bolts properly spaced are formed right in the concrete so that the machine can be bolted solidly to it. The foundation must be carried down to a solid bottom or made of such an area at the bottom as to prevent sinking or displacement when the machine is put in place.

American Locomotives in Peru.

It is officially reported that the most acceptable locomotive in Peru is that manufactured in the United States, not only because of the excellent construction and material of the heavy American machine, but because its mechanism is understood by Peruvian engineers and machinists. With the exception of locomotive orders from Germany, amounting to $9,416, all the locomotives imported in 1915 came from the United States. In other railway supplies the United States supplied 80 per cent. of the total railways imports of Peru last year.

Canadian Railways.

It appears that the Canadian railways are in much need of equipment. It has been recommended that the government undertake to provide a sufficient supply of locomotives and cars to meet the pressing needs of the service. They could be secured under trust agreements to the operating companies under lease, a contract of purchase which could be agreed upon in the future.

United States Steel Corporation.

Order for steel now on the books of the United States Steel Corporation are equal to 80 per cent. of the corporation's annual capacity. On April 30th the unfilled orders amounted to 12,183,083 tons, an increase of 471,439 tons, compared with 11,711,644 on March 31st, being the previous published record.

Appliances for Flue Welding.

The Draper Manufacturing Company, Port Huron, Mich., has recently issued a booklet descriptive of its pneumatic flue welder for scarfing, welding and swedging boiler tubes, and pneumatic tube welding machines for welding and swedging locomotive superheater tubes, and other devices.

Car Loading and Train Length as Bearing Upon the Value of Adequate Train Control

By WALTER V. TURNER, Assistant Manager, Westinghouse Air Brake Co.

In previous articles I have pointed out the importance of car capacity in relation to traffic capacity of a railroad system and at the present time I desire to touch upon the subject of car loading as affecting the capacity of a railroad system to transport commodities.

It is idle to provide marvelously improved carrying capacities of the car unit by employing steel construction, etc., and then not utilize it. The extent to which this full capacity is realized when loading a car is of great significance from the standpoint of operating economy. Campaigns are now being waged by various railroads to awaken the shipper to the necessity for loading cars to their full capacity and thereby assisting himself as well as others to reduce car shortages. Live stock and bulky freight of small weights prevent the utilization of full capacity, as do less than carload lots, or shipments. The latter will be grouped to advantage as improved systems for so doing are evolved and put into practice. Of course the reduction of the empty haul increases the average load for the car, and with every superintendent of transportation this problem of routing the cars to cut down the empty haul is a live issue.

The application of the empty and load freight brake dispenses with the hauling of empty cars back and forth over mountain grades in order to provide the necessary braking control by keeping the average tonnage per brake to the predetermined safe figure, and as mountain grades are usually the "neck of the bottle" for the flow of railroad traffic, these "necks" are restricted by every empty car used for the purpose for which it was never built, namely, that of providing adequate control for the load carried in other cars.

Inasmuch as only from 10 to 15 per cent of the total life of a freight car is spent in actual transit, gleaning the revenue producing tonnage, or ton-miles, improvements in terminal facilities are highly desirable to provide means for more promptly loading and unloading cars and for making inspections and repairs—light or heavy, as facilities permit—simultaneously with the handling of lading. Demurrage charges are being more and more scientifically established to penalize carelessness and lack of co-operation on the part of shippers causing needless detentions to cars by using them as storehouses.

The traffic capacity of the car unit is most closely involved in the ever-present problem of maintenance, and this in turn is dependent upon the factors of organization and cost. In general, it is true that if maintenance charges are stinted depreciation charges will jump. The ideal is, of course, that point for each where the total is minimum and where if either one or the other is raised, or lowered, the sum will increase in amount. Unfortunately, in only too many cases it is true that a penny wise and pound foolish policy prevails in greatly reducing maintenance work and in suffering the more than proportionately increased depreciation unconsciously, because it not only resembles, but really is, "indirect taxation." What is not seen and not known usually gives small concern.

Maintenance and service are inseparable, however, even where neglected maintenance does not cause an immediate increase in depreciation, for example to disregard a leaky brake cylinder packing leather does not mean greater depreciation of the brake apparatus but so far as service is concerned the brake equipment might as well be entirely dispensed with if the elaborate means for putting air in the brake cylinder are unsupported by adequate means for keeping it there.

As to the train unit or train length, it is needless to say that the number of cars hauled in a train is a vital factor in the matter of maximum traffic capacity. The maximum train length will depend upon the locomotive capacity, for the available tractive effort should be such as to start a train without the necessity for the "taking slack" so violently as to endanger on each occasion, the integrity of the train. In passenger service, the single shoe per wheel type of foundation brake rigging is responsible for the highly increased train resistance which marks a needless loss in locomotive capacity and also in fuel and water consumption of from 30 to 35 per cent in many cases.

The lengths of sidings or passing tracks will also govern the lengths of trains on single tracks, the only exception being where trains of maximum length never need pass one another, the only "meets" of such trains being with trains of shorter lengths, where "sawing by" is resorted to. The final limiting value of the inferior train length must not be more than twice the length of the siding. In such case, however, the "sawing by" becomes so very much involved that the practical operating limit for the inferior length of train will be the siding capacity. In some respects this factor of siding length should appear under the division "System of Trains" for a single train considered alone involves no element of passing track length.

For electric railways the length of the station platform frequently determines the length of the train that is permissible to operate, for obviously passengers cannot enter or alight from cars standing beyond the reach of the platform. A very important feature of the reconstruction of some of the New York subways has been the extension of the platforms to permit the running of longer trains. Unfortunately for our reputation for statesmanship, legal limits have in some cases been established for the number of cars to be permitted in a train, but it is to be hoped that the sense of reason and fair play among our people will soon prevail on their representatives not to apply artificial restrictions on the arteries of commerce and handicap society as a whole to just that extent.

The element of train control is probably the most significant of all factors in this problem of train lengths. Considering first the question of serial brake action, or the behavior of brakes on single cars or individual cars in sequence and in relation to the train as a whole. When an ordinary pneumatic brake application is started at the front end of the train, the first car is the first to experience brake action, and each car follows from the head end to the rear, according to its position in the train, the brake on the last car being the last to apply. The time between the application of the brake on the first and the last car of a train is called "time of serial action." For any given type of air brake equipment this time varies with the length of the train, therefore when a brake application is started, the first car will have had its speed reduced before the brake applies on the last car, and before the slack in the train runs in, by an amount proportional to the severity of the brake application, to the total amount of slack in the train and to the time of serial action. The severity of the brake application, or, in other words, the rate of retardation set up, depends upon the brake cylinder pressure realized; the basic cylinder pressure for the nominal braking ratio; the nominal braking ratio, and the efficiency factor. This may be briefly summed up in the mathematical formula,

$$R = \frac{P}{C} P c f$$

where

R = the retarding factor in per cent.

P = the nominal braking ratio, per cent based on.
C = the basic cylinder pressure for P, pounds per square inch.
p = the effective cylinder pressure, pounds per square inch.
ef = the efficiency factor.

By the retardation factor (R) is meant the relation of the actual retarding force to the total weight of the vehicle. It is a measure of the rate of retardation. A retarding factor of 100 per cent obtains where the retarding force equals the weight of the car, or in other words, when the retardation is equal to that due to gravity—32.2 feet per second, or 22 miles per hour per second. As before noted, the nominal braking ratio (P) is the ratio between the nominal brake shoe pressures on the wheels of the car and the weight of the car. It is the "nominal" braking ratio because it makes no allowances for losses in the transmission of the brake cylinder force, by the multiplying, or leverage system, of the foundation brake gear, to the normal or perpendicular brake shoe pressure on each particular wheel in the whole train.

The basic cylinder pressure (C) assumed to be in the cylinder when the braking ratio is established, is taken as the nominal pressure arising from a full service, or emergency, brake application, according to the service of emergency braking ratio in question.

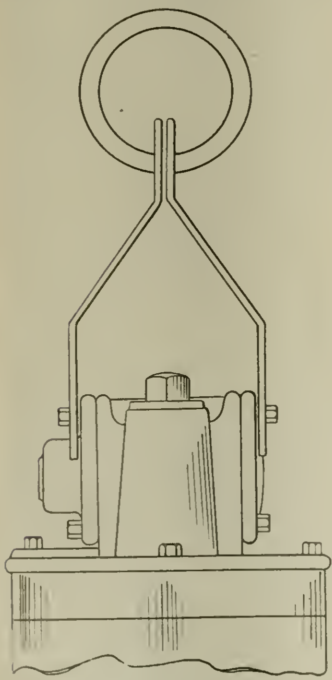
The actual pressure (p) realized in the cylinder when the braking ratio is established, depends upon the brake pipe reduction made, the piston travel, the cylinder packing leakage. For the purpose of computation and comparison, it is necessary to deduct 5 pounds from this pressure especially when it is relatively low, to give the effective pressure because it will take about 5 pounds to compress all release springs and place the brake shoes against the wheels. For the higher brake cylinder pressures of 35 pounds or more this deduction may be neglected, and the (ef), the efficiency factor, be made to compensate for release spring effect, that is, for the lower pressures, the efficiency factor, flexible like the cloak of charity as it is, cannot be made to cover the proportionately great sin of this initial loss, in other words, the efficiency factor cannot conveniently be made a function of cylinder pressure in addition to one of speed and type of foundation brake rigging.

The efficiency factor (ef) is the combined product of the brake rigging efficiency (e) for transmitting and multiplying the cylinder force into normal brake shoe pressure, and the coefficient of brake shoe friction (f) which is the measure of tangential force acting on each wheel in relating to the normal brake shoe pressure. It is not possible, nor is it necessary, to separate these two factors for the purposes of computation. The combined product is the connecting link between the actual average retarding force which must have been acting to effect a given stop distance obtained in actual service and the nominal brake shoe pressure determined by multiplying the brake cylinder pressure by the brake piston area, and the leverage ratio of the brake rigging.

Holding Device for Lifting Air Pumps.

By F. W. Bentley, Missouri Valley, Iowa.

A large number of local devices are in use for holding a 9½-in. air pump while lifting it to place on the locomotive, or lowering it as the case may be. In the use of chains, no matter how securely slung they may be around the pump, they have frequently been known to slip and cause trouble, while grab hooks and irons, that were designed for the purpose, have also failed at the critical moment.



DEVICE FOR LIFTING AIR PUMPS.

The accompanying sketch shows a very simple plate, or what may be called a three-piece arrangement, which though perhaps requiring a little longer time in attaching, is a thoroughly safe and practical contrivance for the purpose. The four upper main tap bolts are removed and the respective plates applied. Four tap bolts are used for securing the plates, and when not in use the bolts are held on the plates by ⅝-in. nuts. It will be observed that it is necessary that the left hand plate be cut with a larger radius at the bottom to accommodate the left valve cylinder cap.

On a long, high lift, running board cranes and pulley blocks need all the attention that is possible, and the device described secures the pump against mishap. For an arrangement entirely safe under all circumstances, in connection with the lifting of pumps, we have found that this device admirably meets all demands.

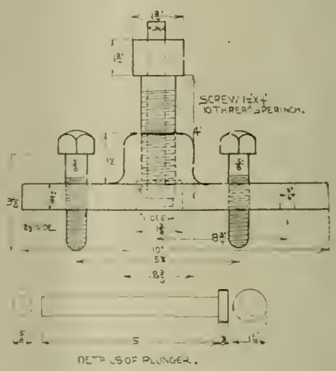
The Demand for Steel.

The address of General Goethals before the American Steel and Iron Institute in New York cleared away much of the fog that has enshrouded the merchant shipping program since it was launched. Now it is apparent that at the maximum the trade will demands to be made upon the trade will not exceed 1,000,000 a month, if it approximates that much. This estimate covers all steel for war purposes, including that to be furnished to the Allies.

Piston Puller for W. A. B. Air Pumps.

By J. H. Hahn, Machinist, Norfolk & Western Ry., Bluefield, Va.

The design of piston puller shown in the accompanying sketch has been used by the writer in the repair shops here for pulling the high pressure and low



DETAILS OF PISTON PULLER FOR WESTINGHOUSE AIR PUMPS.

pressure air piston of the Westinghouse 8½ ins. cross compound pumps off the piston rods with very satisfactory results. While the device was designed especially for the compound pumps, it will prove equally as serviceable when applied to the pistons of the 9½ ins., or 11 ins. pumps.

The piston puller is attached in the usual way, and the screw tightened, and then by striking the plunger a few blows with a sledge the piston is very easily and readily removed from the rod.

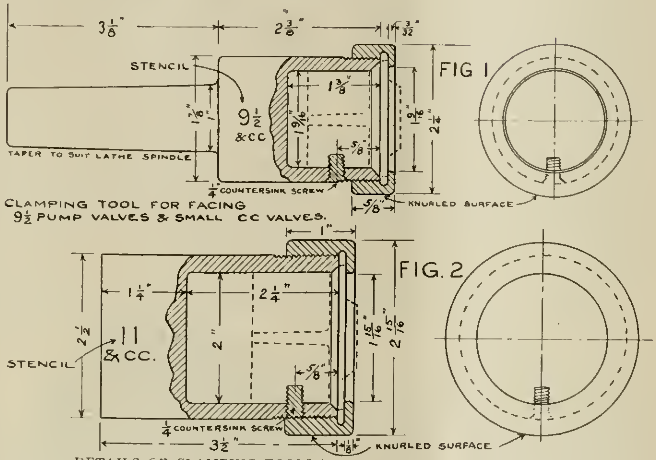
Air Brake Repair Work Tools Devised and Applied to Every Requirement

By GEORGE K. DORWART, Denver, Colo.

No. 11. Clamping Tools for Facing Air Pump Valves.

The accompanying drawings show the details of clamping tools for facing air pump valves, Fig. 1 is adapted for holding the 9½ ins., and also the small cross compound pump valves. The dotted lines show the valve clamped in position for facing. Fig. 2 is arranged for facing the 11 ins., and also the cross compound pump valves, and is to be used in self-centering chuck. The knurled clamping nut can be readily tightened and removed by hand. The ¼ in. set screw shown at the lower edge of both devices comes in contact with one of the valve wings, thereby preventing the valve from turning.

It will be observed that the shank of Fig. 1 is tapered for the purpose of being inserted in a lathe spindle, while the base of Fig. 2 as stated, is held in the self-centering lathe chuck.



DETAILS OF CLAMPING TOOLS FOR FACING AIR PUMP VALVES.

Electromagnetic Brake.

By O. E. Kain, Greenville, Tex.

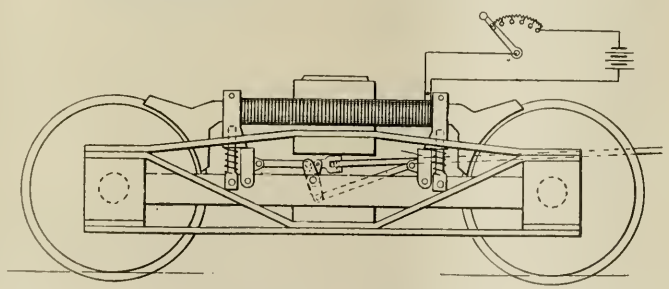
It will be of interest to the readers of Railway and Locomotive Engineering to learn that we have in operation a locomotive on the International & Great Northern railroad, equipped with a new design of brake that is attracting much attention. The locomotive is one of the smaller types of passenger engines with a tractive force of about 15,000 lbs., and it is claimed that it hauls 1,260 tons without slipping. The device is the invention of J. L. Earl, Morgan City, La., and the accompanying drawing will show the main features of the contrivance.

The truck to which the appliance is attached is of the two bar braced type, provided with spiral springs on which rest brackets surrounding the core of an electromagnet, and parts duplicated on each side of the truck. Underneath the brackets are dogs attached to rods which are attached to a lever, the lever being also duplicated on the other side of the truck, a rod connecting the two levers which are connected by suitable means to an operating rod leading to the cab in control of the engineer. A source of electric current with attached controller lead wires for supplying current to the magnet. If the electric current is sent through the magnets the poles through induction magnetize the wheels, and they in turn will magnetize the track so that the traction between the wheels and the track will be increased.

On the other hand when it is desired to use the magnets as a brake, the rod may be moved so as to move the dogs out from under the brackets and thereby permit the poles to contact with the wheels, and the wheels will be magnetically gripped, thus causing the magnets to exert a braking action. The cutting off of the current releases the poles from the wheels, whereupon the springs raise the poles out of contact with the wheels when a reverse motion of the rod will reverse the motion of the dogs and the dogs will be wedged upwardly and held out of contact with the wheels.

It will thus be seen that the device is extremely simple, involving the combination of an electro-magnet having a pole, means for yieldingly supporting the pole in close proximity to a car wheel, with means for positively holding the pole out of contact with the wheel, means also for energizing the magnet pole when held to magnetize the wheel and track through induction, and also means to release the positive holding appliance and permit the pole to come in contact with the wheel when a braking action is desired, as already described.

It is expected that a record of the tests made in the working of the device will be available for publication in a short time. Meanwhile the appliance is looked upon with much curiosity here, and while it would be premature to venture opinions in regard to its merits, it is gratifying to know that it is getting a fair chance in these days when it is so difficult to introduce anything new in the mechanical appliances used on railways. Its simplicity is a step in the right direction, because the modern locomotive with its multiplex appliances has become a burden greater than some of us can bear.


VIEW OF NEW DESIGN OF ELECTROMAGNETIC BRAKE.

Items of Personal Interest

Mr. Benjamin W. Guppy, engineer of structures, Boston & Maine Railroad, Boston, Mass., has been appointed Major in the Engineer Officers' Reserve Corps.

Mr. W. T. Abington has been appointed superintendent of shops of the Denver & Rio Grande, with office at Salt Lake City, Utah, succeeding Mr. E. J. Harris, resigned.

Mr. W. G. Hall has been appointed shop superintendent of the International & Great Northern, with offices at Palestine, Tex., succeeding Mr. W. A. Brule, promoted.

Mr. A. R. Thompson has been appointed road foreman of engines of the Chesapeake & Ohio, with office at Cane Fork, W. Va., succeeding Mr. D. S. Baals, transferred.

Mr. W. Wells has been appointed division master mechanic of the Sudbury division of the Canadian Pacific, with headquarters at Sudbury, Ont., succeeding Mr. T. Hambly, transferred.

Mr. Joseph P. Donnellan has been appointed master mechanic of the Pennsylvania division of the Delaware & Hudson, with office at Carbondale, Pa., succeeding Mr. George S. Graham, resigned.

Mr. D. E. Barton has been appointed acting superintendent of shops of the Atchison, Topeka & Santa Fe, with office at Albuquerque, N. M., succeeding Mr. W. A. George, granted leave of absence.

Mr. Tony Goodman has been appointed general foreman for the Missouri, Kansas & Texas, at Woodward, Okla., and Mr. John Barnhill has been appointed night foreman of the same road at Greenville, Texas.

Mr. E. P. Pfahler, formerly motive power inspector of the Baltimore & Ohio, at Baltimore, Md., has been appointed master mechanic at Glenwood, Pa., succeeding Mr. A. K. McMillan, transferred to Newark, Ohio.

Mr. J. S. Ralston is president of the Ralston Steel Car Company; Mr. Anton Becker, vice-president; Mr. C. N. Replogle, vice-president and general manager, and Mr. F. A. Livingston, secretary and treasurer.

Mr. W. L. Jury, formerly general foreman in the locomotive department of the Sante Fe at Topeka, Kan., has been appointed assistant superintendent of shops at that point, and Mr. J. Frizzel succeeds Mr. Jury as general foreman.

Mr. D. M. Perine, formerly superintendent of motive power of the New York division of the Pennsylvania, has been advanced to the personal staff of the general superintendent of that division, with headquarters in New York City.

Mr. Willis M. Deming has resigned his position with the General Electric Company, of Schenectady, N. Y., and expects to engage in business on the Pacific coast. Mr. Deming has been in the service of the General Electric for twenty-eight years.

Mr. A. N. Lucas, formerly general foreman of the locomotive department of the Chicago, Milwaukee & St. Paul at Milwaukee, Wis., has been appointed assistant superintendent of motive power on the same road with offices at Milwaukee, Wis.

Mr. E. J. Brennan, formerly shop superintendent of the Baltimore & Ohio at Glenwood, Pa., has been appointed general master mechanic on the same road with office at Pittsburgh, and Mr. R. B. Stout, formerly master mechanic at Cumberland, Md., succeeds Mr. Brennan.

Mr. H. I. McMinn, formerly with the Pennsylvania Railroad, has entered the service of the Franklin Railway Supply Company as shop superintendent in charge of the manufacture of the Stone-Franklin Lighting Equipment, with headquarters at Bush Terminal, Brooklyn, New York.

Mr. W. J. Bennett has been appointed assistant superintendent of motive power and car department of the Denver & Rio Grande, with office at Denver, Colo., and Mr. E. J. Harris has been appointed master mechanic of the Utah lines, with office at Salt Lake City, succeeding Mr. Bennett.

Mr. William A. Garrett formerly assistant general manager of the Remington Arms Co., Eddystone, Pa., has been commissioned Major Engineer, Officers' Reserve Corps, and has been assigned to active duty. Major Garrett was formerly vice-president of the Chicago, Great Western.

Mr. Thomas C. Donaldson has been appointed master mechanic of the Rochester & Buffalo division of the Buffalo, Rochester & Pittsburgh, with office at Salamanca, N. Y., and Mr. William F. O'Brien has been appointed road foreman of engines on the same road, with office at Rochester, N. Y.

Mr. J. B. Ennis, chief mechanical engineer of the American Locomotive Company since December, 1912, has been appointed vice president of the company, in charge of engineering. Mr. Ennis has been in the service of the company since its incorporation in 1901, prior to which time he was with the Rogers and Schenectady Locomotive Works.

Mr. H. H. Maxfield, formerly superintendent of motive power of the Western Pennsylvania division of the Pennsylvania railroad, has been appointed superintendent of motive power of the New York division, and Mr. J. L. Cunninghame, formerly master mechanic of the Philadelphia division at Harrisburg, Pa., succeeds Mr. Maxfield as superintendent of motive power of the western division.

Mr. J. R. Lovejoy, vice-president of the General Electric Company, Schenectady, N. Y., announces the appointment of Mr. John G. Barry as general sales manager of the company. Mr. Barry has been a resident of Schenectady for the past twenty years and his many friends are glad to learn of his advancement and increased responsibilities. Mr. Barry continues his present duties as manager of the railway department.

Mr. W. S. Rugg, formerly district manager of the New York office of the Westinghouse Electric & Manufacturing Company, has been appointed manager of the railway department, with headquarters at East Pittsburgh, Pa., succeeding Mr. C. S. Cook. Mr. Rugg is a graduate of Cornell University, and has had many years' experience as an electric engineer. He served for several terms as one of the managers of the American Institute of Electrical Engineers.

Mr. G. A. Moriarity, promoted to the newly created position of mechanical superintendent, Lines East, New York, New Haven & Hartford, entered the service of the Baltimore & Ohio as machinist apprentice in 1887, later working for several roads as machinist, returning to the Baltimore & Ohio as machine shop foreman. He was later with the Erie, serving in several capacities. Entered the service of the New Haven as master mechanic in 1907. In January of this year he was made general master mechanic of the Eastern Grand Division.

Mr. C. T. Stewart has been promoted to the recently created position of mechanical superintendent, Lines West, on the New York, New Haven & Hartford. His first railroad service was with the Erie as a caller. He served with that road later as engine dispatcher, special apprentice, fireman, engine inspector and foreman. He then went with the Lackawanna as machinist, serving later as foreman and general foreman, entering the service of C. N. E. as master mechanic in 1905. In 1913 he was made assistant mechanical superintendent of the New Haven.

Mr. H. C. Oviatt, who has been appointed general superintendent, Lines West, on the New York, New Haven & Hartford, entered service of the railroad as fireman. Promoted to engineer in 1894, remaining six years in that capacity. He was later air brake inspector, road foreman of engines, master mechanic at New Haven, general inspector, assistant mechanical superintendent, and in September, 1913, was made superintendent of Old Colony Division. Since then he has been superintendent of Shore Line Division and later of New Haven Division.

Mr. C. L. McIlvaine formerly master mechanic of the New York, Philadelphia & Norfolk, at Cape Charles, Va., has been appointed master mechanic of the Philadelphia division, and Mr. James Milliken, formerly superintendent of motive power on the same road at Wilmington, Del., has been appointed special engineer in the office of the general superintendent of motive power of the lines east of Pittsburgh and Erie, and Mr. C. D. Young, formerly engineer of tests at Altoona shops, has been promoted to superintendent of motive power at Wilmington, succeeding Mr. Milliken.

Mr. F. Quattrone, chief engineer of the Italian State railways, returned to the United States last month. In the early months of the war Mr. Quattrone placed large contracts running into many millions of dollars for locomotives, cars and other railway material. Recently he has been attached to the International Food Commission of London, and now returns to the United States as a special delegate of the Italian State railways, to be attached to the Italian Embassy at Washington, and will have in charge the purchase and shipment of all materials to be contracted for by the Italian Government.

Mr. M. A. Baird, who has been appointed signal engineer of the Erie, is from Port Jervis, N. Y. He received a grammar school education and began his railroad career with the Erie Railroad January 19, 1887, and served until October 23, 1907, as laborer, blacksmith, signal foreman and signal maintainer. He was appointed general signal inspector October 23, 1907, and in March, 1909, was made supervisor of signals on the New York division. Mr. Baird was promoted to general inspector September 1, 1911, and served in that capacity until October 1, 1915, when he was advanced to chief inspector, the position he held previous to his recent appointment, which was effective May 1, 1917.

Mr. Thomas Dunbar, Sr., has been elected president of the Acme Supply Company, of Chicago, Ill., succeeding Mr. H. H. Schroyer, retired. Mr. Dunbar entered the railway field with the Pullman Company in 1885 as a car builder and was later a template maker. He became general foreman of the company in 1893 and in 1902 was made superintendent. In 1904 he became manager of the works of this company, which position he held until 1910, when he was appointed manager of the mechanical department. Resigning from this position in April, 1916, he went to Arizona for his health. The offices of the Acme Supply Company have recently been moved to 325 North Leamington avenue, Chicago, adjacent to the company's works.

Mr. John G. Barry, manager of the railway department of the General Electric Company, of Schenectady, N. Y., has been appointed general manager of the company. Mr. Barry began his industrial career as production clerk for the Thomson-Houston Company, at Lynn, Mass., in 1890. In 1892 the company joined with the Edison General Electric Company and formed the General Electric Company, and two years later Mr. Barry was transferred to Schenectady in the railway department. He was shortly afterwards appointed assistant manager of the railway department, and in 1907 he was appointed manager of the department, which position he held up to the time of being appointed general manager.

WALTER ALEXANDER.

Mr. C. H. Weaver, elected president of the Air Brake Association, has a record of thirty-two years continuous service with the New York Central. He commenced work as machinist at the Elkhart shops of the Lake Shore & Michigan Southern in 1885, and was foreman of air brake repairs at the Elkhart shops in 1891. In 1893 he was appointed air brake instructor in charge of the air brake instruction car, and in 1905 he was appointed supervisor of air brakes of the Lake Shore & Michigan Southern, the Indiana, Illinois & Iowa railway and also the Lake Erie and Western railway. His present position, since the consolidation of the Lake Shore with the New York Central is supervisor of air brakes, New York Central railroad, west of Buffalo, with headquarters at Cleveland, Ohio. Mr. Weaver is one of the leading experts and instructors on the air brake.

Mr. Walter Alexander, chairman of the Railroad Commission of Wisconsin since August, 1916, has been appointed superintendent of motive power of the Chicago, Milwaukee & St. Paul with headquarters at Milwaukee, Wis. Mr. Alexander came from Scotland at an early age and served an apprenticeship as machinist and draftsman with the Chicago, Milwaukee & St. Paul, and attending the classes of the University of Wisconsin, graduating in the course of mechanical engineering in 1897. For three years he was instructor in engineering in the University of Wisconsin and one year at the Armour Institute and another year at the University of Missouri. He returned to railway work as assistant district master mechanic of the St. Paul at Minneapolis, Minn. Later he was promoted to master mechanic on the same road at Milwaukee, which position he held at the time of his appointment as a member of the railroad commission.

OBITUARY.

Louis B. Pomeroy.

Louis B. Pomeroy, a well known consulting engineer on railway equipment died at his home in Orange, N. J., on May 7. Mr. Pomeroy was born at Port Byron, N. J., in 1857, and was graduated from Irving Institute, Tarrytown. For a number of years he was a special representative of the Carnegie Steel Company, and held a similar position with the Cambria Steel Company. Later he was assistant general manager of the Schenectady Locomotive works. At the time of his death he was connected with the Safety Car Heating and Lighting Company.

Roscoe B. Kendig.

Roscoe B. Kendig, chief mechanical engineer of the New York Central railroad, died, on May 10, in Detroit, Mich. Mr. Kendig was born in Renovo, Pa., in 1868, and served as machinist apprentice on the Pennsylvania Railroad. He became an expert draftsman, and in 1900 was appointed chief draftsman of the Lake Shore & Michigan Southern railroad, and in 1910 general mechanical engineer of the New York Central Lines, and in 1912 chief mechanical engineer.

Albert E. Manchester.

Albert E. Manchester, general superintendent of motive power, Chicago, Milwaukee & St. Paul, died on May 4, in his seventieth year He began railway service in 1864 in the mechanical shops of the Chicago, Milwaukee & St. Paul, and served in nearly every position in the mechanical department. For the last sixteen years he served as superintendent of motive power, and was recently promoted to general superintendent of motive power.

Be gentle, but like the nettle, which is not so gentle that it is trampled on.

Railway Fuel Association Convention.

The members of the International Railway Fuel Association, with Mr. W. H. Averell in the chair, held a convention the middle of last month. The question of pulverized fuel was taken up in a report prepared by Mr. W. L. Robinson, chairman of the committee. He brought out the idea that as mining rates increased and the war demand for fuel became more urgent, something had to be done to meet the condition. The use of pulverized fuel was one of the ways, and a very important way, to meet the case. Pulverized fuel would be attractive also in a forest region of country, where at present oil fuel is required by law.

The average delay on one of the largest roads at its heaviest running repair station is from 10 to 11 hours and the lowest delay is from 3½ to 5 hours. Of these delays ash pit work forms an important factor. The use of pulverized fuel would reduce terminal delay to half what it is at the present time. Attention was called to the fact that only about two-thirds of the total fuel purchased by railroad companies for locomotive operation is actually used for hauling trains, the remaining one-third going into the so-called "standby" losses. These facts are pertinent at the present time and the whole subject is well worthy of careful study.

"The Results of Fuel Economy" was handled in a paper by Mr. W. P. Hakins. He mentioned that one of the largest single items of waste of fuel is by allowing engines to remain under fire longer than necessary, owing to the length of time elapsing between the engine being disconnected from the train and the time the fire is "knocked." There are many delays encountered in housing engines after arrival, in addition to the wasting of fuel, and these tend to reduce the time of washing out boilers, with correspondingly objectionable results, and this curtails the time which might be profitably spent in repairs. Firing up an engine in anticipation of a call is bad practice, unless in special cases where a serious delay to main line traffic is to be avoided. Dispatchers and yard masters should be in possession of information which would render such "protective firing" unnecessary. When an engine stands a considerable time under fire, the netting becomes clogged, and eventually prevents good steaming on the road, with consequent loss of time or extra consumption of fuel. Another waste is by improper firing. A good deal of coal that is shovelled by the fireman is wasted by reason of too much being put in at a time.

The matter of soot was taken up by Mr. F. A. Moreland. All the forms of soot usually produced were shown by views and explained by the speaker. All forms are detrimental to the transference of heat from the flame to the water. The paper practically advanced or supported an argument for a mechanical soot blower of some kind in every steam plant. The committee on Fuel Tests reported. It seems that the opinion prevailed that coal specially prepared as to size for locomotives was superior to run-of-mine. Tests were made, and the committee believe that there was very little to justify the prevailing opinion. Lump coal, cracked, gave probably better results.

A very full and comprehensive report on the subject of Feed Water Heating was presented at this covention, which dealt particularly with the apparatus of the Feed Water Heater Company of 30 Church St., New York. The effect on boiler maintenance was shown, and the actual economy of fuel, due to the application of heat wasted through the stack to the work of heating the feed water, was made plain. The whole arrangement is in essence the utilization of a by-product of locomotive operation, and this the science of economics recognizes as one of the surest methods of producing wealth, or, in this case, reducing the amount of coal burned to do a given piece of work. RAILWAY LOCOMOTIVE AND ENGINEERING will take the matter up in the near future.

Mr. O. G. Hall, chairman of the committee on Coal Storage, said no unusual activity as regards coal storage has been noticed in Canada or the United States for some time past. A movement is on foot at Toronto to develop the hydro-electric power of Ontario and an inquiry, originating at Ottawa, is on foot to ascertain the possibilities of briquetting lignites. As to the absorption of water by submerged coal in storage, a quotation from Mr. Oscar W. Palmberg was submitted. An appeal to the coal operators, coal miners, railroad officials and employes, to increase the fuel supply of the country and eliminate waste in the use of fuel, closed the meeting. The appeal was the result of the work of the executive committee.

Railway Signal Association.

The Railway Signal Association will hold its mid-year meeting at the Hotel McAlpin, New York, on June 12th and 13th. The candidates for offices for next year are as follows: For president, W. H. Elliott, signal engineer, N. Y. C. R. R., Albany, N. Y.; for second vice president, C. J. Kelloway, signal engineer, A. C. L., Wilmington, N. C.; for secretary treasurer, C. C. Rosenberg, City Realty Building, Bethlehem, Pa.; for directors (two years), E. G. Stradling, signal engineer, C. I. & L. Ry., Lafayette, Ind.; A. P. Hix, signal engineer, T. R. R. Asso. of St. L., St. Louis, Mo.; J. H. Cormick, signal engineer, Can. Nor. Ry., Winnipeg, Man.; A. H. Rice, signal engineer, D. & H. Co., Albany, N. Y. For members of nominating committee, active: G. K. Thomas, assistant signal engineer, A. T. & S. F. Ry., Topeka, Kan.; C. G. McCauley, supervisor signals, Wash Term. Co., Washington, D. C.; junior: H. W. Chevalier, draftsman, Sig. Dept., C. M & St. P. Ry., Milwaukee Shops, Wis.; H. E. Johnson, signal foreman, T. & O. C. Ry., Columbus, O.

American Gear Manufacturers' Association Convention.

The first convention of the above association was held at the Hotel Schenley, Pittsburgh, Pa., on May 14 and 15, Mr. F. W. Sinran, president, in the chair. After an executive meeting in the early part of the day, Mr. S. L. Nicholson, sales manager of the Westinghouse Electric & Mfg. Company, spoke on "The Ins and Outs of an Industrial Organization," and Mr. James E. Gleason presented a paper on "The Spiral or Curved Tooth Bevel Gear." On the following morning papers were presented by Mr. Frank Burgess on "Job Gearing—To What Extent Can It Be Standardized," and by Mr. Wm. Ganschow on "Advantages of Gear Standardization." In the afternoon, Mr. George L. Markland discussed the "Difficulties of Gear Standardization."

Canadian Railway Club.

The annual meeting of the Canadian Railway Club was held at Montreal, Que., on May 8th. G. E. Smart, master car builder, Canadian Government Railways, was elected president. The other officers elected were: C. W. Van Buren, general master car builder, Canadian Pacific Ry., first vice president; T. C. Hudson, master mechanic, Canadian Northern Quebec Ry., second vice president. Executive committee: J. Hendry, master car builder, Grand Trunk Ry.; W. H. Winterrowd, assistant to chief mechanical engineer, Canadian Pacific Ry.; E. J. McVeigh, general storekeeper, Grand Trunk Ry.; C. H. W. Connell, division engineer, Canadian Northern Quebec Ry.; A. Crumpton, assistant valuation engineer, Grand Trunk Ry.; E. A. Nix, assistant works manager, Canadian Pacific Ry., Angus shops.

American Association of Engineers.

The third annual convention of the American Association of Engineers was held in Chicago on May 18. The nomination for officers which was for director, one to be elected, were Mr. R. C. Yeoman, Dean of Engineering, Valparaiso University, Ind., and Mr. Wm. H. Salwasser, School of American Bridge Company Gary, Ind. The convention adopted a resolution offering the national headquarters as a recruiting station for the U. S. army. All members of the association who enlist will be carried during the term of enlistment without the payment of dues. The meeting was well attended.

Railroad Equipment Notes.

The Lorain Steel Company has ordered 25 gondola cars from the Ralston Steel Car Company.

The Boynton Refining Company has ordered 25 tank cars from the Pressed Steel Car Company.

The Illinois Central has ordered 500 refrigerator cars from the Haskell & Barker Car Company.

The Northern Pacific has ordered 40 Mikado locomotives from the American Locomotive Company.

The Great Northern has ordered 25 eight-wheel (0-8-0) locomotives from the Baldwin Locomotive Works.

The Fuji-Minobu Railway (Japan) has ordered four 2-6-2 type locomotives from the Baldwin Locomotive Works.

The Atchison, Topeka & Santa Fe has ordered 1,000 gondola cars from the American Car & Foundry Company.

The Alapaeff Mining Company (Russia) has ordered 9 six-wheel locomotives from the Baldwin Locomotive Works.

The Philadelphia & Reading has ordered 20 Mallet (2-8-8-2) type locomotives from the Baldwin Locomotive Works.

The Paris-Orleans Railway has ordered 50 100-ton Mikado (2-8-2) type locomotives from the American Locomotive Company.

The Delaware, Lackawanna & Western has ordered 2 combination library, buffet, lounging and baggage cars from the Pullman Company.

The Duluth & Iron Range has ordered 50 gondolas from the Pressed Steel Car Company, 25 box cars from the Standard Steel Car Company.

The Canadian Government Railways have ordered 1,000 box cars from the Canadian Car & Foundry Company, and 1,000 from the Eastern Car Company.

The Duluth & Iron Range has ordered 25 flat cars from the American Car & Foundry Company and 50 general service cars from the Western Steel Car Foundry Company.

The Chicago, Burlington & Quincy has ordered 25 light Mikado, 20 heavy Mikado, 10 Pacific and 10 Santa Fe type locomotives from the Baldwin Locomotive Works.

The Philadelphia & Reading will build a power and engine house at Rutherford, Pa., to cost $50,000. General contract has been let to A. L. Carhart, Hale building, Philadelphia.

The Buffalo, Rochester & Pittsburgh has awarded contracts for new shops at East Salamanca, N. Y., including machine and erecting shops, blacksmith shops, storehouse and a transfer table.

The Pennsylvania Railroad has ordered the immediate construction of 25 100-ton cars in its Altoona shops. This equipment will be especially adapted for carrying heavy gun trucks and armor plate.

The Great Northern, already reported as having ordered 25 eight-wheel switching locomotives from the Baldwin Locomotive Works, has placed an additional order with that company for 15 more eight-wheel switching locomotives and 85 Mikado locomotives.

The Atchison, Topeka & Santa Fe refrigerator cars, an order for 800 of which was recently placed with the American Car & Foundry Company, will be equipped with the Bohn Collapsible Tanks and Ventilators, manufactured by the White Enamel Refrigerator Company, St. Paul, Minn.

The Russian Government is reported ordering 53 narrow-gauge Mallet type locomotives from the Baldwin Locomotive Works, and is said to have since placed an order with that company for 60 additional Decapod (2-10-0) type locomotives. Additional Russian orders are expected to be placed in this country.

An order for the immediate construction of 25 all-steel cars of 200,000 lb. capacity each has been received by the Altoona shops of the Pennsylvania Railroad. The cars are for the use of the United States Government, and will be used to carry heavy gun trucks and armor plate from the Bethlehem Steel Works to the seaboard.

The Pennsylvania Lines West of Pittsburgh have ordered 35 Santa Fe (2-10-2) type locomotives from the American Locomotive Company. These engines will have cylinders 30 by 32 inches and will weigh 420,000 pounds. Orders also have been placed with the Baldwin Locomotive Works for 10 Mallet (0-8-8-0) type and 25 Santa Fe (2-10-2) type locomotives.

According to press reports negotiations looking to the purchase of more than $100,000,000 worth of locomotives, cars, rails and other equipment in the United States will be one of the principal purposes of the Italian war commission now in this country. A large part of the $100,000,000 already loaned by the United States to the Italian government also may be spent for railroad materials.

The Canadian Government has ordered 50 locomotives from the American Locomotive Company. The contract calls for 30 Mikado (2-8-2) type engines, each weighing 288,000 lbs. and having cylinders 27 by 30 ins.; 10 Pacific (4-6-2), weighing 248,000 lbs., with cylinders 23½ by 28 ins.; 10 Santa Fe (2-10-2) weighing 320,000 lbs., with cylinders 26 by 32 ins. The Canadian Government, according to report, also ordered 50 Mikado (2-8-2) type locomotives from the Canadian Locomotive Company.

The St. Louis & San Francisco has ordered from the General Railway Signal Company materials for a mechanical interlocking at Parsons, Kan.; Saxby & Farmer machine, 30 working levers and 2 spare spaces. The General Railway Signal Company has also received an order for another machine, from the same road, to be installed at Fairland, Okla., 16 levers; also orders from the Louisville & Nashville, the Chicago, North Shore & Milwaukee, the Pere Marquette, the Denver, Laramie & North Western, and the Atchison, Topeka & Santa Fe.

Railway Management in War Time.

B. L. Winchell, director of traffic of the Union Pacific, has tersely expressed the functions and authority of the railway committee of five executives who have charge of the railways as far as the Government is concerned. The following is briefly the new phase in regard to the management of the railways:

"Under this plan the railroads have been amalgamated for all purposes and in effect there is only one nation-wide transportation system in the United States. Terminals mean nothing, strife for Government business is eliminated and equipment is pooled.

"This committee has power to take engines or cars from the Illinois Central and send them to the New York Central Railroad, and vice versa; it has authority to order officers and employes from the Union Pacific System for service elsewhere. It can order shipments diverted from one road to another, without regard to competitive earnings. Expedition is the end in view.

"This step was taken by the railroad officials in a broad gauged and patriotic way, which eliminates the special interests of any company. The plan will furnish data valuable to all of us in future operation of our properties along the lines of helpful co-operation, pooling of equipment, etc."

New Chinese Railway.

The Chinese ministry of communications, says the *Far East*, is completing arrangements for the construction of the long-proposed railway line to connect Pekin and Jehol. The road will traverse the districts of Shunyi, Miyun, Cupeikow and Lanpin, and will, of course, open an important field for commercial development. The route has already been laid out and surveyed. It is estimated that the construction will take about three years, and will cost in the neighborhood of $12,000,000.

Patriotic Literature.

Railroad men throughout the country are lending whole-hearted support to encouragement of patriotism, loyalty and faithful service, and among other associations the National Committee on Patriotic Literature, 461 Eighth Avenue, New York City, has issued two booklets, "Your Flag and Mine," and "Songs of Our Country," in editions of one million each. Copies may be had free on application. The books are illustrated in colors, and contain words, music and concisely the story of the American flag.

The Call to Our Red Cross.

A statement on behalf of the War Council of the American Red Cross has been issued in pamphlet form, and presents many strong reasons why the Red Cross should be liberally supported. As President Wilson has said: "But a small proportion of our people can have the opportunity to serve upon the actual field of battle, but all men, women and children alike may serve, and serve effectively. We must and will all immediately concentrate our energies and efforts and by contributing freely to this supreme cause, help win the war."

Workshop Drawings.

Owing to working conditions some consideration should be shown, both in regard to the size of drawings and the figures and letters should be of fairly good clearness, as nothing leads to mistakes so soon as minute figures and lettering, and beyond this, pretty pictures are not wanted. Only really essential lines should be given, but dimensions should be fully marked in figures at least ¼ in. high, while one system of fractional division should be uniformly adopted; rules and gauges of course, correspond with the drawings.

Books, Bulletins, Catalogues, Etc.

RAILWAY ESTIMATES, DESIGN, QUANTITIES AND COSTS, by F. Lavis. Published by the McGraw-Hill Book Company, New York. 608 pages, with numerous folders and illustrations. Cloth, Price, Five Dollars.

F. Lavis, special lecturer on railway engineering, Yale University, presents in one volume all that is necessary in estimating the probable cost of a proposed railway, the design of the general features of a railway together with a complete analysis of details not hitherto available in any single publication. The work is divided into eleven chapters embracing besides estimates, costs with typical comparisons, descriptions of earthworks, tunnels, masonry, arches and bridges, tracks and buildings, with details of yards and stations. The chapter on rolling stock is of particular interest and shows how carefully the author has covered the subject through a long experience and the careful examination of many records. The need of such a work is well known to every construction engineer, and while much available data has been furnished in the proceedings of engineering societies, and particularly by the American Railway Engineering Association, whose work embraces much in the way of standard practice, the work of the association, however, although of real value, is by no means complete. The work before us covers the entire field furnishing data for the determination of both qualities and costs to aid, not only in the preparation of estimates, but also in the determination of the general features of the design of railroads.

An appendix is furnished giving forms of contracts, appraisal of railroads, timber preservation, general railway statistics of the United States and various foreign countries, all of which enhance the value of the work. The style is clear and luminous, and the author has a fine faculty of presenting comparisons of the various kinds of structures coincident with the special matter under consideration. The drawings are excellent, and the letterpress of the high standard of the McGraw-Hill Company.

Brick Arch Tests.

Bulletin No. 30, issued by the Pennsylvania Railroad Company, test department, showing the result of tests made by the locomotive testing plant at Altoona, Pa., on locomotives equipped with the brick arch and also with the brick renewed, is of special interest on account of the minuteness with which the tests were conducted. The tests covered a wide range of steam pressures, and the results showed that the maximum evaporation, when using highly volatile coal, was increased 15.5 per cent. by the use of the arch, thus clearly indicating a considerably larger boiler capacity. The arch increases the evaporation per pound of coal, and for ordinary rates of working the increased evaporation represents an economy in coal of from 6 to 8 per cent. The cylinder or indicated horsepower was increased 7.2 per cent., and an increase in the dynamometer horsepower was obtained amounting to 6.4 per cent. The tests were conducted under the supervision of Mr. C. D. Young, engineer of tests, and approved by Mr. J. T. Wallis, general superintendent of motive power. We understand that copies of this pamphlet, although intended for limited circulation, can be had on application by persons to whom the information contained in it would be of value.

Joseph Dixon.

Elbert Hubbard, the eminent author, wrote some years ago a biographical sketch of Joseph Dixon, whose name is indelibly associated with the Joseph Dixon Crucible Company, Jersey City, N. J. The sketch is unique and full of interest, as all Mr. Hubbard's writings were, and it is proper and becoming that the pamphlet should be occasionally reprinted lest we forget much of what we owe to Dixon. It may not be generally known that he made the first machine for cutting files, the first matrix for casting type, the first portrait by means of a camera, and the first locomotive with a double crank. He helped Fulton to set his steamboat going, and made a crucible from graphite for the melting of gold and silver. Later he melted steel in crucibles, something that hitherto defied the worker in metals. This was not all. His system of grinding lenses with graphite continues, as well as his mixture of metals known as Babbitt metal. Before Dixon's day lead pencils were of real lead. In his hands graphite came into use, and to-day its use is universal. Then he made stove polish, and housewives arose and called him blessed. In 1867 he organized the corporation known as the Joseph Dixon Crucible Company, and it remains, an ever-expanding monument to the real greatness of the man. The subsequent history of the company is furnished in the interesting publication, and we understand that copies may be had on application to the main office of the company, Jersey City, N. J.

Accident Bulletin.

The total number of persons killed in all classes of accidents during the months of July, August and September, 1916, as shown in reports made by steam railway companies to the Interstate Commerce

Commission, was 2,932 and the number of persons injured 54,003. This includes all train-service accidents sustained by employes while at work, by passengers getting on and off cars, by persons at highway crossings, by persons doing business at stations, etc., as well as by trespassers and others; and also 151 persons killed and 35,885 persons injured in casualties reported as "non-train accidents." The term "non-train" refers to accidents in shops, boats or wharves, stations, freight and engine houses, coal and water stations, tracks and other structures not directly connected with the operation of trains.

Safety on the Baltimore & Ohio.

The illuminated posters that are issued by the Baltimore & Ohio are really gems of art, and show how earnestly the company is carrying on the good work. Among the most recent is a rural scene in gorgeous colors, with a shining automobile full of joy-riders heedless of an approaching locomotive. A ragged boy is signalling frantically to the careless automobilists, who seem bent on their own destruction. The poster tells its own story and the extensive circulation of this fine poster cannot fail to have an effect on the most heedless.

Saving in Coal.

Graphite for May has an able article explanatory of the effect of Dixon's Pioneer Boiler Graphite in boilers. One-sixteenth of an inch of scale reduces the efficiency of a boiler one-eighth. Graphite prevents scale formation, and in certain water districts renders it easy of removal. Flake graphite is a money saver. Scale burns up money. A small plant in Cape May, N. J., saved 143 tons the first year, and 182 tons the second year after beginning the systematic use of graphite.

Railroad's Patriotic Duty.

An official bulletin has been isssued to all the railroads of the United States by the Executive Committee of the American Railway Association's special committee on national defense and contains much that is of value in obtaining a larger amount of service out of the present facilities, and to this end it is urged that the railroads hold meetings at various places all over their systems, so that their officers and employees can discuss the national situation and by mutual cooperation give tangible response to the earnest appeal that is made to every one to aid in the nation's defense by contributing a maximum effort in a unified service. Much will be required of the railroads, and the American Railway Association is doing a patriotic work in publishing from time to time bulletins containing suggestions that are particularly valuable in a national emergency.

Liberty Loan Appeal.

The Treasury Department has issued an illuminated circular asking the co-operation of the industrial classes in the Liberty Loan during the early days of June. Meetings will be held all over the country and a hearty and substantial response is expected. The Pennsylvania, New Haven and other railroads have taken the matter up and are making arrangements for payments by the employes on the installment plan, whereby a small sum each month may be placed towards the national loan.

Accounting Machine.

The Remington Company has issued a circular showing a duplicate payroll as copied from the records of the auditor of disbursements of the Erie Railroad, the work being done by a machine recently placed upon the market by the Remington Typewriter Company, 374 Broadway, New York. The time books and time sheets are footed and extended, verified and audited by a calculating machine which operates before payrolls are written, eliminating the work of a force of clerks. The installation in the Erie offices is very satisfactory.

The Safety Fan.

The Safety Car Heating & Lighting Company has issued a sixteen-page bulletin describing and illustrating a new device known as the safety fan. The fan absolutely controls the direction and distribution of the air blown from an electric fan. It is of pleasing appearance and of a size adapted to its use and location in the car. All interested should secure a copy of the bulletin from the company's main office, 2 Rector Street, New York.

Modernizing Locomotives

(*Continued from page* 179.)

Among the other appliances, often called locomotive specialties, which produce savings of various kinds may be mentioned hollow staybolts. These reveal their own defects automatically and reduce the time and labor of inspection. Lateral motion driving boxes assist in guiding an engine, and in so doing permit the wheel base to be lengthened if desired and another pair of driving wheels to be introduced with corresponding advantage. Air operated ash pans and cylinder cocks have a positive action which renders them advantageous, just as the force lubricators are advantageous. One is sure that when put to work they do their work without fluctuation or uncertainty. Automatic wedges and radial buffers are in much the same class. Their action is positive and sure. They reduce friction and eliminate a tendency to failure. The wedges and indeed the radial buffers give a flexibility to engine movement which is a highly desirable quality and their reduction of friction, be it small or great, is all in the direction of saving fuel and preventing the generated power from being employed unproductively.

Constant resistance trucks give resistance to bolster displacement with substantion initial resistance, and a low form of construction which secures to the engine maximum clearance under the engine frames. The articulated tender truck does away with any special form of axle box and pedestal. The box is hinged so that vertical motion is provided for, and there being no pedestal, the wear of box and pedestal is eliminated. Wear means friction, and friction is the useless and detrimental consumption of power, and such trucks running day afted day, produce a very substantial saving in the aggregate and yet hold the good features of the usual form of construction.

The beneficial effects of the power reverse gear have been alluded to before now in these pages. Not only is the physical labor of the engineman considerably reduced, but by the use of such gear he is able to see what he is doing and his "reaction time" is reduced. In the study of the science of psychology it has been found that an appreciable interval of time elapses from the moment a signal is given until the man responds. When he sees his work, the hand signal of the yardman or trainman is not necesasry, and this interval of time, which is in reality just so much delay, entirely disappears. Flexible metal conduits for water, steam or oil have the effect of doing away with chances of failure incident to the use of the generally accepted methods, and the use of connectors between cars eliminates inspection and coupling time, lengthens the life of the hose and insures positive, exact and ready connection for air or steam.

All or any of the appliances enumerated above are applicable to engines, as they stand to-day, and do not require the buying of new power to secure the advantages supplied by each. A locomotive can be rejuvenated, or, as we say, "modernized," very easily, as all these appliances are designed so as to be quickly and easily and cheaply applied to any type of engine in service to-day. Such an engine is able to take its place far above the efficiency average of an engine which has not been scientifically treated—for that is what "modernizing" means. It is not only given a new lease of life, but in its prolonged existence it is endowed with new powers for good service, economy, and is a money earner of greatly increased power. The time between shoppings is increased and a sort of mechanical "staying power" is given to any engine that has been "modernized." The total amount of saving is in all cases considerably more than would be expected.

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The Mount Royal Tunnel

By H. K. WICKSTEED, Chief Engineer, Department of Surveys, Canadian Northern Railway

The entry of the Canadian Northern Railway to Montreal was one of its most important and complex problems. Important because Montreal is the commercial capital, and principal seaport of the Dominion; complex for the same reasons as obtain in the case of the entry to other great centres of population—expensive property, vested interests, separation of grades, physical impedimenta, etc.

Two other trunk lines already had entrances to Montreal. The Grand Trunk had been built in 60 years ago, and the Canadian Pacific 30 years ago. Their problems were comparatively simple and had been solved. The first had a surface line into the outskirts of the then existing city, and the latter had grown up around its terminals until the question of grade separation had become an acute one. The Canadian Pacific, built 30 years later, had solved the grade question in advance and in a reasonably satisfactory manner, but the smoke and noise nuisances still remain and with increasing traffic are becoming more and more objectionable as time goes on.

FIRST ELECTRIC TRAIN THROUGH THE MOUNT ROYAL TUNNEL AT MONTREAL CANADA.

The topography of Montreal is peculiar. It is situated as everyone knows, on an island some 35 miles long and 4 or 5 miles wide, at the confluence of the Ottawa and the St. Lawrence rivers. The greater river of the two, being navigable much further west than the smaller, the earlier settlements naturally grew upon the St. Lawrence and the nucleus of the city was formed at the head of navigation. Immediately opposite this point and only a short distance inland there rises to an elevation of 800 feet the isolated peak of Mount Royal which gives the city its name.

Montreal in time outgrew the narrow flat along the larger river, and spread over the intervening higher terrace and then up the slopes of the mountain itself, until these became too precipitous to allow of further expansion. It then began to grow parallel to the river and ultimately to extend around each end of the mountain, more especially the north eastern end, until today it reaches nearly across the island.

The two railways already mentioned paralleled the river from the southwest, the Grand Trunk on the flats and the

Canadian Pacific along the edge of the terrace at a higher level. The latter road also built or acquired lines which almost encircled the mountain and obtained an entrance from the east as well. This gave it a very commanding position but the C. P. R. was handicapped by two separate and independent terminals, with all the expense of property and expropriation and upkeep which such an arrangement entailed.

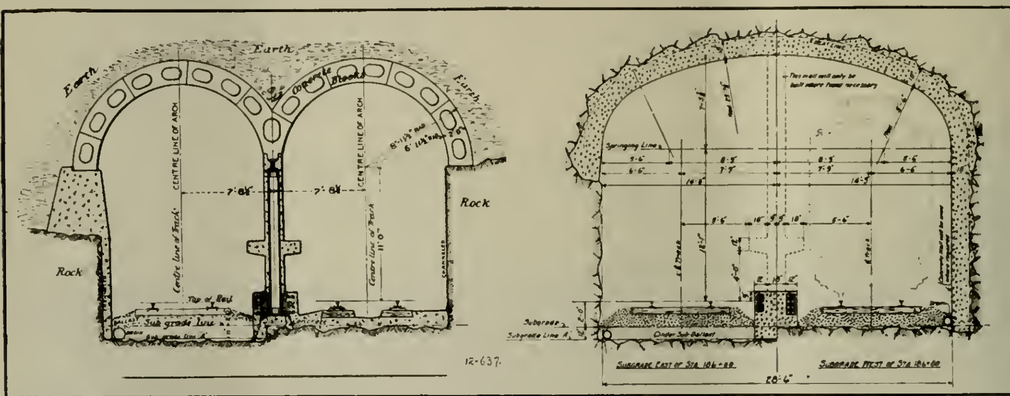
While the city had grown up stream and down, and to a certain extent, across the island, the mountain had blocked access to a most desirable area lying due west from the city's centre, within easy distance as the crow flies, but reached by travellers only when 3 sides of a parallelogram had been traversed. These lands were in the market at a very moderate price. It became evident when the Canadian Northern sought entrance that not only would a tunnel provide more direct access to the city than any other route, but it would give easy grades, avoid property damages, eliminate grade crossings and permit of high speeds to the city's very centre. Last, but by no means least, the Canadian Northern completely solved the problem of the further expansion of the city. It was a civic improvement scheme as well as a railway project and it promised to net to the owners of the trans-montaine property many times the cost of the tunnel. This was the history of the conception and the "raison d'ětre" of the Mount Royal Tunnel.

In detail the tunnel enters the ground where it crosses the C. P. R. belt line and descends on a grade of 0.6 per cent. At a point one mile east of the portal it is 250 ft. below the surface and a shaft was sunk at this point partly with the idea of making more rapid progress with the heading, partly with a view of establishing a station at this point which is immediately at the foot of the precipitous rise. For another mile the superincumbent rock is 400 ft. to over 600 ft. in thickness, but it then diminishes rapidly and half a mile from the terminal it is only 50 ft., and lessens gradually to 25 ft. at the eastern portal. The total length of the tunnel is 3 1-10 miles. The terminal station itself will occupy two city blocks extending from Cathcart St. to Lagauchetiere St. in one direction and from St. Monique to Mansfield Street in the other.

The choice of the site was dictated to a certain extent by the topographical conditions of the vicinity and also by the fact that nearly one half of the area required was for sale at a very moderate figure in one block, but aside from these considerations it would be hard to find a better one in the city. Cathcart St. is within 200 ft. of St. Catherine St., the principal retail thoroughfare in the city. Lagauchetiere St. is on the edge of the terrace and may be considered the boundary between the upper and lower, or retail and wholesale divisions. Dorchester St. runs across the centre of the area, and fronting it will be the main facade of the terminal building. One block further south is Dominion square, the principal mid-city park, and on this fronts the Windsor Hotel, one of Montreal's great hostelries. Lagauchetiere St. is on a somewhat lower level than Dorchester and Cathcart Sts. and the production of the tunnel grade just clears it sufficiently to allow of the legal headroom without materially raising its surface and at the same time it is sufficiently high to cross three of the principal downtown arteries; St. Antoine, St. James and Notre Dame Streets, over head. The grade crossings are thus reduced to one, and this on a street of minor importance, Latour St., which ends at this point, and will probably be provided with another outlet. Absolute grade separation will thus be provided for some 5 miles with no grade exceeding 0.6 per cent. of 32 ft. per mile, a result almost unique in urban railway construction.

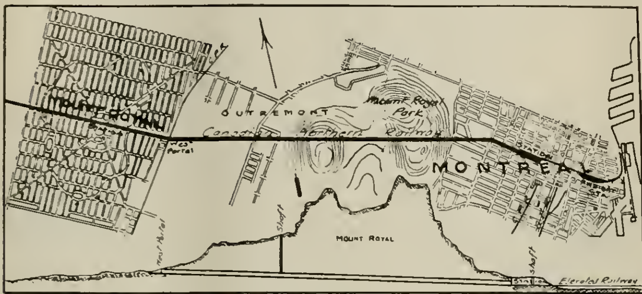
As might be expected the material through which the tunnel is driven is nearly all rock. Near the western portal for some 200 yds., surface clays and gravels predominate. Then comes the Trenton limestone lying in almost horizontal and undisturbed beds nearly to the base of the steeper slope of the Main mountain mass. Next occur some crystalline rocks and under the mountain itself there is igneous rock known to the geologists as essexite. On the east side the limestone is again met with, and some excavation in it is necessary to the very end, but the roof is in a very soft plastic clay for a distance of nearly half a mile and this portion of the tunnel was the most difficult of the whole to build. Had these clays occurred in open country such as that at the west portal the problem would have been comparatively simple and an open trench might have been excavated and subsequently filled. Unfortunately the section in question was under a city street and interference with traffic, sewers, gas and watermains had not only to be avoided, as far as possible, but any settlement of the foundations of adjoining buildings had to be prevented. So serious was the danger of this condition that a shield was used for the entire distance and the roof was arched in with concrete blocks moulded on the ground to the shape of the arch and set in place by specially designed machinery. In spite of this, some little settlement took place, but the resulting damage was small.

The tunnel provides for a double track and this particular portion of it



FORM OF DOUBLE AND SINGLE TUNNEL ON THE CANADIAN NORTHERN AT MONTREAL, CANADA.

was built with a dividing wall of reinforced concrete. There being only one shaft which could be used for ventilation, it was at first proposed to carry this dividing wall completely through in order to facilitate the change of air, but the operation being electrical with nothing to cause special fouling, such as by smoke. One portal is 100 ft. higher than the other, and this has a tendency to induce a current of air from one end to the other, it was finally decided to avoid the expense until an actual experiment had been made. The double arch, therefore, ends with the concrete block section. It was thought the rock section would stand without lining, being everywhere hard and apparently compact, but it was found to be much cut up with very fine seams and after one or two rock falls had taken place it was finally decided to coat it throughout with a thin lining of concrete. This was the more necessary on account of the overhead trolley wire, which, of course, had to be supported from the roof and would have been rendered inoperative by even a moderate rock fall. The very large suburban traffic, which was also anticipated, made it advisable that no chances of failure or interruption should be taken.

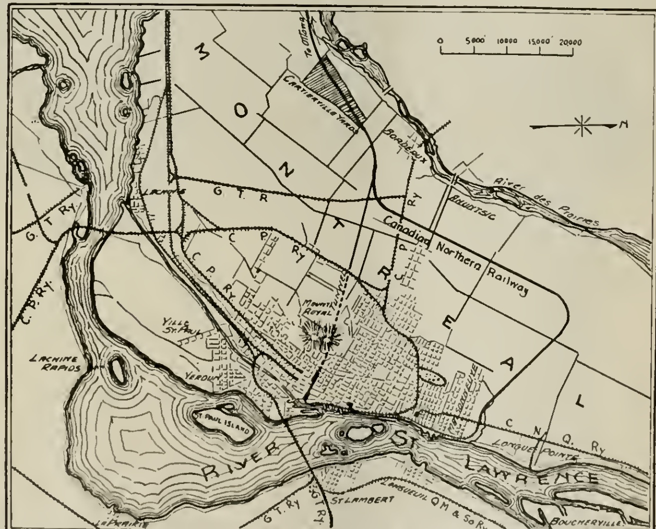


MAP SHOWING LOCATION OF MOUNT ROYAL TUNNEL

A bottom heading was started in 1912, and was carried through from three faces at once, and for a time from four. That is to say, from each end for a time in both directions from the single shaft. The drills were driven by compressed air and mounted on a horizontal shaft held in position by jacking against the rock wall on either side. When a shot was fired the shaft and drills had, of course, to be dismounted and carried back some distance, and before they could be put back after the shot was fired, a considerable quantity of rock debris had necessarily to be removed from the face and the shaft, and the drills had to be carried over this debris, which was a matter of considerable difficulty and time.

In order to obviate this loss of time, a special electrically operated carriage was designed and built upon the works with a long projecting arm which reached over the pile of debris and carried the shaft with its attached drills back out of harm's way and replaced it in position after the shot had been fired. This carriage, necessarily, pretty well blocked the heading and stopped the work of the "mucking" gang, and in order to obviate this delay, an endless belt was arranged which carried the muck back and delivered it to the dump cars behind.

This machine was designed and built on the work at the west portal, and was very successful in its operation. With its help the rate of progress was brought up in the month of May, 1913, to 820 ft. This was at the time a record for hard rock tunnelling in America. It has since been exceeded in the construction of the Roger's pass or Connaught tunnel mentioned and described in the April, 1917, issue of RAILWAY AND LOCOMOTIVE ENGINEERING, page 109, on the C. P. R., although the newer rocks of British Columbia can scarcely be considered as hard to drill as the trappeanncore of the Montreal Mountain.



MAP SHOWING LOCATION OF RAILWAYS ENTERING MONTREAL, QUE., CANADA.

The Mount Royal tunnel, as was expected, was an exceptionally dry tunnel. Only at one point near the western contact between the mountain core and the limestone was there any considerable influx of water, but this was easily taken care of. Inasmuch as over half the heading was driven down grade, this was very fortunate.

The pumps, air compressors, etc., were all electrically driven, and the dump cars hauled by small electric locomotives. The power was obtained from the Montreal Light, Heat and Power Company's lines, not very far from the portal.

Mr. S. P. Brown, formerly connected with the Pennsylvania's tunnel and with the Brooklyn Rapid Transit was managing engineer. Mr. J. C. K. Stuart was chief assistant. Mr. W. C. Lancaster was the designer and superintendent of the electrical work, and Mr. Fisher had charge of the instrumental work of the alignment and grades.

The tunnel itself may now be said to be complete, and tracklaying and ballasting is in progress through it.

The excavation of some 250,000 cu. yds. material on the station site has now commenced. This material being required to pass through the tunnel itself, could not be started before the passageway existed. We are indebted to Mr. H. K. Wicksteed, chief engineer, Department of Surveys, Canadian Northern Railway, and Mr. M. H. MacLeod, general manager and chief engineer of the road.

Mogul 2-6-0 Switcher for the Baltimore & Ohio

Fitted with Extensive Application of Locomotive Specialties

The Lima Locomotive Works, Inc., have recently supplied the Baltimore & Ohio Railroad with a Mogul switcher, which, from all accounts, is giving the purchasers every satisfaction for switching service, in what might be called the transfer work of freight car movement at the terminal where it is placed, which is the city of Chicago. Mr. F. H. Clark is General Superintendent of Motive Power of this railroad.

The use of a pony truck under heavy six-wheel switching engines is regarded, on the B. & O., as a move to secure somewhat easier working conditions on the track. Yard tracks and connections are not always as well kept up as main line tracks. It also permits of a boiler having increased capacity.

The engine as it stands has cylinders 22 x 26 ins., gun iron pistons; piston valves, 14 ins. in diameter; Baker valve gear, and Ragonnet power reverse. The 9½ x 13 ins. The engine truck wheels have an outside diamter of 26 ins.; journals, 5 x 9½ ins. The rigid wheel base is 11 ft., the engine is 18 ft. 11 ins., and the engine and tender, 52 ft. 7 ins. The tender is U-shaped, with slope back tank; number of wheels, 8; diameter, 33 ins.; journals, 5 x 9 ins.; tank capacity, 7,000 gallons; fuel, 9 tons of coal. The weight in working order, on drivers, is 163,700 lbs.; on truck it is 18,600 lbs., and the total engine, 182,300 lbs.; tender loaded, 129,000 lbs. The tractive power is 37,200 lbs., and the factor of adhesion, 4.4. The frames are 4½ ins. wide, spaced 43 ins. between centers.

This engine is pretty well supplied with locomotive specialties, made by the various well konwn supply firms, who have developed many of their appliances to a high degree of excellence. Among them may be mentioned the modern superheater, Brick arch, Everlasting blow-off as it is with the arch, and more heat is extracted from the coal and more water will be boiled. This constitutes an easily attained and positive saving which is absent if the brick arch is not there. It is the more thorough burning of the fuel which permits of extra power being produced.

The Ragonnet power reverse gear is peculiarly useful on a switching engine, as it not only lightens the physical labor of the engineman, but it enables him to keep his head out of the cab window all the time and so see for himself what he is doing. The action of the Baker valve gear has been described in a previous issue, and therefore does not now require recapitulation. The radial buffer, made by the Economy Devices Corporation, does good work on a switcher, where curve radius is short, as it provides for a free movement between engine and tender with the chafing castings in close contact and with a minimum of friction. Verti-

MOGUL SWITCHER FOR THE BALTIMORE & OHIO.

F. H. Clark, Gen. Supt. Motive Power — Lima Locomotive Wks., Inc., Builders

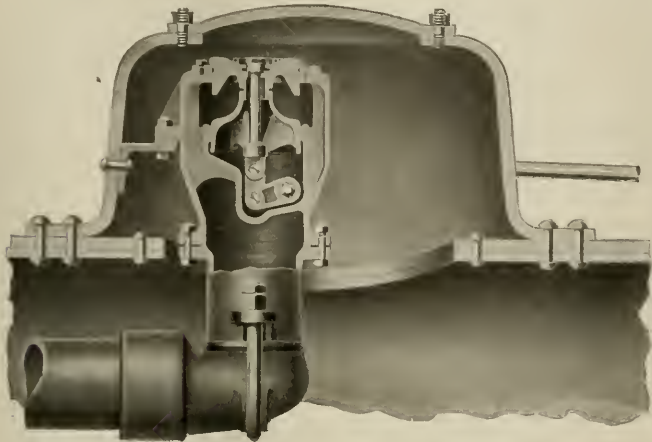
boiler is straight top and radial stayed type, equipped with firebrick arch and superheater; diameter, 80 ins.; thickness of sheets, 13/16 ins.; working pressure, 185 lbs.; fuel, soft coal; water legs at bottom 4½ ins., at top 5 ins.

The firebox material is steel, with a length 83 15/16 ins.; width, 66 ins.; depth front, 76 ins.; depth back, 74 ins.; thickness of crown and sides, ⅜ ins.; thickness of back, 5/16 in.; thickness of tube sheet, ½ in.; firebrick arch, supported by 4 tubes, 3 ins. in diameter; grate area, 38.4 sq. ft. The tubes are 30 of the 5½ ins. flues, No. 9 B. W. G.; 241 of the 2 ins. tubes, .125 in. wire gauge; spaced with ¾ in. bridge at firebox, length 11 ft. The heating surface is made up of tubes and flues, 1,847 sq. ft. Firebox, 164.6 sq. ft.; arch tubes, 26.4 sq. ft., and the superheater, 395 sq. ft. The driving wheels have an outside diamter of 52 ins. and the journals are: main, 10 x 13 ins.; others, cocks, Damascus brake beams, Economy Radial buffer, Commonwealth pilot bumper, Franklin grease cellars, Farlow draft gear, Franklin pneumatic fire-door, Commonwealth tender frame, Andrews tender truck frames, Ashcroft steam gauges, Hanlon water gauges, Sellers injectors, Detroit lubricator, Ragonnet power reverse gear, Coale safety valves, Hanlon sanders, Chambers throttle valve, Baker valve gear, Franklin water joint, Franklin shoes and wedges, Markel rod ends.

The advantages gained by using some of these appliances have been mentioned before now in the pages of RAILWAY AND LOCOMOTIVE ENGINEERING. For example, one of the simplest is the brick arch. It depends for its efficiency on the principle that if 1,000 lbs. of coal is burned on a locomotive grate in the usual way, a certain definite weight of steam is generated thereby. If by the use of the arch the 1,000 lbs. can be more thoroughly burned, cal movements are taken care of between the surfaces in contact, horizontal movements between two distinct surfaces and rolling movements between surfaces spherical in shape. Adjustment is made by means of a wedge and all parts are made of cast steel, and the wearing faces are specially treated.

Three surfaces are here spoken of. The first deals with vertical movements, two are required for horizontal movement, and another for the rolling movement. In one type of radial buffer, twin springs are substituted for the wedge, the chafing faces being the same for both types. This design is used where the tender is required to absorb part of the engine rear-end movements. All movements between engine and tender, whether vertical, horizontal or rolling, are provided for by the radial and spherical surfaces of the chafing plates and the engaging surfaces of what is called the floating block, and thus the spring function is merely that of keeping the surfaces together under a predetermined pressure.

The Chambers throttle valve, used on



CHAMBERS THROTTLE VALVE IN POSITION.

this engine is applicable to engines using superheat, as this one does. The fact that the engine is in transfer service requires a certain amount of drifting in the day's work, and this form of valve takes care of the results of running "shut off" where a superheated steam appliance is in vogue.

In the first place the Chambers throttle valve takes steam from the highest point of the dome and thus avoids syphoning water into the dry pipe. The valve has a single seat, but is fully balanced, which is manifestly easier to grind and keep properly in repair. The valve does not require removal for internal boiler inspection. The parts are standardized so as to be interchangeable with those of any other Chambers valves on the road.

It has been applied to this B. & O. switch engine. The valve, as applied to this engine, is illustrated by our engravings. Some of the principal advantages to be derived from the use of the Chambers valve are: Drifting feature, single seat and separable seat, accessibility to the boiler for internal inspections without removal, non-multiplication of lost motion, graduated opening, standardization of parts, elimination of valve stem packing.

The stuffing box, as applied to this engine, is equipped with packing composed of a brass ring, but experiments have proved that the stuffing box, as shown in our illustration, where a cast iron ring made solid with the shaft, is used in place of the loose brass ring, requires little or no attention.

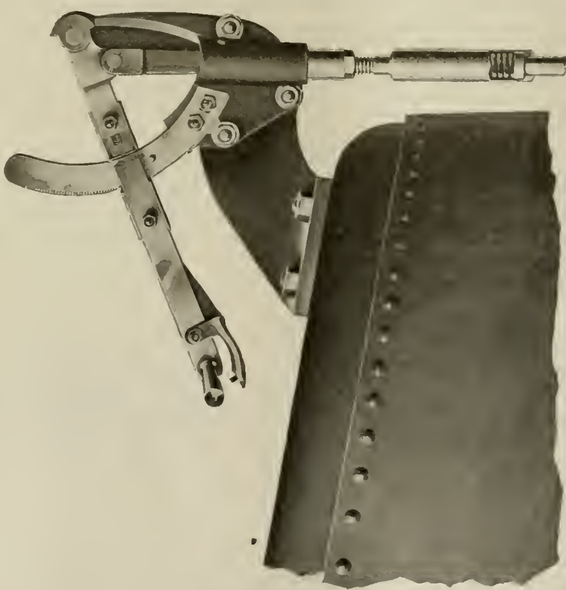
The construction of the valve proper lends itself to application in the dome in such a manner as to provide plenty of room for a man to enter the boiler for internal inspection without removing the valve or breaking a steam joint. On superheated engines this has been of great value, for the reason that after an engine has run for some time there is enough corrosion on the straps, etc., so that when the keys are knocked out there is often enough movement to the dry pipe to loosen things at the front end. This necessitates the taking out of superheater units in order to regrind. The fact that internal inspection is possible in this manner obviates the necessity of an additional man-hole plate for this purpose.

The single valve and seat separable from the head insures a tight valve. It is well known that a small leak, which on a saturated engine gives only a little trouble, becomes a serious matter on a superheated engine, owing to the steam passing through the units and increasing in volume.

While very few records are kept of throttle valve grindings, Chambers throttles have been known to run for at least two years without any attention being given to the grinding of the valve, and it is common for engines to run from shopping to shopping without regrinding.

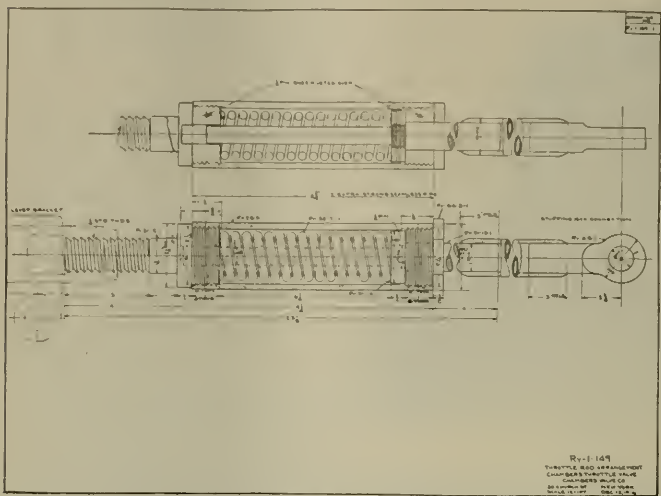
The separate seat just mentioned is composed of a ring of weathered cast iron finished all over so that internal strains are gone, and heat does not affect the shape of the seat. The ring is so made as to give clearance all around the outside so that any distortion in the head does not affect the ring. It will be seen, therefore, that the ring presents a perfect seat to the main valve at all times. All cranks and levers that go into the Chambers valve are of the same length, so that any lost motion that might develop would not be multiplied by unequal lengths of cranks.

The Chambers valve is a positive, flexible, drifting valve which has been recognized by a large number of trunk line



CHAMBERS THROTTLE RIGGING IN LOCOMOTIVE CAB.

roads as a good device for overcoming this serious and expensive difficulty. The valve has a small valve in the top of the main valve, which opens first one-quarter inch, and closes last. There is a notch on the top side of the quadrant and a dog on the lever engages with it when the valve is being closed at a point which insures the main valve being closed and the



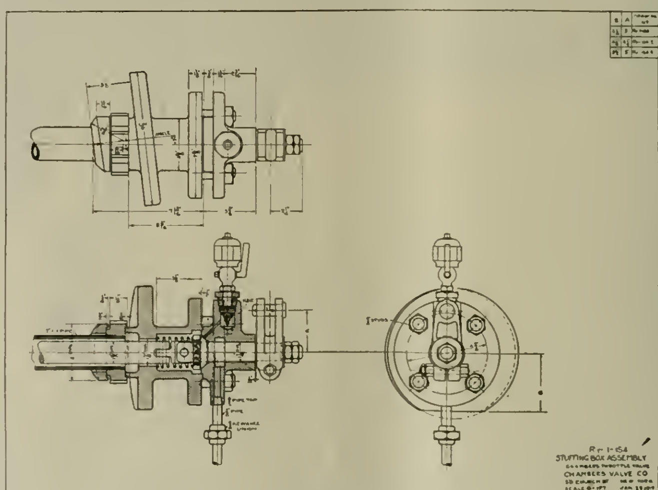
THROTTLE ROD ARRANGEMENT—CHAMBERS VALVE.

small drifting valve open. This provides enough steam on a large superheated engine to drift at the rate of forty to fifty miles per hour and maintains sufficient steam in the cylinders to exclude the air, which, if allowed to enter the cylinder, would cause trouble. The important feature in drifting is never to completely stop the flow of steam to the cylinders. It is the first few revolutions after shutting off that do the damage. It has been proved that three or four revolutions are sufficient to form a vacuum and so cause air to enter. Enginemen who have become accustomed to handling this valve say that they operate it automatically and almost without thought.

The Chambers throttle valve is wholly balanced with steam through the small balancing drifting valve in the top of the main valve which opens first. Steam enters into what is known as the balance chamber exerting an upward pressure in the balancing piston. This steam does the work of levers, bell-cranks and fulcrums on other valves. The balance is positive and by connecting with cranks that maintain the same dimensions at all times and which are equal in length, connecting with the differential fulcrum lever, the result is but 30 lbs. on the handle of the lever to open the valve. In operating, the first movement of the throttle lever from the closed position rotates the operating shaft in the stuffing box with a corresponding upward movement of the inside crank and an upward movement of the valve stem, which lifts the balancing drifting valve. The steam enters the balancing chamber and fully balances the main valve. The shoulder on the valve stem engages the boss on the under side of the balancing piston, which, in turn, raises the main valve. When the main valve and the balancing drifting valve are closed, no steam is in the standpipe or covering pipe connecting the head and the stuffing box, thus making it possible to inspect and repair, if necessary, the joint in the stuffing box which prevents stuffing box steam leaks. The removal of the stuffing box from the back head to the side of the dome eliminates steam leaks in the cab and allows for better arrangement of steam gauges, lubricators, etc., on the back head.

The throttle rod arrangement shown in our half-tone illustration is designed to overcome the differences in expansion between the boiler and the throttle rod. The lever and the stuffing box being rigidly connected to the boiler, move with the boiler. The expansion takes place as the engine is being fired up. The throttle rod being in the open is not affected. The Chambers throttle application takes care of this difference with the use of this arrangement, by having an encased spring with an initial compression of at least 350 lbs. In normal operation the rod can be considered as being solid. As the engine cools, the contraction in the boiler is taken care of by the further compression of this spring. As the engine is again fired up the valve is kept closed by the spring exerting a pressure against the rod, moving the rod correspondingly a distance equal to the expansion of the engine.

As the Chambers throttle valve is not equipped with any form of packing that could grip the rod, and the use of a universal joint in the operating shaft of the stuffing box eliminates the possibility of binding of this shaft, it can be readily seen that no power is required to close the valve, and the compression of the spring is more than ample to keep the valve closed, and also to have it inoperative during normal use of the valve. As the possibilities of binding are eliminated the valve closes of its own weight. It must be possible, after disconnecting the throttle rod from the stuffing box, with the engine cold, to open the valve by pulling on the outside crank and on releasing,



STUFFING BOX ARRANGEMENT—CHAMBERS VALVE.

the valve will close of its own weight.

The Coale safety valve and muffler has been applied to the engine. The peculiar design of this valve with the small diameter of guides reduces the friction of the lower guides, and brings the guiding surfaces close to the plane of seat. The ball socket bearing in the valve is also made close to the plane of the seat, and spring buttons having corresponding bearings which ensure good alignment of the various and complex working parts.

Some of the principal dimensions are here appended for reference: Gauge of track, 4 ft. 8½ ins. Driving wheel diameter, 52 ins. Fuel, kind, soft coal. Cylinders, diameter, 21¾ ins.; stroke, 26 ins. Boiler, diameter, 80 ins.; pressure, 185 lbs. Firebox, length, 83 15/16 ins.; width, 66 ins. Wheel base, rigid, 11 ft.; engine, 18 ft. 11 in. Engine and tender, 52 ft. 7 ins. Maximum tractive power, 37,200 lbs. Factor of adhesion, 4.4. Tubes and flues, number, 241, 30; diameter, 2 ins., 5½ ins.; length 11 ft. Weight in working order, on drivers, 163.700 lbs.; truck, 18,600 lbs.; total engine, 182,300 lbs. Tender loaded, 129,000 lbs. Grate area, 38.4 sq. ft. Heating surfaces, tubes and flues, 1,847 sq. ft.; firebox, 164.6 sq. ft.; arch tubes, 26.4 sq. ft.; total, 2,038 sq ft.; superheater, 395 sq. ft. The engine is doing good work and has met the approval of those using it.

The Operating Side of a Railroad

By A. J. STONE, Vice-President of the Erie Railroad

(*Continued from page* 188, *June*, 1917)

To go into details of "the operating side of a Railroad" would undoubtedly be tedious for you, and many of you who come in contact with the operating work would find a statement of it rather dry. However, since that is my assigned subject I must give it some attention.

Primarily and fundamentally a railroad is built and operated for the purpose of moving passengers and commodities from one place to another in safety, with promptness, and with profit to the railroad. These specifications sound simple, but the detail of their consummation is very great. A person taking a trip from New York to Chicago enters the train in New York and thinks little of the great machine which is put in motion to get him to destination. In the first place, he is one of the pasesngers enjoying the use of equipment and locomotives to the value of a half million dollars before arriving at Chicago and the highway over which he travels has been built at a cost of, say, two hundred thousand dollars a mile, thus representing an expenditure of two hundred million dollars. It ought to be worth two cents a mile to ride on a property which cost two hundred thousand dollars a mile, and which if built for passenger business alone could never be self-sustaining except at a rate of several times higher than the existing passenger rate. If the railroads depended upon their profit from passenger service to pay their fixed charges they would all be bankrupt. It will be appreciated that in order to accomplish the one thing of carrying a passenger between New York and Chicago in safety and with celerity a great organization must be employed and regulated.

Those who contribute to this accomplishment are not necessarily engaged on the train. Starting with the pine forests of the South, where the ties are manufactured and on up to the conductor who punches your ticket or makes a record of your pass, there is a wonderful army who are contributing to the comfort and safety of your trip. The trackmen who maintain the track in a safe and comfortable condition, the laborers and mechanics who build and maintain the cars and locomotives used, the vast industrial plants engaged exclusively in the manufacture of railroad material, the signal and interlocking system men who regulate the safety of movement under the jurisdiction of the train dispatcher and division officers, the car inspectors who examine the equipment as it passes from terminal to terminal, and the unseen force of division officials and general officers who give their constant attention to the means by which your trip may be successfully accomplished, are all necessary factors in the work.

The movement of freight also involves the use of this expensive machine and its extensive organization. One of the differences between the movement of passenger and freight is that the passenger will load and unload himself and will look out for his own safety on the trip in so far as assault and robbery is concerned. The transportation of freight requires initial terminal expense in loading and final terminal expense in unloading and constant supervision en route, to prevent delay, theft or miscarriage. The large bulk of the freight is not moved on any definite schedule, but with the general understanding, which is very positive, that it must be handled promptly and satisfactorily to meet competitive conditions.

Competition for traffic is very keen and a railroad, to exist, must obtain its share of the competitive traffic. In other words, the local business to and from non-competitive stations would not maintain a trunk line railroad. There is, therefore, a keen effort to so handle traffic as to command the business.

In speaking of "The Operating Side of a Railroad" those who are in the operating department are apt to forget that there is any other side to the railroad work and that without the results of the traffic, accounting, financial and construction departments, the operating department's functions would wither. A balancing and co-ordination of all of the departments of a railroad is necessary for the common good and that is one of the functions of the president of a railroad. The tendency of the operating department to handle business in the cheapest possible way without proper regard to competitive conditions, or perhaps public necessity, and the tendency of the traffic department to solicit unprofitable business and enter into unprofitable arrangements, such as the naming of too low a rate, agreeing to unwarranted fast time, involving unwarranted expense, which soon is imitated by competitors to the disadvantage of all, makes it necessary that these things be regulated by the president, upon whom in the end falls the chief responsibility for results. It may be said, however, that the ability of the traffic and operating officers can be gauged to some extent by the amount of attention it is necessary for the president of a railroad to give to the co-ordination of such matters.

To be successful a traffic officer and operating officer must each have sufficient insight into the business of the other to so regulate these matters as to secure satisfactory results without the intervention of higher authority. A proper understanding of the real functions and purpose of a railroad insures this result.

The operating department of the railroads is subject to the regulations of Congress, the Interstate Commerce Commission and forty-eight State commissions, in addition to the mayor and council, the village constable and the justice of the peace of every city and borough through which the road passes. To satisfy the exactions of all of these various constituted authorities is no small task, but has to be done, and a large part of the negotiations involving complaints from these sources is carried on by the division officers without reference to, or without the knowledge of, the general officers. Matters involving the action of higher bodies in authority, such as the State Commissions, the Interstate Commerce Commission, etc., are, of course, handled through the general office with the aid of the legal department.

Among the regulations imposed by the various authorities are such things as these: A train or engine crew may not be held on duty longer than sixteen hours without eight hours rest; a locomotive may not be dispatched from a terminal without complying with all of the requirements of the Locomotive Inspection Bureau of the Interstate Commerce Commission and these inspectors are swarming on railroads. A car may not be permitted to leave a terminal if it has missing a grab iron or uncoupling lever, or with defective brakes or couplers without violation of the Interstate Commerce Commission. The coupler of a locomotive or car may not be less than 31 inches nor more than 35 inches above the top of the rail. The piston travel in an air brake cylinder must be within prescribed limits, and the hand brake apparatus must be in perfect condition. These are requirements of law, in addition to which there are requirements of the American Railway Association, the Master Car Builders' Association, and the local railroad officials as to safety in matters pertaining to the depth of flanges, worn condition of treads of wheels, etc. The division officials must know that each member of an engine and train crew has had a specified amount of rest before going on duty. That responsibility rests with the railroad and not with the employee, although the railroad has no jurisdiction in the matter of compelling an employee to actually rest when given the opportunity. In some States the authorities require the use of electric head lights. In other States an automatic arrangement is required for use of the firemen in opening and closing the fire box door. The local health authorities insist upon a certain quality of ice and drinking water being used, which is very proper in itself. There are numerous other regulations to which a division officer must conform, the virtue of which I am not disparaging. I am simply reciting these exactions to give you an idea of the nature of the problem confronting division officers in keeping within the law.

The various inspectors who are employed for the purpose of seeing that the letter of the law is obeyed are recruited from labor organizations and are necessarily active in order to justify the continuance of their employment. These men pay little attention to the spirit of the law, but insist upon its exact application in accordance with the letter. At a time when the railroads are congested with traffic, the public is clamoring for relief and one branch of the Interstate Commerce Commission is sitting in conference to determine ways and means by which the traffic can be moved, another branch from the Locomotive Inspection Bureau is busy seeing how many locomotives they can put out of service, and many times because of some mere technical violation of the letter of the law. Instances have come to my notice where a whole terminal has been tied up for hours because certain switch engines, in a temperature away below zero, had trivial steam leaks which in no manner interfered with the operation or safety of their performance.

Railroads of the United States today are employing twenty thousand able bodied men in the train service as full crew brakemen, all of whom could be eliminated without in any manner affecting the safe operation of the service. Think what it means to take twenty thousand able bodied men at this time when labor is so scarce and by act of law put them in unproductive employment. If this country could marshal its unproductive force of Government inspectors, supervisors and clerks in the various bureaus, together with the twenty thousand full crew brakemen and devote the energy of this army to the building of ships, the manufacture of war material or employ them in any capacity of productive efficiency, it would benefit thereby to an extent which you can all estimate.

We hear lectures on efficiency and economy from every quarter, and efficiency and economy are absolutely necessary and will become more so as time passes unless an early end of the war is reached. The nations abroad are fighting our battle with Germany and it is well for this country that they are so engaged; otherwise, our battle with Germany might be fought on our soil. It therefore behooves us to realize and appreciate that it is *our* battle which is now in progress and it is just as important that we furnish men and amunition, food and supplies to our allies as it would be to furnish these things were we fighting Germany alone. Indeed we should feel extremely thankful that it is fortunate that Germany is hemmed in by our allies and is not able to reach our shores. The defeat of Germany is absolutely necessary to the safety of this country.

The Germanic forces are estimated to be twelve million armed men—one-eighth of the population of the United States. Think what it would mean to organize an army to contend against the seasoned army of Germany man for man. To do this the United States would become an armed camp and the agricultural and industrial work necessary to maintain the army would call for the employment of every woman, child and old man in the country. A realization of these facts should bring us to a hearty sense of obligation to co-operate with the Government in the work in hand. That co-operation can best be accomplished by increasing the efficiency of the railroad upon which we are employed—each in his own way meeting the problems at hand with loyal, effective and patriotic effort, and effort that is not spasmodic but continuous.

Odd Old Names.

In a recent issue we published some notes about odd names given by trainmen to locomotives and to other things, but we missed a few names that are really worth while.

George Richardson, inventor of the well known safety valve, although a locomotive engineer himself, had no idea of calling his safety valve a "pop" until the trainmen conferred that name upon the device. The Mason-Fairlie engines, numerous at one time on the South Park and other roads, were called "Jim Crows." The old locomotives with sloping fire boxes were always called "Fan Tails," and Cushing's modification of the Wootten dirt burner was popularly known as the "mother hubbard" on account of the position of the cab.

On many roads the injector was long called the "refrigerator," a "cooler" or a "squirt" or the "gun." The vacuum brake was known as the "wind jamber," the caboose was called the "dog house," while the speed recorder to this day retains the popular name of the "Dutch clock." An odd form of consolidation engines on the Missouri Pacific are known as "Alecks."

Petition from Can. Nor. Employees.

A large number of employees of the Canadian Northern presented a memorial to Premier Borden of the Canadian Government protesting against putting into effect the nationalization of the Canadian Northern and Grand Trunk systems. It quotes with approval the conclusions of the minority report, made by A. H. Smith, "the only practical American railway man on the Royal Commission." In conclusion it contends that if the Canadian Northern is given some further assistance, especially to secure equipment, the company will be able to work out its own salvation.

Increase in Price of Railway Supplies.

Just what it is costing railroads to live is shown by figures given out by R. J. Clancy, of the Southern Pacific company, who finds that in two years costs in some cases have advanced as much as 488 per cent. A few of the increases in cost follow: Locomotives, 75 per cent.; passenger cars, 50 per cent.; freight cars, 60 to 80 per cent.; spikes, 130 per cent.; boiler steel, 301 per cent.; white lead, 353 per cent.; manganese, 488 per cent.; nails, 103 per cent.; rivets, 200 per cent.; boiler flues, 169 per cent.; couplers, 112 per cent.; cast iron pipe, 173 per cent.; axles, 227 per cent.; steel tires, 133 per cent.; bolts, 120 per cent.; fire box steel, 231 per cent.; journal bearings, 121 per cent., and bar brass, 165 per cent.

Pistons, Valves, Rings and Bushings

This tendency to overheating was particularly noticeable in the pistons, valves, rings and bushings of the first of the locomotives equipped with the superheating appliances. We recall having an opportunity of examining the first two locomotives equipped with this device on the Delaware, Lackawanna & Western Railroad ten or twelve years ago, and it is no jest to state that the question of the composition of the metallic packing and lubrication was then a burning one. American mechanical ingenuity has, however, completely overcome these difficulties, and today there is no more trouble in controlling the effects of the high temperature of the superheated steam engines than there is on those using saturated steam.

Generally speaking, the changes in the design of the parts has not been revolutionary, but the improvements in the quality of the metal as well as the purity of the oil in meeting the high degrees of temperature have both been particularly marked. During recent visits to some of the leading shops in the South, and also in New England, we found that the use of common cast iron in bushings and rings is rapidly disappearing, and the use of alloys developed from what was known as gun metal, and which has been in use in varied degrees of superiority over cast iron for over a century has come into general favor. This is particularly true in regard to the use of Hunt-Spiller gun iron, which has apparently a decided preference over special grades of cast iron which have been extensively experimented for use in the construction of the parts to which we have referred.

The arrangement of piston valve rings or packing rings in most common use is

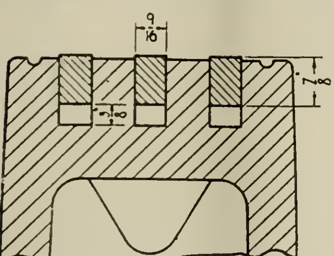


FIG. 1. THREE RING PISTON PACKING.

shown in Fig. 1. Piston packing rings of the design shown in Fig. 2 are also largely in use and made of the same superior quality of metal to which we have already referred.

In regard to the number of ports in the piston valve bushings the tendency seemed to be towards being an even number of ports, so that the bridges are opposite to each other, thereby rendering the calipering of the bridges each of accomplishment and ascertaining the amount of wear. The width of bridges varies from 17/32 to 1¼ in. The duration of the bushings in some instances exceeded a service of over 300,000 miles. Rectangular ports seemed to have a preference in popular use over either diagonal or diamond-shaped ports. It is considered good practice to turn the bridges

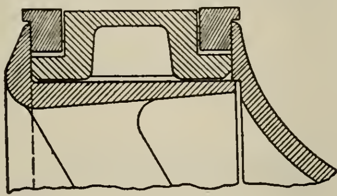


FIG. 2. PISTON VALVE L RING.

1/32 in. smaller in diameter than the rest of the bushing on the outside, so as to obviate the possibility of cracking or burring the edges of the ports when the bushing is pressed into position. The mileage of piston-valve packing rings showed a maximum of 100,000 miles, and although some figures are as low as one-half of this estimate, the average showed that there were about three changes in rings occurring before it became necessary to make a renewal of the bushing. Considerable variations there are in the formation of the rings, what are known as the "Z" ring having the advantage that in the event of being broken in service they are held in place by reason of their shape. It may be stated, however, that as breakages are so extremely rare that this form of ring has not so far been much called for. Fig. 3 shows the formation of this ring, and it will be seen at a glance how, in the case of breakage, it is retained in place. Fig. 3 also shows the general type of bullring in use, and in the element of durability of this attachment those made of the Hunt-Spiller gun metal excels the cast iron commonly in use by at least one-third.

The clever devices introduced by the American Balanced Valve Company in the arrangement of the rings on their balanced valves also give very favorable results and are highly spoken of wherever they have been introduced. They are made with double admission and double exhaust, with internal or external admission.

As shown in Fig. 4, the packing rings are ingeniously arranged whereby the frictional contact of the packing against the cage is induced by a system of wedges operated by a pressure of steam admitted through small openings in the body of the valve. The action is automatic, self-maintaining and almost frictionless, as the weight of the valve and its attachments is carried on the double-ended valve rod which retains its true center, with the result that when the throttle is shut and the engine drifting, there is literally no pressure on the sides of the cage whatever. For a clear understanding of this masterly device, it will be seen in Fig. 4 that the snap rings are numbered "I" and are put in place under tension. Their outside walls are straight, and fit against the straight walls of the follower and spool. The inner walls of the snap rings are beveled, forming a cone. Next to the snap rings are wall rings, "2," the outer sides of which are beveled to fit the cone of the snap rings. These are called wall rings because they form the inner walls of the snap rings, and are uncut, non-expansible steel rings. Between these wall rings, in the center, is placed a double coned expansible ring, called a wedge ring, numbered "4," the sides of which are beveled to fit the inner sides of the wall rings. This wedge ring is put in place under tension, and its effort to expand presses the two wall rings laterally against the cone sides of the snap ring numbered "1." This prevents any lateral wear occurring in all the rings. A wide ring numbered "3" interlocks into each snap ring, and completes the packing, and also performs two important functions, first, it carries the snap rings across ports while the engine is drifting, and, second, it keeps the snap rings parallel and of equal diameter, so that the wide ring and the two snap rings form a very flexible and wide packing ring. All the rings are free to turn round.

The degree of angle on the cones, it will be observed, is much greater on the double tapered wedge ring than on the snap rings. These angles are so calculated that while the pressure is underneath all the rings, the leverage of the double

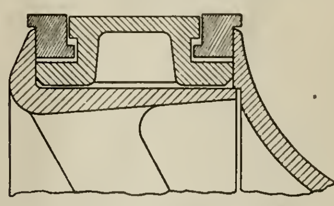


FIG. 3. PISTON VALVE Z RING.

tapered wedge ring pressing the solid wall rings against the cones of the snap rings, is just sufficient to prevent the snap rings from further expansion but not sufficient to reduce the snap rings in diameter. In brief the pressure of the snap rings against the valve chamber depends entirely upon the angles, and it can, therefore, be regulated to any desired degree, and completely prevent an excesive degree of pressure by the rings against the valve chamber.

Under these conditions it will be seen that the rings will remain at the smallest diameter of the cage, so that it is very important that the valve be put into a true cage to begin with, in which case the cage will retain its exact diameter.

In regard to lubrication the corrugated surface of the wide ring furnishes means to retain in the furrowed spaces an extended space or receptacle for carrying the lubricant completely around the inner face of the valve cage or bushing, and has been found to be an excellent preservation of constant lubrication. In the illustration, "5" shows a section of the threaded spool, and "6" the threaded follower, of which there are two on each valve—one on each end.

In the matter of cylinder bushings cast iron is much used in freight locomotives, some using what is known as steeled cast iron for the same class of service. The larger number make use of the improved gun metal in the cylinder bushings of passenger locomotives. The thickness of the bushings vary from ⅝ in. to as much as 1½ ins., the most popular form being a straight bushing extending from the front cylinder head to the back cylinder head. The steam opening in some cases has one or two bridges and in others has only one opening, as shown in Fig. 5. The period between renewals depending much on the original thickness of the bushing an estimate of the service in mileage is, of course, variable.

The improved gun metal is also largely used for piston packing rings on the

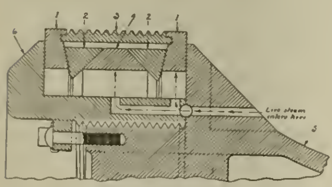


FIG. 4. TYPE OF PISTON VALVE DESIGNED BY THE AMERICAN BALANCED VALVE COMPANY.

superheated locomotives, cast iron not being much in evidence even on the lighter type of engines using saturated steam, the service in mileage of the superior Hunt-Spiller gun metal rings being as high as 70,000 miles while the maximum service obtained from cast iron scarcely approached, under the best conditions, 50,000 miles.

Regarding piston heads and bull rings, cast iron is still much in use although the more durable metal is gradually supplanting it, while some roads are said to be experimenting with a brass or bronze wearing face cast on the outer rim of the piston. As far as the respective figures could be obtained in regard to the element of durability, the cast iron did not approach 60 per cent. in mileage of that shown by the superior gun metal. Fig. 6 shows the details of a steel plate type piston with a bull ring increased in width at the bottom for the purpose of affording a larger bearing area in cases where the more extended bearing is required.

As to the use of the extended piston

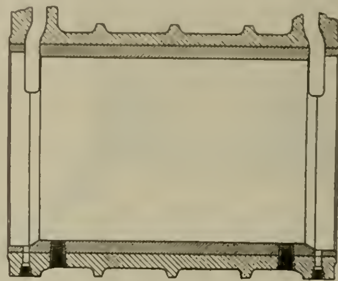


FIG. 5. CYLINDER BUSHING.

rod, it does not seem to be growing in favor, but on the contrary is being eliminated in the lighter type of locomotives. What is known as the Cole type of extended piston rod is the most common in use. Its principal feature is a miniature crosshead at the front of the extended rod, which rests on a cylindrical bearing surface located upon the cylinder head. In the event of the inevitable wear of the bearing it is easily lined up by inserting liners between the small crosshead and its body. The extension guide is self-centered, and requires no central adjustment. Open-hearth steel is generally used on these extended rods. They are in use on a number of the low pressure cylinders of the Mallet type of locomotive, and may be said to have been found unnecessary in cylinders less than 20 ins. in diameter.

In the use of these devices it may be stated that the use of automatic drifting valves delivering some steam to the valves while drifting is quite common in the case of locomotives equipped with superheated appliances.

We cannot close this article without referring however briefly to the service rendered by the various companies engaged in the manufacture of packing for piston rods, valve stems, throttle rods, air pump piston rods and all varieties of movable rods under pressure. Among these the products of the Garlock Packing company, Palmyra, N. Y., seem to meet every emergency. While the increased degrees of temperature and steam pressure do not, generally speaking, affect these devices to the same extent as the more exposed parts that we have referred to, there has been a call for improvement in material and a strengthening in parts which has been met with a degree of promptitude that has silenced criticism. The same may be said of the products of H. G. Hammett, Troy, N. Y., particularly in regard to the continued use of the Richardson balanced slide valve, over twenty thousand of which are now in service, and also of what is known as the trojan metallic packing, which in point of durability is possessed of merits peculiarly its own, as well as pneumatic bell ringers, link grinders and other devices perfected under the skillful hand of Mr. Hammett and his clever staff of engineering assistants, while the perennial popularity of the manufactures of the United States Metallic Packing Company, of Philadelphia, seems to grow with the growing years. Not the least noteworthy of the latter company's products are the pneumatic sanders which, in spite of new devices that rise up full of promise, still grow in popular favor, and bid fair to hold their well-earned popularity.

In alluding to these three companies engaged in some instances in the manufacture of railway appliances, adapted for similar purposes, it would be invidious to make comparisons because while one star differeth from another star in glory, clusters of stars of the first magnitude that resemble each other so nearly in brilliance that the unaided eye but distinguish a surpassing variety, but must content itself to leave them alone in their glory. In this regard we have observed in our journeyings to occasional shops where they continue to turn out fairly good metallic packing of their own,

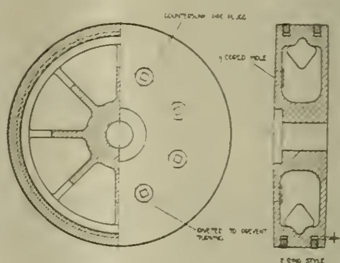


FIG. 6. BOX TYPE PISTON.

seemingly good enough to meet the requirements of the lighter kinds of service, but in general service and particularly in the modern, high-powered type of locomotives, they cannot, as may be expected, hope to successfully equal those manufacturers who have given a life study to the needs of a growing service, and who have perfected devices essential to the manufacture of their products that are utterly beyond the reach of even the best equipped railroad repair shops because the supply people do this work and only this, and they can be relied upon in those things in which they have concentrated their attention.

Heating of Locomotive Feed Water

The Advantages of the Feed Water—Using a By-Product of Locomotive Operation—Heat and Temperature—How the Economy Is Accomplished—Not Only Desirable But an Economic Duty—Waste of Heat and How Prevented—What Coal Is

In the ordinary conception of a locomotive, it is usually thought of as a steam producer, and the generation of steam with the least expenditure of coal is the thing that is desired and striven for. In examining the beneficial effect of the feed water heater it is necessary to alter the viewpoint. Consider the locomotive boiler as a manufactory of heat, on wheels. The diagrams we present in this article are endeavors to properly account for the use of heat, and not the production of steam. Heat is not temperature, it is something quite different, and is measured by an appropriate unit. The temperature of a body is the measure of its power to communicate heat to other bodies. A stove with a temperature of 300 degs. Fahr. has the ability to communicate heat to the human hands if they are below that figure, say at 100 degs. Fahr. One can, under those circumstances, warm one's hands at the stove.

Heat is a measurable quantity, and the unit employed is the amount required to raise one pound of pure water through one degree on the Fahrenheit thermometer. This unit is the B.T.U. or British Thermal Unit. The word British is used to denote the fact that this unit is not based on the French metric system. If we have one pound of water at 212 degs. Fahr. it contains 180 B.T.U. (the freezing point of water is 32 degs. Fahr. and 212 minus 32 is 180).

In diagram No. 1, we show a stream of heat arising from the burning coal on the locomotive grate. In it 4,320 lbs. of coal is burned in an hour, or 60 lbs. per square foot of grate surface. It gives 60,000,000 B.T.U. This volume of heat ascends and passes under and around the brick arch and into the flues. If we follow the heat again, and express the total in 100 shovelfuls, each containing an equal weight of coal, we shall find that out of the 100 scoops of coal thrown into the firebox 27 of them pass into and though the steel of the firebox, and the equivalent of 41.5 goes in to the boiler tubes, making about 63.5 in all.

Losses are by sparks, cinders, hot and unburned gases which go out of the stack, amount to 22 shovelsful (this is where the brick arch is of great use, for without it, 32 shovels would uselessly go out of the stack). Coal absorbed as heat by the tubes is equivalent to 41.5 shovels and the way this figure is arrived at is shown in the table. Heat measured in shovels which goes to the firebox and heats the sheets is equal to about 27 shovels. Coal dropped in the ashpan is equal to a loss of 2 shovels, and the coal absorbed in the superheater equals about 7½ shovels. This makes a total of 100 shovelsful of coal.

TABLE No. 1.

Heat of Combustion in 100 Shovels of Coal

Where heat goes.	No. of shovels.
Ashpan	2.0
Absorbed by tubes	41.5*
Out stack	22.0
To superheater	7.5
To firebox sheets	27.0
Total	100.0

Note:
* To and through tubes 63.5
Out stack as hot and unburned gases, smoke, sparks, etc. ....22.0 †
Absorbed by tubes 41.5
† If Arch was not used this figure would be 32.0 shovels.

Shovels full of coal vary from 14 to 20 lbs. and the average, 16 lbs., is a fair estimate to follow if the reader desires to go further into the subject and to find the weight of coal consumed. In Table No. 2 the heat of steam is accounted for in shovels and the loss out of 100 shovels is easily seen. It is so great that every legitimate and scientific effort or appliance to lessen it is not only desirable but it is imperative that the locomotive should have it.

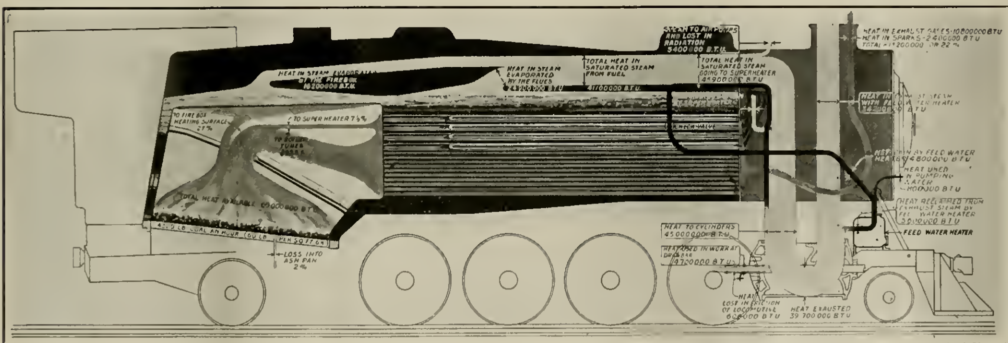
TABLE No. 2.

Heat in Steam Given in 100 Shovels of Coal

Where heat goes.	Shovels Used.	
Exhaust steam	55*	
Air pump and radiation	8	
Loss at stack	22	
	85	Total
	7	Useful work
	92	
	8	Reclaimed by the feed water heater
Total	100	

Note:
* 55 out stack
8 Reclaimed by feed water heater
63 Amount lost without the feed water heater.

In this table the heat of steam measured in shovels of coal burned, which goes up the stack is 55, and the way this figure is got is shown in the foot note. The air pump, and general radiation, use up 8 shovels and the loss at the stack amounts to 22. In useful work 7 shovels appear and 8 represent the amount reclaimed by the feed water heater. The figure given



HEAT DIAGRAM, NO. 1, OF ENGINE WITH FEED WATER HEATER APPLIED.

in Table No. 1 for the superheater, viz.: 7½ must be further explained. This heat taken for drying the steam, 7½ per cent., is accurate enough, as far as the figure goes, but the steam is endowed with a quality (higher temperature) which enables it to withstand the heavy and inevitable losses in cylinder condensation which steam, saturated or superheated, is compelled to encounter. These qualities of dryness and increased temperature of 7½ per cent. of heat subsequently enable the steam so treated to render service, equivalent to 25 per cent. gain.

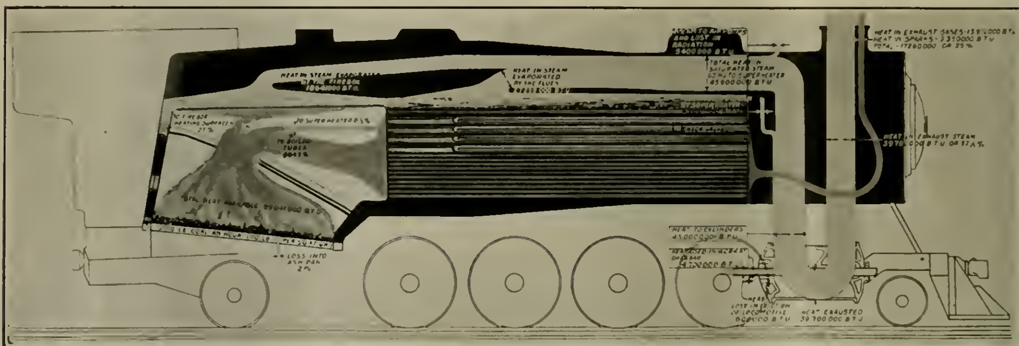
Heat when applied to steam does its work of drying very readily and directly, and is like heating a bar of iron in a blacksmith's furnace. Heat applied to water in sufficient quantity to turn it to steam does not act in the same way all through. Up to 212 degs. Fahr. all goes well with water open to the air, and the water takes up heat much as the bar of iron in the blacksmith's shop. At 212 degs. Fahr. a decided change takes place, and heat seems to be lost and 965.7 B.T.U. disappear into the water before any steam comes off. This is called latent heat. Boiling water under pressure requires still more heat than when it is at 212 degs. Fahr. Steam at, say, 200 lbs. pressure is at a temperature of 381.6 degs. Fahr. It therefore contains more British Thermal Units than steam at 212 degs. Fahr. and when superheated it contains still more thermal units, and is dry, so that it can meet the comparatively cool cylinder walls practically without condensation.

The function of the feed water heater is to raise the temperature of the water which is about to enter the boiler. This is sometimes called preheating. To do this some of the heat in the exhaust steam passing out of the stack is made to give up what would otherwise be waste heat and apply it to heating the feed water for the boiler. A WAB pump modified to handle water is used to force water into the boiler and this takes live steam; but the escaping heat contained in the exhaust steam supplies the required basis for producing the economy of feed water heating. It is in fact an operation similar to that performed in many commercial undertakings. It makes use of a by-product of locomotive operation (viz., waste heat), and applies it to a useful purpose. The gain in heating the feed water, as far as the engine is concerned, far surpasses the loss caused by the operation of the pump.

The apparatus itself, that is, the feed water heater, is placed on the front foot plate close to the smokebox. It therefore draws exhaust steam, at its hottest, from the exhaust passages in the cylinders, and does not interfere with the blast. The position of the feed water heater thus well in front, is such that it is insulated and in severe weather it is protected from snow and cold rain. The apparatus is a cast iron vessel with two heads, inside, one at each end, like the round heads of a boiler, and having a number of small, plain, smooth, brass tubes inserted in it like tubes in a boiler. The feed water from the tender enters the space at the end of the flues and is forced through them by the action of the pump. Each of the plain brass tubes contains a corrugated spirally wound ribbon of flat brass, and this form of agitator is probably the best devised anywhere. The feed water is swirled along by the spiral form of the agitator and is tumbled over and over in its course by the minute corrugations, resembling crimps or small "tucks" in the ribbon of brass. In this way the thoroughly agitated water is all forced to meet the radiating surface of the plain brass pipes, and all the heat contained in the waste and hot exhaust steam is readily given up to the feed water. This by-product (exhaust steam) is made to contribute its quota to the economy of the boiler. The exhaust steam heat is reclaimed in order to heat the feed water, as much as a broken steel part is reclaimed when it is welded together again, and made to take an effective place amid the useful appliances for successfully operating the locomotive.

When the engine is on a long drift or is standing still, no exhaust steam is available, but the device contains an arrangement for turning the exhaust of its own force pump and that of the W.A.B. air pump into the "preheater," and as the amount of water used by the boiler under these circumstances is less than when it is working hard pulling a train, the lesser amount of hot steam turned into the feed water heater is found to be adequate. All through this whole system of water heating, the exhaust steam and the feed water do not come together as the steam contains a certain amount of oil, which would be injurious if introduced into the boiler. There is a full and free interchange of heat between the two, but there is no actual contact. The exhaust steam is condensed as it parts with its heat to the feed water, and the water of condensation is drained off by a pipe and falls to the track. The feed water heater is nothing more or less than a condenser as far as the hot exhaust heat is concerned. It condenses the steam and heats the water passing through the tubes, and the hot water is used for a useful purpose. If it was a condenser for stationary practice the condensed steam would be the important element, but as it is here employed the heating or cold or cool water is what gives it a high value as an economical appliance.

When an injector is used heat in the form of live steam is drawn from the boiler and in "lifting" the water to the boiler it heats the water. Experiment has demonstrated that the water so heated, though beneficial, is not in the least an economy device. The variation one way or the other is between limits as low as 2 per cent., so that as a feed water heater the injector is practically a negligible factor. It gives back to the boiler in the form of hot water so nearly the same amount of heat that it abstracted as live steam that neither debit or credit of the injector is worth taking into notice as a heat saver. Water is put into the boiler,



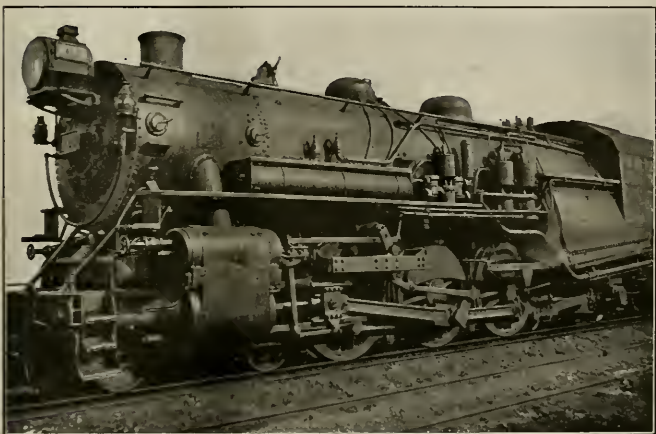
HEAT DIAGRAM NO. 2, OF LOCOMOTIVE WITHOUT FEED WATER HEATER.

but like some commercial enterprises which might be maintained without fear of insolvency, it costs so much to market the goods that the profits are not high enough to carry on the business except for the sole employment of the owner, who would have to find his means of livelihood elsewhere.

To obtain the greatest theoretical saving from heating the feed water, it must be brought up to the temperature of the saturated steam, and from an operating standpoint, feed water heating is a prerequisite most successful in locomotive efficiency. The introduction of comparatively cold water into the locomotive boiler reduces the effectiveness of the engine, especially on heavy grades, where generally a drop in pressure results, often at a critical moment when every pound of steam that the boiler can produce is needed. Feed water heating makes a freer steaming boiler, and confidence takes possession of the fireman.

A very favorable aspect of feed water heating is its effect upon boiler maintenance. The effect of "preheating" is to lessen the difference between the temperatur of feed water injected and the temperature of the steam evaporated. A more uniform temperature will effect a reduction in the strains upon the various parts. Consider what happens when heat is applied to water. For instance, take a boiler at a pressure of 200 lbs. and feed water at 60 deg. Fahr. The first effect is to raise the temperature of the water from 60 deg. to 388 degs., which is the boiling point of water under 200 lbs. A pound of this water will require, roughly, 333.4 B.T.U. It is now at the boiling point, but none of it has actually been turned to steam. Continue the addition of heat, and it will evaporate into steam, and when 837.9 B.T.U. have been added, the original pound of water becomes steam.

It is advisable to use a pump in connection with exhaust steam water heaters for the following reasons. The amount of waste heat that can be abstracted from the exhaust is dependent upon the range over which the water can be heated. The upper point of this range is fixed by the temperature of the exhaust steam, therefore the inlet temperature should be as low as possible in order to reclaim the largest amount of waste heat. The inlet temperature cannot be below the temperature of the water in the tank, but it should not be above it. It is undesirable to raise the temperature by live steam. In the case mentioned above, where the rise of 100 deg. by means of live steam would mean the impossibility of abstracting over 100 B.T.U. from the exhaust steam for each pound of feed water which could be reclaimed.



APPARATUS PLACED UNDER SMOKE BOX USED BY THE LOCOMOTIVE FEED WATER HEATER COMPANY.

Five principles for feed water heating which have been confirmed by separate boards of engineers in England and in France, cover essentials.

1. The apparatus should have simplicity of construction and facilitate examination, cleaning and overhauling.

2. The heater should take up as little room as possible, and be of a minimum weight.

3. It should give a continuous and certain supply of hot water.

4. Feed water should be heated by waste steam.

5. The amount of steam used should vary with the quantity of water required by the boiler.

When we consider that only 8 per cent. of the total heat in the coal is turned into useful work by so efficient an apparatus as the feed water heater and that without it a clear 7½ per cent. is turned into useful work. Both taken together make a total of 15½ per cent. We may well pause in our self-congratulation about our advances in locomotive operation. In the days when the earth was young, a rank and luxurious vegetation crowded its every available foot of surface. Plant life has the power of taking from the air carbon dioxide, and liberating oxygen in the presence of sunlight and when the leaves are filled with chlorophyll or green coloring matter. These ancient forests, submerged, or overthrown by earth, which completely excluded the ogygen from reaching the fallen plant and recombining with the carbon, in time formed what we call coal.

This dormant mass dug up and thrown upon the tender of a locomotive and later introduced into the firebox finds there the temperature conditions necessary for the carbon to combine again with the oxygen from which it had been separated for ages upon ages. In the white hot storm of heat and flame, it gives up its energy to the water. The locomotive as used by man is attended with such a prodigious loss that the present day locomotive might almost be described as a crude machine. Science is only now indicating a way to real efficiency. It therefore appears not only to be desirable, but a scientific duty to adopt any and all means which will give us a better proportion of the energy which Nature has bestowed with so lavish a hand. The feed water heater is a step toward economy and efficiency which growing needs show us to be imperative for us to take. It is not simply a matter of money or first cost. The appalling waste of coal energy permits of scientific locomotive handling, and larger or heavier trains can be taken over the road. It has a dividend-paying background to enhance the brightness of the prospect as it looms up before us. Feed water heating is not "robbing Peter to pay Paul." It is a straightforward advance in locomotive running which can be easily had and appeals most powerfully to the man who bends his back, scoop in hand, all the way up to the motive power officers, the manager and the president who sees the railroad as two lines of figures upon which he must labor to keep the debit total from encroaching upon the profit column, in order to make the road a paying concern.

The Regularly Assigned Engine.

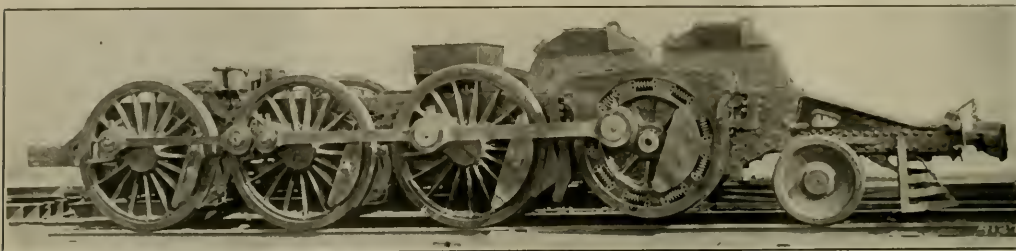
There is a fallacy regarding the advantages of the regular engine that should be laid away with some other things that have outlived their usefulness. The arguments in favor of it were first tolerated, perhaps on the grounds of a false sentiment, but the time has arrived, as we compute time in these days of rapid progress, when the defense of the old system must be classed as out of date.

Pennsylvania Railroad Electric Locomotive

The locomotive, which we here illustrate, was designed to operate on 11,000 volts, single phase, 25 cycle current, taken from an overhead trolley. The current is supplied to the primary of a static transformer which returns it to the track circuit and in so doing excites the "secondary" of the transformer from which the phase converter is operated. This phase converter changes the single phase current supplied to it by the transformer into three phase current for the use of the motors. These motors, of which there are four, have a rating of 1,200 h. p. each; and this gives the locomotive a capacity of 4,800 h. p.

The three phase current taken from the phase converter is supplied, through the necessary control switches, to the primaries of these motors, and the secondary current thus generated in the other windings of the motors is controlled by the motorman by means of water rheostats, which permits close regulation of the tractive effort developed by the locomotive during acceleration.

The two motors which are mounted on each truck-frame are geared to a jack shaft which gives motion to the driving wheels by connecting rods, and the springs in the gears of these jack shafts are so adjusted as to give the effect of a solid gear, up to a tractive effort equivalent to 25 per cent. of the weight on drivers. Therefore, under ordinary conditions the effect produced by a solid gear is approximated.



MACHINERY, MOTORS AND GEAR OF PENNSYLVANIA ELECTRIC LOCOMOTIVES (F.F.L.)

PENNSYLVANIA RAILROAD NEW CLASS (F.F.L.) ELECTRIC LOCOMOTIVES.

The locomotive has two operating speeds, with possibilities of operating at intermediate speeds from zero to the maximum, by means of the rheostat connections. The lowest of these speeds is 10.3 miles an hour and this is obtained by connecting the motors on either truck in cascade with each other and in parallel with those on the other truck. The use of this speed is only for slow movements and around yards. The other speed of 20.6 miles an hour is obtained by connecting the motors on both trucks in parallel, and this is the speed at which the locomotive is designed to operate in road service when it gives a tractive effort of 87,200 lbs.

The cab containing the electrical machinery is 72 ft. 6 ins. long and 10 ft. wide over the sheathing. It has two Z-shaped center girders 26 ins. deep made of plates and angles covered on top with a plate 6 ft. 1⅛ ins. wide, which forms the platform floor to which the electrical machinery is attached. The side framing is of the same type as on Pennsylvania Railroad passenger cars, consisting of U-shaped posts bent at the top to support the lower roof deck and sheathed with ⅛ in. plates. The upper deck extends only over the central part of the cab for a length of 36 ft. 9 ins., leaving a space at each end of cab for the pantagraphs.

To permit removal and replacing of electrical machinery the roof of the upper deck is removable and the turtle back decks at each end of cab are equipped with large hatches. No lining is provided for the body of the cab, but the motorman's ends are lined and insulated and provided with a resilient floor covering. For the protection of the motorman the ends of the cab are also provided with strong vertical members and are separated from the main cab by partitions. The vertical members are similar to those used in Pennsylvania railroad steel passenger and postal cars. Both sides for the full length of the upper deck are made in the form of louvres for ventilation.

Each truck is a motor-truck receiving power from two motors through a spring gear-wheel on each side, the gear-wheel is mounted on a jack shaft. Each gear-wheel is connected to the three drivers by the side rods and the remainder of the drive and running gear is similar to those used on ordinary steam locomotives. The spring gear for each truck is of the three-point suspension type, one point being over the pony truck and the other two points over each frame. There are equalizers over each box, elliptical springs between the journals and helical springs outside of the first and third journals.

Brake shoes are provided for one side of each driver, the brake arrangement being of the usual steam locomotive type with two cylinders, each 16 ins. in diameter, and placed between the frames and between the second and third axles. The train brake and locomotive brake can each be operated independently of the other. Above the frames and between the first pair of drivers is a sand box with sand pipes leading to the front of the first pair of drivers and to the rear of the third pair of drivers and equipped with Leach Double "E" sanders. The gear-wheels have inward projections, forming the jack shaft journals. The bearings are solid bronze forced into a circular opening in the frame casting.

The center plate is located halfway between the first and second axle at an elevation of about the height of the top of the frames. Between the second and third axles an auxiliary spring support has been applied for the purpose of equalizing the loads on the various drivers. This is intended to counterbalance the excess weight due to the position of the motors between the pony truck and first pair of drivers. The contact between the caps over these springs and the bottom surface of the cab is a sliding contact.

Each motor-truck includes a pony truck of the Pennsylvania Railroad type, with an elliptical spring located on each side of the axle and supported on T-links. As the usual T-links alone will not provide sufficient lateral motion, a rocker casting supported by the elliptical springs has been added. The combination T-links and rocker permit sufficient lateral motion for curves of 275 ft. radius.

The articulation between the motor-trucks is of a construction similar to a pedestal attached to the cab center sills. The lower ends of the pedestal legs are connected together with a tie-bar. This permits each truck to rotate without restriction about the center of the center plate. All bearing surfaces in the articulation are plated with manganese steel.

The pulling and pushing strains between the drawbars carry through the trucks, and the articulation in a direct plane is 34½ ins. above the rails, the cab is therefore entirely relieved of these strains.

The principal characteristics of this locomotive are as follows: Railroad classification, FF1; overall length, 76 ft. 6¼ ins; total wheelbase, 63 ft. 11 ins.; driving wheelbase, 38 ft. 8 ins.; rigid wheelbase, 13 ft. 4 ins.; height from rail to locked position of pantagraph, 15 ft. 6 ins.; height from rail to top of cab, 14 ft. 8 ins.; width over cab body, 10 ft.; overall width, 10 ft. 1in.; diameter of driving wheels, 72 ins.; diameter of pony wheels, 36 ins.; weight on drivers, 198 tons; number of driving axles, 6; weight on each pony truck, 21 tons; total weight of locomotive, 240 tons; voltage of locomotive, 11,000; tractive effort, 87,200 lbs.; speed, 20.6 m. p. h.

We understand that the electrical equipment of this locomotive was supplied by the Westinghouse Electric & Manufacturing Company.

The expression "connected in Cascade" occurs in this article. A full explanation of this term, and what it implies, and how it is made, are set forth clearly and with detail in the Electrical Department of this issue, page 232.

Elegant Diner on the Southern

Our illustrations show an outside and an inside view of a dining car built for the Southern Railway by the Barney & Smith Car Company of Dayton, Ohio.

The photographs are illustrations of a modern dining car. The cars are 73 ft. 0 ins. long over end sills and 9 ft. 9⅞ ins. wide over side angles. The underframe for these cars is of the built-up type with built-up body bolsters and crossbearers. The outside sheathing is of 3/16 ins. flat steel plates below the belt rail and 3/32 ins. flat steel sheets above the belt rail, while the interior finish is composite, using steel and agasote.

SOUTHERN RAILWAY STANDARD DINER.

The tables are arranged so as to seat four persons on one side of the car, and two persons at the corresponding tables on the opposite side. There are, of course, the centre lights in the clearstory, with ventilating apparatus as an integral part of the apparatus. Over each table on the flat part of the roof are a series of lights, in which the "box" containing the lamps have ornamental sides, of the metal and art glass type, and a flat frosted bottom, so that an unobstructed flood of light streams down upon the table.

The tops of the windows are filled with art glass, and the clearstory windows, though less elaborate, carry out a similar design. The mouldings and other parts of the general design are smooth and do not afford a place for the lodgment of dust, and what dust does settle inside, can be easily and quickly wiped away by the car cleaners.

The car is carried on 2 six-wheel trucks, and the lighting system is supplied by the axle lighting system. The finish outside is plain to the verge of severity, but this is desirable considering the purpose for which the car was built and the hard conditions of modern service. The car is altogether a good example of modern practice, and has given every satisfaction to builders and owners. They have also given every satisfaction to patrons.

INTERIOR OF SOUTHERN RAILWAY DINING CAR.

Railway and Locomotive Engineering

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Air Brake Questions and Answers.

Railway and Locomotive Engineering has always had a large circulation among men who are interested in the operation and maintenance of the air brake, and for the benefit of these readers of this magazine we have always retained the services of an air brake expert who contributed articles on air brake subjects tending to keep the readers in touch with developments of the art and who arranged for correct answers to all questions asked.

The subject of air brakes has not by any means been exhausted, as will become apparent to anyone reading the articles contributed each month by Mr. W. V. Turner, the assistant manager of the Westinghouse Air Brake Company, but we have described all of the recent types of brake equipments for steam railroad service up to and including the Electro-Pneumatic brake used by the Pennsylvania railroad, and believing that the entire subject of air brakes can be made more interesting in question and answer form, we have decided to devote three full pages to air brake questions and their answers, beginning with next month's (the August) issue.

We will not discontinue articles on the same subject, but they will not be quite so lengthy as those printed in the past, and the questions and answers will appear under three separate headings, "Locomotive Brake Inspection," "Car Brake Inspection" and "Train Handling," one page being devoted to each subject, in order that these questions will at once be of interest to every railroad man who is in any way connected with, or interested in, the operation of the air brake.

These questions will be continued from month to month, and will cover every phase of inspection and repair work and outline the most approved methods of handling the brakes in service and making temporary repairs to defective equipment, while the ordinary references to construction and operation that may be learned from standard instruction pamphlets, will as far as possible, be ignored.

In view of the fact that no air brake instruction books have been placed on the market since the air brake inspection has been governed by federal regulations, the questions and answers should be of special interest, and if they are as favorably received as they should be, at least 3,000 questions and answers will be printed, and any air brake inspector or repairman who starts with a fair knowledge of the operation of the brake should be able to qualify as an air brake expert if he is willing to spend one or two nights a week in the study of these questions and their answers. A complete understanding of them will require no knowledge of higher mathematics as the aim will be to make the subject clear and easily understood instead of surrounding it with technicalities. Those who desire to have special questions answered may feel free to send them in.

Transportation of Troops in War.

The British method of handling their military forces when the work of embarking them for France is of more than passing interest here. About four years before the war, the general managers of the various English railways received from the government each a sealed package with instructions not to open the package but to keep it safely in the company's vault. In 1914 each general manager of specified roads received from the government another sealed package with instructions to destroy the former package and read the one now at hand.

On August 4, 1914, Great Britain declared war on Germany and the railways of the United Kingdom were taken over by the government. In one week one general manager of an expropriated line dispatched ninety trains containing soldiers, military baggage and equipment. The "consist" of each train was specified in the sealed package and what it was to carry was also specified. The point of embarkation was Southampton, and this port was temporarily closed to all but military traffic. Trains ran on 12 minute headway and if a train became 12 minutes late, it was to be sidetracked and deemed to have lost its turn, and the troopship did not wait for it.

Within ten days the whole first line of the British army (about 120,000 men) was in France. No train missed its turn and no serious mishap occurred. This precision of movement was due to the care with which the minutest detail of the scheme had previously been worked out in times of peace and to the fact that although the government had taken charge of the railways the men who usually worked them were left in full and complete command. Each general manager and his own staff and the old employees managed the road as before. The informal committee which existed before the war was given full powers as the Railway Executive Committee. It exercises full and undisputed control and its nominal head is a cabinet minister.

This plan puts the action of the Railway Executive Committee within the purview of Parliament, and while the case is urgent, and the work onerous, the scheme retains the democratic principle, which the English believe to be essential. The compensation to the owners of the railway is fixed by arbitration, if it cannot be mutually agreed upon. Government traffic is carried free, the government taking the earnings due to ordinary traffic, and it pays all operating expenses, and at the same time it guarantees to the stockholders the same net revenue that they had in 1913. Great Britain has twelve per cent of its population under arms with almost as many more engaged in the manufacture of munitions and other necessary services. The government has financed its allies, maintained its own share of the burdens of the war, and has handled the railway transportation problem, without hurry or panic and has been able to carry on its stupendous work in all departments with an efficiency and precision which shows that the old proverb, "where there's a will, there's a way," has lost nothing of its ancient significance.

The Example of the Railroads.

An extensive revision of the passenger train service throughout the country is being made to conform with the recommendations of the Railroad's War Board, to the end that an increasing capacity may be obtained for moving coal, food, Government materials and troops. The promptitude with which the railroad officials have met this call is admirable, and it must not be imagined for a moment that it is in the line of economy as far as the railroads are concerned. It is a considerable financial loss. And it would be well for the country in the present emergency if every enterprise engaged in catering to the needs of the public could be induced to exercise the same spirit of self-effacement and contribute willingly whatever is possible to mitigate the cost of living, which in the face of an abundant harvest should not exist. War is not only a curse from without, but also becomes a curse from within.

And it is to be hoped that the so-called middleman will be dealt with with a degree of promptitude that will tend to allay public clamor who are quick to see that there is a class of men that rises up in war time whose object in life it is to fatten on our misfortunes. As we said at the outset, if the fine spirit shown by our railroads could be inculcated or compelled by drastic action into our entire commercial life we would be spared much of the grievances of the thousand wars of old, and aid in bringing about the dawn of the thousand years of peace.

Economy from the Outside.

In these days when economy of all kinds is the order of the day, though economy is always in order on a railway, one railway at a meeting of its mechanical staff looked very carefully into the matter of reclaiming worn dies. The report of the mechanical engineer showed that the road did not have the proper facilities for cutting the dies when they became worn so as to be too far from standard to give satisfactiory results. The report went on to point out that on account of the small number of dies which could be reclaimed and the cost of machining them, the results would not warrant the expenditure of about $800 for the necessary new equipment.

It was therefore suggested, and approved, that the work of re-cutting and tempering be done by an outside firm which was fully equipped for this very kind of work. The Acme Machinery Company of Cleveland, Ohio, was the concern decided upon as one of the most suitable for taking this work from the railway, but that the re-grinding of the dies was to be done in the railway company's own shops, and that suitable grinders be bought for that part of the work.

Inspectors of tools and machinery were instructed to select what shops were to receive the grinders and to decide the wear limits which were to govern the various foremen and others in picking out the dies to be reclaimed. Dies which exceeded the limits of wear were to be collected and sent to a designated point for shipment to Cleveland, and so from time to time a batch of dies for re-cutting and tempering would go forward to the Acme Machinery Company, and were in due time to be returned ready for service.

The whole matter stood upon a dollar and cent basis. The railway company, though economizing in many matters where reclaiming of parts, appliances and equipment was concerned, found upon careful investigation, that in the matter of cost they could not successfully compete with an outside enterprise, which had made a specialty of a particular and important kind of work, and the railway company instead of doing the work in its own shops, at a probable loss, availed itself of outside assistance and saved money in consequence. Volumes might be written on this subject, but they are unnecessary. The procedure, outlined here, does not differ in essence from a practice, recognized everywhere as legitimate.

The purchase of some good appliance for a locomotive such as a brick arch, a feed water heater, or power-operated reverse gear, is a matter which has been taken up by outside companies and each appliance is handled with the same facility and the same element of saving as that of die reclamation by the Acme firm. The recognition of the efficacy of outside assistance, not for the purpose of escaping necessary work, but upon intelligent investigation and judgment. If it is found that the facilities of some outside concern, and the specialization, in a certain line, has given the outsider a manifest advantage and a superior and particular knowledge of special conditions by adopting which operating or repair costs can be reduced, it would appear to be the part of wisdom for a railway company to avail itself of the advantages which may be introduced from the outside, to effect a substantial saving in cost.

Efficiency on the C. & N. W. Ry.

Enthusiastic meetings are being held at all the leading points on the Chicago & North Western. Every employee is being impressed with the importance of economy, loyalty, patriotism and enthusiasm. The officials and others are addressing large meetings, and every one seems to be terribly in earnest. As the situation is undoubtedly serious the railroad men seem determined to meet it, and with the high prices of material and the scarcity of skilled labor the task is a heavy one. The road has had the reputation of being admirably managed and finely equipped, and it would be a calamity if there should be a falling away from this high standard, and it seems to us that all the road needs is a reasonable increase in rates to meet the situation. We are convinced that the officials generally and the mechanical department particularly could not do much more than they are doing. Human ingenuity and endurance has its limitations.

Railway Accidents in Great Britain.

The list of railway accidents occurring in Great Britain during the second half of 1916 has recently been published by the British Board of Trade, and it is gratifying to learn while the density of traffic had never before reached such dimensions, the number of accidents compares favorably with 1912 and 1913. Eight accidents in one of which there was no loss of life is reported. The most serious accident was the killing of five persons on the Great Southern and Western Railway of Ireland. Thirty injuries occurred in a collision on the Glasgow and Dalry railway. The others were of a much smaller kind. Indeed, the record is remarkable in its degree of safety since the deplorable accident at Gretna Green in 1915, when 227 lives were lost, mostly those of soldiers. That sad lesson seemed to have impressed the railway men, and it is to be hoped that the lesson will continue to be remembered.

Running past signals is the characteristic feature of nearly all of the accidents described in the report. In some of the cases there were two engines on the train. It is a trait in human nature to rely on the vigilance of others, and hence it is that one man pays more attention than two. In any event, the fact is again and again brought out prominently that the human element has its limitations in watchfulness, and until a signal system is adopted that will automatically stop a train that passes a signal, this kind of railway disasters will continue to be recorded.

Workmen's Compensation Laws.

About two-thirds of the employees of this country are now included under compensation laws of one kind or another. There is, however, no uniform basis for determining just what employees or classes of employees shall be admitted. In eight states workmen's compensation acts are compulsory upon the employer. In twenty-four states they may elect to be included. In fifteen states acceptance by both employer and employee is presumed unless either definitely objects. In certain states contribution to a state insurance is obligatory. The general power of a state to enact compensation laws is no longer open to question, and in the course of time a general law may be adopted.

Change of Offices on the Erie.

The headquarters of the stores department and the mechanical department of the Erie Railroad have been removed from 50 Church street, New York City, to Meadville, Pa.

This change was made on June 1. All communications and periodicals addressed to the headquarters of these departments should henceforth be forwarded to the offices at Meadville, Pa., corner Park avenue and Center street.

It is believed that the change will effect much convenience, for Meadville being near the center of the railroad system will be much more convenient than New York City for the mechanical and the stores departments.

The salesman has more to fear from himself than from all the grouchy, cranky or unreasonable customers he'll ever meet.

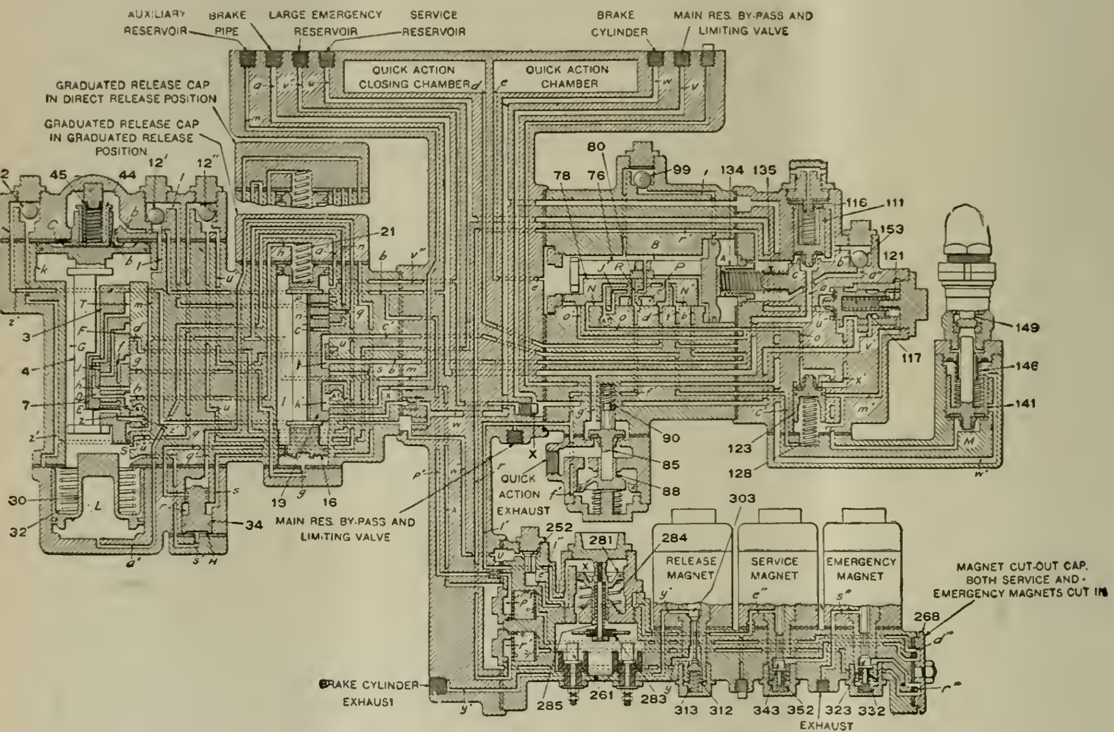
Air Brake Department

Electric Operation of the Universal Valve—Feed Valve Test

In previous issues an effort has been made to explain in detail the operation of the pneumatic portion of the universal valve, which is a part of the electro-pneumatic brake for steam road passenger service.

With an electro-pneumatic brake it will be understood that electric current is used to apply the brakes simultaneously or uniformly or instantly if desired, throughout a train of cars. The retarding force is obtained from the pneumatic or automatic brake and the electric current is used merely to transmit the intent of the operator.

It has also been explained that the universal equipment is what may be termed a "built up" brake in which any feature from that of a plain triple valve up to the highest form of graduated release, safety and protection features may be embodied or dispensed with at will, or by the mere changing of certain portions of the valve. There is but one size of universal valve for all sizes of brake cylinders, it is made in two separate portions without pipe connections and bolted to a bracket which is a fixture on the car. Choked passages in the bracket correspond with the size of brake cylinder that is used on the car and the same size of universal valve is used whether a single brake cylinder is employed or whether two-brake cylinders are used in both service and emergency or whether two cylinders are used with one cylinder for service or both for the emergency action of the air brake.



UNIVERSAL VALVE IN ELECTRIC SERVICE OPERATION.

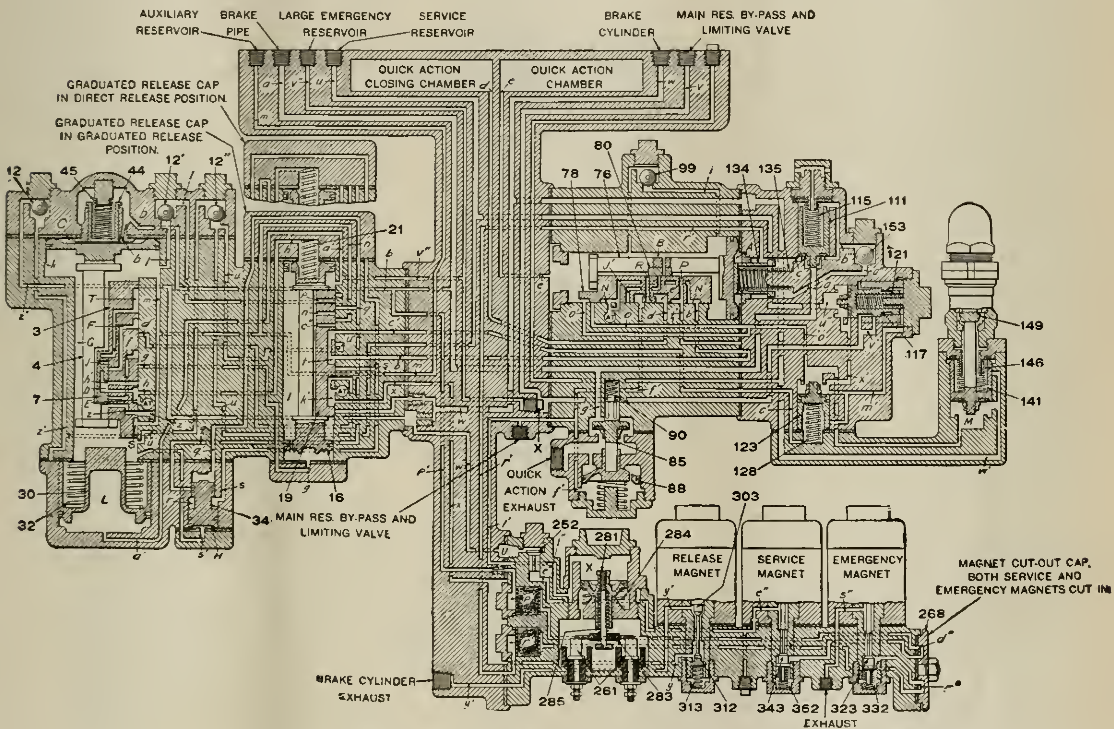
The valve retains all of the features of the quick action triple valve, operates in harmony with all previous types of triple valves, and is designed largely for the purpose eliminating the undesirable features of a triple valve.

It may be well to state at this time, that it is generally recognized that any car brake operating valve that will apply on the same differential in pressure that is necessary to release it, is not a practical valve for modern passenger service, for obviously the brake pipe pressure can be withdrawn from the brake pipe at a faster rate for an application of the brake than it can be restored for a release of brakes. Also, where the same operating mechanism controls both the service and quick action functions of a valve, undesired quick action of brakes is very likely to occur at some stage of the various conditions valves are found in. For this reason, service and emergency functions are positively separated, any defective action of the service portion having no effect whatever upon the quick action operation.

There is also a separation in the flow of air to and from the brake cylinder or brake cylinders, the equalizing slide valve and graduating valve controlling the flow of air from the brake cylinders to the atmosphere for a release of brakes. The principal reason for this arrangement is that by dividing up the work to be done permits of a smaller equalizing slide valve with less bearing surface on its seat, hence less frictional resistance will be encountered in forcing the equalizing valve to release position than if a much greater surface was in contact.

Almost everyone who has had any interest in air brake operation has heard of the effects of brake pipe leakage and a sluggish feed valve, and it is for the purpose of preventing the consequent stuck brake, that the universal valve is designed not to apply with anything less than a definite 4 or 5 lbs. brake pipe reduction.

Conversely the valve is so designed that an increase of 1½ lbs. pressure in the brake pipe after an ordinary service application will cause the equalizing piston to move and as it starts the brake will "bleed" itself off as positively as opening the bleeder cock in an auxiliary reservoir will cause a triple valve to move to release position.



UNIVERSAL VALVE IN ELECTRIC EMERGENCY POSITION.

Briefly, the principal improvements upon triple valve operation are, certainty of application, secured through a minimum size of feed groove which is closed, positively separating auxiliary reservoir and brake pipe pressures, upon a drop of 1½ lbs. in brakepipe pressure, below that in the auxiliary reservoir. Positiveness to release, or bleed itself off, by reducing the pressure in the auxiliary reservoir as the equalizing portion starts toward release position. Will not apply with less than a fixed amount of brake pipe reduction, controlled by the friction increasing cavities in the face of the equalizing slide valve, which are opened to the atmosphere as the equalizing piston closes the feed groove. With the valve operating in graduated release it can absorb no brake pipe pressure during a release of brakes, hence only the volume contained in the brake pipe proper need be increased to effect a complete release of brakes. However, with the valve operating in direct release as at present, the small auxiliary reservoir is charged from the brake pipe during a release of brakes, that is, it is charging during the release.

The valve gives the maximum possible rate of rise in brake pipe pressure during emergency operation. It delivers any percent of emergency braking ratio desired, this being controlled by the volume of the small emergency reservoir, or may be changed to use the large emergency reservoir pressure in the brake cylinder or any volume desired. It contains a perfect graduation of release made possible by the vast difference in volume between the large emergency and auxiliary reservoir. Full emergency braking power is obtainable at any time during or after service application. As stated service and emergency features are entirely separated. Absolute safety is guaranteed by the large volume of air stored in the large emergency reservoir for recharge and a depletion of brake pipe pressure below a predetermined figure results in a full emergency application of the brake. All previously known safety and protective features are embodied, and when the valve is electrically operated, the most perfect form of quick service is available, or, rather, constantly in use. Service braking ratio is limited by the adjustment of a brake cylinder safety valve and for emergency operation the higher brake cylinder pressure is held throughout the stop.

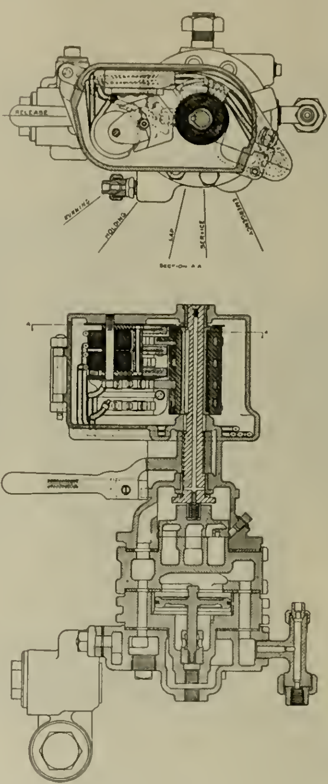
To arrange for electric operation, it is only necessary to remove the blanking flange and apply what is known as the electric portion and install a system of wiring and jumper connections between the cars. The electric portion is composed of magnet valves and an emergency switch piston. These magnets and valves are known as service, emergency and release, the magnets being energized by electric current and operate the magnet valves which are held to their seats by combined spring and air pressure.

These magnets are operated from the brake valve of the locomotive, electric contacts are made at the brake valve through which these magnets may be energized or de-energized at will. The automatic and electric features of the brake valve are interlocked, that is, the same position of the brake valve handle is used either for pneumatic or an electric application and obviously if for any reason, the electric current should fail, it will in no wise interfere with the automatic operation. When the brake valve handle is in running position, all magnets are de-energized. When the brake system is charged and an application of the brake is desired, the brake valve is placed in service application position and before the equalizing piston can be unseated to discharge brake pipe pressure, all of the service magnets are energized by electric current which may be obtained from any low voltage source of energy and in turn the armatures are pulled down and the magnet valves are opened discharging brake pipe pressure into the brake cylinders at a service rate. When the brake valve is returned to lap position, the service magnets are de-energized the magnet valves are reseated, and the brake pipe reduction ceases. At this time, the valve handle on lap position, the release magnets are energized and the release magnet valves close the brake cylinder exhaust port. The normal position of the release magnet valve being open and the normal position of the other magnet valves are closed.

If it is desired to release the brake, the brake valve handle is placed in release position for a time to correspond with pneumatic operation which returns all of the universal valves to their release positions, but the release magnets are energized and the brakes remain applied as with the locomotive brake. When the valve handle is then returned to running position, the release magnets are deenergized and the brake cylinder exhaust ports are opened permitting a release of the brakes. If it is desired to graduate the brakes off, the handle is alternated between running position and lap position and the opening and closing of the brake cylinder exhaust ports is instantaneous as well as simultaneous and the brake cylinder pressure may be reduced at will and in absolutely any quantity desired. If partially released and it is desired to reapply, the re-application is as instantaneous as the electric current will travel, that is, the brake pipe reduction for the application will be started instantly.

An emergency application is made by placing the brake valve handle in emergency position which operates the emergency magnets which instantly discharge the brake pipe pressure from the brake pipe side of the emergency piston of the universal valve. This movement, of course, results in the unseating of the quick action valve and the brake pipe pressure is discharged, but the emergency action is electric. An electric emergency application is also produced by opening the conductor's valve or by any brake pipe opening, for as soon as emergency slide valve of a universal valve moves quick action chamber and quick action closing chamber pressure flow to the emergency switch piston at the same time they flow into the quick action piston chamber which in turn energizes all emergency magnets. Through the action of the emergency switch, a break-in-two of train results in electric emergency on the portion of the train attached to the engine and pneumatic emergency on the cars uncoupled.

It may be noted that when the brake



H-6-E BRAKE VALVE.

system is charged an electric service or electric emergency application results in an application of all brakes regardless as to closed angle cocks, but in release the brakes back of the closed cock cannot be released, for the reason that the universal valve must assume release position through an increase in brake pipe pressure or reduction in auxiliary reservoir pressure before a release can be effected.

As previously stated, electric current is merely used to transmit the operator's intent and its application to air brake operation is a very simple proposition, producing a perfect brake, which eliminates the rough handling, shocks and surges incident to a non-uniform application and release of air brakes.

There is one jumper connection between each of the cars of a train and one between the tender and first car and one between the locomotives, if double heading. The current is obtained from the electric lighting battery boxes, and the battery switch at the end of the battery box of the first car only, must be cut in. Before the engine couples to the train, the engineer must close the brake switch in the cab of the locomotive, and after inspectors have made the jumper connections as well as the car and hose couplings, the usual signal to apply brakes will be given, after which the engineer will make the usual amount, or a 25-lb. brake pipe reduction, after the brake pipe reduction has taken place, the brake valve handle is moved to release position and back to holding position, when the inspectors will examine all brakes to see that all have properly applied and will remain applied. This will be followed by the signal to release brakes, when the engineer will move the brake valve handle from holding to running position, and inspectors will examine all brakes to see that they have properly released. If there is any failure of the brakes to remain applied or any disorder that cannot be quickly remedied, the engineer can open the switch in the cab, cutting out the electric connections, and test and operate the brake pneumatically.

If cars not equipped with electrically operated brakes are to be attached to the rear of trains, the engineer must be so notified and the brake test as outlined must be modified, that is, when the brake valve handle is moved to release and holding positions, the brakes operating pneumatically only, would release, therefore the engineer would be required to hold the brake valve handle on lap position until the pneumatic brakes have been examined, then move the valve handle to release and holding position until the electrically operated brakes have been examined, after which the brake valve would be moved to running position for a release of all brakes.

From this it will be evident that the manner in which this brake will be operated in service is to make the required amount of brake pipe reduction and immediately move the brake valve handle to release and holding position, in a manner that is considered good practice in releasing pneumatic brakes, and thereafter the air may be exhausted from the brake cylinders of all cars as desired, or may be immediately increased by placing the brake valve in service position.

In cleaning or making repairs to one of the H-6-E brake valves, the drum above the valve body should be opened, and the different wires carefully marked, so that there will be no possibility of getting them improperly connected when again assembling the valve. The top wire in the drum is the emergency switch wire, the second, the service application wire, the third, the release magnet line and the lower, the emergency magnet line. The two lower wires are disconnected by the screws at the contact points, the two upper wires, by drawing them part way out of the drum and unwrapping the tape from the thickest part of the insulation, where the wires will be found coupled by special connectors similar to hose couplings. The rotary valve key is not fastened in any manner with lock or jam nuts, to remove it, it is merely pushed down out of the body, and when the valve is assembled it is only necessary to reconnect the wires, push the two longer ones back in place and close the drum.

Feed Valve Tests.

The condition of the brake pipe feed valve of the locomotive is one of the most important considerations in brake operation on modern freight and passenger trains. In one sense the brake pipe feed valve is the most important unit of the entire brake system of the locomotive and cars, for in order to prevent, so far as possible, undesired operation of brakes, the feed valve must constantly maintain the brake pipe pressure at a predetermined figure while the brake valve handle is in running position.

We have frequently commented upon the subject of testing and repairing feed valves, pointing out the impossibility of fitting a supply valve piston to a worn piston bushing, or the impossibility of making a passable fit or obtaining satisfactory operation from a feed valve with a worn piston bushing, and have urged that such feed valve be returned to the manufacturers for rebushing in order that it would be possible to maintain feed valves in service in a condition to at all times pass a specified test.

This test on the shop test racks is no doubt as accurate as can be desired, the Code of Tests in the Manufacturers' Instruction Book refers entirely to a rack test, which will indicate that the feed valve is in first class condition, the 3/64-in. opening to the atmosphere under the influence of which the feed valve should operate within a two-pound limit, is related to a fixed volume of compressed and the rate in drop in pounds per minute in the controlled volume is fixed and unchangeable. In some manner that is not as yet altogether quite clear, the same 3/64-in. opening was suggested and used for a test of the feed valve on a locomotive, that is, if this size of circular opening was made from the brake pipe to the atmosphere from the air hose at the rear of the tender, the feed valve should operate or show a variation in brake pipe pressure or this should cause the brake pipe pressure to fluctuate, but not to exceed the two-pound variation, this regardless as to the volume of compressed air in the brake pipe, which would naturally vary the drop in pressure in the brake pipe in pounds per minute, especially where there is only the volume in the pipe on an engine equipped with the ET equipment, and with locomotives not so equipped, the auxiliary reservoir volume added to that of the brake pipe would increase the total volume as much as 10 times or more. Obviously the test proved unsatisfactory, feed valves in first class condition were removed because they failed to respond to the varying conditions, but the same valves when placed on shop test racks passed all tests.

Another consideration that was apparently overlooked was the fact that, if the fluctuation in pressure was within the two-pound limit on the test rack, and the feed valve was placed in service and the limits of fluctuation did not increase, it would in course of time decrease as the fit of the supply valve piston in its bushing reduced, therefore there would be a time when the feed valve operated perfectly, that is, maintained the brake pipe pressure at a constant figure practically up to its capacity, but against the 3/64-in. opening or larger openings, the air gage would show no fluctuation in pressure and, according to the accepted code of tests the feed valve was no longer in fit condition for service, whereas the fact of the matter was that the feed valve was in a practically perfect condition and more sensitive to respond to the variation in pressure than the test gage was to record the variation.

When it became apparent that the Standard Code of Tests applicable to the shop test rack would not apply to a test for the feed valve on a locomotive in service, the writer was using a testing device with various sized openings, among them being a 3/64-in, 1/16-in. and 11/64-in. and made a test of the feed valve, first, with the brake valve in running position and maximum air pressure on the locomotive, opening the brake pipe at the rear of the tender through the 3/64-in. opening, and if the brake pipe showed a fluctuation within the specified limits, the feed valve was operating as required, but if no variation was shown, the 1/16-in. opening was used, and if no fluctuation was then shown the 11/64-in. opening was partially opened and in a gradual manner and if the feed valve maintained the pressure constant against the three different sized openings, at its maximum, and there was no increase of brake pipe pressure when the large opening was suddenly closed, this feed valve was continued in service, and considered a perfect feed valve, or at least more sensitive to respond to the supplying of pressure to the brake pipe than the test gage was to show the response.

The mistake in this test was apparently in considering that if the feed valve was in a condition that it would not fluctuate against the 3/64-in. opening, but would when the 1/16-in. opening was used, the supply valve was too loose a fit in the bushing or if the pressure dropped back 2 lbs. or more when the large opening was used, that the feed valve was unfit for further service, and upon a further investigation it may be found to be a fact, and that a feed valve should be maintained in a practically perfect condition where triple valves are used as car brake operating valves, in any event the feed valve should at all times be more sensitive to respond to a variation in brake pipe pressure than the most sensitive triple valve in the train. In such cases there will be no undesired operation of brakes on trains while the brake valve handle remains in running position, so long as brake pipe leakage remains within a reasonable figure.

A code of tests for the feed valve of a locomotive has now been formulated, and from present indications it will be satisfactory, but in the opinion of some air brakemen may be a trifle too loose on the condemning limit. This is, to place the brake valve in running position, and fully charge the brake pipe to the pressure to be carried. Attach test device (which should be a cutout cock with a 1/16-in. orifice outlet) to the coupling at the end of the brake pipe, and open the angle cock. Open the cutout cock in the test device slowly until the cock is fully open. Feed valve should maintain the brake pipe pressure constant, or fluctuating within 2½ lbs. of its adjustment. If the brake pipe pressure drop is more than 2½ lbs., and is maintained constant, it is an indication that the supply valve piston is too loose. If the fluctuation is more than 2½ lbs., it indicates a dirty and tight condition of the operating parts of the valve. Feed valves failing, due to either loose pistons or dirty condition, should be removed for further inspection and test on the standard feed valve test rack.

We would be pleased to print any comments from our readers on this very important phase of air brake operation.

The Future of Railways in Russia

Sir George Bury, vice-president of the Canadian Pacific Railway, since his return from Russia has expressed himself very fully in regard to the future of railways in Russia. He states that there is no doubt whatever that after the war, Russia will have to build several hundred thousand miles of railway. Canada has ten times more railway mileage per unit of population than has Russia. Then, again, Russia made the mistake of patterning her railway transportation after that of Europe. Traffic in Russia moves vast distances in great bulk. The country lends itself to low grades and easy curvature. American enterprise should succeed here.

Electrical Department

Inspection of Electric Motors—Series-Paralell-Cascade Connections

Last month we stated and discussed the reasons for care in the inspection of generators. We pointed out why it was necessary to keep the generator clean and free from oil and moisture at all times. The installation of machines was considered and a method was shown and illustrated how to test an electric motor or generator for the condition of the insulation.

We will continue in this article a description of the procedure to follow, and the tests to make, in order that the machine will operate perfectly and without harm to itself.

As mentioned in the last article the foundation on which the machine is to be placed must be solid enough to prevent vibration. Generally the frame of the machine rests directly upon a concrete or iron foundation and the frame is "grounded." That is, the frame is ground potential and no voltage can exist between the frame and the ground. Sometimes, however, it is necessary or advisable to insulate frames from ground. In this case the foundation is capped with a stout wooden frame bolted to the masonry, care being taken that the bolts are so placed that they do not make electrical contact with the frame which secures the machine to the wooden cap, otherwise there would be a continuous metal circuit between the frame and the ground and the wooden cap would be of no use. This wooden cap should be covered with a waterproof insulating paint or compound to prevent it from absorbing moisture and losing its insulating properties.

It is very important, where machines are insulated from the ground, to have the insulated platform extend round the machine of sufficient distance out from it so that the attendant must mount it before he can touch any part of the frame of the electrical apparatus. Suppose the generator is on an insulating foundation and is delivering power at a pressure of 2,200 volts. This pressure is high enough to kill or at least seriously burn any person who may come in contact with it by completing a circuit to the ground. The frame being insulated, could become charged to the 2,200 volts and nothing would happen, as there is no circuit. How can the frame become charged when the wires are all insulated? Only due to a breakdown of the insulation. The insulation may become defective by an accumulation of oil and dirt, undiscovered due to lack of inspection, or due to a mechanical injury, so that the frame is actually at a high and dangerous voltage. If the attendant, while standing on the ground should touch the frame he would receive the full voltage. However, by standing on the insulating platform, he does not complete the circuit and although while touching the machine his body is charged to the same high voltage, there is no danger.

With the frame grounded it is impossible to charge it up for the reason that any leakage will pass to the ground and the machine cannot be operated. One would assume that the strain on the insulation of the windings would be decreased where the machines are insulated from the ground and this is so.

When the machine is mounted and is ready for operation, the next step is to check and adjust the brushes. Brushes should be accurately spaced. The brush holders are mounted on a rocker ring which can be moved and thus the brushes can be properly placed. Two methods can be used to determine the correct location, one the mechanical method, the other the electrical method. When it is impossible to set the brushes by the electrical method, a mechanical method may be used.

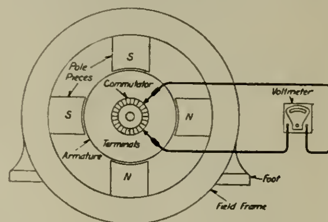


FIG. 1.

The proper position of the brushes, on most machines, is in a plane which passes through the centers of two diametrically opposite main pole pieces. This is only approximate and the brushes should be set by actual trial, by observing the commutation under load with the brushes in different positions.

The electrical method will locate the brushes correctly if due care is exercised. With all the brushes raised from the commutator and the machine standing still, if the shunt field be excited to about one-half its normal strength (that is one-half of the current flowing through the field to that which flows when the machine is operating) and the field current is suddenly broken there will be a voltage induced in the armature conductor. The maximum voltages are produced in those conductors which lie between the main poles, and the minimum voltages are found in those voltages nearest to the centers of the main poles. It will also be found that the induced voltages at equal distances to the right and left of the main pole centers, and are equal in magnitude but opposite to each other. This being the case, if the terminals of a voltmeter were connected to two of the commutator bars, on opposite sides of the center line of a main pole, there would be no deflection when the field current is broken if the center line of the main pole was exactly half way between the two terminals. If the center line does not pass half way, but is nearer one terminal than the other then there would be a deflection on the voltmeter. Fig. 1 illustrates this. By keeping the same distance between the terminals on the commutator and moving the terminals with this relation around the commutator, the center line of the pole-pieces can be exactly located. Having determined the direct location of the brushes, the machine is ready to be put in operation. There are certain general rules to be followed—

(1) Leave all switches open when the machine is not running.

(2) At all times keep the generator or motor clean and free from oil and dust, especially from copper or carbon dust. In case of high voltage machines, a small accumulation of dust on the windings may be the cause of serious "burn-outs." It is well to have available compressed air (which should be dry) so that the operator may blow out the dust from all parts of the windings of the machine. The air pressure should not exceed 25 lbs. per square inch. High pressure air may damage the insulation by lifting the wrappings on the windings and the dust instead of being blown out is being blown inside of the coils.

Series—Parallel and Cascade.

In the article on the new electric locomotive for the Pennsylvania Railroad, reference is made to the operation of the electric motors in "cascade." We often read of series and parallel connections of motors, but the connecting of motors in cascade is not very common. Let us see just what is the difference. In the first place, series and parallel connections, in electric traction work, apply to direct-current motors or single-phase alternating current motors as used on the New Haven locomotives. As far as we can use the terms, we may say that the same current which leaves the power house comes back to the power house, after having passed through all the various motors on the way. The connections of the motors in cascade apply to three-phase alternating electric motors, such as those in use on the Norfolk & Western locomotives and those for the new Pennsylvania locomotives. When these motors are connected in cascade, the current which leaves the power house passes into the first motor only, and returns to the power house by way of the running rail.

The direct current and also the single-phase motor has a commutator and is known as a Series machine—that is, the armature and the fields are connected in series—the current flowing from one to the other. These motors on a locomotive can be grouped in series, where the current which flows through the armature and field of the No. 1 motor also flows through the armature and field of the No. 2 motor and so on to the No. 3 motor and to the No. 4 motor. When these motors are connected in parallel, they are connected side by side, so to speak, and the current which flows through the No. 1 motor does not pass through the No. 2 motor. The arrangement is roughly analogous to a group of faucets, each one filling a basin placed underneath, but in this case to complete the electrical analogy the waste water from the basins would have to return to the source of supply of the faucet system.

In the case of a four-motor locomotive of the D-C type, there is usually a middle combination between the series and the parallel where two of the motors are connected in parallel and the two sets of two motors each connected in series. These combinations are shown by Fig. 1. The first position shows the series, the next position shows the series parallel and the the third position shows the full parallel. These three combinations give three speeds, namely ¼, ½ and full speed.

In the case of the three-phase alternating current locomotive the motors usually are operated in the parallel position, that is, each motor is taking its supply as does the faucet. It is impossible to connect them in series as in the case of the D-C or Single-Phase motor, because the Three-Phase motor has no commutator and there is no connection between the field and the armature. The motor consists of two parts, the Stator, or stationary part, also called the field, and the Rotor, or rotating part, called the armature. This stator has coils of wire placed symmetrically around the inside of the frame in slots, and these coils are connected to the electric power supply. The rotor also has coils and slots. These coils are connected from three points to slip, or collector rings. By means of brushes, connection is made from the slip rings to rheostats or the resistances. The principle of the induction motor depends on Lenz's Law which is as follows: "If a magnet or field is passed by, near a coil of wire, there is induced in this coil a current which exerts a drag on the magnet or field, tending to pull the same back. It is this induced current which makes the motor work. Applied to the induction motor the field in the stator cannot be held back by the induced current in the windings of the rotor. It therefore moves after, or follows, the rotating field. The speed of the rotating field is definite and fixed, depending on the number of poles and the "frequency" of the supply. The rotor never keeps up the same speed of wire, thereis induced in this coil a "slip" of the motor. The amount of slip depends on the load carried by the motor.

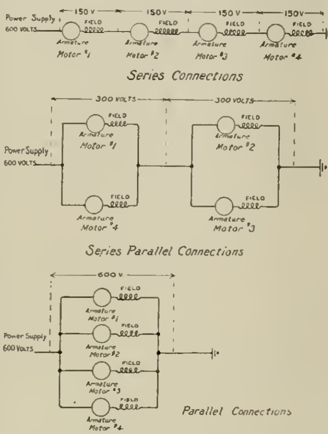


FIG. 1.

It is greater, the heavier the load. Although the windings around the frame, or stator, are equally distributed mechanically, they are grouped electrically into a certain number of sets, each set termed a "pole." When the power is connected to the stator, these poles revolve, electrically, around the winding, and the speed at which this electrical rotation takes place

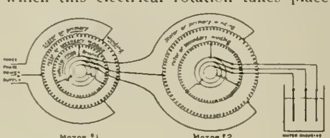


FIG. 2.

in revolutions per minute, depends on the number of poles of the motor, and on the "frequency" of the power supplied. The electric field, in this case, rotates.

Cascade control, sometimes called "Tandem" control, requires the use of two motors and these motors can have the same number of poles or a different number of poles—therefore a different number of speeds and different electrical windings. These two motors may be connected together mechanically, that is on the same axle or on axles connected together by side rods, or they may be on different axles. The connections are as follows: (See Fig 2.) The primary or stator of the first motor is connected to the power supply, and since there is no electrical connection to its rotor, the current there stops, returning, as we have said, to the power house by way of the running rail. The secondary or rotor of this motor, is connected to the primary of the second motor through the collector rings. The secondary of this second motor is closed through adjustable resistance which in the case of the P. R. R. locomotive, is the water rheostats. The induced current from the rotor of the first machine reaches the second machine at the stator. The current stops there, returning back to the first rotor by the connecting wires, and a current in the rotor of the second machine. If the induced current from No. 2 machine went on to a No. 3 machine the same performance would be repeated. The synchronous speed of an induction motor is:

$$\text{Revolutions per minute} = \frac{2 \text{ f } 60}{\text{p}}$$

Where p = the number of poles and f = the frequency of the circuit (cycles per second).

In starting under the cascade or concatenation, the secondary of the second motor is connected through the resistance. Concatenation is a word derived from the Latin, and means "chained together." As the locomotive speeds up, the secondary of the second motor is finally short-circuited. With two single-speed motors it is possible to get four speeds. The speed of two motors in direct concatenation equals $\frac{2 \text{ f } 60}{p_1 + p_2}$ in which p_1 = the number of poles in the No. 1 motor, and p_2 = the number of poles in the No. 2 motor. If the motors are connected in differential concatenation, the speed will be $\frac{2 \text{ f } 60}{p_1 - p_2}$ Let us take an example: Suppose the No. 1 motor has 12 poles and No. 2 motor has 4 poles. The frequency of the supply is 25 cycles. The four speeds will be as follows:

$$(1) \text{ Motor No. 2 alone} = \frac{25 \times 120}{4} = 750 \text{ revolutions.}$$

$$(2) \text{ Motor 1 and 2 in differential} = \frac{25 \times 120}{12 - 4} = 375 \text{ revolutions.}$$

$$(3) \text{ Motor No. 1 alone} = \frac{25 \times 120}{12} = 250 \text{ revolutions.}$$

$$(4) \text{ Motor 1 and 2 direct} = \frac{25 \times 120}{12 + 4} = 187.5 \text{ revolutions.}$$

The motors are in direct concatenation when they tend to start up in the same direction, and in differential concatenation when they tend to start in opposite directions.

In the case of the P. R. R. locomotive where the two motors are of the same number of poles, the speed is just one-half, when connected in cascade, as the denominator of the above fractions would be twice that for the single motor.

Slack Action in Trains

Variation in Braking Rates Owing to Slack Movement

By WALTER V. TURNER, Assistant Manager, Westinghouse Air Brake Co.

In last month's issue I had occasion to mention the effects of slack action in trains, and stated that where

R = the retarding factor in per cent.
P = the nominal braking ratio, per cent., based on.
C = the basic cylinder pressure for P, pounds per square inch.
p = the effective cylinder pressure, pounds per square inch.
ef = the efficiency factor.

$$R = \frac{p}{C} P \, ef$$

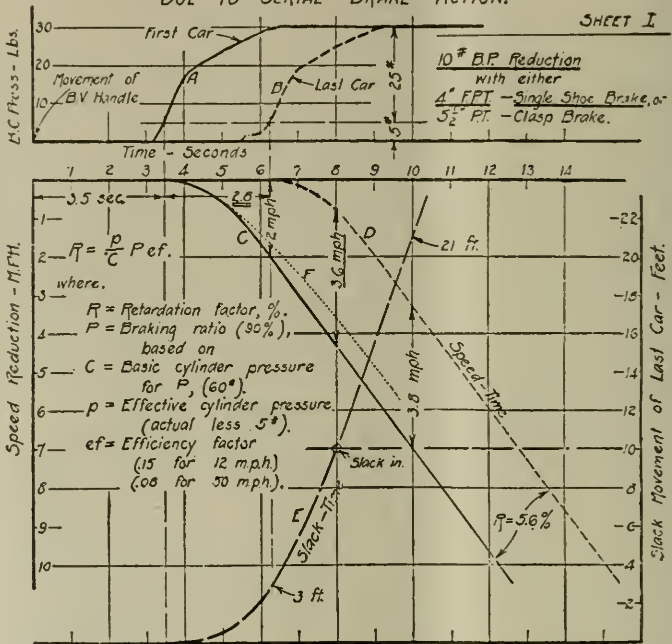
It was explained that this formula was used to calculate the retarding effect or factor of retardation set up by an application of the air brake, and was elaborated to a certain extent, and in an effort to more clearly set forth the information that may be derived from the calculation, if (p), (P) or (ef) be singly or severally raised or lowered in value (R) will be correspondingly raised or lowered, and vice versa. Thus it will be seen that if the actual cylinder pressure (p) be high, due to a heavy brake pipe reduction having been made or to short piston travel the retardation will be correspondingly high; and if this pressure be low, due to a light brake pipe reduction, long piston travel, reduced auxiliary reservoir volume, or leakage, the retardation rate will also be low.

If the braking ratio (P) be high, as, for example, 80 per cent. on a freight train, the retardation set up on the head end of a train in a certain time will be twice that with a braking ratio equal to only 40 per cent., other things being the same, and finally, if the efficiency factor (ef) be low, as it is at high speeds, due to the variation in the co-efficient of shoe friction, the retardation will be low as well, and vice versa, for low speeds. Thus if the efficiency factor be 8 per cent. for a speed of 50 miles per hour, the retardation set up at the head end of the train will be approximately half that where the efficiency factor equals 15 per cent. for a speed of 12 miles per hour.

If the amount of slack movement between the cars of a train is increased more time is given for the cars first experiencing brake action, or experiencing the more severe brake action, to retard before the other cars close in or pull away, as the case may be, therefore the velocity difference between cars will depend upon the amount of slack in the train being greater as the slack is greater though not in direct proportion. It is easy to see that if there were no slack or relative movement between the cars of a train there could be no difference in velocity set up between them. Carrying this to the other extreme it can be imagined that the slack could be so excessive that the last car in the train might be entirely stopped before the slack had closed in. Thus there will be no shock where the slack is zero, and there will be no shock where the slack is sufficient in amount to permit all cars to come to a stop before the slack runs in. This upper limiting of value of slack necessary to avoid shock will vary with the braking characteristics (rate of retardation and time of serial action) and with the initial speed of the train. Somewhere between these limiting values of slack there will be a point at which the maximum shock can occur, all other factors except the one of slack remaining constant. This critical value of slack for maximum shock (the maximum, of course, being different for each condition) tends to become greater as the speed is higher, as the time of serial action is longer, and as the rate of retardation is less. It is obvious that as the length of the train is increased, so also is the total amount of slack.

The foregoing means that in making a brake application there is a critical speed for maximum shock, due in a measure to resonance in slack surging and to the grouping of various vehicles in the train. Variations in the critical speed or from this speed at the time of applying brakes, together with favorable positions and amounts of slack account for the fact that severe shocks do not occur with every brake application in service where they do appear more or less frequently. However, the amount of slack is of no moment if the time of serial action be zero, as with the electro pneumatic brake, for here the last brake starts to apply as soon as the first and all brakes apply as one. As the time of serial action is increased, the dangers due to slack action also increase.

ILLUSTRATING RUNNING OF SLACK IN TRAINS DUE TO SERIAL BRAKE ACTION.



Assumed Conditions:
Slack in 12 passenger cars = 10 feet. Speed = 12 m.p.h. (ef = .15)
Brake pipe reduction = 10#. LN air brake equipment.
4" false piston travel, or 5½" constant piston travel.

Increased time of serial action means increased opportunity for greater retardation on the head end of a train before the slack closes in, thus it is clearly seen that the time of serial brake action is directly proportional to the length of the train.

On the attached diagram, curve (A), is that of brake cylinder pressure on the first car. It shows that brake cylinder pressure begins to rise at about 3.2 seconds after the brake valve handle is moved to application position, and 6.3 seconds later it passes the 5-pound mark, at which it is assumed that the brake shoes have been brought in contact with the wheels. Retardation on the first car then commences and as time continues the speed of the car is more and more reduced, as shown by curve (C). Retardation increases in rate as cylinder pressure builds up until the maximum is reached at a little after 6 seconds time. The slope of curve (C) represents the rate of retardation—as the slope is steeper the retardation or change in velocity for a certain time is greater. Curves (B) and (D) are similar curves for the last car, the serial time being shown as 2.8 seconds, that is, the brake on the last car got into operation 2.8 seconds later than the brake on the first car. Curve (E) is one representing the relative or slack movement between the first and last car, due to the differences in retardation. This movement is equal to the average velocity difference between the two cars multiplied by the time during which the average difference occurs.

Curves (C), (D) and (E) neglect the cars intervening between the first and last and assume a condition equivalent to the removal of the intervening cars, a separation of the first and last car equal to the total slack in the train, and a retention of the time of serial brake action, as with all cars in place. This assumption is not true to actual conditions for the reason that as each of the intervening cars close in on the one ahead the action increases the speed of those ahead to a somewhat higher rate than that shown by curve (C), possibly something like dotted curve (F). However, as each successive car closes in on those ahead the impact accelerates the increasing mass ahead less, and more of the sudden changing of velocity must be done by the colliding car so that the retardation of the first car does not differ materially from that shown by curve (C). Moreover, as each successive car collides with those ahead the velocity difference increases until it is maximum when the last car closes in. This means that as the shock runs back the bunch of cars ahead becomes increasingly solid, so far as the draft gears are concerned, until the last car has a veritable stone wall with which to collide, and finally, as it is not known just what a certain velocity difference means in the force of an actual blow between two cars or one car and a group of others, an allowance for discrepancies may be made in the velocity differences, which it is assumed that draft gear can care for without appreciable shock.

If there be 10 feet of slack in the train, as shown in the diagram, this slack will be all in in 8 seconds' time or 8 seconds after the brake valve movement, and the velocity difference between the head end (which includes the last car but one) and the last car is 3.6 miles per hour. After the impact the train as a whole moves on with a velocity a trifle higher than that represented by curve (C) at the instant of impact, as explained in connection with curve (F). Curves (C) and (D) are shown heavy to the instant of impact of the last car for 10 feet of slack. They are continued with lighter lines in order that the influences of other conditions of slack may be compared. For any actual case the impact causes curve (D) to drop down and be merged with curve (C), which is slightly raised. Dispensing with this geometrical parlance, this can be stated otherwise by saying that the front portion of the train and the rear car move on with the same velocity after the impact, retarding together.

If the amount of slack in the train be cut down to three feet and the time of serial brake action remain unchanged, the velocity difference is seen to be but two miles per hour. With 21 feet of slack, the velocity difference is 3.8 miles per hour, an amount not materially different from that for 10 feet of slack. Thus it is seen that the less the slack in the train the less the velocity difference between the head end and the rear and, therefore, the less the shock. However, after a certain point, about 9 seconds here, when curves (C) and (D) become parallel, due to the cylinder pressure being the same on head end and rear, the velocity difference is the same, irrespective of the amount of slack. The retardation for curves (C) and (D) is 5.6 per cent. It must be remembered that where the speed is such as to permit the head end to stop before the rear end runs in, an increase in the amount of slack tends to decrease the severity of the shock—other things remaining equal—in that more time is afforded the rear end for retardation.

Where variable conditions of braking ratio, piston travel, or cylinder leakage are scattered indiscriminately through a train, causing local differences in retardation to be set up, there can be in general no violent slack action for the reason that the amount of slack intervening between two extreme conditions is probably limited to that of a few cars. It takes cumulative slack action to cause shocks, and for that reason a freight train equipped with the single capacity brake and made up of alternate empty and loaded cars would handle very smoothly, whereas, with the usual train make-up, of all loads at one end and all empties at the other end of the train, shocks of great severity must be expected. Obviously it is impracticable to switch empties and loads into alternate order in making up trains.

In a future issue I will submit a similar diagram to the present one for the purpose of comparison. It will represent the conditions here spoken of.

Peculiarities of the Stephenson Valve Gear

By W. RICHARDSON, Bridgeport, Conn.

In the recent series of articles published in Railway and Locomotive Engineering in regard to the various kinds of valve gear now in use on American locomotives it was particularly gratifying to note with what a degree of fulness and exactness the details of the various devices were described and how much easier it is for the young machinist or engineer of today to master the details of the most intricate mechanism than it was in the last century when only a few unusually skilled mechanics found means or opportunity to master the details now within the reach of all.

In describing the construction and adjustment of the Stephenson valve gear, however, it occurred to me that some reference might have been made to a feature that has been the subject of much discussion and in regard to which no decisive conclusion has yet been brought out. As is well known, the amount of lead or valve opening on the gear referred to increases as the valve stroke is shortened. That is, assuming that there is at the full stroke of the valve ⅛-in. opening when the piston is at the end of the stroke, when the lever is "hooked up" and the stroke of the valve reduced so that the supply of steam is shut off at one-third or even less of the piston stroke, the amount of valve opening at the end of the stroke is increased more than double the amount when the valve is running at the full stroke, with the lever in the extreme end of the quadrant. This is readily accounted for by the altered position of the eccentric rods and their corresponding effect on the position of the rocker. Some authorities claim that this increase in valve opening is beneficial, as the engine is, as a rule, is running at higher velocities, when the lever is hooked up, and it is necessary that a quicker and fuller admission of steam is necessary to strike the rapidly moving piston at a point where it is most desirable. To my mind this is an error, and is one of the organic weaknesses of the Stephenson gearing. I am the more convinced of this because repeated experiments have been made to overcome this undesirable feature, and the nearest approach has been made by distorting the adjustment of the gear so that the amount of valve opening may remain constant while the engine is running forward, while in running backwards the opening will be increased to an abnormal extent by reason of the distortion.

With the same end in view the crank of the Walscharts gear has been experimentally removed from its true position,—that is at right angles to the main crank, with the result that the valve opening may be increased while the engine was running in one direction, and reduced while running in the other. Both experiments resulted in proving that the changes were not in the line of the economical use of steam, and both have been abandoned, which confirms my opinion that the increase in lead or valve opening under any condition is a fallacy, and is one of the reasons that the improved modern valve gears are in every way superior to the older types, not only from ready accessibility but with the substantial degree of security with which they retain their correct adjustment.

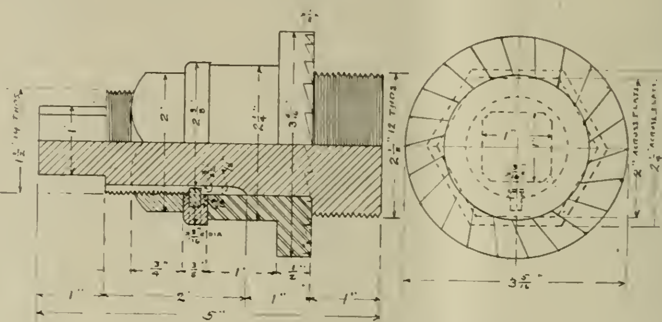
It would be hardly fair, however, to belittle the Stephenson valve gear, as it cannot be denied that it has well served its purpose for over seventy years. Neither has it entirely outlived its usefulness. Its flexibility rendered it easy of adjustment, but its numerous joints rendered it easy to become a source of error, and required constant re-adjustment, and the sooner it disappears altogether the less trouble there will be in roundhouse repair work.

Air Brake Repair Work Tools Devised and Applied to Every Requirement

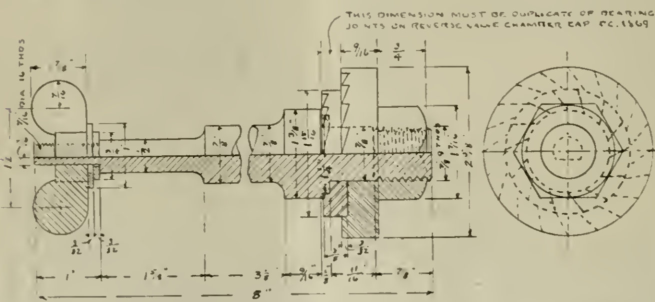
By GEORGE K. DORWART, Denver, Colo.

Valve Cap Nut Joint Face Reamer for 9½ ins., 11 ins., and Compressors.

The accompanying drawing shows the details of a reamer than may be readily applied to the valve cap nut joint face of the 9½ ins., 11 ins., air brake pump, and also to the cross compound compressors. If the dimensions are carefully followed in the construction of the parts the tool wlil be found admirably adapted for renewing the correct facing of the joints of the appliances referred to, and a few turns of the cutting tool will make the bearing of the fittings as good as new, and may be repeatedly applied, as it is not necessary that much metal should be removed in refacing a joint slightly worn.



NO. 12. VALVE CAP NUT FACE REAMER.



REAMER FOR FACING 9½ INS. PUMP STEAM HEAD AND REVERSE CHAMBER BUSHING, NO. 13.

Reamer for Facing 9½-ins. Pump, No. 13.

The drawing, No. 13, shows the complete details of a tool adapted for facing 9½-ins. pump steam head and also the reverse chamber bushing. It will be noted that the dimension relating to the variable sizes of the cutters must be the duplicate of the bearing joints on reverse valve chamber cap, P. C., 1869. It need hardly be stated that if the cutting tools are made of good material and properly tempered they will last for an indefinite period, and produce the exact joints desired without the necessity of complex lathe work.

Air Compressor Troubles

By D. B. HUTCHINS, Council Bluff, Iowa

Frequently the large capacity air compressors now used on steam locomotives develop some unusual disorders, that it is sometimes difficult for the repairman to locate and remedy. Merely performing the work that is reported does not always result in the compressor being in the condition or state of efficiency that it should be, as an example, we sometimes have a report to "examine air valves, pump pounds bad" and the repairman might examine all of the air valves and find all of them to be in good condition and have the proper lift and bearing on the seats, and look no further, and this same compressor might pass the required test, if the steam cylinders and steam valve mechanism was not properly lubricated, but after the lubricator is started feeding, the compressor might stop and could not again be started. This is particularly true of the New York Duplex compressors when the piston valve rings are worn to a point where there is but very little resistance to their movement, so that the weight of the valve and rod will cause them to drop to their lower positions in the head or steam chest when the steam pistons are making an upward stroke. These defective valve rings also cause the compressor to make short uneven strokes, and the proper remedy is to apply properly fitted rings as an increase in the amount of lubrication aggravates the trouble by still further reducing the resistance between the packing rings and their bushings.

In some cases of this trouble occurring at a time when proper repairs cannot be made, a temporary relief may be obtained by removing the steam chest caps, pulling down the valve and springing the rings by pulling them part way out of the grooves in the pistons, but care should be exercised in doing this on account of the possibility of breaking the rings.

Occasionally the lock nut of the steam valve works loose and results in the compressor stopping because proper port openings cannot be obtained, sometimes these nuts cannot be replaced on account of damaged threads, therefore if the piston is correctly fitted on the rod the nut may be entirely removed with but very little chance of the piston becoming disengaged before the end of the trip.

A bent valve stem in the low pressure cylinder would likely cause the button of the valve rod to slip out of the tappet plate and cause the compressor to stop with the high pressure piston at the bottom of its stroke. The same trouble occurring in the high pressure side would cause both pistons to stop at the upper end of the stroke.

A piston rod nut coming off will necessitate the removal of the top head, but they can sometimes be replaced if they come off along the line of road.

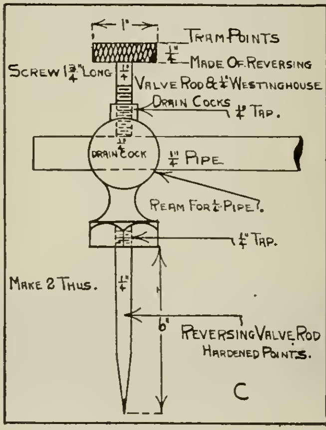
The principal troubles of the 8½ in. Westinghouse compressor are due to gummy intermediate air valves caused by an excessive amount of lubrication in the air cylinder. This causes a pounding of the compressor which may be stopped by closing the brake valve double heading cock, draining the main reservoir and removing the intermediate valve caps and pouring about a pint of kerosene oil into the cylinders. Better success has been obtained in this manner than by using a lye vat as the lye removes all of the lubrication causing the compressor to groan.

This type of compressor sometimes stops with the high pressure piston at the lower end of its stroke and is generally caused by a leaky reversing slide valve. This may also be cause by a broken or bent reversing valve rod. The compressor may also be stopped by a badly worn condition of the steam valve mechanism, or the pounding or uneven strokes may be caused by badly worn packing rings in the low pressure air cylinder, when one-half of the cylinder is lubricated and the other half dry.

HOME MADE TRAM POINTS.

By J. H. Hahn, Norfolk & Western Railway, Bluefield, W. Va.

The annexed drawing shows a set of tram points made from two ¼ in. Westinghouse drain cocks and an old reversing valve rod from a 9½-ins. pump. A piece of ¼ in. iron pipe is used for the slide, and by using pieces of pipe of various length the trams can be used for laying out shoes and wedges, in locating wheel centers and other points where exactness is a requisite. In every respect trams made from this cheap material will be



found as useful as the much more costly kind made of finished hard wood with elaborate attachments which are easily damaged, whereas the plain pipe will be found more durable.

The Old and the New.

By C. Reardon, West Albany, N. Y.

It was very interesting to note in the clever description of the Alexandria shops on the Southern Railway that appeared in the June issue of Railway and Locomotive Engineering, that there is still a lingering of the old system in vogue when each engineer had his own engine, and spent a good deal of time in keeping it in order. We hear occasionally of a desire expressed to restore this ancient order of things, but while there is a fine sentiment of loyalty on the part of an engineer who will devote his own time to the upkeep of his engine, this sentiment does not weigh heavily with the average railroad man because all along the line it has been a hard fight for all that has been secured in the way of improved conditions or shorter hours, not to speak of the method of having locomotives run by double crews in busy seasons so that the whole trend of railway operation is against the return to the older customs. We hear also of engineers having their names emblazoned on the cabs of locomotives after many years running the same engine. There is no harm in this. On the contrary it shows some appreciation on the part of the company, but it is to be hoped that during the unattached periods when the locomotive is undergoing repairs the engineer is not compelled to go around idle as in the old days, waiting until his engine is out of the back shop. In these days of high prices this would be walking backwards, or at least looking in that direction.

Piece Work.

By E. W. Thomson, Pittsburgh, Pa.

In the excellent article published recently in Railway and Locomotive Engineering on the subject of laying out shoes and wedges, while beyond criticism in the exactness of detail, it did not, I think, take into consideration the rate of remuneration allowed to piece workers in some of the leading railroad shops. Indeed it must be said that a mechanic leaving a shop where the older method of payment by the hour is in vogue and beginning piece work, has his eyes opened on beholding the rate of speed with which some operations are performed. Referring to the laying out of shoes and wedges about 37 cents per box is allowed, and testing and filing after planing 11 cents is about the price. Completing the whole operation from beginning to end, including the correct tramming of the wheels, about 75 cents to $1.12, according to the class of engine, is allowed.

With steady work and prompt assistance, good wages may be made at these rates, but it is usually unexpected changes of jobs. It may be removing running boards for which from 63 to 95 cents and 31 cents extra if without a crane. For replacing the running board, 44 cents is about the price. Work of this kind is extremely variable in the difficulty of accomplishment, and of course there is no time allowed for cleaning hands or tools or collecting new tools. The next operation may be removing valve bushings. In this there is considerable variations in the work of extracting the bushing, but the figure is fixed at 75 cents per bushing and 50 cents for replacing which is not so variable.

Indeed the tendency is to equalize all operations apart from the unexpected difficulties that may be encountered and for which no allowance is made, while on the other hand, care is taken that even the most skilled mechanic is not allowed to earn more than a certain fixed amount. Probably some of your able correspondents may compare notes on this important subject.

Recently Built Freight Engines of the Nevada Northern

On account of the great amount of attention that has recently been given to very heavy locomotives built for trunk line service, there is, perhaps, a tendency to overlook the fact that locomotives of notable design are frequently constructed for comparatively short lines, where wheel loads are limited and special operating conditions must be met. There is no reason why locomotives for such service should not show the same high efficiency as the heaviest type of power, and many locomotives of moderate weight and capacity are now being designed and equipped with this end in view.

Our illustrations show two recent Baldwin freight locomotives which were built with these ideas in view. The Mikado, or 2-8-2 type engine, is used on a road having comparatively light grades and curves, while the track is laid with rails weighing 65-75 lbs. per yard. The locomotive develops high hauling and steaming capacity, in consideration of the limited axle load imposed by these conditions. With a tractive force of 37,400 lbs. and a ratio of adhesion of 4.16, it is evident that the weight on drivers is utilized to advantage; while, with reasonably careful handling, there should be but little trouble on account of slipping.

The locomotive on the Midland Valley used Arkansas soft coal as fuel, and has a wide deep firebox placed back of the drivers and over the rear truck. The equipment includes a superheater, Security brick arch and Franklin air operated firedoor. The boiler construction is in accordance with the regular practice of the builders, and the firebox staying includes three rows of Baldwin expansion stays, which support the forward end of the crown-sheet. An extended, self-cleaning front end is applied.

The steam distribution is controlled by 12-in. piston valves, and these are driven by the Southern valve motion. The Ragonnet power reverse mechanism is applied. The use of a power reverse on locomotives of moderate size is becoming general and the results are most satisfactory.

The frames are strongly designed and braced, and the Commonwealth rear frame cradle is applied. In the present case, the rear truck is of the Hodges type, and the frame cradle is made in one piece with suitable brackets for the equalizing beam fulcrums and truck spring hangers.

The Consolidation or 2-8-0 type locomotive for the Nevada Northern Railway is lighter in total weight than the Midland Valley 2-8-2 or Mikado engine, but it carries practically the same weight on the drivers. The cylinders are smaller, but the drivers are less in diameter and the tractive forces developed by the two locomotives are nearly equal. Operating conditions on the Nevada Northern are such that the required hauling and steaming capacity can be combined in a locomotive of the Consolidation type. In the present instance a wide firebox is used; and with driving wheels of comparatively small diameter, and a high-pitched boiler. The throat can be made of sufficient depth to apply an arch with its supporting tubes. A comparison of the boiler dimensions of the two engines here illustrated, shows the grate areas to be practically alike, while the number of tubes is nearly the same in each case; but the longer tubes in the Mikado type engine provide considerably more heating surface than can be obtained in the boiler of the Consolidation engine.

The Nevada Northern locomotive has outside steam pipes, 10-in. piston valves, and Baker valve motion. The details of construction call for little comment, but are thoroughly modern for an engine of this type and weight. The tender has capacity for 7,500 gallons of water and 12 tons of fuel, and is carried on "Standard" rolled steel wheels.

The leading dimensions of these two locomotives are given in the tables:

Midland Valley engine: cylinders, 21 x 26 ins.; valve, piston, 10 ins. diameter.

Boiler—Diameter, 70 ins.; thickness of sheets, 11/16 in.; working pressure, 190 lbs.; fuel, soft coal.

Fire Box—Length, 107 ins.; width, 62¼ ins.; depth, front, 68 ins.; depth, back, 52½ ins.; thickness of sheets, sides, ⅜ in.; thickness of sheets, back, ⅜ in.; thickness of sheets, crown, ⅜ in.; thickness of sheets, tube, ½ in.

Water Space—Front, sides and back, 4 ins.

Tubes—Diameter, 5⅜ and 2 ins.; material, 5⅜ ins. steel, 2 ins. iron; thickness, 5⅜ ins. No. 9 W. G., 2 ins. No. 11 W. G.; number, 5⅜ ins. 25, 2 ins. 168; length, 14 ft.

Heating Surface—Fire box, 156 sq. ft.; tubes, 1,714 sq. ft.; firebox tubes, 19 sq. ft.; total, 1,889 sq ft.; superheater, 423 sq. ft.; grate area, 46.2 sq. ft.

Driving Wheels—Diameter, outside, 51 ins.; journals, 9½ x 10 ins.

Engine Truck Wheels—Diameter, 30 in.; journals, 6 x 10 ins.

Wheel base—Driving, 15 ft.; rigid, 15 ft., total engine, 24 ft. 1 in.; total engine and tender, 58 ft. 7½ ins.

Weight—On driving wheels, 155,800 lbs.; on truck, 20,500 lbs.; total engine, 176,300 lbs.; total engine and tender about 320,000 lbs.

Tender—Wheels, diameter, 33 ins.; journals, 5½ ins. x 10 ins.; tank capacity, 7,500 U. S. gals.; fuel, capacity 12 tons; service, freight. For the Nevada Northern, cylinders, 22 ins. x 28 ins.; valves, piston, 12 ins. diam.

Boiler—Diameter, 66 ins.; thickness of sheets, 11/16 in.; working pressure, 185 lbs.; fuel, soft coal; staying, radial.

Fire box—length, 102⅛ ins.; width, 65⅞ ins.; depth, front, 67½ ins.; depth, back, 56½ ins.; thickness of sheets, sides, 5/16 in.; thickness of sheets, back, 5/16 in.; thickness of sheets, crown, ⅜ in.; thickness of sheets, tube, ½ in.

Water space—Front, sides, back, 4½ ins.

Tubes—Diameter, 5⅜ ins. and 2 ins.; material, 5⅜ ins. steel. 2 ins. iron; thickness, 5⅜ ins., No. 9 W. G.; 2 ins. No. 11 W. G.; number, 5⅜ ins., 24; 2 ins. 172; length, 19 ft. 3 ins.

Heating surface—Fire box, 165 sq. ft.; tubes, 2,373 sq. ft.; firebrick tubes, 29 sq. ft.; total, 2,567 sq. ft.; superheater, 562 sq. ft.; grate area, 46.8 sq. ft.

Driving wheels—Diameter, outside, 57 ins.; journals, main, 9 ins. x 12 ins.; journals, others, 8½ ins. x 12 ins.

Engine truck wheels—Diameter, front, 33 ins.; journals, 5½ x 10 ins.; diameter, back, 40 ins.; journals, 7½ x 12 ins.

Wheel base—Driving, 15 ft. 0 ins.; total engine, 31 ft. 8 ins.; total engine and tender, 61 ft. 7¾ ins.

Weight—On driving wheels, 155,700 lbs.; on truck, front, 16,900 lbs.; on truck, back, 26,800 lbs.; total engine, 199,400 lbs.; total engine and tender, about 320,000 lbs.

Tender—Wheels, diameter, 33 ins.; journals, 5 ins. x 9 ins.; tank capacity, 6,000 gals.; fuel, capacity 10 tons; service, freight.

2-8-0 FOR THE NEVADA NORTHERN. 2-8-2 FOR THE MIDLAND VALLEY.

Items of Personal Interest

Mr. W. L. Garland, 1738 Commercial Trust Building, Philadelphia, Pa., in addition to representing the Safety Car Heating & Lighting Company, will also represent the Vapor Car Heating Company, Inc., dating from June 1.

Mr. S. W. Caton, formerly general car inspector of the Western Maryland, at Hagerstown, Md., has been promoted to master car inspector, with headquarters at Hagerstown.

Capt. Elmer K. Wiles, E. O. R. C., has been called into active service with the Fifth Reserve Engineers, Pittsburgh, Pa., and is now on duty. Captain Wiles was formerly secretary of the Engineers' Society of Western Pennsylvania.

Mr. A. L. Brown has been appointed master mechanic of the Baltimore & Ohio at Glenwood, Pittsburgh, Pa., succeeding Mr. F. P. Pfahler.

Mr. W. G. McPherson, formerly general roundhouse foreman of the Canadian Pacific, at Moose Jaw, Sask., has been appointed division master mechanic at Regina, Sask., succeeding Mr. S. W. Falkins, transferred.

Mr. Dwight C. Morgan, Jr., has been appointed mechanical engineer of the Pittsburgh & Shawmut, with office at Brookville, Pa.

Mr. F. P. Pfahler, formerly master mechanic of the Baltimore & Ohio at Glenwood, Pittsburgh, Pa., has been appointed master mechanic at Cumberland, Md., succeeding Mr. R. B. Stout.

Mr. Paul Bischeld has been appointed district foreman of the Union Pacific, at Salina, Kans., succeeding Mr. J. A. Brice.

Mr. F. G. Flesher has been appointed locomotive foreman of the Canadian Northern, with office at Lucerne, B. C., succeeding Mr. T. C. Young, transferred.

Mr. John Lee, formerly locomotive draftsman at the Winnipeg shops of the Canadian Pacific shops, has been appointed shop engineer at that point.

Mr. H. A. Lyddon has been appointed superintendent of shops of the Northern Pacific, with office at South Tacoma, Wash., succeeding Mr. F. W. Mallott, retired.

Mr. Richard A. Van Houten, formerly sales agent of the Sellers' Manufacturing Company at Chicago, has been appointed manager of the plant at Mayfair, Chicago, in charge of manufacturing operations.

Mr. Charles H. McCormick, formerly attached to the sales department of the Standard Heat & Ventilation Company, has been appointed special agent of the National Railway Appliance Company, New York.

Mr. Warren B. Young has been appointed assistant general foreman of the Central Railroad of New Jersey, with office at Phillipsburg, N. J.

Mr. Walter H. Bentley, vice-president of Mudge & Company, Chicago, Ill., has ben elected president of the Locomotive Specialty Company, Railway Exchange building, Chicago, general distributors of the Ripken main rod arm and other railway specialties.

Mr. William S. Morehead has been appointed assistant general storekeeper of the Illinois Central, with office at Chicago, Ill., with jurisdiction over the Northern lines. Mr. Morehead succeeds Mr. William Davidson, who has been promoted to the position of general storekeeper of the same road, with offices at Burnside, Chicago.

Mr. Ernest Baxter has been appointed general storekeeper of the Wabash, with office at St. Louis, Mo., succeeding Mr. A. J. Lewing, assigned to other duties.

The American Steel Export Company, New York, announces the appointment of Mr. F. H. Tackaberry as traveling representative with the title of general agent. Mr. Tackaberry has recently been associated with the Ordnance Engineering Corporation of New York, and has occupied important executive positions in such organizations as the Industrial Underwriter, Inc., the Locke Steel Belt Company, etc.

Mr. Charles H. McCormick, formerly connected with the Standard Heat & Ventilation Company, has been appointed special sales agent for the National Railway Appliance Company, at 50 East Forty-second Street, New York.

Mr. Robert Parks, formerly general manager of the Bettendorf Company, Bettendorf, Iowa, has become connected with the Canadian Car & Foundry Company.

Mr. C. H. Rhodes has been appointed purchasing agent of the Illinois Steel Company, succeeding Mr. I. C. Hoot.

Mr. Henry V. Vaughan, M. Can. Soc. C. E., who was recently appointed to a high executive position with the Dominion Bridge Company of Canada, has been appointed general manager of the company. Mr. Duggan, the former general manager, becomes chairman of the board of directors, and also the position of chief engineer of the company. Mr. Phelps Johnson is president of the company.

Mr. G. H. Likert has been appointed master mechanic of the Chicago, Rock Island & Pacific, Nebraska division, with office at Goodland, Kans., succeeding Mr. M. B. McPartland, resigned to accept a position with another company.

Mr. Arthur Krohn has been appointed assistant superintendent of motive power of the Missouri, Kansas & Texas, with office at Parsons, Kan., and Mr. A. E. Voight, formerly assistant electrical engineer of the same road, has been appointed electrical engineer, with headquarters at Topeka, Kan.

Mr. O. E. Maxwell has been appointed road foreman of engines of the Pennsylvania Lines at Fort Wayne, Ind., succeeding Mr. J. H. Hanna, transferred.

Mr. R. M. Conley, formerly locomotive engineer on the western division of the Western Pacific, has been promoted to master mechanic of the eastern division with office at Elka, Nev., succeeding Mr. J. Van Cline, resigned, and Mr. J. H. Penny, formerly road foreman of engines, who has been promoted to master mechanic at Oroville, Cal., and Mr. W. M. Chambers has been appointed roundhouse foreman at Portola, Cal., succeeding Mr. W. McFarland, resigned.

Mr. W. W. Scott has been appointed shop superintendent of the Buffalo, Rochester & Pittsburgh, with office at Punxsutawney, Pa.

Mr. W. J. Hiner, formerly assistant purchasing agent of the Cleveland, Cincinnati, Chicago & St. Louis, has been appointed purchasing agent, with office at Cincinnati, Ohio, succeeding Mr. George Tozzer, retired.

Mr. E. P. Nash, general foreman of shops of the Illinois Central, Palestine, Ill., has been recommended for a commission as first lieutenant in the Illinois Cavalry Company of the Chicago railway regiment, the Third Engineers.

Mr. Carl Scholz, formerly manager of the mining and fuel department of the Chicago, Rock Island & Pacific, has been appointed mining engineer of the Chicago, Burlington & Quincy, with headquarters at Chicago, Ill.

Mr. James E. Gorman, who has been chief executive officer for the receiver of the Chicago, Rock Island & Pacific, has been elected president of that road. He was also elected a director, succeeding Mr. W. B. Thompson, resigned, and Mr. E. K. Boisot was elected to succeed Mr. J. S. Alexander.

Mr. F. L. DuBosque has been appointed superintendent of the floating equipment of the New Jersey division, West Jersey & Seashore, and the Philadelphia & Camden Ferry Company, by the Pennsylvania railroad.

Mr. C. B. Brown, chief engineer at Manitou, N. B., of the Canadian Government railways, has also been appointed general manager of the Eastern Lines.

Mr. L. C. Fritch has been appointed general manager of the Seaboard Air Line. Mr. Fritch has had over thirty years' experience in railroad work, largely in the engineering department on several railroads in the Middle West. For the last three years he was general manager of the Canadian Northern, which position he held at the time of his appointment as noted above.

Mr. T. C. Irvine, formerly vice-president of Robert W. Hunt & Co., and in charge of the Montreal and Toronto offices of the company, has been recently given command of the engineers in the fourth Canadian division. He left Toronto with the first Canadian contingent as captain. He was particularly distinguished in several battles and received the D. S. O. for services at the battle of Langemarck.

Mr. H. H. Maxfield, recently appointed superintendent of motive power of the New Jersey division of the Pennsylvania, has been assigned to duty with the Ninth Reserve Engineers, with the rank of captain. First Lieutenant Frank S. Robbins, assistant master mechanic of the Pennsylvania at Pittsburgh, and First Lieutenant George F. Huff, Jr., have also been assigned to the Ninth. Captain Maxfield is to be promoted to lieutenant-colonel, and Lieutenants Robbins and Huff are to be promoted to captains.

Mr. Charles D. Barrett, master mechanic of the Pennsylvania, at Sunbury, Pa., is to be commissioned as a major in the Ninth Reserve Engineers, and Mr. B. W. Kline, electrician of the Pennsylvania at Williamsport, Pa., has been recommended for a commission as captain in the same regiment.

George J. Bury, vice-president of the Canadian Pacific Railway at Montreal, Que., Canada, has recently received the honor of knighthood from King George. Sir George Bury has been connected with the railway from its earliest years and began his career as private secretary to the late Sir William Van Horne. His advancement on the road has been steady and of a substantial character and Sir George, in nearing the top of the ladder, has established a reputation which has been recognized even beyond the commercial boundaries and the vast industrial interests of the railroad of which he is now the practical head. We congratulate Sir George on the recognition of this condition by those who take a large and comprehensive view of the economic interests of the Dominion of Canada.

Mr. S. M. Vauclain, vice-president of the Baldwin Locomotive Works, has been appointed chairman of committees of the Council of National Defense dealing with the locomotive and railway car needs of the country, and particularly of the Allies, the object being to increase the output of American locomotives and cars through co-ordination of the efforts of manufacturers. Mr. Andrew Fletcher, president of the American Locomotive Company; Mr. H. P. Ayres, vice-president of the H. K. Porter Company, and Mr. Joel Coffin, chairman of the Lima Locomotive Corporation, are members of the locomotive committee. The commit-

SIR GEORGE J. BURY.

tee on cars consists of Mr. E. F. Carry, president of the Haskell & Barker Car Company; Mr. C. S. Gawthrop, vice-president American Car & Foundry Company; Mr. Cline Runnels, vice-president

S. M. VAUCLAIN.

of the Pullman Company, Mr. R. L. Gordon, vice-president of the Standard Steel Car Company; Mr. N. S. Reeder, vice-president of the Pressed Steel Car Company, and Mr. S. P, Rush, president of the Buckeye Steel Castings Company.

General Foremen's Association.

The executive committee of the International Railway General Foremen's Association has decided that the annual convention will be postponed until 1918. Committees' report and copies of papers will be distributed, and members are requested to send written discussions to the secretary on or before September 15, 1917. The annual volume of proceedings will be published and distributed as formerly.

Car Inspectors' and Car Foremen's Assn.

The executive committee of the Chief Interchange Car Inspectors' and Car Foremen's Association have decided to postpone holding their convention for one year. The convention was scheduled to be held at St. Louis, Mo., from September 25 to 27. The present officers will retain their positions for another year.

Western Railway Club.

The following were elected officers of the Western Railway Club at the annual meeting held last month at the Hotel Sherman, Chicago, Ill. President A. R. Kipp, mechanical superintendent, Chicago division, Soo Line; first vice-president, A. La Mar, master mechanic, Pennsylvania Lines; second vice-president, G. S. Goodwin, mechanical engineer, Chicago, Rock Island &. Pacific; secretary and treasurer, Joseph W. Taylor.

Westinghouse Elec. and Mfg. Co.

At the annual meeting of the stockholders of the Westinghouse Electric & Manufacturing Company, held at the offices of the company at East Pittsburgh on Wednesday, June 13, a vote was taken on the merger of the Westinghouse Machine Company with the Westinghouse Electric & Manufacturing Company and, as was expected, the vote was unanimously in favor of the merger.

The following directors, whose terms expire this year, were re-elected for four years: J. D. Callery, Paul D. Cravath, Harrison Nesbit, James N. Wallace.

Summer Session of the University of Wisconsin.

The nineteenth annual summer session of the College of Engineering of the University of Wisconsin will be held at Madison during the six weeks' period beginning June 25, 1917. Special courses will be given in chemistry, electrical steam and hydraulic engineering, gas engines, machine design, mechanical drawing, mechanics, shop work and surveying. All courses given in the university summer session are open to engineering students. For information, address F. E. Turneaure, dean, Madison, Wisconsin.

There has been an exhibition at the freight house of the Santa Fe, State and Twelfth streets, Chicago, Ill., two sample cars constructed at the direction of the sub-committee on designs and specifications, of the American Railway Association. One was built at the Altoona shops the other by Pullman.

Manufacturers Locating in New York.

The Merchants' Association of New York are doing excellent work in many directions, and none more commendable than in the gratuitous advice to the large number of manufacturers who are at all times locating in the vicinity of New York. The metropolitan district contains twenty important cities and many smaller communities, and it is a valuable service to such manufacturers in aiding them to select the particular location best suited to their requirements. The idea is not to induce manufacturers to locate in New York but to aid those who are coming to the city or vicinity, and may not be aware of the good work that the association is doing in this direction. A. L. Smith is manager of the Industrial Bureau and should be addressed at the Woolworth Building, 233 Broadway, New York.

Decrease of Car Shortage.

The American Railway Association reports that on June 1 there was a net shortage of empty freight cars on the lines of the United States and Canada of 105,127. These figures compare with a shortage of 148,627 on May 1. The largest car shortage in the history of the country occurred in the autumn of 1906, but as the reports of the American Railway Association only began in 1907, the largest car shortage on record was 137,847 cars reported on February 26 of that year.

War Material in Canada.

A loan of $10,000,000 has been advanced by the Canadian Pacific for the production of war material in Canada. The loan has been granted to the imperial munitions board, which is entrusted by the British Government for placing munition orders in Canada and expediting the production of the same.

Advance Pay on the Canadian Pacific.

An announcement has been made by the Canadian Pacific that all employees of that company in the United States who volunteer for service overseas, will receive six months' pay when they leave on active service. The employees are also assured of their old positions on their return from service. Men who wait to be drafted will receive no recognition.

The Sessions-Standard Friction Draft Gear Company of New York reports receiving an order for the equipment of 2,000 cars, by the Norfolk & Western Railway. The type "K" of this friction gear has been specified.

The man who wins is the man who works. Who neither labor nor trouble shirks. Who uses his hands, his head, his eyes; the man who wins is the man who tries.

Railroad Equipment Notes.

The Illinois Traction System will build six electric locomotives in its Decatur, Ill., shops.

The Baltimore & Ohio, it is said, will erect two additions to its shops at Zanesville, Ohio.

The Marianna Coal Company has ordered 1,000 coal cars from the Cambria Steel Company.

The Atchison, Topeka & Santa Fe will build a machine and repair shop at El Paso, Texas, to cost $10,000.

The Southern Railway has ordered 25 Santa Fe (2-10-2) type locomotives from the American Locomotive Co.

The Central El Lugareno (Cuba) has ordered two Mogul type locomotives from the Baldwin Locomotive Works.

The Richmond Fredericksburg & Potomac is in the market for 15 caboose cars and 15 steel underframes for 50-ton flat cars.

The Alan Wood Iron & Steel Company has ordered three four-wheel (0-4-0) type locomotives from the Baldwin Locomotive Works.

The South African Railways have ordered 20 additional 100-ton Mountain (4-8-2) type locomotives from the American Locomotive Company.

The Russian Government has ordered 250 Decapod locomotives from the American Locomotive Company and 250 from the Baldwin Locomotive Works.

Orders for 10,000 four-wheel box cars for Russia have been placed, 6,500 to be built by the American Car & Foundry Company and 3,500 by the Standard Steel Car Company.

The Monongahela has ordered 6 Consolidation (2-8-0) type locomotives from the American Locomotive Company. Each will weigh 201,000 pounds; cylinders will be 22½ by 30 inches.

The United States Navy has ordered 11 50-ton steel flat, 2 30-ton box and 5 50-ton steel underframe box cars from the American Car & Foundry Company, and 2 flat cars from the Mt. Vernon Car Manufacturing Company.

The South African Government Railways have ordered 20 superheater Mountain type locomotives from the American Locomotive Company. These locomotives will have 22 by 26-in. cylinders, and a total weight in working order of 175,000 lb.

The Yazoo & Mississippi Valley has let contract to T. S. Leake Company, Chicago, to construct round house, machine shop, office building, store house, lavatory, lumber shed, cinder pit and turntable, at Baton Rouge, La., to cost $150,000.

It is understood that Congress will be asked to authorize the expenditure by the Government of $150,000,000 to $200,000,000 for the purchase of 100,000 freight cars, principally for use in this country, but also for use on lines of communication in France.

The Missouri, Kansas & Texas is to install a mechanical interlocking plant at Clinton, Mo., a 24-lever Saxby & Farmer machine having 18 working levers. The material will be furnished by the Union Switch & Signal Company. The distant signals will be electric, low voltage d. c.

The Atchison, Topeka & Santa Fe has awarded the Union Switch & Signal Company a contract for material for the installation of automatic block signals, between Richmond and Fresno, Cal. This work will include 250 style "S" double case ground signals, with relays, switch boxes, etc.

Negotiations are being actively continued relative to the purchase of 100,000 freight cars for the American railroads by the United States Government. A number of important officers of car building companies have been in conference at Washington. It is understood that the proposals to purchase equipment contemplate the construction of composite box and gondola cars, and that the cost will be about $1,500 per car.

The Pennsylvania has ordered from the Union Switch & Signal Company three electro mechanical interlocking machines, one to be installed at Petersburg, Pa.; 12 working levers (mechanical) and 19 electrical levers; one at Tyrone Forge, with a 12-lever mechanical machine with an electrical section of 14 working levers, and one at Eldorado, where the machine will include a four-lever mechanical frame and an electrical section consisting of five working levers.

The Imperial Munitions Board of Canada has authorized the Algoma Steel Corporation and the Dominion Steel Corporation to roll 50,000 tons of standard section rails for Canadian railroads that helped the Dominion government in time of need by sacrificing rails in service for export to the war zone. These roads were unable to secure new rails from American mills. The rails will be distributed among the Canadian Pacific, the Intercolonial, the Grand Trunk and the Temiskaming & Northern Ontario Railroads.

The Interborough Rapid Transit Company, New York City, has awarded the Union Switch & Signal Company a series of contracts to provide interlocking and automatic block signals for the Seventh Avenue Subway from West Forty-third Street to Wall Street, about three miles; the final part of the West Farms Subway connection, and the Pelham Bay Parkway line from Park Avenue and East 135th Street to Pelham Bay Park, about three miles. The interlocking will be electro-pneumatic. Electro-pneumatic automatic train stops will be used throughout. The Seventh Avenue Subway will have seven interlocking aggregating 105 levers. The Pelham Bay Parkway Line includes one 19-lever, two 15-lever and three 11-lever interlocking machines.

Westinghouse Machine Company.

At a meeting of the stockholders of the Westinghouse Machine Company, held at the company's offices at East Pittsburgh, Wednesday, June 13, the proposition to merge the Westinghouse Machine Company with the Westinghouse Electric & Mfg. Company was carried by a large majority, and the directors and officers of the Westinghouse Machine Company empowered to arrange for the execution of the merger. The following directors whose terms expire were re-elected for one year: James D. Callery, E. M. Herr, H. T. Herr, William McConway, John R. McCune, Jos. W. Marsh, L. A. Osborne, Guy E. Tripp, H. H. Westinghouse.

Increased Rates on the Long Island.

The Public Service Commission for the Second District of New York has granted permission to the Long Island Railroad to increase its mileage book rates from 2 cents to 2¼ cents per mile. An increased expenditure of $400,000 a year because of the Adamson eight-hour law, was set forth by the railroad as the principal justification for an increase. The commission found that the company's passenger business had not yielded a fair return for the past 10 years.

Moving an Oil Tank.

A 120-ton oil tank 90 ft. in diameter and 30 ft. high was moved 14 miles from Seattle to Point Wells, Washington, in 30 days by Olson & Nicholson, contractors. Tunnels were driven under the tank and in them were set six lines of transverse timber; under them 50 ft. apart two lines of 16 by 18-in. longitudinal track timbers. The tank was jacked up and lowered to bearing on 60-in. wooden rollers on the track stringers, after which the tank was pulled to the shore by a tackle operated by a capstan and team of horses and loaded on a pair of barges braced together 16 feet apart and moored to the shore at a point about 800 feet from the site of the tank.

Loading Cars.

Load cars 10 per cent. in excess of marked capacity, reduce percentage of cars and locomotives under repairs; improve methods of "firing" locomotives defer scrapping light locomotive; speed up handling of cars in terminals by prompt despatch of trains; load and unload promptly; and enlist co-operation of shippers, as a war measure, to secure heavier loading of cars.

Dunbar Manufacturing Company.

The Acme Supply Company changed its corporate name last month to the Dunbar Manufacturing Company. The main office and sales organization at Chicago will remain substantially the same, with the addition that a new sales office has been opened at St. Paul, Minn., with Rank & Goodell as sales representatives.

General Electric Moves to New Offices.

The New York offices of the General Electric Company have been moved from No. 30 Church Street to the Equitable Life Building, No. 120 Broadway. The entire twentieth floor of the building has been especially arranged and furnished for the General Electric Company. For nine years these offices have been at No. 30 Church Street, where the company located its New York offices when it outgrew the "Edison Building," at No. 44 Broad Street. This building was originally built for the Edison General Electric Company which, in 1892, was combined with the Thomson-Houston Electric Company to form the General Electric Company. In the quarter century since the General Electric Company was formed, its business has increased from about ten millions in gross sales the first year of its organization to gross orders of $167,169,000 during the twenty-fifth year, and its sales offices have naturally increased in number and in importance. The company's offices in New York are the largest and most important among its district offices.

Trouble has sometimes arisen from not remembering that heavy and extra heavy pipe does not vary on its outside diameter by being enlarged, but that the extra strength is obtained in making the hole smaller. Therefore to get the same area for the flow of gas or liquids the next larger size of extra heavy pipe should be used.

Business men who cannot discover, bring out, provide for, keep up, use and pay for the highest qualities in people they employ will soon be far behind in the modern industrial race.—Gerald Stanley Lee.

Books, Bulletins, Catalogues, Etc.

Laws of Physical Science. By Edwin F. Northrup, Ph. D. Publishers, J. B. Lippincott Company, Philadelphia. Price, $2.00; postage extra.

This unique book contains a full list of the general propositions or laws of the various divisions of physical science. The fundamentals of any science are its principles, laws, and theorems. In this case the attributes dealt with, concern or are related to physics. In this book the student finds guidance by having before him an epitome of what is now known regarding that important branch of the science which concerns matter and material things. It interests, not only the general student, but it reaches the man who desires accurate knowledge, and appeals to physicists, chemists, engineers and all those interested in the theory or utility of natural forces. It is compact, neatly bound in flexible leather and excellently printed. A bibliography and index are included in the 210 pages.

Prof. J. V. Nash says: "Professor Northrup's 'Laws of Physical Science' will take its place among that select galaxy of volumes which never grow old, and will be as serviceable to generations yet unborn as it is to the generation of today. As a reference work it is invaluable, containing within the compass of pocket size, information which hitherto has been widely scattered and practically inaccessible to the layman."

It may be truthfully said that this is the only book of its kind available. It is complete, authoritative and as accurate as human care could make it. Wide experience as an inevstigator, inventor, practising electrical specialist, and as an instructor, has revealed to the author the needs of all classes of scientific men. The simplicity and directness with which each law is expressed leaves little or nothing further to be desired.

This book will never go out of date. Prof. Northrup has codified the natural laws of the physical universe within the pages of a single volume. Man-made laws have been compiled in thousands of volumes. They have been and are multiplied year by year and the end is not yet. These laws change from session to session. It is of more than passing interest to note that this is the first attempt to codify the Laws of Nature and place them before the reader as they are, the laws which never change.

Under one cover we find the basic laws of: Mechanics, Hydrostatics, Hydrodynamics, Capillarity, Sound, Heat, Physical Chemistry, Electricity, Magnetism, Light. One may therefore say without straining the force of the words, that a full list of the general propositions or laws of science fills an obvious gap in the literature of physical science. It is not always easy for students in one branch of science to find out or to know the literature on important principles and facts in an entirely different or even in a closely allied branch of science, and this book is a most helpful means for the attainment of such an end.

An example of the style followed all through the book may be taken from page 122. It is a paragraph on "The Intensity of Magnetism," and reads: "The intensity of magnetism of a magnetizable substance, uniformly magnetized is $I = \frac{M}{V}$, where V is its volume and M is its magnetic moment. (Consult Jeans, Electricity and Magnetism, pp. 355 to 358.)"

This instance is taken as a sample, the definition is generally given first, then the equation containing mathematical statements of the law, and the reference work where the subject may be followed out in detail. Mechanical engineers on railways and others having formulas to deal with will find this book a great help in their work.

A Remedy for Car Shortage.

There are many and indeed periodical outcries about car shortage, and the P. R. R. has come forward with an attempt at a practical answer to the vexed question.

Among its other publications the Pennsylvania Railroad issued a special Bulletin, No. 5, last month, containing fourteen illustrations showing how much of car space is usually loaded, and how it may be loaded to full capacity. In brief it may be said that with united effort one car could be made to do the work of two. The Bulletin closes with an earnest appeal to buyers, brokers and shippers, to club together to make combinations of orders so as to fill the car. A united effort in this direction, and the adoption of a method combining carload shipments which are destined to the same point could be made by the railroad transportation department, and a very material addition to car space effected, with a nearer approach to make full use of each car. The Bulletin states that if the freight cars on the Pennsylvania system were fully utilized, it would equal 120,000 additional cars in service.

In order to reach anywhere near the theoretical limit mentioned in this circular, co-operation of shippers, buyers, railroad men and others is required, and this can only be attained by steady and persistent effort and not by spasmodic, though hearty action in time of war. If the end is ever gained the practice will long endure, even after the cause of it all has passed away.

A pictorial representation is given of a box car loaded with 550 cases of tomatoes, and the cases are arranged in three layers, so that less than half of the height of the car is used. Another drawing shows the same car carrying 1,500 cases. The difference in weight of the load in each car is in the proportion of 37,400 to 102,000 lbs., which is in a ratio of not quite one-fifth. In order to fill the car with eight layers of cases, the door must be provided for, and this is done by covering it with a rough sort of guard made out of boards 1 by 6 in., or slab wood, not less than 1¼ in. thick at the centre, and nailed to the door posts. This woodwork is, of course, temporary.

A suggested method for the loading of land fertilizer in bags (weighing 50 tons) is that instead of laying them in three layers, and weighing only 21 tons, they may be piled in eight tiers like the cases mentioned above, and to put temporary boards over the side doors and arrange the bags so that entry will be facilitated. Commercial bags of sugar, five deep, provide for 500 bags, and the weight thus usually taken as a carload is 48,800 lbs. The P. R. R. full load, accounts for 1,000 bags, with a total weight of 10,200 lbs., and shows 10 tiers of bags with appropriate arrangement at the doors, and the temporary wooden guard is there also.

Barrels loaded so that 100 barrels weighing in all 37,280 lbs., and practically measuring 19¾ ins. at the widest part, go into a car under usual conditions. As many as 244 similar barrels can be put in the same car with a total weight of 90,960 lbs. A carload shipment of salt four tiers high and containing 536 bags with 53,600 lbs. weight can be replaced with a carload lot made up of 1,100 bags of 110,000 lbs. total weight. This is in the proportion in weight as 134 is to 275, or about 1 to 22, when reduced to a decimal fraction. A car of 65 barrels of oil weighing 26,650 lbs. can be replaced by one carrying 148 barrels of oil at a total weight of 60,680 lbs.

The final representation is the loading of cotton bales. Usually 50 bales are carried, and the total weight is 25,000 lbs. This arrangement, which is one bale high, can be improved upon so as to accommodate 108 bales, three tiers high, and weighing 54,000 lbs. The door boarding is similar to that already referred to. The proposed load arrangement gives the car more than twice its former capacity, without causing any excess weight to be on the trucks and wheels.

There is much efficacy in the full carload lot. It uses up a smaller number of cars to carry a given amount of load. Not only does it release cars for service as spoken of in the circular, but in a sense it adds vastly to the equipment of any railway, as it reduces the actual work of the locomotive, for other things being equal, the fewer the pairs of wheels in a train the easier that train can be moved. This translated into terms of work for the operating official, means that fewer wheels being equivalent to reduced resistance, another car or two may be added to the train or less coal will be burned to move the load, when no cars are added. Full carload lots means economy all round.

Electric Arc Welding.

A book in regard to Electric Arc Welding has been published by the Lincoln Electric Company, Cleveland, Ohio, furnishing excellent descriptions of various systems of arc welding. Considerable space is given to work in railroad shops, boiler plate work, electric railroad shops, commercial and jobbing plants, besides a mass of general operations. Estimates of installation and other costs are also given, and the book altogether is well worthy the attention of all who are interested in electric arc welding.

Rock Excavations.

The Clark Book Company, New York, have issued a volume of 824 pages, by H. P. Gillette, detailing the methods, plant, tools and costs in excavating, handling and transporting rock. The book is divided into eighteen chapters, including a complete description of hand and machine drilling, chapters on cable drills, augers, and power plant for operating drilling machinery and other details. There are nearly 200 illustrations, and 87 tables. The presswork is excellent, and in cloth binding costs five dollars.

Iron-Aluminum Alloys.

Bulletin No. 95, issued by the Engineering Experiment Station of the University of Illinois, records another series of experiments to determine the magnetic and allied properties of alloys and iron and other metals. It is shown that aluminum like silicon greatly improves the magnetic properties of the metal, and also that aluminum imparts to the metal a greater toughness than silicon. Copies of the Bulletin may be obtained by addressing C. R. Richards, Director, Urbana, Illinois.

Erie Steam Shovels.

Bulletin S-12, issued by the Ball Engine Company, Erie, Pa., describes the type B steam shovel, with ¾-yd. bucket, which is recommended for wide working range, high lift of dipper and level floor bottom. Among its features are accessibility of operating mechanism, low center of gravity, strength, ease and speed of operation, enabling a maximum of six dippers per minute of material to be handled. Illustrations are given of one shovel excavating 600 yards of shale rock per day, loading freight cars, and also as locomotive cranes and pile drivers. Copies may be had on application to the Ball Engine Company at Erie, Pa., and they will respond promptly to the request for their book.

WANTED—Position of chief clerk to sup't motive power and machinery or master mechanic by young man with 16 years' experience, now employed in like position on western trunk line; 16 years in present position; familiar with Federal boiler inspection, M. C. B. rules and have had general railroad experience; Protestant; married, 45 years old, good accountant. Address "Boggs," care Railway Locomotive Engineering, New York.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

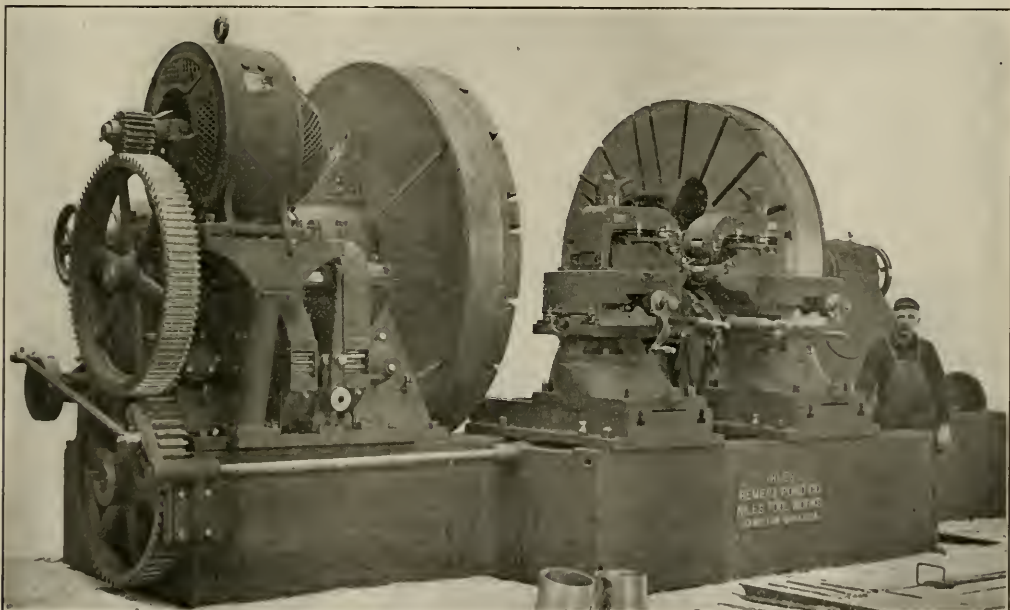
Vol. XXX 114 Liberty Street, New York, August, 1917 No. 8

Heavy Hard-Worked Wheel Lathe

Some time ago the Delaware, Lackawanna & Western Railroad, purchased and installed in their Scranton, Pa., shops a 79-in. wheel lathe, made by the Niles-Bement Pond Company of 111 Broadway, New York. This lathe, a representation of which we give, has a capacity of about 80 ins. over the bed and will take wheels up to 76 ins. in diameter at the tread. The maximum distance between face plates is 110 ins. and 80 ins. minimum. Inside or outside journals may be put in the lathe as the case may be.

The lathe was designed for turning driving wheels in the shortest possible time. It is considerably heavier than any previous lathes built by this company and embodies several valuable features for operation in addition to all the well-known time and labor-saving devices, such as the pneumatic tool clamps, power traverse and pneumatic clamp for the right-hand headstock and also the calipering attachment. The headstocks are mounted on a heavy bed of deep box section thoroughly stiffened by means of box section cross girts at short intervals. The left hand headstock is bolted rigidly to the bed and carries the driving motor; it contains the driving and speed change gearing.

The right-hand headstock, is movable and is adjusted to a sliding fit on the bed. It is provided with power traverse of new construction in the shape of an electric motor. The traverse is operated by a separate motor which, to save floor space, is placed in an accessible location over the bed. The motion is engaged by means of a large friction clutch operated by a lever so that the operator can traverse the headstock without leaving his working position near the wheels. The friction clutch is so adjusted so as to slip when excessive power is applied. The pneumatic headstock clamp is one of the most important new features of the lathe. A quick operating, powerful device which enables the operator to instantly clamp the right-hand headstock is operated by simply turning an air valve.



79-INCH WHEEL LATHE FOR THE DELAWARE, LACKAWANNA & WESTERN RAILROAD.

The tool rests are of rigid construction. They have sufficient in-and-out adjustment on the bed to turn wheels from 40 ins. diameter up to the capacity of the machine. The tool slides have in-and-out adjustment for setting the depth of the cut. The longitudinal traverse is operated by a large hand-wheel and longitudinal power feed. The feed screws have ball thrust bearings and the slide bases have bronze plates on their upper surfaces where the tool slides bear. The tool rests are equipped with patented pneumatic clamps which enable the operator to change and clamp the tools in a few seconds and without the use of a wrench. There is little chance of slipping or vibration of the tools under heavy cuts. The tools are clamped by means of wedge action which forms a firm lock independent of the air pressure. The feed is positive in action. The range is from 3/32 ins. to 7/10 ins. a revolution of the faceplates. There are nine feeding strokes per revolution, so that the feed is practically continuous. Feed ratchets operate in either direction, are of the enclosed type, and are furnished to prevent accident to the operator and also to keep out chips. All gears are either enclosed or covered with suitable guards and the main driving shaft is protected by a sheet metal guard.

We show in our illustration the main driving electric motor. The one for moving the headstock was not in position when the photograph (from which our half-tone was made), was taken. Mr. H. C. Manchester, the superintendent of motive power and equipment of the D. L. & W. writes us respecting this machine ,that "the driving wheel lathe has been in hard service for some years past and turns driving and trailing wheel tires, averaging about nine pairs per working day of ten hours. It is an exceptionally heavy and rigid machine, fully capable of taking the heaviest cuts that modern high-speed steel will stand. Repairs to the machine since placed in service have been very light, and it is in first class condition now, after doing plenty of hard work."

Powerful Pennsylvania Railroad Decapod or 2-10-0 Locomotive Built at the Juniata Shop

In December, of last year, the Pennsylvania Railroad turned out for experimental service a very interesting locomotive of the Decapod (2-10-0) type, known in the Company's classification as I-l-s. This locomotive, which was designed at Altoona, Pa., and built at Juniata Shops, is the first Decapod in the Company's equipment and weighs in working order 365,000 lbs.

The boiler is of the same general design as followed on other recently built Pennsylvania Railroad engine designs, the most notable exception being that the boiler is built to carry a pressure of 250 lbs. The barrel, which has a minimum internal diameter of 82 ins., is made up 1¼ in. plates, 1½ in. rivets in 1 9/16 in. holes being used in the longitudinal joints. The main barrel sheet is made in halves, being jointed on the horizontal center line. The hips, which are peculiar to the Belpaire type of boiler, are flanged integral with the upper half and a one-piece pressed dome is used. The rear end of the lower half of the main barrel is flanged to form the throat sheet, thus avoiding joints. The boiler is equipped with an excellent superheater having 48 units. There are also 244, 2¼ in flues 228 ins. long between tube sheets. The rear tube sheet is set far enough ahead of the fire-box proper to form a combustion chamber about 3 ft. long. In order to avoid joints as far as possible, the bottom of the combustion chamber and the inside throat are flanged in one piece. The boiler is equipped with a fire brick arch with four supporting tubes.

Each of the frames is a single casting 44 ft. 8¼ ins. long with driver brake shaft bearing cast as part of the frame. All sections are rectangular and of ample dimensions and well supported by cross braces and boiler expansion plates. Steam is supplied to the cylinders through a balanced throttle valve and an 8½ in. dry pipe. There are two branch steam pipes each of 6 ins. internal diameter. Twelve inch piston valves are used and the cylinders are 30 ins. diameter by 32 ins. stroke, the cylinder being provided with renewable bushings ¾ in. thick. The smoke box has a diameter of 88½ ins. The exhaust nozzle is circular, with four internal projections. The blower is in the lower part of the stack and is entirely separate from the exhaust nozzle.

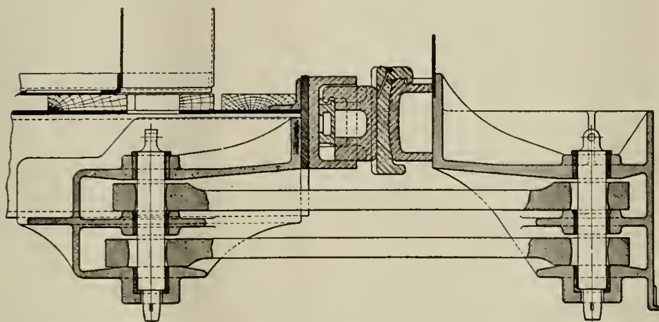
The piston is rolled steel 3/16 in. smaller in diameter than the bore of the cylinder and provided with two cast iron packing rings. The piston-rod, driving axles, crank pins, wrist pins and knuckle pins are hollow and are heat treated. In order to obtain a proper amount of clearance between the top of the rail and the bottom of main rod at its rear end, the key bolt is put in from the bottom instead of from the top. This arrangement has been found to be very satisfactory. To obtain clearance between the rear end of the main rod and the side rod knuckle-pins, a special depressed nut is used.

The driving wheels are 62 ins. diameter. The front and rear wheel tires are flanged and are 5½ ins. wide. The remaining driving wheel tires are flangeless, those of the main wheel being 8½ ins. wide and those of the second and fourth wheels 7½ ins. wide. The locomotive is designed to operate on track having a minimum radius of 350 ft. The driving axle journals are 12 ins. diameter by 16 ins. long for the main wheels and 11 ins. diameter by 16 ins. long for the other wheels. The valve gear is of the usual Pennsylvania Railroad type, except that instead of the gear allowing a maximum cut-off of 90 per cent., the cut-off is limited to 50 per cent. The valve travel is 6 ins., the lead 3/16 in., steam lap 2 ins. and exhaust lap ⅛ in. To insure starting at all points, there are two auxiliary ports in either end of the valve chamber which admit live steam to the cylinders. These ports are each ⅛ in. by 1½ ins. and are open at all times, except when covered by the valves. The steam lap of these ports is ¼ in.

DECAPOD OR 2-10-0 ON THE PENNSYLVANIA RAILROAD.

A. W. Gibbs, Chief Mech. Eng. Penna. Rd. Builders.

In the connections between engine and tender the old style double safety bars with slotted holes have been replaced with a unit safety bar, which is of the same cross section as the draw bar and ½ in. longer, the safety bar being connected to the engine and the tender by the draw bar pins. This device for which the P. R. R. hold the shop rights, is handled by the Economy Devices Company of 30 Church Street, New York. This apparatus may be described by saying, first that



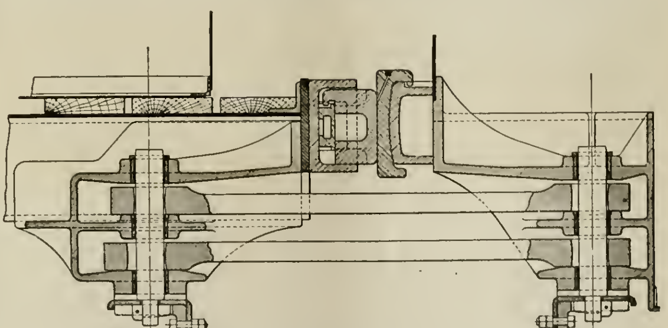
SHACKLE BAR BETWEEN ENGINE AND TENDER WHERE PINS ARE PUT IN FROM ABOVE.

The Interstate Commerce Commission has a standing order concerning the coupling of engine and tender which without specifying any sizes requires a shackle bar and check chains or their equivalent, and these coupling appliances must be sufficiently strong. This means that they must not fail. If they do fail the inference is obvious—they were not strong enough and therefore they did not comply with the law. This might seem at first sight to be a law built on the principle of "Heads, I win—tails, you lose." This, however, is not the intention.

The Interstate Commerce Commission has stated what is requisite in the interests of safety, and has left the details to be worked out by the experts employed by the railways to do that work. At present there is no hard and fast rule between what is "safe" and what is not, for the reason that conditions vary in the railway world. A good workable average with a sufficient factor of safety can be and practically has been arrived at. One of our leading railways has adopted a section of one square inch for size of shackle bar for every 4,500 lbs., of tractive power developed by the engine. One of the important locomotive building establishments uses one square inch of shackle bar section for every 3,000 lbs. tractive effort developed. The other firm of builders uses a square inch for every 3,000 to 4,500 lbs. of tractive effort put forth by the engine, the devisor used being dependent upon the size of engine.

In order to quickly and easily meet a demand for shackle gear which shall not be dependent on safety or check chains, an arrangement of these parts has been brought out by the Economy Devices Corporation.

Check claims have been found more or less unsatisfactory, owing to the large amount of slack which is incident to their use. In fact, a check chain seldom becomes of use in service until the slack has been pulled out of it, ending in a severe jerk. This sudden jerk frequently causes a breakage of the chain, and its holding power is at once gone. The device which is here described does away with check chains, and makes a neat compact apparatus, which complies with the law. When a shackle bar fails, the check chains are able to do little more than bring in the light engine. A full load is not pulled by them. We are informed that the Economy device prevents an engine failure of this kind and takes



VIEW OF SHACKLE BAR BETWEEN ENGINE AND TENDER WHERE PINS HAVE TO BE PUT IN FROM BELOW.

full trains. It relieves railway companies from a large part of the responsibility otherwise thrust upon them by law.

The Economy device consists of a shackle bar, fitting easily on a pin in the usual way. The pin drops through a pair of draw castings, one on the engine and one on the tender. The bearing areas of the pins in these castings may be bushed for removal, after wear, and the lower end of the pin stands on a wide shoulder in the bottom chamber of the casting, a small pointed end passing through and secured with a cotter to prevent the pin from jumping or working out. Below the shackle bar proper is the safety bar, performing the function of a pair of safety chains. This safety bar has the draw pins, just referred to, passing through it, but with a slightly elongated hole in the tender end, so that the safety bar does not "pull," unless the regular shackle bar above it gives out. The slack of the safety bar is only ¾ of an inch, so that no very severe jerk is experienced when emergency demands its service.

An arrangement has been worked out which meets the requirements of a case where the draw pins have to be put in from below. In that case, the engine and tender draw castings being provided with auxiliary pockets for the support of the ends of the Unit safety bar, or as we have called it, the shackle bar. The draw-bar pins extend through the safety bar pockets, thus acting for both the draw-bar and the safety bar. On account of the slight clearance between the holes and pins in the safety bar, it carries no strain, unless the draw-bar breaks or either of the pins fails. Then it becomes the draw-bar. Failure of the draw-bar pins only occurs at the draw-bar pocket, and being securely held in position such failure cannot interfere with their proper action when the safety bar comes into play. The lowest auxiliary pocket contains a slotted piece, which is bent over and bolted to the casting and the other end is bent down slightly to prevent its loss if the nuts are lost. This slotted piece forms the "floor" upon which the pin stands and the small end, fitting the slot in the "floor piece," passes through, and is secured below it by a cotter.

The makers call the whole device the Unit Safety Bar Arrangement, and by it a single safety bar replaces two slotted safety bars or chains. This Unit safety bar offers full resistance when the draw-bar breaks. With two safety bars or chains one only gets the stress, reducing the "safety factor" to 25 per cent of the draw-bar strength. This Unit safety bar being on the center line of the draw-bar, requires not over one inch slack. The double safety bars or chains by reason of their location on each side of the draw-bar require from six to eight times that amount for curving. The "safety factor" of the safety bar is not affected by the small amount of slack provided. If the draw-bar breaks the safety bar slack permits only three-quarters or one inch separation of engine and tender, whereas in the case of double safety bars or chains, even if they should hold, the separation might be sufficient to produce a dangerous condition.

For the driver brakes two 18 in. diameter by 13 in. stroke air cylinders are used, the two cylinders exerting a braking power of 230,000 lbs. Both of the brake cylinders are placed on the vertical center line of the locomotive, one of the cylinders having its axis in a horizontal plane and the other in a vertical plane.

The locomotive is fitted with a standard 9,000 gallon tender, which has a coal capacity of 35,000 lbs. When loaded, the tender weighs 182,000 lbs.

In the following list is given some general data relative to this class of locomotive: Number of pairs of driving wheels, 5; diameter of driving wheels, 62 ins.; size of driving axle journals, 12 ins. and 11 ins. x 36 ins.; length of driving wheel base, 22 ft. 8 ins.; total wheel base of engine, 32 ft. 2 ins.; total wheel base of engine and tender, 73 ft. 0-½ ins.; number of wheels in engine truck, 2; diameter of wheels, 33 ins., and the size of engine truck axle journals, 6½ ins. x 12 ins.; spread of cylinders, 90 ins.; size of cylinders, 30 ins. x 32 ins.; travel of valve, 6 ins.; lap of valve, 2 ins.; type of valve, 12 ins. piston, type of valve gear, Walschaerts, type of boiler, Belpaire wide firebox, minimum internal diameter of boiler, 82 ins., number of tubes, 244, 48, 192; outside diameter of tubes, 2¼ ins., 5½ ins., are 1½ ins.; length of tubes between tube sheets, 228 ins.; fire area through tubes, 9.16 sq. ft.; size of fire box, inside, 80 ins. x 126 ins.; fire grate area, 70 sq ft.; external heating surfaces of tubes, in sq. ft., are 4044 and 2178; heating surface of fire box, 272 sq. ft.; total heating surface of boiler, 6,494 sq. ft.; steam pressure per square inch, 250 lbs.; number of wheels under tender, 8; diameter of tender wheels, 33 ins.; size of tender truck axle journals, 6 x 11 ins.; ratio of heating surface to grate surface, 91.1; ratio of external flue heating surface, to fire box heating surface, 22.87; tractive power per pound of mean effective pressure, 464.5; height of deck plate, 78 ins.

Train Line Maintenance

Causes of Failure—A Possible Remedy

At a recent meeting of the Car Foremen's Association of Chicago Mr. A. McGowan, the supervisor of car works on the Canadian Northern Railway, read a paper on "Train Line Maintenance" in which he gave some interesting facts and figures concerning hose, and how they acted in very severe weather. Mr. McGowan said in effect: The report of the Division of Safety of the Interstate Commerce Commission for the fiscal year ending June 30, 1916, stated that there were 908,566 freight cars inspected, of which 3.72 per cent. were found defective; and 27,220 passenger cars, of which 1.82 per cent. were found defective. The defects were given in tabular form, and those directly chargeable to the air brake totaled 18,696, which was far above those chargeable to any other part of the car.

The number of defects per thousand cars inspected was 45.06. Of this number, 20.58 defects per thousand were chargeable to visible parts of air brakes.

Number of defects per 1,000 cars inspected: Visible parts of air brakes, 20.58; couplers and parts, 6.09; uncoupling mechanism, 4.17; hand holds, 5.00; height of couplers, 1.08; steps, .62; ladders, .77; running boards, 2.20; hand brakes, 4.55.

Some of the most frequent defects in the train line are defective hose and loose and broken train pipes at the hose conenction. This percentage shown on visible parts of the air brake does not bring out the actual state of defective train lines, because to watch this matter closely and replace the most defective hose or broken train pipes immediately is part of the work involved. These defects could not be discovered by the Interstate Commerce Commission inspectors. In attacking this problem, an attempt to cut down the percentage of cars which the Interstate Commerce Commission finds defective should be made because of the air brake, but also on account of the decrease in the material and labor involved.

Opinion seems to be that the average life of hose is about eight months for air hose, and one season for steam hose. In western Canada we find the average life of a steam hose is a little over four months. This, however, may be looked upon as a season in certain parts of the United States, but would not be considered such in the North.

It is the opinion of people familiar with the hose question that a hose should last years if not subjected to mechanical injury. Since it seems that the average life is only eight months there is then a chance for increasing the life of hose two years and four months; or in other words, making it last 4½ times as long.

In the United States there were in 1915 in service 2,370,532 freight cars, 55,810 passenger cars, 98,752 company service cars—a total of 2,525,094; and 66,229 locomotives. This means that there were in use 4,741,064 hose on freight cars, 111,620 on passenger cars, 197,504 on company service cars and 66,229 on locomotives—or a total of 5,116,417 hose. This does not include hose on front ends of locomotives or between engines and tenders.

The renewals of these 5,116,417 hose, with a life of eight months, would be at the rate of 7,674,626 per year; while if the life were three years, they would be at the rate of only 1,705,472 per year. This is a saving at which we should aim in the use of materials only. There are many other things which, in the aggregate, probably represent a larger amount of money, viz., the labor of applying and taking off. the cost chargeable to train delays caused by hose or train pipes bursting in transit, capital account tied up in material, etc.

Hose which costs from 30c. to 60c. or more per foot, if the life of the hose can be increased from eight months to 36 months will make a saving in renewals of 5,969,154 air hose per year, which at 55c. each (22 ins. hose) is equal to $3,293,000.

It is claimed that loose or broken train pipes are even more prevalent than defects of hose, and this is borne out by the table of statistics. The train line often breaks just back of the angle cock when cars are pulled apart.

An inspection of the scrap hose pile will show very plainly that most of the defects in hose are at the nipple end. This is where the great majority of hose fails. The train pipe breaks just back of the angle cock. These facts point plainly to the jerking apart of the cars, while hose are coupled, as being the main cause of the defects.

When cars are pulled apart, the hose bends at the nipple end. The fact that the bend is there and there is the place where the great majority of defects develop, proves conclusively that the short life of hose is mainly chargeable to pulling the cars apart.

When a hose is not coupled and a car is switched round the yard, the hose constantly swings, and all the strain comes on the nipple end.

The strain on the hose when cars are pulled apart without uncoupling, with train line fully charged, is said to be 500 lbs. This not only causes rupture of hose at the nipple end, but it stretches the hose and weakens the fabric throughout its entire length. This stretching is responsible for more hose failures than bending at the angle cock. The porosity of the hose is often charged to poor material when, as a matter of fact, it is really caused by jerking apart.

In a test of 22,000 pieces of air horse, 82 per cent. were found to be porous, and the porosity was not localized but extended all along the hose.

We are accustomed to assume the tonnage reduction in the winter is necessary because of slippery rails, greater radiation of heat, poor lubrication, etc. Investigations on one road have shown that a great deal of this tonnage reduction is necessitated because of leaks in the air line—the impossibility of providing enough air to operate the brakes on long trains. This subject of leakage is a very important one, not only for its effect on the tonnage that may be hauled and the amount of fuel consumed, but also because of its effect on the operation of the compressor pump and to delays which are caused by air sticking.

Leaks may be classified under the following heads: First, leaks of hose coupler proper; second, leaks in the hose itself; third, leaks where the hose connects with the coupler; fourth, leaks where the hose couples to the train pipe. Leaks in the coupler proper are usually chargeable to the wear of the materials and gaskets, or to the coupling being poorly made. Leakage is also caused by snow, frost and ice. Further, when air hose freezes it often becomes so stiff that it will not bend at all. This causes the joint between the two hose to leak whenever there is no movement between the couplings, and also causes leaks at the joints at the angle cock where the hose is often pulled loose.

In a report given to the M. C. B. Association, 1915, Mr. F. W. Brazier, of the New York Central, said that "with a 100-car train, the leakage should be kept down to 2 lbs. or less."

He also said that it requires a pound of coal and 7 lbs. of water to compress 35 lbs. of free air in the compressor. A 100-car train requires 180 cu. ft., and with a 4-lb. per minute leakage the compressor has to pump 40 cu. ft. per minute additional. This is equal to 2,880 cu. ft. per hour, which requires burning 82 lbs. of coal per hour and using 574 lbs. of water. A leakage of 5 or 6 lbs. is not uncommon and a conservative estimate of the coal consumed is 860 to 1,720 lbs. On many trains the leakage in five minutes is equal to the air necessary to make a full service application.

While the question of leakage is the most important of all, with an 80-car train of 10-in. equipment we have a volume of 275,200 cu. ins. If the conditions were such that we had a 12-lb. brake-pipe leakage per minute, we would be losing 130 cu. ft. of free air per minute, which would be equivalent to the efficiency of the 8½-in. cross compound pump. If the leakage was 6 lbs. per minute, we would be losing 65.5 cu. ft. of free air per minute, which would be equivalent to the efficiency of the 11-in. pump. It is estimated that the 11-in. pump consumes 200 lbs. of coal per hour. This would require 4,800 lbs. of coal to operate the pump 24 hours. Estimating the price of coal at $2 per ton, it would cost $9.60 to pump against a 6-lb. leakage on an 80-car train for 24 hours. If 30 trains were being handled under the same conditions for 24 hours, it would cost $288 for fuel alone. While working under the same conditions with the 8½-in. cross compound pump, the cost of fuel would be approximately $100 pumping against leakage."

Another report made up by a railroadman on leakages, is to the effect that: "Comparative cost of maintaining 70 lbs. brake pressure, and 100 lbs. main reservoir on a 60-car freight train (engine boiler pressure 200 lbs.), in one case against a brake pipe leakage of 12 lbs. per minutes, and in the other a brake pipe leakage of 5 lbs. per minute. Twelve pounds per minute brake pipe leakage equals a loss of 18.20 cu. ft. of free air, which represents a loss of 1,092 cu. ft. an hour and 10,920 cu. ft. for ten hours. Five pounds per minute brake pipe leakage equals a loss of 7.54 cu. ft. of free air per minute, 542 cu. ft. an hour, and 4,520 cu. ft. for ten hours.

"An engine fitted with an 11-in. compressor would consume about 47 tons of coal, while supplying a 12 lb. per minute brake pipe leakage continuously for 1,000 hours. The same engine and compressor supplying a 5 lb. per minute leakage continuously for 1,000 hours would consume approximately 19½ tons of coal; 47 minus 19.5 equals 27½ tons; $\frac{27\frac{1}{2}}{47}$ equals .58 or 58 per cent. savings obtained by simply reducing the brake-pipe leakage from 12 to 5 lbs. per minute.

The difficulties encountered and time consumed in coupling and uncoupling hose in winter weather are considerable. Even at zero weather the hose becomes so hard as to lose all flexibility, and during coupling and uncoupling it is necessary to bend hose which in so doing usually cracks the rubber, thus making it porous. A hammer is commonly used for hitting hose couplings to make them lock. This tends to jar hose fittings out of place in frozen bag at nipple and coupling sleeve, causing it to leak when the train is in motion, especially when rounding curves. The hammering on hose couplings also damages it to such an extent that it is necessary to remove hose on account of the gaskets not fitting properly. This same trouble is experienced on the road on account of couplings being drawn up by frozen hose on curves causing brakes to creep on and making it necessary for trainmen to hammer the couplings down in place. Another difficulty is that all angle cocks are not in proper position to allow hose couplings to meet in line, consequently, the hose are twisted before they can be made to lock, and in case they are pulled apart very often, they do not unlock, breaking hose or train pipe.

The time ordinarily consumed in coupling and uncoupling hose on a 40-car freight train under ordinary conditions at the different winter temperatures for one man is as follows:

Zero, uncoupling 45 minutes, coupling 50 minutes; 5 to 10 below, uncoupling 50 minutes, coupling 55 minutes; 15 to 20 below, uncoupling 55 minutes, coupling, 60 minutes; 25 to 30 below, uncoupling 65 minutes, coupling 70 minutes; 35 to 40 below, uncoupling 70 minutes, coupling 75 minutes. Any extra time required for changing hose, gaskets, etc., depends entirely on conditions. This ordinarily takes 15 to 20 minutes; sometimes it takes an hour.

The amount of both yard and road detention chargeable to train line trouble, not to say anything of car and freight delays, is worthy of consideration. One and one-half hours over each engine division is considered a good average of road detention to each freight train handled under Northern winter conditions, caused mainly through hose trouble, creeping on of brakes and extra time taken for pumping up in releasing. Along with this comes flat and shelled wheels from creeping brakes; also there is extra strain on the draft rigging. A broken train line means cutting out of car, and not unusually 24 hours delay in getting repairs made.

The opinion has been quite prevalent that air hose defects could be remedied by more careful attention, and adherence to higher specifications in the purchase of hose. This is not altogether true because the greater number of hose are scrapped because of mechanical injury and not through defective material.

We may point out that among the appliances for keeping down leaks, consumption of time in coupling hose, standing the rigors of hard winter weather, and greatly increasing the life of hose, is the Robinson Connector. The company, on applying its apparatus, guarantees the life of the hose for three years. If a hose fails in less time the Connector Company replaces the defective hose.

This is a matter well worth while looking into, because the loss of the hose by being stretched until it becomes porous or broken by being pulled off when twisted, does not tell the whole story of the loss in economy and efficiency.

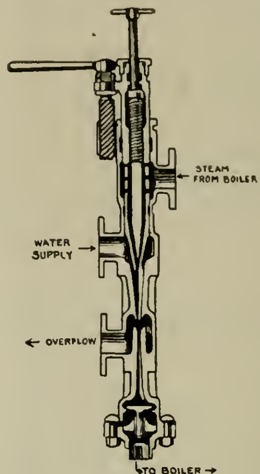
Construction and Operation of the Injector

Giffard's Invention—Subsequent Improvements—Injector Troubles and Their Remedies

When the injector was originally introduced in 1858 by Giffard, a French engineer, the idea of water being forced into a boiler against the same pressure as the motive steam was received with ridicule. This did not hinder its adoption or its subsequent improvement. The explanation in the light of experience, shows that the velocity with which a fluid or gas such as air or steam issues from a vessel is greater for a given pressure, the lighter the fluid or gas. In discharging water or steam from a boiler, the velocity of steam compared to water under the same pressure is, on the average, twenty-five times as great. At 60 lbs. pressure steam has a velocity of 2,400 feet per second, water 94 feet. This ratio is nearly maintained almost equally in all the varying pressures of modern boiler service. It is not surprising therefore that the fluid with the excessive velocity will penetrate the comparatively slow moving even at the same pressure per square inch. Of course the mixture of water and steam in the injector greatly reduces the velocity, for example, one pound of steam at 120 lbs. pressure, having a velocity of 2,850 feet per second, is mixed with ten pounds of water, the resulting velocity of the combined jet of water and condensed steam would be 2,850 ÷ 11 = 259 feet per second. Water alone at the same pressure would have a velocity of 133 feet per second, so that the jet of steam and water has an ample excess of velocity to overcome the opposing jet of water alone from the boiler. An additional velocity of forty to fifty feet per second is quite sufficient to overcome the added resistance of valves and piping necessary for the appliance of the injector.

This is not all. The form of the nozzles are important. At first the steam nozzle was simply that of a long, gradually tapering convergent tube. Much of the energy was lost by the sudden expansion of the jet of steam. At present nearly all modern injectors have steam nozzles tapering towards the discharge end. In Giffard's original invention a regulating spindle was introduced, arranged in such a way that it could be moved up and down thus varying the entrance to the combining tube. In its original form it gave constant trouble. Improvements followed, but the regulation of the openings both for steam and water by hand required a certain amount of skill, and with a view to render the adjustments automatic, in 1864 Mr. Sellers, of Philadelphia, brought out the self-regulating injector, which under modified and improved forms has reached a stable degree of perfection.

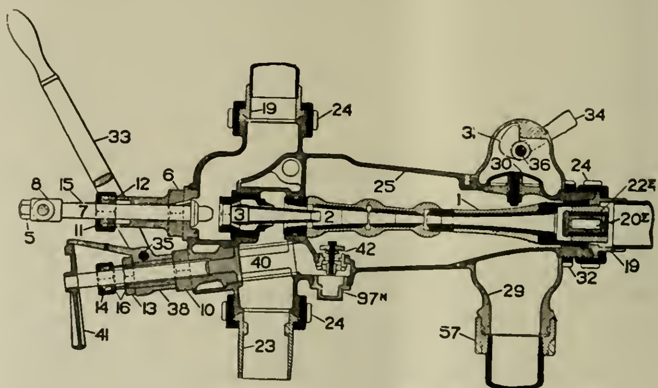
In our own day it may be said that the injectors are all as nearly perfect as human ingenuity and continued experiment can approach perfection. Injector failures are rare occurrences, and it may be set down as a fact that injector troubles are not to be attributed to organic defects.



GIFFARD'S ORIGINAL TYPE OF INJECTOR.

There is much more likelihood in troubles arising with the injector connections than there is about the injector itself. The pipes leading to and from the injector should never be smaller in size than the injector connection. Nearly all injectors used on locomotives are known as the lifting type. In order that the injector may be conveniently reached in the cab of the locomotive it is usually placed higher than the water in the tank, and consequently the water must be lifted the amount of difference between the surface of the water and the injector opening. In order to lift the water, a vacuum is produced in the pipe leading from the tank to the injector, by admitting steam into the injector and allowing it to pass through into the overflow pipe. The interior of the injector is so constructed that the steam finds its way into the overflow pipe much more readily than it does into the pipe leading to the tank. The air in the pipe leading to the tank is induced to mix with the steam and pass out at the overflow pipe, while the weight of the atmosphere on the surface of the water in the tank forces the water into the vacuum thus produced. The joints forming the connection between the injector and the tank should be ot the most secure kind, as a leak in this pipe will greatly diminish, if it does not altogether stop the operation of the injector. In some experiments where injectors are placed below the level of the water in the tank the improvement in the working of the injector is of a marked kind.

In all injector troubles the failure of the water to reach the injector is the most common, and if there is water in the tank and the surface be not frozen, as it may readily be in winter, the trouble will likely be by reason of a leak in the suction pipe or by clogging of the strainers. A heated suction pipe also often refuses to supply water in sufficient quantity for the effective use of the injector. In cases where the injector lifts the water and fails to force it into the boiler, the trouble should be readily evident by the behavior of the injector. If the steam should blow back into the tank it will either be caused by reason of the overflow valve being partly closed, thereby

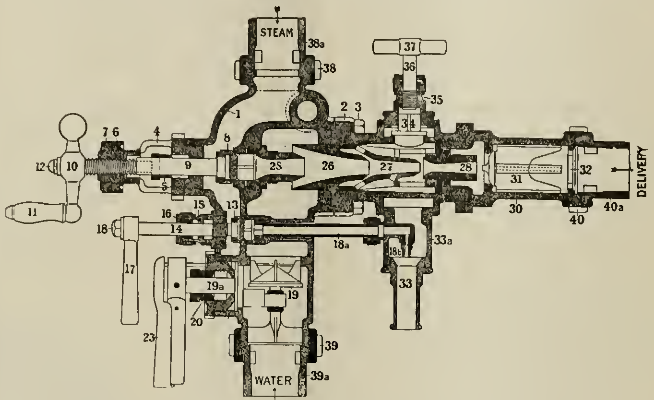


SELLER'S IMPROVED SELF-ACTING INJECTOR.

preventing a ready escape for the combined steam and water which is necessary until the mixture of the two bodies has accumulated sufficient momentum to pass through the check valve opening into the boiler, or it may be caused by the sticking of the check valve, which, though rarely the case, sometimes happens in instances where impurities in the water tend to form solutions that are particularly adhesive in their nature, acting like glue in joining the check valve to the valve seat. A slight tap on the check will sometimes relieve a sticking valve.

Some simple remedies there are that may be temporarily effective as in the case of clogged strainers or obstructions in the suction pipe. In such cases the overflow valve should be closed and the steam blown back through the suction pipe into the tank. This may clear the pipe, but the tank and the strainer should be cleaned as speedily as possible, as the tendency to accumulate impurities in the tank is very great, and nearly all strainers in use in locomotive tanks not only collect impurities but hold them at the entrance of the suction pipe where detached particles sooner or later find their way through and so increase the chances of injector troubles.

As is well known, the degree of reliability to which the mechanism of the injector has attained has been the result of very extensive and careful experiments, the taper openings compressing the mixture of steam and water facilitating and reducing the current in one direction and retarding or entirely checking it in another, are not subject to improvement by changes in their relation to each other, therefore the repairing of injectors should be intrusted only to the most proficient mechanics—specialists familiar with the parts. Specialists do not spring like Athene fully armed from the brow of Jove, but acquire their knowledge by long and careful practical experience. Parts furnished by the original constructors are



NATHAN'S IMPROVED MONITOR INJECTOR.

usually nearer perfection in detail than rough and ready substitutes, and the trained mechanic will prefer their use when a replacing of worn parts is necessary. Much may be saved by a systematic cleaning of injectors, especially where deposits of carbonate of lime are formed. Injectors may be readily cleared of all incrustations by immersing them in a bath of benzine or diluted muriatic acid, the mixture being ten or twelve parts of water to one of acid.

In taking an injector apart it will often be found that the joints have acquired a degree of tightness which almost renders them liable to distortion by reason of the force required to loosen the joints. In such cases it will be found that slightly heating the joints aids greatly in their liability to slacken, as brass expands rapidly in heating. In many shops a supply of injectors, cleaned, repaired and tested, is usually kept on hand, so that when an injector is reported to be defective it can be disconnected and another put in its place, thus avoiding delay and allowing the skilled mechanics to examine the injector under favorable conditions and with proper tools at hand. The practice of striking injectors with hammers and other hardened tools is a very objectionable one. The blows rarely have the effect of dislodging any obstruction in the chambers or tubes of the injectors, while the fine appearance of the injector is irretrievably destroyed.

Railroad Upholstery

Leather Defined—Wrong Names Used Carelessly or by Design—A Substitute Not Necessarily of Inferior Quality—Opinion of a Prominent User

One of the interesting features of the upholstery art as practised on railroads at the present time, consists in the handling of leather. This material goes through several processes before the railway purchasing agent places an order, and it is to this procedure that we wish to direct attention. A railroad buys leather or other upholstering material, and in so doing they buy the finished product of a very important group of manufacturers.

The manufacturers are compelled by the nature of case and from the conditions imposed by the raw material, to furnish different grades of leather, but their desire is, as it should be, to induce their customers to buy the best grade and not necessarily the cheapest material.

We all know from experience that good leather properly finished can safely be recommended and guaranteed. Occasionally a good hide is defective, but that is not always the tanner's fault. The animal from which the hide came may have been diseased, or the leather while being tanned may have become damaged by careless men, or the lime and acids used in the tanning may not have been properly washed out of the hide, with the result that leather quickly deteriorates after it has been in use for a time. These are exceptions and any one can safely guarantee genuine honest machine-buffed leather, not so-called machine-buffed leather, because there is no such thing as "second" machine-buffed leather. The only reason why it should be "second" is because of the defects in a genuine machine-buffed leather, but when a tanner calls leather machine-buffed, when he has taken off shoe-tipping and bag leather from the top, he is not selling machine-buffed, he is only selling split, which is the correct name for it.

One of these grades is made as follows: The top is buffed off by hand, and when finished this makes what is called hand-buffed leather. The buffing is waste, but when hand-buffed leather has been taken off the hide, then all that is left below is splits, or, as some call the first cutting, deep buff. This deep buff is nothing but a split, as all the grain has been taken off the top, but on account of its proximity to the grain the face of the so-called deep buff or first split is smoother and finer than the second or main split, and will finish and can be manipulated so that it will almost look the same as machine-buffed leather.

Next in line is the main split, which is known to the trade as No. 1 split. Then comes the second split. This split is not nearly as strong as the main or No. 1 split. The tanners today try to make everything pass as a No. 1 split, and are often successful on account of the immense demand for this quality of leather. As long as the hide is free from defects, no matter what the size, it is frequently described as No. 1 split.

This is the reason why some users have considerable trouble on account of split leather tearing like ordinary brown pasteboard paper. It is the second split which is causing this trouble, as the main split is fairly strong and will not tear if properly manufactured and is of a uniform thickness.

The second grade is somewhat different. It is made as follows: The first top cut is a buffing extensively used for welts in the shoe and pocketbook trade. Below this buffing is genuine machine-buffed leather. If one compares these grades he will see how fine and smooth the grain is.

While not a new subject, railroad upholstery is receiving a great deal of consideration from the users of railway and steam line cars. Prices of construction materials are constantly advancing, and upholstery is one of the top notchers. The increasing shortage of hides is the chief cause. Large users of leather are being forced to other markets for material to take its place. Leather substitutes are coming into more general use every day.

The upholstery department of the railway business is receiving particular attention. For years mostly all upholstering was of plush. A few years ago leather was given a trial. To meet the demand for economy, the leather manufacturer was forced to make rock bottom prices. He soon found that these prices would not pay for the best leather, and eventually the car builders were being supplied with split leather instead of grain leather. This at first answered the purpose, but it did not take long for it to crack and peel. Cane upholstering was also tried, but, like plush, it was not vermin-proof, nor sanitary. Dust and dirt stuck to it.

Leather substitutes have now come to stay and are proving satisfactory, especially for smoking cars and cars on roads using soft coal. A high grade of leather substitute is stronger than split leather because the latter is merely a sectional sheet of a hide surfaced with practically the same coating that is used to coat let us say, Fabrikoid and similarly treated. It is uniform in thickness; it comes to the purchaser in a roll and thus eliminates waste in cutting it; it is waterproof and washable, and, in the better grades, it is guaranteed to be superior to split leather. The fact that it is waterproof puts it above other forms of material. While it will not hold dust like plush or cane, it naturally gets dirty, but can easily be cleaned with a wet cloth.

Double-texture artificial leather used for curtains will stand both the hottest and the coldest weather. If the rain happens to beat in at a window, its waterproof qualities prevent damage, and its embossing is not hurt by the sun. As it is not affected by heat, the warmth of the car in winter does not injure it. High grade leather substitutes answer the economy question, they being cheaper than other guaranteed upholstery.

With the progress that is being made in the manufacture of leather substitutes and the fact that the material is cheaper than most other upholstery, it certainly looks as if it had made its mark in the industrial and mercantile world. Other grades are used for upholstering household furniture and automobiles, as well as bookbinding.

Leather cannot be artificially produced any more than can beef, hides or poultry can be made by any manufacturing process. Calling a substance by a specific name does not *ipso facto* produce that substance. Such a name is simply a misnomer. Leather is the skin of an animal, or any part of such skin or hide, that is tanned, tawed or otherwise dressed or prepared for use. Nothing else is leather, and nothing else can honestly be called leather. To produce an artificial substance is to produce a substance in exact semblance to the natural substance by art or science, rather than by name, and producing the same, or nearly the same results, but leather remains leather, and the imitation, good and serviceable and quite satisfactory as it is, should not have the specific term "leather" applied to it.

The superintendent of motive power of the Seaboard Air Line Railway, when asked his opinion regarding a substitute, wrote us about the kind he was using, Du Pont Fabricoid, he said:

"The Seaboard Ail Line has several coaches, as well as one private car, that have seats covered with Fabrikoid. This material has been in service a little over a year and is giving satisfactory results in every respect. The Du Pont Fabrikoid Company guarantees this material for a period of one year.

"It requires approximately four yards of covering to upholster one seat and back complete, and we use a grade of material which costs approximately $1.15 per yard, as compared to the best grade of plush at $1.40 per yard, and while we find that it requires just a little more labor to apply the imitation leather, we estimate that the first cost is about equal.

"The imitation leather is desirable, due to the fact that it is sanitary and more easily kept clean, and the maintenance cost is less than that of the plush, and our experience has clearly demonstrated the fact that cars equipped with imitation leather seats do not require the amount of cleaning that those equipped with plush seats do. In our Southern territory we have to keep the windows and ventilators open the greater portion of the year on account of climatic conditions, and as this section is very sandy and dry the dust and sand blows in and penetrates the plush on the seats which is very hard to eradicate unless compressed air is available, while with the imitation leather seats this difficulty is overcome by simply brushing the dust off the seats, after which the seats present a very sanitary appearance, and my personal observation has been that the public is much more pleased with the appearance of the imitation leather seats than with the plush, on account of the sanitary appearance presented."

Government Buying Cars.

Fairfax Harrison, president of the Southern Railway and chairman of the railroads' war board, states that if the Government shall elect to invest the capital necessary for the acquisition of 50,000 to 75,000 cars, the railroads will be glad to make use of them on substantially the same basis as other privately owned cars are used, namely, a fair payment for mileage made by such cars, the railroads to pay current repairs and the Government to pay owners' repairs under Master Car Builders' rules.

Canadian Freight Cars.

The Dominion Government is stated to have closed a contract with the Canadian Car & Foundry Company for the manufacture at an early date of 5,000 freight box cars, each car costing about $2,600.

The work will be done at the Fort William plant of the company, which has been in process of completion for some time. Montreal officers of the company have visited the local plant, which is now being put in readiness so that the cars may be manufactured, beginning the first part of September. The Fort William branch is said to be by far the largest of plants owned by the company.

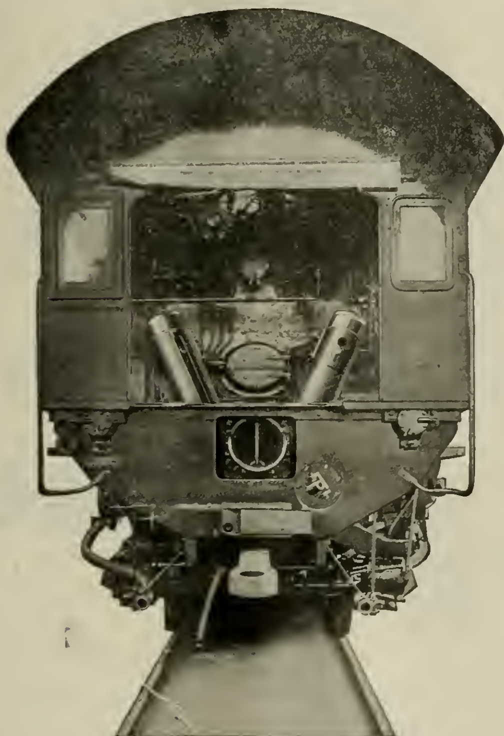
Removal.

The General Electric Company has removed its offices from the Hudson Terminal Building, 30 Church St., to the Equitable Building, 120 Broadway.

Duplex Locomotive Stoker

Mechanism and Method of Operation—The Street Stoker Theory Preserved—Modified to Gain Several Advantages—If Clogged the Stoker Can Be Made to Release Itself—Firedoor Unobstructed—Size of Coal Prepared During Operation

The undoubted success of the Street stoker and its widespread general use was due not only to the high efficiency of the machine but to the flexibility of control which permitted the fireman to vary the delivery of coal to the fire-box with the same facility that he can fire by hand, and these features of the Street stoker have been retained in the Duplex type of stoker, made by the Locomotive Stoker Co. of Pittsburgh.


DUPLEX STOKER AS APPLIED IN THE CAB OF A HEAVY LOCOMOTIVE.

The change in the coal situation, which made the price of screened coal and lump coal more nearly equal, caused a demand for a stoker that would successfully crush lump coal, such as is used in hand firing. The Duplex Stoker was brought out for this reason, and it handles the same size of lump coal as that used in hand firing, and the stoker is made strong enough to crush or break up the hardest lumps.

It is interesting to note the remarkable success of this stoker, and we are told that the mechanical features of it appeal to the mechanical department officials of our different railroads. The Locomotive Stoker Co. have received orders for many of these stokers from roads that never saw the machine but are convinced by its simplicity and mechanical perfection. This is incidentally a feather in the cap of the technical press, and indicates the advertising acumen of the stoker people. Orders have been received for more than five hundred of these machines from twenty different railroads, and they are now in service on the Norfolk & Western, the Chesapeake & Ohio, the Chicago, Burlington & Quincy and the Chicago, Milwaukee & St. Paul.

The propelling agent of the Duplex stoker is the steam end of a Westinghouse (compressor) air pump (11½ ins.). In its essentials the stoker consists of a screw conveyor placed underneath the tender shovel plate. This conveyor moves the coal to the crusher. The crusher is made of a piece of notched or rather sharp ribbed cast steel, in the shape of a half funnel, and the coal as it is urged forward by the screw conveyor comes in contact with the rough surface of the crusher, and it is therefore broken up as it goes toward the small end of the ribbed cone. The word breaker appears to express what actually happens, better than calling the device a crusher.

From this breaking device the coal travels through a short ball joint connection or pipe which delivers it to the "transfer hopper," from which two elevator screws, each encased in a pipe, lifts the coal up to the "distributing elbows," one on each side of the fire door. The mechanism of the elevator screws is such that coal is delivered intermittently to the distributing elbows. The rate at which the coal delivery takes place can be governed by the fireman so as to be proportional to the amount of coal required to meet the work the engine is doing.

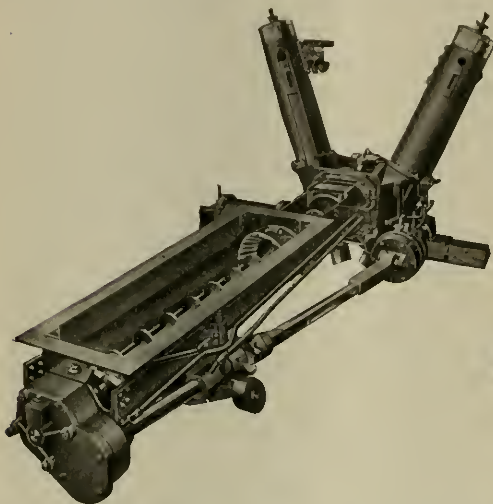
The coal is introduced into the firebox, being blown in by low-pressure jets of steam, and the actual work of distribution is performed by the jets passing over suitable deflector plates, projecting inwardly from the distributing elbows. These deflector plates can be slightly altered in angle so as to extend the scope of their action and more effectively scatter the coal where it is desired to place it. The Westinghouse air compressor, used here as the driving power, is modified so that the stroke of the piston can be stopped at any desired point and reversed by means of a rod extending into the cab. The piston rod in this cylinder terminates in a rod of approximately square section, and on one vertical face of the square a set of teeth is cut. On one horizontal side of the bar another set of teeth is cut. These two sets of teeth form two toothed racks capable of actuating a vertical shaft and also a horizontal shaft, these shafts having spur gear to engage each with the appropriate rack. The horizontally cut teeth actuate the horizontal shaft which operates the conveyor screw, and the vertically cut teeth mesh with spur wheels which turn the vertical shafts which work the elevating screws.

The power of the conveyor screw is applied at the rear of the conveyor by a shaft lying outside, though parallel to, the conveyor trough. It is equipped with the required universal joint and slip connection and a reversing gear is applied whereby the conveyor screw may be stopped or reversed without reference to the elevating screws. The mechanism to do this consists of a ratchet wheel mounted on that portion of the shaft to which is attached the spur gear driven by the rack.

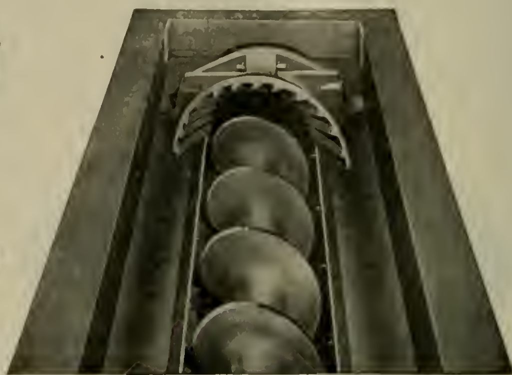
By means of, or in consequence of the reciprocating motion of the rack, this end of the shaft has its direction of rotation reversed at each stroke of the engine. Six sets of pawls are attached to the driving head. Three sets of which drive in the forward direction, the other three sets remaining neutral. When the reverse is thrown in the second three sets of pawls drive the conveyor shaft in the reverse direction while the first three sets remain neutral. The reversal is managed by the fireman with the rod, of which we have spoken, and which comes up through the floor of the deck. The main driving gear and the transmission shaft at the rear or engine-end of the conveyor trough, are closely encased to prevent dirt from getting in, and these parts are tightly packed in soft grease to afford the necessary lubrication.

When the coal goes through the so-called crusher it enters the transfer hopper, which has already been mentiond. At connection with the conveyor screw. The object of starting and stopping the coal delivery, both in the conveyor and the "elevators" is obvious, but the reversal of any of these screws separately is for the purpose of locating and backing the screw out of a temporary blocking or choking, or clogging due to a piece of iron or other foreign matter getting into the mechanism.

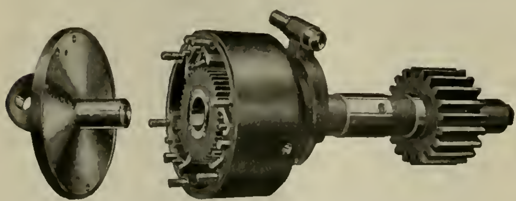
The propelling engine for the whole mechanism runs under a pressure of about 15 to 20 lbs. and the speed of the driving engine is about 10 to 15 strokes per minute. The pressure of the steam jets various adjustments, all in the hands of the fireman, deals with any and all contingencies which may arise, and permits a very close degree of manipulation of the machine by the fireman, so as to fully cope with the work of the engine, be it heavy or light. The main fire door is not obstructed by this stoker (called the "Duplex type D by the makers). The two elevators terminate each in one of the distributing elbows, and a separate entrance is cut into the firebox through the back water space, so that the regular firedoor is available for hand firing if that became necessary, and this can be done without remov-



SKELETON VIEW OF RIGHT SIDE, TYPE "D," DUPLEX STOKER



VIEW OF COAL BREAKING ARRANGEMENT IN DUPLEX STOKER



VIEW OF CONVEYOR DRIVE FOR DUPLEX STOKER

RACK AND RACK HOUSING DISMANTLED

the entrance of this hopper is a vane operated like the rudder of a ship, and this vane distributes the entering coal equally between the two "elevators," or it deflects the coal more to one side or more to the other as the fireman requires. He has a handle for this rudder-like vane placed comfortably within his reach in the cab. Whatever division is made of the entering coal both sides carry their quota up to the distributing elbow, and from there it is blown into the firebox. The elevator screw mechanism is capable of being stopped or started or reversed by a device similar to that described in which blow the coal into the firebox can be altered. Under normal conditions this is between 10 to 25 lbs. If it is desired to throw the coal well up to the front of the firebox, the higher pressure is used. The lesser pressure naturally does not throw the coal to the maximum distance.

There are two gauges on the boiler-head. One of them shows the pressure of the steam to the stoker engine. The other with two needles, one indicating the pressure of the right steam jet. The other needle indicates the pressure of the other jet for blowing the coal into the firebox. The whole mechanism with its ing any part of the Duplex stoker mechanism. The locomotive stoker company also make the well-known Street stoker, and in the Duplex stoker they have added some features, such as breaking up its own coal, entering the firebox by two separate apertures which leave the fire door unobstructed, and giving the possibility for "backing off" an obstruction if such intrudes itself, but which practice has shown does not often take place. The Duplex stoker is a real and substantial advance in the art of mechanically firing an engine and is sure to meet with approval.

Electrically-Driven Turntable Tractors

Heavy Tractors Replacing Older Types

Probably one of the most annoying interruptions that can take place at a round house where the turn table is operated by hand, is for a heavy engine, ill balanced, to be placed ready to be turned. If the ordinary set of hostlers and helpers and wipers cannot turn the engine, men from the shop must be called away from their work, and this has a disorganizing effect on the whole staff. Not only are the men taken away from their work for a definite time, but a psychological factor is introduced which helps to retard things generally. A man taken from his work at irregular times loses some interest in his work, and although he goes back to his work, and takes it up where he left off, a good deal of his zest is gone, and this produces a slow-down, apart from the actual time lost at the table.

Men taken away from inside work to "make good" on turning an engine do not, as a rule, go back as quickly as they can. A dog running through the yard must needs be whistled to, and played with. A round house rat hurrying to its hole will have a stone thrown at it, and various minor distractions will take up time uselessly. None of these things may occupy sufficient time to justify a rebuke to a tardy man, but they all count, and in the aggregate they amount to a palpable loss of time, and added to the psychological effect, which produces the slow down, (this cannot be measured in minutes,) the loss though wholely invisible to the timekeeper nevertheless exists, and produces its effect.

One of the best methods of overcoming this kind of loss, to say nothing of the greater speed achieved, even when the legitimate force have handled the table, is by the use of any good electrically-driven turntable tractor, such perhaps as that built by Nichols of Chicago. Our illustration shows a tractor applied to a 95-foot Chicago & Northwestern turntable. In the foreground can be seen the hinge attaching the tractor frame to the turntable girder. The beam which runs nearly parallel with the circular wall of the pit has a similar hinge on the end attaching it to the turntable girder near the end.

As the tractor is in the nature of a one-wheel locomotive, the wheel and the two hinges form the three points of support necessary to stability, the major portion of the weight being on the circular rail gives a strong pulling power to the tractor. It makes no difference, as far as the pulling power of the device is concerned, whether the load is balanced or is toward the tractor-end or away from the tractor-end. The load should be balanced as nearly as possible, as otherwise the bearing of the truck wheels on the circular rail produce a great drag and require more power to be exerted than would otherwise be necessary. The tractor is designed so that it may be counter-weighted if the loads are heavy enough to slip the tractor wheel.

As to the collecting device for bringing the current from the fixed to the moving part of the table, a typical assembly is applied to one of the standard types of tunrtable centers, and consists of a pipe coming up through the center and fixed in a suitable position, clear of the engine. On this are mounted the necessary number of insulated rings. Around the pipe turns the swiveling frame which carries the brushes. The feed wires come up through the pipe and terminate on the rings. The wires lead away from the brushes to the tractor itself, The whole device is a very simple form of slip ring commutator, and has worked most admirably on almost every type of turntable. In some special cases a modification to suit the clearances on the particular table have had to be resorted to, but these cases form exceptions.

The whole turntable tractor question has become more and more a live one for our large railroads, as their engines have been successively getting longer and heavier and have been taxing and even over-taxing existing turntables. This means that on old tables it is becoming increasingly difficult to balance modern locomotives which have to be turned on the old method of turning tables by hand. Ordinary labor is becoming scarce and often unsatisfactory, so that it is important to turn the tables by power where formerly they were fairly satisfactory when operated by hand.

On many roads the turntables have outgrown the requirements of service, and the longer and heavier tables have been installed in their places. About 50 per cent. of the tractors which one firm has shipped since the first of the year have been for 100-ft. turntables; these turntables having been bought to take care of new big locomotives that so many of the roads are now purchasing.

The Erie Railroad has put in five tractors on 100-ft. turntables in the past six months, two of these being in the process of installation now, at Croxton and Little Ferry, the others being in the West. Roads like the Southern have also made a step in this direction and they too have purchased five of these tractors for 100-ft. turntables.

TURNTABLE TRACTOR READY FOR HEAVY WORK.

For turning the 95-ft. and 100-ft. turntables an extra heavy type of tractor is used, which is capable of being counterweighted up to a point where it will be possible to turn the heaviest locomotives whether balanced or not.

The list of users of the extra heavy tractors includes five tractors for the Lehigh Valley Railroad. The Denver & Rio Grande Railroad has bought some tractors; so have the B. & O; the Carolina, Clinchfield & Ohio; the Central Railroad of New Jersey; the Chicago & Alton; the Duluth, Missabe & Northern; the Hocking Valley Railway; the Oregon Short Line Railroad; the Philadelphia & Reading; the Pittsburgh & Lake Erie; the Queen & Crescent; the St. Louis & San Francisco; the Virginian Railway and the Western Maryland Railway; most of which are on 100-ft. turntables with the exception of the Chicago

& North Western, which are 95-ft. tables; the New York, New Haven & Hartford has 95-ft. tables; the Buffalo, Rochester & Pittsburgh, two of which are 105-ft. tables, and the Western Maryland, two of which are 110-ft. tables.

The turning mechanism is a one-wheel traction device running on the circular rail in the turntable pit and flexibly attached to the end of the turntable girder at two points, which are far enough apart to give a very stable base for the machinery. The effectiveness of a tractor depends entirely on the weight on the circular rail, so that between the standard tractor and the extra heavy type the arrangement can be made to work efficiently on any table which it may be necessary to turn.

There has been no time when electric tractors have been more needed than the present. The saving of time in the roundhouse, if carried far enough, is as important to the railroad as the having of additional locomotives available for service; and anything that can be done to make the earning power or the service time of a locomotive greater than it is now is an important move in the right direction.

Mechanics of the Chilled Iron Wheel

Millions in Service Prove its Adaptability

The following is a brief abstract of a joint address delivered before the Railway Club of Pittsburgh by Mr. George W. Lyndon, president, and Mr. F. K. Vial, consulting engineer, representing the Association of Manufacturers of Chilled Iron Wheels. "Tell me," said a business man to Mr. Lyndon, "why it is that steel has supplanted iron in the rail, wood in the car, and in multitudinous parts of the car and track structure, and has never succeeded in making appreciable inroads on the chilled iron wheel?" The reply was that the material known as chilled iron has been found by continuous use for sixty-seven years to be the best adapted for the service, but its superiority is not entirely due to the scientific processes which have been used in making the wheel, but is principally the result of the material itself.

Chilled iron has remained in the forefront ever since its introduction in 1850, and is today the main factor in the nation's commerce, and this is because it possesses inherent qualities which are not found in other metals. Its principal characteristics are ability to carry any load that can be supported by the steel rail, without crushing or flowing.

The mechanics of the chilled wheel have not been investigated except in a very superficial way. The fundamental properties of chilled iron such as specific gravity, modulus of elasticity for varying tensile strengths, action under repeated stresses, relation of operating conditions to temperature stresses, etc., are not established. Dollars are spent in the investigation of steel where cents are devoted to chilled iron. In the face of this neglect the chilled iron wheel by sheer merit survived in the struggle for existence. A belated pause to consider the basis for this vitality will not be wasted. If the properties of chilled iron were fully understood and properly used in the wheel, a large return on the meager expenditure for investigation would come to the manufacturers in the way of increased profits and to the railroads in the way of reduced costs.

Its economic importance can be realized when it is borne in mind that there are 25,000,000 such wheels in service, representing 8,000,000 tons of metal, requiring an annual production of 3,000,000 wheels or approximately 1,000,000 tons of chilled iron to replace those worn out in service.

It is not our purpose to dwell upon the economic phase of the subject, for this is fully established, but rather to offer a few suggestions that will ultimately lead to a more intelligent design and classification of wheels for the service they are to perform. Since 1875 wheel loads have increased 500 per cent., axle weights 230 per cent. and wheel weights 75 per cent.

The 11,000-lb. wheel load under the 30-ton car was supposed, at the time of its introduction, to be the maximum that could be carried without breaking down the surface metal of the wheel tread and the top of the rail. This opinion, however, did not long impede the growth in wheel loads, for soon the 50-ton car was introduced with 20,000 lbs. concentrated on one wheel. It was then considered that this was the limit in car capacity and that the chilled iron wheel might not be fully satisfactory under this burden. Again, this opinion was exploded, not only by the successful performance under a half million 50-ton cars, but the chilled iron wheel has passed the experimental stage under the 70-ton car with a wheel load of 25,000 lbs. The latest increase is the experimental 85-ton car and 12,000-gallon capacity engine tender requiring an axle having a 6½ x 12 ins. journal and 8⅛-in. wheel fit, designed to carry 60,000 lbs. or 30,000 lbs. per wheel. It is a matter of interest to note that in the year of 1890 thirty tons was considered the maximum car capacity. We now have a single axle of thirty tons capacity or 30,000 lbs. per wheel, which shows the marvelous increase in wheel burden. Chilled iron wheels have been in service for the past five years without structural failure on axles, having an 8-in. wheel fit under ore cars, and in constant service on 2 per cent. grades.

The question now arises, are we nearing the limit for wheel loads? If so, what is the determining factor? What margin still remains for further increases, in bearing power of the metal of wheel and rail; in flange strength; in web and hub. These are the questions we must answer by considering each part of the wheel separately.

The bearing power of iron or steel is largely controlled by the carbon content and naturally since the tread of the cast iron wheel contains 3½ per cent. of carbon it has a much greater bearing power than the rail which contains less than one per cent. of carbon. A 33-in. chilled iron wheel will not perceptibly flatten under a load of 250,000 lbs., which is eight or ten times the present maximum wheel load. Chilled iron wheels are in common use carrying 100,000 lbs., or more under large cranes, "unloading bridges," transfer tables, hydraulic locks, etc. To carry these loads wide special flat-top rails are necessary.

The ordinary railroad rail with a 12-in. top radius will develop a permanent set when the indentation of the wheel into the rail amounts to .007 inches. If we assume that the maximum load carried in rapidly moving service should not cause, when at rest, an indentation greater than one-half this amount, the limiting loads from the rail standpoint are readily calculated by the formula $L = 1,500,000\, d \sqrt{D}$, in which L equals the load, d equals the indentation into the rail and D equals the diameter of the wheels. In this formula the pressure per square inch over the area of contact between wheel and rail is taken at 100,000 lbs. per square inch. The limiting loads for various diameters of wheels are: 42-in. wheels, 34,000 lbs; 36-in. wheels, 31,500 lbs.; 33-in. wheels, 30,200 lbs.; 30-in. wheels, 28,800 lbs. This shows that as far as the bearing power of chilled iron is concerned there is indication of nearing the wheel load limit.

The pressure which the flange must resist in guiding the truck around curves is equal to three-fourths the wheel load provided the track is perfect and the cars in good condition. The pressure is not influenced by the degree of the curve, velocity, centrifugal force or the obliquity of traction, but an allowance must be made for impacts originating from irregularities in the track or locked side bearings and center plates, which added to the curve pressure will make the total maximum lateral pressure against the flange 1½ times the wheel load, or 18,000 lbs. for the 30-ton car and 46,500 lbs. for the 85-ton car.

It is unreasonable to suppose that a flange designed for an 18,000-lb. pressure will have the same factor of safety for 46,500-lb. pressure, in fact the thickness of flange was developed when flange pressure did not exceed 8,000 lbs. It is just as necessary to increase the flange section as to increase all other sections of the wheel when increased duty is imposed, and notwithstanding the fact that the Master Car Builders' Association in their latest report stated that no increased flange width was necessary; this matter is by no means settled, so far as other associations are concerned, and a movement is again under way to determine whether the hundreds of thousands of flanges that are now in use (which are wider than the present M. C. B. standard flange) are not entirely in harmony with present track standards.

When this question is answered, and also the question of track clearance which ought to have been answered long ago, we will then have an opportunity to present to the Master Car Builders' Association a flange with a factor of safety proportional to the load carried, which is not a difficult proposition and which from an engineering standpoint is demanded.

The University of Illinois has undertaken a thorough analysis of the properties of chilled iron and of the stresses within the wheel originating from all conditions that can arise in service as far as they can be duplicated in the laboratory. These include specific gravity, co-efficient of expansion by heat, modulus of elasticity, tensile and compressive strengths, stresses in the wheel originating from pressing on the axle, from vertical load, from side pressure on the flange, from difference in temperature between tread and plate, and also to discover the probable difference in temperature between tread and plate for continuous application of various brake shoe pressures at various velocities. An indication of the magnitude of these stresses already has been determined, as follows:

From pressing on an axle having a 7-in. wheel-fit at 60-ton pressure 18,000 lbs. compression per square inch is developed in the single plate; the greatest tensile stress is in the hub. If the machine work is fairly well done these stresses are symmetrical, but if irregularly machined the stresses will be bunched and necessarily greater than normal; at times sufficient to burst the hub. Under a vertical load of 200,000 lbs. the maximum compressive stress occurs on the radial line between rail and hub amounting to about 18,000 lbs. in the 725-lb. M. C. B. wheel. The tensile stresses in the tangential direction are about 12,000 lbs. These stresses alternate at each revolution of the wheel. The maximum stresses are in the front plate. In the back plate the load stresses are practically nil.

The stresses from vertical load within the limits of railway practice are practically negligible.

The greatest stresses, and therefore the most important are the temperature stresses; for example, a 625-lb. wheel was placed in a brake shoe testing machine and operated at various velocities under a continuous shoe pressure of 1,500 lbs., which corresponds to the retardation required for a 50-ton car on a 3 per cent. grade when operated at 5 miles an hour, and on a 2 per cent. grade when operated at 50 miles an hour. Thermo couples were placed one-half an inch under the surface of the tread, under the rim, at the plate intersection and in the hub. These couples were connected by brushes to a collector ring insulated from the axle so that temperatures could be taken from any part of the wheel at any time without stopping the machine. After running the equivalent of 25 miles the maximum stresses developed near the intersection of plates were found to be: 5 miles an hour, 10,000 lbs. per sq. in.; 10 miles an hour, 12,000 lbs. per sq. in.; 20 miles an hour, 15,000 lbs. sq. in.; 30 miles an hour, 18,000 lbs. per sq. in.; 40 miles an hour, 21,000 lbs. per sq. in.; 50 miles an hour, 24,000 lbs. per sq. in.

Since the above is a greater retardation than is required for controlling 30-ton cars it is evident that if the shoe pressure could be made uniform on all the wheels of the train there would be no over-heating of wheels. There are, however, so many opportunities for irregularities in service that at least 200 per cent. above the theoretical retardation required must be taken into consideration when designing wheels. The test also indicated the great benefit of thermal or cooling stations.

When complete data is worked out for each weight of wheel and the information published in the university bulletin, this study will constitute one of the greatest engineering achievements of modern times. Making standards for the car wheel, which ought to be recognized as the most important part of the car structure without reference to fundamental principals, is absolutely unjustifiable. We may say frankly that the work which has been done for the past eight years by our association, in conjunction with committees of other associations with which we have had to deal, has not yielded material results; nevertheless we have gone along in our work with universities and with railway clubs, all for educational purposes, firmly believing that we were on the right track and that sooner or later our recommendations will be endorsed. In these troublous times when the nation's energy is at the highest state of tension, surely it may be well for all of us to pause for a moment and ask ourselves: What could the railroads do today without the chilled iron car wheel? It has become invaluable.

Refrigerator Cars for Fruit Transportation

Carefully Designed Insulating System—Joint Ownership with Union Pacific Railroad

Not long ago the Union Pacific Railroad decided to obtain some refrigerator cars for the Pacific fruit trade. The Pacific Fruit Express Company is partly owned, and is operated by the Union Pacific, of which railway Mr. C. E. Fuller is superintendent of motive power and machinery. The cars were built by the American Car and Foundry Co. and embody some features of peculiar interest in connection with this special class of work. The cars number in all 1,800, and are fitted with the Bettendorf truck side frames and the axles are 5x9 ins. The wheels weigh as much as 675 lbs. each.

The frames of the car consist of one heavy central I-beam, 18 ins. deep. The ends from the cast steel bolster outward being made of two draw steel beams to take the draw gear. The side sills are composed of pressed steel shapes and the needle beams are of steel. The superstructure of the car is wood (Oregon fir) and the whole is substantially put together.

One of the principal features of the car is its insulated floor. The lowest course, made of wood, is treated with waterproofing compound run in hot, and on this is placed a layer of heavy, black paper. A layer of hairfelt half-an-inch thick rests on the paper, and on the top are two courses of black paper. A ⅝ ins. blind floor is laid on top of the paper and above this is a space of 1⅝ ins., containing air, which is, as everybody knows, a very good insulating medium. On the top of the blind floor rests a 2-inch waterproof lith, and this word signifies a segment or member of anything, and in this case it refers to, it is material which is treated with some hot waterproofing compound and covered with a layer of surface roofing paper, and on this is placed 1½-in. tongued-and-grooved flooring which constitutes the car floor proper. Previous to laying down the car floor, the edges of the boards were painted with white lead and oil and a 3¼ by 3¼-inch galvanized angle is secured to the top of the sills about the edge of the car to help complete the effective insulation of the car.

These Pacific Fruit Express Company cars use ice for cooling and preserving the otherwise perishable load. There are two interior hairfelt courses put in the side walls, and these have been cut off about ⅝ ins. above the floor of the car, and a substantial waterproof lith has been interposed between them and the car lining. By this form of insulation the side walls have been practically brought down to the floor line. If by chance any water comes in contact with the side wall insulation, it would resist any capillary action of the water, and the effective insulation of the side walls would thus be maintained.

Floor racks are used, made of 2 by 4 in. stringers and 1⅜ by 4 in. transverse members. These raise the load 5⅛ ins. above the car floor. The ice receptacles are built on a 3 by 4 ins. frame and the posts, of this size, are permanently framed into the floor and ceiling of the car. On each side 14 ins. below the ceiling, and 14½ ins. above the floor, a course of hairfelt is placed between two layers of black paper. The hairfelt is securely cleated and a layer of slightly heavier black insulating paper is set on this and then a course of ¾ by 3¼ ins. lining is put on over this. A course of shiplap boards and a course of hairfelt is placed between each pair of posts. The ice receptacle is practically a basket of 1¼ by 1¼ ins. square mesh wire, .177 ins. thick held away from the face and end walls by 1⅝ by 3-in. screen supporting strips. Bevel hatchways are used as these facilitate the icing of the cars as they permit the ice men to fill the receptacles to the very top, across the entire width of the car.

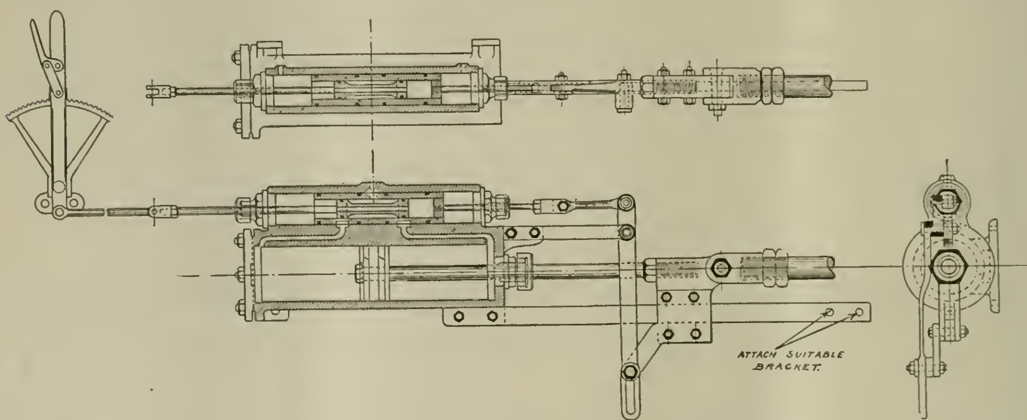
Some of the principal dimensions are as follows:—Length over end sheeting 40 ft. 11⅛ in. Length inide of lining 39 ft. 10¼ ins. Width over eaves 9 ft. 6 ins. Height from top of rack to ceiling, 7 ft. 0 5/16 ins. Length between ice boxes, 33 ft. 2¾ ins. Width over side sheeting, 9 ft. 2⅝ ins. Height from top of rail to top of brake shaft 13 ft. 10 ins. Height from top of rail to top of running board 13 ft. 0½ in. Width inside of lining 8 ft. 2¾ ins. Height from floor to ceiling 7 ft. 5 5/16 in. Capacity 60,000 lbs. Light weight of car 50,000 lbs. Truck wheel base 5 ft. 6 ins. Total wheel base 36 ft. 2 in.

The Brown Power Reverse Gear

Very favorable reports are being made in regard to the Brown Power Reverse Gear, recently taken over by the Southern Locomotive Valve Gear Co., of Knoxville, Tenn., and placed on the market. Its practical reliability in every position of the cut-off and its ready adaptability to switch, freight or passenger locomotives place it in a position beyond experiment, and a brief description of its salient features will be of interest.

This reverse gear is constructed on the inside admission piston valve type, and can be used with either steam or air, same being admitted at the center of steam chest and the distribution is controlled by inside piston valve, which operates in an automatic sleeve valve. This automatic sleeve valve is connected by means of a combination lever to the cross head arm, the movement of the automatic valve being actuated by the movement of the control valve admitting steam or air to the cylinder, which causes the piston to move, thereby causing the automatic valve to move in the opposite direction of that of the piston and return to the lap position with the control valve. The entire movement of the gear is controlled by a reverse lever which is connected direct with the control valve. any position can thus be obtained.

It may be stated it is quite impossible for this style reverse gear to creep, as it is steam locked in every position of the cut-off. The automatic sleeve valve is very sensitive to any movement of the piston, therefore it may be readily seen that should any leak develop on either side of the piston, the automatic valve would immediately move, admitting steam to the weak side, thereby assuring that the piston remain in position as placed by the engineer at all times.



SECTION VIEW OF BROWN POWER REVERSE GEAR.

The elimination of soft packing is another fine feature, and the weight of the gear has been considerably reduced. This gear weighs practically 400 lbs. ready for application. The use of power reverse gear of various kinds, is steadily making progress on our railway systems, as such gear possesses many material advantages and is in line with the scientific advance which we are making on locomotives.

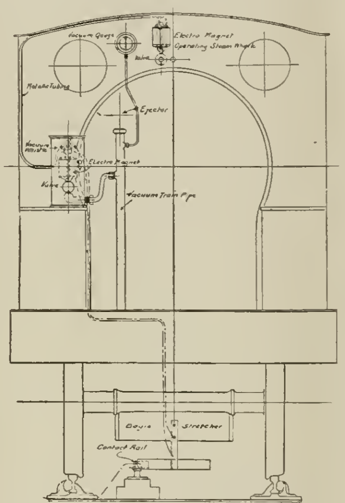
British Stop Signal

The Permanent Way Equipment—The Locomotive Apparatus—Warning to Enginemen and Signalmen—L. & S. W. Type of Tank Engine.

The London and South Western Railway of England had been looking very seriously into the matter of the Automatic Stop Signal before the war, and had begun some experiments with the Prentice wireless system. Another system which we here describe had probably been proceeded with further than the other before the call to arms temporarily slowed down many useful forms of enquiry, both in this country and in England.

In the method of which we here write the apparatus on the permanent-way consisted of a bar placed longitudinally between the rails and electrically insulated. This bar may be pivotted at the center and have a lateral movement at the ends, or it may be rigidly fixed as is deemed expedient. If the former plan is adopted the bar is kept in the normal position, parallel to the rails, by springs, and the amount of lateral deflection of the ends is determined by stops or holders. This bar forms part of an electric circuit which is open when the signal is clear, and closed when the signal is at danger. The switch for closing the circuit is attached to, and is operated by, the rod controlling the signal arm. The electric battery may be placed on the signal post or in any convenient position, but the contact bar is always placed in advance of the signal by an amount determined by the nature of the traffic, and the speed of the trains.

The apparatus on the engine consisted of an electrically insulated flexible contact piece, placed beneath the engine, which makes a lateral rubbing contact when the engine passes over it, with the bar which is in the permanent way. This contact is made with smoothness and without shock. In the cab, in proximity to the engineman, is placed, in a branch of the brake train pipe, a plug-cock, or valve, operated by an electro-magnet, the armature of which withdraws a stop on a disc fixed to, and controlling the opening of the cock or valve on the branch of the train pipe. If the brake used is the vacuum, the opening of the cock or valve applies the brake. With the pressure or Westinghouse brake, the same result is obtained, that is, an application, by allowing the air to escape from the train pipe. In the former or vacuum system the end of the branch, has a reed-pipe interposed which emits a sound with the inrush of air, and in the latter an ordinary organ-pipe whistle is sounded by the escaping air of the Westinghouse brake, in both cases warning the engineman that the signal is at danger, and the brakes are being applied. As an addition, or as an alternative, the energizing of the electro-magnet may be used for operating an auxiliary steam whistle on the engine. When the line is clear, no current passes through the contact of the engine and permanent-way bar, as the circuit through the latter is open. When the signal is at danger and the circuit closed, the contact of the engine and permanent-way bar allows current to pass to the electro-magnet which is energized and the brake is applied. The cock or valve remains open till closed by the engineman.



CAB APPARATUS FOR AUTOMATIC STOP SIGNAL. L. & S. W. Ry.

The warning to signalman is obtained by a track circuit formed inside the signal which is closed by an engine or train waiting for the line to be cleared. The closing of this circuit rings a distinctive bell in the signal box to remind the signalman that the train is at that point and the section is thus blocked. The bell continues ringing until the train has passed out of the section.

The uncertainty in using hand detonators during fog is removed by this apparatus. It is very difficultt for enginemen when two or more trains are passing the spot where the signalman is so to speak stationary, to be sure on which line the detonators were placed. By this new arrangement the brake and the audible signal are automatically brought into use, and the engineman is thus informed that the signal for the line on which he is running, is at danger, or is clear, as the case may be.

The engine which we show in our illustration is a tank engine of 0-4-4 type, and is equipped with the installation for automatic signaling here described. The cylinders are 18½ x 26 ins. The spread of the drivers is 5 ft. 7 ins. The heating surface is in all 1191.6 sq. ft., made up of 216 flue tubes giving 1067.7 sq. ft. and the remainder 123.9 in the firebox, makes up the total. The grate area is 20 sq. ft. and the boiler carries a pressure of 150 lbs. to the square inch. The total length of the engine over buffers is 36 ft. 3 ins., and the total wheel base is 23 ft. 7 ins. The capacity of the tanks comes to 1,300 imperial gallons and the fuel space is 90 cu. ft. The total weight of the engine in working order is 54 (long) tons, 13 cwt. The capacity of the tanks for heating the feed water is 234 sq. ft. The engines are fitted with duplex feed pumps. The engine is run in suburban service.

LONDON AND SOUTH WESTERN ENGINE EQUIPPED WITH STOP SIGNAL APPARATUS

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Intellectual Consent.

A good many people say they believe a thing; so they do, but do not act on their belief. In fact, not to be profane, a good deal of Christian doctrine receives intellectual consent or rather assent, yet this does not cause it to have any serious effect on the lives of those who profess belief. All this is on the assumption that the means to put belief into practice is obvious and near at hand.

In justice to a large number of our fellow beings, we must admit that many believe certain things, yet do not know how to act on them. As an example, the statement that the locomotive is most wasteful of fuel-energy may be believed in, completely, yet the way the locomotive can be made more efficient, may not readily appear even to the believer. He can only give his intellectual consent. He may not be able to practice the economies he acknowledges should be his.

There are many locomotive appliances which if properly used produce economies of various kinds yet until these specialties had been developed, used, proved and able to stand the service test, they were not fully available for railway use. They have been developed and tested up to the point where they are actualities and can be used with advantage, but previously they were practically only "in the air," and in that condition could only receive an intellectual consent as to their efficacy even by those who were most eager to see them brought to a usable state of efficiency. Now the way for practical adoption is clear to all. The men who believe in them can act, and investigation is open to the man who may not yet be convinced.

One thing now fit for practical application stands ready for adoption and that thing is the automatic stop signal. The necessity for its adoption is patent to everyone, yet it is not used as is the vertical plane coupler is used, or the air brake, the dead man's handle on electric trains, or even the headlight, which latter does not make locomotive operation any cheaper or dearer, yet would produce a commotion here if it were abolished, although it is not used in Great Britain.

Prof. George M. Stratton pointed out that the term "color blindness" is too definite and too restricted to embrace the hosts of men running trains who can only be described as color weak. "The color sense," he says, "does not seem to be intended by Nature to bear the brunt of elemental action." Dr. Edward A. Ayres tells us that "if one thousand men gaze at a garden of flowers, fifty of them will see the colors falsely." He does not say that the last fifty will lose all the colors—they are color weak; but "if one thousand women view the flowers, nine hundred-and-ninety-six will perceive them correctly."

This is the color weak statement for men. Add to that the men who run trains, who are really color blind, and the wonder grows that we get on as well as we do. Then all the locomotive runners, color blind, color weak and normal, are everyone amenable to the laws of psychology. Prof. William James, speaking of Attention and Free-will, says, "No object can catch our attention except by the neural (nervous) machinery. But the amount of attention which an object receives after it has caught our mental eye, is another question. It often takes effort to keep the mind upon it." How easily attention can be distracted we know, and how fatally men may give way at a critical moment, is a matter of common knowledge.

Two farmers in a rural district had become accustomed to the blast of a locomotive whistle of a well-known passenger train, at a certain hour of the day. "You can set your watch by that whistle," one often said to the other. On a particular day a road crossing accident happened to this train, and both men were called to give evidence in court. Both swore to having heard the whistle on the particular day in question. It was, however, proved beyond question, that on that very day the whistle on the locomotive was out of order, and two stations back, or about 15 or 20 miles, before the farmers "heard" the blast, the engineman had asked for, and received, permission from the train dispatcher to run to the terminal without the use of the whistle. The farmers believed they had heard a sound which was absolutely non-existent, and swore to the accuracy of their impossible statement.

There is hardly any doubt that all classes of railway men from the rank and file to the highest executive officers give an almost unqualified intellectual consent to the advisability, not to say necessity, of employing the automatic stop signal, which does not depend on nerves, eyes, brain, or of forced attention, or the direct interpretation of sights or sounds. There is hardly a man alive, who is cognizant of the fallibility of even conscientious and well intentioned men in railway service who would have the hardihood to deny the stop signal a place among the important safety appliances within the reach of our railroads today, yet this intellectual consent does not flower out in action, and stop signal equipment is not in daily and universal use. It is fair to suppose from the mass of evidence in its favor that, at least, one great reason why it is not universally adopted, is its first cost, even though that is not thought to be excessive. The several rate decisions of the I. C. C. rather tends to strengthen the opinion held by many that lack of funds, restricts many good and useful applications of things, desirable in themselves. The stop signal is a most satisfactory operating adjunct to railway working, and in the end the public will have to understand the benefits in the way of increased safety it will receive when the stop signal is used. Safety is a direct thing which touches the life of the individual who travels, and that it is a help as a dividend earner, is for the man in the street, beside the mark. It is the public who must eventually give the imperative call for it, and the public must be made aware of the necessity for the thing they ask to be given them.

Some Practical Savings.

At a meeting of the mechanical department staff of one of our leading railways a report was presented by a member showing that by substituting annealed sheet steel for jacketing on passenger engines for the planished iron generally used, a very satisfactory saving might be effected. The cost of annealed steel as compared with that of planished iron showed a saving which would amount approximately to $1,200 a year, and considerably more when all freight and switching engines were included in the change.

There is no doubt that this piece of

revised practice points to large possibilities for any railway that hunts for such opportunities. The chances do not come unless they are sought, and there is no royal road to insight which will lead to the discovery of how money may be saved. The successful practice must be carefully looked for and a faithful and honest judgment must be used after a possible substitute has been brought to light. The substitute must be fully as serviceable and must stand the wear as well or better than the material to be discarded. The chances of breakages and failures must be justly appraised and the first cost must be less than the original material or it must have staying qualities or attributes which ensure lasting service, which are the equivalents to lower first cost, or the change will not yield the results expected.

At the meeting, of which we write, the subject of using journal truing machines was also discussed. The decision reached was that the more important shops on the line were to be equipped with these machines and that at some other stations old lathes of proper dimensions which could be used for this purpose were to be so employed in the future. It was reported by those having this matter in charge that during a specified quarter—three months—there were 1,756 pairs of wheeds with journals trued up. Another quarter also accurately recorded showed a saving of $1,894, which gives approximately an annual saving of $4,611. This sum is not the multiple of the quarter's saving by 4, because conditions change from month to month, and the supply at any one time is a variable quantity. This figure is the result of some very careful work.

In the matter of flat wheels, grinding machines of various kinds were discussed, and the results of getting the flat spots ground out at private companies' works was gone over, and the general amount of satisfaction to be had in this way was talked about. A modifying circumstance had just then arisen on the road in question, and that was the possibilities disclosed by some experiments made at the railway repair shops, in the matter of building up and electrically welding metal at and about the flat spot, and grinding off the excess. The experiments had not been brought to a finality, but the indications were that much good would come of the experiments. The practice was left as it was, that is wheels with flat spots were shipped to outside firms, and the experiments with electric welding were to be carried out still further, and final decision as to standard practice in this respect was left in abeyance. We are not able at this writing to give the comparative figures or to state what the saving would be, if any, but it is clear to the least informed railroad man who has handled and scrapped wheels that the slid flat spot condemns many and many an otherwise serviceable wheel to the scrap heap before it has made a tithe of the mileage that it should have made, and which the purchase price entitles the buyers to expect it to make.

Car Shortage.

The Railroads' War Board informed the railroads of the Country that by making repairs quicker, by a better movement, and by heavier loading, it was in the range of possibilities to make such a saving in the use of freight cars that it would be equivalent to adding to the available equipment 779,000 cars. Carriers and shippers have been asked as a patriotic duty to strive to attain that goal. In response to the call the shortage of freight cars in the United States was reduced in one month from 148,627 to 105,127 cars, almost one-third. Some of the suggestions made were to load cars 10 per cent in excess of marked capacity; reduce percentage of cars and locomotives under repairs; improve methods of firing locomotives; defer scrapping light locomotives; speed up handling of cars in terminals; load and unload cars promptly; enlist co-operation of shippers as a war measure to secure heavier loading of cars.

A Possible Contingency.

Among the many possible contingencies caused by the great war, one is that in case the Railroad War Board discovers a shortage of power on one road, they may pick out suitable power on another line and transfer engines from one railroad to another, much as the responsible officer of a railway may transfer engines from one division to another.

The fact hardly needs stating that in case of transfer of engines from one division to another, the engines can be very easily repaired, as they are never out of reach of supplies, owned by the road where the divisional transfer is made. If engines should be moved from one road to another the case would be different, and we might have to go back to the days when foreign freight cars, if damaged, in a particular way could only be repaired with material of a special type, sent on from the owning road. This was the case before the M. C. B. Association inaugurated standards.

The fact that interchange of engines does not usually take place, and the possibility of such transfer, is only contemplated as an emergency measure, does not call for any action of the M. M. Association, analogous to the making of the M. C. B. rule regarding the repairs to foreign freight cars. It is, however, quite obvious that in the event of the locomotive interchange emergency overtaking us, it will be a matter of satisfaction and a great economy of time, if the engines moved are more or less equipped with specialties of the same or similar design.

These are the days when new engines, although built in perhaps as great numbers as the makers can turn them out, are yet not adequate for home demand, and when at last the war terminates, it is probable that the demand for railroad supplies, from Russia and other European powers will restrict the domestic supply. These are the days when existing engines, built some years ago, must be kept in service and rehabilitated for modern service by the application of appliances for the production of economical operation. Take for example so simple a thing as a brick arch. This appliance has become standard on so many roads that the interchange of engines from one road to another might easily find both roads capable of making repairs with the stock kept on each line for its own use. In such a case little or no delay or trouble would result. This is practically true of a host of other economy devices, and the officials of a road where the interchange emergency may come, might do well to study the whole matter, and they might not only secure better performance for their own engines now on their own line, but be in a position to handle with facility engines coming to them with similar equipment, from an outside railway.

Extension of the Age Limit.

In view of the fact that the younger men of the country will shortly be called into military service, the management of the Pennsylvania Railroad has decided to suspend, temporarily, the regulation covering the age limit for employment. The rule heretofore in force prohibited the hiring of new employes, in any branch of the service, above the age of 45 years. Under the new rule, which has been adopted to meet war conditions, persons between the ages of 45 and 70 years may be employed during the war and for a period of six months thereafter. Inasmuch as such employment is not to be considered permanent, it will not carry with it the privileges of the Pension Department.

This new arrangement, it is believed, will offer an opportunity for large numbers of those who are beyond military age, to perform a patriotic service to the country, in the war emergency, by assisting in the indispensable work of maintaining railroad operation.

Electric Headlights for Locomotives.

All locomotives used by the Baltimore and Ohio railroad in road service are to be equipped with electric headlights. The new headlights are being installed at the rate of 75 engines a month, there being 2,500 locomotives to so equip. The work is being done by the company's forces under the direction of J. H. Davis, electrical engineer.

Air Brake Department

Air Brake Questions and Answers—An Up-to-date Course in Air Brake Study

With this issue we are beginning the series of air brake questions and answers previously mentioned. These will be printed under the three different headings indicated, and will be continued from month to month until each subject is completed. It will require two years or possibly more to complete the entire series, and our aim will be to, so far as possible, avoid the references to description and operation of air brake apparatus that may be found in the various air brake instruction pamphlets. The intent will be to offer a radical departure from ordinary forms of air brake questions and answers, and in this entire series we are assuming that the reader understands in a general way the operation and construction of the various units of the air brake system, and if so, study of these questions and answers should lead to an expert knowledge of air brake operation.

It will be understood that the inspection and maintenance of locomotive air brake equipments is now governed by Federal regulations, or inspection and repair work must conform to the rules formulated by the Interstate Commerce Commission, and in connection herewith we are printing the instructions, which it must be understood, are minimum requirements, that is, these rules are not intended to prevent the employment of shop practices or inspection that would tend to maintain brake equipments in a more efficient condition than specified by the rules of inspection, but that the various cleanings and tests must not be made less frequently than specified.

In view of the constantly changing recommendations in air brake practice and frequent changes in construction of apparatus, it is practically impossible to write a book or pamphlet of air brake information, that will not contain some obsolete matter by the time it comes off the press, therefore the advantage in printing the questions and answers in this form where they can be revised as required each month as the proofs for the paper are being corrected. There will be at least 1,000 questions and answers on each of the three different subjects, and we invite the readers to criticise them and will be pleased to print any comments upon them whenever the object of the question and answer is not perfectly clear.

Considerable progress has been made in the formulation of these questions and answers, and we feel safe in saying that this form of air brake instruction has never before been attempted on such a large scale.

Interstate Commerce Commission Rules for Inspection of Brake and Signal Equipment on Locomotives and Tenders.

(6) It must be known before each trip that the brakes on locomotive and tender are in safe and suitable condition for service; that the air compressor or compressors are in condition to provide an ample supply of air for the service in which the locomotive is put; that the devices for regulating all pressures are properly performing their functions; that the brake valves work properly in all positions, and that the water has been drained out of the air-brake system.

(7) *Compressors.*—The compressor or compressors shall be tested for capacity by orifice test as often as conditions may require, but not less frequently than once in each three months.

The diameter of orifice, speed of compressor, and the air pressure to be maintained for compressors in common use are given in the following table:

Compressor.	Single strokes per minute.	Diameter of orifice.	Air pressure maintained.
W.A.B. 9½"	120	11-64"	60 lbs.
W.A.B. 11"	100	3-16"	60 lbs.
W.A.B. 8½CC	100	9-32"	60 lbs.
N.Y. 2a	120	5-32"	60 lbs.
N.Y. 6a	100	13-64"	60 lbs.
N.Y. 5b	100	15-64"	60 lbs.

This table shall be used for altitudes to and including 1,000 feet. For altitudes over 1,000 feet, the speed of the compressor may be increased 5 single strokes per minute for each 1,000 ft. increase in altitude.

(8) *Testing Main Reservoirs.*—Every main reservoir before being put into service, and at least once each 12 months thereafter, shall be subjected to hydrostatic pressure not less than 25 per cent above the maximum allowed air pressure.

The entire surface of the reservoir shall be hammer-tested each time the locomotive is shopped for general repairs, but not less frequently than once each 18 months.

(9) *Air Gauges.*—Air gauges shall be so located that they may be conveniently read by the engineer from his usual position in the cab. Air gauges shall be tested at least once each three months, also when any irregularity is reported.

Air gauges shall be compared with an accurate test gauge or a dead weight tester and gauges found incorrect shall be repaired before they are returned to service.

(10) *Time of Cleaning.*—Distributing valves or control valves, reducing valves, triple valves, straight air double check valves, dirt collectors and brake cylinders shall be cleaned and brake cylinders lubricated as often as conditions require to maintain them in safe and suitable condition for service, but not less frequently than once in each 6 months.

(11) *Stencilling Dates of Tests and Cleaning.*—The date of testing or cleaning and the initial of the shop or station at which the work is done, shall be legibly stencilled on a conspicuous place on the parts, or placed on a card displayed under glass in the cab of the locomotive, or stamped on metal tags. When metal tags are used the height of letters and figures shall be not less than ⅛ in., and the tags located as follows:

One securely attached to the brakepipe near the automatic brake valve, which will show the date on which the distributing valve, control valve or triple valves, reducing valves, straight air double check valves, dirt collectors and brake cylinders were cleaned and cylinders lubricated.

One securely attached to the air compressor steam pipe, which will show the date on which the compressor was tested by orifice test.

One securely attached to the return pipe near main reservoir, which will show the date on which the hydrostatic test was applied to the main reservoir.

(12) *Piston Travel.*—The minimum piston travel shall be sufficient to provide proper brake shoe clearance when the brakes are released.

The maximum piston travel when the locomotive is standing shall be as follows.

Cam type of driving wheel brake	3½"
Other form of driving wheel brake	6"
Engine truck brake	8"
Tender brake	9"

(13) *Foundation Brake Gear.*—Foundation brake gear shall be maintained in a safe and suitable condition for service. Levers, rods, brake beams, hangers and pins, shall be of ample strength and shall not be fouled in any way which will affect the proper operation of the brake. All pins shall be properly secured in place with cotters, split keys, or nuts. Brake shoes must be properly applied and kept approximately in line with the tread of the wheel. No part of the foundation brake gear of the locomotive or tender shall be less than 2½ in. above the rail.

(14) *Leakage.*—Leakage from the main reservoir and related piping shall not exceed an average of three pounds per minute in a test of three minutes' duration, made after the pressure has

been reduced 40 per cent below the maximum pressure carried.

Brake pipe leakage shall not exceed 5 lbs. per minute.

Brake Cylinder Leakage.—With a full service application from maximum brake brake pipe pressure, and with communication to the brake cylinders closed, the brakes on the locomotive and tender shall remain applied not less than 5 minutes.

(15) *Train Signal System.*—The train signal system, when used, shall be tested and known to be in safe and suitable conditions for service before each trip.

Locomotive Air Brake Inspection.

1. Q.—How often should the air brake and signal system of a locomotive be inspected?

A.—At the end or beginning of each trip or day's work. On double crewed engines, or engines in continuous service, an inspection period is provided once in each 24 hours.

2. Q.—Where is this inspection usually made at large terminals?

A.—At an inspection pit over which the engine passes before having the fire cleaned.

3. Q.—Who generally makes the inspection of the brake?

A.—Inspectors who make no repairs, but report the defects found.

4. Q.—How is an inspection started on an engine equipped with the Westinghouse E. T. brake?

A.—By obtaining approximately 50 lbs. air pressure in the brake cylinders leaving the automatic brake valve in running position and the independent brake valve in lap position, and closing the stop cock in the distributing valve supply pipe.

5. Q.—Why is the inspection started with the brake cylinder leakage test?

A.—Because it is the test of longest duration, and during this time other parts of the equipment are inspected.

6. Q.—How long must the brakes remain applied under this condition?

A.—At least 5 minutes.

7. Q.—Why is the independent brake valve placed on lap instead of slow application position?

A.—For a test of the application cylinder and its connections, and to positively close communication to the brake cylinders.

8. Q.—In what way could compressed air enter the brake cylinders if the handle is left in slow application position?

A.—From the application cylinder past the application piston packing leather and packing ring, if these parts are defective.

9. Q.—Could compressed air enter the brake cylinders even if the independent brake valve is on lap position?

A.—Yes, through a defective supply pipe cut out cock.

10. Q.—What would prevent the brakes from remaining applied for the specified period of time?

A.—Leakage in the brake cylinders or their connections, which should be located and reported.

11. Q.—What would be indicated by the brakes releasing through the distributing valve exhaust port when the independent brake valve was placed on lap position?

A.—Leakage in the application cylinder or its connections.

12. Q.—How would the brake cylinder leakage test then be made?

A.—With the independent brake valve in slow application position.

13. Q.—At what points could application cylinder leakage occur?

A.—In the application cylinder pipe, the application cylinder cover gasket in the safety valve or its connection, at the distributing valve reservoir gasket, at the reservoir studs or at the lower body gasket or rotary valve of the independent brake valve.

14. Q.—What would be wrong if the brake leaked off through the exhaust port of the distributing valve with the independent brake valve in slow application position?

A.—It would indicate that the exhaust valve of the distributing valve was leaking.

15. Q.—After closing the stop cock in the distributing valve supply pipe, and nothing unusual is noticed, how is the inspection continued?

A.—By going under the engine at the pilot, examining the brake cylinders and pipe connection with a torch to locate leakage, and for measuring the brake cylinder piston travel.

16. Q.—What would be indicated if some cylinder leakage could be found, but the gage did not register very much of a drop in pressure?

A.—That the gage was not registering correctly or that the stop cock in the distributing valve supply pipe was leaking badly.

17. Q.—How is brake cylinder leakage to be reported?

A.—That from the non pressure head, or past the piston sleeve, as packing leather leakage, and that from the pressure head as gasket or pipe connection leakage as the case may be. If in the pipe connections it must be reported as brake cylinder pipes leaking, stating at what points.

18. Q.—What should be the limits of brake cylinder piston travel, for engine truck, driver, and trailer brake cylinders?

A.—From 4 to 6 inches, unless travel of engine truck and trailer cylinders is governed by special instructions.

19. Q.—What else should be noticed in connection with the brake cylinders?

A.—That all bolts fastening both heads are in place and tight, that the cylinder is tight on the frame or bracket and that cross-heads and pins and cotter keys are in place.

20. Q.—What should be noticed in connection with the piping, not only of the brake cylinder connections, but on any other of the parts of the engine?

A.—That it is free from leakage, securely clamped, and that no section is badly worn or deteriorated or rubbing against any part of the running gear of the engine.

21. Q.—What should be observed in connection with the brake rigging?

A.—That rods and pins are not badly worn, that all pins have cotters or split keys, that the rigging is not binding against any other part of the locomotive, that no part of the rigging of either the engine or tender is less than 2½ inches above the rail and that the brake shoes are approximately in line with the tread of the wheel.

22. Q.—Is there ever any other parts of the brake equipment under an engine?

A.—Yes, sometimes main reservoirs are located between the frame, which should be inspected, and drained, in the same manner as outside reservoirs. Sometimes there are other sections of piping that can be reached more easily from underneath than from the outside of the engine.

23. Q.—To where is the inspection continued from the engine brake cylinders?

A.—Along the brake pipe and signal, and brake cylinder pipes to between the engine and tender and from there along these same pipes to the rear of the tender.

24. Q.—What is to be observed in connection with the air hose or couplings between the engine and tender?

A.—That they are free from leakage, if metallic connections, they should be moved about to disclose any possible leakage, and if hose connections they should be carefully inspected for cracks, loose clamps, or appearances of a bad condition and it should be known that hose are not rubbing against each other.

25. Q.—What part should be inspected, while following the air pipes to the rear of the tender?

A.—The tender brake cylinder, in the same manner as that accorded the other cylinders.

26. Q.—What should the tender brake cylinder piston travel be?

A.—From 5 to 8 inches, unless governed by special instructions.

27. Q.—What must be done if the brake leaks off before the inspection has proceeded as far as the tender brake cylinder?

A.—The leakage must be located, or the fact reported, and the brake again applied and the piston travel measured with full brake cylinder pressure.

28. Q.—What is to be observed upon coming from under the rear of the tender?

A.—The condition of the air hose at the rear of the tender, the location of the angle cock and signal pipe stop cock, and an examination for leakage through these cocks to the atmosphere. In other words, a certain assurance that no defect of any kind which would interfere with efficiency in apparatus or leak exists.

(*To be continued.*)

Train Handling.

1. Q.—What should be observed in the way of air brake inspection before taking a locomotive away from the engine house?

A.—That the air pressures are correct and properly controlled, that the air compressor is in good condition and the lubricator is operating, that the brake cylinder piston travel is correct, that the water has been drained out of the brake system, that there is no noticeable leakage from the system, that the brake shoes are all brought in proper contact with the wheels and that the signal system is operative if the locomotive is so equipped.

2. Q.—Why is brake cylinder leakage of any consequence, when the distributing valve will maintain the pressure regardless of leakage?

A.—Because excessive leakage will cause a drain on the main reservoir and use up a certain per cent of the capacity of the air compressor, which might otherwise be used to a good advantage for a release and recharge of brakes.

3. Q.—What would excessive brake cylinder leakage then tend to produce in descending heavy grades?

A.—A loss of train control.

4. Q.—Why is a standard piston travel essential, if the braking force remains constant regardless of long travel?

A.—It might be necessary to make the quickest possible release of the engine brake in the event of driving wheels picking up and sliding, and the longer the piston travel, the longer the time that will be required to get the brake released.

5. Q.—Why is this?

A.—On account of the greater volume of compressed air to be exhausted from the brake cylinders when the travel is long.

6. Q.—How is a test for the sensitiveness of the feed valve made?

A.—By making a 2½ or 3 lb. brake pipe reduction to see that the valve opens promptly and returns the gage hand to the original figure of feed valve adjustment.

7. Q.—In what position would the independent brake valve handle be while inspecting or working about the engine?

A.—In slow application position.

8. Q.—In what way would the brake be tested with the automatic brake valve?

A.—By making 5 lbs. brake pipe reduction to see that this operates the distributing valve, then 15 more pounds to see that 50 lbs. brake cylinder pressure is obtained for the total reduction.

9. Q.—What governs the amount of brake cylinder pressure that will obtain for a given brake pipe reduction?

A.—The proportion of the distributing valve reservoir pressure chamber to that of the application chamber and application cylinder, when the distributing valve is sufficiently sensitive.

10. Q.—If the brake pipe pressure is reduced 10 lbs., how much will the pressure chamber lower?

A.—10 lbs. or a like amount.

11. Q.—What pressure will this produce in the application cylinder?

A.—Two and one half times 10 or 25 lbs.

12. Q.—What pressure will this produce in the brake cylinders?

A.—About 25 lbs. if the distributing valve is sufficiently sensitive.

13. Q.—What would cause the brake to leak off after being applied?

A.—A leak in the application cylinder or its connections.

14. Q.—Is the safety valve connected with the application cylinder after a 10 lb. brake pipe reduction and return to lap?

A.—No, not with the equalizing portion in service lap position.

15. Q.—After the full service application of the brake, how should the brake be released?

A.—With the independent brake valve.

16. Q.—For what purpose?

A.—To know that the independent valve can at all times be used to release the engine and tender brake.

17. Q.—What could be wrong if the brake could not then be released with the independent brake valve?

A.—The exhaust port of the independent brake valve could be stopped up or closed with a metal thread protector, or the application cylinder and release pipes might be wrongly connected.

18. Q.—Why would the brake fail to release if the pipes were crossed or wrongly coupled?

A.—Application cylinder pressure would be in the release pipe, and the application cylinder pipe would be connected with the exhaust cavity of the equalizing slide valve.

19. Q.—Would this wrongly connected piping be an excuse for flattening driving wheel tires?

A.—Not likely as someone might conclude that even if the disorder was not discovered, the engineer should have thought fast enough to have closed the stop cock under the brake valve and released the brake with the automatic brake valve.

20. Q.—Why close the stop cock under the brake valve if the brakes are applied throughout the train?

A.—It might be undesirable to release train brakes and the closed stop cock would prevent it.

21. Q.—Why would the brake then release promptly on the engine?

A.—Because the release pipe with application cylinder pressure would be opened to the atmosphere through the automatic brake valve.

22. Q.—In connection with the same subject, why should the brake pipe feed valve and the application portion of the distributing valve be sensitive?

A.—To prevent the development of a brake cylinder pressure that might not show on the air gage.

23. Q.—Under what conditions might this occur?

A.—The feed valve may permit variations in brake pipe pressure, that might in turn produce movements of the equalizing portion of the distributing valve, which might develop a brake cylinder pressure insufficient to return the application portion to release position.

24. Q.—What would prevent the return of the application portion to release position?

A.—Frictional resistance of the application portion to movement.

25. Q.—Why is this portion more readily moved to application than to release position?

A.—On account of less friction when there is no other than atmospheric pressure on the exhaust slide valve.

26. Q.—What would be the result of having just sufficient brake cylinder pressure to hold the brake shoes against the wheels without it being shown on the air gage?

A.—It would tend to overheat and loosen driving wheel tires.

27. Q.—Is this of frequent occurrence?

A.—No, but it is by no means unheard of.

28. Q.—Would this brake action be an excuse for overheating driving wheel tires?

A.—Not likely, as it will not occur if the distributing valve is sufficiently sensitive to respond to variations in pressure.

29. Q.—How is the sensitiveness of the valve determined?

A.—By an application and release with the independent brake valve.

30. Q.—In just what manner?

A.—If the pressure can be graduated out of the brake cylinders in steps of from 5 to 7 lbs. at a time, the application portion is in good condition.

31. Q.—Would such an action occur if there was brake cylinder leakage?

A.—No, the pressure would leak out of the cylinders with the application valve on lap position.

32. Q.—What pressure should be developed in the brake cylinders with an independent brake application?

A.—From 43 to 48 lbs.

33. Q.—Is there any other reason why an inspection of the brake should be made by the engineer before taking the engine away from the enginehouse.

A.—Yes, some air brake disorder might develop after coupling to a train, and it would then be of decided advantage for the engineman to know that the locomotive brake is in good condition.

34. Q.—Is it necessary to make any further inspection than already outlined?

A.—Some instructors specify a more rigid test, but the various slide valve, rotary valve and gasket leakages, and leaks into and out of, the equalizing reservoir should be located by the air brake inspectors.

(To be continued.)

Car Brake Inspection.

1. Q.—When testing brakes on cars on shop repair tracks, how should compressed air be admitted to, and discharged from the brake pipe?

A.—By means of some device that will permit of a service rate as well as an emergency rate of brake pipe reduction, and by which the brake pipe pressure may be increased at a slow predetermined rate for a release test.

2. Q.—If several cars are coupled up and the brakes are to be tested on all cars at the same time, what device may be used to procure the predetermined rate of rise in brake pipe pressure regardless as to the number of cars, brake equipments per car or length and inside diameter of the brake pipe?

A.—A portable brake test truck.

3. Q.—How should this truck be attached to cars?

A.—It should be attached to both brake pipe and signal line, by means of the triple hose fitting. At the opposite end of the train, angle cock and signal pipe stop cock should remain open and the hose couplings should be hung up in the dummy couplings.

4. Q.—After the air pressure is then turned into the brake pipe, what should be done while the brake pipe and reservoirs are charging preparatory to the brake test?

A.—It should be noted that all hand brakes are released, that all brake pipe branch stop cocks are open, that all reservoir bleeder cocks are closed. It should be ascertained that all reservoirs and brake cylinders are securely fastened in their respective positions on the car, and an inspection of the brake rigging should be made.

5. Q.—What should be noticed in connection with the brake rigging?

A.—That brake shoes are of sufficient thickness, and approximately in line with the tread of the wheel, that shoes are clear of the wheels, that the brake rigging is not fouled in any manner, that all rods and levers will clear timbers or parts of the underframe by at least one inch, and that no part of the foundation brake rigging is less than 2½ ins. above the rail.

6. Q.—If necessary to renew a brake shoe, how should the necessary brake rigging slack be obtained?

A.—By turning the automatic slack adjuster nut one fourth of a turn to the right, or in the direction of take up, to know that the pawl is disengaged from the ratchet, then turn in the opposite direction until sufficient slack is obtained. After the shoe is applied, the adjuster nut should be turned in the direction of take up until the cross head is within an inch of its previous position.

7. Q.—How should adjusters be manipulated when cars are equipped with the PC, or two cylinder equipments?

A.—Slack should be let out with both adjusters, and after brake shoes are applied, both cross heads should be left an even distance from the pressure head of the brake cylinder.

8. Q.—What should be observed in connection with brake and signal pipes?

A.—That pipes are securely clamped, in good condition, free from leakage, and that angle cocks and signal pipe angle fittings are properly located.

9. Q.—What is the proper location of the brake pipe angle cock?

A.—The location varies and is generally covered by blue print specifications, on passenger cars they are located so that the center line of the angle cock will be from the center line about 13 inches of the coupler, and very near the center line vertically and about this same distance back of the inside or pulling face of the knuckle. On freight cars these distances are about the same.

10. Q.—What else should be observed in connection with brake pipe angle cocks?

A.—That handles work freely, and that they stand at an angle of from 15 to 30 degrees from a vertical position.

11. Q.—Should there be anything between the angle cocks and air hose?

A.—An extension nipple should be used on the equipment for which they are specified.

12. Q.—How should the brake and signal pipes then be tested for leakage?

A.—Soap suds should be applied with a brush to the car brake operating valve, pipe joints, cocks, and air hose throughout.

13. Q.—What should be done after the system is fully charged and leakage eliminated?

A.—The brake should be applied with a 5-lb. brake pipe reduction which should result in the application of all brakes with triple valve equipments.

14. Q.—How heavy should the reduction be if some of the cars have retarded application types of operating valves?

3.—From 8 to 10 lbs. brake pipe reduction should be made.

15. Q.—How much reduction should then be made when all brakes are known to have applied?

A.—The remainder of a full service brake application.

16. Q.—What should then be done?

A.—The brake cylinder piston travel on all cars should be measured and recorded, and it should be observed that all brake shoes are held solidly against the wheels, and that none of the brake levers are fouling on any part of the underframe of the car.

17. Q.—What will be indicated if one of the brakes leaks off during this inspection?

A.—Brake cylinder leakage.

18. Q.—Where could this leakage be found?

A.—Past the brake cylinder packing leather, from the brake cylinder gasket or from the high speed reducing valve or its connections or through a safety valve if one is used.

19. Q.—What would be indicated if one of the brakes released through the operating valve exhaust port?

A.—That there was a leak in the auxiliary reservoir volume, either to the atmosphere, or into the brake cylinder if the brake released through the exhaust port only after a light brake pipe reduction.

20. Q.—If all brakes are still properly applied, what test comes next?

A.—A release test of the brakes.

21. Q.—How is it made?

A.—By increasing the brake pipe pressure at a slow rate provided by the brake test truck.

22. Q.—What should be done if one of the brakes fails to release during the release test?

A.—It should first be known that the operating valve exhaust port is not obstructed, if a retaining valve is used, that the handle is turned down, then the bleeder cock in the auxiliary reservoir should be opened and if the brake releases, the air escaping through the triple valve exhaust port, the triple valve or operating valve should be removed and replaced by one that is known to be in good condition.

23. Q.—What is indicated by a triple valve failing to release during the test and when the brake cylinder exhaust port is open?

A.—That the packing ring dividing brake pipe and reservoir pressure is defective, and that the reservoir has been charged without obtaining any movement of the triple valve piston and slide valve.

24. Q.—What would be wrong if it required an increase of from 4 to 6 lbs. brake pipe pressure to release one or more of the triple valves?

A.—Those that failed are not sensitive enough, there is too much frictional resistance to their movement.

25. Q.—What should be done with such valves?

A.—They should be removed and replaced with valves in good condition.

26. Q.—If all brakes are found to be operating correctly during the service test, should another test be made?

A.—Yes, the brakes should be operated in quick action and the brake pipe pressure should be slowly increased for a release.

27. Q.—What else should be observed during the time the brake is applied to measure piston travel?

A.—The high speed reducing or safety valves open to discharge brake cylinder air when the proper brake pipe reduction has been made and that the brake levers are standing approximately at right angles to each other.

(To be continued.)

Engines for the Southern Doing Good Work With the Hanna Automatic Stoker

Runs of 170 Miles Accomplished Without Difficulty—Prepared, Run-of-Mine, Wet or Dry Coal Handled—Satisfaction Experienced By Users.

The Southern Railway and its associated lines received not long ago from the Baldwin Locomotive Works 30 locomotives of the Mountain (4-8-2) type for passenger service, and 55 locomotives of the Santa Fe (2-10-2) type for freight service. These locomotives considerably exceed, in weight and hauling capacity, the designs heretofore used on this road; and they constitute a notable group of modern heavy power.

Of the Mountain type locomotives, 23 are for the Southern Railway proper, while 5 went to the Cincinnati, New Orleans and Texas Pacific, and 2 to the Alabama Great Southern.

The 2-10-2 type of locomotives replace Mikados, a large number of which have been built for the Southern by the Baldwin Locomotive Works. A comparison of the leading dimensions of these two types is as follows—that is the 2-10-2 and the 2-8-2:

tom to allow a sufficiently deep water space under the combustion chamber.

Running gear details include motion driving boxes on the front axle, long boxes on the third or main axle, Economy front truck, and Hodges design of trailing truck. The swing of the trucks, and the lateral play between rails and flanges, are sufficient to permit the engine to traverse curves of 16 degs. The wheels of the third, or main pair, have plain tires. Flange lubricators are applied to the front and rear driving wheels.

As the doors in the front wall of the cab are necessarily very narrow, a running board is placed below the cab on each side, and hand holds are placed on the outside of the cab below the side windows, so that the men can easily reach the main running boards from the firing deck. To keep within the clearance limits, the bell is placed on the cured. On the Norfolk & Western there are 49 in service. There are 5 in service on the Chesapeake & Ohio, and the stoker people are putting in 25 more. There are 18 on the Erie, 6 on the Virginian and 10 on the Carolina, Clinchfield & Ohio.

These engines on the Southern are going over the road without the fire door being opened, and without cleaning the fire. They handle stoker-prepared coal or run-of-mine. The coal can be wet without interfering with the operation of the stoker. This is a matter of convenience and comfort for the men on the engine. The presence of the stoker does not prevent or restrict boiler or drawbar inspection. A correspondent writes us that an engine having this stoker ran 85 miles, one day in June of this year, to the cooling station, and only required six minutes for taking coal and water and getting away again.

2-10-2 ENGINE FOR THE SOUTHERN, EQUIPPED WITH THE HANNA STOKER.
J. Hainen, Asst. to the President and S. M. P. Baldwin Locomotive Works, Builders.

Comparing the 2-10-2 type with the Mikado, it may be noted that while the increase in tractive force is 37 per cent. (approximately the same as the increase in total weight and in weight on drivers), the increase in total equivalent

Description.	Cylinders, Inches.	Drivers, Inches.	Steam Pressure.	Grate Area.	Water Heating Surface.	Superheating Surface.	Weight on Drivers.	Weight, Total Engine.	Tractive Force.
2-8-2 type.....	27x30	63	175	53.3	3,198	699	215,700	272,940	51,700
2-10-2 type....	28x32	57	190	88	5,234	1,341	294,400	370,600	71,000

heating surface is 71 per cent., and in grate area 65 per cent. Provision has been made for fully utilizing the high boiler power of the 2-10-2 type of engines, as they are equipped with mechanical stokers. The Hanna stoker has been put on five engines. As in the case of the passenger locomotives, the fire boxes have combustion chambers and brick arches. The boiler has a straight top, but the third ring is sloped on the bottom round of the boiler, and there are four sand boxes, placed two right and two left, also on the round of the boiler.

The narrow fire box doors are advantageously used in the application of the Hanna automatic stoker. This appliance is the product of years of very careful work in which the theory of correct firing is supplemented by a practical device which is used on these 2-10-2 engines by the Southern Railway. The locomotives are in service between Spencer, N. C., and Monroe, Va., a distance of 170 miles.

The Hanna stoker is an overfed stoker of a scatter type, and by it satisfactory control of where the coal is going is se-

The operation of the Hanna stoker may briefly be stated by saying that coal falls by the action of gravity into a conveyor combined with a crusher, which is situated in the water bottom of the tank; from that point it is pushed onward through a flexible pipe into the locomotive hopper on the engine deck plate, but under the deck. Coal is delivered by a worm conveyor to the base of a vertical worm, by which it is carried upwards and forced through a curved pipe to a point above the door, as shown in our illustration. From here it drops down and passes over a ridge plate, to which are pivoted wings.

These wings move alternately up and down, constantly changing the angle at which the coal passes over the distributing plate. This is done by continuous steam blasts, which are driven out over the distributing plate from a series of radially directed nozzles operating in connection with a fan like sheet blast emanating from a lower chamber. These blasts in connection with back corner channels cut in the face of the distributing plate cover the entire grate surface with an even layer of coal.

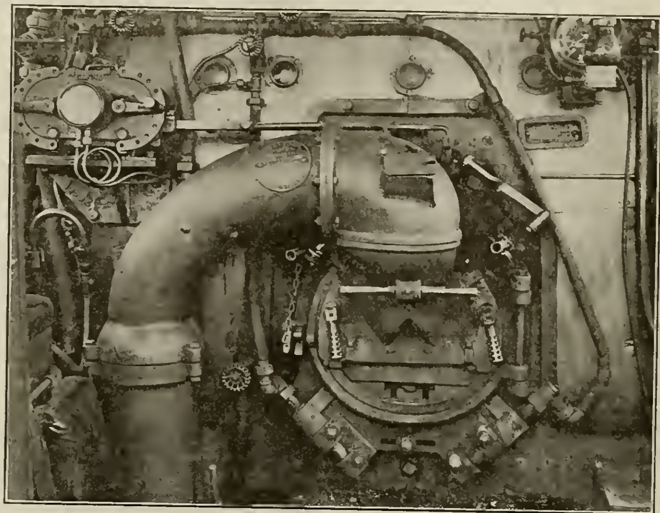
The stoker is worked by a simple two-cylinder double acting reversible engine attached to the left side of the locomotive frame under the fireman's running board and controlled by a throttle on the left side of the cab. Connection between the engine and stoker is made by means of a chain drive to the vertical worm jack shaft, and from this shaft to the locomotive hopper worm shaft, the other end of which engages through mitre gears with the tender crusher drive. This drive is thrown in and out by a jaw clutch, with a lever on the deck, so that the device on the engine can be operated independently of the tender equipment. Connection with the tender apparatus is made by a universal slip shaft, which allows for different movements of engine and tender.

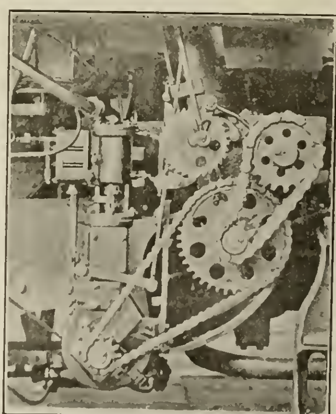
Concerning the wings to which we have made reference above, it may be said that the wing control handles are set so the wings will travel slowly and continuously up and down the sides of the ridge plate, successively changing the point to which the coal is to be thrown. If need be the wings can be stopped at the top so as to make a channel down the center of the fire box; or the wings can be stopped at the bottom making a channel into each back corner; or one wing can be brought to rest at the top and the other at the bottom, and all the coal thrown to one back corner, or vice versa. Other points of delivery can be selected and coal fed to them as desired.

The engines are doing good work, and no organic change in the design of engine or of the boiler or fire box is necessary in order to use the Hanna stoker. It is divided into independent units, and is composed of individual units, readily removed for repair and each operating independently. Should the tender and locomotive units fail, the locomotive can be fired by means of steam blasts, as they do not get out of order when the engine is in service. The tenders are of the same capacity as those used with the passenger locomotives, and are similar in design, made with water bottom. Only very slight changes are necessary on account of the application of stokers.

The following table contains further particulars of these locomotives.

Cylinders—28 x 32 ins. Valves—Piston, 14 ins. diameter. Boiler—Type, straight top; diameter, 88½ ins.; thickness of sheets, ⅞ in.; working pressure, 190 lbs.; fuel, soft coal; staying, radial. Fire Box—Length, 131¾ ins.; width, 96 ins.; depth, front 89¾ ins.; back 73½ ins.; thickness of sheets, sides, back and crown ⅜ in., tubs ⅝ in. Water Space—Front, 6 ins.; sides and back, 5 ins. Tubes—Diameter, 5½ and 2¼ ins.; material, 5½ ins. steel: 2¼ ins. iron: thickness, 5½ ins. No. 9 W. G., 2¼ ins No. 11 W. G.; number, 5½ ins. 50, 2¼ ins. 259; length, 21 ft. 8½ ins. Heating surface—Fire box, 269 sq. ft.; combustion chamber, 66 sq. ft.; tubes, 4,853 sq. ft.; firebrick tubes, 46 sq. ft.; total, 5,234 sq. ft.; superheater, 1,341 sq. ft.; grate area, 88 sq. ft. Driving Wheels—Diameter, outside, 57 ins.; journals, main 12 x 22 ins., others 11 x 12 ins. Engine Truck Wheels—Diameter, front, 33 ins.; journals, 6 x 12 ins.; diameter, back, 42 ins.; journals, 8 x 14 ins. Wheel Base—Driving, 20 ft. 7 ins.; rigid, 20 ft. 7 ins.; total engine, 38 ft. 8 ins.; total engine and tender, 74 ft. 9½ ins. Weight—On driving wheels, 294,400 lbs.; on truck, front, 26,700 lbs.; on truck, back, 49,500 lbs.; total engine, 370,600 lbs.; total engine and tender, about 546,000 lbs. Tender—Wheels, diameter, 33 ins.; journals, 6 x 11 ins.; tank capacity, 9,000 gals.; fuel capacity, 12 tons; service, freight.


VIEW OF CAB OF ENGINE, EQUIPPED WITH THE HANNA MECHANICAL STOKER.


POWER DRIVING MECHANISM OF THE HANNA MECHANICAL STOKER.

Electrical Engineering in the War.

E. W. Rice, Jr., president of the American Institute of Electrical Engineers, delivered an eloquent address at a meeting in New York last month, in which he stated that modern war was largely a question of mechanics and engineering, a statement with which all must agree. It is therefore self-evident that engineering must take a leading and dominant position in the war work. Electrical engineering stands for the latest thing in engineering development. The activities of the electrical engineer embrace practically all other fields of engineering, being, so to speak, the last work in engineering. The electrical engineer, must, therefore, realize that this is his war in a very personal and particular sense. The work must be done collectively. The victory will be on our side, and the world will be made a safe place for those who survive, and we will be able to turn again to the satisfaction and joy of a useful and peaceful existence.

Imperial Japanese Navy has ordered 3 four-wheel (0-4-0) locomotives for the Kure Naval Yard from the American Locomotive Co. One engine will weigh 97,000 pounds and will have cylinders 16 by 24 inches.

Electrical Department

The Source of Electrical Energy—Inspection of Motors

When a gentleman meets a lady on the street, and mindful of the amenities of civilized life, raises his hat in greeting, he performs an act which, as one would say, comes easily to him. It is not only easy, as it seems spontaneously to come from a kindly and deferential spirit but it comes easily to him from a physical point of view, and the man would probably tell you he was hardly conscious of the effort. Leaving out of count the psychological aspect of the case, in which the thoughts inspired in the pleasant act of recognition obscured the more remote feelings and the physical exertion, yet there was nevertheless the physical side to the whole performance. Work, in the mathematical conception was present, even in the easily performed act.

As an undoubted proof of this let any one attempt to produce the motions involved in the greeting, by using an automaton or lay figure of life size There would be the raising and bending of the mechanical arm—the equivalent of the hand-grasp on the hat, and the upward movement of arm and hat with a slight bending or bowing of the head as the dummy simulated the graces and the bearing, of the courteous townsman. One would be surprised at the numbers of little wheels, pulleys, cords, springs, weights with many arrangements and contrivances necessary to reproduce the seemingly simple result. All these in some form would be necessary, for in the last analysis, work, which is pressure acting through distance, would have to be produced by the expenditure of energy in some appropriate form.

The unraveling of a so-called mystery very often consists of showing that there is no mystery in it. One of the studies of physical science about which the clouds, or at least the shadows, of mystery still cling, is electricity. It is called a mysterious force, and is relegated by the average man to the limbo of things we cannot know. There is no doubt that this air of so-called mystery is heightened by the terms employed by electricians, by which the names of prominent pioneers in electrical science are employed as indications of some particular unit. A Farad is the unit of capacity and is called after the illustrious Faraday.

One of the most notable achievements with which Faraday's name is connected is that of discovering induced electricity. In its essence it may be proved by a very simple experiment. On the table lies an ordinary permanent, horse-shoe magnet, and if a closed circuit of wire in the form of an oval or the letter O, be brought toward it, a current of electricity flowing in one direction is found to be briefly present in the wire. As the wire is withdrawn again, a reverse flow of this current may be noticed, in the wire. This is the principle of dynamo. The energy here transformed, with certain losses, analagous to friction, is the muscular force of the arm of the man holding and moving the wire. It is a simple transformation of energy from one kind to another. It is moving or kinetic energy transformed into electrical energy.

There is no mystery about it. It is quite like the energy of burning coal transformed into heat, and that may be further changed into the expansive force of steam and made to push the pistons of an engine. It may either cause the machine to progress along the track as a locomotive, or it may whirl the armature of a forty-foot rotary converter past the pole pieces of the electrical machine and cut the "lines of force" radiating from the poles. In any case it is simply a transformance of energy. The energy of the hand in the first place which permitted the flow in one direction on approach, and its reversal as the coil or circuit was withdrawn was the source of the energy turned into electric current. The energy of the coal abstracted in the firebox of a locomotive is the cause of its energetic movement along the track, but the locomotive could be moved by muscular power, if enough of it was applied. The springs, weights, cords and pulleys, applied to an automaton, use the power already put there or applied in order to imitate a polite greeting, but to do it, force must be found and utilized.

We do not know how it is that the cutting of these lines of force, emanating from a magnet, produce the flow of current, but we can readily comprehend that it is the motion of a material object against resistance that is the cause of the phenomenon.

Tyndall speaks of the apparent viscocity of the "electric field," which is made up of these lines of force. An experiment performed by him showed this very clearly. He suspended a shilling between the pole pieces of an electro-magnet, which could be energized and de-energized as occasion required. The shilling was suspended by a light wire or cord which had been twisted, so that under normal conditions the coin would rotate rapidly as the thread unwound itself and the violence of the recoil would twist the thread a certain number of turns in the opposite direction before it came to rest. When the electric current was let flow, the shilling turned slowly, and it was with apparent difficulty that the thread unwound. A strong current, entirely arrested the motion of the coin and held the thread motionless, under the strong tortional stress of the twisted strands.

Some condition in the atmosphere or space between the magnets, had manifestly been introduced by the flow of current between the magnets along the "lines of force," which had not been there previously. The cutting of these lines by the slow untwisting cord and partly arrested coin proves the existence of the new condition though it is invisible to the eye.

It is the forceable cutting of these lines of force which "induces" the flow of current to which we give that name. Energy in some form, be it the familiar muscular form or that of radiant heat, or steam pressure, or gravity or other force must of necessity be transformed into electrical energy and the knowledge of this fact reduces the amount of so-called mystery which is thought by many to surround the whole subject.

Inspection of Motors.

Last month we described a method for locating the brushes in the correct position. We also discussed the grounding and insulating of the frame of the machine, and we now close with some rules respecting the inspection and care of generators.

There are certain general rules to be followed in connection with electric generators, the first two being mentioned in the preceding article, namely: that all switches should be open when the machine is not running, and that the generator or motor should be clean and free from oil and dust, and should be blown out periodically by compressed air. In addition to these, the following should be included:

(1) Keep small pieces of iron, bolts and tools away from the frame. Small iron fragments will be attracted to the pole-pieces and may become jammed between the armature and the pole, causing serious damage. It must be remembered that the field poles are very strong magnets.

(2) Occasionally give the machine a thorough inspection, bearing in mind that the higher the voltage the oftener this should be done.

(3) See that the bearings are well supplied with oil and that the oil rings are

free to turn. Most electrical machines have self-oiling bearings. One of the best bearings is that using oil rings. A ring is carried round the shaft and is of such diameter that it extends some little distance below the under-side of the shaft and runs through a pool of oil. The shaft when rotating turns the rings and sufficient oil to give perfect lubrication is carried up on the rings on to the shaft. The well should be filled to such a height that the rings will just dip into the oil but not so high as to throw the oil out along the shaft. The bearings must be kept clean.

In many cases electrical generators are driven by belts. The belt on a belt-connecting machine should be tight enough to run slowly without slipping, but the tension should not be too great, or the bearings will heat. Belts should run with the inside lapping, not against it, and the joint of the belt should be dressed smooth so that there will be no jarring as it passes over the pulley. A wave motion, or flapping of the belt, is usually caused by slippage between the belt and the pulley. It may, however, be a warning of an excessive overload on the generator.

Static electricity many times accumulates on belting, especially in dry weather. At times, this static charge of electricity may be of sufficiently high potential to discharge to the ground. If the frame of the machine is not grounded, these charges may jump to the armature or field and thence to the ground, puncturing the insulation. Sometimes, it is necessary to place a number of sharp metal points, which are carefully grounded, close to the belt so that the static charge will jump from the belt to the points and so to the ground harmlessly.

The inspection, care and operation of electric generators has been taken up in detail as a great many of the conditions encountered apply to all types of electrical apparatus. The generator is practically the same as the motor, and is in fact constructed similarly.

At times an electric generator may not give off or develop its normal voltage. The failure of the machine to give full voltage may be due to several causes: (1) The speed of the generator may be below normal. We have noted from previous articles, that the voltage depends on the number of the lines of force which are cut electrically, by the conductors on the armatures, during a given time. If the speed of the generator is below normal, there will be fewer lines of force cut—hence a lower voltage. (2) The switchboard instruments may be incorrect and the voltage may be higher than that indicated, or the current may be greater than is shown by the ammeter. (All electrical instruments may get out of calibration, and it is wise to calibrate all meters occasionally.) (3) The series field in the case of a compound machine may be reversed or part of the shunt field may be reversed or short-circuited. The voltage depends, as we have seen, on the speed and the number of lines of force which are cut. If the series field is reversed, then the lines of force radiating from the field poles will be the difference between the lines of force which each of the fields (that is the series and the shunt) would give separately, rather than the sum. Therefore, at a given speed there would be a lesser number of lines of force cut, and hence there would be a lower voltage. (4) The brushes may be incorrectly set. As we have seen in the previous article, there is one correct position for the brushes. If they are not located in this position there is a certain effect produced on the armature, and the voltage will vary from the normal.

In the case of a self-excited generator, it may, when starting, fail to excite itself, although the generator may have worked perfectly during the preceding run. What may be the trouble? It will be gen-

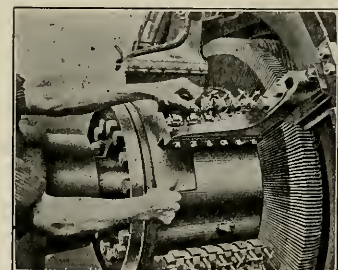


FIG. 1.

erally found that this trouble is caused by a loose connection; or a break in the field circuit, by poor contact at the brushes due to dirt on the commutator; or incorrect position of the brushes; or, perhaps, to a fault in the rheostat. The best procedure is as follows: Examine all connections; try a temporarily increased pressure on the brushes; look for a broken or burnt-out resistance coil in the rheostat. If no open circuit is found in the rheostat or in the field winding, the trouble is probably in the armature. If, however, it is found that nothing is wrong with the connections or the winding, it may be necessary to separately excite the field from another generator or some other outside source, in order to find the trouble.

The condition of the brushes on all types of machines is important for satisfactory operation. The ends of all the brushes should be fitted to the commutator so that they may make good contact over their entire bearing faces. The brushes carry the current into and out of the commutator, and the size of these brushes is determined by the size of the machine and the amount of current handled. In designing the machine, a certain density is figured on or assumed, which determines the cross-section area of the brushes. To give the best results, all of this cross-section area should bear on the commutator. The fitting of the brushes to the commutator can be most easily accomplished after the brush-holders have been adjusted and the brushes inserted. Lift a set of brushes sufficiently to permit a sheet of sandpaper to be inserated between them and the commutator (the sand of the paper being next to the brushes). Drawing the sandpaper in the direction of rotation of the commutator with the pressure on the brushes, the brush end is ground away until the surface of the brush is of the same contour as the commutator, and a good contact is secured. An illustration of brush grinding is shown by Fig. 1.

The brushes require frequent and close inspection to see that they are not sticking in the brush-holders; that the pig-tail shunts made of woven copper wire (one end of which is fastened to the brush and the other end to the holder, and which serves the purpose of taking the current directly from the brush to the holder so that it is not necessary for it to pass from the brush itself to the holder, where the brush is in contact with the holder). These pig-tail shunts should be properly attached to the brushes and to the holders; and the pressure on the brush is sufficient; that worn out brushes are replaced before they reach their limit of travel, and that any free copper which is picked up by the face of the brush is removed.

One of the most important parts of electrical machinery is the commutator. It is the part which is most sensitive to hard usage. Under normal conditions it requires few repairs and only demands little attention and inspection. The surface should always be kept smooth, and if by neglect or accident, is becomes badly roughened, the armature should be removed and the commutator turned down in an engine lathe. Sometimes, with large machines, it is more convenient to rig up a temporary device to do this work. In that case, the armature turns in its own bearings and the roughened part of the commutator (unless in very bad condition) may be smoothed down with a piece of sandpaper. After grinding and truing up with the sandstone or by other means, the surface is finished off with standpaper. Emery cloth should never be used for this purpose, because the emery becomes imbedded in the copper bars and brushes, and this causes excessive wear when the machine is put in operation. Emery when embedded in the copper tends to continue its abrasive action.

Diagrams Showing Time of Change in Slack Action on Trains

By WALTER V. TURNER, Assistant Manager, Westinghouse Air Brake Co.

Last month a diagram showing the time of change in slack action in trains of cars was reproduced, and the present ones are of a similar nature printed for comparison with the one in last month's issue.

In the one shown as Figure 4, a retardation of 2.7 per cent is effective, due in this case to a lower cylinder pressure, than was developed in the former diagram, also due to a velocity difference between the head end and rear and for the same serial time of 2.8 seconds and the same total amount of slack of 10 feet, is proportionately reduced to 1.6 miles per hour; that is, *the less the retardation used until the slack closes in, the less severe will be the shock*, the amount of slack and serial time remaining the same.

This lessened rate of retardation may be due to reduced cylinder pressures, reduced braking ratio, or reduced coefficient of brake shoe friction, due to higher train speeds, and the reduced cylinder pressure may be due to lengthened piston travel or to a light brake pipe reduction.

This explains why it is so necessary to make light brake pipe reductions in applying the brakes on long trains at low speeds and why it is necessary to have piston travel not too short but of the proper length. This in turn explains the necessity for having foundation brake rigging which will not permit a material increase in piston travel as the cylinder pressure is increased, because the slack adjuster, in making the travel proper at 8 inches for full cylinder pressure, throws back the piston position for the lighter cylinder pressures; that is, the cylinder pressures for light brake pipe reductions are far in excess of what they should be, due to the shortened piston travel. This variation or increase in piston travel between that for the five or ten pounds pressure necessary to bring the shoes against the wheels, and the full service pressure of 50 or 60 lbs., is known as "false" piston travel.

Figure 5, when compared with Figure 4, illustrates the effect of the time of serial brake action on shocks in trains. This time is here 4.4 seconds, as compared with 2.8 seconds in Figure 4. The retardation is the same in each case (2.7 per cent), and also the slack (10 feet), but the velocity difference is 2.6 miles per hour instead of 1.6; that is, *the severity of the running of slack is directly proportioned to time of serial brake action.* It is easily seen that in bringing the curves C and D of Figure 4 closer together, as compared with Figure 5, by reducing the time element, the velocity difference, and therefore, the shock intensity, is reduced.

Remembering that as cars are added to a train, the time of serial action is correspondingly lengthened, it is readily appreciated that brake apparatus entirely suitable for trains of short length (the standard of yesterday) cannot serve the more severe operating conditions and demands of the lengthened trains of today. Thus the reduction in serial time for 12 cars from the 4.4 seconds in Fig. 5 to the 2.8 seconds of Fig. 4 (resulting in a reduction of velocity difference from 2.6 to 1.6 miles per hour) is due to the introduction in the triple valve of the quick service feature whereby the brake pipe reduction is started at the brake valve and continued locally at each triple valve in a serial manner through the train, each triple valve venting a bit of brake pipe pressure to the brake cylinder and thereby starting the next triple valve into action more promptly.

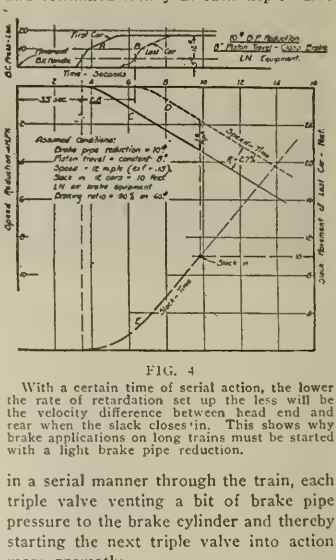


FIG. 4

With a certain time of serial action, the lower the rate of retardation set up the less will be the velocity difference between head end and rear when the slack closes in. This shows why brake applications on long trains must be started with a light brake pipe reduction.

In this problem of serial time the advantage of a suitably designed foundation brake gear which will insure a constant piston travel for all cylinder pressures now appears. With such a rigging a brake pipe reduction may be made in a sufficient amount (7 lbs. should be the minimum) to guarantee the release of all triple valves, without creating a brake cylinder pressure of more than 10 or 12 lbs. This results in a very slight retardation, and the slack closes in with very small velocity differences and, therefore, negligible shocks. The slack may not all be in by the time the second brake pipe reduction is started, but the triple valves are then in service lap position and the drop in pressure required to move the triple valve pistons alone, instead of the triple pistons and slide valves together, as when the first reduction was made, is comparatively slight. This means that the time of serial action is greatly reduced; and likewise the velocity differences by the time that the small amount of slack remaining closes in. The final result is the absence of any noticeable shocks.

Fig. 6 represents a combination of mixed conditions in a train. A comparatively small retardation is set up on the head end (2.7 per cent here) due in this case to proper piston travel and a correspondingly light cylinder pressure. Due to "false" piston travel, and consequent high cylinder pressure, the retardation on the rear end is great (a final value of 5.6 per cent). This same condition can, and does, occur when the cylinder pressures are uniform, but the braking ratio on the end is low and that on the rear is high, as in the case of load carrying mail, baggage, express, or refrigerator cars, and double heading locomotives on the head end of passenger trains, or as in the case of a freight train with loads ahead, empties behind, and lacking an empty and load brake equipment.

This figure shows that when the 10 feet of slack has run in, the velocity difference between the head end and rear is 2.6 miles per hour. The impact decreases the speed of the last car almost instantly to some point M, and raises the speed of the front portion of the train to this same point. From here the differences in retardation cause the first and last cars to slow down, as portrayed by curves G and H respectively. The 10 feet of slack then runs the other way, due to the fact that the brakes are acting so much more effectively at the rear end, and a jerk is experienced with a velocity difference of 2.8 miles per hour. With this condition a shock is had "going and coming".

If the amount of slack is great enough, or the time of serial action small enough to permit curves C and D to cross (which means that the two ends of the train are running at the same speed at that instant) as at some point n without the slack closing in, no buffing impact will be had and the slack will start to run the other way, as shown at s, because the rear end is running at speeds ever lower than the head end as time goes on. The jerk will be correspondingly worse, however, if the slack is increased, unless the train be stopped before the slack runs has time to run completely out.

Now multiply the situation pictured in Fig. 6 by a number of times corresponding to the relation it bears in train length (slack and time of serial action) to the modern freight train and wonder why it is that delays in transit, repairs to rolling stock, and loss and damage claims total the enormous figure that they do on American railroads today. Is it any wonder that the empty and load freight brake was developed to overcome that exceedingly bad condition of having loaded cars on the head end of a train braking at 15 per cent, and the empties at the rear with a braking ratio of 60 per cent? If the positions of the empties and loads be reversed there would be no jerk, but there would need be none, for the run in or buff would buckle the train practically every time the brakes were applied, due to both and mass and low braking ratio of the loads on the rear end. The rôle and purpose of the empty and load brake in making uniform the braking ratio, and likewise the retardation on the empty and loaded cars, can therefore be well appreciated by the resulting decrease in rough handling of trains and damage to lading and equipment.

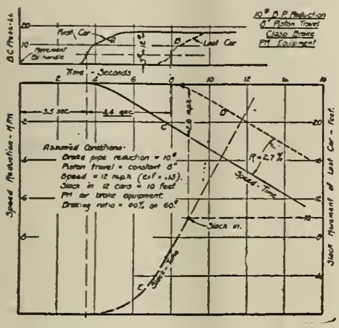


FIG. 5.
Compare with Fig. 4. Increased time of serial action due to type of air-brake equipment or to number of cars in the train means increased velocity difference between the head and rear ends of the train and shocks of corresponding intensity.

My endeavor is to point out the causes of unsatisfactory results in train control; such as improper or neglected adjustments, deficient maintenance, manner in which trains are made up, in some cases inadequate train control, and improper manipulation on the part of the operator. What I desire to impress most forcibly is, that these undesired results are not inherent in the operation of trains, as unfortunately seems to be the impression of some people—for adequate train control apparatus is obtainable, and realization of its full value requires only a comprehension and application of the principles underlying its service.

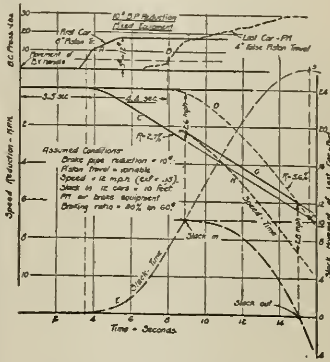


FIG. 6.
Lack of uniformity in retardation due to differences in cylinder pressure or in braking ratio may cause a surging of slack, first in one direction and then in the other. This shows why the Empty and Load Brake makes more certain the smooth handling of long trains. Uniform piston travel and tight cylinder leathers contribute to the elimination of surges or slack action.

Odd Old Names.

By J. Snowden Bell.

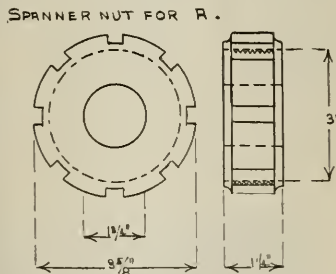
Permit me to call your attention to an error in your article on "Odd Old Names," appearing in your July issue, which consists in that statement that "Cushings modification of the Wootten dirt burner was popularly known as the 'mother hubbard' on account of the cab."

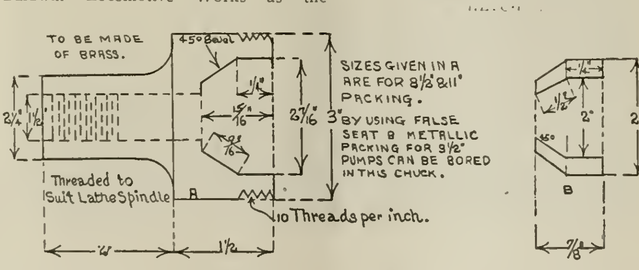
As a matter of fact, Mr. Cushing never made any modification of the Wootten engine, and the position of the cab on top of waist of boiler (which, by the way, is, in the opinion of the writer, the proper position, notwithstanding its recent abandonment and resultant lengthening of frames) was under the design of Mr. John E. Wootten long before Mr. Cushing came to the Philadelphia & Reading.

I must also differ from the statement that "The old locomotives with sloping fire boxes were always called 'Fan Tails.'" The first locomotives with sloping fire boxes were the "Camel" engines of Ross Winans, commencing about 1852, and the design of fire box was reproduced ten years or more later by James Milholland on the Reading road. His engines were known as "monitors" or "gun boats." The design was later adopted in the original class 1 engines of the Pennsylvania, which were probably never nick-named.

A few more "odd old names" are the Phineas Davis engines of the Baltimore & Ohio, known as "grasshoppers"; Ross Winans' modification of them, the "crabs"; his eight coupled engines, the "mud diggers," and Milholland's six coupled and leading wheel engines, the "Pawnees."

[Our esteemed correspondent has our thanks for his valuable historical data, but the matter of names or nick-names, none of them were of universal application. Their use was local and accidental. Even among the best authorities on names there are variations, as in the case of the type of locomotive 4-8-2. This is most generally known as the "Mountain" type, but it is classified by the Baldwin Locomotive Works as the "Sierra" type, and on the New York Central Lines this wheel arrangement is known as the "Mohawk" type locomotive.—Ed.]





Combination Chuck for Boring Metallic Air Pump Piston Rod Packing.

By J. H. Hahn, Bluefield, W. Va.

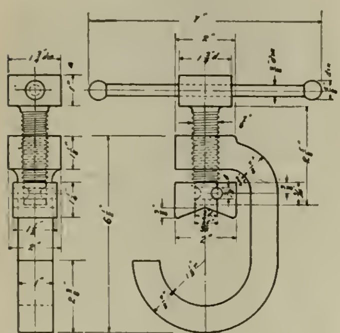
The accompanying sketches show a very useful and handy chuck for boring metallic air pump piston rod packing for the 9½-in., and 8½-in. cross compound air pumps. The details of sizes furnished in the sketch A are such as are adapted for the packing used in 11-in. and 8½-in. cross compound pumps, while the dimensions given in B shows a false seat that is readily applicable to A for boring the packing for the 9½-in. pumps. As shown in the sketch A is threaded to fit the lathe spindle. The appliance may be readily constructed of brass, and with reasonable care will render long service.

Air Brake Repair Work Tools Devised and Applied to Every Requirement

By GEORGE K. DORWART, Denver, Colo.

No. 14.—Air Piston Holder.

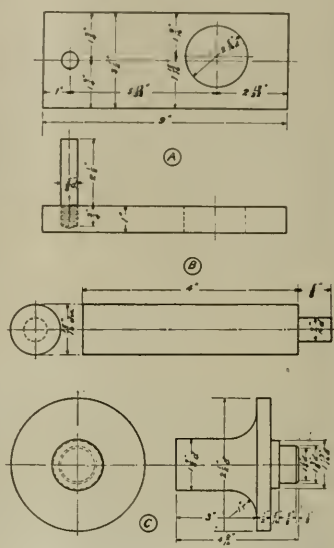
The annexed drawing, No. 14, shows the details of a screw clamp for holding an air piston when oiling a brake cylinder. It is simple in construction and easy of application, and effective in service, readily holding the piston in any position that may be desired. As is well known it is frequently desirable that the air cylinder should be lubricated in its entire length, and a device for holding the piston in any desired position becomes an essential requisite, and the clamp, as shown, has been found well adapted for the purpose. Mr. Dorwart desires to acknowledge the design of the clamp to F. W. Clark, Denver, Colo.



NO. 14. DETAILS OF AIR PISTON HOLDER

No. 15.—Tools for Pressing Out, and Pressing in Pc. No. 31,253.

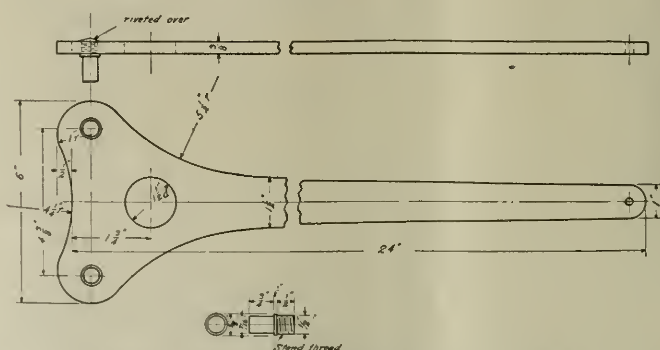
The accompanying drawing, No. 15, shows the details of appliances that may be readily used in pressing out and also in pressing in Pc. No. 31,253, for Westinghouse air brake 9½ ins. steam head. A illustrates a wrought iron plate for pressing in Pc. No. 31,253. B shows dimensions of a steel pin used in connection with the wrought iron plate in pressing in Pc. No. 31,253, and C shows the details of a wrought iron casehardened tool for pressing in Pc. No. 31,253. Tools of this design have proved very serviceable for the purpose intended.



NO. 15. DETAILS OF TOOLS FOR PRESSING OUT AND PRESSING IN PC. 31,253

No. 16.—Wrench for Removing Pc. No. 1,838, and No. 1,747 in Plain Triple Valves.

Drawing No. 16 shows the design and dimensions of a handy wrench for removing Pc. No. 2,838 and No. 1,747 in plain triple valves. The application of a tool of this design is not only efficacious in the use for which it is intended, but also prevents the possibility of any danger in damaging the parts of the valve when taken apart, as is frequently the case in the absence of proper tools.



NO. 16. DETAILS OF WRENCH FOR REMOVING PC., NO. 1,838, AND NO. 1,747 IN PLAIN TRIPLE VALVES

In closing the series of articles descriptive of air brake repair work tools devised and applied to every requirement, the Editor takes the opportunity of stating that they may be added to in the near future. The growing complexity of the details of the air brake are such that the need of new tools grows with the growth of the apparatus, and when the necessity arises leading experts meet the problem with a commendable ingenuity. The presentation in our pages of Mr. Derwart's clever devices has been warmly received by many of the leading air brake men, and we have had assurances that in point of adaptability of application and economy in service they are well suited for the purpose intended.

Piece Work.

By W. J. Paterson, Montreal, Canada.

The subject of piece work was very ably handled by E. W. Thomson, Pittsburgh, Pa., in last month's issue of Railway and Locomotive Engineering, but I think that he overlooked the fact that a well estimated system of piece work is a stimulus to the workmen, and in these days of full expected efficiency, a skilled workman is enabled to increase his earning capacity a good deal above the regular rate without injury to himself or a neglect of the standard of excellence of work expected, provided, of course, that he applies himself diligently to his task and is regularly supplied with work of the kind with which he is perfectly familiar. In this latter regard considerable justifiable complaint has been made, and no doubt will continue to be made, as a loss of money generally occurs where the supply of work has not been of a sufficiently uniform character, and it is not always just to blame those in authority as delays frequently occur in an unforeseen way in some other department. The cultivation of a kindly, social spirit in the different departments leads to uniformity in the handling of the various parts essential to the completion of the work in hand, and to an improvement in the matter of the arrangement of a well-working schedule of operations.

At the Angus shops of the Canadian Pacific a fine spirit of co-operation is maintained between the working mechanics and those who are in charge of the various departments, and every opportunity is given for a full and free consultation in regard to what may be possibly expected within the range of accomplishment, and if this spirit were more general there would be less complaints heard. Indeed, in the matter of general repairs of locomotives, there is such a close degree of similarity in the work to be done that there should be no difficulty in arranging a system that would guarantee an almost unbroken regularity in the time in which all the operations could be completed.

Detecting Cracks.

By J. R. Dow

In railway shops in France and in many shops in England they have a method of locating or detecting cracks in the crank axles that is well worth regarding. While undergoing general repairs, and regardless of whether or not the axles had made the mileage theoretically required of them, or whether they had been in service the length of time expected, all grease and oil is first carefully removed, then the parts most liable to failure are thoroughly washed with kerosene, then carefully dried with clean waste or rags, thoroughly removing every vestige of grease. Two pair of wheels are then placed on the same track at some distance apart and then rolled one pair against the other, allowing them to come in sharp contact at a speed of three or four mills an hour. The shock thus administered has the effect of showing immediately if there is the slightest crack from crystallization or other cause, and the crack, if any, is readily located by the presence of small particles of kerosene on the surface that had been secreted in the cracks. It is claimed that by this method a defective axle was never missed, and not only the axle, but crank pins or driving journals, and in some instances defects in new axles are found that could not have been discovered in any other manner.

Mr. R. W. Benson, Sales Manager, American Flexible Staybolt Company of New York, was recently taken down with an attack of apendicitis which came upon him without warning, but he was promptly taken to the hospital at Baltimore, in which city he was transacting some business at the time. On our going to press we are happy to be able to state that he is making a very satisfactory and rapid recovery.

Recent Additions to the Transit System of London, England

By ROBERT W. A. SALTER
Kew Gardens, London

A further addition to the facilities of London's transit system was effected recently by the completion and opening of the extended line of the London Electric Railway to Watford.

The motor cars at present temporarily employed are those originally constructed for the Ealing extension of the Central London Railway, but as this has been, for the time, postponed, the cars are being utilized until the termination of the war, when it is hoped that labor and materials will be more plentiful. The trailer cars are standard London Electric Railway stock. A point worth mentioning in this connection is that the Central London Railway employs an earth return, whilst the London Electric Railway uses an insulated return. This difficulty was successfully met in the following manner: The motor trucks have been equipped on either side with two additional sets of shoe-gear. On the trailer truck of the motor car clearance beneath the solebar of the body was not sufficient to fix positive shoes. These have, therefore, been arranged on the truck of the adjacent London Electric trailer, and connection made to the motor car by aid of jumpers.

INTERIOR OF CAB SHOWING MAIN SWITCH

Negative switches and fuses were provided to the main circuit, and each of the auxiliary circuits, but in doing this care had to be exercised to reproduce the standard arrangement of the London Electric Railway wiring in order that electrically the difference between the two types of stock should be confined to the control equipment.

The control system is of the automatic relay type furnished by the British-Thomson-Houston Company. The normal method of this system is immediately to place the controller at the "full on" position when starting a train. The current limit relay then picks up the contactors in their correct order of sequence. The current limit relay operates as soon as the motor current falls to a predetermined value.

The motor cars were constructed in England, and the following are their leading dimensions: Length over-all, 47 ft. 9 ins.; width over body, 8 ft. 9 ins.; total height from rail, 9 ft. 3½ ins.; center of bogies, 29 ft. 6 ins.; diameter of motor wheels, 36 ins.; wheel base of motor bogie, 6 ft. 8 ins.; diameter of trailing wheels, 29 ins.; wheel base of trailer bogie, 5 ft.

EXTERIOR VIEW OF MOTOR CAR, LONDON ELECTRIC RAILWAY

Each motor car is fitted with two General Electric 212 motors of 240 hp. geared for a free running speed of 35-40 m.p.h. Special safety devices are the "safety button" and the control circuit governor. The addition to the transit facilities are meeting with general satisfaction, and is a move in the right direction.

Items of Personal Interest

Mr. G. E. Norris, Jr., has been appointed general foreman of the Santa Fe shops at Cushing, Okla.

Mr. T. P. Maroney has been appointed general foreman of the Rock Island at Valley Junction, Ia., succeeding Mr H. F. Martyr, promoted.

Mr. F. T. Ruggles has been appointed roundhouse foreman of the Rock Island at Rock Island, Ill., succeeding Mr. T. P. Maroney, promoted.

Mr. Arthur Krohn has been appointed assistant superintendent of motive power of the Missouri, Kansas & Texas, with headquarters at Parsons, Kan.

Mr. L. A. Larsen has been appointed assistant comptroller of the American Locomotive Company, dating from July 1, with offices in New York.

Mr. A. E. Dales, formerly master mechanic of the Canadian Pacific at Edmonton, Alta., has been appointed division master mechanic at Calgary, Alta.

Mr. W. R. Meeder, formerly master mechanic of the Chicago & Eastern Illinois, has been appointed master mechanic of the Illinois Southern at Sparta, Ill.

Mr. A. H. Beirne has been appointed master mechanic of the western division of the Santa Fe, with office at Dodge City, Kans., succeeding Mr. Edward Norton.

Mr. M. F. Smith, formerly district master mechanic of the Chicago, Milwaukee & St. Paul at Dubuque, Iowa, has been transferred to Milwaukee, Wis., succeeding Mr. A. Young.

Mr. D. J. McCuaig, formerly acting master mechanic of the Grand Trunk at Toronto, has been appointed master mechanic of the Ontario Lines, with offices at Toronto.

Mr. A. N. Munster, formerly general storekeeper of the Boston & Maine, at Boston, Mass., has been appointed purchasing agent, succeeding Mr. B. S. Henckley, resigned.

Mr. H. R. Voelker, formerly general foreman of the Pennsylvania Lines at Bradford, Ohio, has been appointed general foreman on the same road, with office at Louisville, Ky.

Mr. I. I. Hanlin, formerly master mechanic of the Seaboard Air Line at Howells, Ga., has been appointed assistant superintendent of motive power on the same road, with office at Portsmouth, Va.

Mr. W. J. Hiner, formerly assistant purchasing agent of the Cleveland, Cincinnati, Chicago & St. Louis, has been appointed purchasing agent at Cincinnati, Ohio, succeeding Mr. George Tezzer, retired.

Mr. P. S. Walter has been appointed general car inspector of the Pennsylvania Lines west of Pittsburgh, Southwest System, with office at Columbus, Ohio, succeeding Mr. Charles Thiele, promoted.

Mr. John McRae, formerly locomotive foreman of the Canadian Pacific at North Bend, B. C., has been appointed locomotive foreman at Swift Current, Sask., succeeding Mr. S. Hayward, transferred.

Mr. George Thompson, formerly superintendent of motive power of the Denver & Salt Lake, has resigned to accept service with the Oxweld Railroad Service Company, with office at Chicago, Ill.

Mr. W. H. Wortman, formerly division master mechanic of the Canadian Pacific at Calgary, Alta., has been appointed division master mechanic and trainmaster at Cranbrook, B. C., succeeding Mr. G. Moth.

Mr. E. B. Hall, formerly assistant to the general superintendent of motive power of the Chicago & North Western, has been appointed acting assistant superintendent on the same road, with office at Milwaukee, Wis.

Mr. F. Williams has been appointed superintendent and master mechanic of the Gulf, Florida & Alabama, with office at Pensacola, Fla., succeeding Mr. J. P. Lynahan, superintendent, and Mr. B. C. Doton, master mechanic.

Mr. Frank Rusch, formerly general master mechanic of the Chicago, Milwaukee & St. Paul at Tacoma, Wash., has been appointed superintendent of motive power of the Puget Sound Lines, with office at Tacoma, Wash.

Mr. B. B. Milner, engineer of motive power of the New York Central, at New York, will, in addition to the duties heretofore performed by him, assume the duties of chief mechanical engineer, succeeding Mr. R. B. Kendig, recently deceased.

Mr. Charles A. Nelson, formerly in the employ of the Delaware & Hudson Company, has been appointed junior railway mechanical engineer in the division of valuation of the Interstate Commerce Commission, Eastern district, with office at Washington, D. C.

Mr. G. H. Bussing, formerly superintendent of motive power of the Mexico Northwestern, has been promoted to general superintendent in charge of the transportation, maintenance of way and mechanical departments, with office at Ciudad Juarez, Chihuahua, Mexico.

Mr. Edmund T. Perkins, president of the E. T. Perkins Engineering Company, Chicago, has been elected president of the American Association of Engineers, Mr. W. H. Finley, chief engineer of the Chicago & North Western, first vice-president, and P. P. Stewart, chairman of directors.

Mr. E. P. Poole, formerly supervisor of tool equipment and piece work of the Baltimore & Ohio at Baltimore, Md., has been promoted to assistant superintendent of the Mt. Clare shops, Baltimore, Md., and Mr. I. S. Temple has been appointed to succeed Mr. Poole as supervisor of tool equipment and piece work at the Mt. Clare shops.

Mr. H. G. Flanders, formerly roundhouse foreman of the Santa Fe at Clovis, N. M., has been promoted to the position of general foreman of shops at that point, succeeding Mr. H. M. Muchmore, transferred to Slaton, Tex., as division foreman. Mr. R. B. Hall has been appointed roundhouse foreman at Clovis and Mr. H. C. Moore has been appointed assistant roundhouse foreman also at Clovis.

Mr. Samuel L. Nicholson, who has been sales manager of the Westinghouse Electric & Manufacturing Company since 1909, has been promoted to the position of assistant to vice-president, with headquarters at East Pittsburgh. Mr. Nicholson has had a wide experience in electric engineering, both in construction and sales departments. In 1898 he became sales representative of the company to which he is still attached, and gained many friends in New York. As manager of the industrial department a high degree of efficiency was established, and which position he successfully filled until his selection as sales manager of the company in 1909.

Mr. George W. Wilden, formerly mechanical superintendent of the New York, New Haven & Hartford, has been appointed general mechanical superintendent, having general supervision of the mechanical department on standards and practices, with direct charge of the three large shops on the system and power houses. In the new organization, which came into effect last month, among other changes in the mechanical department we note that Mr. A. L. Ralston has been appointed engineer of electric traction, Mr. C. J. Stewart, mechanical superintendent of Lines West; Mr. Geo. A. Moriarty, mechanical superintendent of Lines East. The title of Mr. H. Gilliam, electrical superintendent, is changed to superintendent of electric transmission. Mr. G. O. Hammond is appointed assistant general mechanical superintendent, with headquarters at New Haven, among the master mechanics.

Railway Curves.

In a lecture before the Liverpool Engineering Society recently, Professor S. W. Perrott discussed the problems which arise on railways from the application of transition curves between circular curves and straights and between circular curves of different radii, and considered methods of setting out such curves and of improving existing curves.

He pointed out that sudden change from motion in a straight to that in a circular path is objectionable from the points of view of safety, of resistance to hauling, and of comfort of passengers in trains. The amount of this irregularity of motion depends on a number of things, but chiefly on the speed and the sharpness of the curve. The superelevation of the outer rail on the curve, which is needed at its full height for the length of the curve, renders it necessary to begin canting the rails some distance back along the straight, called the "run off," in order that it may attain its full amount at the tangent point. The motion due to this canting of the outer rail on the straight is not satisfactory. Each coach becomes tilted up on the side of the outer rail and the springs become depressed over the inner rail. But immediately the tangent point is passed the centrifugal force causes the body of the coach to be thrown over to the other side, thus making much greater oscillations possible than those which could have occurred without any tilting up on the run off.

To obviate this sudden centrifugal effect and also the difficulties due to the run off transition curves have been introduced. A true transition curve should determine, by slowly increasing its curvature, that the centrifugal force is applied gradually, so preventing any sudden oscillation, and that the full superelevation is gained gradually throughout its length. The feeling that circular curves of large radius provide sufficiently good running to render transition curves unnecessary is one which should be dissipated. As long as large easy curves are used only for moderately high speeds the need for a transition curve is not great; but the tendency on some of our principal railways to insert only curves of large radius without transition curves on their main lines is a mistake, as the approach to any of these curves by trains at high speeds is necessarily accompanied by irregularities of motion which would not occur had it been made on a transition curve. The difficulty of introducing a spiral in these cases of curves of wide radius is not great, as the "shift" at the worst is only a few inches. Indeed, speaking broadly, it might be said that it is only on curves of large radius that there is any great need for a transition approach, as these curves are generally associated with high speeds, whereas the sharper curves are excluded from lines intended for fast traffic.

Railroad Equipment Notes.

Morris & Co. has ordered 20 tank cars from the American Car & Foundry Company.

The Grand Trunk has ordered 1,000 box cars from the American Car & Foundry Company.

El Paso & Southwestern has ordered 250 gondola cars from the Standard Steel Car Company.

The Canadian Government Railways have ordered 1,000 box cars from the National Steel Car Company.

Swift & Co., Chicago, has ordered 25 8,000-gallon tank cars from the Standard Car Construction Company.

Kansas City Southern has ordered 7 Mallet type locomotives from the American Locomotive Company.

The Erie has given an order to the American Car & Foundry Company to repair 250 gondola and 250 box cars.

Philippine Vegetable Oil Company has ordered 1000 8,000-gallon tank cars from the American Car & Foundry Company.

The Louisville Gas & Coal Company, through H. M. Byllesby, has ordered 25 hopper cars from the Pullman Company.

Terminal Railroad Association of St. Louis has ordered 10 six-wheel (0-6-0) locomotives from the American Locomotive Company.

Chicago Indianapolis & Louisville has ordered two 142-ton Mikado (2-8-2) type locomotives from the American Locomotive company.

The Temiskaming & Northern Ontario has recently ordered 100 40-ton steel frame box cars from the Canadian Car & Foundry Company.

The South Buffalo Railway has ordered 300 steel hopper cars for the Lackawanna Steel Company from the American Car & Foundry Company.

The Chicago Short Line, serving industries in the Calumet district of Chicago, has purchased land upon which a roundhouse and coal pocket will be erected.

The Pennsylvania Lines West of Pittsburgh contemplate an expenditure of about $1,000,000 for enlarging shops at Columbus, Ohio, and installing new equipment.

The Seaboard Air Line has awarded the general contract for a one-story shop building at Portsmouth, Va., 100 by 249 feet, to W. E. Morgan, Savannah, Ga. The estimated cost is $50,000.

The New York Central has ordered from the General Railway Signal Company a mechanical interlocking machine, 60 levers, to take the place of one recently destroyed by a wreck at Dunkirk, N. Y.

The Cleveland, Cincinnati, Chicago & St. Louis is to install at Indianapolis an electric interiocking machine having 48 working levers and eight spare spaces, bought of the General Railway Signal Company.

The United States Government has placed orders for 300 80-ton Consolidation locomotives for service in France, 150 with the American Locomotive Company and 150 with the Baldwin Locomotive Works.

The Philadelphia & Reading has awarded contracts covering the rebuilding of the following bridges: No. 3, north of Conshohocken; No. 17, south of Flourtown, and No. 19, south of Oreland, all on the Plymouth branch.

The Russian government contracts for 500 Decapod locomotives divided equally between the American Locomotive and the Baldwin Locomotive Works, which were held up because of the financing, have now been definitely signed.

The Pittsburgh & Lake Erie has ordered from the Union Switch & Signal Company the materials for the installation of a. c. automatic block signals on the New Castle division. There will be 18 style "T-2," top post signals, 110 volt, 60 cycle.

Orders for about 2,000 tons of steel for various bridges and buildings for the Pennsylvania Railroad have been distributed by L. F. Shoemaker & Co., Fort Pitt Bridge Works, Bethlehem Steel Bridge Corporation, and Phoenix Bridge Company.

The British War Office, which ordered 50 Consolidation and 75 Prairie locomotives from the Baldwin Locomotive Works, has just given that company an additional order for 100 more Consolidation locomotives, at a price, it is said, of $45,000 each.

The Atchison, Topeka & Santa Fe has placed an order with the Baldwin Locomotive Works for 100 locomotives for delivery in 1918. The order includes 70 Mikado (2-8-2) type engines for freight service and 30 for passenger service of a type not yet determined.

Signal Lights on the P. R. R.

The new color scheme of signal indications, by which white lights are now eliminated, was placed in effect, on all lines of the Pennsylvania Railroad East of Pittsburgh, by the end of June. Nearly a year of preparatory work had been required to make the change possible. Some difficulty was experienced in obtaining deliveries of materials, owing to existing war conditions.

The decision to eliminate white from the signal color scheme was reached on account of the increasing use of white lights of various kinds in buildings, driveways, roads and streets close by, or adjacent to, the railroad's right-of-way. Under the new plan, green replaces white for "clear" or "proceed." "Caution" is indicated by yellow and red has the same meaning as heretofore.

In addition to changing the glasses in all the semaphore signals, the following devices have been altered to conform to the new plan of color indication, marker lights on the rear of passenger and freight trains; switch lamps and targets; markers for track tanks; "slow" signs; "resume speed" signs; and hand lamps at interlocking and block signal stations.

No changes have been made in those short portions of the line operated by electric power which are protected by "position light" signals, the longest line of which is the electrified section from Philadelphia to Paoli, Pa. On these electrically operated lines, the signals are composed of electric lights.

Helping Employes to Greater Efficiency.

Above is the title of a neat pamphlet issued by the International Correspondence Schools of Scranton, Pa. After reading and studying the pamphlet we have come to the conclusion that the publication ought to be in the hands of every person with the least ambition to get along in the world who is engaged in an industrial occupation. Every employer of labor is annoyed with individuals who are constantly complaining that they do not receive fair play because others who entered the service after them have progressed more rapidly. There may be exceptions, but it is safe to say that the men who lag behind their fellows never receive the treatment their conduct deserves. To those who believe they are falling behind through no fault of their own we urgently commend a careful study of "Helping Employees to Greater Efficiency," which can be obtained from the International Correspondence Schools of Scranton, Pa., for the asking.

Some men are always looking for a new brand of mistakes to make. Do not imitate them.

The Piston.

Every person familiar with the operation of steam engines knows that the piston is the heart of the engine. An injury befalling the piston, which might not be serious to some other part, renders the whole engine useless. The engine may be of first class design, and may embody the least possible metal most judiciously distributed; the valve gear may be perfect in operation, and possessed of the most enduring qualities, but if the piston is not perfect in its operation as a piston, the usefulness of the whole engine is proportionately impaired.

The office of the piston is to furnish a steam-tight barrier that shall move with the least possible amount of friction. If the cylinder and piston could be made perfectly round and true, the piston could be fitted just loose enough to move freely, and no packing whatever would be required. The only friction in such an arrangement would be that due to the weight of the piston and rod in a horizontal engine, and no friction at all would be perceptible in a vertical cylinder. But first the defects in practice, and second the wear of the metal in use, render packing necessary; hence a piston consists of two principal members; the piston body and the packing. The friction of the packing depends upon the pressure exerted against the rings to produce a steam-tight joint against the cylinder walls, and is independent of the amount of wearing surface presented to the rings.

Of all the details pertaining to steam engines, there is none in which simplicity, durability and certainty are so much demanded as in the piston; and it may be settled as a fact that the simplest form of piston will prove the most efficient.

Music in the Air Brake.

James C. Darby, a Chicago motorman on the Wilson avenue express, has created a sensation by playing tunes on the air brake. He discovered that the harsh sound of an air brake could be converted into a concord of sweet sounds by the application of the index finger over the exhaust. The harder he pushes the shriller the notes become, and by an artistic manipulation a warbled melody appropriate to the surroundings comes to the delighted passengers. He expects with a little more practice to reach the high notes in "The Star-Spangled Banner," and so aid recruiting.

Rolling Stock of Spanish Railroads.

According to statistics recently made public, the railroads of Spain possessed at the beginning of 1916 the following rolling stock: 2,683 locomotives, with a capacity of 1,634,520 horsepower; 6,390 passenger cars to accommodate 270,722 persons; and 59,454 freight and cattle cars, with a capacity of 593,540 tons.

Books, Bulletins, Catalogues, Etc.

Locomotive Valves and Valve Gears. By Jacob H. Yoder, M. E., Supervisor of Apprentices, Pa. R. R. Co., Altoona, Pa., and George B. Wharen, M. E., Instructor Mechanical Engineering, University of Pennsylvania. Published by D. Van Nostrand Company, New York. 272 pages with 275 illustrations. Price three dollars.

Of all the books published on the subject of locomotive valve gears this is the most complete. Coming as it does fresh from the hands of two engineering experts engaged in the instruction of young railway men, with full facilities for the use of a mass of data on the subject, it is not surprising that there is a degree of fulness in the work hitherto unapproached. While the matter and style is primarily adapted for the use of the practical shop man, there is much information that is of benefit to the draftsman and designing engineer. The arrangement of the work is excellent. It is divided into seven chapters embracing "Locomotive Valves and Valve Gears"; "The Stephenson Valve Gear"; "The Walschaerts Valve Gear"; "The Baker, Southern, Joy, Young, Gooch and Allen Valve Gears"; "Effects of Altering the Valve and Its Events"; "Locomotive Valve Setting"; "The Steam Engine Indicator." A perfectly arranged index completes the work. In these days of aiming towards a higher degree of efficiency the book should meet with much popular favor, as it is one of the most important contributions to the locomotive engineering literature of our time, and reflects great credit on the accomplished authors and the enterprising publishers. The paper, letter-press, illustrations and binding are all in the best class and style of the bookmaker's art.

Oxy-Acetylene Welding Practice. By Robert J. Kehl, M.E. Published by the American Technical Society, Chicago. 102 pages, with illustrations. Price One Dollar.

This book is a valuable contribution to the literature of oxy-acetylene welding by an experienced engineer who has devoted much of his time to the subject of welding. The illustrations are of particular interest as furnishing complete details from the simplest operations to the more intricate details of complicated work, so that the work is not only adapted for the use of engineers, but will be found to be useful to those who are more advanced in the welder's art. The style is clear and engaging, and the book as a whole admirably meets the requirements of the purpose for which it is intended. The book will be found to be in every way an up-to-date work on the subject of which it treats, and is well worth careful study.

Headlights and Turbo-Generators for Steam Locomotives.

Bulletin No. 42,014, entitled "Headlights for Tubo-Generators of Steam Locomotives," has just been prepared for distribution by the General Electric Company. A new turbo-generator set has been designed to meet the rigid requirements of locomotive headlight service, and represents the most advanced development along practical lines. Three years have been spent in perfecting and testing the appliance, which consists of an 18-inch, silver plated, copper reflector, equipped with a simple focusing device mounted on a suitable table and enclosed in a steel casing of standard design. The reflector has a 2¼-inch focal length, which is sufficiently long for accurate focusing of the largest headlight lamps. All of the necessary accessories are furnished in accordance with the requirements of existing headlight practice, and the 12-page bulletin, copies of which may be had on application, furnishes diagrams showing the assembly of the complete apparatus.

The Embrittling Action of Sodium Hydroxide on Soft Steel.

Bulletin No. 94, issued by the Engineering Experiment Station of the University of Illinois, contains the record of investigations by S. W. Parr on the above subject and extends to 56 pages with numerous drawings and photograph reproductions. While it is commonly believed that the alkali works into the metal eating out what is technically known as the amorphous inter-crystalline cement which, being thermodynamically less stable than the crystals, would be first attacked. This is presumed to cause a brittleness akin to that caused by burning or overheating and fracture would be intercrystalline. Some claim that the action of sodium hydroxide causes a crystallization by which a coalescence of the smaller crystals with larger crystals is effected. This effect would also be the same as that caused by overheating. It would be impossible in our brief space to present even a summary of Mr. Parr's extensive experiments and intricate deductions. Copies of the bulletin may be had from the university. Price, 30 cents.

The Stroh Steel-Hardening Process.

A finely illustrated catalogue printed in toned paper has been issued by the Stroh Steel-Hardening Process Company, Pittsburgh, Pa., showing the history of the process whereby the casting of the finest alloy steel together with ordinary soft steel in one solid piece has revolutionized many parts of modern machinery particularly in years that are subject to sudden fluctuations. Since the introduction of the Stroh process the parts wear more than ten times as long as previously made parts did, and are still serviceable. The gears constructed by the Stroh alloy process are composed of soft steel in those parts where machining is to be done and of "wear proof" Stroh alloy in the wearing parts. There are no inserts or bushings to come loose. But as already stated, the two kinds of steel form one solid casting, combining the double qualities of resistance to wear on the outer surface of the teeth with soft steel of low cost, ease of machining, and give toughness and resistance to fracture under shock. Applications for copies of this interesting catalogue may be made to the company's office at Pittsburg, Pa.

Electric Thermostatic Control of Steam Heating.

The Gold Car Heating & Lighting Company, 17 Battery Place, New York, has issued an illustrated 16-page Bulletin, giving full details of the company's electric thermostatic control of steam heating for all passenger train cars. The system has been in successful operation on many of the leading railroads, and has been perfected by recent improvements in details. The apparatus automatically maintains an equitable temperature in every car throughout the train, and needs no manual control, reducing the consumption of steam, and lessening the number and weight of parts. It is adapated either for steam or vapor systems, and consists of a thermostat usually placed on the wall at the middle of the car, and one or more electro-magnetic inlet valves placed on the cross over pipes underneath the seats to the number of circuits to be controlled. The lowering of the temperature from whatever cause will affect the thermostat so that the valve is opened and the warming of the car to a predetermined point will operate to close the valve. The illustrations are particularly interesting as showing the mechanical details of the appliance. Copies of the descriptive Bulletin may be had on application.

Gas and Gasoline Driven Air Compressors.

Bulletin 34-Y issued by the Chicago Pneumatic Tool Company, is a finely illustrated publication of 24 pages giving full descriptions of two of the company's best known compressors. These are the gas and gasoline driven machines, designated as class N-SG, and class N-SGL, respectively, many hundreds of which are in service all over the world. They are especially designed to meet the requirements of shops and all construction projects where ease of management, dependability, and economy of operation are desired. An attractive feature is the low first cost which is made possible by the increasing quantity of production. A fine feature is the use of what is known as the Simplate valves, which have been perfected by long experiment and furnish positive frictionless grinding, and require no lubrication. For complete details send for a copy of the bulletin to the company's main office, Chicago, Ill.

Employment of Women and Juveniles.

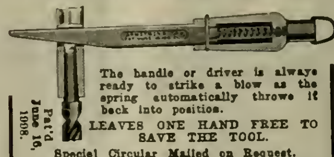
Bulletin No. 223 issued by the Bureau of Labor Statistics of the United States Department of Labor relates the extent to which women and juveniles have replaced men in industry in Great Britain during the war. Nearly one million women have been drawn into the various governmental, industrial and commercial activities directly replacing men, the greater number of them performing operations never before considered possible for them to do. The system of through shifts of eight hours each appears to yield better results than one shift of thirteen to fourteen hours or two shifts of twelve hours. Great stress is laid on the need of recreation for children employed of which there are in Great Britain over half a million, with the probability that it is now greater. The Bulletin is well worth the perusal of all engaged in labor problems at the present time.

Staybolts.

The Flannery Bolt Company's bi-monthly Digest issued last month contains a specially interesting article on boiler shop practice with illustrations of several special devices that have been developed by boiler experts in some of the leading railroad shops, and are of valuable service in the installation of the Tate Flexible Staybolt. The use of the flexible staybolts on foreign equipment is reported as making it difficult for the company to keep pace with the growing demand, and orders should be sent in at least three months ahead to enable the company to meet the expectations of customers. It is gratifying to observe from a report of prices that increase is not so large as might be expected under the present abnormal conditions. Copies of the Digest may be had in applying to the Pittsburgh office of the company.

Pistons, Valves and Bushings.

The severe climatic changes experienced in different parts of North America from Canada to the Gulf has its effect on the working parts of the locomotive when running on the road, which experience has taught the railroad man to guard against, and while it has been largely overcome by the marked improvements of recent years, and the close comparison of results, it should never be for a moment forgotten that bearings are all more apt to become heated in midsummer than in midwinter, and, of course, it involves a closer watch on the important matter of a thorough and systematic lubrication.



WANTED—Position of chief clerk to sup't motive power and machinery or master mechanic by young man with 16 years' experience, now employed in like position on western trunk line; 16 years in present position; familiar with Federal boiler inspection, M. C. B. rules and have had general railroad experience; Protestant; married, 45 years old, good accountant. Address "Boggs," care Railway Locomotive Engineering, New York.

Railway and Locomotive Engineering

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Nice and the Riviera on the P. L. & M. Ry.

The Riviera, meaning the shore, is usually taken to refer to the Mediterranean coast of France. One of the most beautiful cities on this coast is the famous city of Nice, with its numerous and interesting environs. Our frontispiece this month is a view taken in the neighborhood of Nice. It is that of a viaduct over the Wolf river or as it is in French the Loup, a little river that falls from the lofty mountain side, and passes under the bridge which is 56 meters high or about 160 feet in our measure.

SCENE NEAR NICE ON THE PARIS, LYONS AND MEDITERRANEAN RAILWAY ON THE RIVIERA IN FRANCE.

Nearby is Gattières, with clusters of houses on rising-ground; Saint-Jeannet, at the foot of a gigantic rock called "Baou" in the local dialect; La Gaude, a village renowned for its wines and

Vence, a winter and summer resort, recommended for people whom the sea-side does not suit. There is also Saint-Paul-du-Var, a small, quaint old town still surrounded by ramparts, and Tourrettes-sur-Loup, a fortified village perched above precipices, with scenery suggestive of Africa, amidst beds of molasse that look like molten lava; the Loup, the little river that comes foaming through weird glens to pass under the viaduct, may be seen, with the village of Gourdon standing far above it, like an eagle's nest, at an altitude of 800 meters, and Le Bar, with ruins of a feudal castle.

Among the many sights in the new town are the Casino and the Place Masséna, where all the trams start; gardens lying between the Place and the sea containing the Fountain of the Tritons, a monument offered by Nice to France, the Quai du Midi, connected with the port by the Quai Rauba-Capeu; Promenade-Jetty; the famous Promenade des Anglais, which, after following the windings of the Baie des Anges, is continued to the Race-Course; Avenue de la Gare, the busiest thoroughfare, and the most commercial; Boulevard Victor-Hugo and Boulevard Dubouchage; Avenue Masséna, Avenue Félix-Faure; Square Masséna, with a statue of Marshal Masséna by Carrier-Belleuse also a statue of Gambetta.—In the old town is the Place Garibaldi, with a statue of the celebrated general; the Church of Saint-Augustin; Lascaris Palace, Cathedral of Sainte-Réparate, in the Italian style, the Palace of Justice and the Chapelle de la Miséricorde.

Nice is a famous winter resort and the Fêtes du Carnival, held just before Lent; and the Springtime Carnival. Nice is reached by the Paris, Lyons and Mediterranean Railway, commonly spoken of as the P. L. M. Nice is the point of departure not only for the splendid trains of this Line but for automobile tourists for the route through the Alps.

"Spellerizing" as Applied to Pipe

Details of the Process—Its Significance and Utility

The form and chemical composition of matter are well known to have distinct properties. Carbon in the form of coke and the same material in the form of a diamond are very different. The diamond, due to the tremendous pressure to which it has been subjected, is practically pure carbon, bearing no outward resemblance to carbon in the form of coke, coal or charcoal. Metals undergo changes almost as remarkable as this if subjected while hot to certain heat treatment and mechanical manipulations.

Commercially pure iron is produced in several forms: puddled iron, knobbled charcoal iron, ingot iron and soft welding steel have much the same chemical composition as commercial products but may differ considerably in physical properties and durability according to the treatment given in process of manufacture. Uniformity, both as to chemical composition, density and character of structure, and finish have been proved to be the most important factors governing corrosion in pipe. The actual chemical composition of the iron or steel is of comparatively little importance, provided it is not unduly variable in the same piece.

In so far as pipe is concerned, the greatest danger from corrosion occurs in the smaller sizes, owing to their thin walls. The larger sizes, with thick walls, are made from heavy plates of such uniform quality that corrosion does not seriously affect them.

To overcome the tendency to corrosion in the smaller sizes a process has been evolved, known as "Spellerizing." This is technically defined as follows: "Spellerizing is a process of treating metal which consists in subjecting the heated bloom to the action of rolls having regularly shaped projections on their working surfaces, then subjecting the bloom while hot to the action of smooth faced rolls and repeating the operation, whereby the surface of the metal is worked so as to produce a uniformly dense texture better adapted to resist corrosion." Spellerizing works the surface metal to the interior, and interior metal to the surface.

Inasmuch as this process is entirely mechanical and does not depend upon skilled labor beyond attending to the machinery involved, uniform treatment is assured. The Spellerizing process is applicable to the smaller sizes of pipe, say, 4 ins. and under, although it is possible in special cases to Spellerize pipe of a few sizes larger.

As a matter of fact, the process of Spellerizing metal may be considered analogous to the kneading of dough from which bread is made. Dough is kneaded to produce a smooth, uniform texture; to facilitate the escape of confined gases, which would form air holes and other irregularities, and to make an even grain and a smooth surface. Much the same results are obtained by Spellerizing steel. In a general way, this illustrates the principle on which the Spellerizing process is based: that is, the aim is to make the metal uniform, so that corrosion will be uniform, and not in the form of pitting, for pitting in pipe represents the presence of weak spots.

WROUGHT IRON PIPE AFTER IMMERSION IN RUNNING MINE WATER. COMPARATIVE LOSS BY CORROSION SPELLERIZED STEEL PIPE, 73 PER CENT; WROUGHT IRON, 100 PER CENT.

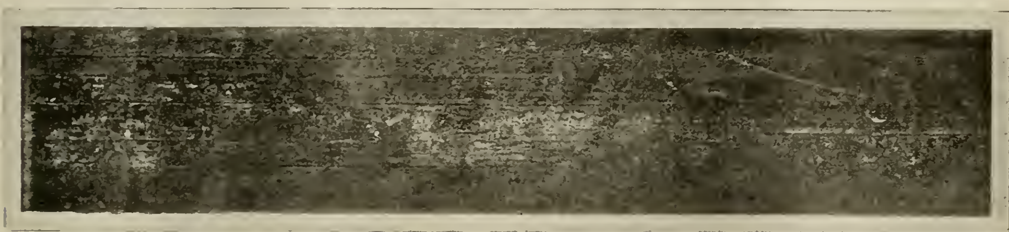
There are several factors such as contact with other materials which are electro-negative to iron, such as carbon or oxide of iron, or electrolysis which is due to stray currents which will cause local failures no matter how carefully the steel is made. Pipe has been made by this process for ten years in increasing amounts, and it is significant to note that official records of the American Iron and Steel Institute show that during this period steel tubes and pipe have increased from 74.3 per cent. of the total production in 1906 to 87.9 per cent. in 1916.

Mr. H. J. Macintire, Professor of Mechanical Engineering, Washington University, in an article relative to corrosion about the power plant, says: "In the case of ordinary steel pipe mill scale is always present, and this likewise is electro-negative to the iron. If this scale is evenly distributed, as in Spellerized steel, the self-corrosion on its account will be slight; but if it is segregated, then local electrolysis and pitting of the material will result."

An authoritative technical paper says on the subject: "The consensus of opinion is that modern steel pipe, particularly if Spellerized, is as durable as wrought iron, and is, besides, cheaper, stronger and more ductile and more uniform in composition." Prof. H. M. Howe believes that pipe steel made in 1906 by this roll-knobbling process tested against pipe steel made in 1897 resulted not only in a somewhat greater loss of weight by corrosion of the latter, but a decidedly deeper pitting of the 1897 steel in six months than occurred in the 1906 steel in thirteen months. In comparison with wrought iron it was found that the two materials lost practically the same weight by corrosion, yet the steel had the advantage of uniform corrosion since the "wrought iron skelp pitted in seven months much deeper than the steel did in thirteen months."

New Spellerized steel pipe and new wrought iron pipe were considered the two best forms by the master mechanic of a large Western Pennsylvania coal mine. They were submerged in running mine water side by side, but insulated from each other. The uniform corrosion of specially worked pipe steel, as compared with irregular corrosion and pitting of wrought iron pipe, resulted in the wrought iron pipe showing corrosion at 100 per cent., as against 73 per cent. for the Spellerized pipe.

There is very little, if any, difference between the corrosion of the wrought iron pipe and the corrosion of the steel pipe. If anything, the wrought iron is pitted a little deeper; that is, the pitting of the steel pipe is probably more general all over the surface, but the pitting of the wrought iron pipe is deeper in spots that are affected. While the corrosion was about the same, there was a pitting in the iron that was not found in the steel, and the steel was corroded more uniformly. From the tests made, the steel pipe appears to be better for such conditions.



SPELLERIZED MILD STEEL PIPE IMMERSED IN RUNNING MINE WATER. COMPARATIVE LOSS BY CORROSION: WROUGHT IRON, 100 PER CENT.; SPELLERIZED STEEL, 73 PER CENT.

Why Hot Water Pipes Freeze More Quickly Than Cold.

It is a constant observation that during a sudden cold snap hot water pipes burst, while the cold water usually freezes up tight without rupture of the pipes carrying it. A French experimenter has recently looked into the cause of this. He finds that the hot water invariably falls to several degrees below zero Centrigrade before beginning to solidify, and that the ice then formed is perfectly solid and transparent. Ordinary cold water, on the other hand, begins to congeal as soon as the "freezing point" is reached; that ice is filled with air bubbles, and presents a soft and mushy appearance.

The explanation is that the air and other impurities in ordinary water furnish nuclei of crystalization. Ice formation thus begins sooner and proceeds more slowly than if these were absent; and the ice formed is more mobile, so that pressure is not so severe. Hot water, however, is to a large extent free of gas particles, which have passed off during the process of heating, so this effect is not observed. Freezing does not take place gradually, but all at once, with somewhat of an explosive effect; and there is no cushion of gas bubbles to take up the shock. That this explanation is correct is indicated by the fact that when a current of air is forced through the hot water just before freezing, it behaves in every detail just like cold water.

New Railroad Device for Couplers.

A new device which seems likely to reduce maintenance outlay for railroads has lately been brought out by a Chicago supply firm. The reclaim release rigging was designed to enable railroads to do away with the chain and clevises on car couplers, which for years have been the source of a great deal of trouble and expense, and at the same time to allow them to use the M.C.B. operating lever without removing it from the car or making any change whatever. There are a number of improved uncoupling devices on the market which are giving very satisfactory results, but many necessitate the removing the entire M.C.B. uncoupling arrangement.

The rigging here mentioned is applicable to any car having the M.C.B. operating lever now using the old style chain and clevises, and it does not necessitate the making of any change. Simply removing the chains and clevises, hooking the reclaim release rigging member into the knuckle lock, and hooking the small eye at the top, which is left open sufficiently to pass over the operating lever. The eye is then closed with a hammer, leaving no nuts or cotter pins to become lost or disconnected, thus making a one-piece connection from the operating lever to the knuckle lock.

The release rigging member is so made that it hangs in and out of the balanced position so that a coupler with a stiff knuckle lock can hold the knuckle lock up, and as the operating lever falls to normal position, the release rigging member will swerve sideways, allowing the operating lever to fall to normal position out of the way of the trainmen.

The cost of this device is practically the same as the chain and clevises, and can be used in repair work to substitute lost clevises, as it is entirely interchangeable with them. Its being easily and quickly applied and is of few parts. It is made by the Reliable Railway Equipment Co.

The Railroads' War Board reports that the present work is centered largely in the organization and training of women for employment by the railroads. We cannot tell how long the war will last nor how many men we may lose by the draft. We want to be ready. The women we are training are in many instances relatives of our employees. They have taken up railroad work eagerly and energetically. Their contribution to the industrial welfare of the country will be of tremendous benefit to women. Many women have extraordinary energy and power of constructive work.

Varied Types of Freight Locomotives for the Chicago, Burlington & Quincy Railroad

Since the latter part of 1910, the Chicago, Burlington & Quincy system has placed in service 281 Baldwin engines of the Mikado (2-8-2) and Santa Fe (2-10-2) types. The Mikados, which total 225 in number, are divided into two classes, 85 having cylinders 27 x 30 ins., and 140 having cylinders 28 x 32 ins. The remaining 56 engines are of the 2-10-2 type, and they all have 30 x 32 in. cylinders. It is interesting to note that, while these locomotives were built on a number of different orders, all the engines of each class are similar in leading dimensions and are of the same hauling capacity. In the development of the locomotives, there has been a constant endeavor to improve the efficiency of the design and to standardize the details. This use of interchangeable parts was also carried out, where practicable, in 15 heavy Pacific (4-6-2) type of locomotives which were built in 1915, for passenger service.

Our half-tone illustrations show the latest designs of the 2-10-2 and the 2-8-2 type of locomotives. Ten of these 2-10-2, fifteen of the lighter Mikados, and 25 heavy Mikados, have recently been built. Particular interest centers in the Santa Fe or 2-10-2 type engines, which develop a tractive force of 71,500 lbs. and carry 287,700 lbs. on the driving wheels. The Burlington road has made a special study of this type of engine and, in co-operation with the builders, has developed a design which is admirably fitted for the requirements of service and the engine is giving excellent results.

The majority of these 2-10-2 type of locomotives, including those most recently built, are equipped with lightweight reciprocating and revolving parts made of special materials. This reduces the weight of the reciprocating parts, and consequently brings down the weight of the counterbalance, with beneficial effects. We have dealt with this phase of the question in another column of this issue. In a test conducted by the railroad company shortly after the 2-10-2 type was introduced, the fact that the use of the light parts materially reduced the stresses on bridges, and track was clearly demonstrated. The piston heads are of rolled steel, and the rods are of nikrome steel, hollow-bored. The main and side rods, and the stub straps, cross-head pins and main crank pins, are also of nikrome steel. Vanadium steel is used for the driving axles, and these, together with the main crank-pins, are hollow-bored. The crossheads are of the Laird type, with cast steel bodies and bronze shoes. This crosshead design has been carefully worked out with the view to provide ample strength with minimum weight. A simple design of Walschaerts valve motion is used, in combination with the Ragonnet power reverse mechanism. The piston valves are double ported, and are 15 ins. in diameter.

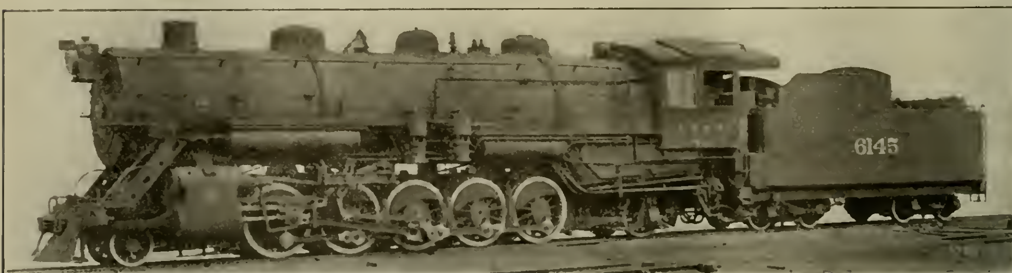
The details of the frames and running gear require no special comment. The wheels of the third, or main pair, have plain tires; and the rear truck is of the Hodges pattern. With a wheel diameter of 60 ins., these locomotives can make good time without resorting to excessively high rotative speeds. The boiler is built with a straight top, but a gusset ring, with the slope on the bottom, is placed immediately ahead of the firebox, in order to provide a sufficiently deep water space under the combustion chamber. The firebox has a deep throat, and is equipped with a Security sectional arch. These engines are all stoker fired, that illustrated being fitted with a Duplex stoker, while the Street type C stoker is applied to the others. Descriptions of both these stokers recently appeared in RAILWAY & LOCOMOTIVE ENGINEERING. The Duplex in August, 1917, and the Street Stoker in March, 1917.

The heavy Mikado type locomotives exert a tractive force of 60,000 lbs., and with a weight of 239,200 lbs. on the drivers, the ratio of adhesion is practically 4. The boiler is similar to that used on the 2-10-2 type as far as shell diameter, number and diameter of tubes and width of firebox is concerned. The boiler barrel and the firebox, however, are shorter in the Mikado type, and this accounts for the smaller heating surface and grate area.

As far as design and materials are concerned, the machinery of these engines is closely similar to that used on the Santa Fe or 2-10-2 type. With 64-in. wheels the Mikados have good speed capacity, and can, if desired, be used in fast freight service; while their high tractive force and ample boiler power enables them to also handle heavy drags over long, hard pulls, and up grades. These engines are equipped with the Security arch and the Street stoker.

The lighter Mikados develop a tractive force of 52,200 lbs., and with an average weight of 54,000 lbs. per pair of drivers, can safely be used where track and bridge conditions would not permit the running of the heavier engines. The wheel diameter is the same as that used on the large Mikados, or 2-8-2 engines, and in design the two classes are generally similar. Light weight reciprocating and revolving parts are a prominent feature. The crossheads interchange with those of the Pacific 2-6-2 type locomotives to which previous reference has been made. It should also be noted that the boilers of the Pacific type engines and the light Mikados, are of the same dimensions. These Mikados are hand-fired, and the tenders are equipped with coal pushers. The brick arch is supported on angle irons which are studded to the side sheets.

These three groups of locomotives constitute a notable addition to the motive power equipment of the Burlington system. Their principal dimensions are given in the tables. The first is the light weight Mikado engine, or the 2-8-2 type:



HEAVY SANTA FÉ TYPE OF LOCOMOTIVE OR 2-10-2 FOR THE C. B. & Q.

F. A. Torrey, Genl. Supt. Motive Power. Baldwin Loco. Wks., Builders.

Gauge, 4 ft. 8½ ins.; cylinders, 27 ins. by 30 ins.; valves, piston, 14 ins. diameter.

Boiler—Type, wagon-top; diameter, 78 ins.; thickness of sheets, ¾ ins. and 13/16 ins.; working pressure, 180 lbs.; fuel, soft coal; staying, radial.

Fire Box—Material, steel; length, 108⅛ ins.; width, 78¼ ins.; depth, front, 85¾ ins.; depth, back, 72 ins.; thickness of sheets, sides, back, crown and tube, ⅝ ins.

Water Space—Front, 6 ins.; sides and back, 6 ins. to 4 ins.

Tubes—Diameter, 5½ ins. and 2¼ ins.; material, 5½ ins, steel; 2¼ ins. iron; thickness, 5½ ins., No. 9 W. G.; 2¼ ins., No. 11 W. G.; number 5½ ins., 34; 2¼ ins., 200; length, 18 ft. 6 ins.

Heating Surface—Fire box, 222 sq. ft.; combustion chamber, 59 sq. ft.; tubes, 3,072 sq. ft.; total, 3,353 sq. ft.; superheater, 769 sq. ft.; grate area, 58.8 sq. ft.

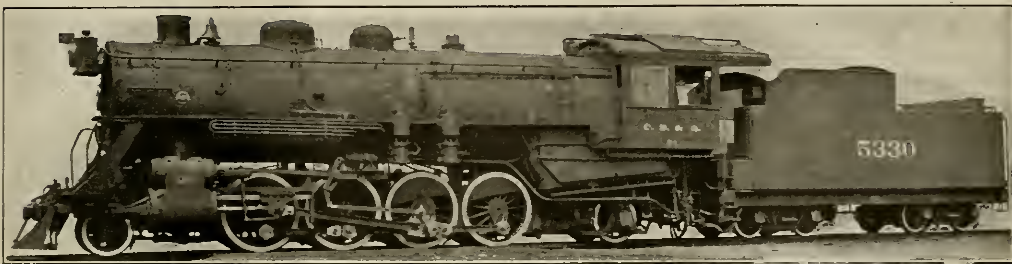
Driving Wheels—Diameter, outside, 64 ins.; journals, main, 11 ins. by 12 ins.

Engine Truck Wheels—Diameter, front, 37¼ ins.; diameter, back, 42½ ins.

Wheel Base—Driving, 16 ft. 9 ins.; rigid, 16 ft. 9 ins.; total engine, 33 ft. 9½ ins.; total engine and tender, 63 ft. 5 ins.

Weight—On driving wheels, 216,000 lbs.; on truck, front, 22,700 lbs.; on truck, back, 34,600 lbs.; total engine, 273,300 lbs.; total engine and tender, about 466,000 lbs.

Tender—Wheels, diameter 33 ins.; tank capacity, 10,000 gals.; fuel capacity, 19 tons; service, freight.



HEAVY MIKADO OR 2-8-2 TYPE FOR THE C. B. & Q. SYSTEM.

F. A. Torrey, Genl. Supt. Motive Power. Baldwin Loco. Wks., Builders.

The Santa Fe or 2-10-2 type locomotive here illustrated is as follows:

Cylinders, 30 ins. by 32 ins.; valves, piston, 15 ins. diameter.

Boiler—Type, straight top; diameter, 88½ ins.; thickness of sheets, ⅞ ins.; working pressure, 175 lbs.; fuel, soft coal.

Fire Box—Material, steel; length, 131⅞ ins.; width, 96 ins.; depth, front, 89¾ ins.; depth, back, 75 ins.; thickness of sheets, sides, ⅜ ins.; back, ⅜ ins., and crown, ⅜ ins.; tube, ⅝ ins.

Tubes—Diameter, 5½ ins. and 2¼ ins.; material, 5½ ins., steel; 2¼ ins., iron; thickness, 5½ ins., No. 9 W.G.; 2¼ ins., No. 11 W. G.; number, 5½ ins., 45; 2¼ ins., 264; length, 22 ft. 7½ ins.

Heating Surface—Fire box, 272 sq. ft.; combustion chamber, 68 sq. ft.; tubes, 4,966 sq. ft.; firebrick tubes, 43 sq. ft.; total, 5,349 sq. ft.; superheater, 1,262 sq. ft.; grate area amounts to 88 sq. ft.

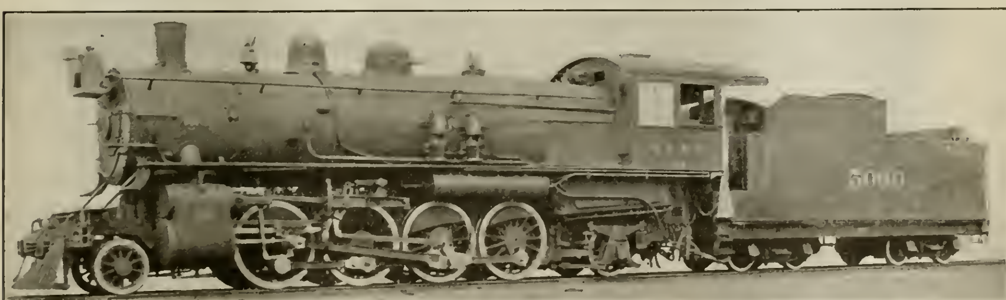
Driving Wheels—diam., outside, 60 ins.

Engine Truck Wheels—Diameter, front, 33 ins.; diameter, back, 42½ ins.

Wheel Base—Driving, 20 ft. 9 ins.; rigid, 20 ft. 9 ins.; total engine, 40 ft. 1 in.; total engine and tender, 75 ft. 2½ ins.

Weight—On driving wheels, 287,700 lbs.; on truck, front, 30,000 lbs.; back, 44,600 lbs.; total engine, 362,300 lbs.; total for engine and tender, about 556,000 lbs.

Tender—Wheels, diameter, 33 ins.; tank capacity, 10,000 U. S. gals.; fuel, 20.8 tons; service, freight.



LIGHT MIKADO OR 2-8-2 TYPE FOR THE CHICAGO, BURLINGTON & QUINCY RAILROAD.

F. A. Torrey, Genl. Supt. Motive Power. Baldwin Loco. Wks., Builders.

The heavy Mikado engines, or 2-8-2 type, are as follows:

Cylinders, 28 ins. by 32 ins.; valves, piston, 14 ins. diameter.

Boiler—Type, straight top; diameter, 88½ ins.; thickness of sheets, ⅞ ins.; working pressure, 180 lbs.; fuel, soft coal.

Fire Box—Material, steel; length, 116⅞ ins.; width, 96 ins. depth, front, 91½ ins.; back, 76¼; thickness of sheets, sides, back, and crown, ⅜ in.; tube, ⅝ in.

Tubes—Diameter, 5½ and 2¼ ins.; material, 5½ ins., steel; 2¼ ins., iron thickness, 5½ ins., No. 9 W.G.; 2¼ ins., No. 11 W. G.; number, 5½ ins., 45; 2¼ ins., 264; length, 18 ft. 7¼ ins.

Heating Surface—Fire box, 277 sq. ft.; combustion chamber, 69 sq. ft.; tubes, 4,080 sq. ft.; firebrick tubes, 39 sq. ft.; total, 4,465 sq. ft.; superheater, 1,031 sq. ft.; grate area, 78 sq. ft.

Driving Wheels—diam., outside, 64 ins.

Engine Truck Wheels—Diameter, front 37¼ ins.; back, 42½ ins.

Wheel Base—Driving, 16 ft. 9 ins.; rigid, 16 ft. 9 ins.; total engine, 35 ft. 9 ins.; total engine and tender 69 ft. 11½ ins.

Weight—On driving wheels, 239,200 lbs.; on truck, front, 27,600 lbs.; back, 47,900 lbs.; total engine, 314,700 lbs.; total engine and tender, 508,400 lbs.

Tender—Wheels, diameter 33 ins.; tank capacity 10,000 U. S. gals.; fuel capacity, 20 tons; service, freight.

Some Aspects of Counterbalancing

Difficulties Involved in Balancing the Reciprocating Parts—No Perfect Balance is Possible—At Best a Matter of Compromise

The proper balancing of locomotive driving wheels is an important matter, but it is not as easy as one might at first sight expect. An idle pulley on a shaft or even a car wheel running along the track and actuated by the movement of the vehicle, does not present any very serious obstacle to perfect balancing. Twenty pounds put on the top of the wheel can be balanced by twenty pounds attached at the bottom, the two weights being at opposite ends of a diameter. Twenty pounds added at the right quarter can be balanced by a like amount at the left quarter, again at the ends of a diameter. These weights if spread out at the same distance from the center, say at the rim, and touching one another, approximate to a heavy tire, and the balance is perfect.

In the driving-wheel balance the case is different, as reciprocating parts have to be balanced by weights which revolve, and the reciprocating parts travel back and forth in a horizontal direction. No perfect balance is therefore possible, but an approximation to it is within reach if the designer be cognizant of the factors in the problem and have a rational theory of how they can best be dealt with.

One of the important uses which heat-treated alloy steel is put to nowadays is the making of reciprocating parts for locomotives. Many designs were used in former days with built-up pistons, wrought-iron crossheads, etc. These were adopted largely owing to their low first cost, and the matter of weight was regarded as of secondary importance. To reduce weight actually increased the cost, paradoxical as that may appear. In 1896 cost was the first consideration and weight second. In 1914 the reverse was the case.

One, if not the principal cause of this, came from a demand of an outside department, not the mechanical. The destructive action of badly-balanced engines on track and bridges, when carefully considered, altered the point of view and modified subsequent action. The "hammer blow" of an ill-balanced driving wheel produces a dangerous condition and it actually became a choice as to whether it would, in the end, be cheaper to reduce the hammer blow of wheel on rail by the use of lighter reciprocating parts, than to increase the weight of the rails. The question was of practical importance and demanded a solution.

Consider one side of a locomotive, with its piston at the beginning of the stroke. The pressure on the crank-pin, let us say, is west and on the counterbalance is east, when both begin to move, and it is possible then to balance the horizontal weight or trust of the reciprocating parts very closely. But they each move in a circle and soon got out of line with one another as movement goes on. At the point where the crank-pin is at its lowest position and the counterbalance at its highest, practically little or no balance of the reciprocating parts can be had, and the upward swing of the counterbalance tends to raise the wheel off the rail. This might be called by such a name as "dynamic abatement," if one so desired, because it is the opposite of "dynamic augment."

At the point where the piston had reached the back of the cylinder, and the counterbalance was as fully forward as it could get, the practical and approximate balance of the reciprocating parts again occurred. Both moved in opposite directions and in the same line. This state of affairs was but momentary, and the rotation of the wheel soon put the whole out of balance again. The balance shaded up and down, like the dawn, the day and the darkness of the night, with

EFFECT OF A HEAVY ILL-BALANCED LOCOMOTIVE ON RAILROAD TRACK.

no abrupt change between any phase of motion, so that when the crank-pin was uppermost, and the counterbalance at its lowest point, the rail received a heavy blow which had nothing to do with the static load, or the weight carried on each driving journals. This blow when measured in pounds has been called the "dynamic augment," and the condition of the track in our illustration shows its intensity.

This dynamic augment, or as many prefer to call it, the "hammer blow," of the wheel is caused entirely by the action of the counterweight when it can do nothing to balance the reciprocating parts. It is, therefore, for the moment an unmixed evil. The absence of the counterbalance would not correct this, because it would put on the crank-pin side of the wheel exactly similar conditions when the crank came to its lowest position.

The whole question of balancing a locomotive is a matter of compromise. The balancing and unbalancing of the reciprocating parts goes in waves, from maximum to minimum and up to maximum again; never theoretically quite correct, but always reducing shock to the mechanism. It waxes and wanes; it grows and fades without any definite line of demarcation, like the ebb and flow of the tide.

We have said that the absence of the counterbalance (that is, its entire removal), if that were possible, at the point, and for the moment when it is useless as far as the reciprocating parts are concerned, would be theoretically a good thing. It cannot be done, however, for crank-pin and reciprocating parts would take its place. Ten pounds balance ten pounds no more effectively than five pounds balance five pounds, though the strains in the connections may be less. These considerations show the method of reasoning employed to produce the better present-day solution of the problem than that which went before.

If at higher cost, and by careful design, or the use of more satisfactory material, or good workmanship, a reduction of the weight of the reciprocating parts can be had, without imperiling the working strength of the parts, it is a most desirable thing to do. Balancing a driving wheel is at best a compromise, and by reducing the ten pounds we have spoken of, to five pounds, we do not alter the efficacy of the balance, but the margin of compromise becomes less and the liability to error sinks in proportion. We do not then require so heavy a counterbalance.

With just as strong though lighter reciprocating parts, the counterbalance weight may be made less, and at the moment when it is at a certain point it becomes, as we have said, an unmixed evil; its destructive action on the track has been brought down by reason of its reduced weight. This is the secret of attacking the problem from the reciprocating-parts-end, and reducing the counterbalance as a consequence of its having less to do. The benefit to the track is great and the wear of the tires where the wheel strikes its hammer blow is also reduced, so that the call for conservation of track and bridges turns out to be a benefit all round.

In glancing over the report of the committee of the American Railway Master Mechanics' Reports on Counterbalancing for the year of 1914 and 1915, one or two striking passages are worth considering. "Centrifugal and reciprocating forces are usually figured at a speed in miles per hour equal to the diameter of the wheels in inches, which may be considered as a maximum for good practice." Thus a wheel 56 ins. in diameter would give what is called "diameter speed," if the engine of which it was part is run at 56 miles per hour. At any speed the reciprocating parts tend to continue their motion at the end of the stroke, and at the diameter speed they give a force of about 40 times their own weight. As an example, let us take authentic figures from the records of a prominent railway not hitherto published and whose name is purposely suppressed. In these engines, which were of the 2-10-2 type, the piston and piston-rod, the valve motion link, the cross-head and pin, and the half of the main rod, weighed in all about 1,675 lbs. when made of nikrome steel. The same articles made of ordinary open-hearth steel, weighed 1,800 lbs. Now 40 times the weight of each showed that the open-hearth steel parts exerted a force of 5,000 lbs. greater than the nikrome steel parts did. That is 2.5 tons, which certainly could be eliminated, and one can easily see that the blow struck on the rail can be very heavy. As such an engine moves along the track it is light at one point and heavy at another, the variations being spaced along the track at the distance of the full circumference of the driving wheels. The engine of which we write carried about 353,600 lbs. on the drivers, and nearly the one two hundred and twelfth part of this weight was that of the reciprocating parts when made of nikrome steel.

An example of an engine of the 4-6-2 type has been given by a well-known writer, where he tells us that the piston and the piston-rod were 900 lbs. weight, and a crosshead of 560 lbs., with a main rod of 970 lbs. Something over the half of this rod, with the other weights, represented that at 60 miles an hour a force of 40 tons. The excess weight in each driver required to balance two-thirds of these reciprocating parts (which is right for those, other than the main driver) caused a dynamic augment of 50 per cent of the static weight on each wheel. Such an engine might have about 93,000 lbs. on the drivers, and under the circumstances this engine would appear to weigh 139,500 lbs. at about every 19 ft. along the road, and only 93,000 (as far as the drivers were concerned) at other points. It does not require exceptional powers of imagination for anyone to perceive the importance of reducing the weight of the reciprocating parts of a locomotive, by selecting suitable alloy steels, and bringing the design of parts up to the highest point of efficiency without sacrificing strength or durability. At the moment that the counterweight strikes its heaviest blow on the track, it is useless as a balance for the reciprocating parts, and it is, for that reason most desirable, and in fact necessary to reduce it. This can be done by reducing the weight of the reciprocating parts, so that when the counterbalance does balance, it may have as little to do as is possible.

One way of accomplishing this most desirable result is by the careful selection of a suitable alloy steel, and subjecting it to the most efficacious heat treatment known to the metallurgical and mechanical fraternity, and also bestowing upon it the greatest care in its forging, working and machining. To this must be added the most painstaking and resourceful designing of parts backed by the intelligence born of experience and results of tests, so that no uncertainty or guesswork may creep in to vitiate the good effects of care in selection, treatment and workmanship. "Eternal viligalnce is the price of safety" here as in the world outside.

Some railroads have used a seismograph or earthquake-recording apparatus to measure the vibrations which are sure to be produced on a working locomotive. This instrument gives the amount of the vibrations, and it tells the story of the variation of these minute movements, so that it is possible to know how far one may go in his legitimate efforts to reduce the rough riding of the machine. It cannot altogether be eliminated, that is not possible, but a very great degree of improvement may be had by a study of the whole question and the application of what remedies are possible, among these the selection and working of the steel are of the utmost importance.

Almost the only way now left open to the designer is that of reducing the weight of the reciprocating parts, because by so doing the revolving counterbalance has less to do, and its superfluous weight can with great benefit be dispensed with. To do this properly is not easy.

Next month, if nothing unforeseen prevents it, we will discuss the matter of alloy steel, and endeavor to point out some of the reasons for its preference in the work of reducing the weight of reciprocating parts, and the reasons for its specific suitability for this work.

Superheating Slide Valve Engines

Difficulty in Lubrication—Variety of Designs—Sizes of Piston Valves

Mr. H. R. Stafford recently wrote a paper which was reproduced in the publication of the Locomotive Club of Schenectady, N. Y. The following is a brief synopsis of the paper: In order to pay the interest on the first cost and upkeep of locomotives in these days of close economy it is necessary to take advantage of everything which will decrease the cost of operation. We have for some time been superheating new power on American roads and have about completed the conversion of the more modern existing power. Coming to engines built from six to sixteen years ago, we find many with slide valve cylinders still in main line service and good for many years yet, if advantage can be made of superheated steam.

Many roads have experimented with superheated steam on slide valve engines, but none of these tests have met with marked success. The difficulty of successfully lubricating slide valves under high temperature has caused a general abandonment of this idea. It is now generally recognized that superheated steam can only be used successfully with piston valves. In applying new piston valves to slide valve locomotives it is usually necessary to cut the frame somewhere in front of the front pedestal and to apply new front sections. This expense in addition to the labor of fitting and lining up new cylinders makes the work almost prohibitive in the eyes of many railways managers.

It very often happens that these engines cannot be spared from service, nor can shop room be had. A good time to apply the superheater is when new flue sheets are required, when this work can be accomplished without any additional detention of the engine.

This application of piston valves to slide valve seats dates back to the earliest applications of piston valves to locomotives. When the piston valve was still a new and untried device, railroads were cautious about building engines with cylinders specially designed for piston valves. They preferred to construct them in such a way that in the event of the failure of the piston valve, slide valves could be readily substituted. One of the first locomotive designers to advocate the use of piston valves was Mr. John Player. In order to get the device tried he got permission of his S. M. P. to apply "cages" to the slide valve cylinders, in which piston valves were fitted, to one engine of an order. The various designs of piston valve "cages," which were brought out about this time, gave all sorts of trouble, although the valves themselves were generally successful. The most trouble was experienced in making the joints on the valve seat and on the steam chest seat, at the same time. The piston valve, however, rapidly became popular and the piston valve cylinder was soon adopted.

When the subject of applying piston valves to slide valve cylinders again came to the front in connection with the superheating of existing engines, the Economy Devices Corporation, after investigating as many of the early designs as possible and studying the history of their failures, evolved and put on the market their Universal Valve Chest. By means of a separate inner cage jointed on the valve seat and an outer chamber surrounding the above and fitted to the steam chest seat, the former trouble with the joint wires was eliminated. At that time the general use of outside steam pipes was not anticipated and steam was admitted through inside pipes to the existing induction ports at the ends of the valve seats.

It soon became apparent that the fear of cracks developing in the saddle passages, due to the use of highly superheated steam, was holding back the application of this device in many cases. This condition led to the development of another type. In this type of chest a single casting is used, held to the valve seat by the steam chest studs, and the steam chest joint proper was thus eliminated. By an ingenious arrangement of joint wires any slight leakage of steam from the ports is avoided, thus eliminating the "fog," which had often been seen issuing from the steam chest casings of slide valve engines. Steam is admitted through the ordinary outside steam pipes directly to the top of the chest, the old induction passages in the cylinder saddles becoming merely insulating spaces. The valve stem is offset, say, 1¾ ins. below the center of the valve. This is to bring it into alinement with the existing valve rod when the old valve gear is used. In case new valve gear is applied the stem can be made central with the valve. Another ingenious feature is the method of applying the heads, to permit the removal of the valve and bushing, without interrupting the regular spacing of the steam chest studs. The wire joint on the head is set well into the chest, inside the line of the steam chest studs. Holes are cored through the heads, permitting the introduction of the steam chest studs in their normal location.

Valve sizes are made dependent upon the length of steam port in the existing valve seat. It is obvious that there is no need to provide greater valve capacity than the existing passages in the cylinder can accommodate. The shape of the steam port passages in the valve chest is such that every square inch of area in the valve bushing ports is made effective, instead of only a fraction of this area, as in the case of the ordinary design of piston valve cylinder. There are no restricted passages or obstructions to cause eddy currents. The castings are made smooth and free from fins by the exercise of a little care. Actual tests in competition with engines of the same class superheated and with new piston valve cylinders and large valves have proved the value of this arrangement. Various sizes and weights of valves as standardized for this arrangement are made. Attention must be called to the great saving in wear and tear due to the use of valves weighing from 58 to 73 lbs., instead of from 150 to 225 lbs.

It was feared at the start that the field for application of the Superheater to locomotives without increasing the size of the cylinders would be somewhat restricted, due to the fact that larger cylinders could be profitably used with superheated steam, thereby taking advantage of the greater expansibility of this medium. It was found, however, that in most cases it was inadvisable to increase the piston thrust, on account of the machinery not being designed for so great an overload. Enlarging cylinders resulted in broken frames, main rods, crank pins, etc. The success of this device is best proved by the fact that although introduced but a little over two years ago it is at present in use on 42 railroads in the United States, Canada and South and Central America. There are approximately 450 engines in service at the present time. Four roads have in excess of 200 engines in service, or with chests ready to apply at the first shopping.

In order to hasten the completion of the work of superheating these engines without waiting until new flue sheets are required, several roads have been trying a novel experiment, made possible by the perfection of the oxy-acetylene welding process. The circular section of both front and back tube sheets containing the tube holes is cut out with the torch. New circular plates, with holes drilled to suit the arrangement of superheater tubes and flues, are then welded in place. By building up sufficient material at the joint, the tube sheets are made more rigid at this point than at the bend of the flange, thus guarding against failure. An example of the remarkable showing often made by the old slide valve engines when converted to superheat in the manner described above, the Delaware & Hudson ten-wheelers may be cited. Engine No. 559 is used to handle the "boat train" to

Lake George. On four days a week this train is unusually heavy, often consisting of ten cars. With the saturated steam engines it was necessary to double-head two 4-6-0 type engines on this train four days a week. When engine No. 559 or other engines of the same class were superheated they handled this train on schedule seven days a week, regardless of the number of cars.

The amount of the saving thus effected is at once apparent. In addition to the usual economy in coal incident to the use of superheated steam, this engine saves the expense of an extra engine and crew four days a week, as well as practically all the coal burned by the extra engine. A point which makes this engine popular with all concerned is that, owing to economy in the use of water, one stop on a bad grade where trouble had always been experienced in starting, is now eliminated.

An example of a particularly successful application of the Universal Valve Chest to engines in freight service is the Delaware, Lackawanna & Western consolidation freight engines. The cylinders are 26 x 30 ins. with steam ports 24 ins. long. These locomotives were extremely unpopular when operated with saturated steam. Two firemen were required and mileage was extremely low between shoppings. They were first superheated with slide valves, but although the performance was improved, mechanical troubles increased. At present the entire lot are being equipped with these valve chests. Those in service are the most popular freight engines on the division, and are fired with ease by one man. All valve troubles have ceased and the milage records made by these engines today are extremely good.

It is a well-known fact that the cost of a new horse-power obtained by superheating an existing engine is less than one-third of the cost of a new horsepower obtained by the purchase of new engines; therefore, it would seem to be the part of wisdom to do all that can be done in the way of superheating existing engines before considering the purchase of new, except when necessary to handle extra heavy or rush periods of work.

Nowadays the scientific aspect of how to produce economy is to the fore.

Handling Superheater Engines

By F. W. CORCORAN, Locomotive Inspector, Southern Pacific Company*

The increase in the number of superheater locomotives being put into use by the Southern Pacific is having a marked effect on efforts being made to reduce fuel consumption and to enable enginemen and others to have a thorough understanding of the requirements necessary to economically operate these locomotives. The rules enumerated by the author, Mr. F. W. Corcoran, are as follows:

First, the lubricator should be open and working properly five minutes before starting on a trip, to insure that the valves and cylinders are properly lubricated when starting. The main steam throttle on the boiler to the lubricator should be wide open. The booster valve must be open at all times while the engine is running, both when working steam and drifting. Enginemen should, as often as possible, note the working of the lubricator while on the road, because there is no moisture in superheated steam to assist in lubricating valves and cylinders, as is the case with a saturated steam locomotive. The oil used should be of sufficient quantity and regularly fed, the amount to be used depending entirely on conditions. Piston speed and water conditions are to be considered, although enginemen should endeavor to use the amount allowed to make the trip. Weather conditions affect the proper working of the lubricator; at times a cold wind blowing into the cab will nearly stop the lubricator feeds.

Second, the water level in the boiler should be regulated so there will be no water carried over into the superheater units.

Third, while working steam and when arriving at a point where a stop is to be made, the throttle should be left slightly open, and when speed will permit, the valves should be given a long travel which will reduce steam chest pressure and allow the superheater damper to close. When the damper is closed, saturated steam only is admitted to the steam chests and the cylinders which are cooling, this soon reduces the temperature below the flash-point of the oil. Enginemen should bear in mind the importance of keeping some steam in the cylinders while the temperature of the steam is above the flash-point of the oil. The practice of shutting off at high speed and leaving the valves in short cut-off is very injurious to both valve and cylinder rings and causes the lubricant to burn.

Fourth, arriving at the top of a grade from where the engine is to drift, the throttle should be left slightly open for about ten minutes to allow the temperature in the cylinders to be reduced, then the lever should be put in full gear before the throttle is closed. Where by-pass valves are used the reverse lever should not be put in full gear, but should be adjusted according to the piston speed, at high speed to a longer cut-off, but never in full gear.

Fifth, engine oil should never be used on piston or valve rods. When no oil is used on piston rods direct, the rod serves as an indicator and when it shows a lack of lubrication the cylinders are in the same condition. Enginemen should watch this closely and the lubricator should be handled accordingly. By feeding the cylinders about the same amount of oil as the valves get, the best results are obtained.

Sixth, when long runs are made working short cut-off, it is advisable to change the cut-off about every twenty miles. The proper way to do this is to close the throttle nearly shut and let the reverse lever down as far as possible where it can be left for about twenty seconds. By this the valves are given a long travel and the valve rings are lubricated by the oil which adheres to the valve bushing.

Seventh, the temperature obtained in the steam chest of a superheater locomotive, working under ordinary conditions is approximately 690 degs. Fahr. At this high temperature proper lubrication is necessary or damage will result to valves and cylinders.

*Reprinted from "The Bulletin," August 1, 1917, Southern Pacific Co., San Francisco, Cal.

Traveling Engineers' Association.

The Executive Committee of the Traveling Engineers' Association has decided that owing to war conditions the association will not hold its annual convention this year. The Executive Committee will meet as usual to transact such business as may be brought before it, and the annual report will be issued, containing information in regard to what has happened in the association during the year. The reports and papers will be printed in full, and new subjects will be selected and committees appointed to report on the same next year, when, it is hoped, peace will have been established.

Higher Wages for Canadian Enginemen.

As the result of negotiations of several months' duration a new wage-contract schedule went into effect last month by agreement of representatives of the Canadian Government Railways, the Brotherhood of Locomotive Engineers, and the Brotherhood of Locomotive Firemen. It provides for a pay increase ranging from 9½ to 31 per cent. Back pay of each month's earnings, according to the increase, is also granted from April 1, 1917. An eight-hour day is also guaranteed. Special high rates are assigned to the men employed on the new heavy freight engine types such as the "Santa Fe" and "Mikado."

Elegant Parlor Cars on the Spokane, Portland & Seattle Railway

The Spokane, Portland & Seattle Railway recently bought from the Barney & Smith Car Company a number of parlor cars for use on their day trains.

The photograph, from which our engraving is made, shows an 18-chair parlor car, with smoking room at one end. These cars were 73 ft. 2 in. over end posts and 10 ft. wide over side sill angles. The underframes are of the built-up type with steel superstructure framing. The outside sheathing is of steel plates ⅛ in. thick, with special roller beveled surface, while the inside finish is also of steel.

The cars are plain as far as interior decoration is concerned, yet there is an elegance which depends entirely on the high class of the design. Electric lamps placed in the clearstory furnish the artificial light, and art glass is used in the interior doors and in the clearstory windows. The seats are rattan chairs with cushioned backs and arms. A series of electric lamps in cup-like shades are placed above the row of chairs so that reading is made easier and pleasanter than if the central clusters alone were relied upon.

The outside of the car is made of sheet steel and the trucks are the six-wheel type. The wheels are 37 ins. in diameter and the spread of the wheels is 5 ft. 3 ins., making a truck wheel base of 10 ft. 6 ins. The body bolster of the car is 8 ft. back of the end. The heavy centre sill is of I-beam built-up section sloping down from a point about 11 ft. 4 ins. back of the end sill and reaching a maximum depth of 2 ft. 6½ ins. The body bolster, also of built-up section, is 11⅝ ins. deep at the center. Heavy triangular needle beams are used, running from the center sills to the outside of the longitudinal sills. They are placed at intervals along the main center sills. The mechanism for operating the axle light is boxed in, so that the belt drive and the electric motor are protected from dust, etc. Altogether the cars present a neat, comfortable and serviceable appearance and have given every satisfaction on the S. P. & S.

INTERIOR OF PARLOR CAR ON THE SPOKANE, PORTLAND & SEATTLE.

Efficient and Economical Railway Car Lighting

The matter of railway car lighting was the subject of a paper recently read by Mr. Geo. Hulse, chief engineer of the Safety Car Heating and Lighting Company. He said, among other things, the proper lighting of railways cars has always brought out special problems, both as to the methods of producing the energy for lighting, and in the application of the light sources to get proper illumination.

As methods of lighting have been improved, new methods have been applied to cars with such modifications as the special conditions make necessary. Oil lighting superseded candles, gas displaced oil lighting, but at present the field is divided between gas and electricity.

Practically all cars using gas light employ oil gas as the illuminant. As the storage space available is limited, it is necessary to carry the gas under pressure and also to have a gas of comparatively high illuminating value. Coal gas, of low candle-power primarily, loses at least 50 per cent. of its illuminating value when compressed to a point high enough to give sufficient storage. Oil gas has not only a much higher candle power uncompressed, but when compressed to ten atmospheres, loses only 10 per cent. of its illuminating power.

Oil gas is made by the distillation of petroleum in cast iron or clay retorts, or in steel generators filled with fire brick checker work. A fixed gas is formed which has for its principal ingredients methane and heavy illuminants with a very small amount of hydrogen. This is practically the Pintsch gas of commerce. After passing through proper washing and purifying apparatus, the gas is compressed to 12 atmospheres and is carried to the railroad yards by suitable pipe lines. The car equipment consists of steel holders, two filling valves, a pressure gauge, a regulator for reducing the pressure to that at which the lamps operate, the pipe line for carrying the gas from the holders to the lamps, and the lamps or burners. All fittings for both the low and high-pressure piping are especially designed. The pressure regulator is placed under the car near the holds so that the amount of high-pressure piping is small and none of it is inside the car. The pressure regulator reduces the gas to the proper pressure and maintains this pressure constant.

One of the early and completely successful applications of the inverted mantle was to car lighting.

In this country two sizes of mantle are used, one which gives 28 candle-power, with a gas consumption of 0.8 cu. ft. per hour, the gas pressure being 1 lb. per sq. in. The other size of mantle, which is used for center lamps gives 90 candle-power, with a gas consumption of 2 cu. ft. per hour at 2 lbs. pressure per sq. in.

The mantles used are of a special form and composition to withstand the hard usage of railway service, and they give three months average life in service. There are upward of 85 gas plants for the manufacture of oil gas in the United States and Canada.

The holders are made exact size and the contents of a holder can always be determined by multiplying its capacity by the gauge pressure in atmospheres. This feature, besides furnishing a means of measuring the amount of gas supplied, is important for reckoning the "hours of lighting" would be ideal if it were not for car interchange.

Cars using oil gas are dependent upon stationary plants, but this has not been found to be a disadvantage, principally because the time required to charge a car is very short. It can be done, if necessary, at a division station stop.

Three methods of electric lighting for railway cars are in use: 1, The head-end system; 2, straight storage; 3, axle-driven generators. In the head-end system use is made of a generator driven by a steam engine at the head of the train, either in the baggage car or on the locomotive. Electrical energy for the lighting is carried back from the generator to the cars. The generator of a head-end system is usually installed in the baggage car, and is driven by a steam turbine, steam for its operation being brought from the the locomotive through suitable hose connections. As the steam supply is cut off when the locomotive is detached from the train it is necessary to have a storage battery on one or more cars to keep the light going.

The head-end system gives efficient and economical results, but its great disadvantage is that light can only be used when a car is in a train with a generator equipment. If the cars are equipped with batteries to supply light during such times as the locomotive is disconnected, the proper arrangements for charging the batteries entail a sacrifice of simplicity and economy.

In the straight storage system each car is equipped with a set of storage batteries of sufficient capacity to supply the lamps for the desired trip. As ordinarily applied, the equipment consists of lamps, storage batteries and charging receptacles, with necessary wiring. At terminal yards the batteries are charged from a stationary power plant. The lamps operate directly from the batteries, a no voltage regulator being used. This system of "lighting" which a holder contains and the fact that the charging of the batteries consumes time must be considered. Cars are not always available in one place long enough to receive the proper charge. The cost of equipping a railroad yard with the proper charging lines is also considerable.

In another system the car-axle is used to drive a generator which supplies the lamps in the car, and for charging a storage battery which supplies energy to the lamps when the car is running below a certain speed.

The equipment consists of a generator mounted on either the car body or the truck with some form of driving system between the car-axle and the generator; a storage battery to maintain the light when the speed of the generator falls below that at which it gives the proper voltage; regulating apparatus to govern the output of the generator at varying speeds; to give the proper charge to the storage battery, and to maintain constant voltage at the lamps; and some means of keeping the polarity of the battery-charging current constant, when the direction of the movement of the car is reversed.

Various systems have been devised to meet these conditions and a large number are in successful operation. The best practice is exemplified by an equipment in which the generator is mounted on the car underframe, the generator controlled for output at varying speeds by a carbon pile rheostat in its field circuit, which give a constant current-output until the battery approaches full charge, when the control is automatically changed to constant voltage, thereby preventing an overcharge of the battery. The voltage at the lamps is kept constant by an automatic carbon pile rheostat placed between the battery and the lamps.

Of the three different systems of electric car lighting, the axle-driven generator system is the one most used. This system renders the car independent of a stationary plant and, in spite of its seeming complexity, it is the only one of the three systems capable of general application to cars.

Adequate and proper illumination of passenger cars of various types presents difficulties not met with in some other lines of illuminating. Car construction limits, to a considerable extent, the position of the lighting fixtures, which, in combination with the seating arrangements makes ideal illumination conditions hard to realize. It is practically impossible to have the lighting fixtures out of the range of vision, and very carefully devised screening of the light is necessary. In addition to this the constant motion of the car makes it necessary to have a greater amount of illumination than is required in places where this condition does not exist.

There has been a tendency to sacrifice proper illumination results in favor of the appearance of the lighting fixtures, and also to look for an appearance of light in the car, rather than for proper illumination; but these mistakes are rapidly being corrected.

Aside from the general illumination necessary, the principal use of artificial illumination in a coach is for reading, and the lighting system should be so designed as to give proper illumination on the reading plane, which is 45 degs. to the horizontal and at right angles to the center line of the car.

Owing to car design and construction, two methods of lighting are available, as regards the placing of the lamps. They may be hung from the roof in a single row down the center line of the car, or a row may be placed on each side deck, directly over the seats. An elaborate series of tests made a short time ago demonstrated that equally good illumination can be obtained with either type of installation. Practical considerations, however, make for center lighting on account of the fewer number of fixtures required and the lesser number of lamps and reflectors to maintain. Another consideration is that, with side lighting, shadows are likely to be cast by a passenger's head which interfere with the proper illumination of his own or another's paper. This occurs with center lighting only when people are standing in the aisles.

The following are some of the results obtained in the test:

The reflector is a prismatic one, having a prismatic bowl under it to give the required light distribution. The prismatic reflector is covered on the outside by an opal-glass envelope, adding to the appearance and serving to keep the prismatic glass clean. This arrangement gives very uniform lighting; the illumination of the aisle and window sittings being practically equal.

A test with a similar type of fixture using the 50-watt train lighting electric lamps showed illumination to be considerably lower than in the preceding test and less uniform, there being more difference between the aisle and the window sittings.

Another test with center lighting, using prismatic open-mouth reflectors, showed the type of unit and the results obtained.

A still further test showed results with side lighting with medium density opal reflectors, and this test compares very closely with center lamp test, using the same class of reflector.

These tests show that by using units best adapted for car-lighting gave an illumination of about 2.5 foot-candles obtained on the reading plane by spacing the center units 6 ft. apart and using lamps with an output of aproximately 390 lumens per lamp. The same results can be obtained in side lighting by placing the units 6 ft. apart, and using lamps with an output of 220 lumens per lamp. This allows a depreciation of 40 per cent. in the efficiency of the lighting system before the illumination drops to 1.5 foot-candles. The word "lumen" is described as the unit of light, and is equal to the quantity of light falling on an area of one square foot, all points of which are one foot distant from a point taken as the light source being of one candle power intensity in all directions; or, if a source of light giving one mean spherical candle power, be placed in the center of a hollow sphere of one foot radius, the light flux falling on one square foot surface of this sphere will be one lumen. To reduce the spherical candle power of a light source to lumens, multiply the mean spherical candle power by 12.57.

Direct lighting with a reflector of medium or heavy density is most satisfactory for a coach, as the walls and ceilings cannot be kept in proper condition to reflect any appreciable amount of the light which falls on them. The direct system with a reflector which properly screens the light also affords, with the darker ceilings and walls, spaces of low illumination for the eye to rest upon.

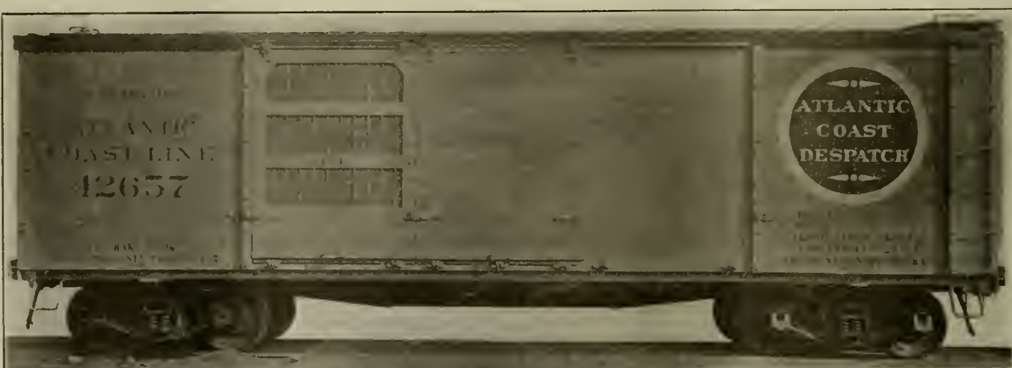
Dining-car lighting is in a class apart from that of other classes of cars, and it is in the dining car that most of the novelties in lighting are used. Obviously the table is the most important item in the car, and a high illumination must be concentrated on each table, although a fairly high general illumination is necessary so that the car will present a bright appearance. Installations with high intensity on the tables and low general illumination have not been satisfactory. Good general illumination can be obtained from center fixtures. For table illumination, fixtures should be mounted over each table, and no more satisfactory type of unit has been developed than that which uses a concentrating reflector and redirecting plate under it to give the proper distribution of light on the table.

Sleeping cars require lighting for general illumination, for reading or working at the tables in the sections, and for illumination of the berths after they are made up. General illumination is obtained by center lamps placed close to the ceiling to prevent interference with the upper berth. Small units placed in the corner of each section provide additional local illumination for reading and to light the made-up berth. The staterooms of a sleeping car and of a compartment car are lighted in the same way. Smoking rooms have a center lamp for general illumination and bracket lamps back of the fixed seats to afford proper lighting for reading. The pasageways are lighted by ceiling fixtures, using either an open-mouth reflector, or a fixture with reflector and directing plate set flush with the ceiling. The proper lighting of the berth section of the car after all the berths are made up is best accomplished by a bracket lamp placed on the bulk-head facing the aisle; this allows all the center lamps to be extinguished, and affords sufficient light for passing through the car.

Parlor and smoking cars presents a difficult problem, as the seats are arranged so that the occupant faces the center of the car. The best results are obtained by the use of a few center lamps for general illumination, and bracket lamps placed on the side of the car back of the chairs for reading light. These cases are practically all the methods which have to be used.

Ventilated Box Cars for the Atlantic Coast Line Railroad

The photograph from which our engraving was made shows a ventilated box car built for the Atlantic Coast Line Railroad. These cars have steel underframe and steel end frame; they are lined throughout with wood and insulating paper, and have two ventilators bottom end ventilators on each end, the latter being patented and furnished by the Wine Railway Appliance Company. The cars are entirely sealed inside, and lined both inside and out, on the upper side of the roof ceiling and on top of the sub-floor with weatherproof insulating paper. The sters, the Return Roller Frictionless side bearings, the Buffalo brake beams and the Atlas brake beam safety guards. The painting material for the under frames, sides and ends was furnished by the H. E. & D. G. Yarnall Company, of Philadelphia, Pa., wooden sills and frames were painted



ATLANTIC COAST LINE RAILWAY, VENTILATED CAR FOR FRUIT AND PERISHABLE FREIGHT.

in each end and also a solid and a ventilating door in each side. The Barney & Smith Car Company, builders of these cars, will soon complete an order for 1,200 box cars.

These cars are known as the Atlantic Coast Despatch type of box car, they being equipped with malleable top and cars are equipped with steel under-frames and steel end frames, also with Murphy X L A roofing, the Jones Peerless car door fixtures, the Wine end-ventilators, the Farlow-Westinghouse draft gear, the Sharon couplers, the Westinghouse air brakes, the Bettendorf cast steel truck-side frames, the Buckeye cast steel bol- by the Spiritine Chemical Company's product. The cars are equipped with United States Standard Safety Appliances, and the under frame, especially the center sills, were designed to meet M. C. B. recommendations for strength requirements. These cars carry perishable freight and are giving every satisfaction.

So-Called Car Shortage

There is really no such thing as car shortage in the sense that there are not or cannot be got sufficient cars to move the traffic. The so-called car shortage is caused very largely, if not entirely, by the lack of facilities for unloading cars that have completed a paying trip. Years ago the late James J. Hill pointed out that the lack of terminal facilities was one of the greatest handicaps on American railroads. Very little, comparatively, has been done to improve conditions since Mr. Hill's time.

Lack of terminals, lack of sidings, lack of modern appliances on many roads, and lack of modern appliances for handling freight by shippers and receivers, have all to be added together, if one is to get a fairly correct view of where most of the trouble lies.

This is one of the peculiar cases where legitimate expenditure ought not only be permitted by Government, but in the interests of the people, the spending of large sums of money by the railroads for these desirable ends might well be facilitated by Government. The whole question is important and the needs of the railway and the country in this direction are growing year by year.

According to record, there was in May last a so-called shortage of 150,000 cars and at the same time there was about 2,500,000 cars in the United States. A little better handling, that is, faster and better loading and unloading, a quickened movement by the railroads, which they are endeavoring to do, by applying specialties to locomotives which reduce their standing time at terminal stations, if carried out would let it be possible to make up the deficiency complained of.

Since November, 1916, about 989 engines have been placed in service and about 44,000 cars, in the same period. There are said to be on order since April of this year about 2,200 locomotives and about 104,917 cars. If these engines and cars are delivered by January, 1918, we will have with those put in service since November, 1917, a total of about 149,000 cars with an average capacity of 50 tons each, and a total of about 3,200 locomotives with probably an average tractive power of 54,000 lbs. or over, by which the alleged car shortage will disappear in the early months of 1918, and unless a slackening of performance takes place, the regular increase of the country's business should be adequately met.

Ingenuity and Utility.

It is the aim of the inventor to make everything in the machine line as simple as possible, and the desire of the purchaser is that it should be so made, and yet a review of the world's experience shows that in nearly every case the most successful machines of any class, if not the most complicated, are far from being the most simple.

The period is not yet beyond record when time was kept by the hour-glass and sun-dial, with which no clock or watch of the present day can compare in simplicity. The time was when a knife was the machine for paring apples. The latest and best machine has bands and pulleys, and cams, and cranks.

The first steam engine was the simplest ever built and free from all objectionable features. The best one is the most complicated, has all the objectionable features, and some of them four times repeated. The poorest turning lathe ever built was the most simple; the best one ever built the most complicated; and so with nearly all machines and tools.

The hour-glass was not discarded because it was simple, nor the clock replaced because it was complicated, but because it performed functions and meets requirements that the hour-glass failed to meet. The knife as an apple parer performed its functions well enough, but was too slow. The latest power apple paring machines do all that could be done with the knife and at the rate of 50 bushels an hour.

The primitive lathe, with two pointed spikes driven through blocks of wood for centers, a spring pole, string and pedal for a motive power, was simple compared to a modern engine lathe, but was restricted in the scope or quantity of work, as was the case with the original of the whole category of machine tools, textile machinery and all mechanical appliances.

Call to mind the simplicity of the Hero engine as depicted by modern artists. A boiler set on a peg, two pieces of pipe with openings in the sides, and, aside from a boiler feeder, the engine is complete. Devoid of the steam pipe nuisance; no gland to pack, no crosshead to oil, no connecting rod which many have tried to avoid, no crank to use up power; in fact none of the things that are objectionable in the present day engine; unfortunately it had none of the present engine's merits. To make the engine useful it had to be separate from the boiler, which added the steam pipe nuisance. To get power the engine had to run fast; to utilize the power it had to be geared down. High speed against atmospheric resistance and friction wasted a large per cent. of the power, and friction wore out various parts, and wear called for repairs. It was the high speed problem carried to an extreme. The Hero engine properly constructed by later mechanicians failed to perform all the functions required of an engine. The stationary engine, though every feature about it except the shaft and driving pulley, are objectionable, is not only tolerated, but even admired for the duty it performs.

While this review shows that the complicated machines have replaced the simple ones, a deeper study will show that it is only because they perform more functions, and when each function is separated from all others, the mechanism which performs that function successfully is the best which is the most simple.

Malicious Mischief.

One of the commonest forms of malicious mischief in this country is that of boys, and even young men, placing upon railway tracks small obstructions such as stones, pieces of wood, splice bars, etc., to see how they will make the locomotive jump. Such acts are not usually dangerous, but they might cause serious damage, and the laws against them ought be to severely enforced. If the Draconian laws in force in Great Britain against such offenses prevailed here, amusements of this kind would not be so common as they are. A press despatch recently reported a case where a boy for fun placed a tie on the rails of a well known railway. The boy was arrested, and when brought before a magistrate was told that he was subject to penal servitude for life for the offense. Owing to the culprit's youth the judge sent him to jail for a couple of months, and at the end of that time to be given a good flogging with a birch rod.

We once knew of a case in Missouri when a farmer tried to sell a worn-out horse to a railroad company by driving the animal into a cattle guard when a train was approaching. The engineer happened to see the animal in time to stop and thereby spoiled that form of sale. Some of the enterprising farmer's friends were joking about the case and word of it reached the ears of a station master, who reported it to headquarters. This led to the arrest of the farmer, who was prosecuted for endangering trains and passed three months in jail.

Up in the Air.

The highest place in the world regularly inhabited is the Buddhist monastery, Halne in Tibet, which is about 16,000 feet above sea level. The next is Galera, a railway station in Peru, which is located at a height of 15,635 feet above sea level. Near it at the same height is a railway terminal 3,547 feet in length. The elevation of the city of Potosi in Bolivia is 13,330 feet. Cuzco, Peru, is 11,350 feet in the air; La Paz, Bolivia, is 10,883 above sea level, and Leadville, the highest town in the United States, stands at an altitude of 10,025 feet.

The first patent granted by the U. S. Government bore date July 31, 1790, and was issued to George Hopkins on a process of working potash and pendash. It was signed by George Washington.

Running Repairs on Steam Locomotives

Readjusting the Main and Connecting Rods

Almost every detail of the modern locomotive has become a subject of regulation by the Interstate Commerce Commission, and it is interesting to revert to these regulations occasionally, and while it will be found that in many of the finer details they may be improved upon it is well that they should be borne in mind. In the heated season it is a fact that the main and connecting rods require more attention than in the cooler seasons, and referring to a few of the regulations that came into force last year, we find that autogenous welding of broken or cracked main or side rods is not permitted. In regard to side motion of rods on crank pins, it shall not exceed one-fourth of an inch. The bore of main rod bearings on locomotives in road service shall not exceed pin diameters more than three-thirty-seconds inch at front or back end. The total lost motion at both ends shall not exceed five-thirty-seconds inch. The bore of side rod bearings shall not exceed pin diameters more than five-thirty-seconds inch on main pin, nor more than three-thirty-seconds on other pins.

In yard service the bore of main rod bearings shall not exceed pin diameters more than one-eighth inch at front end or five-thirty-seconds at back end. The bore of side rod bearings shall not exceed pin diameter more than three-sixteenths inch. Oil and grease cups shall be securely attached to rods, and grease cup plugs shall be equipped with suitable fastenings.

It will be admitted that these regulations allow considerable latitude and longitude in these important connections, and it would not be good practice to allow locomotive rods to run in this loose condition. The rapidity with which the bearings of the rods are worn renders it necessary that they should receive careful and constant attention. Beginning with the main rod, its tendency to increase in length is very great, since every time the keys are driven for the purpose of tightening the brasses the length of the rod is increased. By the length of the rod it will be understood that the distance between the centers of the brasses is referred to. When the locomotive is new, or newly repaired, it is usual to mark the points on the guides at which the piston touches the cylinder head. The distance between these striking points may be a quarter to half an inch more than the stroke of the piston, and the rod should be so adjusted that the space in excess of the stroke will be divided evenly so that there will be an equal amount of clearance at each end of the stroke. If there be any variation it is safer that the lesser space should be in the back end of the cylinder, as the lengthening of the rod already referred to will tend to equalize the amount of clearance. The exact spacing between the working point of the crosshead and the striking point should be maintained as nearly as possible. Apart from the danger of the piston colliding with the cylinder head, a variable space imparts an irregularity to the exhaust which may not be a serious loss in power, but is certainly no kind of gain.

In refitting the brasses in the front end of the main rod they should be left at least one thirty-second of an inch open when fitted to the wrist-pin. This leaves some allowance for driving the key as the brasses wear. In attaching the front end of the main rod care should be taken to note that the rod is not loosely attached to the wrist-pin but should be keyed snugly to a sufficient degree of tightness so that the rod may be moved without any apparent looseness. A loose bearing in the front end of the main rod is a sure beginner of trouble and often leads to serious fractures. The danger of the bearing heating is not great, except in the case of driving the key too tightly, as the movement of the bearing is only a small part of a revolution.

In closing and refitting the brasses on the back end of the main rod care should be taken to retain the square adjustment of the brasses to each other, so that when they are returned to the strap they do not require the pinching pressure of the key to bear equally. The key should be driven in the strap before connecting the rod to the strap and it should be noted that the brasses revolve readily but not loosely, around the crank pin. No lost motion is required in the adjustment of the main rod. It should be closely fitted, and frequently refitted, as the incessant shocks to which it is subjected rapidly wear the bearing parts.

In regard to the inevitable wear of the sides of the main rod and other brasses, the life of the brasses may be prolonged by soldering semi-circular strips to the sides of the brasses. These should be held in place by four or five pins of brass or copper, for which holes may readily be drilled through the reinforcing patches into the brass itself a depth of over a quarter of an inch, care being taken that the pins fit snugly in the holes. When these side patches are attached to the brasses the opportunity should be taken to close the brasses sufficiently together so that they may be bored out, the patches being also faced off to the proper size of the crank pin bearing. It may be added that the patchwork, like the mending of a worn garment, has not the durability of the original, but it is preferable to allowing the rapid reduction of the brasses to go on without applying some remedy.

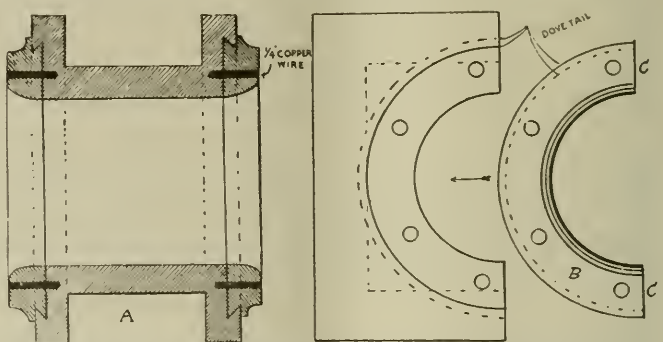


FIG. 1. ROD BRASS WITH DOVETAIL PIECES FOR WEAR.

A more substantial method of patching rod brasses than by soldering is shown in Fig. 1. A represents a sectional or end view of the brass, which, it will be noted, has been reduced in the lathe and a dovetail groove cut into the metal. B shows the patch which is cut in a circular form and divided into two pieces at CC. The patches, when fitted to the proper size by templet or otherwise, are readliy put in place on the brass and held in position by copper wire driven into holes drilled through the patch and a short distance into the brass.

Coming to the refitting of the connecting rods, the brasses should be left so as to move more freely than the fitting of the back end of the main rod already described. The vertical vibrations incidental to the action of the springs, the oscillations arising from variations in the track, and the ever-changing tractive effort essential to variable velocities all combine to render a certain amount of easiness in the joints of the connecting rods a mechanical necessity.

In this connection it may be mentioned that few roads are retaining strap ended side rods, which were at one time considered a necessity. Simple bushings in solid-ended rods are used instead, particularly on both pair of four-coupled locomotives and all but the main pins of multiple coupled locomotives. Some roads are even using bushings for the main crank pin also as shown in Fig. 2.

In readjusting the older type of connecting rods the wedges should be set up and the wheel centers should be trammed, and variations, if any, should be rectified, and the rods fitted while the crank pins are either in the forward or backward center. With the crank pins on the top at one side and exactly plumb, the crank pins at the other side will be on the dead center. In addition to the careful fitting of the brasses already alluded to, it is also important to have the rod with attached brasses, and liners, if necessary, the proper length. It is better that the rod should be fitted tightly between the crank pins than loosely, especially if the boiler is cool. The expansion of the frames when the engine is heated is small, but a rod fitted loosely, or, more properly speaking, a rod that may be a little short imposes a great strain on the bolts in the straps, while a rod that is snugly fitted will convey the strain directly to the crank pins.

When the rod is attached it should not be difficult to move either end of the rod slightly sidewise by tapping the rod with a piece of hardwood, taking care to avoid the pernicious practice of striking the rods with a soft hammer that is soft only in name. Rods that are battered and bruised by hammer blows are not only unsightly but are a sure indication of unskilled and careless workmanship.

A point that is well worth remembering is the testing of the rod when one end is attached in order to show whether it points exactly to the center of the corresponding crank pin. A deviation from this point is a serious drawback but can be readily rectified by the skilful mechanic. If the deviation is particularly marked a slight bending of the rod near the fitted end may be readily accomplished by the use of a screw press, or a slight variation may be overcome by a careful refitting of the brasses by removing a small quantity of the brass at the part of the bearing required to allow the rod to point centrally.

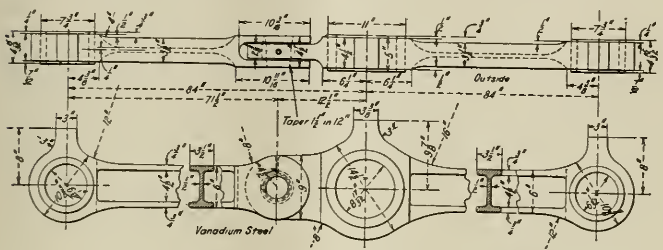


FIG. 2. SIDE RODS FOR PACIFIC TYPE (4-6-2) LOCOMOTIVE.

When the front end of the rod is connected it should also be observed when the strap of the other connection is pushed over the butt end of the rod for the purpose of driving in the bolts whether there is any twist on the rod or not. If any obliquity in the alignment of the rod and strap is visible, the brass at the end should be refitted and a perfect adjustment and alignment secured before driving the bolts in their places. It will occur to the thoughtful mechanic that both ends of the rod should be tested in this way, as one end of the rod is as likely to be in error as the other.

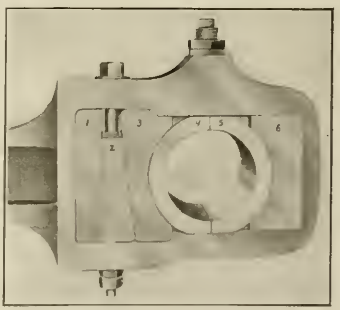


FIG. 3. MARKEL'S DESIGN OF BACK END OF MAIN ROD.

In testing the movement or degree of slackness of the rods time need not be wasted testing the rods in other than the central positions. It is only when at the dead centers that the connecting rods are free from the great strain of moving the engine, and are necessarily pulling in one direction or the other, and should not be expected to be moved easily except when the strain is removed. In brief, no exact idea of their adjustment can be got at any other point except at the centers, and it is safe to presume that if the rods pass the centers easily there is hardly any possibility of difficulty at any other point.

When the brasses are closed in refitting it should be seen that the opening for the oil way is sufficiently enlarged so as to insure a clear space for the oil readily reaching the crank pin without a projecting impediment of a portion of the brass overlapping the oil hole. An obstruction of this kind becomes a ready receptable for the collection of dust or other matter, and a stoppage of lubrication with serious results speedily follows.

The growing tendency of increasing the size of the crank pins in locomotives and fitting the conecting rods with massive bushings of the best material is a good one. The degree of perfection to which the machines used in the location or quartering of the crank pins is such that the correct relation of the parts is assured, and with the correct adjustment and maintenance of the wheel centers in their exact position the adjustment of the connecting rods becomes a matter of simple attachment.

It may be added that a recent improvement in main rods was introduced by Charles Markel, Clinton, Iowa, that is meeting with considerable popular favor. As shown in the illustration Fig. 3, the rod is of the solid end type. The brass is a round turned-up brass, and cannot work up and down in the rod opening as the round surface that the brass fits in on the retaining block prevents this. The two halves of this brass are held in the rod opening by two cast steel retaining blocks which are counterbored to hold the two half brasses from working sideways. When the wedge or key requires lining down all that is necessary is to take out the key bolt, slip the key out sideways, which allows the block to be moved back admitting liners to be put in place to bring the key down to the bottom of the rod opening. The front end of the rod is also fitted up with round turned-up brass, which has one filler block and key. The rod is either right or left and one pattern only is required.

The subject of lubrication has been so recently and so fully discussed in our pages that little need be added further than to emphasize the fact that this important matter requires constant attention. The addition of graphite has been found to be an admirable aid in retaining that degree of coolness which is essential to safety, especially when the rods are newly fitted or readjusted, and no engineer should be without a supply of this fine aid to perfect lubrication of the running parts of a locomotive.

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The Man Will Fail First.

Recently a collision occurred on a trolley line in Connecticut near Branford. About eighteen people are reported to have been killed and about forty injured. The collision happened on a short tangent between two curves, and the newspaper account places the blame on the surviving motorman, who is said to have admitted that he was drowsy and passed the siding where he should have waited, before he realized where he was. The other car was on schedule time, and appears to have been where it had a right to be.

We are not concerned in condemning a trolley line, nor do we wish to excessively blame the man who caused the tragedy. We have often tried to raise our voice in protest against the transportation superstition that all men will act alike, and act correctly, under similar circumstances. This fallacy is old and well established, but it rests on no more reason or authority than the superstition that asserts that a locomotive ought not to be turned out of the shop on Friday. All evidence is against it. Men act differently when urged by exactly the same cause. Given a good machine and a conscientious man, the chances are largely in favor of the theory that the man will fail first.

We all know the dulling effect on the brain of hot, humid weather. We know that certain physical effects produce abnormal mental action. We know how the whole psychological phenomena, which we are cognizant of, show man to be peculiarly liable to temporary mental aberration or failure. How often this abnormality is present we do not know, for much of it escapes being marked out for us by disaster. A man forgets to mail a letter his wife gave him, no serious results follow, and as we say, nothing happens, but who shall say that as far as the psychology of the case is concerned, that it was in any way different from the lapse which produced a railroad wreck. You may lose a nickel, or you may lose a hundred dollars and yet you may have been no more guilty of carelessness or neglect as far as mental make-up is concerned, in the one case than in the other. "Consequential damage" as the M.C.B. Association code says, is unrelated to the cause.

It is this consequential damage that the traveling public is subject to, and suffers grievously by. It is the death-dealing wreck that hurts, and casts a black shadow on all our boasted achievements in transportation. The man who causes a disaster will no doubt be punished, perhaps his family will suffer with him, but is it not time to acknowledge that such treatment of the guilty man utterly fails either to reform him or to adequately protect the public? As well might we throw a stream of water into the smoke of a burning building, while leaving the fire to burn with fury on the floor below.

The truth has come home to many railroad men, both of the operating and the executive departments, and these men see that some trustworthy mechanical means for forcing the imperatively-demanded right action, at the right time, is the prime, indispensable, crying need, if the danger of mental temporary lapse, with its deplorable consequences, is ever to be minimized or brought within the limits of control. The men who run our locomotives and man our trolley lines are not mere laborers, they are trained and skilled in their work. There is a high grade of intelligence possessed by these men and they have a conscientious appreciation of their work and its responsibilities. There is good material to work with, yet it is in the ranks of such men that psychological failure is to be found, and we are on occasion compelled owing to such failures to nail down the coffin lid over the faces of men and women who had a right to live.

Looking back at the origin of the human species as revealed by the doctrine of organic evolution, we find that man's place in nature required him to hunt, select or build a habitation, mate and rear offspring and to battle with the elements. He was fitted for all this, physically. The rapid development of brain power and, some think, of moral obligation also, far outran his primal equipment, and he is now compelled to live a life which Nature had not contemplated or prepared him for. It may be his endeavor to do these new things has taxed eyesight, brain-action and the power of concentrated attention on things which do not intrinsically interest, or entertain the mind. It may be that such considerations may give the key to the mystery of temporary mental failure, though they do not yet unlock the door. If we admit that many human activities such as running an engine, or operating a trolley car or an electric train are in a sense "new" to human nature, is it not but elemental wisdow to carry forward the work of providing adequate mechanical protection for the conscientious but fallible man? With every wish and intention to succeed, this man may find that his mind has wandered or he has become drowsy or tired when the exactions of his task stand there, unrelaxed, imperious, like some dumb force, blindly obeying the laws of their being as they "work out their fatal will, unswerved, unswerving, and know not that they are."

Hot Couplings and Bearings.

As is alluded to in an article on the adjustment of connecting rods published in this issue of Railway and Locomotive Engineering, the Federal regulations are somewhat lax in regard to the amount of lost motion in the bearings of locomotives. The article probably approaches the ideal, which is said to elude and ever will elude the seeker after perfection, but by aiming at the moon it is said that we may get to the top of the tree.

In summer in addition to the greater heat of the atmosphere there is also a marked increase in the amount of dust incident to all vehicular traffic. The particles of grit and other substances of an abrasive kind are apt to get in between the rubbing surfaces of the bearings. These cause cutting and heating of the bearings, and may be impossible to discover and remove without taking the bearing apart. A liberal supply of oil should be used, and if water pipes are attached water should be poured upon the heated parts. If the trouble is in a driving box, it should be examined to see if the wedge is jammed in the driving box. The slight expansion of the box and wedges, owing to the increased degree of temperature, may be sufficient to bind the box in the wedges, in which case the wedge should be slightly loosened, care being taken not to loosen the wedge too much, which may lead to frame breakages and other troubles, and also remembering to set the wedge up again in its proper place when the box has been sufficiently cooled. If lubrication and cold water and wedge-loosening do not have a permanent effect in cooling the box, a remedy may be found in relieving the bearing of some of the load resting upon the box. Hard wood wedges should be carried on the locomotive suitably formed so as to be readily driven in the space between the frame and spring saddle. A slight raising of the saddle will considerably diminish the weight on the bearing.

In the case of overheating the rod brasses the trouble may be more easily handled, but there is an added difficulty in the readiness with which babbitt metal will melt in the brasses before any evidences of heating may be observed by the locomotive engineer. Under such conditions it is generally advisable to keep the engine running until the babbitt is all melted out. Any attempt at cooling while the babbitt is in the melted state rarely fails to close up the oil holes and adds to the work to be done. A loosening of the rod and judicious lubrication generally have the desired effect, especially if graphite is added to the oil.

In regard to the heating of eccentric straps it should be remembered not to suddenly cool a heated cast iron eccentric strap with water. The tendency to crack the eccentric strap is very great. The best method is to slacken the bolts joining the two halves of the eccentric strap together and insert one or more tin liners. Lubricate well and do not move the reverse lever until the eccentric strap is fairly cooled. In conclusion it may be added that, as a rule, it is easier to keep well than to make well.

"The Men Be Pleased"

At a meeting of the mechanical department staff of a prominent railroad, the subject of making some alterations in accordance with suggestions made by a committee of enginemen was taken up. It seems that the vice president of the road had authorized the mechanical department to accede to the wishes of the men. The method of going about the work was something as follows: One engine of a certain type, agreeable to men and officials, was chosen for experiment before others of the same class were altered.

Briefly stated, the recommendations were that the straight-air valve was to be placed in a more convenient position in the cab, that the piping was to be changed to suit this new position of the valve and to accommodate it without other extensive alterations. The reach-rod was to be off-set, and new castings were to be made for the support of the reverse lever quadrant, so as to give more room in the cab. To so alter the cab as to give additional space for clothing, lunch pails, etc., and also to provide sufficient protection against severe weather in the winter, when backing up.

A meeting of certain officials was arranged for, and this committee was to select an engine of the specified type and to have drawings and blue prints prepared. As soon as one engine had been fitted according to these plans, the joint committee of enginemen and officials was to inspect the modified engine, and if it was found to be quite satisfactory, the rest of the class were to be fitted up, as agreed.

There was nothing of a very expensive or troublesome nature in the modifications asked for by the men. They knew what they wanted and the company showed good judgment in treating the whole matter in a pleasant and business-like way. It is hardly to be doubted but that the move was one in the right direction for men and railway. Many poor arrangements of cab accessories are due more to carelessness or lack of thought by the designers or builders, and the men who have to "live and work" with these things are likely to be able to form a correct idea of what they need. The company may not have been responsible for the poor arrangement, yet nevertheless, the re-location of awkwardly placed fittings may actually be a good investment for them.

In this connection, and in a sense related to it, is the up-keep work booked by enginemen at the end of each run. The mere repair work is good as it insures better working machines, but it has a subtle, moral effect as well. It gives enginemen confidence in the appreciation of their judgment by the men in charge of repairs, but it speaks, if one may say so, in an inaudible voice of the policy of the company, so that when it asks for economical operation it shows itself ready and willing to supply the means.

The Age Limit.

The revulsion of feeling against refusing employment to men who had reached forty-five years of age is one of the hopeful signs of the times. How the idea came of condemning a man in the prime of life to involuntary idleness is strange. Youth is more pliable, more subservient, more tractable, but age has experience, steadiness, and a wider and clearer mental vision, and to lose unnecessarily any period of a life of ripened efficiency is nothing more or less than an economic crime. A man in good health at forty-five should be capable of twenty-five years more at least of constantly improving mental and fairly sustained mechanical activity. If the war has done nothing else it has cleared the mental vision of the employers of labor of the fallacy complained of.

The so-called age limit is being abolished, and it is high time, and if in periods of emergency men of sixty or seventy or even older are being looked for and readily engaged, the same condition should have existed always. Not only so but the dispiriting effect on men reaching middle life was of the most pernicious kind. Humanity accommodates itself to any condition, and men who should have looked hopefully towards the future, yielded, we may be sure reluctantly to the inevitable and took not what they wished for and what they were capable of doing but what they could get.

The highly objectionable features of the age limit fallacy have now proved themselves the worthless figments of the mind, that they are. This is not the time to engage the feeble minded, the decrepit and the discards of commercial life. Necessity has demanded strong, vigorous, and practised men in all walks of life, and employers have been compelled to respond by a call for men who they had idly or wantonly forced out, in the insane worship of the "young man" craze.

The railroad companies have been as far wrong in this regard as any other branch of human activity. They merely followed the fashion. Now the companies are looking for men of experience and holding on to them, and it may be fairly said that the middle-aged railway man's opportunity has come, and it is up to himself to show whether he will rise to the occasion, and take his full share of the world's work, and continue to look forward and not backward. If the suppleness of physical activity cannot be fully maintained, it can be more than compensated for by a garnered experience, by clean living and right thinking, and that attribute of self-reliance which relieves those in authority of much of the care incidental to the management of the young and the inexperienced.

It is in ourselves whether we are satisfied with what we have done and fold our arms and become reminiscent or whether we are determined to "rise on stepping stones of our dead selves to nobler things." Again, in the words of Kipling if we are content to rest on the past then—

"The lamp of our youth will be utterly out; but we shall subsist on the smell of it,
And whatever we do, we shall fold our hands and suck our gums and think well of it.
Yes, we shall be perfectly pleased with our work, and that is the perfectest Hell of it!"

Pennsylvania's War Gardens.

A special bulletin just published by the Pennsylvania railroad publicity department shows that nearly 1,200 war gardens are being cultivated on vacant land, the property of the company east of Pittsburgh, by the railroads' employees. The value of the crops raised, it is said, will exceed a quarter of a million dollars.

Air Brake Department

Inspection and Testing the E. T. Locomotive Brake in Passenger Service—Must Conform to the Rules of the Interstate Commerce Commission

In order to make the series of questions and answers that refer to locomotive brake inspection more comprehensive, it may be well to outline in a general way, the manner in which the brakes may be properly inspected and tested in the shortest possible time. Assuming a passenger locomotive of ordinary construction, it is well to proceed in the following manner:

Start the inspection with approximately 45 lbs. pressure in the brake cylinders, the independent brake valve in lap position and the automatic valve in running position. Then start brake cylinder leakage test by closing the stop cock in the distributing valve supply pipe.

Beginning under the engine at the pilot, examine all brake cylinders and pipe connections with a torch, for leakage, measure piston travel, see that all cylinders and cylinder bolts are securely tightened and that no part of foundation brake rigging is less than 2½ ins. above the rail. Report brake shoes that are not approximately in line with the tread of the wheel, note that all piping is properly clamped and free from leakage, drain any main reservoir under engine and note last date of hydrostatic test, see that it is securely fastened, test air hose between engine and tender following air pipes to the rear of tender, giving the tender brake cylinder the same attention as accorded driving brake cylinders.

From the rear of the tender, go to distributing valve side of engine, testing this valve for leakage from exhaust port or gaskets, test main, equalizing and distributing valve reservoirs for leakage and see that all are securely tightened, drain right main reservoir, noting last date of hydrostatic test, and follow brake and signal pipes to pilot. Test air hose and piping between hose and stop cocks on pilot, pass to left main reservoir testing it and related piping for leakage, and open drain cock.

Examine air compressor, as will be specified in the questions and answers, also the waste pipe from the compressor governor. When this operation has been completed close reservoir drain cock, blow dirt out of hose couplings at rear of tender and attach a test gage and device with various sized openings first to the signal hose, and test signal whistle with both a 1/16 in. and 3/64 in. opening, and if necessary with one larger sized opening, as will be explained. The feed valve is then to be tested with both a 3/64 in. and a 1/16 in. circular opening and with one larger sized opening for a capacity test.

After feed valve test has been completed, close orifices and carefully note figure of feed valve adjustment and immediately enter the cab to compare test gage with engine gages. This may be varied if two inspectors are used on the same engine or if special apparatus is used whereby a test gage may be brought into the cab window of the locomotive.

Place automatic brake valve handle on lap position and close the air pump throttle, test all piping in cab, signal valve, brake valve gaskets and exhaust ports for leakage, see that all valves are tight on brackets, note last date of brake cleaning, air compressor and air gage tests and test air pump governor and operating pipe for leakage.

Note the drop in air pressure, as shown by the gages during the interval the brake valve remained on lap position and the pump throttle was closed. Leakage in the main reservoir and pipe connections must not exceed 2 lbs. per minute, if it does another test of 3 minutes duration must be made after the pressure has reduced 60 per cent below the maximum carried. Leakage from the brake pipe volume must not exceed 3 lbs. per minute.

At this time 5 minutes or more will have elapsed since the inspection was started no pressure remaining in the brake cylinders, brake must remain applied for a period of not less than 5 minutes with communication to the brake cylinders closed.

Open air pump throttle, move brake valve to running position, and open the stop cock in the distributing valve supply pipe.

When air pressures have been restored to the maximum, move automatic brake valve to service position, making a 5-lb. brake pipe reduction, which should apply the brakes, unless the distributing valve is of a special type. During this time note that the equalizing discharge valve of the brake valve responds to a light reduction in equalizing reservoir pressure and closes off tightly when the reduction ceases and that the compressor governor is sensitive enough to permit the compressor to start promptly when the brake applies.

From lap position, again move the brake valve to service position, making 5 lbs. more brake pipe reduction, which should result in 25 lbs. brake cylinder pressure for the total 10 lbs. reduction. Make 10 lbs. more to see that 50 lbs. cylinder pressure is obtained for 20 lbs. reduction in brake pipe pressure. Make 20 lbs. more brake pipe reduction and note that brake cylinder pressure does not exceed 68 lbs., and follow with another reduction that will bring brake pipe pressure to a lower figure than brake cylinder pressure to see that there is no back leakage from the brake cylinders into the brake pipe, which would then unseat the equalizing discharge valve of the brake valve.

Release brake with the independent brake valve, application cylinder pressure should be practically exhausted in from 2 to 3 seconds' time.

Move automatic brake valve to release position, until pressure chamber of the distributing valve is charged to 125 or 130 lbs. During this time main reservoir, equalizing reservoir and brake pipe pressure will register the same if air gages are correct, as determined by the test gage when entering the cab, after the feed valve test.

When pressure chamber is sufficiently overcharged make another reduction with the automatic brake valve just sufficient to apply the brake, and with the brake pipe pressure still above 110 lbs., return brake valve to running position. The brake should remain applied.

With the automatic brake valve reduce brake pipe pressure to 110 lbs., then direct from 110 to 90 lbs. and the equalizing reservoir reduction must take place in from 5½ to 6 seconds time. Any variation in this rate of reduction must be reported.

Return automatic brake valve handle to holding position, the feed valve must promptly return the brake pipe pressure to 110 lbs., and the brake must remain applied (standard equipment). Test the release pipe branch between the brake valves for leakage.

Move the automatic brake valve to running position, and after brake has completely released, move independent brake valve to slow application position, 40 lbs. brake cylinder pressure should be obtained in from 6 to 8 seconds' time.

Graduate the brake off by alternating the valve handle between lap and running position, and if the distributing valve is sufficiently sensitive brake cylinder pressure can be exhausted in steps of from 5 to 7 lbs. at a time.

After the brake has again fully released, move the independent brake valve to quick application position, 40 lbs. brake cylinder pressure should be obtained in from 2 to 4 seconds' time and the final pressure should be the same as shown by the test gage during the signal whistle test.

The brake cylinders and brake cylinder operating devices are out of date for attention 6 months after the dates shown by stencil marks on their parts, or on metal tags attached to the brake pipe near the automatic brake valve in the cab, or an a form displayed under glass in the cab.

Air gages and air compressors are out of date for test 3 months after the dates shown inside the glass of the gage or from the date shown on the form in the cab of the locomotive.

Main reservoirs are out of date for hydrostatic test 12 months after dates shown or for a hammer test 18 months after dates shown.

Driver brake, truck brake or trailer brake cylinder piston travel must be between the limits of 4 and 6 inches.

Tender brake piston travel should not exceed 8 inches and must not under any circumstances exceed 9 inches.

Main reservoirs of locomotives MUST be drained of water after or just before each trip.

Lubricating swabs should be maintained on the piston rods of all air compressors.

When operating the various stop cocks and angle cocks they must be opened and closed slowly.

Test gages must be tested at least once each week, by a dead-weight tester or by an accurate test gauge.

Locomotive Air Brake Inspection.

(*Continued from page 263, August, 1917.*)

29. Q.—What is the proper location of the angle cock at the rear of the tender?

A.—It varies with different constructions of tenders, but generally the angle cock is from 13 to 14½ inches from the center line of the coupler and from 12 to 14½ inches back of the inside face of coupler and usually within an inch of the horizontal line of center of coupler. This location is always covered by prints showing the construction of the tender.

30. Q.—Where should the angle fitting at the rear of the signal pipe be located?

A.—Its center line should be several inches lower than the angle cock and a little over 2 inches nearer the coupler.

31. Q.—How should an inspection be continued from the rear of the tender?

A.—To the right, or distributing valve side of the engine, testing the distributing valve, its gaskets, distributing valve, equalizing and main reservoirs and all pipe connections for leakage. Particular attention should be given to see that all bolts, nuts and reservoir hangers are securely tightened, and that there is no vibration.

32. Q.—What other attention should the right main reservoir receive at this time?

A.—It should be drained of any accumulation of water, and examined for stencil marks indicating the last date of hydrostatic test.

33. Q.—From this point, to where should the inspection be continued?

A.—Along the reservoir, brake and signal pipes to the front of the engine, giving the same attention as specified for the brake cylinder pipes.

34. Q.—What attention is to be given the air hose on the pilot?

A.—The same as those between the engine and tender; they are to be tested for leakage by opening the stop cocks if dummy couplings are used; or if none on the pilot, a gage or test coupler must be attached and the hose and piping between them and the stop cocks tested.

35. Q.—What parts are next to be tested?

A.—The left main reservoir and its related piping, the last date of test noted and the drain cock opened and left open to keep the compressor in operation.

36. Q.—How often must a hydrostatic test of the main reservoirs be made?

A.—At least once each 12 months.

37. Q.—How often must the hammer test be made?

A.—Once every 18 months.

38. Q.—What if it happens to be a new reservoir and has no stencil marks?

A.—The date may be shown on a form in the cab, or by a metal tag attached to the return or connecting pipe; otherwise the reservoir is out of date for test, as reservoirs must be tested before being placed in service.

39. Q.—What inspection should be given the air compressor?

A.—To see that there is no leakage from the pipe connections, stuffing boxes, or from gaskets, air valve caps or cages, and that the compressor is not groaning, pounding, blowing or overheating.

40. Q.—What else must be observed?

A.—That the air strainers are clean and that air is drawn in on both strokes of the piston, and that the compressor is tight on the bracket and that the bracket is tight on the boiler.

41. Q.—What causes blows at the steam exhaust of the compressors?

A.—Usually a poor fit of packing rings, worn out rings or worn cylinders, of the steam end, or of the steam valve mechanism.

42. Q.—What is the result if these blows receive no attention or are not corrected?

A.—They usually result in the stopping of the compressor in service and sometimes in an engine failure.

43. Q.—What is the effect of gummy and sticky air valves, especially in the cross compound compressors?

A.—They cause a pound that soon loosens the pump on the bracket and results in breaking off bracket studs in the boiler.

44. Q.—How can the condition of the air cylinder packing rings be ascertained in a general way?

A.—By noting the volume of free air that is drawn into the cylinders; with good rings air will be drawn in freely, and with poor rings very little will be drawn in when the main reservoir pressure is high.

45. Q.—What is the effect of leaky discharge or intermediate air valves?

A.—They reduce the amount of free air that is drawn into the cylinder, reducing the capacity of the compressor and the leaky valves tend to cause overheating of the air cylinders.

46. Q.—What indicates back leakage through these valves?

A.—Uneven strokes of the compressor, the piston moving slowly in the direction of the defective valve, and more rapidly away from it.

47. Q.—What is wrong if air blows back out of the air strainer when the compressor is working?

A.—One of the receiving valves is leaking or off its seat.

48. Q.—What is done at the completion of the compressor inspection?

A.—The main reservoir drain cock is closed, and an air gage or test coupler attached to the signal pipe hose at the rear of the tender.

49. Q.—What is to be done before attaching a gage or coupler to the signal or brake hose at the rear of the tender?

A.—The hose couplings are to be blown out by opening the cocks a trifle.

50. Q.—For what purpose?

A.—To prevent dirt from being blown into the test gage.

51. Q.—How frequently should a test gage be tested and known to register correctly?

A.—It should be tested on a dead weight tester at least once each week.

52. Q.—Is the signal equipment or the brake feed valve to be tested first?

A.—The signal whistle, with a 1/16 and 3/64-in. orifice.

53. Q.—What would likely be wrong if the whistle would sound when the gage was attached but the whistle could not be operated with a 1/16-in. opening?

A.—The diaphragm stem of the signal valve would be too loose in its bushing.

(*To be continued.*)

Train Handling.

(*Continued from page* 264, *August*, 1917.)

35. Q.—How would the brake valve be handled in coupling to a string of uncharged cars if a hurried movement was to be made before the brake test?

A.—By making one or two heavy applications with the automatic brake valve and leaving the valve handle on lap position while the hose connections are made.

36. Q.—For what purpose?

A.—To have a reduced pressure in the pressure chamber of the distributing valve reservoir or in any auxiliary reservoir on the engine or tender, so that there will be no brake sticking.

37. Q.—Is there any other advantage in this?

A.—This will prevent a full application of the engine brakes when the hose are coupled and thus avoid an additional waste of main reservoir pressure through the brake cylinders, and the maximum main reservoir pressure will be accumulated for the charging of the train.

38. Q.—What position of the brake valve will then be used to charge the train?

A.—Full release position.

39. Q.—When should the brake valve handle thereafter be brought to running position?

A.—When the brake pipe pressure is about up to the adjustment of the feed valve.

40. Q.—Why do the compressors stop if the brake valve handle is brought to running position before the auxiliary reservoirs are charged?

A.—Because the auxiliary reservoirs absorb brake pipe pressure at a faster rate than at which the main reservoir pressure can flow through the feed valve into the brake pipe.

41. Q.—How does this cause the compressors to stop?

A.—The difference between main reservoir and brake pipe pressure will exceed the tension of the regulating spring of the excess pressure governor top, and the diaphragm valve of this governor top will become unseated and stop the compressors.

42. Q.—How long will the compressors remain shut down?

A.—Until the main reservoir pressure reduces, through expansion into the brake pipe, to a figure within 20 lbs. of the pressure in the brake pipe.

43. Q.—How is it ascertained that the train is about charged?

A.—By the slowing down of the compressors and the positions of the air gage hands.

44. Q.—How is a test for brake pipe leakage made?

A.—By noting the fall of the brake pipe gage hand after an application of the brakes has been made.

45. Q.—If the brake valve is placed in lap position and the gage hand of the brake pipe falls, how does the action of the brakes indicate whether the fall in pressure is due to brake pipe leakage or an uncharged train?

A.—If it is due to brake pipe leakage the brakes will apply and brake pipe pressure will continue to fall, but if some of the auxiliary reservoirs are still uncharged, the brakes will only apply on the cars with the charged reservoirs and brake pipe pressure will cease to fall when equalization has taken place.

46. Q.—After waiting a reasonable length of time for the reservoirs to become charged, what could be wrong if the compressors stopped every time the brake valve handle was brought to running position?

A.—That brake pipe leakage was in excess of the capacity of the feed valve.

47. Q.—What would be done if the train crew was to state that there was no unusual leakage in the brake pipe?

A.—A test of the capacity of the brake pipe feed valve would be made.

48. Q.—How may this be done?

A.—By closing the brake valve cut out cock and open the brake pipe of the engine to the atmosphere; then with maximum air pressure in the main reservoir and brake pipe above the cut out cock, open the cut out cock and note the fall of main reservoir pressure.

49. Q.—With the main reservoir capacity usually found on modern locomotives, that is, from 60,000 to 80,000 cubic inches, with the brake pipe feed valve in good condition and no restrictions in the brake pipe, how long will it require for the pressure in the main reservoir to reduce 20 lbs. under this condition?

A.—It should reduce from 90 to 70 lbs. in from 30 to 40 seconds, and in passenger service from 130 to 110 lbs. in from 15 to 20 seconds' time.

50. Q.—What would you think wrong if the governor would not hold the compressors shut down during this test; that is, with the brake pipe open to the atmosphere?

A.—That there was some restriction in the brake pipe or brake valve of the locomotive, and that because of it, feed valve pipe pressure was being maintained.

51. Q.—Is there anything else that could cause the compressors to stop besides brake pipe leakage in excess of the capacity of the feed valve?

A.—Yes, a defect of the excess pressure top of the pump governor.

52. Q.—What would you do if the feed valve was working at its maximum capacity during this test; that is, expanding the main reservoir pressure into the brake pipe in the specified length of time?

A.—Examine the piping of the locomotive for leakage, and insist that the leaks in the brake pipe be tightened to a degree that the feed valve will be able to maintain the pressure in the brake pipe.

53. Q.—What would be done if it required approximately one minute for the main reservoir pressure to reduce from 9 to 70 lbs., with the size of reservoirs specified?

A.—The engine would be taken back to the shop unless specific instructions forbid this.

54. Q.—Why not clean the feed valve when indications are that it is defective?

A.—The trouble is not likely to be in the feed valve, and even if it usually requires a drill press to remove obstructions from the feed valve and sometimes necessitates the removal of the supply valve piston bushing.

55. Q.—Why not proceed with the brake valve in release position?

A.—The train might be parted en route, and with large capacity compressors the pressure on the engine may be held to a standard with the angle cock at the rear end of the train open to the atmosphere, so that with the engine brake released with the independent brake valve, the carrying of the brake valve in release position might result in a portion of the train being left along the road.

56. Q.—Is there any other reason why a train should not be run over the road with brake pipe leakage that is in excess of the capacity of the feed valve?

A.—Yes, with excessive brake pipe leakage the control of the train is taken away from the engineer.

57. Q.—In what manner?

A.—If instructions call for a specified amount of brake pipe reduction for a stop, and brake pipe leakage continues the reduction, instructions are not being followed and the brakes are not under the control of the engineer.

58. Q.—How should an attempt to release brakes be made in the event of brakes sticking?

A.—By a quick movement of the brake valve to release and back to running position.

59. Q.—Why a quick movement?

A.—To "kick off" any brakes that may have applied through an inequality of pressure, without overcharging the auxiliary reservoirs at the head end of the train.

60. Q.—Should a few of these movements to release be made just before ascending a grade to insure that brakes are released?

A.—Under no circumstances, except in actual cases of brakes sticking.

61. Q.—What would several of these movements to release likely accomplish?

A.—An overcharge of the auxiliary reservoirs at the heads end.

(*To be continued*)

Car Brake Inspection.

(*Continued from page 265, August, 1917.*)

28. Q.—How much brake pipe reduction is required to open a brake cylinder pressure regulating device that is set at 60 lbs.?

A.—About 24 lbs. if the brake cylinder piston travel is correct.

29. Q.—How can sufficient brake cylinder pressure be obtained to open the reducing valves or safety valves, if but 75 or 80 lbs. brake pipe pressure is available?

A.—By screwing a pipe plug in the operating valve exhaust port, and making two or more brake pipe reductions, fully recharging between reductions.

30. Q.—What should be done if it is found that the slack adjuster has taken up slack almost to the extreme end of its travel, and that the brake shoes are practically of full thickness?

A.—The slack adjuster screw should be run back until the cross head is very near the pressure head of the brake cylinder, then the piston travel should be adjusted by means of the truck levers.

31. Q.—What levers should be used for the adjustment?

A.—The dead truck levers on four wheel trucks, if this will shorten the travel sufficiently and still leave the truck, piston and cylinder levers standing approximately at right angles when the brake is applied, or with a 6-wheel truck the slack should be taken up by means of the turnbuckle nearest the middle of the car.

32. Q.—How is piston travel adjusted with clasp type of foundation brake gear?

A.—A blue print or standard tracing of the rigging should be used to obtain proper lengths of rods and levers, and when these are correct, any necessary adjustments can thereafter be made with the automatic adjuster.

33. Q.—Why is it not necessary to make any changes in the brake rods when slack adjusters are in use?

A.—Because all rods and levers are of such length that, with a new set of brake shoes and the slack adjuster crosshead up to the pressure head of the brake cylinder, an entire set of shoes can be worn out without the aid of any hand adjustment.

34. Q.—What could be wrong if the adjuster would not do this, or would at times take up an amount of slack that would hold the brake shoes against the wheels when the car is standing with the brake released?

A.—It would indicate that some improper adjustment had been made in the rigging or that the car was too high leveraged; that is, that the valve of the cylinder had been multiplied too many times in developing the desired brake shoe pressure.

35. Q.—If the brake rigging of a car is in good condition and new brake shoes have been applied, what should be observed in connection with the operation of the slack adjuster?

A.—That the adjuster is in an operative condition, and that the pipe leading to it is free from leakage.

36. Q.—How is this determined?

A.—By allowing enough brake slack for the piston to travel about 8½ inches when the brake is applied; then make a chalk mark across the adjuster nut and casing and test the pipe connections. The brake piston having passed the pipe connection port in the cylinder will have filled the adjuster pipe with air pressure, and when the brake is released the chalk mark being broken will indicate that the adjuster screw has been moved to take up brake slack.

37. Q.—Should any other chalk mark be made?

A.—After the piston travel has been properly adjusted by means of the adjuster screw, a chalk mark may be made across the adjuster body and the crosshead, which will thereafter show the distance the crosshead has traveled since the last adjustment.

38. Q.—To what distance should piston travel be taken up, by hand, or with the adjuster nut?

A.—To a standing travel of 6½ ins. for single shoe gear and to 7½ ins. for clasp brake rigging.

39. Q.—When applying brake shoes on the average car with single shoe gear, how can the approximately correct travel be obtained if there is no air pressure available?

A.—By moving the crosshead toward the brake cylinder a distance equal to ¾ in. for each brake shoe applied to a 6-wheel truck, and 1 in. for each shoe applied to a 4-wheel truck, but this should always be checked up after the engine couples to the train or air pressure can be obtained.

40. Q.—What attention should be given to air pipes on the inside of the car?

A.—Brake pipe branches and the conductor's valve should be tested, also the signal pipe branch and discharge valve, for leakage. The discharge valve cord should be pulled to know that a strong flow of air issues.

41.—What should be observed in connection with the cords to the discharge and conductors' valves?

A.—That they are properly located and that the conductor's valve especially may be operated from any part of the car.

42. Q.—If the car is equipped with a brake cylinder pressure retaining valve, how should it be tested?

A.—The valve handle should be turned up after the brake has been applied, and if the brake shoes can be moved on the wheels within a period of three minutes from the time the triple valve moves to release position, there is some leakage in the retaining valve, piping or the brake cylinder that should be repaired.

43. Q.—How can this leakage be found if the brake leaks off very quickly?

A.—By having one inspector make several brake applications and releases while another inspector is testing the retaining valve and its pipe connection.

44. Q.—After a passenger train is made up, at a terminal, and the brake pipe has been charged from the yard test plant and the plant hose removed, what are the positions of the angle and signal pipe stop cocks at the ends of the train?

A.—They are closed at both ends.

45. Q.—Why are signal stop cocks closed?

A.—To retain the pressure in the signal pipes.

46. Q.—Why is this desirable?

A.—It will then not be required to charge the signal pipes from the locomotive, and this will be found to be of advantage in hurried movements.

47. Q.—What should be done with the hose couplings at the rear end of the train?

A.—They should be hung up in the dummy couplings provided for the purpose.

48. Q.—If the train is being made up in sections and from the rear, what is a good practice after coupling the brake pipe and signal hose?

A.—To see that there is a flow of air from the rear angle cock and signal stop cock after every coupling has been affected.

49. Q.—For what particular purpose?

A.—To avoid the possibility of leaving an angle or stop cock closed.

50. Q.—What will be the position of all the brake pipe branch stop cocks?

A.—Open with the handle cross ways of the line of pipe.

51. Q.—How will the handles of the reservoir train cocks stand?

A.—In line with the cock.

52. Q.—Is this ever varied?

A.—Yes, the handles are sometimes put on wrong and in some of the older styles of ¼-in. cocks the handle stands in line with the cock when the cock is open.

53. Q.—What should be done if the handle is observed to be cross ways with the cock?

A.—It should be turned in line with the cock for an instant to see that the reservoir is charged.

54. Q.—How can the position of the cock be ascertained if there is no air pressure in the system?

A.—By running a piece of wire into the opening of the cock.

(*To be continued.*)

Notable Design of Eight Coupled Switcher for the Duluth, Missabe & Northern Railway

The Seddon Boiler Feed Arrangement Used

Among the heavy switching locomotives of notable design that have recently been constructed, there are four built by the Baldwin Locomotive Works for the Duluth, Missabe & Northern Railway. These engines are of the 0-8-0 type, and they develop a tractive force of 49,700 lbs., the weight on drivers being 216,000 lbs. The ratio of adhesion is 4.34. The result of this is a locomotive of large hauling capacity, with sufficient weight on drivers to enable full tractive force to be developed under ordinary rail conditions.

The boiler used in this design is of liberal dimensions, and is equipped with a superheater, brick arch and power operated fire-door. The firebox throat is immediately above the rear pair of driving-wheels, and the tubes have a length of 15 ft. The boiler barrel is composed of two rings, and the first of these is conical, so that ample steam space is provided. Three rows of Baldwin expansion stays support the forward end of the firebox crown, and flexible bolts are used in the breakage zones in the throat, sides and back. The large boiler tubes are welded at the firebox end. In accordance with the practice of the Missabe road, the Seddon boiler feed arrangement is used. This device is the invention of C. W. Seddon, superintendent of motive power of the road. The feed is discharged into a specially designed pan, in which a considerable amount of scale forming material is deposited. This arrangement reduces the expense of boiler maintenance on the Missabe road, and cleaner boilers have been the rule since it began to be used, which is about eight years ago.

The steam distribution is controlled by 12-in. piston valves; and the valve motion is of the Walschaerts type. The use of a power reverse mechanism is becoming common on large switchers, and in this case the Ragonnet gear is applied. The pistons have rolled steel heads, with bull-rings bolted on. The piston rods are of heat treated carbon steel.

The equalization system divides between the second and third pairs of driving-wheels, and the engine is cross-equalized in front so that the equivalent of a three-point suspension system is obtained. Each main frame is cast in one piece of 40 per cent. carbon steel. The transverse braces include a heavy cross tie which is bolted to the rear driving pedestals, and supports the front end of the firebox through a vertical expansion plate. The pedestal shoes and wedges are of cast iron, with bronze faces fused on. The driving tires are all flanged, and flange oilers are applied to the front and rear wheels.

The tender trucks are of the arch bar type, and the wheels are of rolled steel. The tank has a water-bottom, the sloping back, so often found on tenders for switching engines, but the sloping back is not being used in this case. The tank, however, is designed so that the enginemen have a good view of the track when they are backing up.

This is a most substantially built locomotive, suitable for severe service but incorporating refinements which improve its efficiency and economy. Further particulars are given in the table which we here append for reference:

General — Cylinders, 24 x 28 ins.; valves, piston, 12 ins. diameter.

Boiler—Diameter, 76 ins.; thickness of sheets, 3/4 in. and 13/16 in.; working pressure, 185 lbs.; fuel, soft coal; staying, radial.

Fire Box—Length, 96 1/8 ins.; width, 72 1/4 ins.; depth, front, 73 1/2 ins.; back, 67 1/4 ins.; thickness of sheets, sides, back and crown, 3/8 in.; tube, 1/2 in.

Water Space—Front, 5 ins.; sides and back, 4 1/2 ins.

Tubes—Diameter, 5 1/2 ins. and 2 ins.; thickness, 5 1/2 ins., No. 9 W. G.; 2 ins., No. 11 W. G. There are 34 tubes 5 1/2 ins. and 225, 2 ins; length, 15 ft.

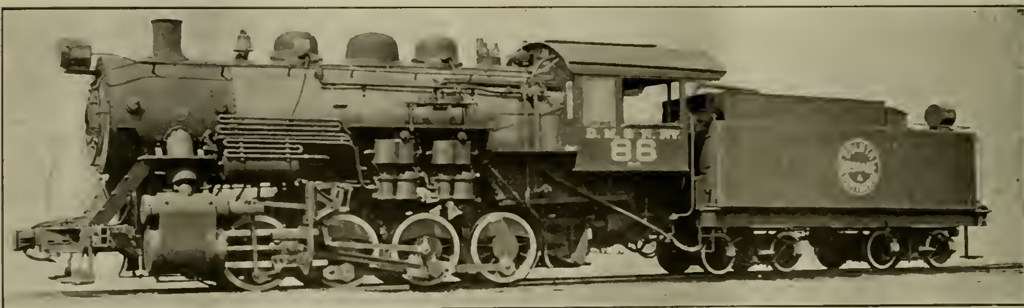
Heating Surface—Fire box, 180 sq. ft.; tubes, 2,487 sq. ft.; firebrick tubes, 23 sq. ft.; total, 2,690 sq. ft.; superheater, 621 sq. ft.; grate area, 48.2 sq. ft.

Driving Wheels — Diameter, outside, 51 ins.; journals, main, 11 x 12 ins.

Wheel Base—Driving, 15 ft.; rigid, 15 ft.; total engine, 15 ft.; total engine and tender, 50 ft. 9 ins.

Weight—On driving wheels, 216,000 lbs.; total engine, 216,000 lbs.; total engine and tender, about 350,000 lbs.

Tender — Wheels, diameter, 33 ins.; journals, 5 1/2 x 10 ins.; tank capacity, 7,000 U. S. gals.; fuel capacity, 14 tons.



HEAVY SWITCHER (0-8-0) FOR THE DULUTH, MISSABE & NORTHERN.

C. W. Seddon, Supt. Motive Power. Baldwin Loco. Wks., Builders.

Saving in Coal.

The railroad systems in the Eastern department have cut out 8,598,696 miles of passenger train service, thus saving 716,113 tons of coal per year. The Pennsylvania system eliminated 3,300,000 miles of train service, thus saving 186,876 tons of coal. The New York Central plans to save 126,000 tons of coal. The Erie has cut out 1,600,000 passenger train miles; the Baltimore & Ohio, 1,168,596; the Chesapeake & Ohio, 850,000.

Eclipse Yoke Changes Hands.

The American Steel Foundries, Chicago, has purchased the Eclipse Cast Steel Coupler Yoke from the National Car Equipment Company. The Eclipse Yoke requires neither keys nor rivets, and is in use on a large number of roads.

Heavy Mountain or 4-8-2 Type of Locomotive for the New York Central Lines

Ragonnet Reverse Gear Applied

The American Locomotive Company have recently built a number of 4-8-2 or Mountain type locomotives for the New York Central lines. The engines are built very much on the lines followed by the builders in supplying power to the N. Y. C. previous to this. The cylinders are 28 ins. diameter by 28 ins. stroke, and the tractive power developed with a steam pressure of 185 lbs. per square inch is 50,000 lbs. The factor of adhesion is 4.68. This is the weight on the driving wheels, 234,000 lbs. divided by the tractive effort, 50,000 lbs. The wheels are 69 ins. in diameter, and the connecting rod drives on the second wheel. Walschaerts valve motion is used, and it is neatly applied so that while readily accessible it is not conspicuously in evidence. Ragonnet reverse gear is used.

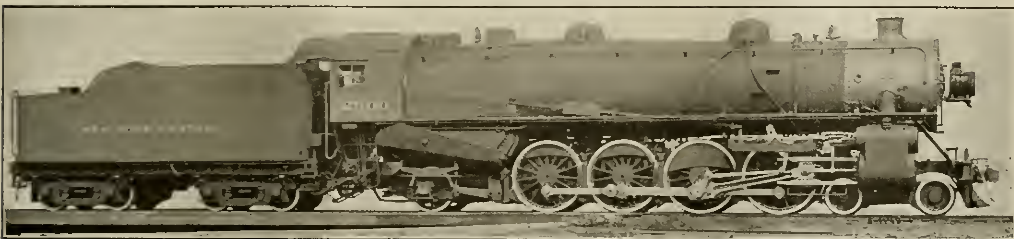
The weight of the whole machine, including the tender, is 509,000, and of this the engine truck gets 52,500 lbs., the trailing truck or carrying wheels claim 56,500 lbs., and the weight on the driving wheels 234,000 lbs. This leaves about 166,500 lbs. for the tender. The tender has a water bottom, and will contain about 8,000 gallons of water and 14 tons of bituminous coal, for which the firebox and boiler are designed. The rear truck or carrying wheels under the cab are equalized with the rear drivers and the fulcrum holes in the equalizing lever are arranged in a set of three so that by altering the fulcrum pin more or less weight may be put on the driving wheels as occasion demands. Some of the principal dimensions are here appended for reference: Track gauge, 4 ft. 8½ ins.; piston type valve used; wheel base driving 18 ft, rigid 18 ft., total 38 ft. 11 ins.; wheel base total, engine and tender, 72 ft. 9 ins.

Weight in working order 343,000 lbs., on drivers 234,000 lbs., on trailer 56,500 lbs., on engine truck 52,500 lbs., engine and tender 509,600 lbs.; boiler, type conical connection, first ring, outside diameter is 81 7/16 ins.; working pressure, 185 lbs. Firebox type wide, length 114¼ ins., width 84¼ ins.; combustion chamber, width 40⅞ ins.; thickness of crown, ⅜ ins.; tube, ½ in.; sides, ⅜ in.; back, ⅜ in.; water space front, sides and back, 5 ins.; depth (top of grate to center of lowest tube), 22¾ ins.; crown staying 1⅛ ins., radial; tubes, knobbled char. iron, number 216, diameter 2¼ ins.; flues, cold drawn seam, steel 45, diameter 5½ ins; thickness tubes, No. 11; flues, No. 9; tube, length, 21 ft. 6 ins.; spacing, ¾ in.; heating surface, tubes and flues, 4,110 sq. ft; heating surface, firebox, 292 sq. ft.; heating surface, arch tubes, 28 sq. ft.; heating surface, total, 4,430 sq. ft.; superheater surface, 1,212 sq. ft.; grate area, 66.8 sq. ft.

Wheels, driving diameter outside tire, 69 ins.; center diameter, 62 ins.; wheels, driving material, main, cast steel; others, cast steel also; wheels, engine truck, diameter, 33 ins.; kind, solid steel; wheels, trailing truck, diameter, 45 ins.; kind, cast steel, tired; wheels, tender truck, diameter, 36 ins.; kind, forged steel; axles, driving journals main, 11½ ins. x 18 ins.; other, 11 ins. x 13 ins.; axles, engine truck journals, 6½ ins. x 12 ins.; axles, trailing truck journals, 9 ins. x 14 ins.; axles, tender truck journals, 5½ ins. x 10 ins.; boxes, driving, main, cast steel; others, cast steel; brake, driver, New York; truck, New York; brake tender, New York; brake pump, 2 No. 5-B Duplex, reservoir, 1—24½ ins. x 42 ins., 1—24½ ins. x 66 ins., 1 18½ ins. x 60 ins.; engine truck, Woodard; trailing truck, radial.

Exhaust pipe single nozzles 7¾ ins.; grate, style, rocking; piston, rod diameter, 4½ ins.; piston packing, 1 side snap, 1 side dunbar; smoke stack, diameter, 20 ins.; top above rail, 15 ft. ¾ in.; tender frame, cast steel; tank, style, water bottom, as is in use on many roads.

Valves, type, 14 ins.; piston travel, 7 ins.; steam lap, 1⅛ ins.; valve, ex., clearance, ⅛ in.; valves, setting, lead, 3/16 in.



MOUNTAIN OR 4-8-2 TYPE ENGINE FOR THE NEW YORK CENTRAL LINES.

John Howard, Supt. Motive Power. Am. Loco. Co., Builders.

English Channel Tunnel Project.

New York capitalists have made inquiries recently regarding the construction of a tunnel under the English channel. The experience gained in driving the tunnels under the Hudson and East rivers would not be neglected in a venture such as has been proposed by statesmen of England and France. The latest advices from London are to the effect that the tunnel will surely be built after the war is over, but that it will not be practicable to begin this work at the present time. Estimates of the cost run from $80,000,000 to $100,000,000. The project has been frequently discussed.

Thames River Bridge.

The sub-structure of the new Thames river bridge being built by the New York, New Haven & Hartford Railroad Company, at New London, has been completed. The war demands has delayed the completion of the bridge, preference being given to government contracts. Since 1908 the old Thames river bridge has been operated as a single track structure, owing to the increase in weight of train equipment. The bridge was constructed in 1888, and has long been the "pinching" point in the system; the draw span of 503 feet was at that time the largest in the world. The old bridge is 2,400 tons, and the new one 5,225 tons. The new bridge will be of the bascule or lift span type. A four-track super-structure is provided for. The new bridge will be a five-span structure, 1,387 feet in length. It is confidentially expected that the needed supply of steel material will be delivered during the present year.

Electrical Department

The Commutator—Atmospheric Electricity—Electrical Condensers, Etc.

The Commutator.

(*Continued from page 269, August, 1917.*)

The commutator is made up of a series of copper bars with sheet mica a few mils in thickness between each bar. Sometimes trouble is experienced from the burning out of this mica insulation between the segments. This is most commonly caused by allowing the mica to become oil-soaked. When burning occurs, the effect can usually be removed by scraping the burned mica and filling the space with a solution of sodium silicate, commonly known as water-glass.

A great many of the machines at the present day have the commutator "undercut." Under-cutting consists in the removing of the mica between the bars below the surface of the copper, to a depth of about 1/16 of an inch. The commutator eventually wears down, due to the friction between the brushes and the commutator, and in certain cases to light sparking, and in the end the mica becomes flush; if it is not worn down equally with the copper it will become higher. This case of "high mica" will start sparking, which burns away the copper and aggravates the difficulty. By prompt action serious damage can be prevented by cutting down the mica.

Sparking at the commutator is a common occurrence, especially in the case of older machines which are not fitted with inter-poles. It will not be out of place to mention some of the causes for sparking at the brushes. (1) The machine may be overloaded. (2) The brushes may not be set exactly at the point of commutation. A position can always be found where there is no perceptible sparking, and at this point the brushes should be set and secured. (3) The brushes may be wedged in the holders or have reached the end of their travel. (4) They may not be fitted to the circumference of the commutator. (5 They may not bear on the commutator with sufficient pressure. (6) The commutator may be rough, and, if so, it should be smoothed off. (7) A commutator bar may be loose or may project above the others. It will then be necessary to true up the commutator by turning in a lathe. (8) The commutator may be dirty and oily. (9) Trouble may be caused by high mica. (10) The carbon brushes may be of an unsuitable grade, in which case another grade should be tried.

The above is a brief statement of the more common causes of sparking; but sparking may be due to an open circuit or loosened connection in the armature. This trouble is indicated by a bright spark which appears to pass completely around the commutator, and may be recognized by the scarring of the commutator at the point of open circuit.

Atmospheric Electricity.

Some interesting observations on atmospheric electricity have recently been brought out, which deal with thunder and lightning. Experiments have been made at Cambridge, England, with a view of measuring the energy of a lightning flash. Many such experiments have been made before now, but they have generally been attended by results fatal to the experimenters. We are happy to say that no mishap has been experienced by Mr. C. E. Wilson, in his work according to the *London Daily Mail* of recent date.

The energy expended in a single discharge of lightning was found to be about 600,000 ton-meters, which is a force capable of raising a weight of 1,000 tons to a height of 2,000 feet, in the air. This force is exerted practically instantaneously, as far as human beings are concerned. To bring these figures to a more comprehensive level one may say that such a force is comparable to the discharge of a broadside from some capital ship.

The dreadnaught in the British navy, H. M. S. Queen Elizabeth, known to the sailors as "Big Lizzie" has eight guns on a side, each 15 ins. in diameter, and a discharge from these eight guns is capable of exerting a force of 210,000 ton-meters at the muzzle. A meter is 39.37 ins. so that this force of 210,000 ton-meters equals, in our figures, 688,975 foot-tons. It would take three broadsides from "Big Lizzie" to equal the discharge force of the lightning flash, as measured at Cambridge. A further concrete idea of the power exerted by these guns may be had, when fired in broadside, by remembering that perhaps 10 or 12 feet is an approximate estimate of the distance through which the whole ship is moved sideways in the water even when the inertia of the ship is thus exerted in recoil.

Sir Joseph Thomson stated in a recent lecture before the Royal Institution, that thunder is due to wave of high pressure which is produced along the course of the flash. It is therefore probable that the air through which the electric flash bores, is driven back and away from the path of the electric current, and that the area of disturbance is greater than most of us suspect. It is as if a snow plow was forced through a deep fall of snow, and in making a path, banked up the snow in a high ridge close to where the plow passed, but that the yielding material was forced back over an area reaching some distance away from where the plow had moved.

To make the analogy complete we would have to suppose that the snow possessed the mobile and elastic power of air and that it at once rushed back to fill the space made by the plow, and that it did this so suddenly and so quickly as to produce an exceedingly loud sound, when the impinging sides came together in the center of the gap. As a lightning flash has considerable length, from cloud to earth, or from cloud to cloud, the length of some of the flashes measured by Mr. Wilson were six miles long, it follows, that the rumbling or rushing sound we sometimes hear, is due to the comparatively slow moving waves of sound, about 11,000 ft. per second, reaching the ear successively or rather continuously although produced, in the first place, by a practically instantaneous flash. What we hear first is the earth-end or last part of the flash which terminated the discharge and later we heard the sound from the upper end. What happened last we hear first, and the beginning of the disturbance, being farthest away, we hear last. The sharp smack or violent crash is no doubt caused by the resonance or the reflecting quality of the earth.

The nature of thunderstorms has recently been made clear by the discovery that whenever a drop of water splits up while it is suspended in air, the water of the drop is positively electrified and the air around it negatively electrified. When big drops of water are broken up, in the air, into small drops, then an electrical effect is produced, and this has been noticed with sprays of water and at waterfalls.

What happens in a thunderstorm is that, first, a current of moisture-laden air is carried up from below into a cooler stratum. As it rises it cools and the moisture condenses into drops and then begins to fall, when it breaks up into smaller drops. As it breaks up, the air about the drops is negatively charged and the drops are positively charged. Finally there is a condition in a thundercloud in which the upper stratum is composed of tiny drops of water negatively charged and the lower, of larger drops, positively charged. Discharges begin in the cloud, or if there is a wind which separates the two parts of the cloud, negatively and positively charged, between the cloud and the earth.

The electrical effect may be increased by drops jostling each other. Incidentally, the theory that gunfire may affect electrical tension in the air is demolished.

Sir J. J. Thomson calculated that all the energy of a lightning flash, that is, the equivalent of twenty-four rounds from the 15 in. gun could be obtained from the electrical charge of the hydrogen molecules in a quarter of a cubic inch of that gas, if we could extract and utilize the force.

Electrical Condensers

What is known as a Leyden jar is one form of electrical condenser. The word condenser as here used does not carry the same meaning as it would if we were speaking of a steam engine. In the case of the steam condenser we refer to an apparatus which cools steam down to the dew-point and it becomes water. That is a physical change of vapor. In applying the word condenser to electricity we mean an apparatus capable of carrying an over-charge of electricity. It is capable of holding more electricity than it could of itself take up. The tin foil sheets on the Leyden jar accumulate or condense a much greater quantity than they could receive or induce.

The Leyden jar is really a glass bottle coated inside and out with a layer of tin foil, a wooden stopper with a short metal rod passing through it and terminating in a chain, connecting with the inside coating of tin foil. The discovery of the Leyden jar was accidental, as were many other discoveries in the arts which have become most useful to mankind. It is said that Musschenbroek and his pupil Cuneus were attempting to collect the supposed electric "fluid." They used a bottle partly filled with water, and held in the hand. A nail was fitted through the stopper to bring the so-called "fluid" from an electric machine to the water. The water in this case served as the inner coating of the jar, and the hand holding the bottle was the outer coating. On touching the nail the operator received an electric shock. Cuneus was himself practically a living "discharging tongs." It is said that this accidental discovery created a very great sensation in the scientific world in Europe and America.

Benjamin Franklin later on proved that the seat of the charges is really on the surface of the glass, and not on the sheets of tin foil. He showed this to be the case beyond doubt by placing a jar on an insulating stand. The inner metallic coat was then taken out, and next the jar was removed out of the outer coating. Neither of the tin foil coatings was found to be electrified while the glass was away from them, but on returning the jar to its former position it was found to be in a state of electric tension. The charges had in the meantime remained on the outer and inner surfaces of the glass of the jar.

The Leyden jar is an example of the principle of induction. A body charged with positive electricity will induce a negative charge on the nearby surface of another and adjacent body, the amount of this inductive effect depending on the nature and kind of medium separating them. Suppose we connect the outer piece of tin foil with a positive source of electricity, and the inner piece of tin foil with the ground. The positively charged side covered with tin foil will induce a negative charge on the inner sheet of tin foil, and repel positive electricity into the ground. The negative charge so induced will in its turn induce a certain amount of positive electricity on the positive piece, thus drawing a greater supply from the source of electricity. The increased positive charge acts upon the negative, and increases by induction the negative charge. The thinner the sheet of insulating glass between the pieces of tin foil the more readily this inductive action goes on, and the larger the pieces of tin foil are, the greater amount of electricity they can carry.

The glass by its inductive capacity permits both sheets of tin foil to collect or accumulate or, as electricians say, to condense a very heavy charge of electricity, much greater, in fact, than they themselves could take up. If we disconnect the sheets of tin foil, the one from the source of electricity and the other from the earth, we find that the charges are not "free," but are really bound upon the sheets of tin foil. One attracting the other "holds" them where they are.

On applying one end of the discharging tongs to a sheet of tin foil, and approaching the connection-end of the other piece of foil with the disengaged end of the tongs, a sharp crackling spark is seen and heard, as the positive and negative charges come together and neutralize each other. If one end of the discharging tongs is brought in contact with one piece of foil and the operator touches the other piece of foil with his hand, an electric shock will be felt over the body of the operator and a spark will be seen as his hand approaches close to the tin foil sheet.

In this experiment, and by taking this view of the Leyden jar here implied, it makes clear the idea which electricians have when they speak of the jar as one member of a family of condensers. The accumulation of electricity and the interaction of positive and negative charges when held on the sheets of tin foil, constitute the condenser action and not the physical change of state which accompanies the condensation of the vapor of water. The condensation of electricity implies something of an over-charge like a bag of wool, filled, shaken together and pressed down so as to hold more than that implied in simply filling the bag. Electrical condensation is like an area painted over and over again so that the surface carries more paint than that required simply to give it color.

Cost of Maintaining Electric Locomotives.

Electric locomotives on the Norfolk & Western Ry., according to that company's report for the six months ended December 31, 1916, proved much more expensive to maintain and operate than steam locomotives. The average cost of repairs, power and lubricants for electric locomotive equipment per 100 locomotive miles was $62.90, while that of repairs, fuel, stores and lubricants for steam locomotive equipment was only $25.21. Repairs were respectively $32.69 and $12.70. Power and lubricants for the electric locomotives cost $30.21 per 100 locomotive miles, as against $12.51 for fuel, stores and lubricants for steam locomotives.

A table in the report divides the steam equipment by divisions and by classes of locomotive (passenger and freight). On the Pocahontas Division, which is the one electrified, repairs to freight and to passenger steam locomotives cost respectively $14.60 and $8.53, while fuel, stores and lubricants cost $15.86 and $6.01, making totals respectively of $30.46 and $14.54.

Semi-Magnetic Dynamic Braking Control for Crane Hoist Service.

The General Electric Company has recently brought out an automatic device, which can be added to their standard Type B drum controller, and thus make a very serviceable semi-magnetic dynamic braking control for crane hoist service.

The additional equipment consists of: A panel for wall mounting which contains a D-C contactor and current limit relay; an extra resistance which is inserted in the circuit during the acceleration and deceleration period.

A dynamic braking, manually operated, drum type controller is more severe on the commutator of a direct current series motor than is a plain reversing manual controller, because, when lowering, the motor is connected similarly to a shunt wound motor, and does not have the inherent protection of the series field. In many installations, where the service is severe, a semi-magnetic equipment will materially assist commutation. This equipment is useful also where the service is not quite severe enough to justify the expense of a full magnetic equipment.

Westinghouse Booster Rotary Converter.

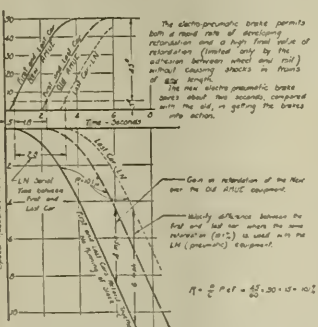
Synchronous booster rotary converters are well adapted for any application for which a relatively wide, automatic or non-automatic variation in direct voltage is necessary. They are desirable for lighting systems where considerable voltage variation is required for the compensation of drop in long feeders, and in parallel with storage batteries.

Slack Action and Impact Between Cars in Passenger Trains

By WALTER V. TURNER, Manager of Engineering, Westinghouse Air Brake Co.

The attached diagram will in a measure illustrate the significance of the use of the electro-pneumatic brake for eliminating shocks in trains, for with this brake there is no time of serial action for any length of train, all brakes in the entire train applying at the same instant. Irrespective of the condition of slack or rate of retardation, there can be no slack action, for all cars retard alike. This means that a brake of any effectiveness can be used without any loss of time in applying it, and without fear of the running of slack in the train and resultant rough handling. This presupposes, of course, that the braking ratio and piston travel are uniform throughout the train, a condition which it is reasonable to require.

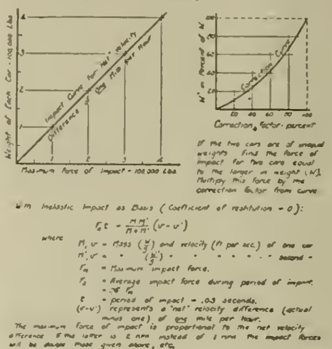
Previous diagrams in this connection show a delay of 3.5 seconds from the movement of the brake valve handle befor the brake on the first car becomes effective, and a further delay of 2.8 seconds before the brake on the last car accomplishes anything. These delays are due to the time required for air to flow from the brake pipe, for the triple valve parts to move and for air to flow from the auxiliary reservoir to the brake cylinder. This diagram shows for the old electric brake or the electro pneumatic



Cut showing the time of serial action to Zero by employing the Electro-pneumatic brake entirely. The slack action for any rate of retardation. The slack action for any rate of retardation and for any amount of slack that is necessary in order to have the braking ratio and piston travel uniform through the train.

The best brake—the entire train considered—is the one which, in affording the best means of retardation, creates the least velocity differences between the various vehicles in a train.

(AMUE) a delay of only 2.3 seconds from the operation of the brake valve to the application of all brakes in the train. This application is effected by simultaneously reducing with an electro-magnet the brake pipe pressure locally on each car. The delay, or dead time, is due to the movement of the triple valve parts in sequence, and the flow of air from the auxiliary reservoir to the cylinders. The newly evolved electro-pneumatic brake, however, cuts down this dead time to one-half second by eliminating the necessity for the move-



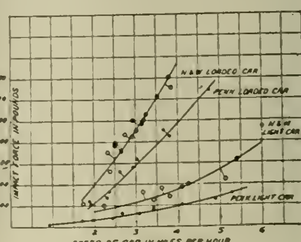
For every mile per hour "net" velocity difference (actual difference less one) the force of the impact due to one car colliding with another is approximately equal to the car weight.

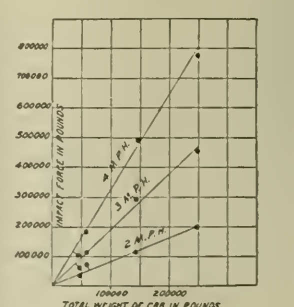
FIG. 8.

ment of pneumatic parts of the triple valve and cutting down the time for the flow of air from the auxiliary reservoir to the brake cylinder. The advantage of this saving may be grasped by noting that at the end of 6 seconds from the movement of the brake valve the train with the new brake is running a little more than 8 miles per hour slower than the initial speed, and 4 miles per hour slower than the train with the previous type of electro-pneumatic brake; also this is 7 miles per hour slower than the first car of the train equipped with the straight pneumatic brake, where the maximum retardation is used consistent with tolerable shock conditions. It should be understood that with this type of electro-pneumatic brake, it is not a question of tolerable shock, but one of no shock whatever.

To convey some idea of what it would mean to use the straight pneumatic brake equipment with a rate of retardation equal to the 10.1 per cent shown here for the electro-pneumatic brake, dotted curves have been added to represent the performance of an LN pneumatic equipment on the last car of a train. The velocity difference between the head and rear cars is shown to be 6 miles per hour, and this should make clear the relation between train control devices and the ability to run longer trains more smoothly and with less loss of time. From the foregoing it will become apparent that notwithstanding the greatly increased weights and lengths of trains in recent years brake development has at least kept an equal pace with the requirements of adequate train control. The capacity of modern brake apparatus is far from exhaustion, the only consideration being that proper engineering be employed in the choice of brake equipments for the conditions to be met and due care be exercised in its installation, with particular reference to the maintenance of correct volume proportions.

So far impacts have been spoken of in terms of velocity differences only. The figure 8 has been prepared to show what the actual force of impact may be. This curve shows that for each net velocity difference of one mile per hour the maximum blow due to impact is equal to the weight of one of the colliding vehicles. If the net velocity difference be twice this, or two miles per hour, the blow will have twice the intensity; if three miles per hour, three times the blow. By net velocity difference is meant the actual velocity difference less one mile per hour, which is a rough and ready allowance to give for the capacity of draft gear; this, of





course, will vary with the weight of the vehicle and the characteristics of the draft gear. A net time of 0.03 has been assumed as the total period of impact; by net time of impact is meant the time of impact neglecting the part played by the draft gear, which has been sufficiently allowed for in determining the net velocity differences; or, in other words, the "net" time for impact is started from some point in the last stages of draft gear action. In establishing this impact curve it is assumed that the average force of impact (Fa) for the net impact period is equal to 76 per cent of the maximum force (Fm). This factor conforms to the results of a very elaborate series of scientific tests.

The correction curve of Fig. 8 provides for determining the impact when the two colliding vehicles are of unequal mass. To employ it, assume that both cars agree in weight with the heavier and find this force of blow in the regular way; then, by noting the weight of the lighter in percentage of the heavier, find from the correction curve the impact in per centage of the maximum blow first found. For instance, suppose the net velocity difference between an 80,000-lb. car and one weighing 100,000 lbs. to be one mile per hour. The blow for the two 100,000-lb. cars would be 100,000 lbs. The lighter car is 80 per cent of the other in weight; therefore, the blow between the two, as shown by the correction curve, is about 88 per cent of that for the two cars weighing as much as the heavier, or 88,000 lbs. If a car collides with a string of 10 or more cars "solid" equal to the first in weight, the force of impact is double that obtaining when one of these cars collides with another only with the same velocity difference. By "solid" is meant the removal of all slack between the cars due to the couplers being solid, so that the bunch acts as one continuous vehicle.

In case two "solid" groups of cars collide, a proportionately modified allowance must be made for the draft gear capacity to absorb shocks.

As a significant check on the arbitrary deduction made for determining the net velocity difference in Fig. 8, note that the curves in the upper chart of Fig. 9, if continued, would pass through the base line at approximately one mile per hour. Reading from the lower chart it is seen that for a velocity difference of three miles per hour (net difference of two, according to the above basis) a 200,000-lb. car gives 375,000 lbs. almost 400,000 lbs. as the force of impact. According to Fig. 8, the impact would be 400,000 lbs. Considering this matter carefully, it is not amazing that trains are wrecked by brake applications and that even passenger trains are frequently parted through rapid changes in slack between the cars of the train.

Care and Maintenance of the Locomotive Electric Headlight

By JAMES DOUGALL, M. E. No. 1077

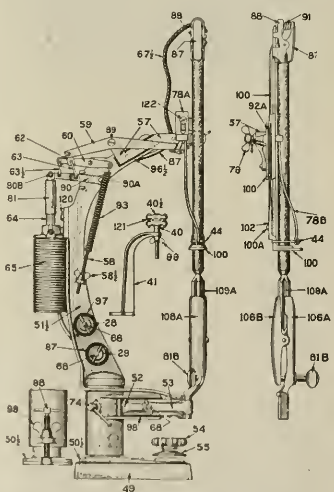
Of the many safety devices connected with the modern locomotive, the headlight and the electrical apparatus for its operation seem to get very little attention in current literature.

In the following I will endeavor to give the results of twelve months close observation of headlights, some of the troubles and ills they are subject to, and the methods used in making adjustments. I have from 28 to 30 equipments constantly under observation, both in freight and passenger service, and they are probably representative of conditions applying elsewhere. The machines are all of the Pyle-National manufacture, Type C, and Type E, and the part numbers used are the ones taken from that company's part book.

I. The Lamp.

The most frequent cause of trouble is due to careless and haphazard lamp adjustment. The arc lamp is the life of the whole system, and if out of adjustment would be better off the engine altogether. Very few of the men who run locomotives seem to give enough attention to a proper understanding of the few and simple details of adjustment, which are required to get good and efficient service from the lamps. The lamp consists, essentially, of a magnet coil and plunger, connected by a series of levers to the carbon, for the purpose of separating it from the copper electrode, thereby striking an electric arc from which we get the light.

The spring, No. 93, when properly adjusted, is solely for the purpose of counterbalancing this mechanical system, and has no connection with the quantity and quality of the light obtained. Too often, as soon as something goes wrong with the light, the engineer or fireman sets to work to remedy matters by tightening up on No. 93, thereby preventing the operation of the magnet, very little or no separation of the carbon and the copper electrode is possible, an excessive rush of current is sent through the whole system and ultimately we have a burnt magnet coil or fused electrodes and still no light.



DETAILS OF ARC LAMP FOR PYLE-NATIONAL TYPE E, ELECTRIC HEADLIGHT.

Out of 325 headlight inspections, 32 cases were that of too tight No. 93, or almost 10 per cent., sometimes, but very rarely, spring too loose. It should be just tight enough to counterbalance the system of levers and no more. The carbon clutch, No. 44, is probably the next most common source of trouble. If this piece sticks on the slide on which it works it has enough leverage to prevent movement of the magnet plunger, and we have a condition similar to that produced by a too tight No. 93. Therefore, when the arc does not form as it ought, we should try this part and see that it is free.

The clutch action on the carbon depends on the condition of the edges of the hole in No. 44, through which the carbon passes. Quite frequently the front upper and the back lower edges are worn off and the clutch does not take hold of the carbon till the plunger and levers have moved too far, thereby preventing the proper opening for an arc. This condition can only be remedied by installing a new No. 44 or turning the old one over so as to present new edges to engage with the carbon. During the year I have used some 16 new pieces, and turned about as many, so that about 10 per cent. of the troubles were due to this cause.

II. Connections.

While the wiring itself is usually well protected and installed in conduit, the various connections and binding posts cannot be given too much attention. They are subject to great vibration, great extremes of heat and cold, oil and many other enemies of good electrical contact. The connections at the arc lamp seem particularly liable to come loose, and when this happens, great heat is generated and the connection is soon destroyed. At the same time the wires may fall out and come together, making a short circuit, and damage the dynamo. Therefore, it should be part of the duty of the headlight man to check over the connections at the lamp and at the generator after every trip. Care being taken that the wires are not cut by the binding screws being forced in too tightly.

Two other points where poor contacts are very common are the connection made by the copper electrode with its holder, and the connection made by the carbon clamp on its slide. Both these places should be frequently cleaned and the small contact springs on the carbon clamp bent out so as to make good connection with the slide, always leaving a free movement for the carbon.

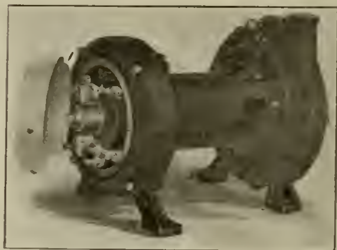
The electrode should be scraped after every trip as there is a hard scale formed on it by the heat of the arc, and this scale is non-conductor. Often when a lamp is reported as chattering persistently I find a dirty and pitted slide, and the trouble goes when this is cleaned up. Both of these troubles have been removed in late types of equipment, but I presume many engineers are getting along with old style lamps. The improvements in the carbon holder and in the electrode and holder are applicable to any type of Pyle-National lamp.

III. Adjustments.

While making adjustments 'round the lamp the current should be shut off, as I have found cases where short circuits have been formed between the different parts of the lamp and between the lamp and reflector causing trouble. If at any time it is desired to test whether current is coming to the lamp or not, always use a piece of carbon to cause a short circuit between the two binding posts, never use a screwdriver or any metallic article, as the metal may fuse and stick, or the resulting flash may give a serious burn. Although the system is low voltage, and the electrical shock in no way to be feared, as a measure of safety, do not try experiments, as there is quite a development of power when the machine is shorted momentarily, and you may be unpleasantly surprised at the amount of burning that can take place.

While a good arc will always give some light, our labor will be in vain if the reflector is in bad condition. To get a good beam that can be controlled and focussed on the track where it belongs, we must have a perfect reflector, both as to its surface and as to its shape. While the surface of the reflector may be dull, we still have a fair light if the shape is correct. If there are irregularities in the surface we have beams of light widely diffused, and one cannot produce any light on the track with any amount of manipulation. Great care should be taken in handling the reflector at all times so that it is never dinged, as even a small bulge will cut down the light very considerably.

When it is necessary to clean the surface of the reflector, remove the lamp and reflector from the cage and lay it on its back on a flat bench, the edge of the base and the center stud of the bowl giving the whole a solid support. The electrode should be removed. Blow—not wipe—all dust from the surface, as this dust is sure to be gritty. Put about two tablespoonsful of coal oil in the bottom of the bowl; into this put one tablespoonful of lampblack, taking care that the black is shaken from the original package so as to avoid any grit. With a piece of clean waste, free from hard substances, mix the oil and black and rub up the surface, making the lines of rubbing run from the center of the bowl to the edge, never with a circular motion. When you have gone over the surface two or three times throw away the first piece of waste and



TURBO-GENERATOR, TYPE E, FOR PYLE-NATIONAL HEADLIGHT.

clean off the surplus oil and black with a second piece, but do not try for any polish yet. Now shake some dry lampblack all over the surface of the bowl, and finally clean it out with a third handful of waste, and you will be surprised at the result.

Use three pieces of waste for every reflector so as to avoid any possible grit, as it is almost impossible to lay a piece of oily waste down without gathering some foreign substance. One small grit will do irreparable damage to the nickeled surface. In rubbing use plenty of force, but always keep the lines of rubbing from the center to the edge of the bowl.

Focussing the lamp can only be properly done on the track, and care should be taken when the lamp is dismounted for cleaning that the base is not moved on the slide, and the vertical adjustment left as set by the engineer. A very slight movement will make a very great difference in the resulting light.

In the dynamo we have very few sources of trouble to watch, perhaps the most important ones being worn brushes and brush holders and high mica in the commutator.

It is good policy to renew the brushes as soon as they are worn to ¾ in. in length. When they are shorter than this the spring tension is too light and they are liable to chatter and cause sparking and burning. They will wear in the holders and get out of position on the commutator. The trouble of adjusting spring tension, etc., will more than offset the cost of new brushes. To save time, or for some other reason, the pigtails, or short wire connections from the brushes to the holders, have been cut off. This is very poor policy as the contact made by the brush in the holder is not at all sufficient to carry the current generated without heating. You should always be sure that the brush is shaped correctly where it bears on the commutator, and that the copper wire is well fastened by the screws provided for it on the holders. The tension of the brush springs is set when the machine leaves the factory and should not require re-setting except in special cases. It, however, should be just enough to ensure a good contact, and any excess over this will only serve to wear out brushes and copper.

The mica separating the copper segments of the commutator from each other is usually harder than the copper, in time this will be found to be higher than the bars, and it must be cut down if we are to have a good and continuous connection with the brushes. This can be done very well with a four-in. slim taper, three cornered, file with the tip broken off, working this along the mica till you feel the file cutting copper on both sides. The file will give the proper depth of groove and it leaves very little polishing to be done. After filing down all the mica, the commutator has to be polished with a piece of sandpaper, No. 00, held on it while the machine is running. Always use sandpaper and never emery, as particles of emery will set in the copper and in the brushes and cause continual trouble. If you ever find that the commutator is out of true, it must be faced off in a lathe and the mica cut down and polished; no amount of cleaning up a commutator out of true will get any results. When the commutator takes on a brown and polished surface it is in the best of condition, and should run a long time without being touched. I have a number that are in this condition and have been running daily for over a year without trouble.

Turbines.

We have a rule that requires the opening and examining of all the turbines at least every thirty days, and a report is made of the speed they are running and their general condition. This is a very necessary precaution and should be in force everywhere. The turbine in both the Type C and Type E machines is running at a high speed, and the valves will change enough in that time to give a marked increase in speed. In the Type E machines I find about 1/64 in. in that time, of wear in the valve, besides some pitting and scoring of the valve faces; in the Type C scoring is certain to take place, owing to the design of the valves and the direction of the steam flow. Good valves and seats are absolutely necessary if we are going to have a steady light and good regulation of the voltage. In the Type C valves I correct this scoring by filing off the plunger, No. 38, and renewing the false seats, No. 35 B, always taking care that the valves seat themselves before the governor weights are at more than a right angle with the face of the wheel. I find the average travel of the sleeve on the shaft when everything is as it should be to be about 3/16 in. The governor screws in both types of machines once properly set will remain right indefinitely. I have only had to readjust 3 sets out of 300, and they had been tampered with. I find that Type C machines give the best results when running 1750 to 1800 R. P. M. without load.

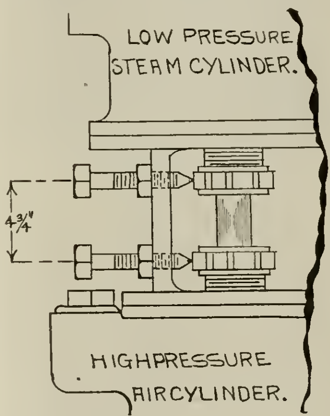
In the Type E governor valve, the most important adjustment to watch is the travel of the valve. This should be 1/16 in. plus or minus. For making this measurement I got up a plunger type of depth guage consisting of a ½-in. copper sleeve with a 3/16-in. plunger fitting fairly tightly in it, this plunger being graduated in 32nds. I use this guage as follows: Remove the governor valve cap, insert the guage so that the sleeve will bear on the upper edges of the valve seat, press the plunger down on the tip of the valve, which will be open full. Remove the guage and mark the plunger at the top of the sleeve with a lead pencil. Now take out the valve seat and the valve cage and valve, and by holding them in the left hand close the valve to its seat. Reinsert the guage, pushing the sleeve down against the edge of the seat as before when the plunger will rise and indicate at the top the amount of travel the valve has. This little tool is handy to use, and it enables one to watch the variation of the valve with little trouble.

Where I find the Type E valves pitted and scored, I grind them in in the usual manner with compound and take the measurement afterwards. The Type E machines give the best results when running at 2750 to 2800 R. P. M., although I have one machine which has been running a year at 2650 without any trouble. I find a decided improvement in the condition of the inside of the turbine is made by pouring a small quantity of valve oil into the case once a month, as it seems to form a film over the metal parts and prevents the formation of scale and rust.

Oiling, Etc.

While the engineers and firemen seem to understand fairly well the importance of oil and grease on other parts of the engines under their charge they seem quite indifferent to the fact that the headlight turbine needs a little attention in this line, too. I have had machines come in with the oil cups filled with pin dope, hard oil, grease and sometimes plugged up entirely and having every indication of having had no oil for a long time. Then the engineer wonders why his machine suddenly slows down and tries to run away or seems to be about to break up. One trouble I encountered with the type C oil cup is that it will fill up with condensed steam. This trouble I have overcome by having all the cups tapped in the bottom with a ⅛-in. pipe plug and drain out the surplus water after every trip.

In the type E machine this does not



VIEW OF METHOD OF LOCKING STUFFING BOX NUTS.

occur and by filling the oil cup three times and letting the oil run down into the bearing they will get enough oil to keep in good condition. The best oil is none too good and I use superheater valve oil altogether and get every satisfaction from it. The inside bearing on both machines requires little oil, maybe 1 spoonful a month, and should not be allowed to slop over, as the extra oil will get in the armature and may destroy the insulation of the machine.

Altogether the headlight equipments of the type I have seen are a particularly rugged and efficient apparatus and given reasonable and regular care with a little common sense in their handling will give good and economical service. Never start a machine suddenly, give it time to warm up and get rid of the water which will accumulate while it is standing, give it oil regularly, and keep it fairly clean inside and out, and you will have little to worry about. Of the various troubles I have encountered 90 per cent. were due to neglect and carelessness and 1 per cent. to defects in the machine, so it would seem that any information that will lead to a better understanding of the headlight and its generator by those who have charge of them will be of service.

Locking Stuffing Box Nuts.

By J. H. Hahn, Bluefield, Va.

Considerable trouble is often experienced by the stuffing box nuts working off on low pressure steam cylinder and high pressure air cylinder of the 8½-in. cross compound pumps, when the metal is soft, or when fibrous piston rod packing is used, and gland nuts and stuffing boxes are frequently more or less damaged.

The sketch I am sending you shows a simple and effective method of locking these nuts. The center piece is drilled and tapped for ⅝-in. set bolts, as shown. The bolts are 5 ins. long, and are provided with lock nuts. When metallic piston and packing is used, the swab holder or shield will prevent the nuts from working off.

Wooden Valve Instead of Rubber.

By W. E. Thomson, Lincoln, Neb.

Being unable to secure a hard rubber valve about seven months ago for use on a large wash-out pump, to meet the emergency a piece of hard maple, thoroughly dried and turned up and faced so that it would just slip into a metal band, was used. When this was thoroughly soaked in water, the piece of wood expanded tightly into the band, and was thus used in place of the hard rubber. After seven months of service it was discovered that there was actually less wear on the wooden valve than was found on the rubber valves. This wash-out pump is now fitted with an entire set of wooden valves, and is giving excellent service.

Railroads Moving the Army.

Fairfax Harrison, chairman of the railroads' war board, announces that plans for the largest troop movement ever scheduled in the history of the United States have already been perfected at the request of the Government. The movement will start on Sept. 5, and between that date and Sept 9, 200,000 men are to be entrained. This represents about 30 per cent. of the new army. One field army of 80,000 men requires 6,229 cars, comprising 366 trains hauled by 366 locomotives. It is expected that a second movement of approximately 200,000 men will begin on Sept. 19, continuing for four days thereafter, and a third movement of the same size on Oct. 3.

Items of Personal Interest

Mr. A. E. Cliff has been appointed general manager of the Illinois Central, with headquarters at Chicago, Ill.

Mr. A. G. Nutting has been appointed supervisor of signals on the Northern Pacific, with headquarters at Livingston, Mont., succeeding Mr. F. A. Allen.

Mr. Amos C. Davis, general foreman of the Altoona erecting shop of the Pennsylvania, has been appointed general foreman of the East Altoona enginehouse.

Mr. H. G. Flanders, formerly roundhouse foreman of the Atchison, Topeka & Santa Fe at Clovis, N. M., has been promoted to general foreman at that point.

Mr. Harry S. Schum, formerly general foreman of the East Altoona enginehouse of the Pennsylvania, has been appointed master mechanic of the Altoona machine shops.

Mr. David A. Munro, formerly manager of the J. N. Jones Manufacturing Company, has been appointed to take charge of the Railway Specialties Corporation, New York.

Mr. J. R. Dwyer has been appointed fuel supervisor on the Louisiana division of the Texas & Pacific, with office at Alexandria, La., succeeding Mr. D. H. Varnell.

Mr. Leon A. Starkweather, formerly motive power inspector of the Pennsylvania, has been appointed assistant master mechanic of the New York division of the same road.

Mr. F. P. McDonald has been appointed master mechanic of the Stockton division of the Southern Pacific, with office at Stockton, Cal., succeeding Mr. A. D. Williams, promoted.

Mr. G. E. Cessford, formerly district master mechanic of the Chicago, Milwaukee & St. Paul, at Deer Lodge, Mont., has been transferred to Tacoma, Wash., succeeding Mr. T. I. Hamilton.

Mr. A. D. Bruce, in charge of purchases and supplies for the Vapor Car Heating Company, has been elected secretary and comptroller of the company, succeeding Mr. Arthur P. Harper, resigned.

Mr. George C. Christy, formerly general foreman of the McComb shops of the Illinois Central, has been appointed master mechanic at Vicksburg, Miss., succeeding Mr. C. Listrom, deceased.

Mr. Joseph Slutzker, formerly assistant master mechanic of the Altoona machine shops of the Pennsylvania, has been promoted to assistant engineer of motive power of the Western Pennsylvania division.

Mr. M. F. Smith, formerly district master mechanic of the Chicago, Milwaukee & St. Paul at Dubuque, Ia., has been transferred to Milwaukee, Wis., succeeding Mr. A. Young, resigned to enter military service.

Mr. Samuel S. Parslow, who has been attached to the mechanical valuation department of the Great Northern for the last two years, has been appointed shop superintendent on the same road at Great Falls, Mont.

Mr. H. H. Maxfield, superintendent of motive power of the New Jersey division of the Pennsylvania, has been commissioned lieutenant-colonel of the Ninth Engineers of the National Army, while Mr. C. D. Barrett, master mechanic of the Williamsport division at Sunbury, Pa., and Mr. C. S. Gaskill, master mechanic of the Baltimore division at Orangeville, Md., hold commissions as majors, and Mr. F. S. Robbins, assistant master mechanic of the Pittsburgh division at Pittsburgh, Pa., is commissioned as a captain. These officers have been furloughed by the railroad company, and to fill their places the following appointments have been made: Mr. F. G. Grimshaw, assistant engineer of electrical equipment, Philadelphia terminal division, has been promoted to superintendent of motive power, New Jersey division; Mr. R. G. Bennett, assistant engineer of motive power, central division, succeeds Mr. Barrett at Sunbury; Mr. G. H. Watkins, assistant engineer of motive power, Western Pennsylvania division, succeeds Mr. Gaskill at Orangeville; and Mr. J. H. Thomas, assistant general foreman, Pitcairn shop, succeeds Mr. Robbins at Pittsburgh.

LIEUT. COL. H. H. MAXFIELD, NINTH ENGINEERS.

Mr. G. A. Cooper, formerly representative in the railroad department of the United States Graphite Company at Chicago, Ill., has been appointed advertising manager of the company, with headquarters at Saginaw, Mich.

Mr. H. L. Needham, formerly general foreman of the locomotive department of the Illinois Central at Twenty-seventh street, Chicago, has been appointed master mechanic of the Springfield division, with office at Clinton, Ill.

Mr. D. B. Mugan, formerly in charge of the electrical department of the Illinois Central at New Orleans, La., has been appointed resident manager of the Edison Storage Battery Supply Company, with office at New Orleans.

Mr. W. E. Dunham, formerly supervisor of motive power and machinery of the Chicago & North Western at Winona, Minn., has been appointed assistant to the general superintendent of motive power, with office at Chicago, Ill.

Mr. W. H. Bradley, formerly master mechanic on the Chicago & North Western at Clinton, Iowa, has been appointed assistant to the general superintendent of motive power, with office at Chicago, Ill., succeeding Mr. E. C. Hall.

Mr. F. A. Griffin, formerly master mechanic of the Erie at Port Jervis, N. Y., has been appointed general inspector of the lines East, with headquarters at New York, and Mr. M. S. Jackson, formerly special inspector at Cleveland, Ohio, succeeds Mr. Griffin.

Mr. E. P. Howell, formerly erecting shop foreman of the Atlantic Coast Line at Waycross, Ga., has been appointed general foreman at that point, and Mr. E. S. Myer has been appointed gang foreman of the Waycross shops, succeeding Mr. H. C. Spicer, who succeeds Mr. Howell.

Mr. M. G. Lodge has been elected president of the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio; Mr. J. W. Carrel, vice president and general manager, and Mr. L. A. Hall, secretary and treasurer. The policy and organization of the company will be the same as heretofore.

Mr. L. O. Cameron, formerly manager of sales in the southern district for the Pressed Steel Car Company, has transferred his headquarters to the Munsey building, Washington, D. C., and will hereafter represent the Pressed Steel Car Company, and also the Oxweld Railroad Service Company.

Mr. F. R. Cooper, formerly superintendent of motor power of the Kansas City Southern, and until recently connected with the Breakless Staybolt Company of Pittsburgh, has resigned his position with the latter company to become sales manager of the Gold Car Heating & Lighting Company, with offices at New York.

Mr. William Anderson, formerly master mechanic of the Chicago & Northwestern at Boone, Ia., has been appointed supervisor of motive power and machinery on the same road, with headquarters at Winona, Minn., succeeding Mr. W. E. Dunham. Mr. L. Chapman, formerly master mechanic at Belle Plaine, Ia., succeeds Mr. Anderson.

Mr. T. J. Hamilton, formerly district master mechanic of the Chicago, Milwaukee & St. Paul, at Tacoma, Wash., has been appointed assistant superintendent of the Missoula division, with office at Avery, Idaho, and Mr. G. E. Cessford, formerly district master mechanic at Deer Lodge, Mont., has been transferred to Tacoma, succeeding Mr. Hamilton.

Mr. J. T. Wallis, general superintendent of motive power of the Pennsylvania, has also been appointed to the same office on the New York, Philadelphia & Norfolk; Mr. A. H. Rudd, signal engineer; Mr. C. D. Young, superintendent of motive power. This action follows the appointment of Mr. Elisha Lee, general manager of the Pennsylvania, to be general manager of the New York, Philadelphia & Norfolk, also officials in other departments have had their jurisdiction extended.

Mr. John M. Daniels, Freeport, Pa., and Mr. Eugene F. Dawson, Columbus, Ohio, has been awarded the Frank Thomson scholarships for 1917. Mr. Dawson will enter the Engineering department of the Ohio State University, and Mr. Daniels will enter the University of Pennsylvania, also in the engineering department. The purpose of the scholarship is to enable sons of railway men of the Pennsylvania system to obtain technical education and fit themselves for the service of the railroad.

American Electro-Chemical Society Meeting.

The thirty-second general meeting of the American Electro-Chemical Society will beheld in Pittsburgh October 3 to 6. A special feature of the meeting will be a series of papers and discussions on Electro-Chemical War Supplies, and the part the Electro-Chemical industry will play in the present struggle. On Thursday, October 3, will be held a regular meeting of the society in the morning, with optional excursions to industrial plants in the afternoon. In the evening an illustrated lecture on a semi-technical subject will be given. On Friday, October 4, a symposium on Electro-Chemical War Supplies will be held in the morning, followed by excursions to industrial plants in the afternoon.

Railroad Equipment Notes.

The Chicago & Northwestern has plans to build a tank shop 50 by 375 feet at its Chicago shops.

The Norfolk & Western shops at Roanoke, Va., are building 10 Mallet engines of the 2-8-8-2 type.

The Georgia, Florida & Alabama will build shops, etc., at Pensacola, Fla., at an estimated cost of $50,000.

The Toronto, Hamilton & Buffalo has ordered six switching locomotives from the Canadian Locomotive Company.

The Central Railway of Brazil has ordered two consolidation (2-8-0) type locomotives from the Baldwin Locomotive Works.

The Chesapeake & Ohio has contracted for the construction of an 8-stall addition to its roundhouse at Richmond, Va., Fulton yards.

The Temiskaming & Northern Ontario recently ordered 100 40-ton steel frame box cars from the Canadian Car & Foundry Company.

According to report, the Hudson Bay Company has given an order to American car builders for 1,200 steel gondola cars, to be shipped to the Dutch East Indies.

The Mark Manufacturing Company, Chicago, has ordered 18 70-ton capacity steel gondola cars of special construction from the American Car & Foundry Company.

The Southern Pacific Company is rehabilitating a portion of one of its car shops at Sacramento, Cal., which was lately injured by fire. The work will cost approximately $30,000.

The Pittsburgh & Lake Erie has awarded a contract to the Roberts & Schaefer Company, Chicago, for a complete tandem four-pit cinder handling plant for installation at Hazelton, Ohio.

The Great Northern, in addition to the repair shops now being constructed for it at Superior, Wis., by Westinghouse, Church, Kerr & Company, has let contract to the same firm for a power plant to cost $35,000.

The Chicago & North Western has awarded the general contract for the erection of the power house, machine shop and blacksmith shop at the Chase yards, Milwaukee, Wis., to the Walsh Construction Company, Chicago.

Illinois Central has prepared plans for improvements to its engine terminal at Clinton, Ill., to consist of a new coaling station and addition to the roundhouse to cost $38,000 and a new reinforced concrete power house to cost $20,000.

The Russian Government is about to place orders for an additional 10,000 1,200-pood (43,200 lb.) capacity four-wheel box cars. This is the second lot of 10,000 cars on this order on which 40,000 cars have been authorized. It is understood that Canadian car builders may receive this lot.

The United States Government has placed orders with the Baldwin Locomotive Works for 764 locomotives in addition to the 150 that company now has on order, and the 150 which will be built by the American Locomotive Company. The locomotives are for service with the forces in France, and will be given preference over all other work.

The United States Government, it is understood, contemplates placing an order shortly for 17,000 cars for French railways, as a part of an extensive program of military railroad construction in that country. The orders will be divided between four or five of the leading manufacturers. The cars will be four-wheel, flat bottom, low side gondolas, of 12 metric tons capacity.

The United States Government has distributed among several mills, orders for 150,000 tons of either Bessemer or open hearth rails for lines in France incidental to an extensive program of military railroad building in that country. The United States Steel Corporation received about 90,000 tons of these orders, and 60,000 tons was divided between three independent manufacturers.

Over 100 of the locomotives used in the construction of the Panama Canal have been disposed of by Governor Harding, of the Canal Zone, according to reports to Secretary of War Baker. Ten locomotives have been transferred to the Alaska engineering commission; two were sold to the Chile Exploration Company, and 95 were sold to the A. B. Shaw Company, which does a contracting business in New York.

The United States Government is asking for bids on about $2,000,000 worth of machine tools for use in France, and the Pennsylvania Railroad, acting in behalf of the United States Government, is asking for bids on seven vertical boring and turning mills, two vertical turret lathes, one horizontal boring and drilling machine, and a car wheel boring mill, which are required for the use of the regiment of engineers which it recently helped to raise.

Books, Bulletins, Catalogues, Etc.

Are We Capable of Self-Government? By Frank W. Noxon, Secretary, Railway Business Association. Price, $1.50 . New York. Harper & Bros., 1917.

A thoughtless man who takes up this book may feel something like the happy individual who entered a restaurant and was drearily spoken to by a sad-faced waitress. "Tea or Coffee?" inquired the sad-faced one. "Don't tell me," the man replied brightly, "please don't tell me—let me guess." If you read the book you won't guess so readily as you expect. Mr. Noxon, in the opening chapters, like Dickens, gives you, "the whole science of government, or how not to do it." The author says: "We have asked whether the American people are 'capable' of self-government—whether they can work out mechanism, methods, personnel and conditions under which it will be possible for government to avoid the mistakes which in the past have turned republics into dependencies, into empires, or into deserted ruins. We now study the business men of 1916 as a body. We seek an answer, not by attempting judgment upon the wisdom or folly of enactments or policies from some supposed business point of view, or from our own personal point of view, but by narrating the mode by which those enactments and policies were adopted. By what means did the body of American business men develop standards? How were those standards debated with the rest of the public and brought into harmony with the general conscience and aspiration? Through what media did the business body as a whole exert influence upon enactment and policy of government?" Going on further in the study of the question he says:

"One reason was that politics and business in the past had mingled in ways that evoked a demand for their divorcement. Politicians had been vigilant to disarm suspicion that they were blackmailers or venal tools, as some of their predecessors were accused of having been. Every business man, banker and railroader had stood charged with serving a special interest. There was no such thing as 'representative business,' which could deal openly with representative government." Some straightforward answers to these questions are given in the book.

The desire of some for an increase in the capacity of the Erie canal is given as a typical desire for "pork." The actual increase in the amount paid in Civil war pensions, 35 years after the war, was $138,462,130. This may be taken as an example of "how not to do it."

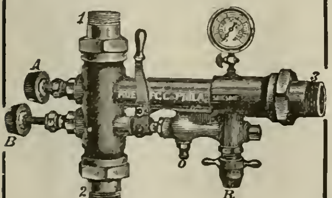
In his chapter on "the voice of all business" there is shown the beginning of a regenerative scheme, and in "the miracle of bank legislation," the work of approximating to the Canadian and Scottish plans is put in as evidence of the progressive and practical form in which the voice of all business is not only being heard, but is being carefully listened to. Men cannot be made to think by act of Congress, though their thinking ability may be stimulated thereby.

The conception of railway regulation, as possible without government ownership, grew up, and though somewhat restrictive in form, as we now know it, there is no doubt that in time it will include regulation for legitimate profit as it now holds down the rate increase idea. The regulation will in the future be more and more "business steering," not done by the holder of the tiller at the stern, but by the man on the "look out," who views the seas, the passing ships, the rocks and breakers, and can perceive the lighthouse beam even in a partial fog.

The whole record of progress is good, as given by our author. We need not light-heartedly guess about the tea or the coffee. We have a reason why we ask for one or the other, and are advanced enough to know when we get it, and which it is. "The regulation of trade" followed similar lines to those which brought the whole "regulation" idea to the front, in the first place. The republic is approaching a point where the "common people" have something to do with the government, and professional politicians have discovered that a king has arisen who may not know Joseph.

We believe that leadership is a real want today. Leadership that shall be strong, intelligent and definite. Mr. Noxon, however, does not seek the role of leader; though he has facts and figures in abundance and is possessed of that rare faculty of interpreting those facts, and of seeing the set of the current by noting tendencies which are like the straws on the surface of the stream.

The chapter on "organized labor and the law" gives the reader some facts he has probably never heard of before. The book is, in a sense, a revealer of secrets—open secrets which ought to be "common knowledge." The country, like the ship that found herself, is beginning to see the advantage of all men working together, and of doing something toward a common end. The book is worth reading by the every-day railroad man who wants to see where we are going, and to know why. It is not technical, and what is said of economics, finance and politics can be easily understood. There is a fine vein of humor throughout, and there is not a dull or dry page in the volume. There are facts given, plain facts, unadorned, save by the novel and picturesque handling of them by the author. This does not



imply that his view is taken through rose-tinted spectacles or through smoked glasses, which obscure or distort. Mr. Noxon does not think we have "got there" yet, but the trail is blazed. Time, thought and team-play will win the game. Read it if you want to know how to assist. The last pages practically ask "what are you doing to help gain the top of the grade and haul the load?" The author does not give Republican facts or Democratic facts—or labor facts, or capitalistic facts he gives just facts! Read, understand and answer intelligently and be comforted.

PROCEEDINGS OF THE 24TH ANNUAL CONVENTION OF THE AIR BRAKE ASSOCIATION. 253 pages, numerous illustrations. Edited by F. M. Nellis, secretary, 165 Broadway, New York. Price $3.00.

The proceedings of the 24th annual convention of the Air Brake Association, held in Memphis, Tenn., May 1-4, 1917, appear in a handsome volume. The secretary's report shows an increase in membership and funds, the former showing 1,035 members in good standing, and the latter a balance in the treasury of $2,189.31. The high price of publishing the annual volume was complained of and its omission suggested on account of the increased price of material, but it would be detrimental to the interests of the association to discontinue the publication even temporarily. In the June issue of RAILWAY AND LOCOMOTIVE ENGINEERING we presented a condensed report of the proceedings, embracing a variety of important subjects all setting forth the perfection of air brake appliances. It is to the credit of the members that at a time when so many associations are postponing holding their conventions, that the Air Brake convention is looked upon as a vital part of the solution of the problems in air brake construction and operation that it cannot safely be dispensed with, and whether in the tumult of war or the piping times of peace this branch of the air brake men's work will go on. The volume should be in the hands of every brake man.

Statistics of Steam Railways in the United States

From the report just published by the Interstate Commerce Commission, it appears that there were at the close of the last fiscal year 259,210.86 miles of steam railway line operated, including 11,856.42 miles used under trackage rights. The aggregate mileage of railway tracks of all kinds, including yards and sidings, was 394,944.26 miles. The increase in mileage for one year was 3,802.75 miles. The number of steam locomotives was 63,578, other than steam, 284. Passenger cars, 54,664; freight service, 2,326,-987; company service, 96,508. The average number of employees in service was 1,654,075. Of the capital stock outstanding for the roads 40.96 per cent paid no dividends. The average rate of dividends paid on all stocks was 4.71. The capital invested amounted to $17,525,576,-908. During the year the number of passengers carried was 1,005,683,174, with an average of 34 miles for each passenger. The average receipts per passenger per mile was 2.06 cents. Number of tons of freight carried, 2,225,943,388, with an average of 170 miles per ton. The average receipts per ton per mile was 0.716 cents. The net revenue amounted to $3,-472,641,941, and the operating expenses $2,277,292,278. The net increase of income during the year amounted to $181,-084,474.

Ripken Main Rod Arm.

The Locomotive Specialty Company, Railway Exchange, Chicago, of which Walter H. Bentley is president, has issued a finely illustrated bulletin descriptive of the Ripken main rod arm. The device consists of an arm fastened near the forward end of the main rod, and takes advantage of the oscillation of the main rod, as well as the crosshead movement in actuating the combination lever, and replaces the usual crosshead connection in outside valve gears now in general use. Its use has the effect of removing the retarding effect which the combination lever has on the main gear action when actuated by the crosshead. It gives an increased port opening more rapidly, and retains it longer, thereby giving the steam a better opportunity to more fully follow the piston, and thereby gives a longer maximum cutoff. The amount of lead is not affected, the effect being simply a quicker opening of the valve, a larger and longer maintained port opening. It has a noticeable improvement in train acceleration, and assists in a uniform maintenance of speed. It is especially adapted for use on the Walschaerts or Baker valve gear, and has already met the warm approval of eminent engineering authorities. Copies of the descriptive bulletin may be had on application.

Internal Combustion Locomotives.

Record No. 85, issued by the Baldwin Locomotive Works, presents details of various changes and improvements that have been made since the introduction of Baldwin gasoline locomotives several years ago. Following steam locomotive design where practicable, an efficient gasoline locomotive has been developed, and its special fitness has been demonstrated in contracting operations, plantations, quarries, brick yards and other industries, and also in light switching in railroad yards. These are well adapted to localities where water is scarce, or where coal or electricity is very expensive. There are about 30 illustrations in the Record, showing a variety of standard sizes. The industrial gasoline locomotives range in weight from 3½ to 9 tons. The switching locomotives are 23 tons, and special designs may be contracted for to suit any traffic. A view is shown of the heavier type of design used at Chicago on the Erie, and which has proved eminently satisfactory for switching purposes, as is also an illustration of a lighter type, 350 of which were built for the Russian government. The Record is unusually interesting, and copies may be had by applying to the company's main office, Philadelphia.

Resuscitation.

The Department of the Interior has just issued a chart on the subject of resuscitation from gas asphyxiation, drowning and electric shock. The chart shows the Schaefer, or prone, pressure method of artificial respiration, which is the latest and most approved method advocated by eminent authorities. Copies of the chart will be sent free of charge to all persons requesting it. It is suitable for posting in fire stations, engine houses, and all industrial establishments where there is danger of accidents of the kind referred to.

Reactions.

The last quarterly issue of this publication issued by the Goldschmidt Thermit Company, Equitable Building, New York, is of particular interest to railroad men, showing, as it does, more than a dozen illustrations of locomotive repairs. Among the most notable is the repair of a large cast steel locomotive tender frame in which no less than ten welds were made on the badly damaged frame, the result being that the frame was made as good as new at a comparatively small cost, not speaking of the saving of time in comparison with procuring a new frame. The welding of complete new sections in locomotive frames are shown, and, indeed, there seems to be no limit to the possibilities of the successful use of thermit in the repairing of the largest kinds of engine fractures. Copies of the publication may be had on application.

Industrial Efficiency in British Munitions Factories.

Bulletin 230 of the Department of Labor, published at the request of the Council of National Defense, is of especial interest in its reference to wages. It shows that the absence of sickness, physical and mental,and efficiency of workers are influenced by the earnings, and that output, which has been closely investigated as an indication of fatigue, may be influenced by the wage system in force Generally speaking, payment by time alone has no direct influence in stimulating the inclination to work, while payment by the piece does have such influence. Thus, in one factory 17 girls drilling fuses and working on the piece-rate basis, in one week increased their output by 24 per cent on the day-shift and by 40 per cent on the night-shift over their output when working on a time-wage basis.

Graphite.

The Joseph Dixon Crucible Company's publication for August sets forth with much force the growing popularity of Dixon's pencils, now manufactured in 17 varieties or degrees of hardness. They are especially serviceable in the hands of engineers and draftsmen. Not only are they the smoothest but the longest wearing and most uniformly graded. Samples may be had free, and, speaking from experience, we will use none other except under compulsion. We have not quite arrived at Falstaff's stalwart declaration that he would do nothing under compulsion, but in the matter of pencils we are making a high, heroic effort to have some on hand all the time. Send for a sample to the company's office, Dept. 190-J, Jersey City, N. J., and be convinced.

Outdoor Metering Outfits.

The Outdoor Metering Outfits, described in Bulletin No. 46,251-B, which has just been issued by the General Electric Company, are admirably adapted for use in outdoor substations for measuring the amount of power supplied to the various feeders. These outfits are compact in design and are especially built for outdoor metering service. They are offered as thoroughly reliable and accurate units. The transformer elements are modifications of standard switchboard transformers thus maintaining the General Electric Company's standard of operation. The low installation cost; the low maintenance cost; the accessibility for inspecting and testing; as well as the safety of construction are special features mentioned in this bulletin.

Storage Batteries.

Bulletin 608 issued by the Edison Storage Battery Company, Orange, N. J., describes the use of Edison storage battery locomotives that are used in coal and metal mining, and in general industrial service. There are a number of photographs of locomotives in actual service, with complete general data and dimensions of Edison type A storage batteries used on the locomotives. There is also a description of the Edison electric safety lamp, which has been in use for several years and grown in favor wherever it is in service.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXX 114 Liberty Street, New York, October, 1917 No. 10

Completion of the Quebec Bridge

The completion of the hugh cantilever bridge at Quebec took place on Thursday the 20th of September, 1917. It is the largest bridge of its kind in the world, and to Canada belongs the distinction of having pursued this work with unfaltering determination, amid many difficulties and against two disastrous failures, which in all cost the lives of between 80 and 90 workmen. If it had not been for the original fall of one of the cantilever arms in 1907, and the loss of the central or connection span last year, it is very probable that no lives would have been forfeited in the great work.

The hoisting operation began Monday the 17th. The span, which weighs 5,000 tons, was lifted by hydraulic jacks 150 ft. from pontoons on the St. Lawrence river.

A wind blowing 25 miles an hour stopped the lifting operation for several hours. It was decided, however, to go on with the work. The jacks worked smoothly, and two hoists were taken in 28 minutes, leaving the span 18 ft. yet to go. The last hoist was made successfully, and the work proceeded without a hitch.

In our November, 1916, issue, page 363, we gave a description of the jacks, and how the whole scheme was carried out. The procedure was similar this year. The central span was built at Sillery cove, just above Quebec, and floated up to the bridge site on pontoons.

Int. Film Service.

QUEBEC BRIDGE COMPLETED—CENTRAL SPAN FINALLY IN PLACE.

One of our illustrations shows the connecting span being placed ready for hoisting. Tugs worked at each end of the span, and two others at the ends of long cables are to be seen up-stream holding the floating bridge against the flow of the river, and thereby taking this strain off the working tugs engaged in placing the bridge.

On looking at the photographs reproduced here, one may see the lifting links of rods, which are perforated at intervals, according to the "lift" of the jacks. There were eight jacks at each end, and from each end of the cantilevers there hung down a swinging built-up girder. These two girders were to hold the span when the jacks were being lowered, and the lifting links were also going down to be connected up for another lift. The smaller illustration shows very clearly the lifting rods and the hanging girders used to sustain the span when the jacks were being re-adjusted.

The work of connecting up the central span, which has now been successfully accomplished, ended the critical part of the operation. An effort last year to put a similar span in place resulted in disaster. One of the link pin castings broke, causing 14 deaths. In our October, 1916, issue, page 325, we gave an account of the 1907 failure, a new design of fastening was used this year.

The successful completion of this bridge will mean the fulfilment of practically a 64-year engineering dream. In 1853 bridge plans were prepared, and in 1892 the cantilever form was determined. A structure 3,239 ft. from shore to shore was finally approved, to stand 150 ft. above the river. It was estimated that the finished bridge would cost 17 millions of dollars, but the difficulties encountered and now happily overcome, will probably cause the actual outlay to exceed this figure. The St. Lawrence is crossed at Montreal by the Grand Trunk bridge—the Victoria bridge, as it is called. The C. P. R. have also a bridge over the river at Montreal, and now this broad stream is spanned again at Quebec by the largest cantilever bridge in the world. It will be some months yet before trains can pass over the structure. The running time between Halifax and Winnipeg will then be reduced half a day. Eight railways will have running rights over the bridge. Painting of the bridge, it is estimated, will take three years and will cost $35,000. —"Finis Coronat Opus."

Int. Film Service.

CENTRAL SPAN, CLEAR OF BARGES, READY FOR THE LIFT.

The Composition of Alloy Steel an Important Factor in Counterbalancing Locomotives

Microscopic Structure of Alloy Steel—The Function of Nickel, Chromium or Vanadium—The Eutectic Alloy—The Reduction of Reciprocating Weights on Locomotives—The Essentials in the Problem.

The composition of steel is interesting and especially so when viewed under the microscope. This instrument reveals many so-called secrets when applied to alloy steel. Years ago, railway axles in England were made of as pure iron as could be manufactured. Lowmoor and Bowling iron giving perhaps the best results. Iron axles made from this material were highly satisfactory for the load they had to support, and the work they had to do. Axles if made of this material today, would be too bulky for modern use, but in their own day they gave good service. They never broke, their failure took another form, they bent, and this state or condition revealed itself by the heating of the journals and the wobbling of the wheels.

The object today is to get an alloy steel which will not break or deform under the heavier stresses that the working parts are now subject to, and a further requisite has been forced upon the consideration of the mechanical engineer and the locomotive designer, which has in a way, nothing to do with the working stresses which all moving machinery is subject to. This is the matter of counterbalancing locomotives as exactly as may be, for the sake of bridges and track.

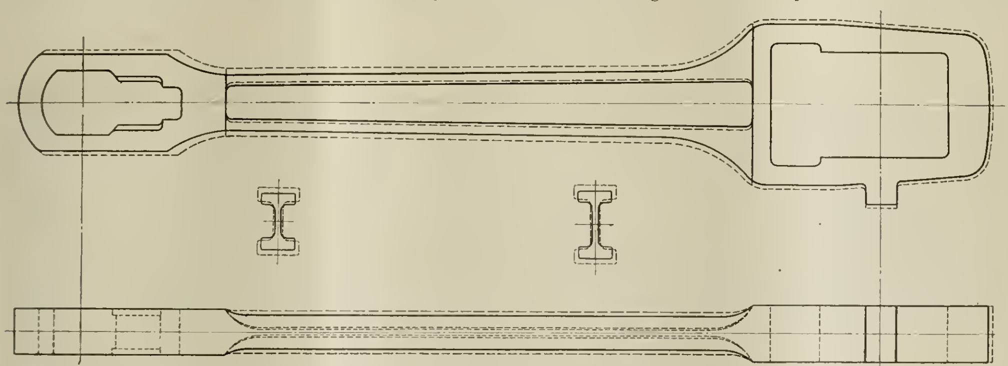
Steel when viewed under a microscope shows that it is composed of minute particles or grains, and that the contact of these grains with one another is more or less imperfect. The grains are not all of the same hardness nor are they all of the same size. Many of these grains are comparatively soft and others are "glass" hard. The addition of nickel (with proper heat treatment—which means temperature, careful annealing and quenching) has the effect of reducing the size of the grains and of permitting their mutual contacts to be better. We would say such steel was fine and close grained. Nickel has also the property of causing the distribution of carbon to be more even and better throughout the mass than without the nickel.

The cracking of iron axles and other parts of a working machine is simply caused by the grains, which being in imperfect contact, move with reference to one another or "work" on one another, if you like the phrase. This movement is infinitesimal, but it is there, and by repeated and reversed stresses it develops, and finally we have what is called a "fracture in detail," and eventually a rupture of the axle or other working part. The tendency of this "working" of the particles causes them to become more "free" and in time to assume the crystalline form owing to this so-called freedom of the particles. We often say steel has "crystallized." This term is only an approximation of the truth. The comparative freedom of the particles gives them room to form more perfect crystals. The object of introducing nickel is to counteract this so-called crystallization, by causing smaller grains to be formed, with better individual contact, or as we might speak of it, as possessing more "holding" power, and therefore less liability to crystallize, or to open and crack. The better distribution of the carbon throughout the mass makes the steel more homogeneous, and of course that means having fewer irregularities in structure, so that one part is approximately as good as another.

So much for nickel, but there are other desirable things that nickel cannot do and which are very necessary to have done. Now, even with nickel and its ability to make smaller grains, and give each a better contact, it lacks completeness. It does not do these things perfectly. An axle, let us say, subject to many, many heavy and rapidly reversed stresses will probably have some "slip" among the particles, not much of course, but it is possible for the "slip" to take place, so that although the metal may feel cool to the touch on the surface, it may have in its interior enough "working" or movement of the particles, one against the other, to produce a good deal of internal heat and may even overheat the molecules or grains of the steel where the action of the stresses is most severe. Chromium comes in here and plays its part, and a very important part it is.

Before going further with this subject it is necessary to say a word about the melting point of two or more metallic substances. For example, a mixture of tin and bismuth, in equal proportions, melts at 286 degs. Fahr. Tin alone melts at 442 degs. Fahr., and bismuth alone melts at 504 degs. Fahr. The melting point of the compound is far below the temperature required to fuse either one alone. The compound having this lower melting point, is called an eutectic alloy of tin and bismuth. This word eutectic is derived from the Greek, and signifies "eu," well, or satisfactory or advantageous, and "tektein" meaning to produce. So that an eutectic alloy is one that is advantageous or satisfactory to work with in the arts. It is for us a well-built alloy. Thus it is correctly said of pure cast iron, that it is not a carbide of iron, but an eutectic alloy of carbon and iron and graphite. Now the strong point or the advantageous point for us, is that any true eutectoid gives to such an alloy a lower melting temperature than either of the constituents would give if taken each by itself. Applying this to steel, it is not satisfactory as in the case of other alloys. The presence of chromium protects the steel from having this comparatively low melting temperature, so that the danger of having some of the internal grains become hot enough to be overheated, due to the heavy internal stresses which come upon them, though the surface is cool enough to touch, is warded off. Chromium defeats, to an appreciable extent, the consequences of the eutectic condition which we regard as an advantage in other alloys. The nickel and the chromium together add to the value of the steel and even in compression the alloy steel having these ingredients and therefore close grained, can withstand the the pushing together of its minute particles better than it could if they were not present, because the contact being good to begin with, and the metal dense, the particles do not yield to pressure as they would if chromium and nickel were not in it.

The steel has its compression value raised, vanadium protects the steel from the evil effects of various oxides, while titanium is a true deoxidizer. The danger due to the presence of sulphur or phosphorus is that they form sulphides and phosphides. These organize foreign bodies inside the metal and either weaken it or render it more brittle. Sulphur with iron, produces sulphide of iron, which is a compound of sulphur and iron, and this sulphide of iron has a low melting point. Therefore, when the piece is heated, it melts and destroys the ability of the metal to resist strains. This is why steel is said to be "hot short." Sulphur has a further injurious effect. It produces excessive shrinkage and internal microscopic checks or cracks. To coin a new phrase, perhaps applicable here as far as meaning is concerned, is to say that chromium (and also vanadium) tends to make the steel "hot long." In dealing with these ingredients of alloy steel, it is customary to state the amount of carbon as say 40 point. This means that carbon, in quantity amounting to 40 one-hundredths of 1 per cent., is in the steel. It ought strictly be written as 0.40 per cent. A distinction, more or less arbitrary, is drawn between mild steel and hard steel. Mild steel is practically that which contains up to 60 point carbon, or really 0.60, which is sixty one-hundredths of 1 per cent. of carbon. Steels which contain less than this amount are generally spoken of as mild steels and those which go above that figure in carbon content, are referred to as high carbon steels.



LOCOMOTIVE MAIN ROD. DOTTED LINE SHOWS OPEN HEARTH STEEL ROD WEIGHING 965 LBS. FULL LINE SHOWS NIKROME STEEL ROD WEIGHING 810 LBS. OR A SAVING OF 155 LBS. THAT IS 16 PER CENT.

We have now, let us say, a nickel-chromium steel, where the arrangement of its various minute particles is as good as we know how to get, and that we have given it the proper kind and amount of heat treatment, which is another way of saying that it has been carefully and intelligently heated, cooled and quenched. We have, therefore, a good steel, strong in tension and compression, able to stand vibrations of load and the rapid reversal of stresses, which are almost equal to the effect of blows. If such a steel is used for the working parts of a locomotive, the designer finds that he has a material at command which requires only a minimum of metal, to give the same strength for service, which formerly other and more bulky and heavier metals had usually been called upon to perform. The effect of introducing chromium is that it increases the tensile strength of the steel, it also makes the steel harder, and it raises the elastic limit. Further than this it produces the valuable effect of increasing the ability of the steel to resist shock, and to withstand the results of alternating stresses. It has the effect of facilitating or enhancing the good results of heat treatment, more than does any other element.

In the matter of case-hardening the presence of chromium aids in the absorption of carbon, giving the outer surface a finer grained, harder and better wearing exterior. When rolled or forged, chromium under 0.50 per cent gives to the steel a quality which does not appreciably affect the physical properties of steel if it happens to contain 0.25 per cent. of carbon, but the heat treatment may, for steel as low as 0.20 per cent., have a very marked influence in the physical results obtained.

Nickel in steel raises the elastic ratio, which is the numerical relation between elastic limit and the tensile strength. Nickel adds to the ductility of the steel, its toughness, and its power of resistance to abrasion, or to shock, and it helps the good effects of heat treatment, and it retards corrosion.

When manganese is introduced into steel, it slightly increases the elastic limit, if acting alone. In combination with nickel and chromium, it also increases the elastic limit and slightly toughens the steel, and in addition it performs the part of a purifier in the ladle. It assists, when the steel is rolled, by eliminating the hot short condition, by combining with, and so absorbing, the sulphur. This applies to manganese, in quantity up to 1.0 per cent. Steel containing more than this is brittle up to 2.0 per cent., and if the content of manganese goes above 2.0 per cent. it makes the steel extremely tough.

Carbon steel in its natural state contains from 0.40 to 0.50 per cent., and this gives a tensile strength of about 70,000 lbs. and an elastic limit of 40,000 lbs. It also gives an elongation of about 22 per cent. and a reduction of area of about 50 per cent. Heat treatment will increase the tensile strength about 10,000 lbs. if the steel be oil-quenched and drawn, but it will reduce the elongation and bring down the reduction of area. As a general thing increasing the carbon content of steel raises only the tensile strength, and induces brittleness.

A significant remark was made by the late L. R. Pomeroy, in an individual paper read before the American Railway Master Mechanics' Association, in 1916, on "Alloy Steel in Locomotive Design." In dealing with the effects of heat treatment he said: "The effects of heat treatment are so great that a certain steel may be given a very wide range of properties, depending on treatment, and any desired set of properties within that range may be obtained solely by varying the heat treatment. The principal varient is the degree of the second heating. The lower this is, the stronger and stiffer the steel, and the higher, the weaker and more ductile it is."

From the brief survey of some of the attributes of alloy steel here presented, it is evident that the whole science of mixing metals and especially the compounding of steel with other substances is yet in its very earliest stages. We know, however, that we have made a good start in the production of a most useful built-up metal,—that of heat treated alloy steel. The proper proportions, or should one say, the most advantageous quantities for our purpose, of steel with chromium and nickel, may be got by the empirical method; try and test, and note results, and then having got the best alloy we can, we are able to still further add to its value in a truly marvelous way, by judicious heat treatment. In fact the results of heat treatment are probably much wider and more varied in scope than we yet know, or have any adequate idea of. The object striven for in attempting to deal with this high grade alloy, for railroad use, is to cut down weight when applied to the reciprocating parts of locomotive machinery, while retaining maximum strength. This is attainable by good design, by correct alloying, by heat treatment, and by careful and thorough working of the metal. These involve two things, and they are requisites up to the very limits of essentials. These essential requisites are intelligent and scientific design, and careful and painstaking workmanship. Excellence in both these directions will never exceed the ideal of completeness. The rewards to be gained by the solution of this engineering problem are well worth any effort. Economy in operation, and the conservation of track, roadbed and bridges are some of the things within the reach of the mechanical engineer.

Our illustration shows a connecting-rod of a locomotive. The full lines are the Nikrome steel rod, and the dotted lines, the open-hearth steel size of the same rod. This rod is used on a large Pacific type of engine. The open-hearth steel rod weighs 965 lbs., and the Nikrome steel rod weighs 810 lbs., making a saving, when Nikrome steel is used, of 155 lbs., or about 16 per cent.

It should, however, be stated that it is not always possible to obtain as large a saving as this by the use of Nikrome steel, and a similar large saving should not be expected on side rods or rods in which the heads are comparatively large in proportion to the body, as the saving on the head of any rod is not as great as in the body of that rod. However, the saving is substantial and very fully illustrates what can be done.

The steady pressure of existing conditions and the experimental science view that is today coloring all our endeavors in the railroad world, are forcing the pace. These are compelling the alert, designing engineer to a realization of the necessities of our needs, and are indicating the way to meet each case with achieved advantage. Good alloy steel, intelligent design, and persistent and careful workmanship have come to the front as never before. They are now necessities that must be met and handled so as to produce the successful solution of the whole complex problem.

Facts Concerning Air and Water.

It is said that the atmosphere, which is the aeriform envelope encircling the earth, is about 45 miles deep. Calculations as to this figure are not entirely satisfactory, and often rest on mere assumptions. It exerts a pressure on the earth equal to a weight of 14.7 lbs. per square inch at the sea level. The air is principally a mixture of nitrogen and oxygen in the proportions of 76.90 by weight of nitrogen to 23.10 of oxygen, or by measure 79.10 of nitrogen to 20.90 of oxygen. Oxygen is the element that sustains life and combustion. Nitrogen acts as a dilutant to oxygen.

Water is the most important compound in nature. It is an essential part of every body possessing corporeal vitality. Water is formed by the union of two volumes of hydrogen and one of oxygen. Its chemical symbol is H_2O.

Water exists in three conditions, solid as ice, liquid as water, and in the gaseous as vapor or steam. Water freezes at 32 degs. Fahr., boils at 212 degs. Fahr., and evaporates at all temperatures. The U. S. gallon contains 231 cu. ins., weighs 8.34 lbs., and is 815 times heavier than an equal bulk of air. When water is evaporated into steam at the pressure of the atmosphere, the steam occupies 1,644 times the bulk of the water. It is also the most universal solvent in nature. It enters into combination with nearly all substances containing oxygen.

At 180 lbs. steam gauge pressure the temperature of boiling point of water is 379.3 degs. Fahr. At that pressure its steam volume is 150 times the volume of the water from which it was evaporated. The speed of steam, escaping at 100 lbs. gauge pressure into the atmosphere, is 1,957 feet per second. A cubic foot of water contains 7½ gallons at 62 degs. Fahr., and weighs 62½ lbs. About nine-elevenths of the earth's surface is covered by water leaving nearly 36 million square miles of land. Readers of Locomotive Engineering are found dotted all over that land. Under the pressure of the atmosphere 14.7 lbs. to the square inch water boils at 212 degs. Fahr., as may be readily demonstrated at 100 degs. C. At higher altitudes the boiling point lowers about 1 deg. Fahr. for every 510 feet of elevation.

Shay Geared Locomotive Used as a Switcher

Comparative Tests Against an 0-6-0 Switcher

In order to demonstrate some of the service possibilities of a Shay geared engine, the builders, the Lima Locomotive Works, Inc., of Lima, Ohio, tried one at their own grounds not long ago, and at the same time made a comparative test with an 0-6-0 switcher loaned to them by a neighboring railroad for that purpose. The Shay engine was not used for transfer work or where a long haul, necessitating some speed, had to be made. The Lima engine showed to the greatest advantage when put to "spot" cars, and where the trains so handled were heavy and the start had to be powerful, as the distance to be covered between stops was necessarily short.

The Shay geared engines took sharp curves and turn-outs on which rod-connected engines would be at a great disadvantage. Their pulling capacity, low wheel-loads and short curving radius permitted of track lay-outs best suited to industrial needs. These Shay engines accelerated more quickly and spotted cars more readily than rod-connected engines could. They therefore gave more service with less maintenance than rod-connected engines can be expected to give.

The Shay engines experimented with weighed about 50 tons, or 100,000 lbs. Each was equipped with three vertically placed cylinders 11 by 12 ins., and had a 52-in. wheel base, though the total wheel base measured 28 ft. 10 ins. The sharpest curve that it was thought advisable to lay down for these geared engines had a radius of 100 ft. The driving, and in fact all the wheels, for all are drivers, are 32 ins. in diameter, with a 19 to 42 gear ratio. That is 19 for the pinion and 42 for the geared wheel. The tractive power developed at about 4 m. p. h. was 22,500 lbs. The total heating surface measures 795 sq. ft.

Tests of both types of engines were made by the Lima Locomotive Works, Inc., April 14, 1917. The company, however, build both Shay and rod-engines. These tests were made with an 0-6-0 type of engine and a Shay engine of equal tractive effort. Two series of runs were made with the engines, operated at maximum tractive effort by experienced enginemen. The purpose of Test No. 1 was to obtain comparative rates of acceleration of the two engines when working under exactly similar conditions of road and track. The purpose of Test No. 2 was to determine the time required by the two engines to "spot" a given loaded car at definite points. A dead locomotive was used as the "load" in all the tests.

A complete record of acceleration test or Test No. 1 showed that these runs were made over a 500-foot length of track from a standing start up to running speed. The front bumper of the engine was opposite the first stake at the start, and the time at which the cab passed each stake was noted. The average time of three consecutive runs was used in making up the final result.

From standing start up to	100 ft.	200 ft.	300 ft.	400 ft.	500 ft.
Time required by Shay (seconds)	11½	18	23½	28½	32¾
Time required by direct (seconds)	16	23¼	28¾	33¼	37½
Time saved by Shay	28%	22½%	18¼%	14¼%	12¾%

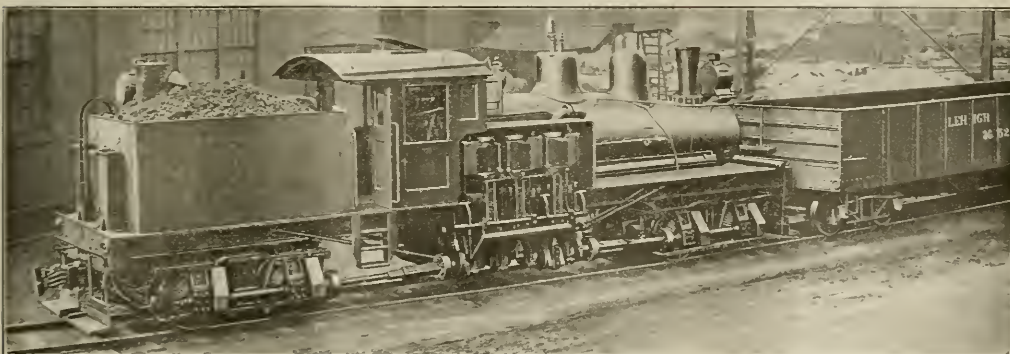
This test clearly shows the Shay locomotive to have a higher initial acceleration than the rod-locomotive. It will get up to the same speed in less time. The actual time saved varies from 13 to 28 per cent., depending upon the length of the run. In getting up to a speed of 12 miles an hour, an average rate for switching, shows that the Shay locomotive requires 22 per cent. less time than the rod-connected locomotive does. Messrs. A. J. Townsend and H. W. Snyder conducted these tests.

In the spotting test, which revealed the comparative value and performance of the Shay engine, and the six-wheel switcher, it is evident that the geared is the better machine for the purpose. For this test, runs were made over a 700-ft. length of track. The engine was run for 200 ft. and stopped, then started and run for 200 ft. further, reversed and run back 300 ft. The time was noted at the start, when stopped, when reversed, and when passing the 300-ft. stake on the return. The average of these three consecutive runs appears in the final result.

This test shows that the Shay locomotive started and stopped in a space of 200 ft. in 13 per cent. less time than the rod-locomotive. Then, starting again, reversing at 200 ft. and running back 300 ft., the Shay locomotive took 11 per cent. less time than the rod-locomotive. From the first until it had run 700 ft., including one stop and one reverse, the Shay locomotive required about 11 per cent. less time.

In all cases the Shay locomotive spotted locations more accurately than the rod-locomotive.

From the foregoing some advantages have been claimed for the geared locomo-



SHAY LOCOMOTIVE USED AS A SWITCHER FOR SPOTTING CARS.

W. E. Woodard, Vice-Prest. in Charge of Engineering. Lima Locomotive Works, Inc., Builders.

tive, and may be stated as follows: Shay geared engines used in industrial service do practically 10 per cent. more work than rod-engines of equal weight. Their first cost is ⅓ less than rod-engine and tender of equal tractive effort, and ⅕ less than a saddle-tank engine. They can go anywhere that a box car can go, thus making the box car (instead of the engine) the limiting factor of curvature. They permit layout of tracks, etc., to be made from a manufacturing standpoint instead of being governed by the engine's limitations, and local characteristics. All the weight is carried on the driving wheels, and is widely distributed, as all the wheels are driving wheels. This permits the use of light rail and operation on more or less soft, marshy ground. No counterbalance is used in the driving wheels. Geared locomotives produce no more effect on the track than would a car of equal wheel load. There are 12 to 18 power impulses to each revolution of the drivers, and this produces an even, steady pull. Fuel and water consumption are said to be extremely low.

The value of an industrial or switching locomotive doing special work depends upon its ability to accurately spot the required car at a given point in a minimum time, also its ability quickly to accelerate loads. The tests referred to above show the Shay engines to be 11 per cent. quicker and more accurate at spotting cars and to average 22 per cent. less time in attaining a speed of 12 miles an hour.

	Weight, Approximate.	Relative Work as Switcher.
Shay	50 tons loaded	110
0-6-0 type, with tender	90 tons engine and tender	100
0-6-0 type saddle tank	54 tons loaded	100

In a report covering the investigation of the comparative efficiencies of the direct locomotive and the Shay geared locomotive in switching service, we are told that the investigation was undertaken to determine the difference in time required to handle the same amount of switching with a direct locomotive and a Shay geared locomotive of the same tractive power. These interesting and valuable tests were conducted at the plant of the Lima Locomotive Works in April of this year. The engines tested were a direct locomotive of the 0-6-0 type loaned by courtesy of a railroad consenting to the test, and a standard Shay locomotive of equal tractive power being used in yard service. Our illustrations show these two engines coupled to an engine and tender weighing about 332,000 lbs., which was the "load" used for the test. Stakes were driven along the track for time observations, the distance between stakes being 100 ft.

From standing start up to	100 ft	200 ft	300 ft.	400 ft.	500 ft.
Time required by Shay locomotive, (seconds)	11½	18	23½	28½	32¾
Time required by direct (seconds)	16	23¼	28¾	33¼	37½
Time saved by Shay locomotive	28%	22½%	18¼%	14¼%	12¾%

The two series of test runs were made with the engines operated at maximum tractive power run by experienced enginemen. In each test trial runs were made with both engines before records were taken to enable each engineman to obtain the maximum power out of his engine under the required conditions of the test.

The test runs were made over a 500-ft. length of track from a standing start up to running speed. The front bumper of the switch engine was opposite Stake No. 1 at the start, and the time at which the cab passed each stake was noted. After making the trial runs, the average time of three consecutive runs was taken as the final result.

The second test runs were made over a 700-ft. length of track. The engine was started at Stake No. 3, run for 200 ft., and stopped at Stake No. 5. Then it was immediately started and ran 200 ft. to Stake No. 7, when it was reversed and run back. Time was noted at the start, when stopped, when reversed and at Stake No. 4; 300 ft. from the reversing position, with the engine running. After making the trial trips, the average time of three consecutive runs was taken for a final result.

The results of the first test showed the space time curves. These were plotted directly from the time observations. Then from these curves the velocity in miles per hour was calculated, and the resulting curves were plotted.

It is evident that the Shay locomotive picked up the load faster than did the direct locomotive. After going about 200 ft. both locomotives attained a speed of about 12 miles an hour, and from that point they both increased in speed at the same rate. A comparison of the values for space and time is tabulated above.

It is also evident that the Shay locomotives started and stopped in a space of 200 ft. in 13 per cent. less time than did the direct locomotive. Then, starting again, reversing at 200 ft. and running back 300 ft., the Shay locomotive took 11 per cent. less time than did the direct locomotive. From the first start until it had run 700 ft., which includes the stop and one reverse, the Shay locomotive again required about 11 per cent. less time. In all cases the Shay locomotive spotted the locations more accurately than did the direct locomotive. It may be truthfully said that the value of a switching locomotive depends upon its ability to quickly accelerate loads, and its ability to accurately spot the load at given points in a minimum time.

The first test clearly shows that the Shay locomotive had a higher initial acceleration than the direct locomotive, and therefore got up to a given speed in less time. The actual amount of time saved varied from 13 to 28 per cent., according to the length of the run. The Shay locomotive required about 22 per cent. less time than the direct locomotive.

The results of the second test show that in short-haul switching, and in spotting cars the Shay locomotive effected a saving in time of about 10 per cent. Therefore in the same time it can handle a correspondingly greater amount of work with the same train crew. Where both accuracy and speed in spotting the cars are necessary, such as occurs about industrial plants and in other circumstances, the Shay engine saved time as it can be quickly stopped at the right place, while the direct locomotive will often run past the point a short distance and have to be backed up.

Another investigation was undertaken to determine the effect which the general design of the boiler had upon the water line in the boiler with the Shay locomotive operating on steep grades.

In order to prevent water being drawn into the cylinders of Shay locomotives operating under these conditions, a design was prepared giving the maximum possible amount of steam space under the dome. The water lines of boilers of different proportions under the same service conditions were investigated, and the results compared so as to get a boiler of suitable design.

The first design tested was a wagon-top boiler, with a short taper course, the dome slightly ahead of the firebox crown, which is a new design for the

LIMA "SHAY" SWITCHER COUPLED TO CAMBRIA & INDIANA 2-8-2 USED AS THE "LOAD."

60-ton Shay locomotive. The next was a wagon-top boiler, with about the same height over the crown sheet and the taper course a little longer, but with the dome directly over the firebox, which was formerly used on the 60-ton locomotive. The last was an extended wagon-top boiler, with a smaller height over the crown and the taper course in front, but with the dome considerably ahead of the firebox, which is used on the 70-ton locomotive.

The amount of water in the boiler was assumed for the purposes of this investigation to remain constant for up and down grade and on the level, and two different grades were considered, one 6 per cent. and the other 12 per cent. The lowest reading on the gauge glass was taken as 3 ins. above the highest point of the crown sheet in accordance with the Interstate Commerce Commission rules. As the lowest water level at the gauge glass occurs when the locomotive is heading down grade, the water line while on a down grade was readily determined for each boiler for both a 6 per cent. and a 12 per cent. grade. Then, assuming a constant quantity of water for each grade, the location of the water line for the up grade and on the level, was calculated.

The difference in the gauge glass readings on the level and on the grades varies but little for the three types of boilers. From this it is evident that the shape of the front course of the shell does not materially affect the location of the water line, and therefore need not be considered. Since, when on a grade the Shay locomotive must operate both backward and forward, it is evident that the most satisfactory location for the dome would be directly over the intersection of the water line for the up and down grades. This point occurs at approximately the same distance ahead of the firebox for all three boilers. This point also varies but little in going from the 6 per cent. to the 12 per cent. grade, moving a little nearer the firebox and higher as the grade increases. From this it will be seen that theoretically the dome should be placed over the front of the firebox. In view of these facts it is evident that, with the dome properly placed, the steam space at the dome is directly proportional to the height of the roof sheet above the crown sheet.

The conclusions which may be drawn, and in fact were drawn, by Mr. A. J. Townsend, who made the investigation, were that the dome should be placed as near to the firebox crown sheet as the radial stays will permit, and that the vertical height between the roof sheet and crown sheet should be made as large as possible, to be consistent with the diameter of the boiler and the number of tubes required. Also that the general style of boiler, with a possible replacement of the two front courses, by a single course, is advantageous and should be adopted.

The principal dimensions of the rod-engine, with tender which was loaned for the test, are as follows: The engine used was a six-wheel switcher built in 1901, has 18x24 ins. cylinders, 56 ins. boiler; heating surface, 1495.8 sq. ft.; grate area, 15.3 sq. ft.; steam pressure, 160 lbs.; driving wheels, 51 ins. outside diameter (with new tires); wheel base, 10 ft. 6 ins.; weight, 100,400 lbs.

COMPARISON OF 50-TON SHAY AND DIRECT LOCOMOTIVES OF EQUAL TRACTIVE POWER.

	Weight, Approximate.	Relative Price.	Relative Work as Switcher.
Shay	50 tons loaded	100	110
0-6-0 type with tender	90 tons engine and tender	157	100
0-6-0 saddle tank	54 tons loaded	120	100

Concrete Railway Ties.

A leading paper published on the other side of the water, in speaking of concrete railway ties, says that one of the difficulties in the way of their more extensive adoption is the attachment of the rail to the sleeper, and another difficulty is a tendency for the concrete tie to crack and disintegrate. In view of the high price of timber and the demands for its use in other directions the present is evidently a favorable time for further trial of the concrete, or the steel and concrete tie, if satisfactory forms can be invented which do not involve the use of very much iron or steel for reinforcement.

In this country the Pennsylvania Lines have now over 4,000 concrete ties in use, and the P. R. R. and other railways have carried out trials of a good many different types. In England the South-Eastern and Chatham, the Midland and Great Northern Joint Committee, the Great Central, the Great Eastern, the London and South-Western, and the London and North-Western have tried such ties, or are arranging to do so. One of the most extensive systems to use them is the Italian Railway Administration, which in 1906 placed an order for 300,000 of them. The French Railways in Indo-China have been using them extensively for years. Trials have also been made on railways in France, Spain, Sweden, Bavaria and India, but it cannot be said that as yet they have been made standard anywhere, as there are difficulties yet which must be overcome.

Increased Railway Rates in Australia.

The Australian railways have for a number of years had to meet increased charges without increasing the freight and passenger rates. The percentage of net earnings fell from 3.85 per cent. in 1914 to 2.88 in 1915, and the State Minister has issued an order increasing the railway rates and fares. A British railway expert made a special investigation, and his report was adopted. The State of Victoria is the first to benefit by the new rates. The mileage of the Australia railways is over 20,000. No expense was incurred in revaluation. It was not an increase of expense that was desired, but an increase in income.

Improvements on Danish Railways.

The reports of Danish engineers dealing with projected improvements of the railway and ferry communications, the construction of new railways, harbors, and quays in Denmark, have just been presented, and it is expected that work on the proposed improvements will shortly be begun. The carrying out of the projects will involve an expenditure of 22 million dollars, and the work will cover a period of sixteen years.

Signal Engineers.

The United States Civil Service Commission announces an open competitive examination for senior signal engineer, Grade 2, for men only. Vacancies in the Interstate Commission under the act providing for the valuation of the property of common carriers, at salaries ranging from $1,800 to $2,000 a year. Applicants should apply for Form 2439 to the United States Civil Service Commission, Washington, D. C.

Car Handling.

It is generally conceded that the methods of today, both for the handling of railroad cars for reloading and in the movement of commodities urgently required at any given point for any given purpose as moved today, are likely to produce perhaps not a return to the old plan of pooling, as was permitted by law, but a way will be found to take advantage of those methods now employed for handling cars and the business of the railroads which have proved efficient. So, in the times which are to come plans will be considered for the development of the railroads, far reaching in effect and which will have an important bearing on the value of the outstanding securities of the carriers and also on future issues of securities made by them.

Construction and Operation of Locomotive Safety Valves

Variations and Improvements in Designs—Methods of Repair and Adjustment

In common with many of the devices used on the modern locomotive, the safety valve may properly be said to have reached a degree of perfection in construction and operation that little further improvement may be expected. To the inexperienced it might seem a simple problem to fit a movable plug in an orifice to be held in place by a spring adjusted to a desired pressure, and easy, and to some extent effective as this is, it has its mechanical draw-backs, particularly in the vibration or chattering at the opening and closing of the plug or valve, with the effect of damaging the valve and valve seat, not to speak of the disagreeable succession of noises incident to the chattering referred to. Not only so, but it was soon discovered that the lift of the valve did not increase sufficiently to

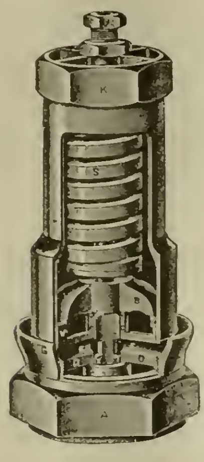


FIG. 1. THE CROSBY ORIGINAL ENCASED LOCOMOTIVE POP SAFETY VALVE.

relieve the boiler under all circumstances, but that the pressure might continue to increase while the valve is in operation, and would also continue to blow after the pressure of the steam had fallen below the point of opening. This is largely owing to the unavoidable friction of its parts. Hence the importance of improving the device.

With the advent of high-powered locomotives it became necessary to effect improvements on the safety valve. Among the earlier improvements the Crosby locomotive pop safety valve, Fig. 1 shows the original design of this device. The valve proper rests upon two flat annular seats VV and WW on the same plane, and is held down by the steel spiral spring S. The tension of the spring is obtained by screwing down the threaded bolt L. The area contained between the seats W and V is what the steam pressure acts upon ordinarily to overcome the resistance of the spring. The area contained within the smaller seat WW is not acted upon until the valve opens.

When the pressure under the valve is within about one pound of the maximum pressure required, the valve opens slightly, the steam passing the outer seat into the encasing cylinder, and thence into the air. The steam also enters through the inner seat into what is known as the well of the valve when there are passages EE for the escape of the steam from the well into the air when the valve is open. When the pressure in the boiler attains the maximum point, the valve rises higher and steam is admitted into the well faster than it can escape through the passages in the arms, and its pressure rapidly accumulates under the inner seat. This pressure, thus acting upon an additional area, overcomes the increasing resistance of the spring, and forces the valve wide open, thereby rapidly relieving the pressure in the boiler. When the pressure is lessened, the flow of steam into the well also is lessened, and the pressure therein diminishing, the valve gradually settles down. This action continues until the area of the opening into the well is less than the area of the apertures in the arms, and the valve promptly closes.

It will thus be seen that the organic principle of the device is the designing of the under-side of the valve, so that the effective area may be considerably augmented, thereby increasing the load on the spring, and with it the lift when the valve begins to open a little. The process of building up the pressure of the steam on a larger area until the full boiler pressure is acting over the whole area of the valve. This building up process is almost instantaneous. Latter improvements provided the valve with an overhanging knife-edged lip, which descends to a face at a lower level than the main seating of the valve. At the same time the direction of the steam flow is changed from horizontal to approximately vertical by the lip, and so the reaction of the steam flow further assists in lifting the valve.

By the use of what is known as the screwed ring, the amount of initial blow may be regulated by varying the outer curved face of the discharge passage. Lowering the ring increases the area of the annular passage outside the inner seat, and so delays the lift of the valve. In the improved Crosby Pop valve, as shown in Fig. 2, the difference between the opening and closing pressures can be adjusted so as to be very small indeed. The full open blowing and the prompt closing is always effected without any chattering or hammering.

Modifications of this clever design have been made by drilling a number of holes in the overhanging lip, or by reducing the depth of the knife-edge, or by making a communication between the annular cavity and a channel in the face, thus permitting escape to the atmosphere. The latter may be provided with a throttling arrangement whereby the "pop" may be regulated.

Fig. 3 shows the Ashton Master Mechanics' standard locomotive muffled safety valve where there is an ingenuous

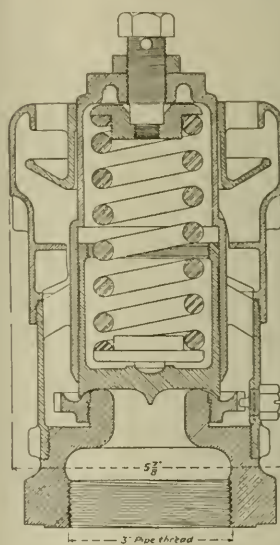


FIG. 2. CROSBY IMPROVED LOCOMOTIVE SAFETY VALVE.

combination of these three modifications or improvements referred to. One of the leading features on the construction of the Ashton safety valve is the means provided for pop regulation. The pop, or blow-back, is controlled by patented regulators, which extend through the top and outside of the valve body, whereby they are always readily accessible. This regulating requires no special wrenches, and does not make use of adjustable rings or sleeves, which are apt to become inoperative from binding or corrosion. There is also no outside casing to move for pop adjustment that may be damaged by wrenches. In the Ashton valve also the knife edge lip wing valve is an exclusive form of construction, which insures the most steady and invariable pop.

The knife edge lip wears down proportionately to the valve seat, thus maintaining the outlet of the main pop chamber in the same relative proportion to the inlet. This obviates the necessity of frequent adjustment.

Fig. 4 shows what is known as the Ashton Master Mechanics' standard locomotive open pop safety valve. The principal features are the same as the muffled type. In both types the pop may be regulated by slackening the check-nut on either or both of the top regulators marked 2 and 3, and screw down for increased pop, or contrary for less pop. The device has been found to be very reliable and effective.

As we stated at the outset, all of the manufacturers of safety valves have reached a high degree of perfection in their products. Among these the Coale "Type F" improved muffled safety valve

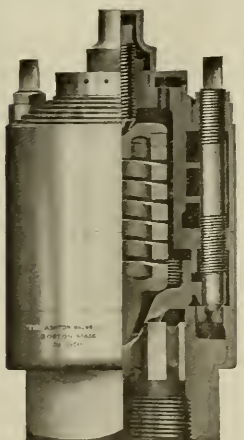


FIG. 3. THE ASHTON MASTER MECHANICS' STANDARD LOCOMOTIVE MUFFLED SAFETY VALVE.

with a new form of adjusting ring, shown in Fig. 5, is at once of substantial construction and efficient operation.

The Star muffled safety valve has also reached a degree of merit peculiarly its own in the simplicity and neatness of design, as shown in Fig. 6, and is among the leading products of the Star Brass Manufacturing Company.

The amount of steam discharge from safety valves of given size can be closely estimated by the use of Napier's rule for the flow of steam, as follows: Flow of steam per second; absolute pressure in pounds per square inch, multiplied by area in square inches of discharge opening, divided by 70. Multiplied by 3,600 gives flow in pounds of steam per hour.

The safety valves should be located at the highest point on the boiler, where clearance limits will permit, in vertical

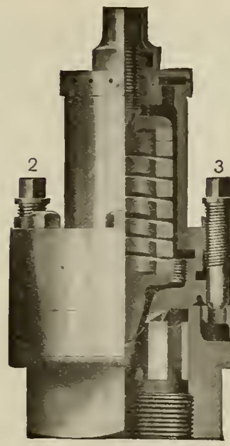


FIG. 4. THE ASHTON MASTER MECHANICS' STANDARD LOCOMOTIVE OPEN POP SAFETY VALVE.

position, avoiding the use of piping, long nipples and ells between the safety valves and the boiler. When the safety valves are located on an independent dome, the opening from the boiler into the dome, and the area between the supporting ribs in the dome, should not be less than the inlet area of the valves. In a hydrostatic test of the boiler the screwing down of the safety valves should not be practiced. Valves with springs designed for certain pressures should not be subjected to extreme pressures. A special high pressure valve should be used in place of one of the safety valves, and the other valve or valves should be removed and replaced with caps or plugs during the test. The safety valves should be thoroughly overhauled and put in good condition whenever the locomotive is at the shop for general repairs. Standard gauges should be used in order that important dimensions may be maintained as originally designed.

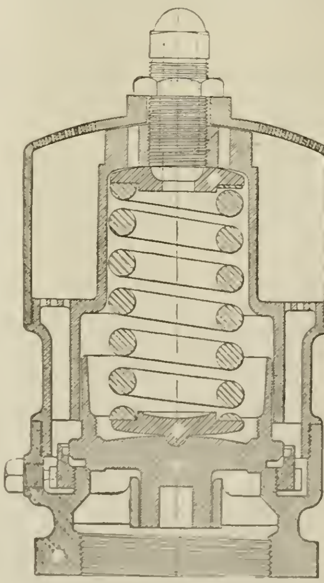


FIG. 5. TYPE "F" COALE IMPROVED MUFFLED SAFETY VALVE.

Regarding the best method of determining the capacity of safety valves the most satisfactory is by actual test in a testing plant, with safety valves fully equipped with springs, as in actual road service. It is also advisable that it should be positively known that safety valves will prevent undue rise in pressure under extreme conditions, they should be subjected to a road test. Constructing engi-

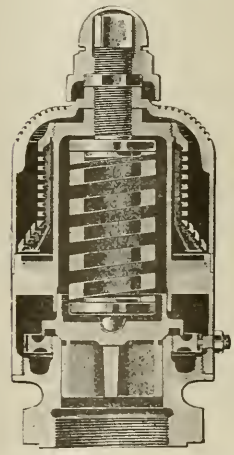


FIG. 6. STAR IMPROVED MUFFLED SAFETY VALVE.

neers have established the following formula for determining the size of valve required, assuming that the valves have a 45 degree seat:

D—The total of the actual diameters of the inner edge of the seats of valves required.

H—Total heating surface of boiler in square feet, superheating surface not to be included.

L—Vertical lift of valve in inches.

P—Absolute boiler pressure in pounds per square inch.

$$D = .036 \times \frac{H}{L \times P}.$$

Hence the following example:

$$\frac{.036 \times 2878}{.1 \times 200} = 5.2 \text{ ins. diameter.}$$

This would require two valves 3 ins. in diameter.

Every locomotive should be equipped with not less than two, and not more than three safety valves. In the case of three safety valves, the third valve should be adjusted at from three to five pounds above the opening point at which the second valve is adjusted. Bronze alloys are recommended by the best authorities in the manufacture of valves and valve seats.

The occasional refitting and readjustment of the safety valves are operations that are to be anticipated as arising among the necessities of locomotive service. Impurities in the water are apt to be caught between the valve and valve seat on the occasion of the shutting of the valves. The springs vary in their tension on account of the heating and cooling to which they are subjected, the tendency being that after a few weeks' service the point of pressure at which the valves will open and allow the steam to blow off will decrease, rendering a readjustment necessary. Coincident with a contemplated change in the tension of the safety valve springs, it is well to be assured that the steam gauge has not also undergone some change in the recording of the steam pressure. One is as likely to run into error as the other, and the brief time taken in testing a steam gauge is time well spent preparatory to the readjustment of the safety valve springs.

In the older types of safety valves there are usually two small holes drilled in the upper surface of the valve, into which a two-pronged fork, with handle, used like a boring brace, can be readily applied and the grinding readily proceeded with as in the case of a check or angle valve, care being taken that the valve should be lifted at short intervals. Drying and polishing will readily show the nature and extent of the bearing. If much grinding is required to fit the joint, the tendency to form a shoulder on the seat or valve is very great, especially when the coarser kind of emery is used, but protuberances may be readily removed by filing or scraping without the necessity of reducing the shoulder that may arise in the lathe.

In adjusting the safety valves care should be taken that the valve stem does not press against the sides of the hole in the spring cap. The holes in the caps should be large enough to admit of some slight variation from the exact center without the possibility of the stem rubbing against the sides, any pressure of this kind readily affecting the opening and closing of the valves. In adjusting the pressure of the springs on the safety valves, as already stated, the valves should not be both set at exactly the same pressure. A variation not exceeding five pounds—many roads make it two or three pounds—is advisable, as it is not necessary that both valves should open unless in cases of rapid increase of steam pressure. All steam escaping from safety valves is a waste of energy, and on the opening of the first valve, set to the lower pressure, the engine men know to put the injector in operation, or institute some other method of utilizing the overplus energy, or diminishing the fuel consumption, which is always a vital, as well as a burning question in the economical use of steam as a motive power.

In the setting of the valves at a varied pressure, it is also an item of economy to set the best working valve, if there be a variation in their working, at the highest pressure. It will be readily noted that both valves rarely close with the same degree of rapidity, and the quick closing valve is, of course, the more economical.

It may be stated that in the cases of the valves being of the latest and most improved type, and where they are adjustable by a head bolt, it is good practice that the valve and valve seat be ground separately, the valve being ground on a perfectly flat surface of iron or steel; the parts should be cleaned with water and put together and the valve will generally be found to be tight.

Lack of space prevents from alluding to the types of safety valves in use in foreign countries, but it may be truly said that in this as in nearly every other mechanical device, the best have been conceived and perfected in the atmosphere of American enterprise. The old world is conservative in the introduction of new means and methods. The intellectual eyes of the new world are constantly looking for something new. Here is encouragement towards the ideal and hence progress. We may not yet rest upon our laurels; much lies before us.

Brick Arch Tests on the Texas & Pacific Railway

Comparative Tables—Importance of the Pyrometer

A short time ago the American Arch Company, of 30 Church street, New York, undertook some exceedingly interesting investigations on the Texas & Pacific Railway. The primary object of these tests was to ascertain the firebox temperatures at different points, with a view of determining whether or not the Gaines fire brick wall caused a localization of temperatures sufficient to injure the firebox sheets. Advantage was taken, however, of this opportunity to obtain data on boiler performance and combustion conditions. The temperatures at different points in the firebox were taken by means of pyrometers furnished by the University of Illinois; and all temperature observations were made by Prof. J. M. Snodgrass, of that institution.

Two series of standing tests were run. Four of them were made with the Gaines wall standing in its place, and four tests with the Gaines wall removed and the air ducts closed. The rate of firing in the standing tests approximated to the severest road conditions, and the endeavor was made to run all tests at the same rate by keeping constant the front end draft.

As a check on the standing tests, one road test was run with Engine 511, between Longview Junction and Marshall, with the Gaines wall in place; and a similar test was run with Engine 500 without the Gaines wall. In both tests, the locomotives were handled by the regular crews and no attempt was made to control their operation of the locomotives.

Table No. 1 gives some general information on these tests. The first was run for an hour; but for fear that the pyrometer might not stand up under the conditions imposed, subsequent tests were run for thirty minutes each. Each test was run with a "flying" start—that is, the locomotive was operated under the test conditions for fifteen or twenty minutes before any test readings were taken. This was done in order to get all the brickwork in the firebox heated to maximum temperature. The location of Pyrometer No. 1 is shown in the last column of Table No. 1. The table also indicates the positions in which the temperature readings were made during the tests. These locations are serially shown in Fig. 1.

Table No. 2 shows the average temperatures and draft during the standing tests. During these tests readings were taken with a Radiation Pyrometer through the opening in the fire door, as a check on the temperatures secured by the L & N Pyrometer placed within the firebox. It will be noted that the temperatures secured with the Radiation Pyrometer run fairly uniform throughout the tests, although they were higher in the road test than in the standing test. This may have been due to the pulsating effect of the exhaust, tending to lift the mass of the flame higher up and in a more direct line with the Radiation Pyrometer. While the front end draft was nearly constant throughout the tests, it will be noted that with the same draft, more fuel oil was consumed without the Gaines wall than with it. As the amount of oil consumed has a direct bearing on the temperatures, the temperatures obtained without the wall would probably have been a little lower if the amount of oil could have been kept constant.

TABLE NO. 1

General Information

Test No. 1	Engine No. 2	Kind of Test 3	Length of Test. Minutes 4	Gaines Wall 5	Location of Pyrometer No. 1 6
1	511	Standing	60	With	C
2	511	Standing	30	With	B
3	511	Standing	30	With	A
4	511	Standing	30	With	D
5	511	Standing	30	Without	D'
6	511	Standing	30	Without	B'
7	511	Standing	30	Without	A'
8	511	Standing	30	Without	C'
9	511	Road	91 Running	With	—
10	500	Road	74 Running	Without	—

The conclusions reached in this series of tests may be briefly stated as follows: Firebox temperatures were in no case found to be excessively high, but on the other hand they were lower than would be expected under normal conditions. Firebox temperatures with the Gaines wall were higher in the back end and dropped gradually toward the flue sheet. Firebox temperatures without the Gaines wall were more uniform from the door to the combustion chamber, with a decided drop in the combustion chamber. The firebox temperatures above the wall were higher without, than with the wall in place. This is contrary to what many would expect to be the case.

The maximum temperature obtained was 2,300 degs. Fahr. in the rear of the firebox with the Gaines wall. The average temperature was about 2,000 degs. Fahr. Under maximum temperature conditions and with clean sheets, the temperature of the fire side of the sheet would be about 512 degs—there being a temperature drop of 130 degs. Fahr. between the fire side and water side of the sheet. Under average temperature conditions, the temperature of the fire side of the sheet would be 468 degs. Fahr., with a drop of 86 degs. Fahr. between the fire side and water side of the sheet. As the tensile strength of boiler plate increases with temperature up to about 600 degs. Fahr., the maximum temperatures attained were not high enough to damage the sheet when kept free from scale and mud.

TABLE NO. 2

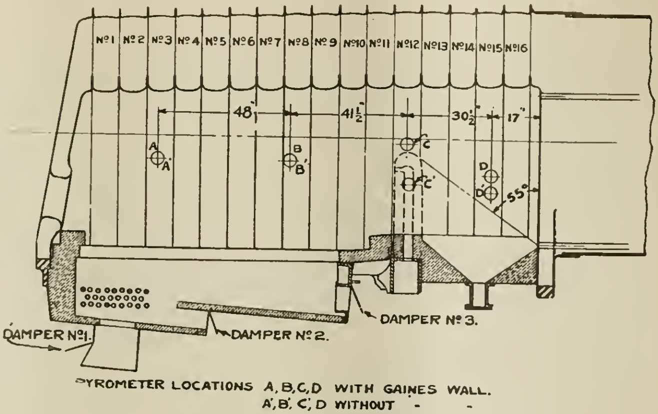
Average Temperature and Draft—Standing Test—Engine 511

Test No.	L. & N. Pyrometer Location	Firebox Temperature F°: L. & N. Pyrometer: Average	Maximum	Radiation Pyrometer Through Door	Front End Temp. F°	Draft Inches of Water: Fire Pan	Front End	Pounds Oil Burned Per Hour
3	A	2,315	2,330	—	595	3.8	8.4	3,952
7	A'	2,000	2,040	2,000	645	4.1	8.9	4,164
2	B	2,050	2,140	2,045	—	3.0	7.8	4,004
6	B'	1,940	2,055	2,040	615	3.8	8.5	4,008
1	C	1,855	1,875	2,315	—	2.9	8.0	3,139
8	C'	1,960	2,020	2,015	625	3.9	8.3	4,261
4	D	1,580	1,645	2,0[illegible]5	590	3.8	8.5	3,607
5	D'	1,710	1,730	2,030	580	3.7	8.0	4,135
Road Test Engines 500 and 511								
Engine 511, with Gaines Wall				2,110	570	3.3	6.9	2,157*
Engine 500, without Gaines Wall				2,175	600	4.1	7.3	2,982*

Pyrometer Locations A, B, C and D are with Gaines Wall.
Pyrometer Locations A', B', C' and D' are without Gaines Wall.
* Pounds of oil burned on trip Longview to Marshall.

There was no localization or "building up" of temperatures above the wall. Removal of the wall caused a decrease of 13.5 per cent. in evaporation and boiler efficiency. This was accompanied by an average increase of 30 degs Fahr. in the front end temperatures, and a noticeable increase in the amount of smoke made. With the Gaines wall in place, 4,000 lbs. of oil were burned per hour without smoke. Without the wall, considerable smoke was made at this rate of firing. The air supply was ample—the gas analysis indicating 43 per cent. excess of air at the highest rates of firing. Indications are given by these tests that with a combustion chamber firebox of this type an air opening of 1 sq. in. per gallon of oil burned per hour is sufficient. With the Gaines wall in place, combustion conditions are almost perfect. It may be safely stated that with firing carried out with ordinary intelligence, these locomotives can be driven to their maximum capacity without making smoke and with high boiler efficiency.

The matter of boiler performance, which one might almost call a by-product of this series of tests, shows that on the Texas & Pacific the Gaines brick wall and combustion chamber rendered good service. Table No. 3 shows the average boiler pressure and steam temperatures, with and without the wall. It is apparent that the removal of the wall had practically no effect on the amount of superheat obtained, the slight rise being due to the increase in the amount of oil fired.



FIREBOX USED IN T. & P. TESTS, SHOWING POSITION OF PYROMETERS. GAINES WALL, DOTTED LINE.

Table No. 4 shows the rate of combustion and evaporation, with and without the wall. With the wall in place, an average of 3,675 lbs. of oil per hour was fired, resulting in an apparent evaporation of 47,968 lbs. of water per hour. With the wall removed and the same front end draft, the average amount of oil fired per hour increased to 4,142 lbs., while the water apparently evaporated decreased to 46,842 lbs. The average evaporation per pound of oil with wall in place was 13.05 lbs.; without the wall, 11.30 lbs. This is a difference of 13.5 per cent. in favor of the wall.

The combustion chamber does not here enter into consideration. As the wall is only a part of the combustion chamber installation, this 13.5 per cent. is not a true measure of the efficiency of the Gaines Combustion Chamber, and it should be borne in mind that this difference is due to the wall.

The front end temperatures obtained under these high rates of firing are remarkably low, and indicate that an 18-ft. flue, used in conjunction with long firebox and combustion chamber, will give high evaporation and efficiency. These Texas & Pacific boilers have ample heating surface and could be driven at higher rates than are here shown, if it were possible to get the oil into the firebox.

TABLE NO. 3

Steam Pressure and Temperature—Standing Test—Engine 511

Test No.	Gaines Wall	Boiler Pressure	Steam Temperature: In Boiler	Steam Temperature: In Valve Chamber	Steam Temperature: Superheat	Lbs. Oil Fired Per Hour
1	With	174	377.2	——	——	3,139
2	With	167	374.0	——	——	4,004
3	With	182	380.6	581	225	3,952
4	With	183	381.0	582	229	3,607
5	Without	181	380.2	580	227	4,135
6	Without	183	381.0	588	234	4,008
7	Without	183	381.0	589	235	4,164
8	Without	182	380.6	589	236	4,261

Locomotive capacity and boiler capacity depend upon the amount of fuel that can be burned and heat liberated in the firebox; and when using fuel oil, the volume of the firebox becomes an all-important consideration. The indications are that with skillful firing, proper design of pan and ample air supply, about 10 lbs. of oil can be burned effectively per cubic foot of firebox volume, per hour.

The boiler efficiencies obtained, that is, with and without the wall, are strictly comparable; and they show an increased efficiency of 13.5 per cent., due to the wall alone. The indications are that the wall and combustion chamber, taken together, would give an increase in boiler efficiency of more than 20 per cent. when burning fuel oil under the conditions stated. This is a material saving and well worthy of the most serious consideration. The combustion conditions were nearly as perfect as they could be during the standing tests. There was a noticeable absence of smoke in all the tests run with the Gaines wall in place.

It has been suggested that the Gaines wall installation restricts the flow of gas through the bottom flues. The fire pan draft readings do not bear this out, neither does the temperature of the steam. It may reasonably be said that if the wall hindered the gas flow through the lower tubes, it would increase the flow through the upper flues and thus cause a higher degree of superheat. Such, however, is not the case. There is no evidence that the wall in any way restricts the flow through the lower flues. The area of gas passage above the wall is 10.9 sq. ft. The net flue area is 8.7 sq. ft., which gives an excess area above the wall of 25 per cent. It is evident, therefore, that no throttling of the gases could take place at this point. As a matter of interest, it is stated that the average weight of gases passing over the wall was 78,000 lbs. per hour; and that the velocity of flow at this point was 120 ft. a second.

In several tests without the wall, the air ducts extending up through the wall were plugged; but this seems to have had little or no effect on the air supply. The amount of air forced into the fire pan seemed to depend upon the difference between the atmospheric pressure and the pressure in the fire pan, and a moderate change in the amount of air opening merely resulted in increasing or decreasing the partial vacuum in the pan. If the air opening is decreased, the fire pan rarefaction increases, and more air, per square inch of opening, is drawn in. The indications are that 1 sq. in. of air opening is required per gallon of oil burned per hour. A firebox with shorter flameway and less volume would probably require more.

TABLE NO. 4

Rate of Combustion and Evaporation—Standing Test—Engine 511

Test No.	Gaines Wall	Oil—Lbs. Fired Per Hr.	Oil—Lbs. per Hr. per Cu. Ft. Firebox Volume	Water—Apparent Evaporation. Lbs. Per Hr.	Water—Apparent Evaporation. Per Lb. of Oil.	Water—Apparent Evaporation. Per Sq. Ft. Evap. Surf.
1	With	3,139	7.25	41,697	13.25	10.84
2	With	4,004	9.25	52,720	13.16	13.70
3	With	3,956	9.12	50,241	12.17	13.06
4	With	3,607	8.33	47,216	13.09	12.27
Average	With	3,675	8.49	47,968	13.05	12.47
5	Without	4,135	9.56	47,500	11.48	12.35
6	Without	4,008	9.25	46,036	11.48	11.97
7	Without	4,164	9.61	44,607	10.71	11.60
8	Without	4,261	9.84	49,227	11.55	12.80
Average	Without	4,142	9.59	46,842	11.30	12.15

Some locomotive data of the Texas & Pacific Railway is here appended. Class G-1, type 2-10-2 Engines 500 and 511: Cylinders are 28 x 32 ins.; valve, piston 14 ins. dia.; boiler, straight, 84 ins. dia.; pressure, 185 lbs.; firebox, 82 ins. wide, 176½ ins. long; Jacobs-Shupert type, with Gaines combustion chamber. Tubes: 41, 5⅜ ins.; 267, 2 ins.; length, 18 ft. Heating surface: firebox, 307 sq. ft.; tubes, 3,539 sq. ft.; total, 3,846 sq. ft. Superheater, 886 sq. ft.; grate area, 70 sq. ft. Driving wheels, dia. 63 ins. Weight on driving wheels, 262,100 lbs.; weight on front truck, 27,100 lbs.; weight on back truck, 35,400 lbs.; total engine, 324,600 lbs.; total engine and tender, 501,300 lbs. Tank capacity, 9,500 gals. of water; 3,100 gals of oil. Fuel: Louisiana Fuel Oil; gravity, 24 to 30; weight per gal., 7.437 lbs.; B .T. U. per one gal., 143,754; B. T. U. per one lb., 19.332.

TABLE NO. 5

Boiler Horsepower and Efficiency—Standing Test—Engine 511

Test No.	Gaines Wall	Oil—Lbs. Per Hr.	Equivalent Evaporation. From and at 212 deg. Pounds Per Hr.	Equivalent Evaporation. Per Lb. of Oil	Equivalent Evaporation. Per Sq. Ft. Ht. Surface	Boiler Horsepower Total	Boiler Horsepower Per Cu. Ft. Firebox Vol.	Boiler Efficiency
1	With	3,139	54,206	17.30	11.45	1,571	3.63	86.8
2	With	4,004	68,536	17.11	14.48	1,986	4.59	85.8
3	With	3,952	65,815	16.65	16.65	1,907	4.40	83.5
4	With	3,607	61,852	17.14	13.07	1,792	4.13	86.0
Average	With	3,675	62,602	17.03	13.22	1,814	4.19	85.5
5	Without	4,135	62,225	15.05	13.15	1,804	4.16	75.5
6	Without	4,008	60,307	15.04	12.74	1,748	4.03	75.5
7	Without	4,164	58,435	14.03	12.35	1,694	3.91	70.4
8	Without	4,264	64,487	15.13	13.62	1,869	4.31	75.9
Average	Without	4,142	61,363	14.81	12.96	1,779	4.10	74.3

To this report are appended some recommendations by the Arch Company, and these may briefly be stated for the information of our readers. They concern oil-burning engines.

The channel for the flameway from the burner should be narrow at the burner and widen out gradually throughout its entire length. The channel should not be less than 18 ins. deep. At least 30 per cent. of the total air opening should be located around the burner, preferably below and at the sides of the burner. The bottom of the channel should be uniformly level; and the middle damper, when employed as in the design used on this road, should be eliminated, as it has a tendency to lift the flame and cause an undesirable drumming. The dampers on the hopper (or boot) and on the front of the pan should be well constructed and arranged, so as to be held rigid in any position, as any vibration of the damper caused by the draft is undesirable. The burner should be located so that the atomizer opening is not over 5 ins. above the floor of the pan. The burner must be kept horizontal and in alignment with the center of the channel.

The report, which is one of the most complete we have seen, is signed by Mr. J. T. Anthony, assistant to the president of the American Arch Company, and by Mr. G. M. Bean, sales engineer of the same company. These two names appended to the report bring with them the endorsation of the Arch company; but the sanction to make public the results of their labors on the important railway which caused the tests to be made, shows that the Texas & Pacific Railway, of which Mr. A. P. Prendergast is mechanical superintendent, is satisfied with the accuracy of the work done. This road, therefore, has added its name to the growing list of those who desire a knowledge of the tested and tried truth, and who believe in applying the scientific method to finding physical nature's methods, and of using them in the practical work of a busy railway line.

American Engineers at the Front.

An Associated Press dispatch states that an American regiment of engineers has taken over the operation of an important line of French strategic railways and are hauling ammunition and other supplies to the French army. Bullets have been showered upon the moving trains but so far none of the enginemen or trainmen have been injured. The regiment is known as an operating unit in contradistinction to those engineers enlisted as construction units.

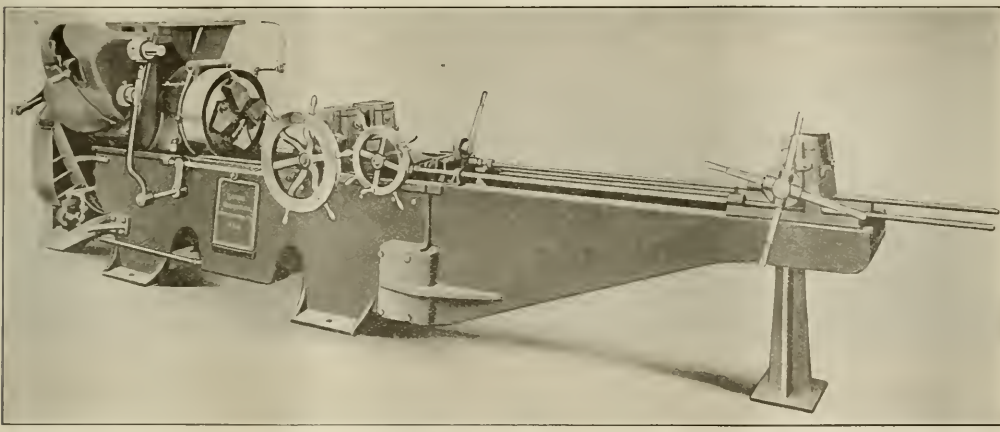
Watchful Waiting.

I never see a man trying to beat a train to a crossing that I don't wish the guards in the asylum tended more to business.

New Design of Landis Threading Machine for the Larger Type of Hollow Staybolts

It is gratifying to observe with what a marked degree of promptness and accuracy the leading machine manufacturers meet the requirements of the constantly increasing demand for new devices to solve the complex problems of machine construction. The accompanying reproduced photograph shows a Landis threading machine which was designed and built for a large shipbuilding plant for threading hollow staybolt tubes. The tubes vary from six to eight feet in length and from $2\frac{3}{4}$ ins. to $3\frac{1}{2}$ ins. in diameter.

The machine is equipped with an auxiliary bed which is attached to the main bed of the machine. This extension bed supports an auxiliary carriage fitted with threaded grips employed in timing the threads on the ends of the tubes and also chasers fit in the threads already cut on the master stay tube. Grip the other end of the master tube with the threaded grips in the auxiliary carriage. These grips should be sufficiently loose so that they can adjust themselves endwise with the thread on the master tube. After the master tube is gripped in the extension carriage these threaded grips should be securely gripped in the auxiliary carriage vise jaws. Then throw in the leadscrew nut of the main carriage and grip the tubes in the regular vise of the main carriage. The chasers, the leadscrew and the threads on the staybolt tubes then will be all timed. Remove the master stay tube and place the tubes which have already been threaded on one end in the threaded grips of the auxiliary carriage



LANDIS THREADING MACHINE FOR LARGE STAYBOLTS.

in supporting the tubes. The machine is furnished with a leadscrew attachment which insures a high degree of accuracy and a perfect start of the thread, also a pitch indicator which shows the correct position for engaging the leadscrew nut. The illustration shows the machine arranged for an A. C. constant speed motor with mechanical speed change box and silent chain and sprocket drive. The photograph was taken prior to mounting the motor in position.

The method of threading the hollow staybolt tubes on this machine is as follows: Thread one end of all the tubes which are to be threaded, by gripping them in the vise of the regular carriage. Then take a master tube which has both ends threaded and with threads continuous. Place the master tube in the machine, close down the chasers in the threaded portion on one end, that is, make the grooves or serrated surfaces of the

and engage the leadscrew nut when the pitch indicator on the main carriage shows the correct position for engaging this nut. The operation of threading the second end on all the tubes can then proceed and the threads on both ends of the tube will then be continuous. The machine employs the Landis All-Steel Rotary Die Head and long life chasers which insure a high production of accurate threads.

Extending the Age Limit.

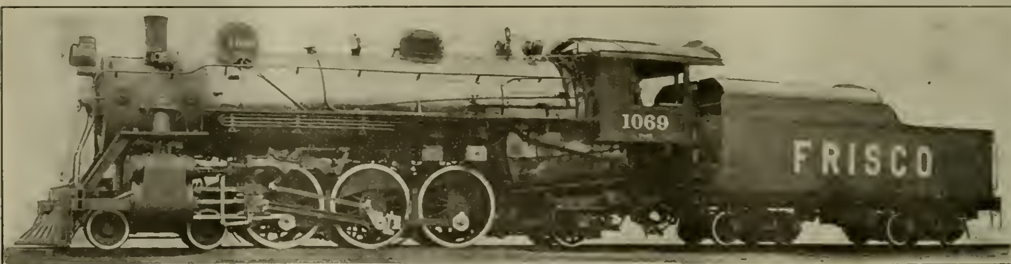
The New York, New Haven and Hartford Railway Company has taken steps to employ both younger and older men in the Operating Department than have been accepted heretofore. The old age limits were 21 years to 35 years. Under the new plan the limits for firemen will be 18 to 45 years, for trainmen, 18 to 50 years; and for other employees, 18 to 60 years.

Pacific and Santa Fe Type Locomotives for the St. Louis-San Francisco Railway

Comparison Between the New and Older Types of Locomotives

The St. Louis-San Francisco Ry. has recently received 40 locomotives from The Baldwin Locomotive Works. Of these, ten are of the Pacific type for express passenger service, and 30 are of the Santa Fe (2-10-2) type for heavy freight service. In many respects, the two types are similar in construction; and interchangeable details are used where practicable. Thirty additional locomotives of the 2-10-2 type are now under construction.

This is the third design of Pacific type locomotive thus far built by The Baldwin Locomotive Works for the Frisco, and a comparison of its leading dimensions with those of the two preceding classes shows an interesting progress in weight and capacity. Such a comparison is as follows:-



PACIFIC 4-6-2 TYPE LOCOMOTIVE FOR THE ST. LOUIS-SAN FRANCISCO RAILWAY.
P. T. Dunlop, Gen. Supt. Motive Power. Baldwin Locomotive Wks., Builders.

Date	1904	1910	1917
Cylinders	20 in. x 26 in.	26 in. x 28 in.	26½ in. x 28 in.
Drivers	69 in.	69 in.	73 in.
Steam pressure	200 lbs.	160 lbs.	200 lbs.
Grate area	43.3 sq. ft.	51 sq. ft.	63.5 sq. ft.
Water heating surface	2,863 sq. ft.	2,852 sq. ft.	4,200 sq. ft.
Superheating surface	....	590 sq. ft.	996 sq. ft.
Weight on drivers	114,890 lbs.	134,900 lbs.	190,000 lbs. (est.)
Weight, total engine	190,970 lbs.	220,650 lbs.	296,000 lbs. (est.)
Tractive force	25,600 lbs.	37,300 lbs.	45,800 lbs.

The new Pacific type locomotives carry wheel loads which are close to the maximum now in use, and the design is well proportioned for through service where excessive bursts of speed are not required, but where trains are heavy and schedules are difficult.

The boiler is of the wagon-top type, equipped with the Jacobs-Shupert firebox. The first barrel ring is tapered, providing a long wagon-top with a liberal amount of steam space. The dome is placed on the third ring, while the safety valves and the whistle are over the firebox. The back-head, throat, and roof are sloping, and the mud ring is sloped at a fairly steep angle. With this construction, it has been necessary to use several channel sections of tapering width. The brick arch is supported on four tubes, and a smoke suppressing device is applied, with five steam jets on each side. The locomotives are fired by Street stokers, this being one of the few cases where stokers have, thus far, been applied to passenger locomotives.

The valve gear is of the Baker type, and is controlled by the Ragonnet power reverse mechanism. An interesting detail is the pistons, which have rolled steel heads of dished section, with bull rings and packing rings of Hunt-Spiller metal. The piston rods are extended, and are hollow throughout their length.

The frames are heavy, as the main sections have a uniform width of 6½ ins. This is also the depth over the pedestals. The frames are braced transversely at each pair of pedestals, and also by the guide yoke, valve motion bearer, and a broad cast steel tie placed between the main and rear pairs of drivers. A large steel casting placed between the cylinders and leading driving pedestals, holds the frames at this point and also supports the driving brake shaft. The Commonwealth rear frame cradle is applied.

Careful attention has been given to the arrangement of running boards, steps, hand-rails and cab fittings. The steam turret is placed outside the cab, and is fitted with valves for the injectors, air pumps, headlight dynamo, steam heat, stoker engine, flange oiler on leading drivers, blower, and power reverse. The last-named device can, in this case, be operated by steam if necessary. A speed recorder is applied, and the equipment of the locomotive throughout is unusually complete.

The Santa Fe, or 2-10-2 type of locomotives, develop a tractive force of 71,500 lbs., and carries 296,000 lbs. on the driving-wheels; so that the ratio of adhesion is 4.14. The total number of engines to be built, sixty in all, makes this one of the most important orders for the 2-10-2 type thus far placed by any railroad.

The boiler, in this case, has a Jacobs-Shupert firebox with combustion chamber, which extends forward into the barrel; so that notwithstanding the long driving wheel-base and the fact that the firebox is entirely back of the drivers, the tube length is only 22 ft. The first barrel ring has a slope on the top center line, and the third ring is sloped on the bottom; while the mud ring has a slope of 24 ins. from front to back. Advantage has been taken of the space between the mud-ring and the rear frame cradle, to apply a large double-hopper ash-pan with a liberal amount of air-opening. Like the passenger locomotives, these engines are equipped with arches, Street stokers and smoke consumers. A steam grate shaker is also applied. The superheater is of large size, as it consists of 45 elements with a superheating surface of 1,233 sq. ft.

The machinery and running gear details are similar to those of the passenger locomotives. The piston valves are interchangeable; and as the frame width and driving journals are of the same dimensions, the driving boxes and shoes and wedges interchange. The same is true of the rear trucks. The driving brake, in the Santa Fe or 2-10-2 type, is divided between the third and fourth pairs of driving wheels. The front cylinders are bolted to the guide yoke, while the rear cylinders are placed in a horizontal position just back of the main drivers. These cylinders are bolted to a crosstie which is lipped over the frames between the third and fourth, and also between the fourth and fifth pairs of wheels. As in the case of the passenger locomotives, the frame bracing is unusually strong, and carefully designed.

No relief or by-pass valves are used on the cylinders of these locomotives, but automatic drifting valves are applied. The equipment details include rail washers at each end.

The tenders of the freight and passenger locomotives are of the same capacity, and are closely similar in design. The tender frame is a one-piece steel casting, furnished by the Commonwealth Steel Company. The principal dimensions of both types are given in the tables. Beginning with the Pacific or 4-6-2 type, we have: Cylinders, 29 ins. x 30 ins., and valves, piston, 13 ins. in diam.

Boiler.—Type, wagon-top: diameter, 86 ins.; thickness of sheets, 25/32; working pressure, 200 lbs.; fuel, soft coal; firebox, Jacobs-Shupert.

Fire Box.—Length, 115¼ ins.; width, 95⅜ ins.; depth, front, 97⅞ ins.; depth, back, 65⅞ ins.; thickness of sheets, sides, 5/16 in.; thickness of sheets, back, ⅜ in.; journals, 6 in. x 11 ins.; tank capacity, 10,000 gals.; fuel, 18 tons; service, freight.

The Santa Fe or 2-10-2 type is built with the following dimensions: cylinders, 26½ x 28 ins.; valves, piston, 13 ins. diam.

Boiler.—Type, Wagon-top; diameter, 76½ ins.; thickness of sheets, ¾ in.; working pressure, 200 lbs.; fuel, soft coal; staying, Jacobs-Shupert.

Fire Box.—Material, steel; length, 115-9/16 ins.; width, 79 ins.; depth, front, 90½ ins.; depth, back, 74⅜ ins.; thickness of sheets, sides, 5/16 in.; thickness of sheets, back, ⅜ in.; thickness of sheets, crown, 5/16 in.; thickness of sheets, tube, ½ in.

Water Space.—Front and back, 5 ins.; sides, 4 ins.

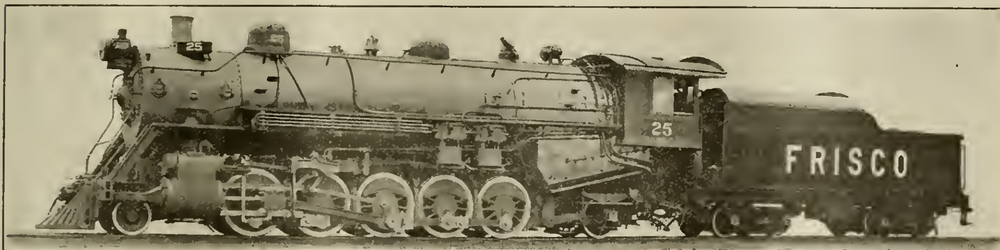
Tubes.—Diameter, 5½ ins. and 2¼ ins.; material, steel; thickness, 5½ ins., No. 9 W. G., 2¼ ins., No. 10 W. G.; number, 5½ ins., 38; 2¼ ins., 225; length, 21 ft.

Heating Surface.—Fire box, 251 sq. ft.; tubes, 3916 sq. ft.; firebrick tubes, 33 sq. ft.; total, 4200 sq. ft.; superheater, 996 sq. ft.; grate area, 63.5 sq. ft.

and ceilings can be maintained in better reflecting condition.

Postal cars require greater illumination than those of any other class, as the work done in them requires constant and arduous use of the worker's eyes. An investigation was conducted some years ago by one of the large railroads. Various types of installation were tested, and determinations were made of the amount of light necessary for the postal clerks to work. From the results obtained by these tests the committee issued specifications for lighting which must be met in every postal car.

Postal cars are generally divided into three sections: the letter distributing cases, the bag distributing racks, and the storage space. The distributing cases require high illumination on the vertical plane of the box labels, and on a horizontal plane for reading the addresses on the mail. The bag distributing racks require high illumination on the horizontal plane, for the labels on the bag racks. The storage end requires a fair general illumination.



SANTA FE 2-10-2 TYPE LOCOMOTIVE FOR THE ST. LOUIS-SAN FRANCISCO RAILWAY.
P. T. Dunlop, Gen. Supt. Motive Power. Baldwin Locomotive Wks., Builders.

thickness of sheets, crown 5/16 in.; thickness of tube, ½ in.

Water Space.—Front and back, 5 ins.; sides, 4 ins.;

Tubes.—Diameter, 5½ and 2¼ ins.; material, steel; thickness, 5½ ins., No. 9 W. G., 2¼ ins., No. 10 W. G.; number, 5½ ins., 45; 2¼ ins., 259; length, 22 ins.

Heating Surface.—Fire box, 239 sq. ft.; combustion chamber, 82 sq. ft.; tubes, 4761 sq. ft.; firebrick tubes, 43 sq. ft.; total, 5125 sq. ft.; superheater, 1233 sq. ft.; grate area, 76.2 sq. ft.

Driving Wheels.—Diameter, outside, 60 ins.; journals, main, 12 ins. x 13½ ins.; others, 11 ins. x 13½ ins.

Engine Truck Wheels.—Diameter, front, 33 ins.; journals, 6½ x 12 ins.; diameter, back, 42 ins.; journals, 9½ x 14 ins.

Wheel Base.—Driving, 21 ft.; rigid, 21 ft.; total engine, 39 ft., 2 ins.; total engine and tender, 76 ft., 4½ ins.

Weight.—On driving wheels, 296,000 lbs.; on truck, front, 26,000 lbs.; on truck, back, 58,000 lbs.; total engine, 380,000 lbs.; total engine and tender, 570,000 lbs.

Tender.—Wheels, diameter, 33 ins.; journals, 6 ins. x 11 ins.; tank capacity, 10,000 U. S. gals.; fuel capacity, 18 tons; service, passenger.

Driving Wheels.—diameter, outside, 73 ins.; journals, main, 12 ins. x 13½ ins.; journals, others, 11 ins. x 13½ ins.

Engine Truck Wheels.—Diameter, front, 33 ins.; journals, 6½ ins. x 12 ins.; diameter, back, 42 ins.; journals, 9½ ins. x 14 ins.

Wheel Base.—Driving, 13 ft.; rigid, 13 ft.; total engine, 33 ft. 11 ins.; total engine and tender, 71 ft., 7 ins.

Weight, Estimated.—On driving wheels, 190,700 lbs.; on truck, front, 45,300 lbs.; on truck, back, 60,000 lbs.; total engine, 296,000 lbs.; total engine and tender, 487,000 lbs.

Facts Regarding Car Lighting.

The conditions in parlor cars are similar to that in the passenger coach, and the same type of installation is used, although indirect lighting can be better used in parlor cars owing to the fact that the walls

A private car is a combination of several types of cars and the lighting is accomplished in the different sections somewhat as it is in the class of car to which that section corresponds. The observation room resembles somewhat the parlor smoker, and general illumination is obtained by center lighting, with bracket lamps behind the chairs for local lighting. Local lighting is provided for the gauges and speed indicating devices with which most business and private cars are equipped. The dining room of a private car is lighted by a single unit placed directly over and throwing a high illumination on the table. The staterooms are lighted with center lamps, with local lighting for the mirrors. Berth lamps are provided when required and at the beds special reading lamps are provided.

All cars having vestibules have lamps over each step. A flush type metal reflector is generally used. Much remains to be done before the lighting of railway cars will be all that can be desired, but effort is still being expended to obtain proper and adequate illumination.

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Locomotive and Power House Oils.

A mechanical department meeting held on one of our leading railways, discussed the matter of using locomotive and power house engine oils; the consensus of opinion was that a considerable saving could be effected by a modification of the practice which obtained up to the time on the road.

It was decided, after going into the matter pretty thoroughly, that the use of engine oil be discontinued on the road, and that car oil and valve oil be used exclusively, and that for yard engines, which had been fitted with grease cellars, only a certain grade of pin-grease be used. The use of this pin-grease for road full service was discussed, but it was thought advisable to make further investigation into the subject, before going to that length, but the possibility of economy and satisfaction in its use was distinctly contemplated.

Power house engine oil, it was decided, might be discontinued with advantage, but gas-engine oil and air-compressor oil was to be used. The latter to take the place of power-house engine oil. It had been determined by test that gas-engine oil was a fit lubricant for air-compressor and power-house purposes. The net result of these deliberations brought about an arrangement whereby two kinds of oil, i. e., power house engine oil and air compressor oil, were "cut out," and only gas engine oil was to be employed. The superintendent of stores was notified of this decision.

The matter of lubricators naturally came up for discussion, and the subject was very closely canvassed. It was decided to equip seven hundred and thirty-four locomotives with bull's-eye lubricators instead of those of the tubular type. Such an equipment, involving considerable outlay—probably $1,000 a month—would consume a good deal of time to effect. Five-feed lubricators were barred from future purchases for superheater engines, and the feeling and the resulting vote, brought three-feed lubricators to the fore for this class of locomotives. To do this work, connections had to be made directly into the steam pipe, thus eliminating the steam chest connections. New engines, with superheaters, of course, were hereafter to be treated in this way. As far as the work had gone when the mechanical department meeting was held, two hundred and sixty-seven engines on the east end, and forty-three on the west end—a total of 310—had then been equipped with the Bull's-eye type of lubricator. Further tests on the grease and other allied questions were set down to be reported on at the next meeting.

As far as the elimination of what is called "chance" is concerned, the methods adopted on this road appear to be very satisfactory. The meeting does not rely wholly on the opinion of any one, however important his rank, but looks at the results of whatever tests or investigations have been made, and the whole subject is weighed, after a full and free interchange of views, in the dollar-and-cent scales, and the probable savings to be effected are scrutinized. There is no leap in the dark, but a staking out of the course to be pursued, and every one concerned is then expected to adhere to that course. What would be known in the field of sport as "team-play" becomes the natural result, and this is practically the scientific pursuit of economy with good judgment, prudence, and a large measure of thrift.

Railroads' War Board Reports.

The circulars that are issued by the American Railway Association show a vast increase, particularly in freight service. An enlargement of capacity of nearly 800,000 cars has been added without purchasing new cars. While this is particularly gratifying, the question naturally arises—why could something in this direction not have been accomplished before? Doubtless the interchange of cars being now a matter of national control has greatly facilitated the progress of events, but it occurs to us that the methods formerly in vogue in allowing cars to settle down with their loads and wait for prolonged periods until the consignees were "good and ready" to empty them had a great deal to do with the alleged car shortage. The demurrage charges were neither here nor there. The railroad companies were reluctant to make complaints against their customers lest they might take wing and fly away. Of course, the shippers and receivers took advantage of the easy-going methods. The stress of war has changed all this, and we are all on the alert now. It is to be hoped that when the cruel war is over this lesson, and other lessons, will have been so well learned that they will not be forgotten in a hurry.

It is needless to point out what has been pointed out before, that in our country, by reason of its vast extent and by reason of its Federal Government, and its historic evolution, the problem of public ownership, of railroads, and, not less, the problem of public operation, are surcharged with difficulties. The first trouble would be to acquire the effective control of the railroads, even if desired. Almost all of the railroads are incorporated by the different States. There is no authority to compel the States to surrender State charters in favor of State ownership. Neither is there authority to equip railroads so chartered with the power of eminent domain in every State of the Union. Even if the National Government, in spite of every difficulty, were to succeed in absorbing the railroads of the entire Union, every State would lose all the income which it now collects from the railroads by taxation, because United States property is not subject to taxation in any State. An economic and social problem would arise that would greatly magnify the embarrassments.

Again, if we contemplate for a moment the new kind of political machine that could and would be speedily erected out of the Government ownership of railroads, it must give the boldest pause. There is no country in the world where the public ownership of railroads has been tried where the service both in regard to low cost and efficient operation is for a moment to be compared to the American system of open competition, and all it needs is an efficient government control, and that may be reasonably expected in the near future.

Economical Use of Compressed Air.

While the wise spirit of economy is in our midst we take it upon us to state that in the use of compressed air in railroad repair shops we have observed a tendency to extravagance, a disregard of the quantity of air used for any operation, as if its cost were a negligible quantity. The general impression seems to be that air is cheap. This is true as far as ordinary atmosphere is concerned. As a motive power, the air quiescent or moving in currents costs nothing. But when it comes to forcing the atmosphere into smaller bulk in order to increase its pressure the cost is much greater than is generally imagined.

The equivalent, or even greater in steam pressure, must be first used in compressing the air. The action of complex machinery under the best conditions involves considerable loss in friction. To this must be added the loss in heat and in steam pressure caused by exhausting at considerable pressure. This is increased as the compression of the air approaches the limit of capacity of the enclosing apparatus. The loss by leakage is also considerable, and much of each of these losses cannot be avoided.

An important loss, however, often occurs in the filling of a larger portion of the air hoist cylinder that does not represent any portion of the lift. It can be readily seen that if the piston is raised a considerable distance before it begins to lift the desired load the space in the cylinder must necessarily be filled with air at a high pressure before any work begins to be accomplished. All lifting should begin, if possible, with the piston at the end of the cylinder.

Many of these hoists are now placed in a horizontal position, and by a clever arrangement of pulleys furnish a multiplying point very suitable for light work. At the same time close attention should be given to the economical use of compressed air. Its cost is much greater than steam. The real advantage in the use of compressed air being that it remains cool, so that attached appliances can be handled with a degree of safety impossible in the use of steam.

Oil Burner Firebox Furnace.

Some general recommendations incident to the results of test with and without the Gaines brick wall and combustion chamber, which were recently conducted by the American Arch Company, of New York, on two Texas & Pacific locomotives, are of interest. We therefore reproduce them without comment.

The flame channel from burner to flash-wall should be narrow and deep, as the radiation from the heated brick lining hastens the vaporization and shortens the flame length.

As much furnace volume as possible should be secured. Dropping the fire pan below the mud ring accomplishes this, and at the same time allows a maximum firebox heating surface to be exposed.

A short arch spanning the flame channel and extending back about one-third of the distance from the burner-wall to the flash-wall, should be used to carry the gases and air that are admitted around the burner back to the rear of the pan.

The radiated heat from this arch on the upper part of the oil stream will hasten the completion of the combustion and shorten the flame.

As a general rule, the air openings should be proportioned so as to provide one square inch of opening for each gallon of oil burned per hour, the maximum rate of firing to govern the total opening.

The principal source of air supply should be through openings in the back two-thirds of the pan. It is preferable that the openings be well distributed over this area in a number of small openings, rather than through one or two large openings. About 30 per cent. of the total air supply should be admitted around the burner, below and at the sides of the burner, rather than over the burner.

In smaller types of fireboxes, the tube-supported arch is desirable. It should be located as low over the flame as possible, in order that a long arch may be used without restricting the opening between arch and crown sheet.

Burners should be located not more than 5 ins. from the floor of the fire pan. Perfect alignment with the flame channel should be maintained at all times. It is desirable to use as small a burner as will fire the engine at the maximum rates. The smaller the burner, the more readily it can be adjusted at the lower rates of firing.

Burner operating connections and valves should be so arranged as to give the fireman a fine regulation of the fire at all times—as slight regulation of the flow of oil through the burner has a very marked effect on the results obtained.

It is believed by the Arch Co., that the use of the short arch above the burner will result in material reduction in smoke under road conditions, for the following reason:

Smoke is caused by the precipitation of carbon, due to the breaking-down of the hydrocarbon constituents of the oil, before the oil gets thoroughly mixed with the oxygen furnished by the air. This breaking-down of the hydrocarbons is due entirely to temperature; and if breaking-down temperature is reached before the oil is mixed with oxygen, carbon will be precipitated in a form very difficult to burn—and smoke will be the result.

The use of the short arch above the burner and the introduction of at least 30 per cent. of the air around the burner, will tend to give an efficient mixing of air and oil, which will tend to prevent the formation of smoke.

Theoretically, it would be advantageous to bring all the air in around the burner; but this is not practical, for the reason that it is impossible to get an efficient mixing of the oil with such a large supply of air.

Labor Saving Devices.

In railroad shops the best devices are usually the invention of workmen, and not by men appointed to work up labor saving methods. There is a spirit among the American workmen moving them to introduce methods that will reduce labor, surpassing that of any other country. The tool machinist is very often selected from the most efficient men in the shop, and, naturally he turns his attention to labor saving devices, but they do not all come from the tool room.

The development of tools is an interesting subject. What is known as the lathe, grew out of the potter's wheel. The lathe developed slowly. At the beginning of the last century it was a man-driven tool. A belt was used that acted by up and down movements and was connected with a flexible piece of wood fastened to the roof of the shop. The piece of wood was known as a lathe. Its function was to draw the belt up and the workman's to draw it down. In this way the revolving head to which the work was attached, made irregular revolutions. The first real improvement was the slide rest. It appeared in England about 1810, but had been used previously in a small way by watchmakers in Switzerland. Until the slide rest was invented, the power was furnished by one man and the work was produced by the skill of his hand. Now there are lathes that would require the power of 600 men to operate. This is merely one illustration of tool development.

Show the Fireman Your Orders.

Nearly all railroad companies require the locomotive engineer to show his running orders to the firemen, which is a very good practice. If you are ordered to side track at Auburn for No. 21, the fireman begins in time to figure on that in the care of his fire. If he has a good steamer, he will let the fire burn low in approaching the meeting point to avoid waste of steam through the safety valves. If the engine is a poor steamer, the fireman will scheme to keep the steam up at the meeting point, so that when the engineer pulls out the fireman has a head of steam ready for the work. It sometimes happens, too, that the engineer forgets the orders relating to the meeting point and the fireman will nearly always direct his attention to that serious mistake. The old saying that two heads are better than one is never better exemplified than in knowledge of train orders.

The Quebec Bridge.

There is something about the engineering profession which often forces men, even of pronounced ability to "cut and try" as their work progresses, and perhaps the Quebec Bridge is a good example of this kind. The first failure, which was the fall of one of the cantilever arms, has been traced to the imperfect proportioning of the lacing bars of the compression members. The second failure occurred by the breaking of one of the steel castings on the end of the central span, by which it was being lifted to place. The new design was intended to prevent slip and avoid the danger of breakage and it was successful.

Air Brake Department

Train Brake Inspection—Locomotive Air Brake Inspection—Questions and Answers

Train Brake Inspection—Passenger Service.

In modern passenger train service, brakes are usually tested from a yard test plant before the outbound locomotive is coupled, except at division terminals, where only a change of engines is made or where but slight changes in the make up of the train are necessary.

Briefly, a terminal test of brakes consists chiefly of coupling up brake and signal hose throughout the train opening all angle cocks and stop cocks in brake and signal pipes with the exception of those at the rear or opposite end of the train from which the yard plant or locomotive is coupled, to inspect the entire train for leakage and to see that all hand brakes are released and that all stop cocks in the branch pipe leading to the car brake operating valves are open and that the bleeder cocks of all reservoirs are closed. It must also be known that all conductors valves are closed and free from leakage, that car discharge valves are free from leakage and that retaining valve handles, if retaining valves are used, are turned down.

After this part of the inspection has been finished, a 25-lb. application of the brake should be made and the brake on every car inspected to note that the brake cylinder piston travel is within the specified limits, that all brake shoes are against the wheels and that the signal system is charged.

When this has been ascertained, a signal to release brakes should be given and another inspection must be made to see that all brakes have properly released, and that all brake shoes are clear of the wheels.

When a road engine is coupled, a proceed signal is given, for the purpose of knowing that the coupling has been effected, after this the brake and signal hose are coupled.

Under no circumstances is it permissible for a train to leave a terminal until a test of brakes has been made, and in no case must the train be started until one of the trainmen or inspectors has personally notified the engineman of the condition of brakes, the number of cars in the train and the number of operative brakes in the train. Conductor and engineman are both held responsible for securing this information. The signal for the application of brakes for test is to be given after the required air pressure has equalized throughout the train, this to be decided by the engineman, and the signal may be given by hand, lamp, flag, or communicating signal or by a verbal request, and when a full service or 25-lb. application of the brake has been made the trainmen or inspectors are to examine every brake beginning with the tender brake to the rear of the train to see that all are properly applied, and the brakes shall remain applied until this has been ascertained. If the brakes are found to be in proper condition, the inspector or trainman shall signal for a release of brakes, which must be four blasts of the signal whistle, and must be transmitted from the car discharge valve cord of the REAR car of the train. The test of brakes is not completed until after the brakes have been re-examined to know that all have released without the use of the release valves or bleeder cocks.

A terminal test of brakes must be made whenever there is a change in the make-up of a train.

When a train has been parted or an angle cock has been closed for any reason whatever, a road test of brakes must be made before the train is permitted to move.

A road test consists of signalling for an application of brakes, and an inspector or trainman at the rear, seeing the brakes on rear portion of train apply, will signal for a release of brakes, and if the release occurs in the proper manner, it will indicate that no angle cocks have been left closed and that, so far as the brake system is concerned, the train is ready to proceed.

A running test of brakes must be made by the engineman upon the first opportunity after leaving a terminal and before descending a heavy grade.

When making up trains from several tracks, it is permissible to make terminal tests of brakes in sections, and after the train is assembled complete, only a road test will be necessary provided all cars have previously been subjected to the terminal test.

Under no circumstances may a locomotive with an inoperative driver brake leave a terminal. If a driver brake becomes inoperative en route, engine may proceed to the next available terminal where repairs can be made.

A train should never leave a terminal with an inoperative brake.

It is permissible to operate trains with cars with brakes inoperative, provided that 85 per cent. or more of the brakes are operative.

A non-air car must never be the first car in a train.

A car with an inoperative hand brake must never be the rear car of a train.

Regardless of percent of brakes operative, no two cars with brakes cut out may be placed in consecutive order in a train.

The word "car" means all cars, or any dead engine that may be in a train.

The tender of a locomotive is counted as one car, in figuring the percentage of operative brakes.

On a double brake equipment, if one of the brakes is inoperative, the car is counted as having the brake inoperative or as a "non-air" car.

When a train is composed of 6 cars or less, it is not permissible to have an inoperative brake, or more than 2 inoperative brakes with less than 14 cars in the train.

Locomotive Air Brake Inspection. A-1 Equipment.

To outline a complete system of air brake inspection for locomotives equipped with the New York L. T., the Westinghouse A 1, or the combined automatic and straight air brake, would be largely a repetition of what has been printed with reference to the inspection of the E. T. brake.

Brake cylinders, brake valves, pressure regulating devices are tested in the same general way on all locomotives, the principal differences in the tests are encountered in the brake cylinder leakage test. This may be made in several different ways with the L. T. equipment, but preferably with the straight air brake valve on lap position with either this or the combined automatic and straight air brake. The brake cylinder pressure thus developed will be that governed by the adjustment of the reducing valve and it should be understood that the Federal Regulations are minimum requirements and are in no wise intended to prevent a more severe test than specified or that any work may not be performed more frequently, or in other words, if the brakes remain applied for a period of five minutes time from an original 43 or 45 lb. brake cylinder pressure, the test is more severe or the brake certainly will remain applied for this length of time from an original 50 lb. cylinder pressure.

Where a large number of engines are handled at a given point, a brake cylinder leakage test for the A-1 equipment is somewhat difficult, as the requirements specify that communication to the brake cylinders must be closed. Some considerable time is required to make the test by closing the triple valve exhaust ports and making the test with the brake valve handle in running position, hence a test that may be made is to make a 15 lb. brake pipe reduction to start the brake cylinder leakage test, and if the brake remains applied for a period of 5 minutes time and the brake pipe leakage is not in excess of 10 lbs., the spirit of the law will have been complied with as the total brake cylinder volume will not have exceeded that produced "by a full service (25 lb.) brake pipe reduction."

If however, the brake pipe leakage is in excess of the 10 lbs. in 5 minutes, or if the brake leaks off during this test, the test is void and must be made, preferably in the engine house, by attaching an air gage to the exhaust port of the triple valve, making a full service reduction and returning the brake valve handle to running position, after which the brakes must remain applied for a period of 5 minutes time.

With this brake, a 5 lb. brake pipe reduction should result in a movement of all triple valves to application position, the proper amount of brake pipe reduction, brake cylinder piston travel considered, should result in the opening of the high speed reducing valves, all of which will be brought out in the questions and answers.

Locomotive Air Brake Inspection.

(*Continued from page 297, Sept., 1917.*)

54. Q.—What else might cause this?

A.—A bad condition of the rubber diaphragm of the signal valve.

55. Q.—What pressure should be shown on the gage?

A.—From 43 to 48 lbs.

56. Q.—Why not some definite figure?

A.—Because some allowance must be made for variations in gages and slight differences in adjustment.

57. Q.—What is wrong if the first blast of the whistle is unusually long with the pressure above 50 lbs. and reducing slowly?

A.—The reducing valve is out of order.

58. Q.—Could a signal system become overcharged in any other manner except by a defective reducing valve?

A.—Yes, by an application of the automatic brake while the independent brake valve is in application position, or through a defective application portion of the distributing valve while the independent brake is applied.

59. Q.—Could a defective condition of the distributing valve affect the signal system at this time?

A.—No, as the stop cock in the distributing valve supply pipe is closed and main reservoir pressure could not enter the application cylinder and signal system through the brake cylinders.

60. Q.—What might be wrong if the signal line pressure was but 25 lbs. and the brake cylinder gage hand showed 45 lbs. when the brake was applied for the brake cylinder leakage test?

A.—It would indicate that the wrong spring, or one with about 20 lbs. tension, was used in the non-return check valve of the signal system, or that the small gage was out of order.

61. Q.—What should be observed when operating the whistle with a test gage?

A.—That the blasts of the whistle are of the proper length, and that the pressure is promptly restored after a reduction.

62. Q.—When the reducing valve is in good condition, what varies the length of the blasts obtained with the 1/16 opening?

A.—Principally the amount of air that passes through the choke fitting of the non-return check valve and the fit of the diaphragm stem of the signal valve.

63. Q.—What importance should be attached to the length of the blast obtained?

It should be taken as an indication of the condition of the signal valve.

64. Q.—For what reason?

A.—Because the fact that the whistle can be operated with a 1/16-in. opening is not an assurance that the whistle will operate when the engine is coupled to a 14 or 15-car passenger train.

65. Q.—How can a more accurate and reliable test of the signal equipment be made?

A.—With the 3/64-in. orifice, allowing ample time to elapse between the openings of the orifice, and if the signal valve and all parts are in first class condition, the signal whistle can be operated with this opening.

66. Q.—Why do the last few pounds feed up very slowly in the signal pipe?

A.—Because the supply is from a pressure controlled by the reducing valve, and when the pressures are very nearly equal, the rate of feed up is slow.

62. Q.—What if the charging of the signal pipes from 0 to maximum pressure is very slow?

A.—It indicates that the flow of air through the signal line non-return check valve choke fitting is obstructed.

68. Q.—Would anything else cause a slow charging of the signal line?

A.—A very bad leak in the signal pipes which should be discovered?

69. Q.—What might be wrong if the signal whistle operated correctly on a short train but would not on a long train, with the signal valve in good condition?

A.—The opening through the signal line choke fitting may be enlarged.

70. Q.—How would this prevent the operation of the whistle?

A.—By tending to destroy the violence of the reduction made at the car discharge valve.

71. Q.—How is a test made to discover an enlarged opening through the choke fitting?

A.—By using a test gage with different sized openings through a disc, with say an 11-64-in. orifice, it should be possible to bring the hand of the test gage to the pin.

72. Q.—Is it necessary to use any apparatus for detecting an enlarged choke fitting in the signal system?

A.—No, with a little practice and observation, it can be detected by merely opening the signal pipe stop cock and holding the hand over the hose coupling to note the amount of air escaping.

73. Q.—Where do the enlarged fittings come from?

A.—Sometimes a choke from the dead engine fixture with a 1-8-in. opening is used, sometimes they are enlarged intentionally, and if the opening is not greater than ⅛ in. the effect is not so noticeable.

74. Q.—How many blasts of the whistle should be used for a test?

A.—Four blasts, in a given period of time if a 1-16-in. opening is used for testing the signal system.

75. Q.—How is a feed valve tested?

A.—By using a 3-64-in. a 1-16-in. and preferably one larger opening in the form of orifice disc openings.

76. Q.—What should be the result of opening the brake pipe to the atmosphere through three different sized openings one after the other?

A.—It should result in operating the feed valve and the pressure should be maintained constant at the figure of feed valve adjustment.

77. Q.—What should be done if the feed valve permitted the pressure to drop back when the brake pipe was opened to the atmosphere through a small opening?

A.—If the drop was more than 1½ or 2 lbs. below the adjustment of the feed valve, it should be replaced by one known to be in good condition.

78. Q.—If there is a noticeable operation when either of the two openings mentioned are used, how much of a movement of the test gage hand is permissible?

A.—The pressure must not vary or fluctuate over two pounds.

79. Q.—Why not?

A.—The feed valve must be more sensitive to open and supply brake pipe leakage than any triple valve in the train is sensitive to respond to variations in the pressure in the brake pipe.

80. Q.—What will be the probable result if the feed valve is not more sensitive?

A.—A triple valve may move to application position when the feed valve is closed and fail to move to release position when the feed valve again opens, which might result in a stuck brake or a slid flat wheel.

81. Q.—From a brake operating point of view, what unit must be maintained in the most sensitive condition?

A.—The brake pipe feed valve.

82. Q.—What is generally wrong if the feed valve fluctuation is more than two pounds?

A.—The supply valve piston is generally too neat a fit, or is packed too near an air tight fit in the bushing by oil or dirt.

(To be continued.)

Train Handling.

(*Continued from page 298, Sept., 1917.*)

62. Q.—What is meant by an overcharged auxiliary reservoir?

A.—One that contains a higher pressure than the feed valve of the locomotive is adjusted to carry.

63. Q.—What would this result in?

A.—An application of the brakes and likely in the stalling of the train.

64. Q.—What should be observed if the compressor stops for an unusual length of time?

A.—The position of the air gage hands.

65. Q.—What would be indicated if the compressor stopped and the gage hands were more than 20 lbs. apart and the brake pipe pressure somewhat below the adjustment of the feed valve?

A.—That there was a development of excessive brake pipe leakage or that the stoppage was due to an irregularity of the feed valve.

66. Q.—What if the valve handle was moved to release position and the compressor did not start?

A.—It would indicate that the feed valve piston had stuck shut, or that for some reason the brake pipe and feed valve pipe pressure was not being maintained.

67. Q.—Why would the compressor fail to start if the feed valve piston was stuck with the communication to the brake pipe closed and there was no other disorder?

A.—Because with the brake valve in release position the feed valve pipe receives no pressure from the main reservoir.

68. Q.—How does this affect the governor?

A.—The main reservoir pressure under the diaphragms of the excess pressure top exceeds the feed valve pipe pressure and spring pressure on top of the diaphragms.

69. Q.—How can the compressor be kept in operation?

A.—By moving the brake valve slightly away from release toward running position.

70. Q.—How will this movement start the compressors even if the feed valve is stuck shut?

A.—In this position the brake valve rotary valve will be in a position to supply the feed valve pipe with air pressure and maintain the pressure above the diaphragms of the excess pressure governor top.

71. Q.—How will the pressure in the brake pipe be regulated?

A.—By a little observation a point may be found for the brake valve handle where the brake pipe pressure will be maintained without moving the brake valve to full release position.

72. Q.—Suppose that by moving the brake valve to full release position main reservoir had lowered and brake pressure increased until the gage hands were less than 20 lbs. apart and the compressors would not start.

A.—That would indicate that the governor was at fault, or that the compressor had broken down.

73. Q.—What would it indicate with two compressors on the locomotive?

A.—That the governor was at fault, as it is not likely that both compressors would fail at one or the same time.

74. Q.—What would you first do in an effort to start the compressor?

A.—Move the brake valve handle to lap position.

75. Q.—For what purpose?

A.—To eliminate the excess pressure governor top from the disorder.

76. Q.—How would this do so?

A.—By cutting off the flow of air through the operating pipe of the excess pressure and increasing the pressure in the excess pressure pipe.

77. Q.—How does the movement to lap position increase the pressure above the diaphragms of the excess pressure governor top?

A.—By a suitable port through the rotary valve of the brake valve.

78. Q.—What would you then do if the compressors started when the brake valve was placed on lap position, but stopped every time the valve handle was brought back to running position, the gage hands still being less than 20 lbs. apart?

A.—Hold the brake valve handle on lap position long enough to place a blind joint in the excess pressure operating pipe.

79. Q.—What if the compressor would not start with the brake valve handle in any position and less than standard pressure on the engine?

A.—Either the maximum governor top would be at fault or the compressor broken.

80. Q.—If the governor top is at fault, how can it usually be detected?

A.—By a blow of air from the vent port in the neck of the governor.

81. Q.—What would this indicate?

A.—That the diaphragm valve was unseated.

82. Q.—What if no air pressure escaped at the vent port?

A.—The vent port might be stopped up or the governor piston stuck in the cylinder.

83. Q.—How would you ascertain whether the governor or compressor was at fault?

A.—By slacking off the union connection in the steam pipe between the governor and compressor.

84. Q.—Why.

A.—To see whether the compressor was receiving a full supply of steam.

85. Q.—If you found that there was insufficient steam issuing for the operation of the compressor, what would be done?

A.—Make an examination of the governor and try to jar the governor piston loose.

86. Q.—If the governor piston was stuck in the bushing and would open by jarring the governor, what should be done?

A.—The air pipes to the governor should be disconnected and the tops removed and the pipes again connected.

87. Q.—For what purpose?

A.—To prevent a recurrence of the sticking of the piston until proper repairs can be made.

88. Q.—If you found that the compressor received an ample supply of steam, what would you be sure of before deciding that it was broken?

A.—That it it was well lubricated and that steam could be exhausted from the cylinders?

89. Q.—How would you determine whether steam could be exhausted through the exhaust pipe?

A.—By slacking off or disconnecting the exhaust pipe at the pump.

90. Q.—Is this liable to happen out on the road?

A.—No, but it sometimes does when an engine comes out of the shop or if there is any train heating apparatus connected with the exhaust pipe.

91. Q.—If you found a compressor broken down, would you attempt to make any repairs?

A.—Not on the main line of a railroad, especially with the large capacity types of compressors.

92. Q.—What would be done?

A.—The conductor would notify the proper authority and the train would proceed under the instructions given.

9. Q.—What generally causes the cross compound compressors to stop or break down?

A.—It very seldom happens, and if it does it is usually due to worn out or broken packing rings in the main piston valve.

94. Q.—Is there any trouble with pistons pulling off of the rods or rods breaking in these compressors?

A.—No.

95. Q.—What usually stops the single acting compressors?

A.—Lack of lubrication in the steam cylinder, worn out or broken steam valve mechanism or pistons pulling off of rods and some times bent reversing valve rods.

96. Q.—Is there a great deal of importance attached to what should be done in the event of a broken down compressor?

A. No.

97. Q.—Why not?

A.—Because no one is expected to work on them along the road, and it is not necessary for an engineer to know exactly what is wrong with it.

(*To be continued.*)

Car Brake Inspection.

(Continued from page 299, Sept., 1917.)

55. Q.—Are angle cocks in the brake pipe ever found to be closed when the handles stand in line with the pipe?

A.—Yes, some cases are known where mistakes have been made in applying handles and where the bushings in cocks have turned.

56. Q.—How is this indicated during a brake test?

A.—The brakes fail to apply or release at the opposite end of the train from the wrongly applied handle.

57. Q.—When the road engine backs against a made-up passenger train and couples, what is the first thing to be observed?

A.—That the engine starts forward and stretches the train.

58. Q.—For what purpose?

A.—To see that the coupling has been properly made.

59. Q.—If the train is charged when the engine couples, which angle cock is first to be opened after the hose are coupled?

A.—The one at the rear of the tender.

60. Q.—Why?

A.—So that no brake application will occur on the train.

61. Q.—How should the angle cock handle be turned?

A.—Very slowly in line with the pipe.

62. Q.—Why should all angle cocks be turned slowly at all times?

A.—To prevent quick action applications of the brakes.

63. Q.—What effect has quick action or emergency applications on the foundation brake rigging of cars and locomotive tenders?

A.—It tends to fracture rods, levers and hangers, distort brake beams and result in shoes being out of line with the tread of the wheel, and gradually paves the way for a failure of the brake rigging.

64. Q.—What effect have these applications on the triple valves?

A.—They result in the fracture, bending and breaking of emergency and quick action valves, and cause a quantity of dirt and foreign matter to pass from the brake pipe into the brake cylinders.

65. Q.—What effect has this on the brake cylinder packing leather?

A.—It results in a premature destruction of the leather.

66. Q.—How does the number of times a leather must pass through a brake cylinder to wear it out compare with the number of brake applications that are made on a car, on an average, during a year's time.

A.—The number of times the leather must pass through the cylinder to become worn out, is equal to the average number of brake applications that occur on a car in 22 years' time.

67. Q.—What does this indicate?

A.—That packing leathers are subjected to unfair usage.

68. Q.—When connecting the signal line hose, how are the stop cocks opened in turn?

A.—In the reverse order to the angle cocks, that is, the one farthest from the locomotive first.

69. Q.—Why is this?

A.—In order that but one blast of the signal whistle of the locomotive will result from opening the stop cocks.

70. Q.—Why is this desirable?

A.—Because one blast of the whistle is no signal.

71. Q.—How many blasts would result if the cock on the tender was first opened?

A.—Two blasts through two different reductions in signal pipe pressure.

72. Q.—What signal would this be?

A.—To start ahead.

73. Q.—Why is it essential that cocks should be opened in the specified order?

A.—So that should it become necessary to renew a signal hose gasket, or disconnect a signal hose coupling, very near leaving time a proceed signal will not be transmitted.

74. Q.—How could this result in an injury to an inspector or trainman?

A.—The engineman might think that a shifting movement or the cutting off of a car was desired and start the train.

75. Q.—Have any accidents ever resulted from a failure to observe this?

A.—Yes, and inspectors have been injured, and in some instances, fatally.

76. Q.—After the engine has been properly coupled and the hose connected and cocks opened, what should be done?

A.—The engineman should be notified that brakes are ready for test.

77. Q.—Who decides when the brake system is sufficiently charged for the brake test?

A.—The engineer.

78. Q.—What will he then do?

A.—Make a full service application of the brake.

79. Q.—How much brake pipe reduction?

A.—Either 25 or 30 lbs., depending upon the type of brake equipment in use and the instructions covering the amount of reduction.

80. Q.—What is then to be done?

A.—All brakes in the train are to be examined to see that they are properly applied.

81. Q.—What should be the length of brake cylinder piston travel on the cars?

A.—From 6 to 7½ inches.

82. Q.—Which brake is first examined?

A.—The one on the tender.

83. Q.—What follows after all brakes are known to be properly applied?

A.—The signal to release brakes.

84. Q.—What is this?

A.—Four blasts of the signal whistle.

85. Q.—How made?

A.—By pulls on the cord of the car discharge valve of the rear car.

86. Q.—Must this signal be transmitted from the rear car?

A.—Yes, in all cases for a signal to release brakes during a brake test.

87. Q.—How long should the discharge valve be held open?

A.—For one second, on short trains and about 2 seconds on long trains.

88. Q.—How long a time should intervene between blasts on a short train?

A.—From 2 to 3 seconds.

89. Q.—On trains of 10 cars or more?

A.—About 4 seconds, or allow the discharge valve to remain closed between pulls for a space of 2½ times the length of time it is held open.

90. Q.—What inspection follows the release signal?

A.—An examination of all of the brakes, to see that the brake piston has receded into the cylinder and that the brake shoes are free from contact with the wheels.

91. Q.—Which is the last brake to be examined?

A.—The one on the tender.

92. Q.—What would be observed if the tender brake had not released?

A.—Whether the engine was equipped with the ET brake or a combined automatic and straight air brake.

93. Q.—What would be indicated if the engine had the ET equipment?

A.—That the engineer had the independent brake applied.

94. Q.—What if there was a triple valve on the tender?

A.—If it was combined brake, it would indicate that the engineman had the straight air brake applied.

95. Q.—What if the tender brake was of the ordinary triple valve type with no straight brake on the locomotive?

A.—It would indicate that the tender brake was defective or that the auxiliary reservoir had been overcharged.

96. Q.—What should be done?

A.—The engineman should be notified that the tender brake had not released.

97. Q.—After all brakes have been known to have released properly, what should be done?

A.—Both the engineman and conductor must be notified of the condition of the brakes, the number of operative brakes and the number of cars in the train.

98. Q.—Is this an absolute rule?

A.—Yes, under no circumstances will a train be permitted to leave a terminal until the brakes have been tested and the engineman and conductor notified that test is complete.

99. Q.—What different kinds of brake tests are made?

A.—A terminal test, a road test and a running test by the proper and usual methods.

(To be continued.)

Electrical Department

The Importance of the Transformer—Faraday's Experiments Led to the Transforming of Electric Energy of One Voltage to That of Another Voltage—"Step Down" and "Step Up" Transformers

The transformer is one of the most important pieces of electrical apparatus that we know. It is used extensively throughout the world. There are thousands and thousands of them in use, ranging in power from a small fraction of a kilowatt to thousands of kilowatts. Without a doubt the transformer, more than any other type of electrical apparatus, has been responsible for the rapid growth of the electrical art. Prior to its commercial discovery all of the electricity used was of the direct current kind. Direct current was generated by engine-driven dynamos or generators and was distributed to the cables leading to trolley wires, house lights, etc. Direct current dynamos or generators, as we know, have commutators. A commutator is made up of a large number of copper segments with thin sheets of mica placed between each segment. The number of segments between two adjacent brush holders determines the maximum voltage or pressure which can be obtained from the machine. This is true as the voltage between two adjacent segments of the commutator cannot exceed, say, 10 volts.

Most of the D. C. generators were therefore only capable of giving about 500 volts, with some delivering 600 volts. Five hundred to six hundred volts is a very low voltage for distribution, although at the time it was first used it was thought to be quite a high voltage. As the demand for electric power increased it was realized that the voltage must be increased to make up for the losses in the conductors or that the size of the conductors be increased. To increase the size of the conductors means the use of more copper and hence a larger investment and higher overhead charges. The ideal solution would simply be to increase the voltage, but this was impossible with the design of the D. C. generator employed.

During this period George Westinghouse, the founder of the extensive Westinghouse interests, was advocating the use of alternating current because that system made possible the transmission of electric power to distances beyond the range of direct current.

Alternating current generators do not have commutators, so that the voltage could be greatly increased and the electricity transmitted over smaller wires to greater distances. This higher voltage could then be "transformed" or brought down to a working voltage for lights and other uses by means of this apparatus called a transformer.

When in its crude form Westinghouse saw the possibilities of this progressive step and he realized that, for the electrical industry to grow and scientifically develop, the alternating current system must be perfected, and it is due to his energy, his forethought and his belief in the electrical science of the future. He saw in his mind's eye the good work to be done by the transformer and what extensive use could be made of it, and he practically commercialized the transformer, using the principle which had been discovered and demonstrated by Faraday.

Faraday, as we have said, in a previous issue, discovered the principle of induction and demonstrated how a current could be induced in a closed coil of wire if another coil carrying electric current was brought near to it and drawn away again. This same principle of induction applies to the transformer. Let us examine Faraday's experiment. He took a ring of iron I, Fig. 1, and wound on it two sets of turns P and S. He found that, when current was made and broken on, say, the turns P, that a current of electricity at a certain voltage was induced in the turns of wire marked S in Fig. 1. The making and breaking of the current in turns P caused a change in the number of lines of force, and it is this change, as we have previously seen, which induces in the iron ring a magnetic flux. This magnetic flux (or the lines of force) cuts the wires S and induces a current. Alternating current varies from maximum to minimum several times a second so that, if the turns P were connected to an alternating current source of power supply, there would be an alternating voltage and alternating current induced in the turns S, and this would be available for lighting or other forms of power.

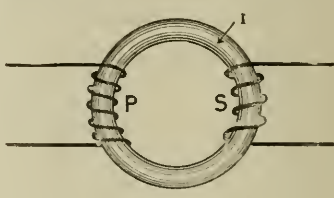


FIG. 1.

We have mentioned above that the function of the transformer is to transform electrical energy at one voltage to electrical energy at another voltage. The transformer shown by Faraday's experiment is composed of two separate sets or coils of insulated wire wound on an iron core. The ratio of the electrical voltages between these coils is equal to the ratio of the number of turns of wire in each coil. For instance, if there were 10 turns in coil P and 5 turns in coil S, Fig. 1, and 220 volts of alternating current was connected to the coil P, then the voltage across the terminals of coil S would be in the ratio of 10 : 5 or equal to 110 volts.

Electrical power is represented by kilowatts, or the product of volts and current. We have just seen that the voltage changes from 220 to 110. What does the current do? Does it reduce one half, or does it remain the same, or does it increase to double? If there were no losses in the transformer, i. e., if the transformer was 100 per cent. efficient, the current would have to double when the voltage was transformed to one-half in order to keep the product the same. No machine or apparatus is of 100 per cent. efficiency, but the transformer, having no rotating machinery or moving parts, is of high efficiency approximating 98 per cent. In the case, therefore, of the transformer with ratio of 10 turns to 5 turns, if 100 amperes were flowing into the 10 turns, then there would be $\frac{98}{100}$ of 200 amperes in the 5 turns, or 196 amperes, 4 amperes not being available on account of losses in the transformer; or if there were 200 amperes in the 5 turns, then the current flowing into the 10 turns would be $100 \times \frac{100}{98}$, or 102 amperes, the other 2 amperes being required to make up the losses which necessarily take place in the transformer.

In most cases transformers are used to reduce a high-voltage supply of energy into low-voltage energy that is safer and more convenient for operating lamps, motors and other devices.

With the transmission of power to long distances at voltages as high as 120,000 volts, transformers are used to increase the voltage generated by the electric generators up to the transmission voltage. The former devices which reduce voltage are called "step-down" transformers and the latter, which increase voltage, are known as "step-up" transformers. In practice the arrangement represented in Fig. 1 would not be satisfactory, as there would be a large magnetic leakage. By magnetic leakage we mean that many of the lines of force created by the current flowing in coil P radiate away from the iron core, and do not cut the turns of the coil S. The energy expended in forming these lines of force is therefore lost as far as use is concerned and the transformer would be of low efficiency compared with those of modern design. To avoid this magnetic leakage, the primary, say coil P, and secondary, say coil S, are placed close together, in many cases being wound one upon the other, or subdivided and placed side by side alternately and carefully insulated. The object of this procedure is to reduce the magnetic leakage to a minimum. Arranging the coils and the iron in this form, practically all the flux (or lines of force) produced by the primary coil must pass through the secondary.

In the case of power transformers there are two general types of construction which reduce the magnetic leakage to a minimum, namely, "core" transformers and "shell" transformers. The names apply to the position of the iron in reference to the coils. When the coils are outside of the iron, the iron forms the core and the transformer is of the core type construction. When the iron is on the outside of the coils the transformer is known as the shell type of construction, as the iron forms a kind of shell around the coils.

In the core type there are two different arrangements of primary and secondary coils. They may be arranged concentrically with reference to one another or they may be arranged in groups of high-voltage and low-voltage coils stacked alternately one upon the other. The construction is shown in Fig. 2. The iron core is marked 2a. It is not solid, but it made up of thin iron laminations, and the pieces a, b, c, Fig. 2, are laid alternatively so that when pinned at w, v, x and y the whole is like a solid mass. It might be well to point out that the iron laminations b are not put into place until after the coils are placed over the laminations a and c.

As we mentioned above, there are two arrangements of primary and secondary coils. When the coils are arranged concentrically the low-voltage coils are generally wound in cylindrical form, usually in one layer. The arrangement is shown by 2b, Fig. 2. This is satisfactory for moderate voltages up to, say, 7,000 volts, but for higher voltages the high voltage coils are thin discs stacked one upon the other. The arrangement is illustrated at 2c.

The electric transformer can be placed in any convenient place outside or inside a building, and not having any

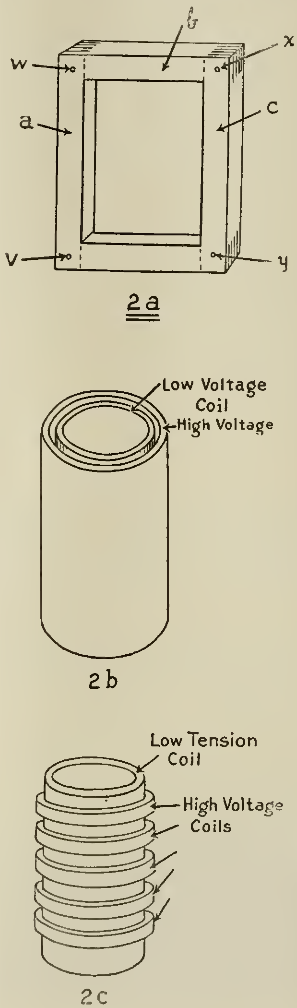


FIG. 2.

moving parts to wear or get out of order, the attention it requires is exceedingly small. It does its work silently and efficiently.

In our next article we hope to describe the construction of the "shell-type" transformer, and show how the type is mounted in the iron cases for protection. We will also explain what is meant by oil insulated water-cooled, oil insulated self-cooled, and air-blast transformers.

The New Electric Locomotive on the Pennsylvania.

The electric locomotive built at the Pennsylvania's Altoona shops and used in hauling heavy trains around the Horseshoe Curve and over the Allegheny Mountains, when the main line between Altoona and Connemaugh is electrified, was given its first trial trip last month on the electrified portion of the main line between Overbrook and Paoli. The tests were continued for several days. The locomotive was designed for great power at low speed, having a rating of 4,800 horsepower. The freight train, which was drawn by the electric locomotive, consisted of an idle steam engine, 68 loaded freight cars and a cabin car. The actual work of electrifying the section of the main line referred to has not yet been authorized by the company.

Electrification Work on the St. Paul.

Work upon electrification through the Cascade Mountains on the Chicago, Milwaukee & St. Paul Railway is now in full swing, and it will be only a short time before the St. Paul's second great electrified zone will be in operation. This is the intelligence brought to Chicago by C. A. Goodnow, vice-president of the railway, who had just returned from the West. Mr. Goodnow, who had charge of the first electrification through the Rockies, is also directing the new undertaking through the Cascades, Washington.

Electric Drive for Battleships.

Contracts totaling approximately $2,000,000 have been placed recently with the Westinghouse Electric & Manufacturing Company by the New York Shipbuilding Company for furnishing the necessary electrical equipments for the propulsion of the new super-dreadnaughts *Colorado* and *Washington*.

The equipments to be furnished are practically of the same design as that contracted for by the Navy Department for the U. S. S. *Tennessee*, now building at the New York navy yard. The four propellers, as in the case of the *Tennessee*, instead of being mechanically connected to driving engines or turbines, are to be driven by individual motors. The current for the motors will be furnished by two turbine generators.

The Texas Company's Booklet.

The Texas Company has issued a handsome booklet describing and illustrating the collecting and transporting of oil. Each page is illustrated with views of refineries and other details, particularly in Texaco, Panama. The company supplies arilroads, steamboats and other transportation and miscellaneous industries.

Poorly Designed Foundation Brake Rigging and Slid Flat Wheels

By WALTER V. TURNER, Manager of Engineering, Westinghouse Air Brake Co.

The relation between impacts, due to slack action in trains, and slid flat wheels is not as apparent as it should be if due appreciation is given to causes for acute and chronic suffering of our railroads from this form of damage to equipment. Wheels slide because the fulcrum (or pivot about which the wheel moves with relation to the rail) at the point of rail contact fails; that is, the demand on the rail in the way of thrust exceeds the adhesion or static friction between the wheel and the rail. A buff or jerk in the direction of motion of the train increases the car velocity and the rotative speed of the wheels, and a certain thrust of the wheels is required of the rail to increase their angular velocity. If the brakes are applied this rail thrust due to impact is augmented by the thrust set up by brake shoe friction. The sum of the two thrusts must not exceed the adhesion if the wheels are not to be slid. If this total does exceed the adhesion, the car is said to be "knocked off its feet." An impact opposite to the direction of train movement neutralizes the rail thrust due to braking, but may carry the thrust beyond in the other direction up to the limiting value of adhesion, with like result, only the impact required to do this must be correspondingly greater than the first. In other words, the total rail thrust is equal to the algebraic sum of the thrust set up by the impact and that caused by braking.

The impact "knocking the car off its feet" lasts a very short time only, and the rail thrust brought into play by this impact lasts only as long, but brakeshoe friction in this very short interval of time has jumped up in value, becoming static in nature where it was kinetic before, and the wheel-rail friction has dropped in value, becoming kinetic where it was static or rolling before, and the wheels may continue to slide. The continued sliding of the wheels depends upon these changes in values of shoe-wheel and wheel-rail friction being sufficient to make the former greater than the latter. This will, in turn, of course depend on the relation of the shoe pressure to the weight on the wheel and the condition of the surfaces of the shoe and rail. Where wheel sliding does persist—and it is only too often—it may be said that the impact has broken the relation of the wheel to the rail and brake shoe friction continues the wheels sliding. As a numerical illustration, a freight car weighing 50,000 lbs. has an adhesion of 3,125 pounds per pair of wheels if the adhesion factor is 25 per cent. A brake pressure of 29 lbs. gives 690 lbs. brake shoe friction per pair of wheels for a braking ratio of 60 per cent. based on 50 lbs., cylinder pressure and an efficiency factor of 15 per cent. An impact of 200,000 lbs. will bring the total rail thrust up to the above adhesion limit. A greater braking force, a greater impact (which is not unusual in service), or a reduced adhesion will result in the breaking of the adhesion between the wheel and the rail through the impact. If the brake shoe friction at this instant exceeds the wheel-rail friction, the wheels will continue to slide. This will be true if the rail friction drops to 1,250 lbs. (10%) and the shoe friction doubles to 1,380 lbs. (efficiency factor rising to 30%) due to the respective changes from static to kinetic friction, and conversely, under the same conditions an impact in the opposite direction must exceed 300,000 lbs. to break the adhesion between the wheel and the rail or to change this static friction to kinetic. This impact computation is based on two 700 lb. wheels on a 500 lb. axle, having a combined moment of inertia of 143.

From the foregoing it can be seen that shocks in long trains must be subdued or eliminated if slid flat wheels and the host of other troubles are not to be had.

No discussion on the matter of train control can in any sense be complete without some reference being made to that part of the brake installation known as the foundation brake rigging and a volume might be written on the subject.

As a chain is no stronger than its weakest link, and measures to increase the efficiency of that chain should patently start with the weakest link, so it is also true that the advantages of improved types of air controlling devices can be realized only in minor degree unless improvements be made in that link; namely, the foundation brake gear, which today is the link weakest in efficiency in the whole air brake system. The term link takes on a double meaning when one appreciates the "connecting" rôle of the foundation brake rigging for it is that mechanical system of levers, rods, pins, hangers, brake beams, brake shoes, etc., which transmits and multiplies the pressure of air in the brake cylinder into brake shoe pressure on the wheels of the car. It is the connection between brake cylinder and wheel which converts fluid pressure at the former point into mechanical force at the latter.

The first and essential requisite of foundation brake rigging is that it be designed with due regard to the strength, rigidity and arrangement which will always maintain the proper volume proportions between the brake cylinder and the auxiliary reservoir; that is to say, it must always provide a piston travel constant as nearly as possible under all variations in cylinder pressure. Also, it should not apply to the wheels, unbalanced lateral pressures so great as to force the journals out from under their bearings, causing journal troubles, and to excessive binding between journal boxes and pedestal jaws, thereby permitting a shifting of weight from one pair of wheels to another, due to irregularities in the track surface, and causing wheel sliding. Suitable truck design cannot be dissociated from these requirements for adequate brake rigging.

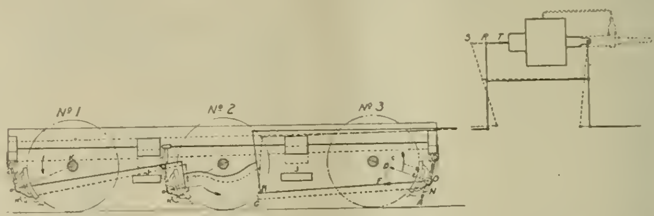


DIAGRAM SHOWING LOW-HUNG BRAKE SHOES CAUSING "FALSE" PISTON TRAVEL.

The single-shoe-per-wheel type of foundation brake rigging, in such prevalent use meets none of these requirements, but is a sinner of the first order in its disregard for them. In the diagram of the single shoe per wheel rigging, the positions of rods, levers, truck frames and shoes are shown in full lines for a position where about a 5 lb. brake cylinder pressure just about brings the shoes in contact with the wheels. The dotted lines show the positions of the parts after an appreciable braking force is exerted, such as for a full service application of brakes. The difference in piston travel which this variation in cylinder pressure produces, is represented by the distance RS on the center line of the cylinder. This is false piston travel. The pulling down of the truck frame and other parts, from the full line to the dotted line positions is caused by the brake shoes being hung at some point on the wheel considerably lower than the center line of the wheel (horizontal) and being hung from the truck frame, which is separated from the journal boxes and the wheels by the usual truck springs. The braking force being applied along the pull rod OH, gives a tangential component OA at the brake shoe, which, permitted by the just mentioned spring suspension, pulls the shoe down into the dotted position, and this cumulative effect on each wheel results in the false piston travel RS. The operation of the automatic slack adjuster returns point S and, of course, point R towards point T until distance TS equals the setting of the slack adjuster. This reduces distance RT and therefore the brake shoe clearance for release position, until in many instances RT actually becomes zero. Point T represents the position of the piston in release and point R that piston position where the shoes first come in contact with the wheels, that is, there is a very much reduced shoe clearance or none whatever with the single shoe type of brake rigging and shoe dragging means highly increased train resistances with a corresponding reduction in motive power capacity, increase in fuel and water (or electric power) consumption, and shocks due to the necessity for "taking slack" in order to get a train under way.

The point very difficult for many to grasp, when this action of the automatic adjuster is explained, and they immediately suggest dispensing with the adjuster altogether, is without the adjuster point S might go out so far that the brake piston might strike the non-pressure head of the brake cylinder, and this it would do unless careful and repeated manual adjustments were made—adjustments almost impossible to accomplish in the minor degree required under present conditions. Moreover such adjustments would merely duplicate in a laborious way the work of the present slack adjuster and this remedy would provide no betterment whatever. The only fault the automatic slack adjuster has is that of revealing the evils of false piston travel and the necessity for striking at the fundamental cause in order to effect a cure. Also, in this same connection, it is well to mention that the slack adjuster should take up about 1/32 of an inch only for each operation instead of the full distance that the piston travels beyond the adjuster setting, otherwise where the full overtravel is taken up with one adjuster operation, an unusually high cylinder pressure, such as obtained in emergency, would cause the shoes to grip the wheels with the air exhausted from the cylinder, to such an extent that the car could not be moved at all.

The distance RT representing the piston travel for light brake pipe reductions, and as before pointed out, short piston travel means correspondingly high cylinder pressures and therefore severe shocks in trains, due to serial brake action in long trains. When high pressures are desired, heavier brake pipe reductions can readily be made, but if flexibility is to be had it is indispensable that the brake installation permit obtaining light cylinder pressures as well as heavy ones.

British Railway Improved Rolling Stock

By W. PARKER, President Railway Club, London, England

Among British railroads the Midland Railway, which is of normal British 4 ft. 8½ ins. gauge, has always held a leading place in regard to its passenger coaches, and in the provision of comfortable travel for the democracy. As long ago as 1872 third class carriages were included on all trains and in 1875 second-class carriages were abolished. The latter arrangement has since been copied by a number of other British railways, but on the Midland line it followed the introduction in 1874 of Pullman cars. The Midland Railway was the first transport company to introduce these cars into England.

In 1914 just before the outbreak of war the Midland Railway decided to build a number of main line carriages in which the Midland clerestory roof familiar to American travelers between Liverpool and St. Pancras (London), gave place to the newer semi-elliptical style. The stock is composed of three types, i. e., a composite brake, a third-class and a third-class brake, each having lavatory accommodation.

Special features are the square side construction of the guards and luggage compartment. This latter is in order to obtain "look-outs" for the guard along the side of his train, the width over which does not exceed the loading gauge. The body sides of the passenger compartment sections follow the now well known contour of 9 ft. wide main line carriages—this will clearly be seen on close examination of the end view. The section width allows of three comfortable seats a side with arm rests in the first-class compartments and four seats in the third.

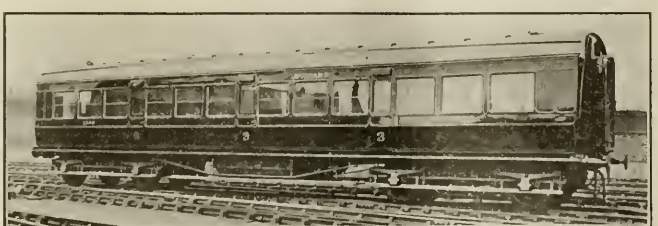
The body is framed in oak with mahogany outside panels and mouldings, and first-class compartments are finished in walnut and upholstered in blue cloth, while the third-class compartments are finished in mahogany with terra-cotta plush upholstery.

All ceilings and partitions, above the net racks, are lined with hard compressed asbestos millboard and painted dead white and the passenger compartments have frames showing places of interest served by the Midland Railway.

Each first-class compartment is provided with two hassocks which adds to the comfort of passengers, especially ladies. The first-class corridors are moulded and panelled in walnut, and the third-class with mahogany, while all interior wood-work fittings are polished.

Floors throughout are covered with linoleum except the lavatories, these being laid with cement; while the first-class compartments have rugs, and the corridors leading to them are carpeted. The carriages are heated by a direct steam system, under the control of passengers, a heater being placed under one seat in each compartment and also in the lavatories to prevent the water being frozen in severe weather; the usual valves are fitted with the object of effecting the liberation of water from condensation with the minimum waste of steam. Electric lighting with individual control of the lights is installed throughout.

In order to minimize the danger of telescoping in the event of collision, the ends and gangways are constructed of steel, and buffers of a specially strong design are fitted, the latter having oval faces, the vertical face being quite straight, thus obviating the tendency of buffers to mount each other, as in the case of curved faces. The buffer guides are fitted with inner plungers at the back of which are auxiliary rubber springs for

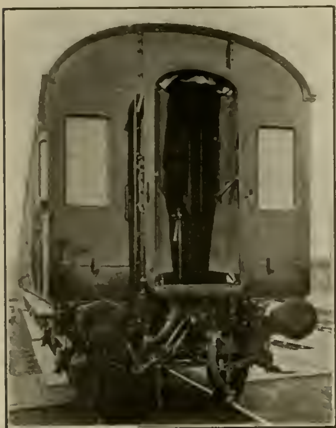


TYPE OF PASSENGER COACH, MIDLAND RAILWAY, ENGLAND.

the purpose of absorbing severe shock. All floor, roof and partition boards and the interior panelling are fire-proofed.

In each brake compartment an emergency outfit, consisting of tools, fire buckets and extinguishers, ladders, etc., is provided. All the interior metal fittings, in both first and third-class compartments, are oxidized bronze.

The chief dimensions, etc., are as follows: Length of body, 54 ft.; length first-class compartment, 7 ft. 3 ins.; length third class, 6 ft. 3 ins.; length bogie centers, 37 ft.; length bogie wheelbase, 10 ft.; width of body inside, 8 ft. 4⅞ ins.; width of body outside (passenger compartments), 9 ft.; width of body outside (guards and luggage), 8 ft. 6 ins.; width of corridor, 2 ft. 15/16 in.; width over footboards, 9 ft.; height above rails, 12 ft. 5½ ins.; height to top



VIEW OF STEEL END PASSENGER COACH, MIDLAND RAILWAY, ENGLAND.

of cornice, 10 ft. 8 ins.; height center of buffers, 3 ft. 5¼ ins.; weight in running order, 29 tons.

Kindness in Shop Management.

By C. Richardson, Bridgeport, Conn.

In the last issue of Railway and Locomotive Engineering an editorial made excellent reference to the fact that the age limit at which a man may look for employment at railroad work, with some hope of success, had been extended. The war has contributed to this result, and it is to be hoped that when the war is over there will be no lapse into older methods. Nearly all the marked improvements of methods of management that have occurred during the present century have the abiding quality. This is particularly true of the treatment of working men generally, and more particularly of the higher officials towards those in subordinate positions. In the olden days it seemed that after some capable mechanic had been selected from among the others to take charge of a certain section of the work he was not to be altogether trusted. It would have been a lowering of the dignity of the higher official if his appointee had been allowed a full opportunity to supervise the part of the work that was allotted to him. In many cases the result was that the promise of hope, so far as the capabilities of the subordinate were concerned, was unfulfilled. Like a recruit forever at drill, he was simply marking time when he should have been marching bravely onwards.

Usually, when the "old man" came on his unwelcome rounds the day's disasters could be seen in his morning's face. A word of encouragement never fell from such a man. Importance sat upon his dark brow. He and he alone was infallible, or he seemed to think that he was, and in this delusion he lived and moved, and had his perverted being.

Higher education has done away with this class of railroad man. A better spirit is manifesting itself everywhere, and is begetting a feeling of self-respect and self-reliance. Men know better than before what their duties are. Officials realize more fully than they ever realized before what their duties are, and what respect they owe to those upon whom they depend to aid them in the work to be done.

Any system that leads towards harmonious action, and at the same time leaves opportunities for the development of the latent qualities of the earnest, conscientious mechanic, is the system that should be encouraged. The spirit engendered by the adoption of such systems is one of the most cheering signs of the time in which we live.

Begging Expert Information.

A certain, generally recognized etiquette prevents most people from asking professional advice from doctors and lawyers without expecting to pay for it; but the same people will ask for real professional advice from an engineer and feel aggrieved if he mentions payment or sends in a bill for services rendered. The real trouble is that engineers are not in the habit of selling their services, and people do not recognize that the information possessed by a trained engineer has been acquired with fully as much labor and trouble as that undergone by any other professional man in learning his business. It is time the popular belief concerning this practice of acquiring knowledge without paying for it were stopped.

If a competent mechanical engineer was consulted before any machine or device was placed on the market or offered for sale, there would be fewer failures and disappointments and it would pay well for such expert service. Men who want to use the brains and training of skilled mechanics without paying for the same, would resent an impeachment of "sponging" on anybody. Yet to the expert depending upon making his living by using his brains and training, they are despicable dead-beats.

There is another class of men or a few of the same class, who seem to think that a mechanical paper exists for no other purpose than to do their expert designing free. They will ask questions in mathematics which any fair scholar in their place could work out in a few minutes. They want you to design engines for certain work, valve gear for certain engines, and boilers for a dozen different purposes each stating many local peculiarities that materially affect the case, and where sound judgment of a first class mechanic is necessary to insure success.

One of this class once wrote to us, asking for the proper horse power, size of boiler, size of screw, with many other particulars of an engine and its attachments to drive a boat 25 feet long at ten miles per hour. Now we know enough about locomotives to get along, but our knowledge of steamboats is limited and we do not pretend to be competent to advise about them So we wrote to our correspondent, advising him to employ a competent engineer to work out his problem and offered to recommend a mechanical engineer who was competent to do the work satisfactorily. We received a postal card in reply which reads: "The reason you don't answer wright is becoss you don't no, you editors ain't so smart as you pretend." This remark caused us a bad shock but we are getting over it.

This is the age of the specialist. Every man of ordinary intelligence can learn to be an expert on one particular line of work even if it is opening oysters. By exchanging information we can all obtain expert service in everything. An expert engineer will verify your plans or point out their weak points in a few minutes and perhaps save you thousands of dollars. But don't expect his services for nothing, nor that he will charge you by the hour. He has to receive something for the time and labor spent in laboring to educate himself.

Public Employment.

Bulletin 220 of the Bureau of Labor Statistics reports the proceedings of the fourth annual meeting of the American Association of Public Employment offices, which was held recently in Buffalo, N. Y. The purpose of the association is to study the administrative details of the employment bureaus and seek to improve methods and secure uniformity and co-operation among the employment offices in the country.

Remarkable Experiences With Pipe Material That Will Bend But Not Break

Among the striking improvements in the manufacture of metals in recent years there are none more remarkable than the advance that has been made in material for pipe. A few years ago it would be impossible to obtain pipe that would withstand the unusual strains involved in present day service. Some of these unusual experiences would scarcely be believed if they were not verified by a "cloud of witnesses." These incidents, while in a sense may be unusual, they are valuable as showing the progress made in metallurgical science, and are of interest to all who are interested in the improvement of mechanical appliances.

A volume might be made of these experiences, all showing the inherent qualities or "punishability" of pipe, the result for the most part of unusual accidents. Indeed it would be impossible to duplicate the circumstances under which many of these unlooked for tests occurred.

In our various illustrations Fig. 1 shows a piece of 5 3/16 ins. steel casing that was originally about 18 ft. long, and was stuck in an oil well. About 170 qts. of nitroglycerine had been placed in the well and was suddenly shot off with the idea of blowing this piece out, and at the same time "shooting" the well. Instead of shooting it out, however, the casing was reduced in length from 18 ft. to approximately 6 ft. It was drawn to the surface after great difficulty and was crushed, twisted and distorted, but no fracture was shown.

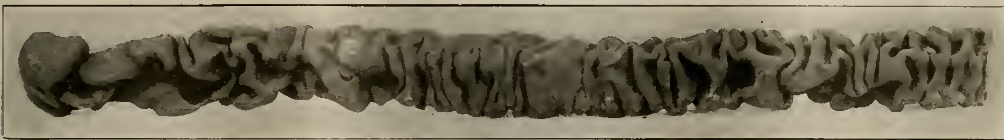


FIG. 1.

The incident reproduced in Fig. 2 occurred when a string of 340 ft. of 10 ins. 32.515 lbs South Penn. oil well casing fell 236 ft when an elevator let go. The picture shows what happened to the lower length of pipe when the casing hit the bottom of the well. The thread protector was forced over the threads and up over the pipe approximately 12 or 13 ins. and the pipe was bent backward and inward. As will be noted, however, the material shows no fracture. This happened in the Oklahoma oil field.

FIG. 2.

Fig. 3 shows a "3 in 1" section of casing. There was a string 1,440 ft. long of 8¼ in. 24 lb. steel casing; the elevator let go and the string of pipe weighing something over 34,000 lbs., dropped 200 feet to a bottom of limestone. The three sections on the bottom were telescoped—one inside and one outside. It will be seen that there was no failure in the weld, and the three lengths telescoped without a crack. The exterior apparently shows a straight length of casing. The particular piece here given was machined to show the three separate sections as telescoped. The circumstances are substantially the same as those in Fig. 2, but the results are very different. This incident occurred in the Ohio field, and such experiences might be multiplied from numerous sources as well as from files of the research department of the National Tube Company.

FIG. 3.

Boiling Water.

When water is boiled and turned to steam under pressure, as it is in the boiler of a locomotive, it requires more heat than if it was only in contact with the atmosphere. For example, when the steam gauge shows 200 lbs., deducting 15 lbs. for the pressure of the atmosphere, we have 285 lbs., and the temperature of the steam at this pressure is 381.6 degs. Fahr., and it contains 1198.34 B. T. U. One British Thermal Unit is the quantity of heat required to raise one pound of pure water through one degree on the Fahrenheit thermometer.

It takes about 5½ times the quantity of heat to evaporate a pound of water from the boiling point that it takes to raise the temperature from the freezing to the boiling point. Water has the greatest capacity for receiving heat of any liquid. The amount of heat needed to raise the temperature of one pound of water 1 deg. Fahr., or one B. T. U., will raise the temperature of 1 lb. of steel 11½ degs. Fahr. Thirty pounds of water evaporated per hour from a temperature of 100 degs. Fahr. to steam of 70 lbs. gauge pressure is generally taken as one horse power of work.

Railroad Men Financially Patriotic.

Reports from ninety-five railroad companies state that 165,000 employees subscribed for $17,045,266 of the Liberty Loan bonds. Some roads have not made final reports, but indications are that the total subscriptions to the bonds by railway officers and employees will amount to approximately $200,000,000, the bulk of which is in small amounts of $50 and $100 bonds. Railroad men are financially as well as personally patriotic. The railroads will reinstate their employees in old positions after they return from military service.

Items of Personal Interest

Mr. W. O. Cray has been appointed foreman of the Santa Fe shops at Tulsa, Okla.

Mr. C. G. Sauerberg has been appointed roundhouse foreman on the Santa Fe, with office at Chanute, Kans.

Mr. Benjamin Starkey has been appointed tool foreman of the Chicago & North Western, at Kaukauna, Wis.

Mr. H. H. Willard has been appointed roundhouse foreman of the Chicago, Milwaukee & St. Paul, at Madison, Wis.

Mr. R. W. Burnett has been appointed master car builder of the Delaware & Hudson, with office at Albany, N. Y.

Mr. H. A. Empie has been appointed general fuel agent of the Delaware & Hudson, with headquarters at Albany, N. Y.

Mr. E. Lindsay has been appointed assistant master mechanic of the Atlantic, Quebec & Western, with office at New Carlisle, Que.

Mr. R. Crosby, formerly car inspector of the Canadian Northern, at Blue River, Sask., has been appointed car foreman at Moose Jaw, Sask.

Mr. William Nelson has been appointed mechanical engineer of the Minneapolis, St. Paul & Sault Ste., Maine, succeeding Mr. H. C. Bayless.

Mr. E. E. Cope, formerly road foreman of engines on the Buffalo, Rochester & Pittsburgh, at Dubois, Pa., has been appointed master mechanic at that point.

Mr. A. L. Moler has been appointed master mechanic of the Saratoga and Champlain division of the Delaware & Hudson, with office at Colome, N. Y.

Mr. A. Steylmeier, formerly assistant boiler foreman at the West Albany shops of the New York Central, has been appointed general foreman boiler maker at that place.

Mr. W. Small, formerly acting foreman of the Canadian Pacific, at Revelstoke, B. C., has been appointed locomotive foreman at Kamloops, B. C., succeeding Mr. J. W. Jackson.

Mr. A. B. Ogilvie has been appointed road foreman of engines of the Grand Trunk, with jurisdiction over Thirty-first and Thirty-second districts, including the Ottawa terminal.

Mr G. H. Wilson, formerly assistant master mechanic, has been appointed master mechanic of the Montreal shops of the Grand Trunk, succeeding Mr. A. A. Mayer, resigned.

Mr. H. C Huckins, formerly general foreman of the Chicago & Eastern Illinois, at Salem, Ill., has been appointed general foreman of the Illinois Southern, with office at Sparta, Ill.

Mr. T. L. Reed, formerly master mechanic of the Seaboard Air Line, at Hamlet, N. C., has been appointed master mechanic of the Georgia division of the same road at Howells, Ga.

Mr. J. W. Watson, formerly assistant master mechanic of the Seaboard Air Line, at Andrews, S. C., has been appointed master mechanic on the same road, with office at Hamlet, N. C.

Mr. A. McDonald, formerly foreman of the erecting shop at Stratford, Ont., on the Grand Trunk, has been appointed assistant master mechanic at the Montreal shops of the Grand Trunk.

Mr. W. H. Sample, formerly master mechanic of the Grand Trunk, at Montreal, Que., has been appointed superintendent of motive power on the same road, with headquarters at Montreal.

Mr. H. B. Brown, formerly general fuel inspector of the Illinois Central, at Chicago, has been appointed superintendent of the fuel department of the Lehigh Valley, at South Bethlehem, Pa.

Mr. E. R. Battley, formerly general foreman of motive power on the Grand Trunk, at Deering, Me., has been appointed master mechanic of the Eastern lines of the same road, with office at Montreal.

Mr. C. Pence, formerly car foreman of the Rock Island, at Valley Junction, Ia., has been appointed general car foreman, with office at Horton, Kans., succeeding Mr. J. Deans, transferred to Trenton, Mo.

Mr. W. H. Bradley, formerly master mechanic of the Chicago & North Western, at Clinton, Ia., has been appointed assistant to the general superintendent of motive power, with office at Chicago, Ill.

Mr. W. J. Amor has been appointed superintendent of car shops and yards of the western lines, Canadian government railways, with offices at Transcona, Man., succeeding Mr. J. L. Hodgson, deceased.

Mr. J. O. Haberman has been appointed roundhouse foreman of the Santa Fe, at Albuquerque, N. M., succeeding Mr. A. H. Bierne, who has been appointed master mechanic on the same road, with office at Dodge City, Kans.

Mr. J. W. Jackson, formerly locomotive foreman of the Canadian Pacific, at Kamloops, B. C., has been appointed acting division master mechanic of the Cranbrook division, British Columbia district, with office at Cranbrook, B. C.

Mr. Joseph Greiser, formerly general foreman in the motive power department of the Delaware, Lackawanna & Western at Scranton, Pa., has been appointed superintendent of shops, with jurisdiction over the Scranton locomotive shops.

Mr. Heber L. Harvey, formerly road foreman of engines on the Wisconsin division of the Chicago & North Western, has been appointed master mechanic of the Iowa and Minnesota division, with headquarters at Belle Plaine, Iowa.

Mr. Albert Ganzut, formerly electrician on the Kansas City Terminal Railway, has resigned from that position, and is now traveling electric inspector of the First district of the Chicago, Rock Island & Pacific, with headquarters at Chicago.

Mr. J. H. Jowett has been elected vice-president of the Ingersoll-Rand Company, and Mr. L. D. Albin, formerly assistant general sales manager, is appointed general sales manager, both with headquarters at the company's offices, 11 Broadway, New York.

Mr. A. Fuller has been appointed foreman at the West Albany shops of the New York Central, succeeding Mr. D. Brewer, and Mr. E. Iverson, formerly machine shop foreman of the West Albany shops, has been appointed assistant-general foreman of shops.

Mr. F. R. Corper, formerly superintendent of motive power of the Kansas City Southern, and latterly with the Breakless Staybolt Company at Pittsburgh, Pa., has been appointed sales manager of the Gold Car Heating & Lighting Company, with offices at New York.

M. F. F. Gaines, superintendent of motive power of the Central of Georgia, at Savannah, Ga., has been granted leave of absence on account of ill health, and Mr. William H. Fetner, general master mechanic, at Savannah, has been appointed acting superintendent of motive power.

Mr. Leland T. Johnson has been appointed special representative of the Acar Manufacturing Company, 30 Church street, New York, manufacturers of the blue signal safety device, with headquarters at the Hotel Sherman, Chicago, and Mr. Burt E Dana, New York salesman, with office at 30 Church street, New York.

Mr. W. P. Hinton, hitherto traffic manager of the Grand Trunk Pacific railway, has been appointed vice-president and general manager of that railway to succeed Morley Donaldson, who has retired on account of ill health. Mr. Hinton was at one time connected with the old Canada-Atlantic Railway with headquarters at Ottawa.

Mr. P. Topping and Mr. E. Wells, formerly assistant engineers of the St. Louis-San Francisco, at St. Louis, Mo., have received commissions as captain and first lieutenant, respectively, in the Engineers' Reserve Corps. Captain Topping has been assigned to the Fifth Engineers, United States Army, and Lieutenant Wells has been detailed to Ft. Leavenworth, Kan.

Mr. L. S. Stoker, formerly foreman electrician of the Pullman Company at Pittsburgh, Pa., has been transferred to the Chicago Central district, with headquarters at Chicago, and Mr. P. D. Bahner, formerly foreman electrician at Washington, D. C., has been transferred to Pittsburgh, succeeding Mr. Stoker.

Mr. W. Wells, formerly division master mechanic on the Algoma district of the Schreiber, and Mr. T. Sudbury, Ont., has been appointed master mechanic at Schreiber, and Mr. T. Hambly, formerly acting master mechanic at North Bay, has been appointed division master mechanic at Sudbury, and Mr. C. Gribbin has been appointed master mechanic at North Bay.

Mr. W. D. Robb, for the last fifteen years superintendent of motive power of the Grand Trunk, has been appointed vice-president in charge of motive power, car equipment and machinery, with headquarters at Montreal, Que. Mr. Robb began his railway career as an apprentice machinist on the Grand Trunk in 1871, and has occupied nearly every position in the motive power department.

Mr. B. H. Davis, formerly assistant master mechanic of the Delaware, Lackawanna & Western, at Scranton, Pa., has been appointed master mechanic of Scranton, Syracuse & Utica and Bangor & Portland divisions, and Mr. Charles W. McGuirk, formerly general foreman in the motive power department at Scranton,

G. O. HAMMOND.

has been appointed assistant master mechanic, succeeding Mr. Davis.

Mr. W. D. Johnston, formerly master mechanic of the Cincinnati, Hamilton & Dayton, at Dayton, Ohio, has been appointed master mechanic of the Toledo division of the Northwest district of the Baltimore & Ohio, at Dayton, and Mr. M. P. Hoban has been appointed road foreman of engines at Dayton, and Mr. O. R. Stevens has been appointed road foreman of engines, at Lima, Ohio.

GEORGE W. WILDIN.

Mr. G. W. Wildin, formerly general mechanical superintendent of the New York, New Haven & Hartford, having been appointed general manager of the road, Mr. G. O. Hammond, formerly assistant general mechanical superintendent has been promoted to general mechanical superintendent. Mr. W. L. Bean, who has been acting as assistant to the president of the road, has been appointed assistant to the general mechanical superintendent. Mr. Wildin, whose career as a railroad man has been frequently referred to in our pages, is from Illinois. Twenty-five years ago he graduated from the Kansas Agricultural College with the degree of Bachelor of Science, and took a position as mechanical draftsman in the Topeka shops of the Santa Fe. Later he was machinist, fireman and locomotive engineer. From mechanical engineer in the Mexican Central in 1901, he was similarly engaged for three years on the Jersey Central, then four years as mechanical superintendent on the Erie. For the last ten years he has been practically the head of the mechanical department of the road of which he is now general manager. His successor as general mechanical superintendent, Mr. G. O. Hammond, is a New York man, a graduate of Stevens Institute, where he received the degree of mechanical engineer. He entered the service of the Erie as special apprentice machinist in 1898, foreman of the Meadville shops in 1903, then machinery inspector and chief draftsman, 1905, and assistant mechanical superintendent, 1909. In 1913 he had a similar appointment on the New Haven, and latterly assistant general mechanical superintendent until promoted to his present position. Mr. W. L. Bean has also had a wide railroad experience. Graduating as mechanical engineer from the University of Minnesota in 1902, he entered railway service with the Northern Pacific as special apprentice, and on the Santa Fe he served successively as erecting shop foreman, locomotive inspector at Baldwin Locomotive Works, machine shop foreman at La Junta, Colo., division foreman at Pelen, N. M., motive power assistant at Topeka, chief engineer of the Oxweld Railroad Service Company, at Chicago, and in 1916 he came to the New Haven, where he has been acting as assistant to the president, until his appointment as above.

Mr. William L. Allison, vice-president of the American Arch Company, is now in active service at Camp Grant, Rockford, Ill., with the rank of major of infantry. Major Allison is from North Carolina, of Revolutionary stock, and is a graduate of the Davis Military school, of Winston-Salem, N. C. He was several years in the employ of the Baldwin Locomotive Works, and in 1904 he became mechanical engineer of the Santa Fe. In 1909 he held a similar position with the Franklin Railway Supply Company. Latterly he became general sales manager of the American Arch. Company, and became vice-president of the company in 1914.

Sir Erie Geddes, recently appointed first lord of the Admiralty, began his industrial career at the age of 17 on the Baltimore & Ohio Railroad, where he remained for three years. He was born in India of Scottish parents. On returning to India at the age of 21 he superintended the construction of a railroad. In 1903

SIR ERIC GEDDES, K. C. B.

he entered the service of the North Eastern Railway of England, and rose rapidly to the position of deputy general manager. At the outbreak of the war he helped to organize the railroads in France, and was appointed director general of transportation, then deputy director general of munitions, and latterly head of the navy, as above stated. It may be noted that the latter office pays no salary, but Sir Eric still retains his position as deputy manager of the North Eastern Railway. He is said to be a master in organization. In his new position he is undertaking the reorganization and administration of the entire civil and active fling departments of the British navy. He was knighted by King George in 1916. He is now in his 41st year.

The First Lord of the Admiralty is a cabinet officer. He is usually a civilian, but is assisted by four sea Lords, and two civil lords and parliamentary secretaries. The name Admiralty is derived from the fact that, it is now composed of the "Commissioners for executing the office of Lord High Admiral of the United Kingdom." The board thus composed is the admiralty board. There is no such man, nor has there been since 1708, as Lord High Admiral, and as at present constituted, his office is said to be in commission, with the cabinet minister in parliament as first Lord.

Mr. J. B. Diven has been appointed master mechanic of the Philadelphia Terminal division of the Pennsylvania at Philadelphia. Mr. James Young, Jr., has been appointed assistant engineer of motive power, New Jersey division. Mr. J. H. Fulmer, formerly master mechanic at Mt. Carbon shop, has been appointed inspector in the office of the superintendent of motive power, Eastern Pennsylvania division, with offices at Altoona. Mr. C. J. Hallwell becomes master mechanic at Mt. Carbon shop. Mr. F. E. Marsh, formerly assistant master mechanic at the Altoona shops, has been appointed master mechanic of the New York, Philadelphia & Norfolk, at Cape Charles, Va.

Mr. Frank S. Gannon has been elected President of the Savannah & Atlanta Railway Company. Mr. Gannon has had an extensive and valuable experience in the management of railway properties, a fact which cannot fail to prove of advantage to him in his new position, of his qualifications for which there can be no question.

Beginning his railroad experience with the Erie, he has been closely identified with the Baltimore & Ohio, the New York Railways, the Southern Railway, and was for some time President of the Staten Island Railway. He was at one time President of the Norfolk & Southern, and is now President of the Montana, Wyoming & Southern. For some time he has been actively practicing his profession as consulting expert in railroad management. The Savannah and Atlanta Railway is a consolidation of the Savannah Northwestern and Savannah & Atlanta roads. It is practically a continuation of the Georgia Railroad from Cammack, 145 miles north of Savannah and completes a new through line to the sea for the Chicago, Burlington & Quincy, Louisville & Nashville and N. C. & St Louis.

Master Mechanics' Scholarships in the Stevens Institute.

The American Railway Master Mechanics' Association has four perpetual scholarships in the Stevens Institute of Technology, and we are under the impression that the scholarships are not so well known to the persons for whose benefit they are intended as they ought to be.

A circular issued in 1891 reads: Candidates for Scholarships in Stevens Institute of Technology must be sons of members, or of honorary members or of deceased members. The students must have worked for at least one year in a recognized machine shop, and they are required to take the course of mechanical engineering. The rules of the school require applicants for admission to be over seventeen years of age.

Candidates for the Stevens Institute Scholarships are required to apply to the Secretary of the Association, who will supply them with certificates if they are found eligible.

Candidates will be examined on the following subjects:

Arithmetic.—The preparation should be especially thorough upon the properties of numbers, the operations of common and decimal fractions, the methods of finding the greatest common divisor, the extraction of the roots of numbers.

Algebra.—Simple equations, theory of radicals, equations of the second degree, arithmetical geometrical progression, permutations by binomial theorem, intermediate co-efficients, logarithms and sines.

Geometry.—All plane, solid and spherical geometry.

Analytical and Plane Trigonometry.—The fundamental formulæ and their demonstration.

English Grammar.—Practical acquaintance with the parts of speech, their relations, agreements and government; the proper use of tenses and moods; the construction and arrangement of sentences.

Composition.—An essay on some topic assigned at time of examination. Legible handwriting, correct spelling and punctuation.

Universal History.—The questions relate to the great events, their causes and effects. A conspicuous place is given to the history of the United States.

Rhetoric.—All subjects which are contained in the text books on rhetoric. Text book—Hart's Rhetoric.

French.—Translation from Knapp's Modern French Reading.

Physics.—What is contained in Deschanel's Natural Philosophy.

If there is more than one candidate, the applicant who passes the highest examination will be chosen.

Officers of Baldwin Locomotive Works.

Several changes have been made in the organization of the Baldwin Locomotive Works and the Standard Steel Works Company. While William L. Austin continues to be chairman of the board of the Baldwin Locomotive Works, and Alba B. Johnson, president; Samuel L. Vauclain, formerly vice-president, becomes senior vice-president. Grafton Greenough, formerly sales manager, is now vice-president in charge of sales; J. P. Sykes, formerly general superintendent, becomes vice president in charge of manufacture, and James McNaughton, formerly vice-president of the American Locomotive Company, becomes consulting vice-president.

The officers of the Standard Steel Works Company are as follows: William Burnham, heretofore president, has been elected chairman of the board, and other officers have been elected as follows: Alba B. Johnson, president; Samuel M. Vauclain, senior vice-president; Robert Radford, vice-president and treasurer; A. A. Stevenson, vice-president and engineer; Wm. H. Pugh, Jr., secretary; T. L. Rogers, assistant treasurer, and O. C. Skinner, works manager.

P. R. R. Men in the Army.

Thus far, 2,540 employees of the Pennsylvania Railroad, Lines East of Pittsburgh, have entered the Army and Navy of the United States as volunteers, and have been granted furloughs from the railroad service. Of this number, 75 have been appointed Commissioned Officers and 30 are Student Officers in various Officers' Training Camps. The remainder, numbering 2,442, are enlisted men in the Army and Navy. The Commissioned Officers include one Colonel, one Lieutenant Colonel, two Majors, 21 Captains, 23 First Lieutenants, 22 Second Lieutenants, three Ensigns and one Pay Clerk.

Track Supply Association.

At the annual meeting of the Track Supply Association, the following officers were elected: President, E. T. Howsen, Chicago; vice-president, J. J. Cozzens, Union Switch & Signal Company, New York; secretary-treasurer, W. C. Kidd, Ramapo Iron Works, Hillburn, N. Y.; directors, F. A. Darby, Frictionless Rail Company, Boston; E. Coleman, American Hoist & Derrick Company, St. Paul, Minn.

Government Freight Cars.

Supplementing present Government control of the railroads, the National Council of Defense has completed plans to buy 100,000 freight cars to be actually owned by the Government and operated on all the railroads of the country. The cost of this Government owned equipment will be $150,000,000.

What It Costs to Stop a Freight Train.

Under the old-fashioned methods of operating railroads, and not so long ago either, everyone with any authority, from the president to the section foreman, thought it perfectly proper to hold up a freight train to suit his personal convenience, but with a more accurate knowledge of costs a great change has taken place in this respect. Investigations have demonstrated that to stop the average heavy freight train from a speed of 15 miles an hour, and to again to bring it up to the same speed, means the expenditure of from 300 to 750 lbs. of coal, and this again means that if many avoidable stops are made a material percentage of profits is wasted. As a consequence schedules on well managed roads are now arranged so that there shall be as little interference with the movement of freight trains as possible, even if some passenger trains have to be inconvenienced in the process.

Initial Strain.

An engineer can hardly pass an occasional hour in a machine shop watching the operations of workmen without noticing that many of the men act on the impression that the more tightly a thing is screwed up the safer it is. It is therefore desirable to point out that very tight screwing is seldom necessary and that often the over-tightening of connections may be a source of danger. In some cases a certain amount of initial strain is necessary to prevent settling, but the requirements of different classes of work should be carefully considered and no haphazard method of tightening everything be adopted. It is highly important that this matter should be thoroughly understood by the general run of artisans, for it is not to be supposed that overseers and foremen can watch every move in tightening a nut, nor should it be necessary for them to do so.

Our experience is that half-trained workmen are the most likely to display want of judgment in the tightening of bolts. We have known of a railroad bridge that was severely damaged by the over-tightening of bolts. The tightening of the bolts had been done by a set of inexperienced workmen who thought the tighter the nuts, the more likely were they to hold. When three heavy locomotives were run upon the bridge as a test so many of the nuts flew off that the bridge nearly collapsed.

If the pull upon a bolt is at right angles to its length, there is not the slightest use for heavy initial strain; it merely needs to be screwed up sufficiently to keep the parts in close contact, there being no tendency to displace the bolt or nut longitudinally; but if the pull upon the bolt is longitudinal, some stress is necessary to prevent knocking, as the amount of this can easily be determined in each particular case. Let us consider for a moment the action of initial stress upon a bolt longitudinally strained such as the bolts holding the bearing cap of a steam engine. If in such a case the nuts were only screwed up to touch the metal, then when tension comes upon the bolt it is slightly elongated, thus removing the parts joined. On the cessation of the tension these parts come together again. This being constantly repeated, knocking will be set up, causing injury to the parts concerned.

If the amount of initial tension upon the bolt is equal to that which can be brought upon it in the course of work, it is evident that in that case the parts held by it will not be separated, as the bolt will be further extended unless the working stress exceeds the initial stress already upon the bolt. The amount of tension that can be put upon a bolt with an ordinary wrench is very great. Suppose that an inch nut is being tightened up with a 15-inch wrench, then the pitch of the thread being ⅛ inch, and the circle described by the end of the wrench is 47 inches, the force applied to it is multiplied by 376, so 24 pounds pressure on the end of the wrench could put tons of tension on the bolt, which is more than it should be subjected to. At a strain of about eight tons per sectional square inch the elastic limit of wrought iron is reached, and it begins to stretch permanently, hence if this point is approached by the initial tension the bolts will gradually yield and want constant tightening, whereas if the initial force is kept well within the elastic limit they will remain in adjustment for an indefinite time.

New Bridge Over Niagara River.

A new steel arch bridge about 560 ft. span, is to take the place of the Niagara cantilever bridge of the Michigan Central at Niagara Falls. The present cantilever bridge is famous as being the first of its kind in this country, being built in 1883-84. Each of the two cantilevers is 395 ft. long, with 195 ft, anchor arm, 175 ft. river arm, and 25 ft. tower arm. The suspended span is 120 ft., making a total length of 910 ft. The height is 240 ft. from the water to the rail. The trusses are 28 ft. from center to center, and the deck carries a double track. It was strengthened in 1900 to adapt it to the increased loading. The new bridge will carry three tracks. It will have a clear span of 560 ft. with a rise of about 132 ft. from the hinges to the bottom chord. The time set for the completion of the new bridge is indefinite owing to the difficulty of securing a full line of material. The work is under the direction of J. F. Deimling, chief engineer of the Michigan Central.

Firth of Forth Tunnel.

The engineering supplement of the London *Times*, dealing with the project of a tunnel to connect Fifeshire with Edinburgh, says:

"It was suggested at a meeting of the Mining Institute of Scotland that a tunnel should be constructed under the Firth of Forth, connecting Fifeshire with Edinburgh. It was not proposed that such a scheme should be undertaken solely as a commercial venture, or even for the purpose of naval and military strategy. A tunnel would cater for goods and passenger traffic, and would also be useful by providing an alternative crossing in the event of the Forth bridge being damaged.

"The principal argument in favor of constructing a tunnel is, however, that the work could be largely done in the form of coal mining, the coal being excavated and marketed, and the borings directed from the respective sides so as to meet ultimately and constitute a passage for traffic.

"For a number of years miners on both sides of the Forth have been working the same seams of coal. On the north side the seams are worked from the Low Valley Field Colliery, about five miles west of Dunfermline, and on the south side from the Lowthians pits. In each case the excavations are going under the firth, and as at this point the estuary is only two miles in width, it would be only a question of time, if the work were directed properly, when the two sets of men would meet about halfway across. Already, an inspector of mines has stated that there are excavations two miles in length, projecting under the firth, though these could not be utilized as part of a tunnel.

"There might be difficulties in haulage and ventilation, but it is believed that these could be overcome. A boring could be made at first capable of taking an ordinary 7-ton railway wagon. At the side of this boring there could be erected a single screening unit, so that the coal excavated could be screened and put into wagons for direct conveyance to the markets. So far as operations under the Forth have been carried on, the conditions as to gas and dust have been found to be such that a tunneling scheme could be undertaken with perfect safety. The work could be carried out economically, because the coal obtained would always more than pay for the cost of labor, materials and supervision."

Mr. Arthur S. Lewis, formerly with the Chicago-Cleveland Car Roofing Company, has been appointed assistant to the president of the Flint & Chester Company, New York. Mr. Lewis will have charge of sales to railroads and other large corporations.

Railroad Equipment Notes

The Erie is in the market for 88 underframes for passenger cars.

The Southern Railway is in the market for about 4,000 freight cars.

The Illinois Central will shortly begin enlargement of its shops at Jackson, Tenn.

The Virginian Railway is reported as about to place orders for 1,000 55-ton steel hopper cars.

The Toronto, Hamilton & Buffalo has ordered 5 caboose cars from the American Car & Foundry Company.

The New York Central has reserved space with the American Locomotive Company for about 250 additional locomotives.

The Pennsylvania Railroad has awarded a contract for the construction of new shop buildings at its Greenville yards, Jersey City, N. J.

The Erie Railroad is reported planning for improvements in its roundhouse and shop buildings at Salamanca, N. Y. To cost about $15,000.

The Inland Steel Company has ordered 72 50-ton general service cars and 35 50-ton hopper cars from the Bettendorf Company, Bettendorf, Ia.

The United States Government has ordered 500 30-ton steel underframe ballast cars for service in France. Contract was awarded the Rodger Ballast Car Company.

The New York, New Haven & Hartford has ordered five electric locomotives from the Westinghouse Electric & Manufacturing Company, and it is understood will soon buy 15 more.

The Chesapeake & Ohio has had plans prepared for a new engine house and shop building to be erected at Raleigh, W. Va. The structures will be 58 by 140 ft., and 30 by 70 ft., respectively.

The Canadian Car & Foundry Company is negotiating with the Russian authorities for a large portion of the big Russian order which will shortly be distributed to the Canadian companies, totaling 10,000 four-wheel cars.

The American Railroad of Porto Rico has ordered 3 compound Consolidation locomotives from the American Locomotive Company. These locomotives will have 14 and 20 by 20-in. cylinders, and a maximum tractive effort of 15,000 lbs.

According to an announcement by William Sproule, president of the Southern Pacific, 65 new locomotives, costing over $2,500,000, are on order for the Pacific System Lines. Ten of the locomotives are to be built at the company's shops.

The Union Pacific is to install a mechanical interlocking at Laramie, Wyo., a 32-lever Saxby & Farmer machine, with 24 working levers and eight spare spaces. The material will be furnished by the General Railway Signal Company.

The Atchison, Topeka & Santa Fe has ordered from the General Railway Signal Company an electric interlocking plant for Bragdon, Colo.; a 32-lever, Model 2 unit lever type machine, with 23 working levers. The material will be installed by the railroad forces.

New York, New Haven & Hartford's forces are now at work on a new 18-stall brick, concrete and hollow tile roundhouse at Cedar Hill yard, just east of New Haven. The roundhouse will be about 98 ft. wide, 488 ft. long and will cost about $141,000.

The Central of Georgia will extend its automatic block signal territory in the vicinity of Macon, Ga. Seventeen 1-arm and one 2-arm style "S" double-case, low-voltage, ground signals and other material have been ordered from the Union Switch & Signal Company.

The Pennsylvania Lines West of Pittsburgh have awarded contracts for the construction of new reinforced concrete shops at its Irvington works, near Indianapolis, Ind. The structures will consist of a 30-stall roundhouse, machine and repaid shops and power plant.

Inquiry for about 10,000 additional cars for the United States Government has come out. The former order for 6,000 cars, which was increased to 9,000, has been further enlarged by the placing of 500 small cars with the Pressed Steel Car Company, and 500 convertible ballast cars with the American Car & Foundry Company.

The Atchison, Topeka & Santa Fe has awarded a contract to the Cresmer Manufacturing Company, Riverside, Cal., for the erection of buildings at its car shops at San Bernardino, including a one-story refrigerator car repair shed, 46 by 1,200 ft.; a one-story blacksmith shop, 50 by 385 ft., and a one-story car repair shop, 46 by 310 ft. The cost of these improvements will approximate $60,000.

The Pennsylvania Railroad's purchasing department is said to have closed for practically all of the equipment required for locomotive shops in France to be built for the United States Government. Quick deliveries were required. It is understood that the Niles-Bement Pond Company, Manning, Maxwell, Moore, Inc., the Gisholt Machine Company, and the Warner & Swasey Company received a large share of the orders, while the entire crane order went to the Cleveland Crane & Engineering Company, Cleveland, which agreed to complete the contract for 18 cranes in approximately 90 days. Shipment of the first cranes will be made September 15, or 25 days after receipt of the order. Several of the cranes are of 65-ton capacity and 80-ft. span.

Meeting of American Gear Manufacturers.

The American Gear Manufacturers' Association held its semi-annual session in Chicago, Thursday, Friday and Saturday, September 13, 14 and 15, at the Edgewater Beach Hotel. The Association numbers among its members practically all of the prominent gear manufacturers in the country. The Chicago session was the largest of any yet convened. Pittsburgh was the scene of the last meeting—held in May.

Among others, a paper by B. S. Waterman, Brown & Sharpe Mfg. Company, on "Inspection of Gearing" was read; also another by H. E. Eberhardt of the Newark Gear Cutting Machine Company, on "Spur Gearing by the Rotary or Disc Cutting Process," and another by F. Schneider of Van Dorn, Dutton & Co., Cleveland, on "Spur Gears by the Shaper Method." All papers read at the convention were instructive and promoted much discussion. The members returned home feeling much had been accomplished of benefit to the industry—especially now that the country is at war and united understanding and effort necessary.

Railway Signal Association.

At the twenty-second annual meeting of the Railway Signal Association, held at Atlantic City, N. J., on Sept. 18 and 19, President C. A. Dunham opened the proceedings with a stirring address in the course of which he referred to the war conditions as affecting the signal department very materially. Many had joined the army and the best wishes of the members went with them. Their names will be kept on the roll without dues.

Secretary C. C. Rosenberg reported a membership of 1,281, an increase of 13 during the year. These include 703 senior, 226 junior and 344 associate, and representative votes are cast by 70 railroads, operating about 173,000 miles of road and 186,000 signal blades. The various committees reported many new revisions of designs. In the discussion on glasses the committee recommended that the motive power department should be brought into the movement to reduce the great variety of glasses. Nearly all of the proposed changes in apparatus and appliances will be submitted to the members by letter ballot.

The election of officers of the Association for the ensuing year resulted in the unanimous choice of the following: President, William H. Elliott (N. Y. C.); second vice-president, C. J. Kelloway (A. C. L.); secretary and treasurer, C. C. Rosenberg, Bethlehem, Pa.

A Splendid Start

Women have made a splendid start in various branches of railroad work to make up war-time deficiencies of men, according to reports of the New York Central Ranlroad, where the company has ordered the employment and training of feminine workers wherever possible in all departments.

A gang of thirty women, under direction of a woman bookkeeper, is employed by the New York Central at Collinwood, Ohio, in sorting 3,000 tons of scrap, nuts, steel plates, spikes, bolts, brake shoes—practically every part of a superannuated engine or a broken-down car. These women examine and sort every piece of scrap; they do the work as well as men and appear to like it.

Interborough Rapid Transit Company.

With respect to war measures, the Company has not adopted any general policy covering the enlistment or drafting of employes, except that members of families of such employes will be given the preference in filling vacancies thus created, whether male or female, in all cases where the work is suitable and the applicants competent. On account of the necessities and importance of the service, there may be a general exemption of railroad employes, both electrical and steam, but to the extent that this does not occur it is the intention to substitute dependent members of employes' families to the greatest possible extent in filling such vacancies.

American Locomotive Extensions.

The American Locomotive Company has purchased the land and buildings of the Henrico Iron Works Corporation at Richmond, Va., suitable, with improvements which are being installed, for making locomotive gray iron castings. The American Locomotive Company has on hand unfilled orders amounting to nearly $80,000,000.

Books, Bulletins, Catalogues, Etc.

Accident Bulletin.

The Interstate Commerce Commission has just issued for the Government Printing Office, Accident Bulletin No. 62, containing the details of railway accidents in the United States during the last three months of 1916. These are compiled from monthly returns, and in point of completeness approach a degree of reliability that grows with the growing years. In the condensed summary it is shown that from accidents of all kinds there were 2,391 fatalities, and 50,467 injuries. Of these, trespassers, non-trespassers and employees not on duty, furnished 1,696 fatalities. The most notable feature is the reduction of fatalities among what may be called the trespasser class, being about 500 less than the previous three months. Almost all of the fatalities, as may be expected, come under the heading of train-service accidents. Collisions and derailments furnish only 16 per cent. of the total, so that the fact still remains apparent that the list of deaths and injuries on railways is largely attributable to the contributory negligence of the victims. The total number of passengers killed during the period referred, was 60, and injured 1,834. Among these, 28 passengers were killed getting off or on trains.

Graphite.

An especially interesting article in the latest issue of the Joseph Dixon Crucible Company's house organ, is a description and illustration of the Sweeley Graphite Lubricators for air cylinders of locomotive air pumps. The manufacturers claim that 14 months of continuous service feeding Dixon No. 1 Flake Graphite into air cylinder of air pump, without the aid of a drop of oil, has shown conclusively that this method of lubricating air pump cylinders is far superior to any method heretofore tried. Careful experiments were made to determine the exact amount of graphite required to give ample lubrication and at the same time to guard against too much material being fed into the air system. It was found that ½ oz. of No. 1 Flake Graphite, fed into a Westinghouse 9½ in. pump during 12 to 14 hours' period that pump was in service would give best results. The maintenance of the air cylinders of air pumps is the particular part of the pump that makes the pump go to shop for overhauling and repairs. It is indicated that this system of lubrication will extend length of time between overhauling of pump at least 100 per cent. The same design of feeding mechanism used in the Sweeley locomotive cylinder graphite lubricator and the stationary engine type is used in this air pump lubricator. The inventor is Mr. E. H. Sweeley of Richmond Hill, N. Y. See Railway and Locomotive Engineering for June, 1917, page 188. This device is being manufactured and distributed by the Nathan Manufacturing Co., of Flushing, L. I.

Ventilated Commutating Pole Motor.

The General Electric Company has just issued bulletin No. 44417-A, describing in detail the GE-258 Ventilated Commutating Pole Railway Motor which has been developed to help solve the problem of electric railways in rapid and economical city transportation by the use of light weight cars. In general details of design and construction, the GE-258 Motor follows G-E railway motor practice, incorporating the special features and manufacturing processes of standard ventilated motors, while light weight, compactness, and rigidity are obtained to a considerable degree by the use of ball bearings for the armature shaft. It also possesses to the fullest extent the characteristics of reliability and low cost of maintenance said to be inherent in General Electric railway motors. The GE-258 Motor is manufactured in two forms, one suitable for 24-in. wheels and maximum of 4-in. axle diameter; the other, for 30-inch wheels and a maximum of 4½-in. axle. The motors are designed to use a maximum gear ratio which will give the car speeds necessary to maintain usual city schedules.

The Utilization of Pyrite.

The possible recovery and utilization of pyrite occurring with bituminous coal, is suggested in circular 5 of the Engineering Experiment Station of the University of Illinois, by Prof. E. A. Holbrook. The circular referred to presents a discussion of the composition of pyrite. It contains 50 per cent of pure sulphur, and in bituminous coal in certain districts as much as 6 per cent of pyrite is found incrusted in flakes or irregular particles in the coal. A clean pyrite product is worth six to seven times as much as coal. The market at present is active, as the demand for sulphuric acid is very great. The supply formerly from Spain has ceased, while the extent of the uses for the mineral has increased. The circular presents a description of the machinery required in a preparation plant, and a statement of the methods to be employed. Copies of this publication may be had by addressing the Engineering Experiment Station, Urbana, Illinois.

A price mark looks all right on almost anything except a man.

It is easier to dodge responsibility than it is to dodge the result.

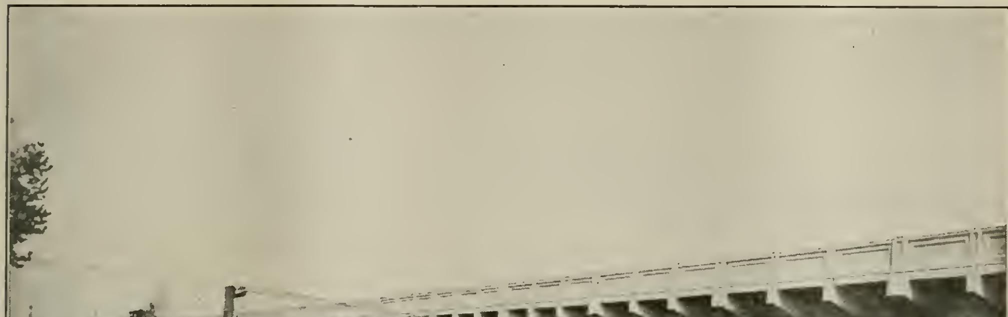
Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXX — 114 Liberty Street, New York, November, 1917 — No. 11

Extensive Improvements on the Southern Railway

The operations in connection with the double tracking of the Southern Railway line between Washington and Atlanta is the largest and most progressive railroad construction movement that has ever been undertaken in the South, and as it approaches completion it is gratifying to know that the advantages already arising from the improved facilities surpass the expectations of the enterprising promoters. The distance between Washington, D. C., and Atlanta, Ga., is 649 miles, partly through what is known as the Piedmont section of the South, along the eastern slope of the Blue Ridge and Alleghany Mountains. That portion of the road between Washington and Charlotte, 380 miles, has been double tracked and in



DOUBLE TRACK CONCRETE VIADUCT OVER THE DAN RIVER AT DANVILLE, VA.

operation for some time. In this part, the most notable work is the concrete double track viaduct across the Dan River at Danville, Va. The structure as shown in our frontispiece illustration, consists of 36 spans each 26 feet in length; 35 piers and two abutments of reinforced concrete throughout; length, 936 feet; height above normal water level, 40 ft; width, 42 ft.; two tracks and two seven foot sidewalks with reinforced concrete handrails. The masonry and reinforcing includes 14,900 sq. yds. reinforced concrete masonry, and 685 tons reinforcing steel.

While the bridge is the most monumental work of its kind in the new improvements on the Southern Railway, other engineering problems of much magnitude have been successfully solved, among others the moving of the entire Southern Railway station at Danville from its former location to its permanent new location, a distance of over fifty feet across a street. The station is a two story brick structure weighing about 1,100 tons, and its removal intact to its proper place alongside the new double track line was speedily and successfully accomplished, keeping the station in perfect condition.

The reducing of many grades and cutting out of numerous curves made much of the work particularly heavy, especially in the vicinity of Mount Airy and Toccoa, Ga., which is one of the most mountainous sections through which the main line from Washington to Atlanta passes. The result of the operations at once places the Southern Railway among the leading railways in America, while we can bear personal testimony to the superiority of the motive power and rolling stock equipment which is unsurpassed both in elegance of finish and in power.

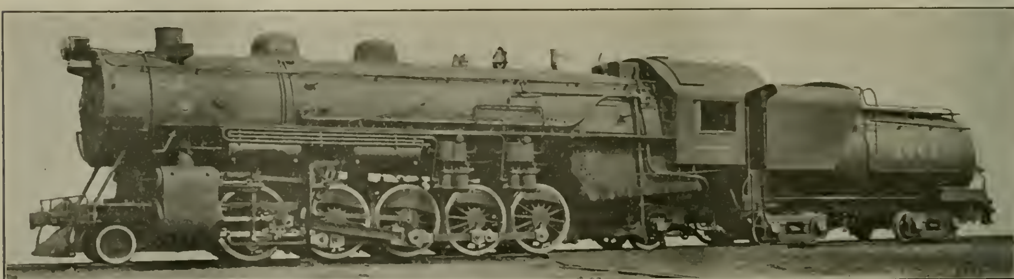
Santa Fe and Mikado Type Locomotives for the Union Pacific System

The Baldwin Locomotive Works is filling an order for 27 Santa Fe or 2-10-2 type locomotives for the Union Pacific System. The order is divided. The Union Pacific Railroad receives fifteen engines, the Los Angeles & Salt Lake Railroads—six engines and the Utah Railway—six engines. The Los Angeles engines are oil burners, while the others use coal as fuel. All are of the same hauling capacity, and differ in minor details only, the equipment being modified to fit them for service on their respective roads.

These locomotives develop a tractive force of 70,450 lbs., and with 285,500 lbs. on the driving-wheels, the ratio of adhesion is 4.05. The total equivalent heating surface, assuming that each square foot of superheating surface is equivalent to 1½ sq. ft. of water evaporating surface, is 7,045 sq. ft., or one square foot for each 10 lbs. of tractive force. This indicates ample steaming capacity for the heavy class of freight service in which these engines will be used.

The boiler is of the straight-top type, with a wide deep firebox placed back of the drivers and over the rear truck. A combustion chamber approximately four feet long, extends forward into the boiler barrel, and the tubes have a length of 22 ft. The middle barrel ring has a slope on the bottom, to provide a sufficiently deep water-space under the combustion chamber. All seams in the firebox and combustion chamber are welded, with the exception of that uniting the back sheet with the crown and sides. The seam around the fire-door opening is also welded. The use of flexible staybolts is confined to the probable breaking zones, and to the six front rows of stays over the combustion chamber crown. In the case of the three upper rows of flexible stays on each side, bosses are welded to the outside sheet in order to provide a sufficient number of threads for the staybolt sleeves. Both coal and oil burners are equipped with Security Sectional Arches, and the coal burners are fired with Street type "C" mechanical stokers. The superheater is designed with 45 elements, and presents a superheating surface of 1,262 sq. ft. The piston-valves are 15 ins. in diameter and are driven by Walschaerts motion, which is in turn controlled by the Ragonnet power reversing gear, type A, having both air and steam connections. The piston heads are steel castings of dished section, 7 ins. wide, with phosphor-bronze bearing rings and gun-iron packing rings. The piston rods are of open-hearth steel, heat treated and hollow-bored. The same material is used for the crank-pins, and driving and trailing axles. The axles are hollow-bored. Long driving boxes are applied to the main axle, and lateral motion boxes to the front axle. The latter are used in connection with the Economy constant resistance leading truck.

The frames are annealed vanadium steel castings, 5½ ins. wide, and spaced 42 ins. between centers. They are braced transversely between adjacent driving-wheels, and also at the third, fourth and fifth pairs of driving pedestals. The pedestal wedges are self-adjusting. The Commonwealth rear frame cradle is aplied, in combination with the Delta trailing truck. This truck is built with a massive steel casting, which serves the triple purpose of a frame, a radius bar, and an equalizer. In the present case, the truck is equalized with the two rear pairs of drivers. The equalization is through a central, vertical, heart-shaped link, which is suspended from a transverse beam hung from the rear driving springs. This link acts not only as the equalizer connection, but also as the rear truck radius-bar pin. It is circular in section at its lower end, and is guided in the frame cradle casting.



HEAVY 2-10-2 ENGINE FOR THE UNION PACIFIC SYSTEM.

C. E. Fuller, Supt. Motive Power and Machinery. Baldwin Locomotive Works, Builders.

The bearing between the equalizer frame of the truck and the locomotive frame is made with a spherical surface, to provide sufficient flexibility.

The driving-brake system divides between the third and fourth pairs of wheels. The rear cylinders are placed in a horizontal position back of the main pair of wheels, while the front cylinders are placed vertically and are bolted to the cylinder saddle casting. The arrangement is such that all the shoes bear on the backs of their respective wheels.

The tender is carried on forged steel wheels, and is of the Vanderbilt type, with equalized trucks and one-piece, cast steel frame. The principal dimensions are here given for reference:

Type.—2-10-2, gauge, 4 ft. 8½ ins.; cylinders, 29½ ins. x 30 ins.; valves, piston, 15 ins. diam.

Boiler.—Type, straight top; diameter, 88 ins.; thickness of sheets, ⅞ in. and 1 in.; working pressure, 200 lbs.; fuel, coal; staying, radial.

Fire Box.—Material, steel; length, 126 ins.; width, 96 ins.; depth, front, 93½ ins.; depth, back, 75½ ins.; thickness of sheets, sides, back and crown, ⅜ ins.; thickness of sheets, tube, ½ in.

Tubes.—Diameter, 5½ ins. and 2¼ ins.; material, iron; thickness, 5½ ins., 0.150 ins., 2¼ ins., 0.125 ins.; number, 5½ ins., 45; 2¼ ins., 260; length, 22 ft.

Heating Surface.—Fire box, 249 sq. ft.; combustion chamber, 99 sq. ft.; tubes, 4,774 sq. ft.; firebrick tubes, 30 sq. ft.; total, 5,152 sq. ft.; superheater, 1,262 sq. ft.; grate area, 84 sq. ft.

Driving Wheels.—Diameter, outside, 63 ins.; journals, main, 12 ins. x 18 ins.; journals, others, 10 ins. x 12 ins.

Engine Truck Wheels.—Diameter, front, 30 ins.; journals, 6½ ins. x 14 ins.; diameter, back, 45 ins.; jour. 9 ins. x 14 ins.

Wheel base.—Driving, 22 ft. 6 ins.; rigid, 22 ft. 6 ins.; total engine, 41 ft. 5 ins.; total engine and tender, 77 ft. 6 ins.

Weight.—On driving wheels, 285,500 lbs.; on truck, front, 23,600 lbs.; on truck, back, 48,500 lbs.; total, engine, 357,600 lbs.; total engine and tender, 552,200 lbs.

Tender.—Wheels, diameter, 33 ins.; journals, 6 ins. x 11 ins.; tank capacity, 10,000 U. S. gals.; fuel, capacity, 17 tons.; service, freight.

The Mikado or 2-8-2 engines, which are included in the same order and were built by the Baldwin Works, are much the same as the Santa Fe type or 2-10-2 engines just described. They are equipped with the one-piece cast steel tender frame. There are fifty-one of these engines in the order of which the Baldwin works have delivered twenty.

These Mikado locomotives develop a tractive force of 51,075 lbs. and in addition to working freight traffic are extensively used in passenger service on the mountain divisions of the Union Pacific. They are equipped with superheater, brick-arch supported on studs, Ragonnet reverse gear type A, Commonwealth rear frame cradle, and Delta trailing truck. The driving and trailing truck axles are heat-treated and hollow-bored. The valve gear is of the Walschaerts type, and the valves are set with a lead of ⅛ ins. The engine shown in the photograph is hand-fired, but similar locomotives, now in order, will be equipped with the type C of Street, and others will have the Duplex stokers.

Some of the principle dimensions of these engines are as follows:

Cylinders, 26 ins. x 28 ins.; valves, piston, 15 ins. diam.

Boiler.—Type, straight; diameter, 82 ins.; thickness of sheets, ¾ ins.; working pressure, 200 lbs.; fuel, coal; staying, radial.

Fire Box.—Material, steel; depth, 120⅝ ins.; width, 84 ins.; depth, front, 87½ ins.; depth, back, 73½ ins.; thickness of sheets, sides, ⅜ ins.; thickness of sheets, back, ⅜ ins.; thickness of sheets, crown, ⅜ ins.; thickness of sheets, tube, ½ ins.

Water Space.—Front, sides and back, 5 ins.

Tubes.—Diameter, 5⅜ ins. and 2 ins. material, 5⅜ ins., steel; 2 ins., iron; thickness, 5⅜ ins., 0.150 ins., 2 ins., 0.125 ins.; number, 5⅜ ins., 36; 2 ins., 275; length, 20 ft. 6 ins.

Heating Surface.—Fire box, 242 sq. ft.; tubes, 3974 sq. ft.; total, 4216 sq. ft.; superheater, 912 sq. ft.; grate area, 70 sq. ft.

Driving Wheels.—Diameter, outside, 63 ins.; diameter, center, 56 ins.; journals, main, 11 ins. x 12 ins.; journals, others, 9 ins. x 12 ins.

Engine Truck Wheels.—Diameter, front, 30 ins.; journals, 6½ ins. x 14 ins.; diameter, back, 45 ins.; journals, 8 ins. x 14 ins.

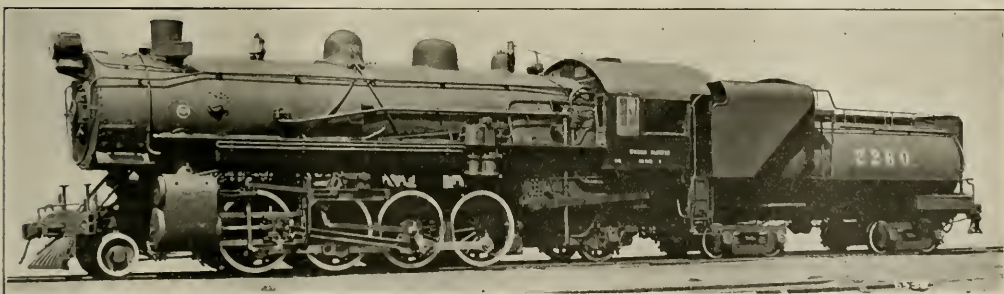
Wheel Base.—Driving, 16 ft. 6 ins.; rigid, 16 ft. 6 ins.; total engine, 35 ft. 2 ins.; total engine and tender, 69 ft. 9⅛ ins.

Weight.—On driving wheels, 219,400 lbs.; on truck, front, 24,500 lbs.; on truck, back, 38,900 lbs.; total engine, 282,800 lbs.; total engine and tender about 450,000 lbs.

Tender.—Tank capacity, 9,000 U. S. gal.; fuel capacity, 14 tons.

Some of the specialties with which these engines are equipped are the lateral motion front driving box made by the Economy Devices Corporation and also their lateral motion truck. The Commonwealth cradle and trailing truck, the equalized tender truck and the one-piece cast steel frame for the tender, are used. The new M. C. B. type D coupler, made by the National Malleable Castings Co., has been adopted for these engines. The Buckeye cast steel coupler yoke is employed, and so are the Franklin adjustable driving box wedges. The Economy radial buffer and also the Pyles Headlight and two cross-compound air pumps, all find a place on this 2-10-2 engine. The N. Y. Air Brake is part of the equipment, and a steel pilot completes the outfit.

The engines have so far given every satisfaction, and a dynamometer test is being made with a Westinghouse car in order to determine the tonnage rating for the future. Ten of these engines have already been delivered and twenty more are to follow. The engines have been carefully designed and their general appearance is good. They look compact, strong, and well proportioned, and altogether give a pleasing appearance, which is not generally thought of in the designing of heavy steam power.



UNION PACIFIC 2-8-2 RECENTLY PUT INTO SERVICE

C. E. Fuller, Superintendent of Rolling Stock and Machinery. Baldwin Locomotive Works, Builders.

Combustion and Smoke Abatement*

What Smoke Really Is—How It Is Formed—How It Can Be Reduced—Function of the Arch—Good Effects of the Gaines Wall and the Combustion Chamber

The formation of smoke is due primarily to the decomposition of the volatile hydrocarbons contained in all bituminous, semi-bituminous and lignitic coals; though the presence of coal-dust that is fed into the firebox of a locomotive and, being caught up by the draft, is whirled out through the flues unburned, adds to the smoke emission. As the name indicates, the volatile hydrocarbons are compounds of carbon and hydrogen, and are of a very complex character. The heavier compounds are driven off in the form of tar, in a semi-liquid or solid state; while the lighter hydrocarbons are driven off in a gaseous state. The distillation begins at a temperature of about 400 degs. Fahr., and is completed at a temperature of 1600 degs. Fahr. The decomposition of the volatile matter by the action of heat takes place very readily at temperatures above 1400 degs. Fahr.

The exact composition of the hydrocarbons when first distilled from the coal at the different temperatures is not known, as they break down very readily under the influence of heat and are so unstable that it is impossible to collect samples for analysis.

The indications are, however, that the heavy hydrocarbons when first driven off contain (by weight) about 85 per cent. carbon, 10 per cent. hydrogen, and 5 per cent. oxygen. Under the influence of heat, these hydrocarbons break down into carbon, hydrogen and oxygen. The lighter hydrocarbons of the methane (CH_4) series, and lighter unsaturated hydrocarbons. The hydrogen, a colorless gas, is highly inflammable and burns readily if there is a supply of oxygen above the fuel bed. The lighter hydrocarbons also burn readily, if the oxygen supply is sufficient. If it is insufficient, the hydrocarbon is broken down by the heat, into carbon and hydrogen; the hydrogen either combining with the oxygen that may be present, to form water, H_2O, or escaping unburned, through the flues.

Carbon does not exist in a gaseous state at temperatures with which we are familiar in furnace practice:—To us it is practically always a solid, so that when the various hydrocarbons are decomposed, carbon is precipitated as a solid in the form of soot; and these incandescent particles, floating in the flame, give to it the familiar luminous appearance. We are apt to think of this carbon as being set free and deposited in the form of atoms, but such is not the case. We have no knowledge of the atom existing as a unit, separate and distinct. The small particles of soot with which we have to deal are probably made up of a large number of carbon molecules. The very smallest soot particle that exists is this molecule, which consists of a number of carbon atoms (probably twelve), held together by some kind of bond or attractive force of an electrical nature. As a result, the soot particles (which are the primary source of all smoke) have a very tenacious structure; and are extremely difficult to break down, when once formed.

In order to burn them completely, it is necessary to supply a number of oxygen molecules, sufficient to combine with each carbon atom; to bring them into contact with the carbon atoms at a temperature high enough to produce combustion; and to provide sufficient time for combustion to take place. These conditions are similar to those met with in burning the "fixed carbon" on the grate, but are more difficult to fulfill. A piece of coke, or carbon, burning on the grate is held more or less in place by its weight, or contact with the adjacent parts of the bed, until it is consumed; and combustion is accelerated by the high temperature prevailing in the fuel bed and by the violent scrubbing action of the oxygen (in the air) rushing through the fuel bed.

The particle of soot (resulting from the breaking down of the hydrocarbons) is well on its way to the flues at the instant of its formation. It is not brought into violent mechanical contact with a supply of oxygen, but floats along in an atmosphere that has been robbed of much of its oxygen in passing through the fuel bed. The temperatures prevailing in the upper part of the firebox are generally sufficiently high to insure ignition and combustion; but under ordinary conditions, the time available for combustion varies from 1-5 to 1-10 of a second, and this is actually insufficient. The small quantity of oxygen above the fuel bed; the difficulty of bringing the oxygen in contact with the soot, due to ineffective mixing and the interference of the large volumes of inert and non-combustible gases, and the short time available for combustion; make the burning of soot and the elimination of smoke in locomotive operation a difficult matter. With the conditions that prevail in the locomotive firebox, it is easier to prevent the formation of soot (or smoke) than to burn it when once formed. The precipitation of soot can be prevented only by having an excess of heated air (or oxygen) above the fuel bed, and bringing this heated oxygen in intimate contact with the volatile hydrocarbons at the instant they are distilled from the coal.

Research work done by the United States Bureau of Mines indicates that the hydrocarbons are decomposed when they have traveled but a few inches from the top of the fuel bed; and if the precipitation of carbon is to be prevented, the air (or oxygen) must be introduced at the top of the fuel bed and intimately mixed with the issuing hydrocarbons. The chief function of the brick arch used by many railroads in abating smoke is that of a gas mixer. By baffling the gases and compelling them to pass through a relatively restricted area above the arch, an intimate mixture of the volatile combustible with the oxygen is insured. While the mixing of the gases at the end of the arch does not take place soon enough to entirely eliminate smoke, it has the effect of reducing the smoke emission, as shown by various elaborate tests.

Turning to Fig. 1 a firebox without an arch is shown, with a characteristic fire, i. e., with a bank of green coal under the fire door, the fire gradually thinning down toward the front, where the strong draft may possibly have pulled a hole in it. Under such conditions, the bank of green coal under the door is expelling large volumes rich in hydrocarbons. These hydrocarbon gases passing up along the top zone of the firebox, are decomposed by the heat, causing the formation of soot, which either escapes at the front end as smoke, or is deposited on the heating surfaces and so retards the flow of heat to the water. At the same time, a large excess of air rushing through the thin portion of the fire at the front is passing directly into the lower flues; without in any way aiding the combustion of the hydrocarbons which are distilled in the back of the box, and this condition very often causes leaky flues or failures.

Such conditions as here pictured are not at all uncommon in locomotive fireboxes unequipped with the arch. Front end gas analyses often show a large excess of oxygen, due to the blast of air through the lower flues; in combination with high carbon monoxide, CO, hydrogen and hydrocarbon contents due to incomplete combustion of the volatile hydrocarbons, arising from the bank of coal under the door.

Fig. 2 illustrates the action of the arch under similar conditions. Here, any excess air coming through the thin portion of the fire on the front of the grates, is heated, deflected and forced backward

*Abstract of a paper read before the Smoke Prevention Association by Mr. J. T. Anthony.

and over the end of the arch, where it is mixed with the gaseous combustibles arising from the green coal under the door. With the ordinary type of firebox, the combustion chamber space and the flameway are insufficient to give all the particles of soot and combustible gas, time to burn before reaching the flue sheet; but such a mixing as the arch affords results in a material reduction of the hydrocarbons. This facilitates the mixture of the oxygen and the hydrocarbons from the time they leave the top of the fuel bed, the arch mechanically accelerates this mixture.

Fig. 4 illustrates the action of the arch on streams of cold air entering through the fire door and holes in the fire. Air thus admitted is made to mingle with the products of combustion and the combustible gases, thereby aiding combustion, and being brought to the temperature of other gases, they are prevented from causing uneven temperatures or violent temperature fluctuations at the flue sheet. It is evident from the foregoing that the arch is not in itself sufficient to prevent smoke. Intelligent firing is also necessary. Smokeless firing and intelligent firing are practically synonymous terms, although there are conditions under which smokeless firing is impossible, regardless of the care and intelligence exercised by the fireman.

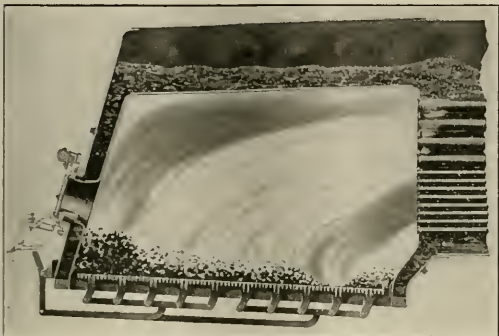


FIG. 1. BANK UNDER DOOR AND HOLE AT FRONT.

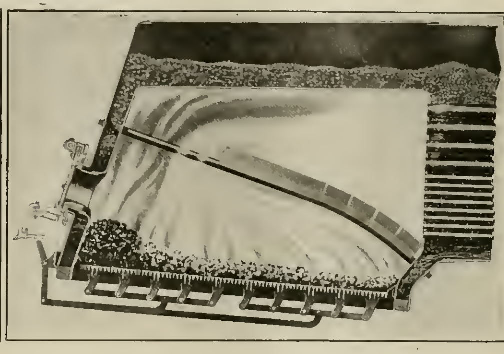


FIG. 2. EVEN FIRE. HEAVY BANK UNDER DOOR.

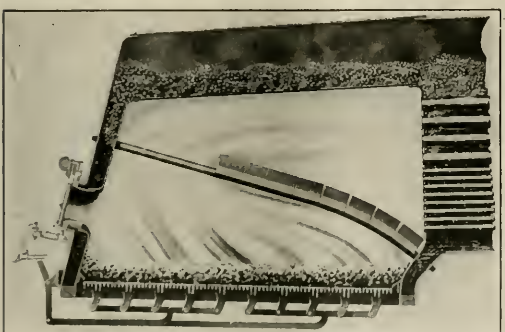


FIG. 3. EVEN FIRE WITH BRICK ARCH.

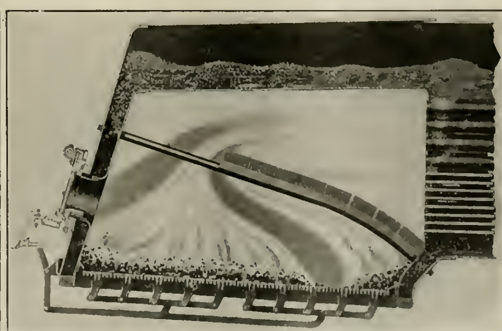


FIG. 4. AIR ENTERING DOOR AND BY HOLE IN FRONT.

the smoke, and under moderate rates of firing will result in the almost complete burning of the combustible gases.

The arch, however, is not sufficient alone to eliminate smoke when the method of firing illustrated here, is followed. A heavy bank of green coal restricts the flow of air at the point where it is most needed and at the time when it is most required, with the result that most of the hydrocarbons are broken down and the carbon precipitated before being brought into contact with the oxygen entering through the front grates.

Fig. 3 illustrates the light level fire which should be carried, if smoke is to be reduced to the minimum. With the fuel bed in this condition and a "scatter" type of firing being followed, a uniform air supply is obtained throughout the fuel bed, as well as a uniform distillation of

In some quarters, however, there has been prevalent an idea that smoke is merely a nuisance; and that the emission of dark clouds of smoke does not signify any appreciable heat loss. As a matter of fact, the emission of smoke not only indicates bad furnace conditions, but in many cases the soot and tar escaping as smoke may contain from 10 to 15 per cent. of the heat value of the coal. Tests conducted by the United States Bureau of Mines (and set forth in their Technical Paper 137) showed that when burning Penn gas coal, as high as 32 per cent. of the combustible arising from the fuel bed is accounted for in the soot and tar which are the source of the smoke.

Table No. 1 (from bulletin mentioned above) shows the composition of gases arising from the fuel bed and the percentage of the soot and tar therein contained. It is evident from these figures that the fuel bed acts chiefly as a gas producer, and a large part of the latent heat contained in the coal is generated by the burning of combustible gases in the combustion space provided above the fuel bed. As a specific example, the second case shown in Table No 1, where 47½ lbs. of coal are burned per square foot of grate per hour, with the fuel bed 6 ins. thick.

Table No. 2 shows (in pounds per cubic foot of gas) the weights of the different gases leaving the fuel bed, heat value per pound and B. T. U.'s per cubic foot of gas. As shown, the gas has a total heat value of 156.6 B. T. U.'s per cubic foot; of which 70.7 B. T. U.'s (or 45 per cent.) are developed in the fuel bed, and 85.9 B. T. U.'s (or 55 per cent. of the total heat contained in the coal) are developed by the burning of the combustible gases above the fuel bed.

The tar and soot mentioned in this table contain 12 per cent. of the heat in the coal. If one-half of this were to escape unburned as smoke, the resulting heat loss would be 6 per cent. The amount of heat developed by the gases burning above the fuel bed will serve to illustrate the importance of firebox volume and combustion chamber space; and will also explain why intelligent firing with the brick arch is not always sufficient to prevent smoke. The ordinary firebox in service to-day has not volume and combustion chamber space sufficient to provide the time element that is essential for the complete combustion of volatile hydrocarbons and the total elimination of smoke. This deficiency has been recognized by many of our leading railroads; and during the past few years some fireboxes have been provided with combustion chambers, particularly in locomotives of the 2-10-2 and Mallet types, but combustion-chamber engines are few, when compared with the total number in service. It is also probable that we have been too conservative as to the length of combustion chambers that have been installed. Tests indicate that an 18- or 19-ft. flue is sufficient to reduce the front end temperatures to a normal figure.

TABLE No. I—GAS SAMPLES TAKEN AT TOP OF FUEL BED

Weight in Grams Per Cubic Foot or Total Gases, at Temperature of 60 Degs. Fahr and Pressure of 30 Ins. Mercury

Lbs. Coal Fired Per Sq. Ft. of Grate Per Hour	Thickness of Fuel Bed	C in CO	CH_4	H_2	C_2H_4	Total Gaseous Combustible	Tar	Soot	Total Soot and Tar	Total Combustible	Tar, Percentage of Total Combustible
22.3	6	2.034	628	,209	.732	3.603	.528	.482	1.010	4.613	21.9
47.5	6	2.136	.142	.068	.036	2.382	.241	.369	.610	2.992	20.4
63.4	6	1.466	215	.072	.107	1.860	.107	.215	.322	2.182	14.7
124.0	6	1.488	.018	.014	.326	1.846	.004	.016	.020	1.866	1.1
52.0	12	2.536	.484	.173	.242	3.135	.945	.477	1.422	4.857	29.3
105.5	12	2.522	.516	.241	.344	3.623	.658	.738	1.396	5.019	27.8
131.0	12	2.389	036	.036	.036	2.497	.055	.092	.147	2.644	5.6
185.0	12	1.634	.108	.072	.036	1.850	.123	.415	.538	2.388	22.6

Flues of this length, when used in conjunction with a firebox of ample grate area and long combustion chamber, result in a boiler design that gives both high efficiency and capacity.

For coal-burning service, a modification of the oil burner design, Fig. 5, is being most successfully used on several railroads, this combination of the bridge wall with air ducts through the wall admitting a secondary air supply above the fire is known as the Gaines Locomotive Furnace. Here an attempt has been made to increase the firebox volume and flameway by reducing the flue length and installing a combustion chamber between the bridge wall and flue sheet. The design of firebox shown has obtained some of the results desired; but for high volatile coal, burned at high rates of combustion, the combustion-chamber space is too limited. Fig. 6 shows a Gaines Furnace in combination with a barrel combustion chamber. Here additional firebox volume and flameway have been obtained by materially increasing the length of the combustion chamber; and as this particular design was used on Mallet engines, this result was obtained without unduly shortening the flues.

Our railroads may well be proud of the work that has been done along these lines; but the burning of high volatile coal at high rates of combustion, with the total elimination of smoke, has not yet been successfully accomplished; and the indications are that some radical changes in locomotive firebox design and methods of firing coal will be necessary for the accomplishment of this object.

The Master Mechanics' Proceedings of 1913 contain the report of the Smoke Committee, appointed by the General Managers' Association of Chicago, which states that "while running, the brick arch is capable of effecting a 50 per cent. reduction in smoke, irrespective of steam jets." The tests upon which this statement was based were run with Penn gas coal of the following composition:

TABLE No. II—GAS SAMPLES TAKEN AT TOP OF FUEL BED

Constituent	Weight, Grams Per. Cu. Ft.	Weight, Pounds Per Cu. Ft.	Heat Value Per Pound	B.T.U. Per Cu. Ft. Gas
Heat Developed in Fuel Bed				
C in CO	2.136	.00471	4,500	21.2
C in CO_2	1.546	.00341	14,500	49.5
				Total, 70.7
Potential Heat in Gases, Soot and Tar				
C in CO	2.136	.00471	10,000	47.1
CH_4	.142	.000313	24,000	7.5
H_2	.068	.000149	62,000	9.3
C_2H_4	.036	.000079	21,600	1.7
Soot	.369	.000813	14,500	11.8
Tar	.241	.000531	16,000	8.5
				Total, 85.9

Fixed Carbon, 57.74 per cent.; Volatile matter, 34.07 per cent.; Moisture, 1.05 per cent.; Ash, 7.14 per cent.; B. T. U. per pound of dry coal, 14520. The smoke reduction of 50 per cent. was accompanied by an increase in evaporation of 8.6 per cent., due to the arch. The Chicago Smoke Commission (of which W. F. M. Goss was Chief Engineer) made extensive tests, with and without the arch. They found and reported that the brick arch decreased the average density of visible smoke emissions, by 33 per cent.

FIG. 5. ARCH, GAINES FURNACE AND SHORT COMBUSTION CHAMBER.

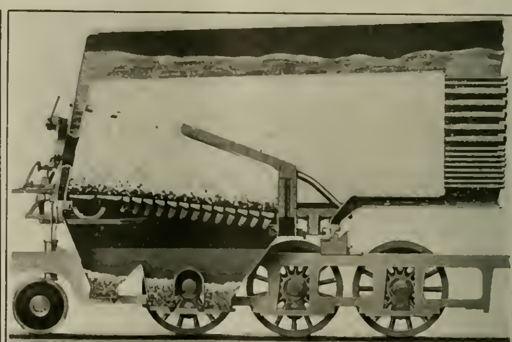


FIG. 6. ARCH, GAINES BRICK WALL AND LARGE COMBUSTION CHAMBER.

and also the total average quantity of cinders and fuel-dust emitted in smoke, by 25 per cent. It further decreased the amount of carbon contained in cinders and fuel-dust per ton of coal consumed, by 24 per cent., and it decreased the amount of ash contained in same, 28 per cent. It decreased the volume of air intermingled with gases of combustion discharged through stack, by 15 per cent., and the arch increased the volume of CO_2 discharged through stack by 6 per cent. It decreased the volume of CO discharged through stack by 10 per cent., and increased evaporation per pound of coal by 7 per cent.

These tests were run with coal from Macoupin County, Ill., of the following composition: Fixed Carbon, 37.47 per cent.; Volatile matter, 38.41 per cent.; Moisture, 9.89 per cent.; Ash, 12.23 per cent.; B. T. U. per pound of dry coal, 12,884.

Both of the above tests were run with a 0-6-0 type switching locomotive, with a narrow firebox 40 ins. wide by 106 ins. long, with 29 sq. ft. of grate area. Air inlet through ashpan was 5.7 sq. ft., or 20 per cent., of the grate area. The arch was 66 ins. long, and was supported on two arch tubes. The Final Conclusions of the above test report, also state that "the presence of the brick arch in the locomotive firebox increases efficiency and decreases fuel consumption, decreases the loss of heat units in smoke and ash smoke, also use of incorrect methods of discharged and reduces the visible smoke. Also the use of incorrect methods of firing, as indicated by the results of the tests in which inexperienced firemen were employed, reduces efficiency, increases fuel consumption and fuel losses and it also increases smoke discharges."

Tests recently conducted on a Mikado type locomotive show smoke reductions varying from 50 per cent. at low and medium rates of firing to 31 per cent. The locomotive used was hand fired, with high volatile Penn gas coal screened over a 1¼ ins. mesh screen; the coal having the following composition: Fixed Carbon, 54.00 per cent.; Volatile matter, 31.00 per cent.; Moisture, .92 per cent.; Ash, 14.08 per cent.; B. T. U. per pound, of dry coal, 13,088.

This locomotive had 70 sq. ft. of grate area; a barrel combustion chamber 42 ins. long; a 76 ins. arch supported on four 3 ins. arch tubes; an air opening through ashpan of 7.80 sq. ft. (or 11 per cent. of the grate area) and air openings in grate of 20.21 sq. ft. (or 28.8 per cent. of the grate area). In these tests the increase in evaporation, due to the arch, varied from 8½ to 15½ per cent. These three tests are probably the most thorough and reliable that have ever been conducted for the specific purpose of determining the effect of a brick arch on locomotive smoke abatement; and the test results were a reduction in smoke of from 30 to 50 per cent., corroborated by the practical experience of railroad men throughout the country. The principal measures taken by railroads today to meet smoke ordinances, consist of issuing firing instructions and equipping locomotives with brick arches. While it is generally recognized that the brick arch will reduce the smoke emission from a locomotive, the reason therefore has been explained as well as may be in the paper of which this is a very full abstract.

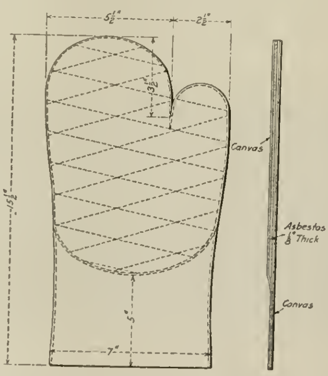
Mittens for Hot Firebrick

The function and uses of the firebrick arch have been very fully described before now. The origin of the fireclay for making the bricks has been connected with the formation of coal, and the aid that the brick arch itself rendered in securing thorough combustion in the firebox is now well known. Asbestos mittens, which have been made at the Renovo shops of the Pennsylvania Railroad, are used for handling hot firebrick.

The removal of firebricks from the firebox of a locomotive for any cause is a matter requiring considerable time, as the engine has usually to cool down sufficiently to permit a man going into the firebox, and even then the brick is so hot that in his hurry and probable discomfort, some rough handling or the dropping the heated brick may happen, with consequent loss to the company. It is not too much to say that another serious loss of bricks, charged against locomotive operation, is often due to the handling in transit and before the bricks are put in the firebox. This may not be the result of careless or wilful misuse of the brick, but to the difficulty of doing the work with sufficient care, or of getting new brick owing to Government shipments taking priority.

In order to reduce the loss owing to broken brick, the P. R. R. devised the asbestos mitten, an illustration of which we are able to give through the courtesy of the railway. The mittens are made for about 35 cents a pair and are good for handling bricks in about fifteen engines before they wear out. At this rate the quick handling of brick, per engine, requires approximately the expenditure of about 2⅓ cents.

When the fire has been knocked out of a locomotive and steam blown down to probably about half gauge pressure, the



ASBESTOS MITTEN FOR HANDLING HOT ARCH BRICK P. R. R.

blower is turned on and a man enters the box and is able to stand the intense heat for a short time owing to the friendly stream of cold air which enters from below the grates and through the door, by the action of the blower. The asbestos mittens permit the work to be done quickly and the man comes out of the hot firebox in a short time, and the bricks have been handled, not dislodged and flung out.

The back and palm of the mitten is made of canvas, and the palm is reinforced by a sheet of asbestos, covered again by a layer of canvas. It is needless to say that the men who use these mittens regard them with favor on account of the comfort and facility they give while the work is being done, and the company find them satisfactory as a means of shortening the time an engine is out of service, and the substantial reduction in the number of good bricks which would otherwise be broken. The elimination of breakages makes for economy. This is a very important point.

Washing Coal for Fuel Economy.

It has been repeatedly demonstrated that no one form of plant will treat all grades of coal equally well. Each plant must be arranged for the pit or pits from which the supply is derived. In most cases the ash can be brought down under 4 per cent, on the clean coal, although there are variations, some coal being cleaner than others when dealt with in bulk. The pyrites separation necessitates the crushing of the hand-picked material to separate the stone and shale, but otherwise the separation would be done on the jigs, the pyrites being a heavy substance, is easily separated from the coal, but the work has to be closely supervised to maintain an even sulphur content in the cleaned coal.

Locomotive Boiler Attachments

Their Adjustment, Repair and Inspection

It will be readily noticeable that among the locomotive boiler attachments the check valves have the most common tendency to become leaky, and it is good practice that when the boiler is being washed out, or other convenient opportunity, the check valves should be examined and the caps removed, and the passages in the checks thoroughly cleared of scale or other impurities that are apt to become located in the check valves, and if allowed to remain, not only will the joints begin to leak, but they will materially affest the working of the injectors. Should the check valves require regrinding, a finely powdered grindstone and soap mixed till it has the consistency of paste will be found more adaptable to the operation than emery and oil. The hardness of emery renders it very apt to cut into the softer metals. Even with pulverized sandstone of the finest kind it is necessary, after a few half turns, to lift the parts away from each other slightly in order that the wet material may continue to flow freely between the valve and valve seat. In the event of the bearing parts being cut, it is well to reduce the surface to as nearly a fit as possible by smooth filing before beginning the grinding operation. When the two surfaces are apparently ground to a fit, they should be thoro ghly dried with cotton waste, and then rubbed together tightly until the surfaces are polished. Should any unpolished part remain, the grinding should be repeated, and the re-polishing continued until a complete fit is made. In many of the leading railroad shops the check valves are tested before being reattached to the boiler.

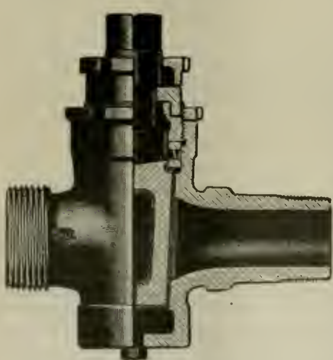


FIG. 1. SECTIONAL VIEW OF BORDO BLOW-OFF PLUG VALVE.

The same remarks apply in a general way to blow-off cocks and other boiler mountings. In the case of the blow-off cock it is advisable to remove the cock from the boiler, and in the absence of any specially designed grinding appliance, the plug may be held in the vise by the upper end, and the shell may be ground on the plug, taking care as usual to lift the shell a little from bearing on the plug, continuing the operation for a dozen or more half turns. Both shell and plug should then be carefully cleaned and rubbed together. The bearing will show itself by lines of contact, and on these lines the paste should be applied, and the rubbing continued until the entire length of the plug and shell show an equal bearing. An application of beeswax and tallow will greatly aid in the free working of the plug in the cock. The tendency of the older types of blow-off cocks to leak or become encrusted and difficult to move was very common, but these difficulties have been completely overcome by enclosing caps and suitable packing, as shown in Figures 1 and 2. There are also special devices in use that reduce the amount of manual labor in grinding cocks, the most being appliances mounted on a bench where the plugs are held firmly while the shells are attached to mechanism making a partial revolution, and are lifted at short intervals by an eccentric contrivance from beneath, a spring meanwhile bearing lightly on the top of the shell.

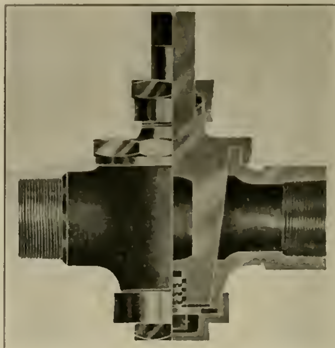


FIG. 2. BLOW-OFF VALVE. ASHTON VALVE COMPANY.

With regard to the gauge cocks, many clever devices have been tried to facilitate the self-grinding idea, which would be an excellent improvement if they all worked as well in practice as in theory. Their tendency to leak is very great, as they are constantly being used by the careful engineer and fireman, and scale or other impurities readily lodge between the joints of the stem and seat. In many roundhouses a supply of gauge cocks is kept on hand, and in the periods of boiler washing, or on other occasions, when the boiler is partially cooled, the gauge cocks that may be leaking can be quickly exchanged, and the refitting of the valves performed under favorable conditions.

Of the various types of blower valves for steam and air it may be said that they have reached a degree of perfection both in regard to stability in construction and ready to adaptability in action that the cost of maintenance is eliminated. The same may be said of the glass water gauges, for since the promulgation of the Federal law requiring their attachment to locomotive boilers, the manufacturers of boiler fittings have vied with each other in producing water gauges that in point of safety and durability are in marked contrast with the progress in vogue in the earlier days. Figures 3, 4 and 5 show designs of glass water gauges that are among the most popular in locomotive service at the present time.

In regard to the attachments of the boiler, generally a brief quotation from the Federal law may serve as a reminder in regard to the testing of the more important details:

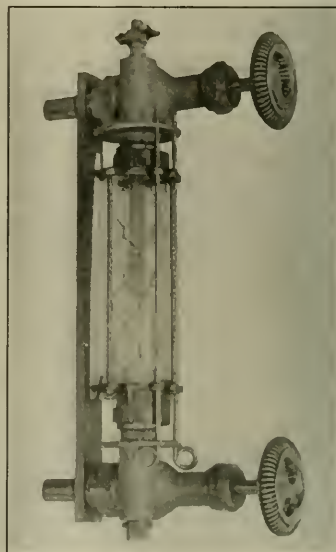


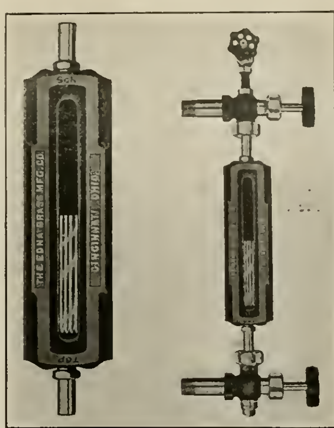
FIG. 3. IRON CLAD WATER GLASS PROTECTOR AND E. S. E. WATER GAUGE COCKS. SARGENT COMPANY.

"Every boiler before being put into service, and at least once every twelve months thereafter, must be subjected to a hydrostatic pressure equal to 25 per cent above the working steam pressure. At the time, or preferably immediately after the hydrostatic test has been made, the dome cap and throttle standpipe must be removed, so that the interior of the boiler can be inspected as well as conditions will permit. After any defective parts found have been repaired, the boiler must be fired up and the steam pressure raised to not less than the allowed working pressure, and the boiler and appurtenances carefully examined. All cocks, valves, seams, bolts and rivets must be tight under this pressure, and all defects disclosed must be repaired.

All rigid staybolts must be tested at least once each month, and immediately after each hydrostatic test, by tapping each bolt with a hammer and noting from the sound of vibration of the sheet whether or not the bolt is broken. This test can also be made with the boiler full of water, providing it has a pressure of not less than fifty pounds.

Flexible staybolts, with caps, must be tested at least once every 18 months, by having the cap removed. Flexible staybolts without caps must be tested each month, same as rigid staybolts.

Steam gauges must be tested at least once every three months, or when any irregularity is reported The test is to be made by removing the steam gauge from the boiler and mounting it, together with an accurate test gauge, on fittings provided for that purpose, whereby a pressure applied to the steam gauge can be compared with that applied to the test gauge.



FIGS. 4-5. REFLEX WATER GAUGE. EDNA BRASS MFG. COMPANY.

Safety valves must be tested once every three months, by having the boiler fired up and the fire forced to see that the safety valves lift at the desired pressure and relieve the boiler from any accumulation more than 5 per cent above the allowed steam working pressure.

Water glasses, valves and gauge cocks must be tested each trip by being opened and closed to see that the water level is properly registered. They must also be kept clean and free from scale by being cleaned once each month. Injectors must be tested before each trip by being actually operated.

These tests are to be made as described above, the calculation of the factor of safety, of course, depending upon the railroad company. The other tests can be made by the inspector personally, or can be made by any one designated for the purpose by the railroad company, the inspector to be an actual witness of the tests."

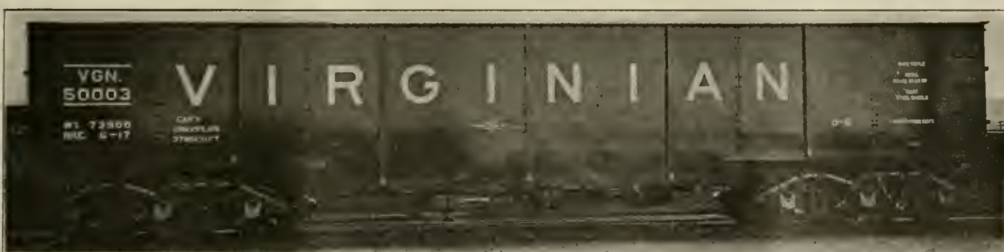
A Giant Gondola for the Virginian

Heavy Gondola Carrying Coal and Rough Freight—Built for Weighty Service—Can Be Dumped by Being Turned Upside Down—Heavy Six-Wheel Truck—Steel Wheels

Four experimental gondola cars for the Virginian Railway of 120 tons each have been built as a starter for the carrying of coal from the mines to tidewater, at which point they are dumped by special apparatus. The floors of these cars are not designed to let any of the load pass through. The cars are so constructed that the side construction will carry the bulk of the load, while the centre of the car, composed of an H-section, is principally reserved for pulling and buffing. The H-section is 12-ins. deep, and weighs 84.5 lbs. a foot. It approaches to within about 24 ins. of the plane of the bolsters at each end. It is here fastened to a heavy centre plate and draw casting, which takes the National radial draw gear.

The weight of the load between the bolsters is carried to the sides through four built-up sections surrounding the centre sills at each end. By thus suspending the floor plates from the under side of the built-up girders, and exposing the centre sill in the loading space, several hundred cubic feet has been gained in the loading space, which adds materially to the carrying capacity of the car. The floor plates between the transverse girders, are made stiff by the use of heavy angles. The plates are made out of ¼-in stuff, principally to resist the effects of corrosion, and, of course, for strength as well. To prevent the lodgment of coal back of the upper flange of the center sill girder, during the dumping operation, the space is occupied by an oak filler block, securely held in place.

The central depression of the car floor is 30 ft. long. The sides and ends of the car are composed of ¼-in. plates. The sides are further strengthened against any tendency to bulge, by the use of five 3-in. cross-tie sections, weighing 9 lbs. a foot, and two similar sections are put in a transverse position to stiffen the end walls of the car. Additional rigidity is secured by the interior gusset plates which are used. A heavy bulb-angle is run round the top and a proportional angle is placed at the bottom. A further purpose of the exterior cross-tie side post is to make a bearing in the cradle of the dumping apparatus, by which the contents of the



HEAVY GONDOLA CAR FOR EXPERIMENTAL PURPOSES, ON THE VIRGINIAN.

car are most thoroughly unloaded.

The trucks which carry the car are

INTERIOR OF VIRGINIAN GONDOLA.

two in number, each having six wheels. The trucks are of the Lewis pattern, the frame being hinged over the centre wheel. In this car the American Steel Foundries Company furnished the truck and Davis steel wheels are used. The truck bolster is made in the form of a spider, spanning the central axle and transmitting the load to each of four points. Each corner of the bolster is carried on helical springs and on the apex of each is a Stuki roller side bearing. The journal boxes are of the well known McCord type, made of pressed steel. The Davis steel wheels are 33 ins. in diameter, and are mounted on M. C. B. standard axles designed to carry 50,000 lbs. each, with 6 x 11 ins. journals. The wheel base of the truck is 9 ft. and each truck weighs 16,350 lbs.

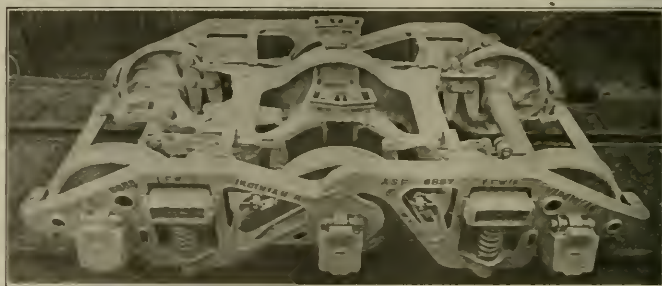
There is one feature of the trucks not generally used. It is an extension casting projecting over the axle nearest the end of the car. The purpose of this is to influence the radical draw gear, in accordance with the curving of the truck on the track. This extension is fitted with a spring connection to the truck frames so that nothing in the way of breakage strains are introduced.

The radial draw gear is pivoted close to the center plate and gear housing, the draw gear being placed immediately above the center plate. The latter are machined so as to secure a uniform bearing. The couplers have shanks 6 by 8 ins. and are provided with lugs on the heads and guard arms to prevent excessive side motion. The lateral play allowed on the carry iron is 7¼ ins. on either side of the center line.

The principal dimensions and weights are given in the following table:

Length of body, inside, 50 ft. Width, inside, 9 ft. 8½ ins. Width, over all, 10 ft. 3½ ins. Depth, at ends, 7 ft. 4⅛ ins. Depth, at middle, 8 ft. 7⅛ ins. Height from top of rail, 11 ft. 1½ ins. Length over faces of couplers, 53 ft. 7 ins. Distance between truck centers, 37 ft. 4¾ ins. Wheel-base of each truck, 9 ft. Weight of each truck, 16,350 lbs. Weight of car, including trucks, 73,900 lbs. Capacity, full level, 3,785 cu. ft. Capacity, full level, 218,000 lbs. Permissible overload, 10 per cent. Load per axle, with 10 per cent. overloaded added, 52,283 lbs. Weight of each wheel is about 665 lbs.

The tare weight of the car is 73,900 lbs. This includes the weight of both trucks. When to this is added the full car capacity of 218,000 lbs., we have 291,900 lbs. Taking 10 per cent. of 218,000 we get in all 313,700 lbs. This is carried on six axles, or 52,283 lbs. for each. This gives a wheel load of 26,141 lbs. per wheel.



LEWIS PATTERN TRUCK USED UNDER VIRGINIAN GONDOLA.

United States Rolling Stock for France

The first locomotive for American war service railroads in France was completed in 20 working days, and engines of this type are now being turned out at the rate of about 30 per day. Nearly 680 of these locomotives and over 9,000 standard-gauge freight cars are on order. Other narrow-gauge rolling stock for transportation along the battle front are also on order, and additional orders for both narrow and standard-gauge equipment are likely to be placed in the future.

The first order for war locomotives was placed with the Baldwin Locomotive Works, Inc., of Philadelphia on July 18, and the first engine completed on August 9. This was nothwithstanding the fact that the boiler was constructed specially for this type of engine and was fitted with a superheater. In other respects the locomotive is similar to locomotives built by the Baldwin Works, Inc., for the British Government. It is not as powerful a type as that used on many roads in the United States, but on a road where the heaviest engines haul a train of about 90 loaded freight cars, this war locomotive is expected to take 60 loaded cars. Like all the rest of this equipment, it is painted a battleship gray and bears the letters "U. S. A.," designating the United States Army. The locomotive weighs 166,400 lbs., with a tender of about 275,000 lbs.

A modern army requires an adequate system of railways for moving troops and supplies to the front, and for distributing ammunition to the batteries on the firing line. The present war has demonstrated that success or failure depends very largely upon the extent to which transportation facilities are provided.

With the entrance of the United States into the war, the government became a purchaser of railway locomotives, cars and supplies. Last July an order was placed with the Baldwin Locomotive Works for 150 standard-gauge freight locomotives, all of which were to be completed by October 1, that is in 75 days. A similar order was placed with the American Locomotive Company.

WAR LOCOMOTIVE BUILT IN THE U. S. FOR FRANCE.

In general design these locomotives are similar to a large number which have been built for service in France. This fact simplified the preliminary work, and rapid progress was made in the construction of the locomotives.

The first locomotive was erected at Eddystone, and the photograph which is here reproduced was taken in the yard immediately outside of the shop. It gives a good idea of what our iron war horse looks like at the present time.

The locomotives comprised in this order are of the consolidation (or 2-4-0) type, having four pairs of driving-wheels and a two-wheel leading truck. This type was introduced in the United States, for heavy freight service, in 1866, and is used in large numbers on all railroads. The design follows American practice, except as to the couplings and buffers, which are made to suit French standards. American materials are used, conforming to specifications issued by the American Society for Testing Materials. The maximum width of the locomotive over all is limited to 9 ft., to correspond as nearly as possible with British and French loading gauges. Westinghouse air brakes are applied with fittings modified to suit French standards.

These locomotives are suitable for making long runs and handling heavy supply and troop trains. They are designed to traverse curves of 350 ft. radius and to operate on rough track. As the rails at the battle front are often covered with greasy mud, a pipe system is applied at each end of the locomotive, for washing the rails with a copious flow of hot water and steam. The equipment also includes a water-lifting valve, by means of which the tender tank can be filled from streams or ponds alongside the track. One might, to use military language, call this an emergency kit for the engine.

The locomotives use superheated steam, and the superheater is furnished by the Locomotive Superheater Company of New York. This device effects a saving in fuel and water consumption, and increases the capacity of the locomotive. The steam chest valves are of the piston type, and are driven by Walschaerts valve gear. Bituminous coal is the fuel. The cab is built of steel plate, and follows English practice in design. Steam heat equipment is applied, for use when hauling passenger trains. The tender is of the eight-wheel type, and follows closely American design.

Subsequent to placing the initial order for 150 consolidation (or 2-4-0) type of locomotives, the Government has ordered additional locomotives of similar construction. In addition an order for light tank locomotives of the 2-6-2 type, with a track gauge of 60 cms. (1 ft. 11⅝ in.) has been placed. An order has also been given by the Government for gasoline locomotives. These locomotives are self-contained and consume no fuel while standing idle.

The Baldwin Locomotive Works has completed in its many years of existence, up to the present time, a total of over 46,200 locomotives. At the present the company is employing approximately 20,000 men in its two plants at Philadelphia and Eddystone. Preference is now being given to Government orders.

Some of the principal dimensions of the first locomotive here follow:

Cylinders—21 ins. by 28 ins.

Valves—Type, piston; diameter, 10 ins.

Boiler—Diameter, 70 ins.; working pressure, 190 lbs.

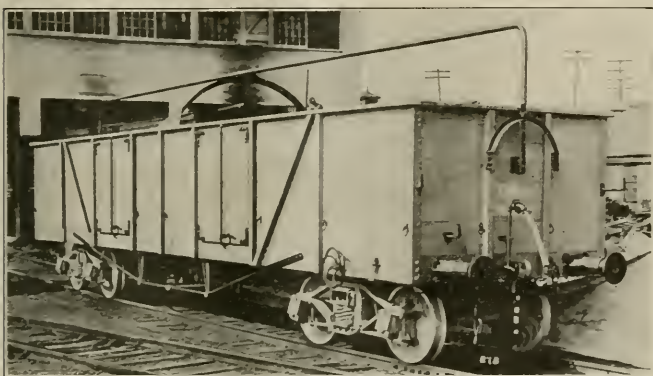
Firebox—Length, 122 15/16 ins.; width, 38¼ ins.

Tubes—Diameter, 5⅜ ins. and 2 ins.; number, 5⅜ ins., 26 ins., 2 ins., 165 ins.; length, 13 ft. 9 ins.

Heating Surface—Firebox, 181 sq. ft.; tubes, 1,681 sq. ft.; total, 1,862 sq. ft.; superheater, 420 sq. ft.; grate area, 32.7 sq. ft.

Driving Wheels—Diameter, 56 ins.; journals, 9½ ins. by 10 ins.

Wheel Base—Driving, 15 ft. 6 ins.; total engine, 23 ft. 8 ins.; total engine and tender, 57 ft. 4½ ins. Weight—On driving wheels, 150,000 lbs.; total engine, 166,400 lbs.; total engine and tender, 275,000 lbs. Tank Capacity—Water, 5,400 U. S. gals.; coal, 9 tons. Tractive Force—35,600 lbs Engine truck wheels 33 ins.



FIRST CAR BUILT HERE FOR SERVICE OF THE UNITED STATES ARMY SERVING IN FRANCE.

The freight cars for the American lines in France have about three times the capacity of the former standard gauge freight cars used until recently by the French railway. They have the same coupling, equipment, etc., as the French rolling stock, so as to be interchangeable with it. The iron railing which runs the length of the car over the top is used to carry a tarpaulin to protect the contents of the car from the weather. The inside length of the car is 36 ft., and its capacity 33 tons.

The cubical volume of this car is 1,386 cu. ft., and its tare weight is 32,800 lbs. It is stencilled, in addition to the designation above referred to, 9-17, which gives its date of construction as September 1917. It is made of wood with angle-iron corners and side frames. It has the M. C. B. journal boxes, four-wheel arch-bar trucks and air-brakes. It is what is known here as a high side gondola, fitted with side spring buffers in accordance with European practice. The semi-circular steel member in the centre of the car, upon which the tarpaulin-bar rests, not only acts as a curved brace from side to side, but it prevents the bar sagging when under the weight of the heavy tarpaulin cover. This bar can be swung down to one side, out of the way, when the car is loaded with rough freight. One can say with the French mothers, wives and children of the poilus, as one of "our" trains moves to the front in France: "Vive l'armée."

Canadian Headlight Order.

The Canadian Board of Railway Commissioners, some months ago, passed a general order regarding locomotive headlights. It is in substance as follows: "Every railway is required to equip its locomotives, used between sunset and sunrise, with headlights which will enable men in the cab of a locomotive with normal vision, under normal weather conditions, to see a dark object, the size of a man, for a distance of 1,000 ft. or more, ahead of the locomotive; such headlight to be maintained in good condition."

Engines habitually used to run backward, are to be similarly equipped.

On yard engines a reduction is permitted, if the railways so desire it, which will bring down the effect of the light so that it will be sufficient to show a dark object the size of a man 300 ft. distant from the locomotive, under normal weather conditions.

This order goes into effect about now and must be fully complied with, and all engines completely equipped by January 1, 1921. Every such railway company failing to comply with the requirements of the provisions of these regulations will be liable to a penalty of $100 for each such failure. It means what it says.

The Automatic Straight Air Brake

Relies on Sensitive Diaphragm Action—Self-Revealing if Front Angle Cock Is Shut—Rapidity of Action—Eliminates the "Run in" of Slack—Interchangeable With Existing Brake Devices—A Fuel Saver.

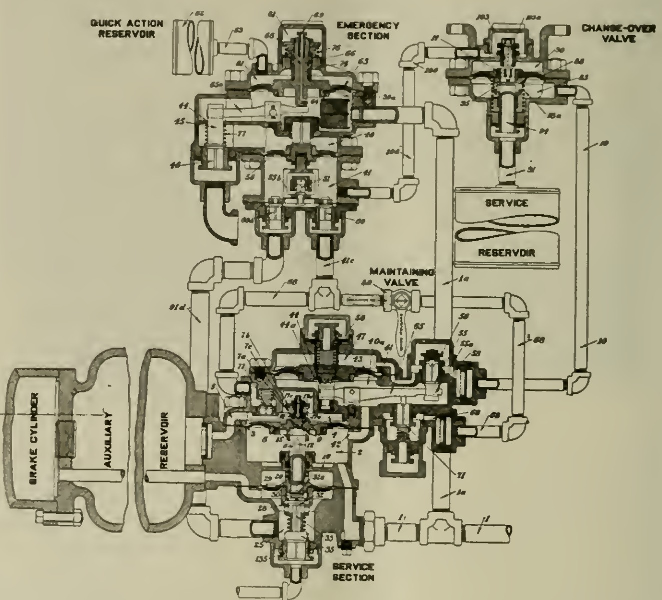
A new system of air brake mechanism has recently been brought out, which, if expectations are fulfilled, is destined to put a very effective mechanism in the hands of the operating locomotive engineman, and one which probably ranks as a coal saver and an appliance which will help to increase the capacity of the present-day locomotive—a thing which is of the utmost importance, especially in war times. The system, which is thoroughly workable with the Westinghouse and New York Air Brake apparatus, has been placed on the market by the Automatic Straight Air Brake Company, of New York, N. Y.

One of the salient features of the new apparatus is that it is first and foremost a triple valve especially modified to meet and overcome several adverse conditions which have hitherto prevailed. Its action depends on a diaphragm made of extremely thin copper sheets, and there is no slide valve movement. The diaphragm action in this as in the other like cases, is exceedingly sensitive. In fact, it has been truly said that for mechanical movements a properly made diaphragm exceeds in sensitiveness that of human touch, and that it gives a definite, though extremely small, opening when desired, to the valve it operates, and this is accomplished quickly, positively and with a precision which leaves human manipulation far behind indeed.

If for any reason, either through malicious action or pure forgetfulness, the angle cock at the back of the tender is purposely shut, or carelessly left in the shut position, the brake itself automatically apprises the engineman that something is wrong. On one large railroad an employee devised and patented a mechanism to reveal the fact, before starting, that the angle cock had been closed. It was humorously christened by the men on the road, and went by the name of the "Tramp Detector." In a long air pipe, fitted with numerous, though easy bends, and filled with an easily compressible fluid like air, and that fed in only at one end, occupies a certain time in equalizing the pressure front and back, and all this time the pressure is unequally depleted by such leaks as there may be, and with a shut angle cock, no additional air can enter, the result of the leaks and the inevitable surge of air throughout the pipes and the other parts of the mechanism produces a brake action such that the train cannot be moved until the brakes are released, and this necessitates the discovery of the closed angle cock and it must be opened or the train will resist motion until all is set right.

In the matter of rapidity of action we may quote some figures given in a record of tests made at the company's test rack by Mr. Geo. L. Fowler, a consulting engineer in New York, whose accuracy of measurement and observational faculties are of the highest order. In test No. 4 a 20-lb. reduction was made in a 100-car train, with a total length of train pipe of 4,600 ft. The brake on the last car applied 13.6 seconds after the first and released in 28.6 seconds after the first car. This means that the reduction of air pressure of 20 lbs. produced its effect on the first car and the effect was apparent 4,600 ft. away in 13.6 seconds thereafter. The fall of pressure with its effect, therefore, moved back 4,600 ft. in 13.6 seconds or at the rate of about 19 seconds to the mile. That is 3⅓ miles per minute and an idea of the rapidity of this action may be had when we remember that sound in air has a velocity of 1,100 ft. per second, or 12½ miles per minute. In this case the high velocity of sound in air was less than 4 times as fast as this brake impulse. An emergency (Test No. 7) showed that the brakes applied in 6.3 seconds after the first car. Taking the 4,600 ft. length of train as before, we have the impulse going back at the rate of about 7½ miles a minute, while the impulse of sound in air goes away from a speaker 12½ miles a minute, so that in this special emergency test the brake acted so quickly as to be more than half as fast as the effect of prompt action to a powerful shout.

Another advantage of this brake is that a constant brake cylinder pressure can be maintained while a train of usual length is passing down a long grade. This can be done without a stop or any release for recharging. All leaks are supplied and the pressure is maintained at any desired figure so that when the brakes are on, they stay on and so possess the important advantage of immunity from brake slackening, release or other form of failure. This is effectually guarded, that danger and disaster need not menace the occupants of the cab; while this brake is held on graduated release; other brakes use recharging. The mechanism used to accomplish this is simple, or to speak



DIAGRAMATIC REPRESENTATION OF AUTOMATIC STRAIGHT AIR BRAKE.

more correctly, it is a detour, or round about path, for the air, but the sensitive diaphragms obviate the chance of failure and do what has hitherto been done by the intervention of an outside piece of apparatus.

If it be so desired the A. S. A. triple valve on a train can be set before starting so that a predetermined number of them (say 50 out of 100) may be set so that in train operation the rear 50 cars will release, but the front 50 cars will hold and the brake remain in service, while the rest are completely released. This logically brings us to consider a very important feature of the A. S. A. brake, namely, the ability of the mechanism to maintain any desired brake cylinder pressure regardless of piston travel, and normal leakage.

In other cases about equal volumes of compressed air are so fed into the brake cylinders that if one has a piston travel which gives it a unit volume, and another takes twice the volume of air or, say, two volume units, it is manifest that the pressure in the two-unit cylinders will be less than that in the one-unit cylinder. In the A. S. A. system the feeding in is on the pressure system and not on the volume plan, so that whether it takes in volume much or little, the amount of air fed in is such that the brake cylinder pressure is brought up to the same figure. It is as if the brake to be efficient had said to itself "D—n the volumes required, I only stop feeding when the pressures all through the train are equal." This mode of mechanical reasoning puts a similar push on each piston and as all are of the same area the same effect is produced on each, whether one has walked out a few inches nearer the dead end of its cylinder than the other. If ten men each honestly pull 50 lbs. on a rope, the total strain on the rope will be 500 lbs. and it is a foregone conclusion that they cannot all stand together on the same spot, but distribute themselves along the rope, as closely as they can. It is absolutely impossible to find in a 100-car train that the piston travel is much of an improvement on the position of the men at the rope. The brake action, with the diaphragms is so rapid that it out-distances the "run in" of the slack and forestalls its action. The A. S. A. brake beats the slack action to it, when it comes to speed, and it prevents those mishaps and breaks-in-two which frequently give a great deal of trouble on the road.

In the matter of emergency, the A. S. A. brake makes this long word mean exactly what it says. The emergency is truly for use in an emergency. It is all the time as if the brake mechanism held this as a reserve or "up its sleeve." In a case where it is possible for an engineman to fritter away his air, he may find at a pinch that he requires it at once. The frittering away of the air may be due to nervousness, to imperfect knowledge of the conditions ahead, or it may be due to oversight, to carelessness or want of time, but there it is and a trainload of people, unknowingly face death, but the emergency brake is also there, it has not been frittered away and is not "rattled." So when disaster, at close range, stares an engineman in the face, the emergency brake acts promptly and pushes with the full, hitherto unbroken, unused force which it accumulated when all was going well.

The A. S. A. brake makes claims as a coal saver, because a release can be made on any train at any speed, without a full stop being necessary. The conservation of momentum has thus a large effect on fuel saving. The varieties of undesired emergency action, spoken of in the 1913 Air Brake Proceedings, are eliminated and the constantly encountered dragging brakes, which add a useless pull to the hard worked locomotive, are here done away, and a substantial coal economy substituted in their stead. In these, as in other matters, the Automatic Straight Air Brake appears to be an economy device, which, if all its claims are well founded, should put the apparatus in the same high class, of which we have frequently spoken, which gives to old locomotives a new lease of life, increases their capacity, and helps to solve for us the National transportation problem which daily presses for an adequate solution.

Superheaters for Steam Shovels.

The steam shovel is of that type of power plant which, due to restrictions of space and weight, steam has to be generated under conditions that are highly unfavorable to the attainment of good furnace and boiler efficiency. The primary reason for the limitations is to be found in the size to which grate area and boiler evaporating surfaces are restricted, making it necessary to operate these power plants with a highly forced draft and with a considerable overload on the evaporating surfaces of the boiler. All of this makes for comparative inefficiency of operation, and this inefficiency makes itself felt in a higher fuel and water consumption, particularly since refinements such as feed water heating, condensing, etc., which tend to increase general plant efficiency, cannot be conveniently resorted to in the majority of these small power plants.

The engineering problems resulting from these conditions have for years had the attention of the designers of that type of movable power plant which is to be found in the largest quantities, and that is the locomotive. Its efficiency has undergone a tremendous increase since the introduction of highly superheated steam, as is evidenced by the fact that about 22,000 superheater locomotives are now in operation in the United States alone. Attention must be called to the fact that the design and load conditions of a locomotive boiler, the same as those of a steam shovel or other movable power plant boiler, lend themselves particularly well to an increase of efficiency by the installation of properly designed superheaters.

In the operation of locomotives, the saving in steam by weight has often been found to be 35 per cent. and more, and it can be easily imagined how much the reduction of the amount of fuel, caused by the reduction in steam consumption, can relieve a grate that is overcrowded. The stack losses increase very fast with the amount of coal fired per square foot of grate area in boilers with small grates, and it is evident that a reduction in the amount of coal fired per square foot per hour greatly reduced this loss. This is one of the reasons why a reduction of steam consumption through superheating is accompanied by a correspondingly large saving in coal.

Oiling Air Pumps.

Oiling an air pump from the running board involves more or less danger, and in the interest of Safety First, Mr. S. M. Dickerson, Ft. Worth, Texas, an engineer on the Missouri, Kansas & Texas Lines, designed a folding step, which, securely attached under the air pump, renders the operation of oiling the pump at once easy and secure. The opened step projects about half way to the ground, and when folded is out of the way. The Safety Committee approved of the device, and it is being applied to nearly all of the locomotives on the road.

Du Pont Products.

A handy little booklet has just been issued, containing a list of all the products manufactured by the E. L. du Pont de Nemours and associated companies, namely Du Pont Chemical Works, Du Pont Fabrikoid Company, the Arlington Company, and Harrisons, Inc. The booklet will be of interest as well as of value to many mercantile and industrial men, and while it does not indicate the multiplex uses to which the products may be put, it affords lists that are full of suggestions as to the magnitude of the products, among which may be mentioned the largest white lead output in the United States and the largest sulphuric acid producers. A copy will be sent to any address upon application to the main office, Wilmerding, Pa.

Co-operation.

In a recent address to the Traffic Club of Philadelphia, Mr. George D. Dixon, vice-president in charge of traffic on the Pennsylvania Railroad, said, among other things, substantially as follows: He believed that "we have been brought up, in this country, in a school of political and social economy, which taught the principle of 'each one for himself,' as the underlying basis of the push, hustle and initiative which were to bring success. We placed competition upon a pedestal and worshiped it!

"Until very lately, whenever the people of any American community were dissatisfied with, let us say for example, their gas company, the standard remedy immediately proposed was to have another gas company to compete with the first one, and it was generally believed that, in some mysterious way, a multiplicity of competing and mutually hostile public service enterprises were a certain blessing to any community fortunate enough to possess them.

In brief, the orthodox doctrine of yesterday taught that the ideal condition was to have as many corporations as possible fighting each other for the public's business, and the public fighting all the corporations."

The war is showing us that the seller and the buyer of transportation are not enemies, but are really friends, and those who have stirred up enmity between them, and have prospered by keeping such enmity alive, have wronged both, and are indeed the apostles of a false creed.

Christian doctrine requires us to love our enemies, but it can hardly now refer to more than the beginning of the good fellowship and co-operation of which Mr. Dixon speaks, whatever it may grow into as time goes on. At any rate, the aim embodied in this idea is in the right direction, and a larger measure of attainment may be ours in the fullness of time.

Many instances of railroad co-operation might be given, in which destructive competition has been replaced by helpfulness. At one time the burning of a trestle bridge, or the failure of a turntable on one line, would have been hailed with feelings of open satisfaction by those on a rival line, as an occurrence which would seriously hamper, if it did not entirely hinder, a competitor. Nowadays facilities to carry on traffic would be offered by any decent railway in the country. A breakdown of the telegraph system of one line would similarly and generously be treated by the line more favorably situated. Newspapers invariably assist each other in case disaster suddenly comes upon one, and this help is offered without reference to the policical bias or social leanings of the unfortunate sheet.

Co-operation is more and more becoming a recognized feature in the everyday life of any community. The point to be here noted is that the principle of co-operation, while it is antagonistic to destructive competition, does not bring all to the same dead level, but tends to raise the standard of endeavor. You do not win the race because your co-contestant has fallen, but because you can run faster or better than he can. You do not gain by default, you succeed by better or swifter performance. One may say this is successful competition, so it is in a sense, but the old, hard, and cruel view of your winning, has given place to one of reward for the best service, while you admit the right of others to an equal chance. If two men push a stone, the combined effort of two is greater than that of one alone. If the two fight to see who shall push the stone, energy is unproductively lost in the fight, and the victor, even supposing him to be the stronger of the two, when freed of the fight, only can apply one-man power to the stone, which would have been more quickly carried back and to a greater distance by the two working together, and the rights to the territory uncovered by the moved stone, could be amicably settled by arbitration and not by the fortuitous results of an uncertain and exhausting combat, which is after all, but another form of useless and destructive competition. This may be a new view to many, but the principle of co-operation is older than history.

This principle, many believe, is the one without which mankind could not have rrsen rrom the lower animals and have become, as he surely has, the cave man, the savage, the barbarian and finally the gentle and civilized being he is (leaving out for the moment the calamitous and insensate backward rush of three nations from civilized standards.) Co-operation is a primal law—it is one of the fundamental laws of Nature. Mr. P. Chalmers Mitchell, a scientist, honored alike by degrees from the universities of Pennsylvania, Oxford, and Amsterdam, a fellow of the leading zoological societies in several parts of the world, and himself an acknowledged authority says: "I could adduce from the writings of Darwin himself, and from those of later naturalists, a thousand instances taken from the animal kingdom in which success has come about by means analogous with the cultivation of all the peaceful arts, the raising of intelligence and heightening of emotions of love and pity."

In much the same vein P. Kropotkin, the noted Russian writer and man of science, in his book on *Mutual Aid*, says: "'Don't compete! competition is always injurious to the species, and you have plenty of resources to avoid it'! That is the tendency of Nature, not always realized in full, but always present. That is the watchword which comes to us from the bush, the forest, the river and the ocean. That is what Nature teaches us; and that is what all those animals which have attained the highest position in their respective classes have done. That is what man—the most primitive man—has been doing; and that is why man has reached the position upon which we stand now." Mutual help or co-operation, is not some new theory or dogma. "Unbridled individualism is a modern growth, but is not characteristic of primitive mankind."

How this co-operation idea affects railroads as they are, is a subject which can only be briefly touched on, but it affords an opportunity for thought, to those who are willing and anxious to think. A question often asked is, if railways want engines and cars why do they not buy them? Mr. Dixon answers this enquiry by pointing out two causes. He says speaking principally of locomotives: "In the first place, we haven't the money. In the second place, if we had it, we couldn't get enought cars or locomotives to do appreciable good, for a very long time. The proper occasion to have allowed railroads more money, was several years ago, before the war started. Then we could have bought equipment, enlarged yards and terminals, and provided the additional facilities that were plainly required. But the time I speak of was before we Americans had been taught what co-operation was; and the railroads did not get the money.

I do not believe the general public realizes the situation that exists in regard to new locomotives, and how it happens that engines two years ago sold for $25,000 recently commanded $70,000 each. The truth of the matter is that it has now become almost impossible to buy new engines at any price, from any of our American works. The reason is that the military exigencies of ourselves and our Allies require that all, or practically all, of the locomotives that can be turned out in the United States shall be sent abroad to carry troops and supplies to the battlefields in France."

We can only point out, as we have previously done, that the Nation's hope of dealing with this problem is to use all the various appliances for cheapening the cost of operation or increasing the capacity of those locomotives now doing business. These appliances are of proved value, good at any time, but doubly efficient in time of need, and the fact that this is a time of need is brought home to us by Mr. Dixon when he says that he regards the difficulty of buying new engines and cars for use in this country as the most serious condition that the United States has ever been called on to face. It is a severe economic stress, and the co-operation idea, old as the hills, is our one way of escape. Make use of the appliances that will approximately make half-a-dozen engines have the capacity of ten. Help by co-operation and give this "new-old" doctrine a regular road test, when conditions are arduous.

Some Advantages of Peripheral Drive

The use of cold saws in the shop are many and various. There are, roughly speaking, two kinds of saws which may be distinguished by reference to the method of drive. They are the central or arbor driven saws and the saws which are actuated by what is called the peripheral drive. In this case the sawteeth are the only things actually on the periphery, but the word is here extended so as to mean the slots or driving holes, with which the toothed procket wheel engages, and these slots are cut in the face of the saw, a few inches from its cutting edge, and the saw is loosely spoken of as having a peripheral drive in order to distinguish it from the saw driven from its center.

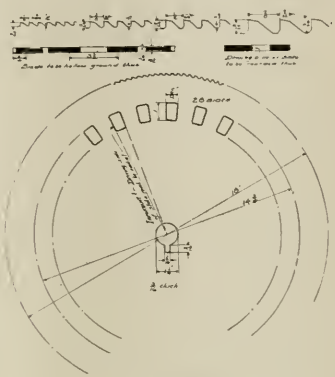
As a good many arbor driven saws are held by two friction collars, in addition to the key usually on the shaft, they should be taken into consideration, in investigating the relative strength of the drives. Assuming that the collars are 4 ins. in diameter, and the cutting force of 1,000 lbs. If so applied, it would be as follows:

$$\frac{2 \times 1{,}000}{9} = 222.22$$

The 18-in. peripherially driven saw, here taken as an example, has the center of the slots on a radius of 6.875 ins. which would give a cutting force of

$$\frac{6.875 \times 1{,}000}{9} = 763.88 \text{ lbs.}$$

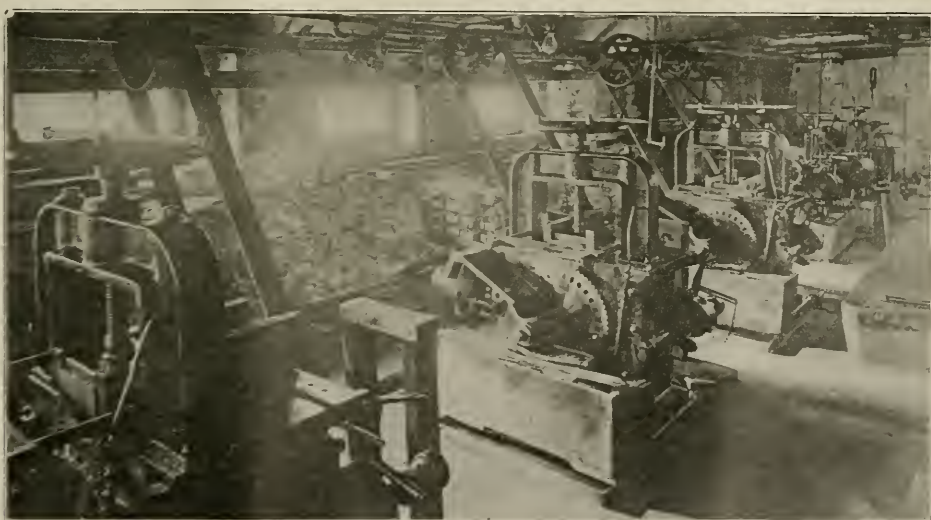
In regard to the advantages of the peripherally driven saw it might be said that as the radial slots in the saw-blades are placed as near the edge of the blade as it is possible to do, the sprocket wheel, which drives the blade, has the effect of drawing the blade through the work instead of forcing it from the center. In most cases the sprocket drive is applied



COLD SAW DRIVEN NEAR THE PERIPHERY.

directly below and in front of the cutting point of the blade, which does away with the tendency for the blade to buckle or bend in rapid cutting. This permits the use of thinner blades with a certain saving of power and less waste of stock in cutting, as the "kerf," or part cutout is comparatively thin. Another advantage which is claimed by the saw makers, is that because there is no large center collar needed to preserve the rigidity of the blade, it is possible to utilize considerably more of the saw radius than on an arbor driven blade of the same diameter. That means that a saw of this kind can be made to cut close in to the the arbor.

In comparing the power of the two types of saws, we find that the saw which we use as an example—the Higley saw, taken without interest or prejudice, exerts 3 2/5 times the power that the other kind of saw uses. We have taken 1,000 lbs. driving force at random, as the arithmetic part of the problem thereby becomes easy. Both types waste power, but the peripherally driven saw wastes the lesser quantity of the two.



A GROUP OF COLD SAWS IN A SHOP, EACH HAVING THE PERIPHERAL DRIVE.

Reverting to Wooden Cars.

As an emergency exists which makes it almost impossible to get a sufficient quantity of steel plate to meet the demand for car deliveries, attention is being directed toward cars of wooden construction. They cannot be built as light and durable as steel cars, but when rolling stock is in such abnormal demand, there may be advantages in reverting for the meantime to the use of wooden cars, which could be delivered in a comparatively short time, and could be earning substantial revenue while waiting for the steel material.

The Baltimore & Ohio railroad are installing electric headlights on all of its locomotives, over 2,500 in number, at the rate of from 75 to 100 engines a month. The rate of installation will increase as the work goes on.

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Efficiency of Grate Area.

When the size of a locomotive grate is spoken of, the number of square feet of grate surface is usually given. Say it is 50 sq. ft. Now, as a matter of fact, no vital information is contained in this statement, any more than if a man told you that the side of his apartment house had a wall area of 3,000 sq. ft. and expected you to form a good idea of the number of windows that were on that side of the house.

In the case of the locomotive grate, the square feet making up the area of the grate may have much or little air opening between the fingers, and the air opening is the thing that counts. It is the thing that a man must base his estimate of the grate on. Theoretically if fuel could be burned without ash pan or grate it would be so much the better, but this is out of the question except for oil fuel and for pulverized coal. These forms of fire producing material require no mechanical support and the combustion is well nigh ideal, so that ash is practically non-existent or is reduced to a minimum.

Burning coal cannot be managed this way, and grate and ashpan are necessary. An investigation of the whole question was made by a committee of the Fuel Association some time ago and it turned out that for burning bituminous coal, sixty-two varieties of grates were examined. The full, clear air opening, stated in percentage of grate area, showed a minimum of 25.8 in one design of interlocking finger grates, and a maximum of 49.6 in a design of the herring-bone type; the average being 37.2, which is not high.

This average represents, as all averages do, a number of sets below that figure and some above, so that it is fair to suppose that the passage of air to the fuel bed is obstructed by the portion of the grate required to carry the coal. The committee, commenting on this point, said:

"The item of greatest importance from a combustion standpoint is that of the percentage of air opening. Theoretically the best grate from the standpoint of resistance to the passage of air to the fire would be one of minimum material with the greatest possible percentage of air opening equally distributed over the entire surface. Whether in practice this principle gives the most efficient grate is a thing the committee has not been able to determine."

The thought naturally comes up here, viz.: The advisability of stating this percentage when the grate area is given. For example, suppose the grate area t be 58 sq. ft. and the percentage of air opening to be one-quarter of this. The grate area could be written down with a shilling mark, or a hyphen with dots as follows: 58/25 or again, 58-25 or again, 58:25. In any one of these systems of notation the air opening and the size of the grate would be indicated at the same time.

A grate designed by Mr. Geo. Hatch of the Locomotive Pulverized Fuel Co., which company does not use a grate, gives an air opening close to half the area of the grate, and the Hulson grate gives an unobstructed air opening of 55 per cent., which is about the largest opening for air evenly distributed over the surface of the grate of any we know.

The class of coal burned on any grate is practically the prominent feature of the style of grate and of the air openings through it. The Hulson people recommend "a grate with a ⅝-in. opening, the top of the finger five-eighths of an inch, which gives 55 per cent. air space. Where fuel would permit of it, this opening could be made as much as an inch wide and still maintain the ⅝-in. finger. However, 55 per cent. air space is as much as can readily be accommodated through ashpan opening."

The ashpan is another obstruction, but it is stated that about 15 per cent. of the air opening through the grates has been found to give very satisfactory results. This, if true, is very fortunate for designers, as otherwise they might be compelled to cut down the ashpan dimensions to unworkable limits. The percentage of air opening through the grate should be stated, if the real value of the grate area is to be appraised by the one asking for or reading the dimensions. The air supply to the fire is vital and all grates of the same size do not have equal value. The fire-bed will obstruct the flow of air in any case, but to give the area without stating approximately how much of it is effective is very much like asking a man how many stones he can carry, and leaving the weight and size of the stones entirely to conjecture.

Caveat Emptor.

In glancing over the pages of our magazine from month to month, one cannot fail to be impressed with the evidences of the good work done by mechanical invention, new appliances and apparatus. "What was good enough for my father is good enough for me" is false doctrine, and never had any legitimate place in the mind of a growing, thinking, progressive man. It was the watchword of the lazy, the always-tired, and the let-it-go-at-that, fraternity. Men of that stamp may hold their jobs, but they do not earn their money.

Progress is one of the eternal laws of Nature. The doctrine of organic evolution proves it. It took the horse somewhere about three billion years to get from the little four-toed animal, the size of a dog, to the high stepping steed of today. The animal was not individually conscious of the change, but its remains prove that the evolutionary progress had gone on. The Westinghouse airbrake began as a cylinder full of compressed air, supplied to brake cylinders as required. Today it is a most efficient apparatus and it has passed through the stages of a continuous evolution in the life of one man. The difference which exists between what man can make, and what Nature does, is only a matter of time. Man shortens the period required in the process, though the principle in each case is practically the same.

In the railroad world we have got past that old legal maxim, "Caveat Emptor"—let the purchaser beware. We have, and we are now doing far better than that. Everywhere we find among the railway supply people a marked ability in invention and in subsequent design, but we find not only a readiness, but an eagerness to have their product tested and proved to be what they say it is, to the entire satisfaction of the purchaser. We see evidences of a desire to get at the worst conditions and meet them. Reputable supply firms are ready to let road service conditions, hard as they are, do their worst, but sellers of railroad appliances do not grumble even if their devices fall into unsympathetic and even careless hands. The devices must make good, or they are not offered for sale.

In the recent tests which we gave an account of, made by the Lima Locomotive Works, they did not seek to coddle their engine. It took its chance and succeeded. The tests made by American Arch Co. on the T. & P., did not look for preferential treatment, the arch stood the test, without favor, and made good. The feed water device either saves hard cash by utilizing the waste heat of the engine, or its advocates do not look for consideration. The pulverized fuel for locomotives is a substantial advantage on hard worked road engines, and the worth of the whole thing rests on what it does, not on what its friends say of it—there is none of the caveat emptor about all this. There is a frankness in this test idea that would effectually silence a man from Missouri.

In this kind of treatment of the things offered for sale to a railroad, there is the intelligent hastening of the evolution of the primary idea. A good example is the improved Ragonnet reverse fear, explained elsewhere in this issue. Weak points if discovered in any appliance when the service test is applied, are at once remedied or improved, and no time is lost in dreaming of ideal conditions. The whole record of progress makes a continuous line, and this process is slowly and surely developing the scientific view of locomotive operation, and this view is the only one that can survive, or can succeed in re-making the locomotive, and taking it out of the class of crude, imperfect and wasteful railroad appliances—albeit, the most important of all—and placing it in the class to which it rightfully belongs, viz.: a clean-cut instrument of precision and of economical work.

The Way Up.

A glance at our items of personal interest will show the most casual observer that nearly all of the men who have risen to the highest positions began at the lowest, and while many of them had the advantage of a good education, in no case did that early grounding relieve them of the drudgery of mechanical toil on the path to preferment. The habits of the student, however, remained with them. They were not done with books when they left the school; they still remained students. It is the men who read that run the world. The railroad men of today have many advantages comparatively unknown and undreamed of in the earlier days of railroading. There are now standard text books on every engineering subject. These are constantly being added to, while the engineering press keeps the willing reader informed up to the present hour.

Not only so, but in railroading, the clubs that have been established form not only an excellent medium for the interchange of opinion, but to the young, and others not so young, they give an opportunity of high companionship, like an embattled army, where the high spirited and the chivalrous may exhibit their heroic qualities, and spread a spirit of contagion that brings out the nobler attributes in others that otherwise might stagnate in the weeds of sloth.

None of us know all that is known in railroading or railroad science, but we can all contribute something to the general fund of information, and it is this spontaneous and general expression of opinion at the railroad club meetings that gives the high educational value to these institutions, apart from the enduring friendships that may have their origin in such communion.

It is not boasting to state that our own work in this educational field of human endeavor has met with a degree of popular approval that is very gratifying. Thousands of the readers of Railway and Locomotive Engineering have testified to the helpfulness that they have received from our pages. Many of these friendly voices come from the far ends of the earth, and while we may never see them face to face, their kindly encouragement induces us to hope that we will continue to meet their expectations—be even more worthy of their approval, as time goes on.

A scientific spirit is beginning to pervade the whole railroad world, which is evidenced in the number and the importance of the tests that have been and are being conducted. Engineering departments of universities vie with prominent supply firms in testing the value of appliances and methods, with the truth ever in view, lead where it may. It is the facts so elicited from Nature that our future progress must be built upon. The man who reads, and the student, comes to these facts with mind prepared to understand and take them in. He makes his own advance, and in doing so helps those around him to understand and make use of the science of railroading.

Fitting the Exhaust Pipe.

The proper adjustment of the exhaust pipe in its relation to the smoke-stack is of importance in the proper firing of the locomotive. The dimensions of both exhaust pipe and smoke-stack are the work of the constructing engineer, but the adjustment is in the hands of the mechanics. Not only should the exhaust pipe point exactly to the center of the smoke-stack, but it should be set perfectly plumb when the engine is level. In new work the exhaust pipe should first be placed in proper position and the smoke-stack adjusted so as to be exactly over the center of the exhaust pipe. It will be noted that the volume of the exhaust in locomotive is not always alike and whether the draft on the fire is indirect by a compact volume of steam filling the smoke-stack and producing a vacuum into which the air rushes like water following a pump plunger, or whether the exhausted steam is merely a limited jet occupying only a portion of the circle of the smoke-stack, and so inducing draft largely by friction of the particles of air, it is in either case of the utmost importance that the blast or jet should be in the exact center.

If the exhausted steam expands in its upward passage in sufficient volume to fill the stack at its base, a low pressure of exhaust steam will produce a strong vacuum which will be equally felt on every part of the fire. On the other hand, if the exhaust steam strikes unevenly on the stack, leaving a portion of the stack untouched by the expanding jet of steam, the effect on the fire is of the most pernicious kind. The evil is increased if a portion of the exhaust jet strikes outside of the stack. This is often the case where low nozzles are used, and also in the case of double nozzles.

Sometimes the form of the exhaust pipe is the cause of much trouble. Exhaust pipes that have a bend in them in order to bring the nozzles in line with the center of the stack invariably affect the steaming qualities of the engine injuriously. A straight exhaust pipe will cause the jet to retain a straight direction, whereas exhaust pipes of a bending form, even if straight for some distance at the nozzle, have the effect of causing the exhaust steam to flare or spread. These defects are sometimes so radical that the outside of the smoke stack will bear witness to the unevenness of the exhaust. The rapid condensation of the exhaust steam into water will show itself on one side of the stack, and when this is the case an uneven condition of the fire and consequent lack of good firing qualities may be looked for.

Indeed, the proper adjustment of the exhaust pipe, as well as its form, may be looked upon as of vital importance in locomotive construction, and on investigating the causes of defective steaming qualities it is well to begin by testing the alignment of the smoke-stack and exhaust pipe.

Variety in Machine Tools.

It is generally conceded that the lathe is the most popular of machine tools. More lathes are built than any other machine tool, the next being drilling machines. The superiority of the milling machine over the planer, or shaper is also evident from its ability to manufacture parts in large quantities. Planers have their place in the machine shop, and will always be used for jobbing and repair work, and for planing the working surfaces of machines that must be highly accurate. The shaper and slotter have also their required places. In brief, the development of any type of machine does not result in displacing another. It often makes a broader market for all.

Air Brake Department

Improved Triple Valve Test Rack—Questions and Answers

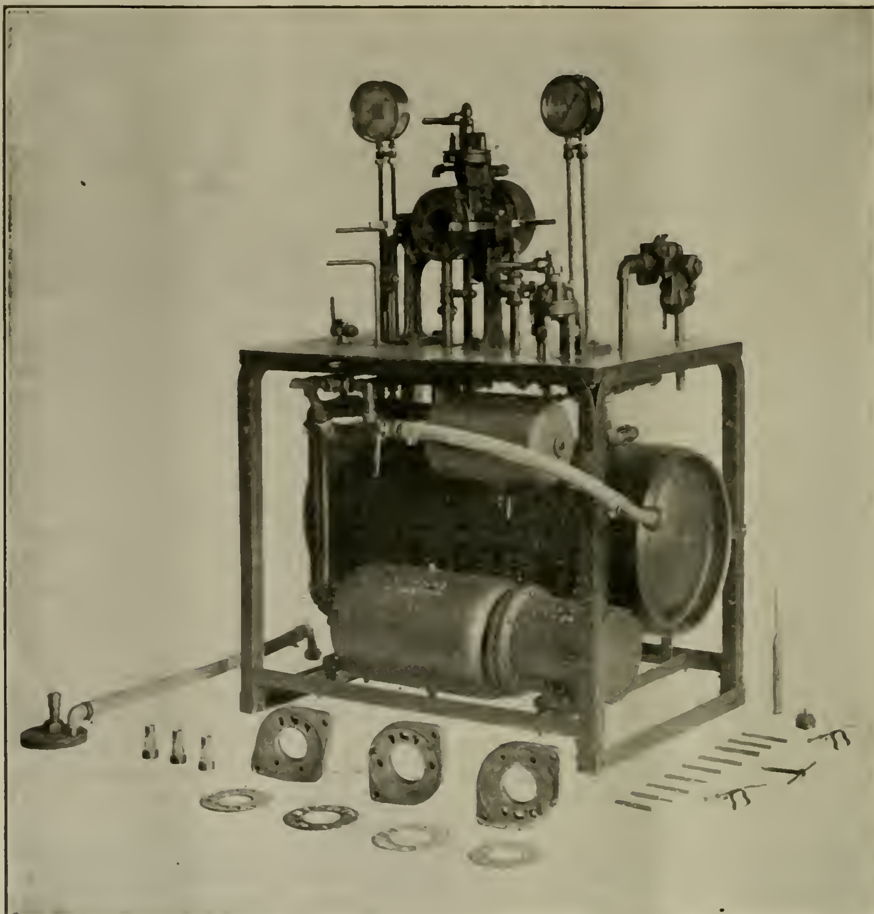
Westinghouse Improved No. 3 T Triple Valve Test Rack.

The photographic view is of the new type of triple valve test rack, which replaces the standard rack which was introduced in 1904, and has very creditably fulfilled the purpose for which it was intended, but with the gradual advancement that has taken place in train operating conditions, it has been necessary to make certain modifications to produce a more accurate triple valve test than can be obtained with the present standard rack. With this rack there is less apparatus, a triple valve may be thoroughly tested in somewhat less time, and the present rack may be converted to this standard at a reasonable cost.

The chief factors considered in ascertaining the condition of a triple valve with this rack are: (1) Whether the valve meets with the necessary initial requirements from a manufacturing standpoint, (2) Whether after operation in service it is still in condition for future periods of service, and (3) Under what conditions of performance it should be removed from service as immediately requiring repairs that are inevitable.

After observing the condition of triple valves, or the workmanship that has been done on triple valves, that could still be passed over a standard rack and meet the specified requirements so far as the standard code of tests was concerned, it is apparent to any air brake man that there is something radically wrong, that is, a repairman so disposed could pass most any kind of a triple valve over the rack.

The present rack provides for a friction test that is accurate, a packing ring



IMPROVED WESTINGHOUSE TRIPLE VALVE TEST RACK.

leakage test that is made with a differential encountered in service and is made with the packing ring at a point in the piston bushing where the maximum wear occurs. There are also more accurate means provided for making the service port capacity and sensitiveness to emergency tests. Space will not permit of a detailed description of the tests that are to be conducted and it is unnecessary as a complete code accompanies an installation of the rack. From an air brake operating point of view, we trust that this rack will be adopted and installed at all points where triple valves are repaired, cleaned and tested, as the rack itself has stood a continuous test for the past year and proved satisfactory in every detail, condemning the defective valves that could ordinarily be passed over the standard rack. In the next issue an effort will be made to go into the subject in detail without the necessity of giving the complete code of tests.

Locomotive Air Brake Inspection.

(*Continued from page* 331, *Oct.*, 1917.)

83. Q.—What is wrong if the feed valve fails to operate, but permits a drop in pressure when the different sized openings to the brake pipe are used?

A.—It indicates that the supply valve piston is too loose a fit in the bushing, and that main reservoir pressure is passing the piston at the same rate that it is passing through the regulating valve seat and out of the orifice disc, and as a result no movement of the piston can be obtained.

84. Q.—Is there any reason why the feed valve would not show any fluctuation when the 3-64-in., 1-16-in. and a larger opening was used, but the pressure in the brake pipe remained constant?

A.—Yes, the feed valve might be in perfect condition and more sensitive to respond to lowering of brake pipe pressure than the air gage was to record it.

85. Q. What may then be considered as a perfect feed valve?

A.—One that will permit of no lowering of brake pipe pressure or will maintain it practically constant almost up to its capacity.

86. Q.—Are there many feed valves found that may be considered practically perfect?

A.—No, they do not remain in this condition very long, until they start a fluctuation on a predetermined rate of drop in brake pipe pressure or until they manifest a tendency to permit the brake pipe pressure to drop during the test.

87. Q.—What is wrong if the brake pipe pressure gradually increases above 110 lbs. or the figure of feed valve adjustment?

A.—The supply valve or the regulating valve of the feed valve are leaking or the feed valve gasket may be leaking, otherwise there is a leak from the main reservoir into the brake pipe from some other point.

88. Q.—Where could these leaks be from?

A.—From the rotary valve of the automatic brake valve, through the brake valve body gaskets? It may be through the double heading cock, if located in the reservoir pipe, through a dead engine fixture if one is used, or from a water scoop operating reservoir when they are used on the tender.

89. Q.—How can it be determined whether the leakage is through the feed valve or feed valve gasket, through the rotary valve, or past a double heading cock in the reservoir pipe, the double heading cock having a brake pipe connection?

A.—By placing the automatic brake valve in lap position, which will eliminate the feed valve and gasket. Then closing the double heading cock will eliminate the leaky rotary valve, but if the brake pipe pressure continues to increase it indicates a leaky double heading cock.

90. Q.—Where is the inspection continued to from the rear of the tender?

A.—To the cab of the engine.

91. Q.—What is the last thing to be observed before removing the test gage?

A.—The figure of feed valve adjustment or the pressure in the brake pipe.

92. Q.—For what purpose?

A.—So that a comparison of the gages may be made without returning to the test gage.

93. Q.—What is then the first thing to be noticed when entering the cab?

A.—The brake pipe and equalizing reservoir gage hands.

94. Q.—For what purpose?

A.—To see that they correspond with the test gage before any change in pressure is likely to take place.

95. Q.—What is next to be done?

A.—The air pump throttle is closed and the automatic brake valve handle placed on lap position.

96. Q.—What test will then be made?

A.—The main reservoir and brake pipe leakage test.

97. Q.—What are the limits of leakage from the brake pipe for general conditions?

A.—Three pounds per minute.

98. Q.—From the main reservoir and related piping?

A.—The same, three pounds per minute should not be exceeded.

99. Q.—What would be wrong if the leakage from the main reservoir showed in excess of 3 lbs. per minute during a period of 3 minutes and no leakage could be found?

A.—It would indicate that the temperature of the compressed air in the main reservoir had been very high and that the consequent loss in pressure was due to a reduction in temperature.

100. Q.—What should then be done?

A.—Another test should be made when the pressure had been reduced to 60 per cent. of the maximum or 85 lbs. from an original 140 lbs.

101. Q.—What if the leakage is then still in excess of 3 lbs. per minute?

A.—The source of leakage must be discovered or the fact reported.

102. Q.—What if the compressor does not shut down tightly during the main reservoir leakage test?

A.—The test is void and the air pump throttle valve should be reported as leaking, and that the main reservoir leakage test has not been made.

103. Q.—What should the inspector be doing while the three minutes time for the main reservoir leakage test is elapsing?

A.—He should test all of the piping in the cab, the brake valves and signal valve and feed valve and reducing valve for leakage past cap nuts or gaskets and examine the brake valve exhaust ports for leakage.

104. Q.—Where is the exhaust port of the independent brake valve?

A.—Under the body of the valve.

105. Q.—Where does the independent brake valve exhaust the application cylinder pressure when both brake valves are in running position after an application of the brake?

A.—Through the direct exhaust port of the automatic brake valve.

106. Q.—What else is to be tested above the running board?

A.—The pump governor and pipes leading to it, and any other piping above the running board.

107. Q.—What else in the cab is to be noticed while the leakage tests are being conducted?

A.—The last date of air gage test, the last date of cleaning of brake equipment.

108. Q.—What other date is to be noted?

A.—The last date of air compressor test.

109. Q.—What if there are no tags or stencil marks indicating this?

A.—If this information is not shown on a form displayed under glass in the cab, the parts are out of date for cleaning or test.

110. Q.—When a tag is used to indicate the last date of brake cylinder and brake cylinder operating valve cleaning and test where it is located?

A.—It is attached to the brake pipe near the automatic brake valve.

111. Q.—When is an air compressor out of date for test?

A.—Three months after the last date shown, by metal tag on steam pipe or on a form in the cab.

(*To be continued.*)

Train Handling.

(*Continued from page 332, Oct., 1917.*)

98. Q.—From the foregoing, why is it of advantage to know that the relief port of the governor is open, and the governor sensitive before starting on a trip?

A.—It will very materially assist in locating the cause, should the compressor stop in service.

99. Q.—After a brake test has been made on a freight train, and the proper pressures have accumulated, when is the first application of the brakes made?

A.—When the train starts descending the first grade.

100. Q.—What if this is a mountain grade, and some distance from the terminal?

A.—A brake test must be made, according to the instructions for that particular division, before descending the grade.

101. Q.—For what purpose?

A.—To know that no angle cocks have been closed in the brake pipe, and that the required percentage of brakes are in good condition.

102. Q.—What determines this percentage and the required efficiency of the brakes?

A.—Largely the length and per cent. of grade.

103. Q.—What per cent. of operative brakes are required by the Federal Regulations?

A.—Eighty-five per cent. or more.

104. Q.—How is this interpreted?

A.—That with 100 cars, 85 brakes must be operative and in good condition, and all brakes in an operative condition must be used.

105. Q.—Is it permissible to have the brake cut out on the car next to the engine?

A.—No.

106. Q.—Why not?

A.—Because it might prevent a quick action application of the brakes in a case of emergency.

107. Q.—In what manner?

A.—The length of piping then between the brake valve, or distributing valve and the first triple valve in the train, may be sufficient to destroy the rapidity of reduction necessary to insure quick action.

108. Q.—How does the length of intervening pipe destroy the violence of the brake pipe reduction?

A.—The initiation and propagation of quick action, depends upon a certain rate and continuation of drop in brake pipe pressure, which is accomplished by openings of certain size to correspond with the volume of compressed air in the brake pipe, and with the brake on the first car cut out, and no brake pipe venting device on the tender of the locomotive, the required rate of reduction may not be obtained when desired.

109. Q.—What other rule in cutting out brakes is this frictional resistance to the flow of compressed air responsible for?

A.—That no two cars may have the brakes cut out successively.

110. Q.—What do you understand by this?

A.—That when it is necessary to cut out the brakes on two cars in any portion of the train, at least one operative brake must be between them.

111. Q.—What governs the amount of brake pipe reduction that is to be made for the initial reduction for a stop?

A.—It is principally governed by the speed of the train, condition of track, the length of the train and the type of brake equipment on the train.

112. Q.—What causes shocks to trains during brake applications?

A.—Differences in speed between the various cars in the train.

113. Q.—What permits this difference in speed?

A.—Slack in the couplings.

114. Q.—About how much slack is there in a 100 car train?

A.—About 50 feet.

115. Q.—What is the chief consideration in stopping a freight train on an approximately level track?

A.—To stop the train without shock or damage regardless as to the distance required.

116. Q.—What is the secret of smooth train handling?

A.—Ability to control the slack action.

117. Q.—From a viewpoint of smooth handling only, what would be the ideal stop with a train?

A.—To close the engine throttle and leave the train drift to a standstill.

118. Q.—What would be the next best?

A.—To gently catch up the slack with a very light application of the independent brake and allow the engine to stop the train.

119. Q.—Why is it contrary to instruction to use the independent brake in stopping a train?

A.—Because an engineer who did not thoroughly understand the art of train braking would likely do more damage to the train than if it was entirely ignored.

120. Q.—What is the independent brake valve intended for?

A.—Handling the brakes on the locomotive alone.

121. Q.—The automatic brake valve?

A.—For handling the locomotive and train brakes.

122. Q.—What is the effect of a heavy application of the independent brake when coupled to a train on which the brakes are released?

A.—A quick change in the speed at which the engine is running and a heavy run in from the rear which tends to wreck the train.

123. Q.—Allowing a train to drift to a stop, or stopping with the independent brake valve would no doubt stop a train on a level track, but is this considered train braking?

A.—No.

124. Q.—Why not?

A.—Because each car in a train is equipped with an air brake that is intended to be used in stopping the train.

125. Q.—What is the best kind of an application that can be used in stopping a freight train on a level track?

A.—As a general thing, the very lightest possible brake pipe reduction that will apply all of the brakes in the train.

126. Q.—What if the train is running at a high rate of speed?

A.—Make the same light reduction, and follow with another just sufficient to bring the speed of the train down to 18 or 20 miles per hour, the release and recharge for making the final light reduction to stop the train.

127. Q.—How far from the stopping point should the light reduction be made?

A.—Far enough away to permit the light reduction in itself to bring the train to a stop.

128. Q.—Should a further reduction be made?

A.—Yes, when the speed is down to a point where the train will stop within an engine length.

129. Q.—What is the purpose of this final reduction if not to assist in shortening the stop?

A.—To hold the slack in on the front cars to prevent a run out when the brakes on the rear are as effective as the light initial reduction will make them.

130. Q.—What is the idea of this brake valve movement?

A.—To bring the train to a stop while the brake pipe exhaust of the automatic brake valve is discharging air from the brake pipe and building up braking force at the head end of the train.

131. Q.—How will the actual stop then be made if the train is running at a low speed to begin with?

A.—With one application, but two reductions, the last reduction to have no bearings whatever upon the length of the stop.

132. Q.—What is the object is making a very light initial reduction for the stop?

A.—Not to build up enough braking force in any part of the train to part it.

133. Q.—Explain more fully?

A.—The heavier the brake pipe reduction, the greater or higher the brake cylinder pressure that will result and the higher the brake cylinder pressure the greater the retarding effect of the brake.

(To be continued.)

Car Brake Inspection.

(*Continued from page 333, Oct., 1917.*)

100. Q.—What is a road test?

A.—A test made during which a man stationed at the rear of the train notes that brakes apply and release properly at the rear of the train to indicate that no angle cocks in the train have been left closed.

101. Q.—When are such tests made?

A.—After a train has been parted, or after an angle cock has been closed for any reason whatever, or sometimes after a train is made up in sections and a terminal test has made on the different sections.

102. Q.—What is the meaning of four blasts of the signal whistle when the train is standing?

A.—To release brakes, if brakes are applied, or to apply brakes if they are released.

103. Q.—If the train is running?

A.—To reduce speed.

104. Q.—What is the meaning of five blasts of the whistle?

A.—If the train is standing, to call in the flagman; if the train is running, to increase speed.

105. Q.—Of three blasts of the whistle?

A.—When standing, to back up; when running, to stop at the next station.

106. Q.—Of two blasts of the whistle?

A.—When train is standing to start; when train is running to stop at once.

107. Q.—How is a hand signal to release brakes given?

A.—By holding the hand, a flag or lantern at arm's length above the head.

108. Q.—How is the signal to apply brakes given by hand?

A.—By swinging the hand, flag or lamp, horizontally above the head.

109. Q.—When shall the engineer apply the brakes for a terminal test of brakes?

A.—Upon a request from the trainman or inspector, or upon a signal from them after the required pressure has been obtained.

110. Q.—What is this required pressure?

A.—The maximum carried in the brake pipe as regulated by the feed valve of the locomotive.

111. Q.—Is this ever varied?

A.—Sometimes at division or intermediate terminals the rule may be varied by special instructions.

112. Q.—After the engine is coupled to the train and the brake application for the test has been made, what would be done if one of the brakes in the train did not apply?

A.—It would depend somewhat upon the length of time the locomotive has been coupled, that is, if the reservoirs on the car have had time to become charged.

113. Q.—If they have had ample time?

A.—The stop cock in the brake pipe branch to the triple valve would be examined to see that it is open and the bleeder cocks in the reservoirs to see that they are closed.

114. Q.—What if found to be in their proper positions?

A.—The bleeder cock would be opened to see whether the auxiliary reservoir is charged.

115. Q.—How can you be sure whether the brake pipe branch cut out is open regardless of the position of the handle?

A.—By the groove cut in the top of the key which runs in the same direction as the opening through the key.

116. Q.—What if there was no air pressure in the auxiliary reservoir?

A.—It would indicate stoppage in the brake pipe or air strainer or in the feed groove of the triple valve.

117. Q.—What if the reservoir was apparently fully charged?

A.—It would indicate that the triple valve was defective or that the air pressure had leaked through a defective brake cylinder or connection.

118. Q.—Could a brake get into a condition where it would apply with a short train and fail to apply when made up in a long train?

A.—Yes.

119. Q.—Would such a brake be cut out if the fault was in the brake cylinder, that if the packing leather would not set out properly with a slow entering of pressure into the cylinder?

A.—No.

120. Q.—Why not?

A.—The brake would be operative in cases of emergency.

121. Q.—In figuring up the percentage of operative brakes how would this brake be considered?

A.—As inoperative.

122. Q.—Should a passenger train ever leave a terminal with an inoperative brake?

A.—Not without orders to do so from the division superintendent.

123. Q.—Why not?

A.—Because in such an event the brake on the train as a whole is defective.

124. Q.—How is such a conclusion arrived at?

A.—All of the brake apparatus from the air compressor strainer to the rear angle cock is one complete brake, and any part not properly performing its functions constitutes a defective brake and in the last analysis it would be considered as such.

125. Q.—Is there a practical reason why a train should not be permitted to leave an originating terminal with an inoperative brake?

A.—In passenger service, brakes may become inoperative enroute or it might be necessary to cut out a brake, and this might result in having less than the percentage of operative brakes required by the Federal Regulations.

126. Q.—Under just what condition?

A.—If the train was composed of 6 cars or less.

127. Q.—What if the train is on the road and it is necessary to cut out a brake or enough brakes so that less than the required 85 per cent. are operative what must be done?

A.—The division superintendent must be notified, who will issue specific instructions as to the manner in which the brakes will be operated and under what conditions the train will proceed.

128. Q.—What does the word "car" mean in reference to percentage of operative brakes?

A.——It means a car or a dead engine in a train or the tender of a steam locomotive.

129. Q.—What is the tender brake then counted as in figuring the percentage of operative brakes?

A.—As one car.

130. Q.—The locomotive?

A.—It is not counted in any way.

131. Q.—Particularly, why not?

A.—Because it is against the law to operate an engine either in road or yard service with a defective driver brake.

132. Q.—How is the percentage of operative brakes figured?

A.—By dividing the number of operative brakes by the total number of the brakes in the train.

133. Q.—Or in other words?

A.—By the number of cars in the train, the tender counted as a car.

134. Q.—As an example, with 6 cars in the train, should it become necessary to cut out one brake what would be the percentage of operative brakes?

A.—5÷6=.833 or 83 per cent operative, which is less than that required by law, and the train could not proceed.

135. Q.—How can a table be arranged to show this?

A.—

Cars in train.	Maximum number of cars allowed without operative air brakes.
6 cars or less	0
7 cars to 13 cars, inclusive	1
14 " " 19 " "	2
20 " " 26 " "	3
27 " " 33 " "	4
34 " " 39 " "	5
40 " " 46 " "	6
47 " " 53 " "	7

136. Q.—What other care must be exercised in cutting out brakes?

A.—To see that no two cars with air brakes cut out shall be placed in consecutive order in the train.

(*To be continued.*)

Improved Ragonnet Power Gear

A new and what is said to be a more efficient form of the Ragonnet Reverse gear has lately been brought out by the Economy Devices Corporation of New York The gear first put upon the market was known by the letter A. The new type which is spoken of as type B, has some very satisfactory improvements on the original form.

The first engines on which type B gear was used, were the Erie Pacific, or 4-6-2 type of locomotives, delivered by the American Locomotive Company several months ago, and the second lot were some Atlantic Coast Line engines. There are a large number of engines now on order at the American and the Baldwin Works for various roads, which will use the type B gear, and some of them are about ready to be delivered.

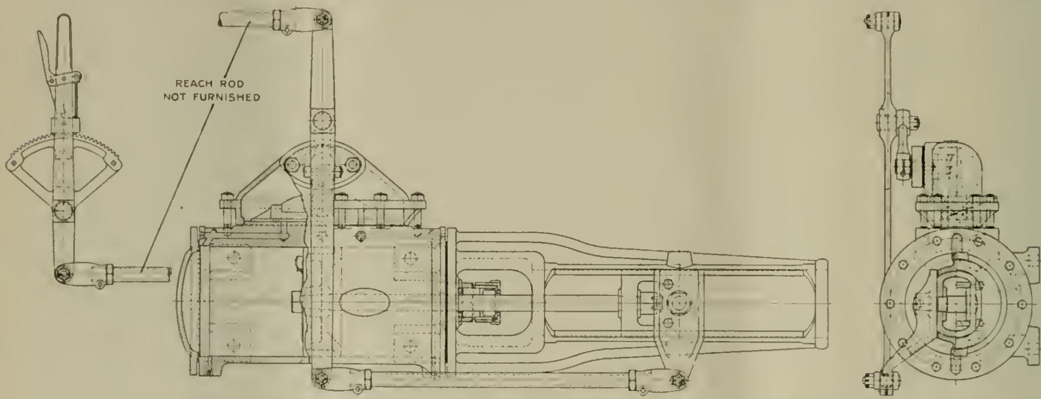
This type of gear consists of a plain 10-inch cylinder with a specially finished bore. The ports are drilled instead of being cored as in the type A, thus getting rid of any trouble with core sand.

The mechanism is controlled by a slide valve which is considerably longer than the distance between its steam edges. The admission of steam to the ports is effected through drilled holes. The valve itself has a large wearing surface but a small unbalanced area, and therefore moves with little friction on its seat. The valve is actuated by a rocker which passes through a guide, tightness being secured by means of a rocker joint ring.

The floating lever is fulcrumed on the upper arm of the rocker and is of such proportions that a very slight movement of the crosshead will produce a relatively large displacement of the valve, from its central position. The guide is of the well known bored out type, similar to that used on stationary Corliss engines. It is self-aligning, being centered in the bore of the cylinder by the front head of which it is a part. The piston rod is 1¾ ins. in diameter, enabling the Westinghouse piston rod packing suitable for an 11 in. pump to be used. All pins in the reach rod and connecting rod, are case-hardened and they work in hardened steel bushings. The jaws of the reach rod and connecting rod are interchangeable and enable these rods to be readily adjusted as to length. The cab lever is small and compact, occupying very little room and is pleasing in appearance.

The connection between the valve and the rocker is effected by means of sliding blocks and pins. By an ingenious arrangement of these details, it is impossible for any part to become disconnected or to work loose within the valve chest, as the valve and rocker must be assembled within the valve chest before it is applied to the cylinder. The piston is packed with three rings of "Ragonay" packing specially made to give equally good service in steam or air. A handy nut lock is used on the follower nuts, one single plate sufficing for all bolts. The mechanism can only be put together in one way, which allows it to be described by the trite phrase, that it is "fool proof."

Some of the advantages claimed for type B, reverse gear are easily stated and are not extravagant. One of them is that the apparatus is extremely sensitive to slight changes in the position of the cab lever, and that it gives prompt action to resist the pull and push transmitted through the reach rod when the engine is running. There is a very considerable reduction in the number of parts employed in this new gear, which makes the whole affair simple. One stuffing box, present in type A is eliminated from the newer design. A larger cylinder is used on type B, which provides stronger holding power than was formerly employed. This is in order to meet the requirements produced by the growing size of modern power and the exacting conditions of modern service. The pins and bushings used, are case-hardened to resist undue wear and the jaws are adjustable all round. Nuts are not used inside the valve chamber, and are not there to work loose or come off. This defect is hard to find and difficult to reach when nuts are present. Their absence in this design is therefore a decided advantage, and the pins that are used, cannot come out. The small hand lever in the cab has been improved by the substitution of a compact compression coil spring. There is in type B an improved form of piston packing. Other minor improvements have been introduced, here and there, which contribute to easier maintenance, and have in view the important function of safeguarding against engine failures.



RAGONNET REVERSE GEAR. (TYPE B) ECONOMY DEVICES CORP., NEW YORK.

The whole design may be considered as an improvement on the one that preceded it. The designer has had the actual service conditions before him as he worked out these later details, and these conditions gave evidence of their existence in the performance of reversing gear, type A; so that by bringing the results of this experience to bear on the later type, he has been able to improve the old gear good as it was for something better and, as is well known, in the heavier class of locomotives the installation of a power reverse gear has become a necessity that it would be idle to entertain the idea of dispensing with and its service in future is thereby secured beyond any reasonable doubt.

Electrical Department

Transformers, Air Blast and Oil Cooled—Two Types, the "Core" and the "Shell" Type—Details of Their Construction and Use—Regenerative Braking

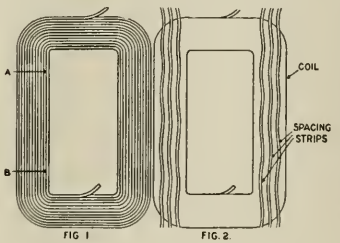
In the preceding issue we discussed the elementary design of the transformer. We showed that the function of the transformer is to transform electrical energy at one voltage into electrical energy at another voltage. The simple transformer as experimented with, by Faraday, consisted of a ring of iron with two separate sets of coils of wire wound on it. We pointed out that due to elimination of rotating parts the transformer was of very high efficiency, approximating 98 per cent. As pointed out, there are two general types of transformer construction, namely, the "core" and the "shell" types; the name applying to the position of the iron ring in reference to the coils. The construction of the core type was shown and explained and we will now proceed to explain the construction of the shell type.

The shell type coils are wound in single sections with square or rectangular wire. That is, they are wound like a roll of tape around an opening rectangular in shape, which Fig. 1 illustrates. After winding they are clamped, and so held to an exact size during the process of dipping and drying. The copper wire which is either square or ribbon-shaped, is insulated by a paper or cloth and must be treated so as to become a part of the coil, so to speak. The treatment consists in dipping in a vat of varnish and drying in ovens. The varnish is a special one, made free from any substance which would be injurious to the insulation and it is specially suited to withstand electrical pressure or voltage as well as heat. The coils are first dried, then dipped in varnish and drained and then again dried, this cycle being repeated until the surface is thoroughly coated with varnish. It usually takes as many as six dippings. By this process the whole insulation is thoroughly impregnated, the turns are bound together and the insulation strengthened.

The coils are assembled side by side in groups and the groups bound together to make the transformer. We know that electric current flowing through copper wire, or any kind of wire for that matter, produces heat. In order to get the most out of the copper used, the transformer should be worked at a high temperature but of course not sufficient to exceed the safe limit. It is therefore necessary to get rid of the heat in the transformer coils, and to do this, the coils when grouped together side by side are not placed one directly against the other. Strips are inserted between the coils, so placed that ducts are formed and the heat can be carried away by air or oil flowing in the ducts, the amount of heat taken off depending on the method employed for cooling. Enough of these ventilating ducts must be provided to insure a uniform temperature, and must be correctly located so that hot spots will not exist. If a part of the coil is not properly cooled it will be overheated and cause a burnout.

The spacing strips may be straight (the type used in air blast transformers) or they may be wavy in form, as used in the insulated transformers and shown in Fig. 2. These strips vary in thickness depending on the size and type of the transformer. An average thickness would be approximately ½ in.

The iron, consisting of punchings of silicon steel less than .02 in. thick in the shell type of transformer, is built around the group of coils enclosing them entirely, for the distance A B in Fig. 1. When completed, the transformer has the appearance shown in Fig. 3, the iron forming a shell around the main body of the assembled coils, only the ends projecting. The coil of pipe shown above the transformer is used for cooling purposes only, and will be explained fully when the different types of transformers are taken up.



WIRES AND DUCTS FOR OIL COOLED TRANSFORMERS.

The type of transformers in general use is the Air Blast Transformer, the Oil Insulated Self-Cooled (O I S C) and the Oil Insulated Water Cooled (O I W C) transformers.

The air blast transformer is mounted in a housing, which is provided with dampers for governing the inflow of cooling air as the actual duct area is in excess of the actual area required for the cooling of the transformer. For this reason the dampers are provided and when several transformers are receiving air from the same cooling air chamber the supply of air passing through each transformer can be regulated.

The air entering the transformer at the bottom, divides into two separate paths, one flowing upward through the coil ducts and the other through the ducts betweent the coils and the iron core. A longitudinal section of a Westinghouse air blast transformer is shown in Fig. 4. The damper is shown as well as the air passages.

The selection of a place for installing air blast transformers is of great importance. They should be installed in a room free from dirt and dust. The air duct or chamber for conducting the cold air should be of ample size. Precaution must be taken to prevent water from dripping roofs or from steam pipes from dropping on or entering the transformer.

One of the most important things to attend to is to see that the transformers are dry before being put into service. They are dry when leaving the manufacturers and precautions are taken to have them dry on reaching their destination. Accidents sometimes occur by which the coils become damp or even wet. Whenever there is reason to suppose that a transformer has been exposed to moisture either in transit or in storage or otherwise, it must not be put into service until the moisture has been dried out thoroughly. Moisture, as we know, does not go well with electricity and unless got rid of will cause serious burnouts. In general there are three methods which may be followed in drying a transformer. 1st—By internal heat. 2nd—By external heat. 3rd—By a combination of the two.

To dry by internal heat is to create heat in the copper wires themselves and thus drive all moisture out of the insulation around these wires. No better way to generate heat can be found than by the electric current flowing through the wires themselves. This is the method adopted. The actual procedure is to short-circuit the low voltage winding and impress on the high voltage winding sufficient voltage to pass the desired current through the coils. When the low tension leads are connected directly together, the resistance is so low that a very small voltage, 1 to 2 per cent of the normal high tension voltage, impressed on the high voltage winding will cause a flow of current sufficient to produce heat enough to dry out the coils. A current of from 1/5 to ¼ of the full load current is ample. When the drying is going on, the dampers should be wide open so as to allow a full circulation of air.

The second method is to apply heat externally to the windings. The best way of accomplishing this is to set the transformer (damper open) over a box having a top opening the exact size of the opening in the transformer. Heat is generated in the box by the passage of an electric current through resistance grids and the box should be provided with a side opening so that air will be drawn in over the hot resistances and up through the transformer. The transformer practically forms a chimney for a circulation of hot air. There may be conditions where electric current is not available for heating the resistances, and heat must be generated by direct combustion of gas,

FIG. 3. DRYING TRANSFORMER.

coal, or wood. It is very important if heat is generated in this manner that none of the products of combustion enter the box, as these gases are very injurious to the insulation.

There is no way of definitely knowing when the transformer is perfectly dry, but measurements of the insulation resistance is good indication. At a given temperature, the higher the resistance the dryer the transformer must be. The measurement of the insulation resistance is simple and the same method of test is used in connection with motors and generators. This method was described fully in our June issue and may be referred to by turning to page 200.

Regenerative Braking

Considerable energy is available (expressed in foot-pounds or horsepower) on a down grade. For instance, with a 3,250-ton train down the 2.36 per cent grade between certain points, the horsepower available can be calculated as follows: For each 1 per cent grade, the downpull along the grade is 20 lbs. per ton, so that on the 2.36 per cent grade there will be 47.2 lbs. per ton minus the friction of the train, which we will assume as 7 lbs. per ton. There is then a net amount of 40.2 lbs. per ton, which, with a 3,520-ton train, made up of 3,250 tons trailing load and a 270-ton locomotive, gives 141,504 lbs. The speed in feet per minute at 14 miles per hour is 1,232, so that the horsepower to be dissipated at the brakeshoes, as heat or as available for regeneration is:

$141{,}504 \times 1{,}232 \div 33{,}000 = 5{,}285$ horsepower.

Regeneration is then the taking of the power available on account of the train descending a grade and which nominally is dissipated as heat at the brakeshoes, and using this power to return to the electrical conductor as electrical energy which helps to supply power to some other train operating against a grade, thus requiring less power to be taken from the main power station than would be the case without the regeneration. Returning electric power to the conductor or line, as we term it, means that electric power is actually generated on the locomotive and the horsepower developed on the down grade is converted into watts.

If electric power is shut down from the overhead wire the locomotive is, for the time being, turned into a moving generating station. The generation of electricity goes on whether the turning of the wheels is effected by an outside steam engine, as at the powerhouse, or by the movement of a turbine, or by the drivers being turned by the engine and train rolling down the grade, but in any case this turning of the wheels requires some form of force to be applied.

The logical procedure is to make use of the electric motors, which normally supply the motive power for the propulsion of the train, for generating the electric current to be put into the line, and this is exactly what is done. The motors are connected on locomotives to the axles by gearing, side rods or a combination of both, so that these motors revolve at all times with the revolution of the drivers. Just how these motors are turned into generators, and how it is possible to return power to this overhead line, and what takes place in the motor, are extremely interesting matters.

As the train tops the hill and a few cars have passed beyond this crest, the engineman shuts off the master controller, changes over to the regeneration position by a simple movement of a handle and then by bringing the master controller on again the locomotive begins to regenerate and picks up car by car as each comes over the crown and begins to descend the 2.3 per cent grade.

In dealing with direct-current and single-phase series motors, we may say that the motors used on these two systems are of the series-commutating type, this type of motor having the proper characteristics for general railway work. The series motor gets its name from the arrangement of connections between the armature and the field, these two parts of the motor being connected in series, so that the same current which flows through the armature also passes through the field coils.

In order to regenerate on either of these two systems, the voltage (which is analogous to pressure in a pipe), generated by the motors, must be greater than the voltage or pressure on the electrical conductor, and this pressure generated must be under control. The conditions to be met are similar to the case of a water pipe under, say 100 lbs. pressure. In order to force water into this pipe at 100 lbs. pressure, a greater pressure must be used to overcome the pressure in the pipe. The motors must therefore become, for the time being, electric generators. Generators are based upon the discovery by Faraday, in 1831, that an electric current and voltage are generated in conductors by moving them in a magnetic field. Moving the conductor in a magnetic field causes the conductor to cut what is known as "lines of force" and the voltage obtained depends upon the number of these lines of force cut in a given time. It is seen then that the stronger the field; that is, the more the lines of force, the higher will be the voltage at the same rate of cutting, or with the same lines of force, if the conductor cut them in a shorter time; i. e., at a greater rate, the voltage will also be greater. This point is here referred to, to make clear the arrangement followed on the systems of regeneration.

In the case of the motors, the armatures are driven by gearing or side-rods or both, and we have a magnetic field which can be produced by current flowing through the field coils mounted on the pole pieces. It is then only a question of combining and controlling these features and we have the generator. It would be impossible to regenerate with the armature and fleld of the motor connected in series.

In the D.C. operation, the field can be excited from a separate source of power such as a storage battery, but better, from a motor-generator set. The motor-generator set would probably consist of two machines coupled together, one of which is a motor and the other a generator. The motor would be connected to the line voltage, or, as we would say, the trolley wire, and would run probably all the time either with the locomotive hauling or regenerating. The generator would supply the proper amount of current for exciting the field of the motors when in the regenerating position. If four or more motors are mounted on the locomotives, a wide variation of speed during regeneration can be obtained by combining the motors in the parallel and series combination. During acceleration of the locomotive, the motors are operated in combination, starting, say, in the case of the four-motor equipment, with the four motors in series, then transferring to two motors in parallel, and two of these parallel sets in series, and finally, to the four motors in parallel. Three running speeds are thus possible with these combinations, say, 8 miles an hour with the four motors in series, 16 miles an hour with the second arrangement, and 32 miles an hour with the four motors in parallel. These combinations work equally well in the reverse direction when regenerating.

At the highest speed, say, 32 miles an hour, if regeneration is commenced, the motors will be used as four in parallel, and as the train speed decreases, at a speed as outlined below, the combination would be changed over into two in parallel and two sets in series, and with the further reduction of speed, motors would be connected four in series. The reason for changing the combination is apparent from the following: As the train is reducing in speed the control must be such that more current is passed through the fields of the motors which are generating so as to keep the voltage up above the line voltage. The operation of the motors connected in series to give the proper voltage is analogous to a double-acting pump or compressor where the air pressure or water pressure obtained from the first piston passes into a high pressure cylinder, where it is increased to a much higher pressure by the movement of the second piston. It is not possible to carry this regeneration down to zero speed and air-brakes are required to complete the stop.

Regeneration must not be confused with what is known as "dynamic braking"—with direct current equipments of small sizes. If two series motors with fields reversed are connected together on themselves, either directly or through resistance, one of these motors will pick up as a generator, the other as a motor running backwards, and the car will be brought to a standstill. The voltages generated in this way are very low, since the resistance of the circuits is very low, and, moreover, the current circulates between these two motors and does not in any way return to the power supply; as with this arrangement there is no connections to the line or trolley wire. With regeneration proper the energy of the moving train which would otherwise cause it to "run away" on a steep down grade is changed into electric energy and given back to the overhead wire and to the power-house. It is new energy developed by the moving train going down hill. The train cannot run away because part of the motion is, by the arrangement of motors, split into slow-train motion and electric current. The work of pushing a train up grade gives it the potential energy of position, just as a stone carried to the top of a mountain acquires the potential energy of position with reference to the valley below.

Anticipating and Preventing Failure.

In dealing with the important and ever-present reality of safety among employes, a very considerable amount of opinion and theory have been committed to paper. One which strikes the eye readily enough is from the pen of Mr. W. E. Watters, secretary of the central safety committee of the National Malleable Castings Company. A transcript of his remarks are given in *Safety Engineering*. When speaking of sailing on a sea of safety, he says: "Many accidents are caused by mind wandering, and we ask our men to try a new sail—the sail known as attitude. We ask them to feel kindly toward every movement that we suggest that is for their betterment and for the company's interest. Soon, by taking this attitude, we find that their old experiences pass away and their craft sails on into our executive class. We try to deeply impress upon their minds that the cause of most accidents is mind wandering. We say to our men: 'If you are tying your shoe, be sure and think shoe.' In other words, we ask them to think, think, think.

"We never like the foreman who takes a wily attitude. We know positively that this attitude deprives him of power. You know and I know that people have no confidence in a crafty man. We seek among our foremen a quality known as faithfulness."

Here is an interesting psychological problem raised at once. We agree with Mr. Watters, but how are men to be induced to think, and how is mind wandering to be prevented? "Think," as Mr. Watters uses it here, probably means attention, and as Prof. C. E. Seashore points out that voluntary attention is seldom more than a precarious makeshift in the ordinary work and experiences of daily life; it is too rare and costly. Voluntary attention is one of the highest achievements of man. Attention that serves the steady flow of consciousness must be spontaneous and semi-automatic.

When work becomes largely automatic it ceases to be monotonous. The endeavor to avert or, one may say, to do away with the necessity for close attention is everywhere present in safety appliances. Gear-wheels, circular saws and other moving parts of machinery are covered for the purpose of preventing any injury being inflicted upon a man who is not paying attention to the danger he is close to. Mind wandering is another name for want of attention to the matter in hand, if one may call it so. The mind has a curious faculty of selecting, among all the varied impressions it receives, that which interests it most, and that is entirely apart from any good it may do, or any intrinsic importance it may have.

If this faculty of concentrated attention from which all irrelevant considerations have been rigidly excluded, is rare—and there seems to be plenty of evidence that it is quite rare—then the only alternative in the endeavor to secure safety, is to put it beyond the power of wandering mind, or slackened attention, to produce the condition we call dangerous. A man must be treated as a partially defective machine, and he must be positively prevented from failing.

In train operation the same kind of mind is on the footplate as is in the factory or the repair shop, and the principle of prevention of failure is as necessary on the line as in the shop. The covering of moving parts brings about immunity from accident in operating the machine, and the automatic stop is the form this safety appliance must take on the railroad. One is as logically necessary as the other. Man fails inadvertently and not by design or wish. The old argument that the automatic stop signal on the road would tend to make a man rely on it, and so become careless, is faulty reasoning. A man should not have a loaded revolver lying loose in his house. If the weapon must be kept nearby, the charge should be withdrawn, because the danger does not lie in the revolver, loaded or unloaded; the danger is wholly in the man's mental make-up. He may mistake the condition of the small-bore and injure himself or others. The weapon is dangerous only because of the man. By withdrawing the cartridge he saves himself from the results of a fatal mistake. He can't fire an empty repeater, even by the impulse of angry intention. He is safe only because he can't fail.

Grand Trunk Adpots Eight-Hour Law.

The Grand Trunk Railway of Canada has agreed to grant the enginemen and firemen on all its lines the benefit of the "eight-hour law" pay now in force in the United States. The employees on the company's lines in the United States already enjoy the rates provided by this law.

The Frank Thomson Scholarships.

The Pennsylvania railroad publishes an announcement that the Frank Thomson scholarships for the four-year collegiate term beginning with 1918-19 has now two vacancies, one to be awarded to a son of a living or deceased employee of the lines east of Pittsburgh, and the other similarly applied to on the lines west. The examination board of the college entrance of New York City will conduct the examinations. Eight scholarships are simultaneously maintained.

Evil Effects of False Brake Cylinder Piston Travel

A Correctly Designed Type of Clasp Brake Gear is Essential for Modern Equipment Passenger Cars.

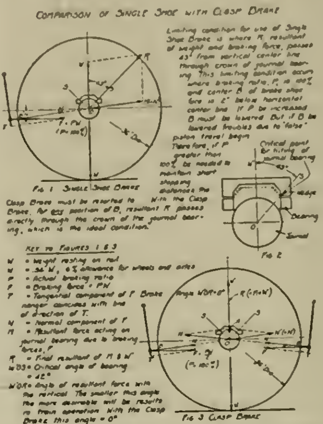
By WALTER V. TURNER, Manager of Engineering, Westinghouse Air Brake Co.

Brake cylinder piston travel, where the single shoe type of brake gear permits it to vary, is a function of the time or duration of the brake application, as well as of the cylinder pressure. As explained last month, a condition of four inches false piston travel represents more nearly what the variation in travel with cylinder pressure would be for an actual brake application, for the piston travel will not lengthen out immediately after the brake application. It takes a certain period of time for the jolting of the cars and trucks to assist the brake shoes to pull down on the wheel treads, and thereby lengthen the piston travel, which is significant, because the shocks occur in the early stages of a brake application. It is necessary to make at least a 6 or 7 lb. brake pipe reduction in order to insure that all triple valves apply and that sufficient differential may be set up to release them when desired. In the attempt to apply brakes lightly and avoid shocks, insufficient reductions are made, with the inevitable result of stuck brakes. To sum up all of these things:

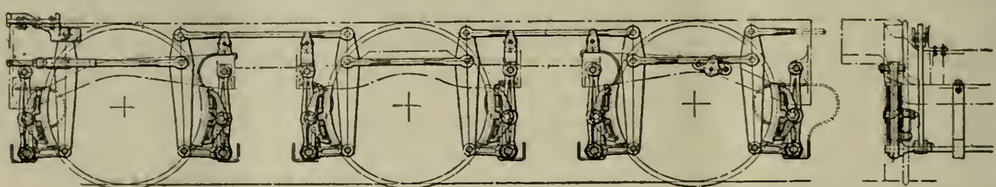
In modern heavy passenger train service, the single shoe type of foundation brake gear with inherent false piston travel is responsible for:

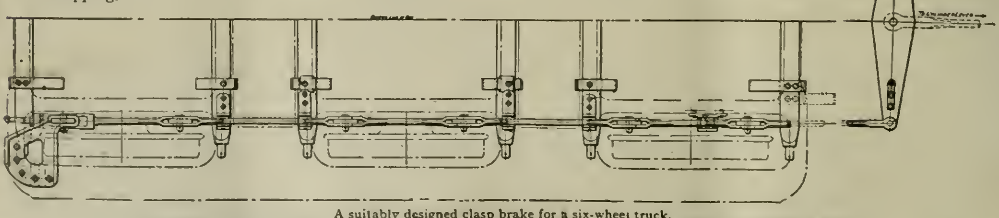
(1) Rough handling of trains in:
- Starting. (Violent taking of slack necessary to get train under way.)
- Slowing down.
- Stopping.

(2) Inability "to make the time" because of:
- Hard pulling train, due to brake shoes dragging and stuck brakes.
- Long drawn out stops, "dribbling on" brakes in attempts to avoid shocks.
- Delays due to hot journals, stuck brakes, flat wheels, and damage from shocks.



(3) Unwarranted expense in:
- Excessive fuel and water consumption.
- Reduced capacity of engine.
- Slid flat wheels due to shocks, stuck brakes and shifting of weight from one pair of wheels to another.
- Hot journals.
- Burned brake shoes and brake heads.



A suitably designed clasp brake for a six-wheel truck.
Proper truck construction must contribute with suitable clasp brake design in the elimination of false piston travel.

Obviously, the way to cure these troubles is not to dally with the effects, but to strike back at the underlying causes by applying a suitable designed foundation brake gear of the two-shoe per wheel or "clasp" type. The attached diagram, comparing a single shoe with clasp brake type of gear, proves that the clasp brake should be employed whenever it is necessary to exceed a braking ratio of 100 per cent. for either emergency or service applications of the brake. And if the point is taken as here established for the failure of the single shoe brake to be "equal to the job" the need for the clasp brake on account of the overloaded brake shoe will have been cared for long before it arises. This applies to passenger service only, for in freight service, where a comparatively low braking ratio is used, the absolute value of the brake shoe pressures may, nevertheless, be such as to warrant the use of two shoes per wheel in order to divide the load and reduce the brake shoe costs.

For two reasons the foregoing list of troubles, occurring in passenger service, do not occur in freight service: First, the braking ratio is limited to 80 per cent., and, second, the type of truck generally used does not permit relative movement between the truck frame and wheel. In a further summing up, it may be said that a well designed clasp brake rigging, such as that shown here, eliminates the single shoe brake evils as above scheduled as no other device can possibly do. A more direct comparison may be drawn up between the single shoe and the clasp types of brake gear by saying that with the clasp brake it is possible to have:

- Shorter stops in emergency, due to reduced brake shoe duty.
- Reduced brake shoe wear.
- Reduced brake shoe maintenance.
- No brake shoe dragging—reduced train resistance.
- Longer trains handled with less loss of time, using same motive power equipment.
- Fewer delays.
- Smoother stops.
- More accurate stops.
- Fewer slid flat wheels from shocks and stuck brakes, and the transfer of load from one pair of wheels to another.
- Fewer stuck brakes.
- Fewer hot journal bearings.

In order to have some measure of relief from the evils attendant upon the use of the single shoe brake gear, pending the accumulation of funds required in order to meet the sometimes very great expense of remodeling trucks to provide for a suitable clasp rigging, a device has been designed which makes the auxiliary reservoir volume a function of the piston travel. The brake application starts with an auxiliary of very much reduced size, which keeps down the brake cylinder pressure for light brake pipe reductions. The continued outward movement of the brake piston cuts in, at predetermined points, additional auxiliary volumes, finally giving full service pressure when the proper brake pipe reduction has been made. This provides even greater flexibility of brake operation than can be obtained with the clasp brake, but, of course, all of the troubles and losses due to brake shoes dragging on the wheels still remain. This device also arranges for the use of the first small auxiliary reservoir for all reapplications of the brake after a partial release, thereby cutting down the build-up in pressure on that retained in the cylinder and making smooth handling of long trains at low speeds much more certain.

The Lubrication of Locomotives

The Utility of Mixed Lubricants—The Importance of Feeders—Good Lubrication a Saver of Fuel.

By E. STANDIFORD, Youngstown, Ohio.

Various kinds and qualities of oil are used for lubricating the various parts of the locomotive, such as axle boxes, connecting rods and valves. Rape oil alone or mixed with a small quantity of mineral oil is much used. Tallow is not used as much as formerly, although it is a good lubricant for axle boxes when running warm, but if there is no tendency to heating it should not be used, as it will thicken the oil, causing it to flow too slowly, especially in cold weather. For use in sight-feed lubricators for the cylinders and slide valves a thick mineral oil is commonly used. It stands the heat well, and is free from the corrosive effect peculiar to tallow which was formerly used for these parts. Feeders or wicks to fit in the siphon pipes are usually made with plaited wire and with a loop at the end for strands of worsted to be held in. For the rotating parts, such as coupling rods, short feeders, known as plug feeders, are required, the worsted bearing reaching to the top of the pipe, so as to leave a small space to catch the oil when it is thrown about by the movement of the engine. A piece of cane or cork should be screwed in the hole in the oil cup to prevent the oil being thrown out, and these materials being porous, the air will be admitted to replace the oil as it is used. A spring button may be fitted into the oil hole, with a small hole drilled through the button admitting the air.

For the axle boxes, slide-bar cups, and other stationary oil vessels, tail feeders are used. The worsted in these is required to be long enough to reach to the bottom of the oil recess and the oil will find its way through the feeder to the bearing by capillary attraction. The number of strands of worsted required for the feeder must be determined by the thickness of the oil used. If the feeder is found to siphon too large a quantity of oil, more strands should be added, and the number of strands lessened if a sufficient quantity of oil is not reaching the bearing.

Some feeders ready made, also some pieces of cane or cork, should always be kept by enginemen. An engineer when getting his engine ready for the day's work should see that all lubricator and oil cup covers are secure. If they are left loose they are liable to work out when running and be lost. If any part is found not to take much oil it should be inspected at once; the feeders cleaned or renewed, or the oil cup cleaned out as required. Tail feeders should be adjusted and gland swabs or mops seen to be properly in their places.

Mops for the glands are made of worsted or lamp cotton, plaited and tied into a ring to fit the gland nuts. The ends of the cotton or worsted after being tied should not be left hanging around the rod; mops with straggling tails conduct half the oil to the ground, consequently wasting it.

The parts with plug feeders should be oiled before leaving the shed, as the engine cannot always be placed in the right position when standing with a train. The horn-blocks require a little oil, especially on a line with many curves, and the engine will ride easier with horn-blocks greased. The slide bar and gland cups should be the last to be filled up, so as to save going around to them when the engine is moving. The pins in the link motion require a little oil in the holes made for the purpose; neglect to oil these small but important parts is likely to cause them to get hot and seize.

It is difficult to fix a rule as to how many drops of oil per mile any particular part should use, owing to the fact that different kinds and qualities of oils are used by different companies, also that engines work under greatly dissimilar conditions. An engineer should make himself well acquainted with the character of the material he is supplied with so as to know just how to deal with it.

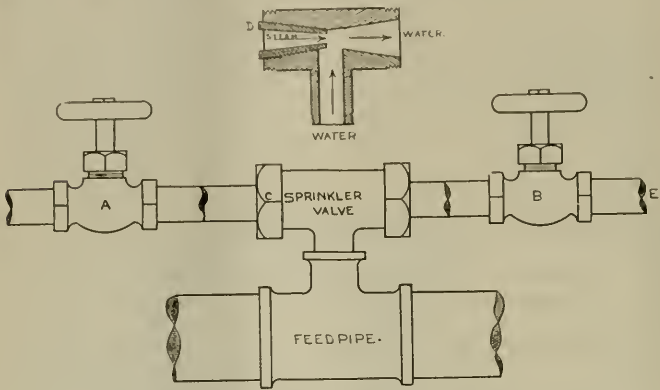
When an engine is running its first trips when new or after coming out of the repair shops, it is the best plan to be rather generous with the lubricator until everything is in good order, for once a bearing gets hot it is often a source of trouble and anxiety for some time after. Some engineers are in the habit of putting cylinder oil in the axleboxes; this is a practice that is not at all advisable, especially in cold weather; in warm weather a little of it helps to check the oil from being used too quickly, but if a large quantity of mineral oil is put into the axleboxes it will not siphon through the feeders until the axlebox begins to grow warm. If an engineer finds that some one else has been running his engine and has served the axle boxes with thick oil, the best way is to clean the feeders and mix the thick oil with a liberal supply of paraffin oil, which will have the effect of helping it to pass through the feeders, and also have the effect of softening the pads, which may have become hardened.

In conclusion, it may be said that a well-lubricated engine should be lighter on coal than one marked light on oil consumption. This fact requires no extended experiments.

Water Sprinkler Valve.

By J. H. Hahn, Bluefield, W. Va.

The accompanying sketch shows a cold water sprinkler or squirt hose valve of the siphon type, and is more substantial and safer than those that are generally in use. The valve A is located in the steam line from the turret in a convenient location in the cab, and the valve B is located in the water line to the sprinkler hose. The nozzle D is held in position by a collar and nut C, and the nozzle should project 1/16 in. outside of the valve body as shown at D. The sprinkler hose to be attached to the pipe at E. The sprinkler valve is attached directly to the injector feed water pipe, and no dimensions are necessary, as local conditions will suggest the size of pipe. However ½ in. pipe has proven very satisfactory. A good valve of the same type may also be made by using a ¾ in. T and by using nipples and bushings the nozzle may be reduced to ⅛ in. pipe. The sprinkler valves may be applied to the feed pipe without drilling and tapping by welding the nipple in the feed pipe by the welding process.



DETAILS OF WATER SPRINKLER VALVE.

The Perkins Safety Switch

Considerable interest is being manifested among railroad men generally and in the South particularly, in the Perkins Safety Switch. As will be seen by our illustrations, the device eliminates the older types of frog and split switch which, as is well known, have been regarded as the cause of some deplorable accidents on railroads. It will be observed that when the switch is set for the siding the movable rail has passed over the top of the fixed rail, and forms a perfect junction with the succeeding rail thereby forming an even unbroken line rail from one end of the switch to the other, thereby providing safety from broken, worn or damaged frogs, at all times, as the movable rail never touches the main line rail except when a train is going into a side track.

Its installation is easy and economical, and by reason of its simplicity of construction is said to be much cheaper than other kinds of switches. In saying this, however, account must be taken of the fact that the Perkins switch has some rods, levers and working parts which must be made to work freely in the winter and kept in good repair during the entire year.

Our illustrations show a view of the Southern railway yards at the John Street crossing in Atlanta, Ga., where the device was installed some months ago and has given every satisfaction.

We have had the opportunity of examining a working model of the device, and it seemed to us that it contained some very valuable features. The main line, when the switch is set for it, forms an unbroken and solid track, while the elevation of the frog rail where it lies on top of the main line track rail, is such as to preclude high speed while the main line passing through the switch can sustain any main line speed that the rest of the track will carry.

THE PERKINS UNBROKEN MAIN LINE

Performance of P. & R. Mallets.

In the June, 1917, issue of Railway and Locomotive Engineering, page 180, we gave an account of the construction and design of some Mallet or 2-8-8-2 type of locomotives built by the Baldwin Locomotive Works for the Philadelphia & Reading Railway, of which Mr. J. A. Seiders is superintendent of motive power and rolling equipment. The engines are among the largest of this type and are able to develop a tractive effort of 98,400 lbs. The weight of the engine itself is 478,500 lbs., and with the tender makes 634,820 lbs.

The engines, of which the P. & R. have six, were designed to operate on the Frackville incline above Pottsville, Pa., which has a ruling grade of 3.3 per cent and curves of 16 degs., and the engines handle from 35 to 38 light 50-ton capacity coal cars, going up, and the same number of loaded cars coming down. They have been operating very successfully up to the present time in this service, hauling 35 to 40 per cent heavier trains than the large Mikados previously used, at the same time the work is now made easier on both engine and track.

It was necessary to work out a very compact design, on account of the necessity of keeping within the tunnel clearances of 15 ft. in height by 11 ft. in width. Two-wheel swing bolster trucks are used front and back, as the engines are run backward for a large part of the time. The grates are 9 ft. wide by 12 ft. long, or 108 sq. ft., and the machines are fired very satisfactorily fired by Street stokers of the C type, using an equal mixture of anthracite buckwheat and bituminous coals to make the mixture.

SWITCH SET FOR SIDE TRACK SERVICE

Increase of Wages

Announcement has been made that another increase in wages for shop employees aggregating nearly $2,000,000 a year has just been promulgated by the Westinghouse Electric & Manufacturing Company. All employees observing shop hours, except munition workers, will receive an additional bonus of 10 per cent.

Items of Personal Interest

Mr. F. W. Schultz has been appointed master mechanic of the Kansas City, Mexico & Orient of Texas at San Angelo, Texas, succeeding Mr. T. C. Kyle.

Mr. E. S. McMillan has been appointed road foreman of engines of the Grand Trunk, Montreal Terminals, succeeding Mr. F. H. Holland, assigned to other duties.

Mr. H. R. Voelker, formerly foreman in the shops of the Pennsylvania Lines West, at Bradford, Ohio, has been appointed general foreman in the shops at Louisville, Ky.

Mr. R. J. Williams has been appointed superintendent of motive power of the Pere Marquette, with headquarters at Detroit, Mich., succeeding Mr. W. L. Kellogg resigned.

Mr. R. C. Manning has been appointed assistant to Mr. W. D. Robb, vice-president of the Grand Trunk Railway System, in charge of motive power, car equipment and machinery.

Mr. H. F. Bardwell has been appointed New York district manager for the Vanadium-Alloys Steel Company, of Pittsburgh and Latrobe, Pa., with offices at 30 Church street, New York.

Mr. Charles Manley has been appointed superintendent of machinery of the Missouri & North Arkansas, with jurisdiction over all mechanical and car departments, with office at Harrison, Ark.

Mr. E. Kennedy, formerly assistant general manager of the West Albany shops of the New York Central, is now connected with Manning, Maxwell & Moore, with headquarters at Chicago, Ill.

Mr. A. G. Shaver has been retained as consulting engineer by the A. G. A. Railway Light & Signal Company, Elizabeth, N. J. Mr. Shaver's headquarters will be room 857, Peoples Gas Building, Chicago.

Mr. M. B. McPartland has been appointed master mechanic of the Denver & Salt Lake, with jurisdiction over the motive power and car departments, with headquarters at Utah Junction, Denver, Colo.

Mr. H. W. Brewer, formerly erecting shop foreman at the West Albany shops of the New York Central, has resigned to become general foreman of the DuBois shops of the Buffalo, Rochester and Pittsburgh.

Mr. G. H. Walters, formerly engineer of tests in the stores department of the Chicago, Milwaukee & St. Paul, at Milwaukee, Wis., has been appointed assistant purchasing agent, with office at Chicago, Ill.

Mr. E. V. Williams, formerly general foreman of the shops of the New York Central, at West Albany, has been appointed superintendent of shops of the Buffalo, Rochester & Pittsburgh his office is situated at the town of Du Bois, Pa.

Mr. Edmund Barany, machine designer of the Singer Manufacturing Company, Elizabeth, N. J., has assumed the duties of mechanical engineer and assistant to general superintendent of the Cleveland Twist Drill Company.

Mr. L. F. Wilson, vice-president of the Bird-Archer Company, Chicago, has been called into active service with the Second division of the regular army at Chicamauga Park, Ga., with the rank of major in the quartermaster corps.

Mr. H. E. Byram has been elected president of the Chicago, Milwaukee & St. Paul, succeeding Mr. A. I. Earling, who became chairman of the board. Mr. Byram was formerly president of the Chicago, Burlington & Quincy.

Mr. W. J. Bennett, formerly assistant superintendent of motive power of the Denver & Rio Grande, at Denver, Colo., has been appointed superintendent of motive power and car departments, succeeding Mr. J. F. Enright, deceased.

Mr. L. S. Kinnard, formerly master mechanic of the Pennsylvania Lines, at Logansport, Ind., has been appointed superintendent of motive power of the Chicago & Eastern Illinois, with offices at Chicago, succeeding Mr. J. E. Epler.

Mr. Victor U. Powell has been appointed master mechanic of Chicago Terminal and Illinois division of the Illinois Central, with office at Burnside Shops, Chicago, succeeding Mr. Henry C. Eich, resigned to accept service with another company.

Mr. C. W. Burkett has been appointed assistant master mechanic of the Monongahela division of the Pennsylvania, with offices at South Pittsburg, Pa., succeeding Mr. E. H. Newbury, transferred to shop inspector in the office of the superintendent of motive power at Pittsburgh.

Mr. H. C. May, formerly superintendent of motive power of the Lehigh Valley, at South Bethlehem, Pa., has been appointed to a similar position on the Chicago, Indianapolis & Louisville, with headquarters at Lafayette, Ind., succeeding Mr. C. P. Burgman, assigned to other duties.

Mr. F. N. Hibbits, formerly superintendent of motive power of the Lehigh Valley, and for the last two years assistant general superintendent of the Baldwin Locomotive Works, has been reappointed to his previous position on the Lehigh Valley, succeeding Mr. H. C. May, resigned, to accept service with another company.

Mr. A. A. Hemingway, formerly car repair foreman of the Delaware & Hudson, at Colonie, N. Y., has been appointed divisional car foreman of the Saratoga division, with headquarters at Colonie, and Mr. J. E. O'Neil has been appointed divisional car foreman of the Susquehanna division, with headquarters at Oneonta, N. Y.

Mr. John J. Harty, vice-president and general manager of the Canadian Locomotive Company, Kingston, Ont., has been elected president of the company. He is also a director of the Dominion Foundries & Steel Company and is a son of William Harty, who was, some years ago, president of the Canadian Locomotive Company and is still one of its largest stockholders.

Mr. H. E. Gifford, Jr., has been appointed northwestern representative of the A. G. A. Railway Light & Signal Company, Elizabeth, N. J. Mr. Gifford has been connected with the signal business for about 12 years, in which time he has gained a varied experience both in railway and supply work. His headquarters will be room 857, Peoples Gas Building, Chicago.

Mr. O. C. Wright, formerly assistant engineer of motive power of the Pennsylvania Lines West at Pittsburgh, Pa., has been appointed master mechanic on the Southwestern System at Logansport, Ind., and Mr. E. B. De Vilbiss, formerly assistant engineer of motive power at Toledo, Ohio, has been transferred to the general office at Pittsburgh, Pa., succeeding Mr. Wright.

Mr. Francis M. Waring, formerly acting engineer of tests of the Pennsylvania, at Altoona, Pa., has been appointed engineer of tests. Mr. Waring is a graduate of the Virginia Polytechnic Institute and entered the employ of the Pennslyvania in 1900, in the mechanical department, and in 1912 he was appointed foreman in the physical laboratory, and more recently acting engineer of tests.

Mr. W. P. Kenney, road foreman of engines on the Missouri, Kansas and Texas, has been transferred from Greenville, Tex., to Muskogee, Okla., as general foreman. Mr. W. M. Rieman has been appointed general foreman at Greenville, and Mr. W. H. Gallagher has been appointed trainmaster and road foreman, succeeding Mr. Fred Rutledge, transferred to McAlester, Okla.

Mr. C. M. Starke, formerly master mechanic of the Illinois Central at McComb, Miss., has been appointed assistant superintendent of motive power of the Missouri, Kansas & Texas, with headquarters at Parsons, Kans. Mr. Starke served as machinist apprentice on the Illinois Central, and was master mechanic at Water Valley on that road when he received his present appointment.

Mr. E. W. Smith, formerly assistant engineer of motive power of the Pennsylvania at Altoona, Pa., has been appointed master mechanic, with office at Harrisburg, succeeding Mr. C. L. McIlvaine, promoted, and Mr. C. O. Keagy, formerly general foreman of the West Philadelphia shops, has been appointed master mechanic of the Middle division of the main line, with office at Altoona, Pa.

Mr. Frank B. Archibald, for the past five years eastern manager of the National Lock Washer Company, has been elected vice-president; Mr. J. Howard Horn, eastern representative for the past seven years, has been appointed sales manager. On or about December 1, offices will be opened in Philadelphia, Pa., and St. Louis, Mo., these in addition to present offices in Chicago and Detroit, Mich.

Mr. H. C. Eich, formerly master mechanic of the Chicago Terminal of the Illinois Central, has been appointed superintendent of motive power of the Chicago Great Western, with offices at Oelwein, Ia. Mr. Eich served his apprenticeship as a machinist in the Chicago shops of the Illinois Central, and rose rapidly to the position of master mechanic, first serving in that capacity at East St. Louis, and later at Memphis, Tenn.

Mr. A. C. Adams, formerly master mechanic of the Seaboard Air Line, at Raleigh, N. C., has been appointed superintendent of shops of the New York, New Haven & Hartford,, at Readville, Mass., and Mr. J. C. Breckenfeld, formerly inspector of tools and machinery on the New York, New Haven & Hartford, has been appointed assistant superintendent of locomotive shops at Readville, and Mr. John Reid, formerly general foreman at New Haven, has been appointed inspector of tools and machinery, succeeding Mr. Breckenfeld.

Mr. Harry M. Sperry has been appointed publicity representative of the Union Switch & Signal Company; General Railway Signal Company; Federal Signal Company, and Hall Switch & Signal Company, with headquarters at 120 Broadway, New York. Mr. Sperry has had a wide experience as a signal engineer, having prepared plans and methods of signalling for the subways in New York and vicinity. In this, his chosen sphere of activity, he is unrivalled. He was elected President of the National Railway Appliance Association, last year.

Mr. Herbert G. Morgan has been appointed signal engineer of the Illinois Central, with headquarters at Chicago, Ill. Mr. Morgan is a graduate of Purdue University, and was engaged for some years with the Bell Telephone Company, and in 1907 entered the drafting room of the Illinois Central. In 1909 he was chief draftsman in the signal department of the Chicago & Northwestern. In 1910 he was appointed assistant engineer for the General Railway Signal Company, at Rochester, N. Y. In 1913 he was again in the signal department of the Illinois Central as office engineer, and latterly in the valuation department as pilot signal engineer until his recent appointment.

Mr. John M. Henry, formerly assistant superintendent of the New York division of the Pennsylvania at Jersey City, N. J., has been appointed assistant general superintendent of motive power of the lines east of Pittsburgh, with headquarters at Altoona, Pa. Mr. Henry is a graduate of Purdue University and entered the service of the Pennsylvania as a special apprentice at Altoona in 1889. In 1901 he was made motive power inspector. Latterly he became assistant engineer of motive power of the Erie division, master mechanic at Elmira, and later at Olean, Sunbury and West Philadelphia. In 1913 he was superintendent of motive power at Pittsburgh, Pa. In 1917 he was transferred as assistant superintendent of the New York division, and has been now promoted as above.

Mr. William W. Atterbury, vice-president, in charge of operation of the Pennsylvania Lines, has been appointed director-general of transportation for the troops in France, with the rank of brigadier-general in the national army. Mr. Atterbury is from Indiana and graduated from Yale University, and entered the service of the Pennsylvania in 1886 as an apprentice in the Altoona shops. He served as assistant road foreman of engines on various divisions of the road. In 1892 he was promoted to assistant engineer of motive power on the northwest system of the road, and in 1893 to master mechanic at Fort Wayne, Ind. In 1896 he was appointed superintendent of motive power of the Pennsylvania Lines East, and in 1901 to general superintendent of motive power, and in 1903 he was advanced to manager, and in 1909 was elected vice-president in charge of transportation.

WILLIAM W. ATTERBURY

Traveling Engineers' Association.

A meeting of the Executive Committee of the Traveling Engineers' Association was held in Chicago on October 9. It was decided to publish the reports of the Committees, which were prepared for the last annual meeting, which was postponed on account of war conditions.' Subjects were selected for consideration by the Association for the next meeting, to be held in September, 1918, at Chicago, Ill. On motion, the services of the Association were offered to Mr. Willard, chairman of the Railroad Department of the National Board of Defense.

In the course of the meeting, President J. R. Scott made some very interesting remarks, which were principally related to the duties of the members during war time, as the traveling engineer from his past experience as a locomotive engineer, can prove very valuable to the railways, especially in the effort to reduce the cost of fuel. A great many engineers and firemen who are of military age, have responded to the call of our Country—many regiments composed of railroad employes are now in France ready to take places where needed. This patriotic response to our Nation's call has necessitated the promotion of senior firemen and the employment of a great many inexperienced men, who will have to be educated—and in all instances increased supervision will be necessary to bring them to the highest standard of efficiency. It is important that they understand what we want and why we want it. On account of the scarcity of fuel, a poorer quality may have to be used and these men must be taught how to use each scoop of coal so that every unit of heat possible will be generated.

Association of Manufacturers of Chilled Car Wheels

At the annual meeting of the above association, held in New York, October 9, 1917, the following officers were elected: President and treasurer, George W. Lyndon; vice-presidents, E. F. Carry and J. A. Kilpatrick; secretary, George F. Griffin; consulting engineer, F. K. Vial. Board of Directors: J. M. Buick, vice-president, American Car & Foundry Co.; J. A. Kilpatrick, president, Albany Car Wheel Co.; W. S. Atwood, chief engineer, Canadian Car & Fdy. Co.; Charles A. Lindstrom, assistant to president, Central Car Wheel Co.; F. K. Vial, chief engineer, Griffin Wheel Co.; E. F. Carry, president, Haskell & Baker Car Co.; A. G. Wellington, president, Maryland Car Wheel Works; W. C. Arthurs, president, Mt. Vernon Car Mfg. Co.; J. D. Rhodes, president, National Car Wheel Co.; F. B. Cooley, president, New York Car Wheel Co.; A. J. Miller, general manager; Ramapo Foundry & Wheel Works; William F. Cutler, vice-president, Southern Wheel Co.

In the course of an able address delivered by the president, Mr. George W. Lyndon, he stated that "the recognition of a standard 850 lb. chilled iron wheel by the Master Car Builders' Association will dispel the illusions of our competitors with respect to the limit of the carrying capacity of chilled iron. It is now a well established fact that the load that can be carried on a chilled iron wheel is only measured by the ability of the rail to support it. Many 3-in., 950 lb. chilled iron wheels are running under heavy engine tenders of 12,000 gallons capacity, and are giving such a good account of themselves that no other type of wheel is considered by the users. We deal not only with the Master Car Builders' Association, but are in close association with the American Railway Association, the American Railway Engineering Association, the Interstate Commerce Commission, the Bureau of Standards, the American Society of Testing Materials, the American Foundrymen's Association, and the State universities. All this work through associations, railways and universities is educational, and must be beneficial to our association in determining standards through the Master Car Builders' Association.

"We are not influenced by commercial considerations in asking for heavier wheels. We know the increased weights are necessary. Who knows what the result of the work of the University of Illinois may be? Perhaps the analyses of the stresses within the wheel may suggest a redistribution of the metal, and we may be able to decrease weights, which we will be ready to do with as great interest as we are now anxious to increase them. With the flange improvement settled to our satisfaction and extra weight added to withstand heat stresses, the chilled iron wheel will have a future record as wonderful as it has maintained during the past 67 years of universal use."

Annual Report of the Westinghouse Air Brake Company.

The annual report of the Westinghouse Air Brake Company and Subsidiary Companies for the fiscal year ending July 31, 1917, was submitted to the stockholders at the general office of the company, Wilmerding, Pa., on October 18. An interesting item in the report is the allusion to the munition contracts, which have been satisfactorily completed, and as there has been an enormous increase in facilities for doing this class of work by companies normally engaged in the manufacture of munitions, and at the same time the demand for brake apparatus to equip cars and locomotives urgently needed for the transportation of troops and supplies, every possible effort on the part of the Westinghouse Company has been made to meet the demand for air brake material and hence the company has disposed of its munitions plants. This action does not imply any unwillingness on the part of the Brake Company to put all its facilities at the service of the Government on any terms that the Government may nominate, but in preventing delay in the immediate increase of transportation facilities, the company is doing more for the successful conduct of the war than can possibly otherwise be done.

Saving Cars on the Pennsylvania.

The Pennsylvania railroad has established a system of car saving at several of the leading points along the road. An increase of nearly 24 per cent. has been brought about in the average number of tons of less-than-carload freight loaded per car since what is known as the "Shipping Day" plan went into effect. The purpose of the plan is to concentrate less-than-carload freight, as far as practicable, into full carloads at the point of origin, and thus avoid the delays, the waste of space, and the liability to loss, damage and errors, resulting from the older system, which involved double handling of the freight in order to make up full carloads at freight transfer stations. When the new system is in complete operation, it will save on the Pennsylvania Lines East, the use of upward of 1,000 cars per day, which will be available for rendering increased service of other forms to the Government and the shipping public.

New Railway Supply Agency.

We take pleasure in stating that Mr. Oscar F. Ostby, well known in railroad and railroad supply circles, has opened an office in the Grand Central Terminal, New York. He has a good line of general railway supplies, and is the official representative of the Grip Nut Company, of Chicago, and of the Glazier Manufacturing Company, of Rochester, N. Y. This latter company makes oil headlights, reflectors and cases complete, and is prepared to furnish cases and reflectors for electric or acetyline headlights. The manufacture of reflectors requires very exact and intelligent work and the company which Mr. Ostby now represents, has achieved an enviable reputation for this specialty. Mr. Ostby's office is in room No. 2736, in the Grand Central, and he is prepared to receive visitors and friends on the first of November, of this year.

Reducing Passenger Traffic.

The keen appreciation of the public in the railroad situation is manifested by the aid that is being given in relieving the congestion of the freight department. Since May 1, the railroads have been enabled to reduce their passenger service by approximately 25,000,000 miles. Thousands of their train crews and locomotives have been released for use in the freight service, thereby facilitating the movement of troops, coal, food products and supplies needed by the Government. The shippers are also responding willingly to the effort to make one car do the work formerly requiring two, and there is scarcely a murmur of complaint.

National Railway Appliance Exhibition.

An announcement has been made that the National Railway Appliances Association will hold its tenth annual exhibition at the Coliseum and Annex, Chicago, March 18-21, 1918. Applications for space should be filed in the office of the secretary-treasurer, 122 Michigan avenue. As formerly, it is expected that the meetings of the American Railway Engineering Association, the Railway Signal Association, and the Association of Railway Telegraph Superintendents will be held during the same week that the exhibition is held.

War Board for Canadian Railways

A Railways War Board composed of the representatives of the Canadian Pacific, the Grand Trunk and the Government Railways (shortly to embrace the Canadian Northern) is under consideration by the Canadian Government. The board would work toward co-ordination of effort to prevent freight congestion and to facilitate the expeditious handling of traffic during the war. Co-ordination with United States lines is also proposed. The standardization of the size of rails on various railroads is likewise being considered.

Macleod Company's Extensions.

The Macleod Company, Cincinnati, Ohio, has been compelled, on account of their rapidly expanding business in Sand Blast Equipment and Metallurgical Furnaces, to enlarge their plant and have increased their capital to $100,000,000. The company has been established for over twenty years. In that time they have supplied very many of the industries in America and other countries.

Car Builders Wanted

The following orders have been received at Altoona, Pa., from the War Department: "Five hundred car builders or car repairmen for work in French railway shops, must be recruited in your district at once."

McCord Purchases Property.

McCord & Co. have purchased three and one-half acres of land at West Pullman, Ill., from the Illinois Central. A portion of the property is improved with a plant that has been used by the McCord company as a steel foundry for the manufacture of journal boxes.

Railroad Equipment Notes

The Marion & Eastern, Marion, Ill., is in the market for 1,000 steel coal cars.

The Bangor & Aroostook has ordered 100 box cars from the Laconia Car Company.

The Chilean Government is in the market for a number of Mikado (2-8-2) type locomotives.

The Russian Government is expected to place orders for 1,500 locomotives, the United States acting for Russia.

The Lehigh Valley is planning to build a brick boiler house and machine shop at Buffalo, N. Y., at a cost of $50,400.

The British Government is reported negotiating for 70 ten-wheel (4-6-0) locomotives for the Egyptian State Railways.

The Central of Georgia, which is in the market for 500 underframes for ventilated box cars, will build this equipment in its own shops.

The Illinois Central, according to report, is preparing specifications and will issue inquiries soon for about 4,000 freight cars.

Bliss Dallet & Co. have ordered one 26-ton six-wheel (0-6-0) locomotive from the American Locomotive Company. The cylinders will be 11 by 16 inches.

The Illinois Central has placed an order with the Pullman Company for 45 passenger cars, including 25 coaches, 15 baggage and 5 combination baggage and mail cars.

The Shantung Railway has ordered 2 80-ton Consolidation (2-8-0) type locomotives from the American Locomotive Company. The cylinders will be 20½ by 26 inches.

The Chicago Great Western has let a contract to T. S. Leake & Company, Chicago, for an 11-stall roundhouse at Clarion, Iowa, division headquarters on its Omaha line.

The Union Miniere Du Haut Katanga of Central Africa has ordered four 24-ton six-wheel (0-6-0) locomotives from the American Locomotive Company. The cylinders will be 10 by 16 inches.

The Spokane, Portland & Seattle will add eight stalls to its roundhouse at Vancouver, Wash., which, including improvements to its shop at the same terminal, will involve an expense of about $16,000.

The Union Pacific system is inquiring for several thousand freight cars, including 1,000 hopper bottom gondola, 1,000 drop bottom gondola, 1,000 single deck stock, 500 flat, 200 tank, 50 caboose cars and 1,000 logging trucks.

The Illinois Central has awarded contract to G. A. Johnson & Son, 1335 North Clark street, Chicago, to construct a transfer table, repair mill building and erect a concrete and brick coach yard building at Memphis, Tenn., to cost about $10,000.

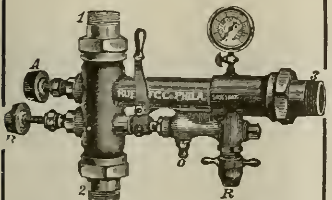
The Arnold Company, of Chicago, is to supervise construction of the railroad shop plant for the Vicksburg, Shreveport & Pacific, at Monroe, La. This report should be corrected to state that the Arnold Company are the engineers and constructors for the complete plant, handling the entire proposition.

The Illinois Central reported as contemplating the purchase of 100 locomotives, is buying approximately that number, including 50 Mikado (2-8-2) type, 25 switching (0-6-0) and 4 Santa Fe (2-10-2) type. The same office issues inquiries for 13 or more locomotives for the Central of Georgia, making a total of 90 to 100 engines.

The Vicksburg, Shreveport & Pacific will erect various buildings at Monroe, La., to include: Blacksmith shop, 60 by 120 feet; seven-stall addition to roundhouse, 97 feet deep; machine shop, 97 by 120 feet, saw-tooth roof; all of concrete and timber. The estimated total cost is $100,000. The Arnold Company, of Chicago, is to supervise construction.

The United States Government has just placed orders for 4,800 narrow gauge freight cars for army use in France. Contracts for 1,000 cars each were taken by the Pressed Steel Car Company, according to report, the Standard Steel Car Company and the Ralston Steel Car Company, while the American Car & Foundry Company received an order for 1,800 cars.

The National Tube Company has revived a former inquiry for steel freight cars and is now getting prices on 50 70-ton hopper, 50 70-ton hopper coke, 245 70-ton gondola, 30 50-ton dump car bodies, 15 70-ton flat and 10 100-ton skelp cars for the Lake Terminal, Lorain, Ohio; 30 70-ton hopper, 4 70-ton gondola and 12 70-ton flat cars for the McKeesport Connecting, McKeesport, Pa., and 40 70-ton hopper and 14 70-ton gondola cars for the Benwood & Wheeling Connecting, Wheeling, W. Va.



Books, Bulletins, Catalogues, Etc.

Co-operation in the Regulation of Railroads.

How the States can co-operate in the efficient national regulation of railroads, was the subject of an address by Mr. Samuel Rea, President of the Pennsylvania railroad system, before the members of the National association of railroad commissioners, at Washington, D. C., October 17. The address now appears in pamphlet form, extending to 30 pages, and presents in a clear and forcible manner the admirable progress already made in transportation by the co-operation of the railroads. The abolition of useless reports was advocated and some amazing statistics presented. It appears that no less than 151 tons of printed reports had to be presented to the Federal Commission before a consideration of a 5 per cent increase in rates could be considered. Over 3,000,000 official separate reports from 2,385 railroads were presented. Mr. Rea insisted that this was 2,300 too much, and when he turned to his own company, the Pennsylvania, where there are 115 separate active transportation companies he admitted that this is just 114 too many. Obsolete merger laws came in for a severe scorching. Out of this miserable tangle, Mr. Rea believes that a practical valuation is possible, and that a simplification of accounting, elimination of unnecessary reports, prompt according of reasonable rates, legalizing of pooling traffic, encouragement of mergers to promote efficiency and relief from obsolete laws are all within the range of possibility.

It would be hazardous to venture an opinion as to whether this deplorable state of affairs is one of the evils that must be expected in a democracy, or whether it is an outgrowth of the sudden development of a vast continent that will remedy itself in the years that are to be, but surely the co-operation that Mr. Rea so eloquently pleads for could be attempted, and it is to be hoped that when we see the end of this world war, the high spirit of patriotism that the railroad men have shown will not pass into a memory but will abide, and that the seeds sown in self-sacrifice will blossom into the fulness of unimagined fruition.

Baldwin Record No. 86.

The Baldwin Locomotive Works new Record of 40 pages, illustrate and describe 36 types of locomotives built at the company's works for industrial and contractors' service. They represent the most modern practice. The locomotives are specially adapted for service in and about steel mills, blast furnaces and smelters. Some of the designs are particularly interesting on account of the unusually narrow gauge and uneven and sharp curves, involving a gauge of 2 ft. The Marshall type of valve gear appears on some of the types rendering the parts easily accesible for oiling and inspection. Nearly all of them are suitable where fire risks must be eliminated. The reservoir of these fireless engines is charged with steam and hot water from a stationary plant, and the pressure is considerably reduced before it is used in the cylinders. As the storage pressure gradually falls, a certain amount of the heated water becomes converted into steam. When the pressure in the reservoir approaches the cylinder working pressure, the locomotive should be recharged. This is done by admitting steam through a perforated pipe in the bottom of the reservoir. Quite a number of the types are of the standard 4 ft. 8½ ins. gauge. Among others a compact four-coupled 21-ton type for the French War Office. This locomotive will haul 200 tons on a straight level track, also haul four cars weighing about 80 tons up on average grades of .4 of one per cent, for a distance of 6.2 miles without recharging the reservoir.

Storage Affects Coal.

The subject treated in Bulletin No. 97, issued by the Experimental Engineering Station of the University of Illinois, Urbana, Ill., is of fundamental importance, as a number of causes render it necessary that large quantities of coal should be stored from time to time. Extensive experiments show that fresh-mined coal is very active. Certain constituents have a marked affinity for oxygen, with which they enter into combination at ordinary temperatures. The extent of this reaction depends on the variety and fineness of the coal, but the actual loss of heat value resulting from storage is small. Certain gases are set free, the tendency to absorb oxygen from the air is a marked characteristic, and is accompanied by the generation of a small amount of heat, occasioning some small loss. There is a small increase in weight in the coal, with a correspondingly small amount of heat loss. Bituminous coal can be stocked without appreciable loss of heat provided that the temperature is not allowed to rise above 180 deg. Fahr. Any method of storage must check the absorption of oxygen, so that the generation of heat shall not proceed faster than the loss of heat due to absorption or radiation. Underwater storage prevents loss of heat values. Dry storage is safe if the fine material is screened out at the storage yard and lump only, preferably sized, is stocked. The most serious part of the problem relates to spontaneous heating.

The Bulletin treats at length on pyrites, sulphates and oxidization, and is illustrated with designs of bins and screens. A limited number of copies is available for free distribution.

Locomotive Tests.

The Iowa State College has been conducting a series of locomotive tests with Iowa and Illinois coals, and the results are published in Bulletin 44 of the Engineering experiment station. There are 40 pages of matter interspersed with numerous illustrations and graphic tabulations of coal efficiencies by runs. The superiority of the Iowa coal was evidenced, but at the end of a run the Iowa coal left a clinker more difficult to remove than that from Illinois coal. Railway companies are interested in knowing just where lies the economical limit of haul between any two coal fields, that is—how far they can haul the locomotive coal from one mine until it becomes cheaper to use that from the next. In this regard the work of engineering experiment is of much value. The cost of mining and loading coal varies between mines. The cost of freight per ton per mile also varies on different branch lines, and if data were available covering the entire country, considerable saving could be effected. As it is, much has been done in this direction, and the report before us is an admirable example of what might be accomplished. The Bulletins are published tri-monthly by the Iowa State College of Agriculture and Mechanics Arts.

Staybolts.

The Flannery Bolt Company's latest Digest has an interesting article regarding the number of locomotives built in America for the Russian Government. The orders approach 2,000 for the last ten months. All are equipped with the Tate flexible staybolts, covering the natural breaking zone of the rigid stay, requiring on an average of 500 bolts to each boiler, comprising adjustable button head crown stays, flush bolts, and water space stays. Additional articles of interest refer to the proper method of alignment of the bolt showing that it is necessary to connect the bolt at right angles with the flat sheets of the firebox and radial to the curved portion of the crown sheet, and allow the outer sheet connections to come where they will, according to the layout of staybolt pitches for the firebox sheets, the need of suitable rigging, tools and appliances, whether it be a large or small installation is also pointed out, as much depends on the proper manner of applying each part so that the best results may be obtained. Copies of the Digest may be had on application to the Flannery Bolt Company, Pittsburg, Pa.

Locomotive Superheater Bulletin.

Bulletin No. 2, issued by the Locomotive Superheater Company furnishes a complete order list of superheater parts. There are 44 illustrations embracing all of the parts that are essential to the appliance, besides a chart of assembled superheater. Details are furnished of the name, number required, information required on requisition for ordering—such as builder's number of engine, railroad company's number of engine, classification and type of engine, forged or cast steel return bends, and other details. The use of the Bulletin will greatly facilitate the correct ordering of parts, as without its use it would be difficult indeed to avoid errors where there are a variety of locomotives equipped with the superheater. Copies may be had from the company's offices, 30 Church Street, New York, or Peoples Gas Building, Chicago.

The Railroad Train's Load.

The following amusing poem was contributed by Mr. B. A. Worthington, president of the Chicago & Alton, to one of the railroad publications while disclaiming authorship:

A ton one mile and an engine mile, and a
  tractive haul as well,
A loaded car and an empty car—then his
  eyes began to swell;
A commercial mile, a net mile, and a
  gross ton mile, oh, dear!
Tons and miles and trains and cars, it
  surely is most queer.
If we get five cents for hauling a crab
  from Boston's quaint old streets
To Friscotown, by the Golden Horn, what
  are the net receipts?
How much for coal, for wear and tear,
  for all the trainmen's pay?
How much dead weight does the engine
  haul if the crab dies on the way?
How many grades to the lineal mile, how
  many ties in a section?
The engine loss and the waste of wood?
  Oh, is there any connection?
Oil, tallow and waste, the water supply
  and fuel for locomo's,
Repairs and renewals of engines and cars,
  goodness only knows.
How many tons to a pint of oil, how
  many ton miles to boot,
And ton miles to a ton of coal, as the
  engine goes toot-toot?
What is the total tractive power? It's as
  easy as A B C,
C square into S into eighty-five, P di-
  vided by D equals T.

If I were an automobilist, I'd rather wait a minute at a crossing than forever in a cemetery.

Either a man must make a way for himself or get out of the way of others.

Statement of the ownership, management, etc., required by the act of Congress of August 24, 1912, of Railway and Locomotive Engineering, *published monthly at New York, N. Y., for October 1, 1917.*

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Harry A. Kenney, who, having been duly sworn according to law, deposes and says that he is the General Manager of the Railway and Locomotive Engineering, *and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:*

1. That the names and addresses of the publisher, editor, managing editor and business managers are: Publisher, Angus Sinclair Co., Inc., 114 Liberty St., New York, N. Y.; Editor, Angus Sinclair, 114 Liberty St., New York, N. Y.; Managing Editor, James Kennedy, 114 Liberty St., New York, N. Y.; Business Manager, Harry A. Kenney, 114 Liberty St., New York, N. Y.

2. That the owners are: Angus Sinclair Co., Inc., 114 Liberty St., New York, N. Y. Stockholders owning 1 per cent. of the total amount of stock: Angus Sinclair, 114 Liberty St., New York, N. Y.; James Kennedy, 114 Liberty St., New York, N. Y.; Harry A. Kenney, 114 Liberty St., New York, N. Y.; Mrs. O. J. Schanbacker, 40 Heddon Terrace, Newark, N. J.

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[SEAL] Harry A. Kenney,
General Manager.

Sworn to and subscribed before me this fourth day of October, 1917.

Oliver R. Grant.
Notary Public.

My commission expires March 30, 1919.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXX | 114 Liberty Street, New York, December, 1917 | No. 12

Development and Manufacture of Journal Box Packings

Many engineers are of opinion that an all wool packing for journal boxes gives the best results. This is owing to the fact that when purchased from waste dealers, the product least liable to variations has been the threads obtained from the makers of the best kinds of carpets. Such threads do possess a better average of the properties desirable in a packing than any other, the long coarse wool and the method of spinning giving a natural resilience. The demand for these threads is great, and the price high, and there is not sufficient available to fill the requirements of the railroads.

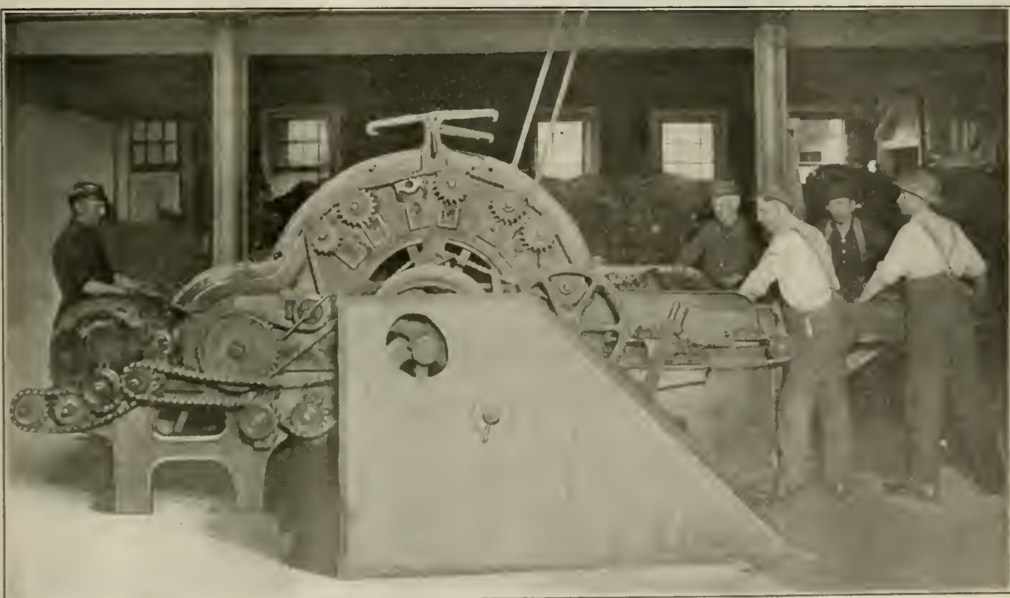


TABLE AND MACHINE FOR SPREADING, MIXING AND FLEECING JOURNAL BOX PACKING.

Others are of opinion that an all cotton packing gives best results, but the fact is that cotton has more often been abandoned as a packing for one containing wool than the reverse. Cotton is much more easily obtainable as it exists in larger quantities. In regard to the comparative costs of railway lubrication the data available have not been sufficiently segragated to show what is actually chargeable to packing. On this point railroad men have not reached an agreement.

Twenty years ago the Franklin Mfg. Co. built a plant with the express object of centralizing the development and manufacture of journal box packings. Service conditions had become more severe, and large, indirect losses due to hot boxes and consequent delays, became apparent. The Galena-Signal Oil Co. had undertaken the standardizing the grades and methods of manufacture, and the application of lubricants, and real progress began to be made. The lubricants were purified and specially adapted to the highest service, and in the matter of packing it was soon discovered that neither wool nor cotton possesses all of the desirable qualities to the proper and adequate degree, and each has some to a greater degree than the other. Cotton threads lack resilience, but the packing absorbs a large percentage of oil compared with wool. It has, however, good capillary properties, and the threads are usually long and strong. The absorption property of wool is low, and its capillarity poorer than cotton. On the other hand, threads of the right type have fair resiliency, and readily part with their oil to the journal surface. Hence it is reasonable to suppose that a mixture of the two, in correct proportions, will produce a better average result than either alone. The cotton carries the oil and keeps the wool threads well supplied, and each functions in its own province. In addition, the mixing improves some of the properties previously low; for instance, separating the cotton threads prevents their retaining the utilizable oil between threads which is noticeable in pure cotton.

It should be known that when the idea of manufacturing what may properly be called scientific packing came into active operation, through General Charles Miller recognizing the importance of the subject and under his supervision experiments were made with a variety of materials having resilient and absorbing qualities. Resilient fibres of vegetable origin such as Louisiana moss, cocoa fibre, Tampico and various lake grasses, while they do not add to the absorbent or capillary action of a packing increase the resiliency of the moss, and aid in the power of expansion which keeps the packing in contact with the journal. Hence the best and most economical packing for journal boxes consists briefly of wool threads, cotton threads and resilient fibres.

The mills in New England and the Atlantic States furnish the chief materials, especially the long, strong threads, commercially 90 to 100 per cent. wool, occurring in carpet mills, and almost free from foreign materials. Other materials, such as merinos, tapestry and dress goods, as well as old carpets, can be used if properly sorted and treated. These, together with what is known as cotton rips—long coarse cotton thread used in cotton carpets and upholstering, together with various vegetable substances already referred to, form the bulk of the material, which, carefully cleaned and sifted and mixed in varying proportions according to the nature of the service, is then ready for the mechanical process of spreading, mixing and fleecing which has been perfected by machines specially constructed for the purpose. A thorough mixing of the raw materials is first arranged by making large "composts" of each element—wool, cotton and fibre. The material is taken from the waste bales, hand-picked, spread out and distributed on the compost, thus thoroughly blending the material from the different bales. A mix of about twenty pounds is then made by hand-pulling from the composts, weighing and spreading it evenly and regularly on a table. Passing through a machine, the ingredients are intimately mixed and form a fleece with the threads all running in one direction. This is rolled up into a bolster form and put up in 100 or 500-lbs., bales. This method retains uniformity of mix and the thread arrangement, whereby the packers or oilers can more easily handle, and will more surely follow instructions issued by the department head.

SECTION SHOWING CARDS IN SPINNING DEPARTMENT.

The Franklin Mfg. Co. has also developed and standardized certain mixes which cover all classes of service. Some of these possess the desirable properties to a less extent than others, allowing a graduation in the price paid, and meeting less exacting conditions. The percentage of mixtures of material is specified, for example, 15 per cent resilient fibre, 45 per cent. cotton, 40 per cent. wool. Probably the best known packing in the country is that known as Perfection Packing. It has been in use for a number of years and has been adopted as a standard by large steam and electric roads, and is universally regarded as a standard railroad specialty. In addition to wool and cotton in equal quantities of 35 per cent. with 15 per cent. fibre there is 15 per cent. of asbestos, the presence of which is readily distinguished by the white flakes distributed through the material. Extensive service tests have established the superiority of this packing.

A report on one large electric road shows special records kept of twenty-eight cars using Perfection Packing for all motor and axle bearings. All ran 10,000 miles without a single hot box. At this stage the packing was changed according to the regular custom of the road, but would be treated in the reclaiming plant, and the packing saved used for trailer journal boxes. Other special records show runs up to 18,000 miles. It may be stated, however, that a knowledge of all items in the operating conditions is necessary in order to recommend one mixture over another, and as may be expected, some mixtures listed under one heading are available for other types of service.

VIEW OF A PART OF THE SPINNING DEPARTMENT.

A few remarks may be added in regard to applying the necessary attention to a heated journal. A smoking box should be promptly attended to. The height of the journal collar on the brass will show whether the lining is out of the brass. The box may be packed too full of waste, and the waste may have worked up under the brass which would cause heating. The brass may not fit the journal, or the packing may be loose and moved away from the journal and become dry, or the journal may be rough due to the presence of some abrasive or cutting matter in the waste. The bearing area may be too small. If the packing is oily and properly lubricating an uncut journal, the trouble must be in the brass. A new brass should be inserted if the lining has melted or is becoming loose. In repacking a box the old packing should be removed, and a piece of fresh packing, wrung moderately dry, and placed in a twisted form in the extreme back of the box. The remainder of the box should be packed firmly under the journal with loose waste, as far out as the collar. A small portion of the packing should be finally laced in the front of the box in a separate piece, and should not extend more than one-half inch above the bottom of the journal collar. Care should be taken that no loose threads be allowed to hang over the front edge of the box. In handling brasses or packing or other material, care should be taken not to lay the material on the ground.

It should be noted that the packing must not extend above the center line of the journal in order to avoid the tendency of the packing to be drawn between the brass and journal. In regard to the amount of oil necessary a good test is to twist several threads of the packing and if oil appears it is an indication that there is enough oil to lubricate the bearing. Too much oil makes the packing less resilient, besides causing waste of oil without any advantage in the way of lubrication. If it should be necessary to apply water to a heated journal, the weight of the car should be taken off the journal. Waste should be placed along the sides and under the journal, and the water poured into the box instead of upon the journal. In this way the water is partially warmed before it comes to the journal and the journal is cooled gradually.

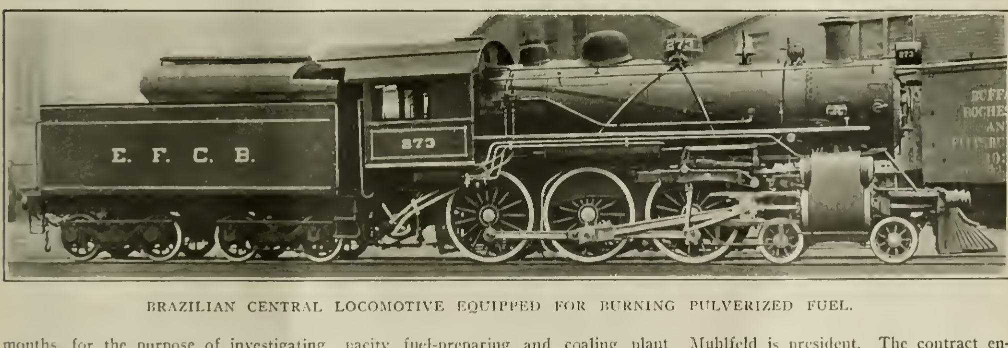
In applying a new brass a block of hard wood should be placed between the top of the wheel and the sills of the car. The lifting jack should be placed on a block of wood across the ends of the ties. A small block of wood placed between the top of the jack and the box will keep the jack from slipping. The jack should be raised sufficiently to relieve any weight on the brass so that it may be readily removed and the new brass applied, taking particular care that both brass and bearing are perfectly clean.

Successful Introduction of Pulverized Fuel on the Central Railway of Brazil

About two years ago a director of the Central Railway of Brazil, Dr. Miguel Arrojado Lisboa, noticed in one of the technical papers that the use of pulverized fuel for locomotives was being developed in this country, and through Dr. J. J. daSilva Freire, sub-director and locomotive superintendent of this railway, he arranged for the latter's assistant, Dr. Joaquim de Assis Ribeiro, chief of traction, to come to the United States to make a personal investigation. Dr. Ribeiro came in November, 1915, remained about three months, for the purpose of investigating the use of American and English imported and Brazilian national coals in pulverized form, as well as in gas producers. On his return, he made an elaborate report on the subject, which was issued in printed form by the director, in June of 1916. About May 1, 1916, Dr. Freire came to the United States on various important missions for the Central Railway of Brazil and for the Brazilian Government. His activities included a further investigation of the use of pulverized fuel for locomotives and stationary boilers. This he did as the result of Dr. Ribeiro's report. Dr. Freire remained here about three and a half months, during which time he not only completed his investigations, but also recommended to the Central Railway of Brazil their adopting the use of pulverized fuel.

As the result of the entire investigation carefully made by these highly competent engineers, the Central Railway of Brazil decided to install a 15-ton per hour capacity fuel-preparing and coaling plant and a stationary boiler equipment at Barra do Pirahy, which is really an enginehouse and shop terminal about 65 miles north of Rio.

Article 75, of Section XXI, of the Brazilian Budget law for 1917, authorized the President of the Republic to spend with the Central Railway of Brazil about $480,000 for the acquisition of the necessary material to construct a mill for the pulverization of domestic coal; for the purchase of 12 locomotives to burn Brazilian coal, and for the purchase of the rights to burn pulverized coal in locomotives, as done in the United States. An order was placed by that railway with the American Locomotive Company for 12 passenger locomotives, ten-wheel (4-6-0 type), to be equipped with pulverized fuel burning apparatus as designed and furnished by the International Pulverized Fuel Corporation, the foreign agency of the Locomotive Pulverized Fuel Company of New York, and of both of which concerns Mr. J. E. Muhlfeld is president. The contract entered into with the Brazilian Government covered the equipping of two hundred and fifty locomotives with the company's pulverized fuel burning appliance during the next five years, and also includes the equipping of stationary boilers and industrial furnaces. All the apparatus for the complete installation of the pulverizing plant was shipped by the company from the United States to Brazil, and with the stationary boiler and locomotive equip-



BRAZILIAN CENTRAL LOCOMOTIVE EQUIPPED FOR BURNING PULVERIZED FUEL.

ment was installed and put into operation by the representative, Mr. A. N. Adamson.

The operation of this 15-ton per hour capacity plant was commenced on August

BRAZILIAN COAL GRINDING PLANT IN COURSE OF ERECTION.

22, 1916. The first fuel to be pulverized was some imported American slack which was very fine in size and equivalent to anthracite slush, and which, after pulverizing, ran between 85 and 90 per cent., through 200 mesh, with very little moisture.

The first locomotive to be put in regular service was the No. 273, which made its inaugural trip on August 27. This trip was made by Dr. Assis Ribeiro, and several engineers also rode on the engine. The train left Barra at 10:52 A. M., running to Entre Rios, a distance of 55 miles, with a tonnage of 500, freight. Time 3 hours and 5 minutes, the same schedule as the passenger train makes with a tonnage of 300. The average steam pressure was 172 lbs. and the maximum was 175 lbs. On the return trip the engine hauled 612 tons of freight. Time 4 hours and 6 minutes, but it was more or less held up at passing points. The pulverized fuel equipment worked perfectly, and gave no trouble at all. Dr. Assis Ribeiro expressed himself as very much pleased with the locomotive performance, and recommended at once that the use of pulverized fuel be extended. Dr. Ribeiro's original and later recommendations came not as a result of any snap judgment, but from a very painstaking and thorough technical and practical investigation and the railway operating results have now fully justified his original opinions and later conclusions.

A test was made with engine No. 273 burning what may be called National fuel, that is, Brazilian coal, taken from the Sao Jeronymous mine, Rio Grande do Sul, which is a mine that Dr. L. Paes Leme is interested in. This mining development is being rapidly advanced by Dr. Luiz Paes Leme, who also visited the United States in 1916 for the purpose of investigating the most efficacious utilization of this Brazilian fuel. The analysis of this coal is:

Volatile matter	33.04 per cent.
Fixed carbon	46.96 per cent.
Ash	20.00 per cent.

On this trip Dr. Assis Ribeiro and Dr. Paes Leme were interested and observant travelers. The train made the passenger schedule between stations, but was held up at all points from 10 minutes to 1 hour. The steam pressure was maintained all the time, with a clean stack; the ash and slag in the firebox appeared to be of about the same physical condition as that of anthracite coal, the ash being a gray-white, the slag, though not fully run together, was, on this occasion, more like drops, or shot.

The return trip with 300 tons (passenger loading) proved to be entirely satisfactory, the engine making the time from Entre Rios to Barra in 1 hour and 55 minutes, the total stops amounting to 17 minutes, which is 10 minutes faster than best passenger schedule with only two stops. Dr. Assis Ribeiro, the chief of traction of the Brazilian Central, expressed himself as being very much pleased with the performance, and he and all other local offiials have been convinced that pulverized fuel is successful, and especially so with native coal.

The *Journal do Commercio* of Rio de Janeiro on September 10, 1917, gave the following account of the special trip, made in honor of the President of the Republic of Brazil: "The first official experience with national coal pulverized, was realized yesterday, September 9, on the Central Railway of Brazil, with the special train that transported Dr. Wenceslao Braz, President of the Republic of Brazil, and his staff. Locomotive No. 282 was attached to the president's special train at Barra do Pirahy and pulled it to Cruzeiro, a distance of 147 kilometers, or about 90 miles, the time being 3 hours. This trip gave very excellent results, as was verified in the long stretch between Barra do Pirahy and Cruzeiro. During a greater part of the trip the president remained on the locomotive, assisting in the feeding of the furnace with pulverized national coal reduced in the plant recently constructed for that purpose at Barra do Pirahy, the coal having come from the Sao Jeronymous mine, and being of the same analysis as that given above. The President of the Republic showed himself very much impressed with the calorific value of the coal and the ease and regularity with which the steam pressure was maintained by the locomotive throughout the trip, and without any smoke. The tonnage of the train was 210, the same weight was hauled back on the return trip. The total coal used being about 4 tons. The running time going was 3 hours, the return, 3 hours and 25 minutes. The president sent a telegram to the Minister of Public Works, as follows: 'The fuel problems of our country have been solved.' He also sent a telegram of congratulation to Dr. Assis Ribeiro. The president and the director expressed themselves as being entirely satisfied, and were also highly pleased at the demonstration, and spoke most approvingly of the simplicity of the machinery and the control exercised over the fire, all of which was demonstrated while they were on the locomotive."

INTERIOR OF MILL FOR GRINDING COAL TO THE POWDER FORM.

The outcome of this trip were the following telegrams and these were also published in the *Journal do Commercio* of Rio of September 10, 1917:

"To the Minister of Railways, Dr. Tavares de Lyra, from the President of the Republic: From Barra do Pirahy to Vargem Alegre, I traveled on 10-wheel locomotive No. 282, fitted for the use of pulverized fuel. This trip was made with a speed of 65 kilometers per hour, having a train of 210 tons behind it. I take great pleasure in giving you this communication, which I am certain will be received by all Brazilians interested in the solution of one of our most important national problems.

"Wenceslao Braz, President."

Dr. Augiar Moreira, director of the Central Railway of Brazil, who accompanied the President of the Republic to the station of Cruzeiro, sent to Dr. Assis Ribeiro, of that road, the following telegram:

"In the name of his excellency the President of the Republic, who traveled on locomotive No. 282 between Barra and Vargem Alegre, which pulled his special train, and on my own account, I congratulate you for the brilliant success of your efforts in the solution of the problem of trying national coal, pulverized. Extend to your aids who operate the plant my congratulations. "Augiar Moreira."

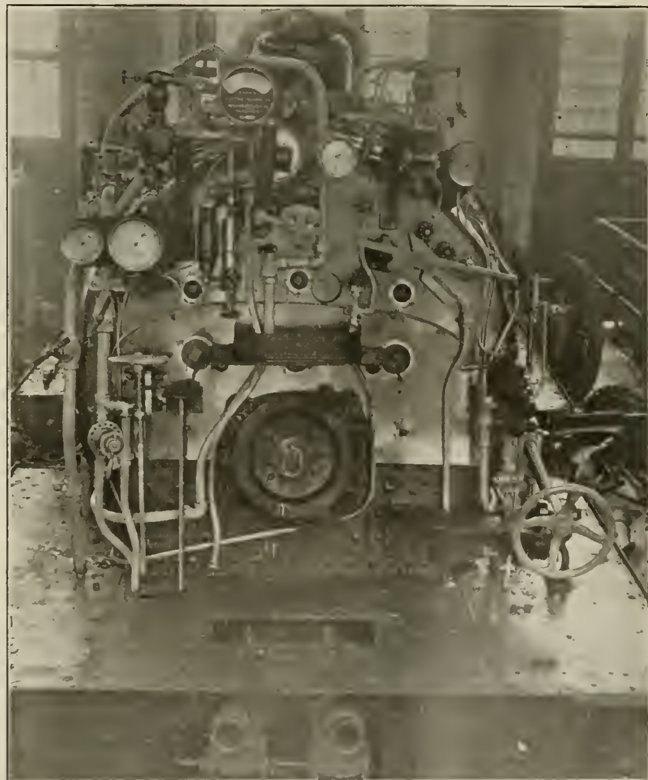
The foregoing account and the telegrams which we have been able to publish give a good idea of the importance which this method of using slack coal and what was originally a by-product of the mine, is to those interested in fuel matters in Brazil. The subject as taken up by the President of the Republic assumes almost national importance, and has in this way created a favorable impression concerning American methods, which extends to United States articles of commerce. It cannot but help to have a beneficial effect on all kinds of trade between that country and ours.

The report of Mr. A. L. M. Gottschalk, U. S. consul-general at Rio Janeiro, made to the United States Department of Commerce, is worthy of attention. It says, among other things, something as follows: The Central Railroad of Brazil inaugurated a series of experiments with its new coal-pulverizing plant at Barra do Pirahy, which has caused considerable interest and comment in engineering circles here generally. The plant was furnished by an American firm, it was installed here by one of its engineers, and is said to have cost (with the locomotives and license rights) between $500,000 and $750,000, United States currency. The pulverizer is described as being similar in construction to a cement plant. The coal, freed of its moisture, goes into a hopper and is pulverized so that 80 per cent. of it can pass through a 200-mesh screen. It is then put on the locomotive by means of a conveyer screw and blast, thus bringing the ignitable powder to the locomotive furnace, where combustion takes place. The recent experiments were conducted under the direction of Dr. Assis Ribeiro, a well known Brazilian engineer, who is assistant director in charge of traction for the Central Railroad. The experiments were an unqualified success.

It is now proposed to continue the experiments, first with domestic coal and American coal mixed, and then finally with Brazilian coal, from the Jacuhy district. The Jacuhy River, in the State of Rio Grande, waters a district that is said to be rich in the peculiar, and until now somewhat problematically useful, coal of Brazil—"problematically useful," because it is a coal that does not burn economically in the usual lump form. It is, however, believed that once pulverized, this coal will give results quite equal to the lignite that is burned in the United States in pulverized form, and should prove to be exceedingly adaptable to the needs of railroads.

If the continuation of the experiments alluded to above should make available for railroad purposes the domestic coal supply of Brazil, there is an enormous field of possibilities open to railroading here. For a long time the problem of all the railroads, but notably that of the Central, has been one of fuel, and many of the best judges of these matters now believe that this problem is on the high road to solution.

The opinion of the consul-general in which he expresses the belief that the difficult railway fuel problem is on the high road to satisfactory solution will mean a future growth to Brazil, and railroad building and railway supplies and equipment are likely to be called for in large quantities. The door appears to be opening and we hope our friends will not let this exceptional chance slip past them.



INTERIOR OF CAB OF BRAZILIAN ENGINE USING POWDERED COAL.

Removal.

The Falls Hollow Staybolt Company has removed its Chicago office from the Fisher building to 654 Railway Exchange building. Mr J. F. Chisholm, sales engineer.

Consolidation and Pacific Type Locomotives for the Southern Pacific Lines

At the present time there is a sharp demand for locomotives for use in this country. The government have pre-empted all the resources and energies of the regular builders, and great as their capacities are, the locomotive builders are not able to supply a single engine for use on the railways of the United States. In this dilemma, those roads which have equipment suitable for building, have turned their attention to it. Among the prominent roads to build for themselves is the Southern Pacific Company, of which Mr. George McCormick is general superintendent of motive power.

The engines turned out of the company's shops at Sacramento, Cal., up to date, are nine consolidation (2-8-0); and two Pacific type engines 4-6-2. The 2-8-0 engines are for freight service and develop a tractive effort of 45,470 lbs. They weigh in working order 217,800 lbs., of which the weight on the drivers is 193,700 lbs. The amount on the engine truck is therefore 24,100 lbs. The total weight of engine and tender in working order, and taken together is 351,200 lbs. The driving wheel base is 15 ft. 8 ins., the total wheel base is 24 ft. 4 ins. and the full wheel base of engine and tender is 56 ft. $3\frac{3}{4}$ ins. The ratios and some general data follows:

Ratios—Weight on drivers÷tractive effort, 4.26; total weight÷tractive effort, 4.79; tractive effort x diameter drivers ÷ equivalent heating surface,* 692; equivalent heating surface*÷grate area, 75.6; firebox heating surface÷equivalent heating surface,* per cent., 4.70; weight on drivers÷equivalent heating surface,* 51.7; total weight÷equivalent heating surface,* 58.2; volume both cylinders, 13.2 cu. ft.; equivalent heating surface*÷volume cylinders, 283.6; grate area÷volume cylinders, 3.75.

*Equivalent heating surface equals total evaporative heating surface plus 1.5 times the superheating surface.

Cylinders.—kind, simple; diameter and stroke, 22 in. x 30 ins.

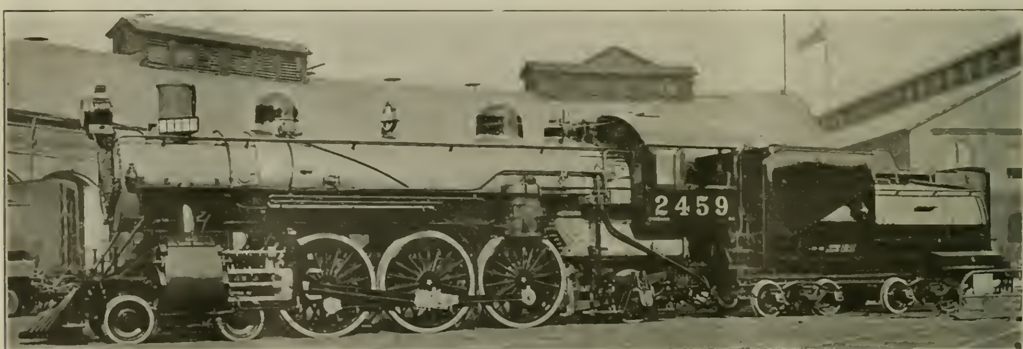
Valves—kind, piston; diameter, 12 ins.; greatest travel, 6 ins.; inside lap 1 in.; exhaust clearance, 1/16 in.; lead in full gear, 3/32 in.

Wheels.—Driving, diameter over tires, 57 ins.; driving, thickness of tires, $3\frac{1}{2}$ ins.; driving journals, main, diameter and length, 10 ins. x 12 ins.; driving journals, others, diameter and length, 9 ins. x 12 ins.; engine truck wheels, diameter, 30 ins.; engine truck, journals, 6 ins. x 10 ins.

Boiler.—Style, straight; working pressure, 210 lbs. per sq. in.; outside diameter of first ring, 80 ins.; firebox, length and width, 108 ins. x 66 ins.; firebox, water space, front, sides and back, 5 ins.; tubes, number and outside diameter, 250, 2 ins.; flues, number and outside diameter, 36, $5\frac{3}{8}$ ins.; tubes and flues length, 15 ft., 0 ins.; heating surface, tubes and flues, 2,708 sq. ft.; heating surface, firebox, 176 sq. ft.; heating surface, total, 2,884 sq. ft.; superheater heating surface, 574 sq. ft.; equivalent heating surface,* 3,745 sq. ft.; grate area, 49.5 ft.; fuel, oil.

CONSOLIDATION ENGINE FOR THE SOUTHERN PACIFIC CO.

Geo. McCormick, Genl. S. M. P. S. P. Co., Builders.



PACIFIC TYPE LOCOMOTIVE FOR THE SOUTHERN PACIFIC CO.

Geo. McCormick, Genl. S. M. P. S. P. Co., Builders.

Tender.—Tank, Vanderbilt style; frame, built-up type, steel frame; weight, 133,400 lbs.; wheels, diameter, 33 ins.; journals, diameter and length, 5½ ins. x 10 ins.; water capacity, 7,000 gallons; oil capacity, 2,940 gallons.

Among the specialties applied to this locomotive are the Westinghouse ET brake equipment with 8½ ins. air compressor; the "Viloco" air bell ringer; the M. C. B. Climax coupler; the Franklin driving box lubricators; the Nathan No. 11 Simplex injectors, reversible boiler checks, feed water strainers and No. 5 Bull's Eye lubricator; the Consolidated safety valves; the Leach type double outside sander; the Tate flexible staybolts; the Crosby steam gauges; the superheater made by the Locomotive Superheater Co. of New York, and the Klinger Reflex water gauge.

The Pacific or 4-6-2 type of engine is used in passenger service, burns oil, and develops a tractive effort of 31,420 lbs. The weight of this engine in working order is 234,200 lbs. The weight on the driving wheels is 150,400 lbs., this puts 38,000 lbs. on the engine truck, and the trailing truck carries 45,800 lbs. The weight of the engine and tender in full working order and taken together, 372,300 lbs. The wheel base of engine and tender, 63 ft. ¼ in. That of the engine alone is 3 ft. 4 ins. and the driving wheel base itself measures 13 ft. 4 ins. The ratios and some general dimensions are given below:

Ratios.—Weight on drivers÷tractive effort, 4.79; total weight÷tractive effort, 7.46; tractive effort x diameter of drivers ÷equivalent heating surface,* 677.2; equivalent heating surface*÷grate area, 72.1; firebox heating surface÷equivalent heating surface*, per cent., 4.88; weight on drivers÷equivalent heating surface,* 42.14; total weight÷equivalent heating surface,* 65.6; volume both cylinders, 12.32 cu. ft.; equivalent heating surface* ÷volume cylinders, 289.7; grate area÷volume cylinders, 4.02.

*Equivalent heating surface equals total evaporative heating surface plus 1.5 times the superheating surface.

Cylinder.—kind, simple; diameter and stroke, 22 ins. x 28 ins.

Valves.—kind, piston; diameter, 12 ins.; greatest travel, 6 ins.; inside lap, 1 in.; exhaust clearance, 1/16 in.; lead in full gear, 3/32 in.

Wheels.—Driving, diameter over tires, 77 ins.; driving, thickness of tires, 3½ ins.; driving journals, main, diameter and length, 10 ins. x 12 ins.; driving journals, others, diameters and length, 9 ins. x 12 ins.; engine truck wheels, diameter, 33 ins.; engine truck, journals, 6 ins. x 10 ins.; trailing truck wheels, diameter, 45 ins.; trailing truck journals, 8 ins. x 14 ins.

Boiler.—Style, straight; working pressure, 210 lbs. per sq. in.; outside diameter of first ring, 70 ins.; firebox, length and width, inside, 108 ins. x 66 ins.; firebox, water space, front, sides and back, 5 ins.; tubes, number and outside diameter, 182, 2 ins.; flues, number and outside diameter, 24, 5⅜ ins.; tubes and flues, length, 20 ft. 0 ins.; heating surface, tubes and flues, 2,571 sq. ft.; heating surface, firebox, 174 sq. ft.; heating surface, total, 2,745 sq. ft.; superheating surface, 550 sq. ft.; equivalent heating surface, 3,570 sq. ft.; grate area, 49.5 sq. ft.

Tender.—Tank, Vanderbilt type: frame, built-up type, steel frame; weight, 138,100 lbs.; wheels, diameter, 33 ins.; journals, diameter and length, 5½ ins. x 10 ins.; water capacity, 7,000 gallons; oil capacity, 2,940 gallons.

Among the specialties applied to this locomotive are the Westinghouse ET brake equipment with 8½-in. air compressor, "Viloco" air bell ringer, M. C. B. Climax couplers, Franklin driving box lubricators, Nathan No. 11 Simplex injectors, reversible boiler checks, feed water strainers and No. 5 Bull's Eye lubricator, Consolidated safety valves, Leach type double outside sander, Tate flexible staybolts, Crosby steam gauges, the Locomotive superheater and the Klinger water gauge.

There is one feature which is not given much attention to, by railway men, and that is what may be called the aesthetic side of locomotive design. It is essential that a locomotive shall be a practical working machine, and as useful as it can be. This is essential and nobody quarrels with this idea, nevertheless the designs thus far got out by the Southern Pacific officials have so far succeeded that the neat and pleasing lines have not been completely obscured by the purely utilitarian. The S. P. engines are decidedly "good looking" and the officials of the road must be congratulated on this aspect of their unique design.

Locomotive Design and Construction from a Maintenance Standpoint

Greater Service Than Ever Before Called For, and Being Successfully Met

At a recent meeting of the Canadian Railway Club, held at Montreal, Que., Mr. W. H. Winterrowd, assistant to the chief mechanical engineer, Canadian Pacific Railway, read a paper bearing the above mentioned title. He spoke substantially as follows: It is a question if there has ever existed an enginehouse foreman who has not, at some time or other, had the feeling that if some part of a locomotive had been designed a little differently, he could make repairs quicker, easier, and at less expense. While in many instances he may have been justified in this feeling there are other cases influenced by other factors. The type and size of a locomotive have an important bearing on certain details of design. Bridges, turntables, enginehouses, repair shops, terminal and water facilities must enter into the calculation. Today, under changed conditions, the railroads are being called upon to render greater service than ever before. But little new equipment is available other than that which the railroads may build in their own shops. Repair shops are being worked fully. Skilled railway mechanics are scarce. Material of all kinds is difficult to obtain. All of which means that maximum service must be obtained from every bit of existing equipment. It is, therefore, essential to consider every legitimate means whereby the "out of service period" of a locomotive may be decreased and the "in service period" increased. All new locomotives should be constructed to give maximum service with minimum maintenance. All locomotives being rebuilt, or modernized, should be turned out of the shops prepared to give similar results. Any improvement that can be made to any locomotive, new, modernized, or under repairs, which will result in increased service, increased efficiency, or decreased maintenance, will help to increase the capacity of the railroads.

It seems hardly necessary to state that a well designed boiler of ample capacity is easier and cheaper to maintain than one of smaller capacity, which has to be continually forced. Within its limits of weight and size a boiler should be designed to have a capacity as large as possible consistent with other governing factors. In this connection the values of the superheater, the brick arch, and the feed water heater are unquestionable. These values have been practically demonstrated from the standpoint of economy as well as locomotive capacity. The maintenance of locomotive boilers is an important factor, the greatest difficulties being leaky flues, leaky mud rings, broken staybolts and cracks in firebox sheets. Knowing that firebox heating surface does a great deal more work per square foot than flue heating surface, boiler capacity does not depend upon long flues, and short flues are the easier to maintain.

Flue location and spacing should be carefully considered so as to permit easy maintenance, proper distribution of stresses with a minimum amount of staying, and also to facilitate washing out, particularly in bad water districts. Many failures are frequently the result of crowding in too many flues, placing them too close to the heel of the flue sheet flange, and the use of too small a bridge.

The flue sheet flange radius should be carefully considered in relation to the flue layout. Too small a radius with flues located close to the heel will not give as much flexibility as may be desired and will make the top flues difficult to maintain. Continued expanding of the flues will cause the sheet to flow, often resulting in flange cracks. The bead on the flues adjacent to the flanges should always rest on the flat surface of the sheet and never on the curved inside surface of the heel. With two and one-quarter inch, or greater diameter flues it is best that the width of bridges be not less than three-quarters of an inch.

Assuming that these points have been taken into consideration, it is important to see that the shop layer-out and driller follow the design. There have been cases where a layer-out has located flues incorrectly and also added one or more. It is also important that flue sheet holes be drilled the proper diameter as it is almost impossible to keep flues tight in holes that are too large. The radii of door and back head sheet flanges should be studied in relation to the staybolt stresses. A moderately large back head sheet radius will reduce the stress in outer rows of bolts by transferring a portion of the load to the wrapper sheet. Too small a door opening radius will frequently result in cracking of the sheet at this point as provision is insufficient for expansion. Mud ring corners of ample radius will be easy to construct and maintain. Trouble due to small radius has, in many instances, been overcome by electric or acetylene welding the bottom edges of the sheets at this point to the mud ring. Flexible staybolts reduce staybolt breakage. A careful investigation will indicate the zones of maximum staybolt stress and sheet movement. In these zones the flexible bolts will give good results and reduce staybolt renewals. Washout plugs should be so located that all points of the firebox and barrel can be easily reached with standard washout equipment.

Grates should have sufficient air space, be free as possible from dead spots, and be easy to remove. Where certain kinds of fuel are used, properly designed dump grates may be a means of reducing the time the engine is on the ash pit. In connection with the barrel of the boiler, points which may be mentioned are, throttle and dome arrangement which will permit interior inspection of the boiler without the removal of the standpipe; also the elimination of all small studs. Expansion slides, instead of an expansion sheet, under the front of the mud ring, will eliminate the maintenance of a considerable number of bolts and rivets. Proper consideration of all other expansion sheets will further reduce maintenance of many bolts and rivets and tend to eliminate the many resulting troubles as well.

Frames should be of ample cross section and well braced to hold them rigid. Maximum cross section may be of little avail unless accompanied by sufficient and properly located bracing. In this connection, it hardly seems necessary to mention the advantages of a valve gear outside the frames. The outside gear has made possible better frame bracing, to say nothing of the advantages of easier inspection and maintenance of the gear itself. As far as possible, bolt holes in frames should not be located where stresses are greatest. Where cylinder design will permit, a one-piece frame with a top tie splice seems desirable. Where large cylinders prevent the above arrangement, a one-piece frame with ample depth under the cylinders, and having no reduction in thickness, will give excellent service. The advantages of outside steam pipes are self evident from the standpoint of both construction and maintenance. Cylinders should have saddle faces well bolted together to prevent working. All other things being equal a double row of bolts is better insurance than a single row. Weakening grooves cut in covers will reduce repairs to a minimum in case of failure.

All bearing pressures should be as low as consistent with good practice in order to reduce wear and resultant replacement. Ample pin length is desireable in order to obtain lateral stability. Arrangement of motion and design of back steam chest and back cylinder covers should be such that both valve stem and piston rod packing will be easily accessible. Fillets on pins, axles, etc., should be of ample radius. Small fillets are frequently the cause of failure. Where possible a piston rod of sufficient length to permit piston ring renewals without the removal of the rod from the cross head will reduce maintenance cost. Rod bolts and wedges may be dispensed with by the use of solid bushes. Rods should be designed and arranged so that it may be possible to remove them with a minimum of labor. The Canadian Pacific Railway has found that knuckle pins with a small extension on the threaded end through which a strong flat cotter can be placed have been excellent insurance against the usual consequences of loose nuts. Selection of high grade, close grained, cast iron for cylinder and valve bushes, piston heads and rings, and in some cases rod bushes, is more than warranted in view of the increased mileage obtainable and the corresponding decrease in maintenance. If conditions permit the consideration of heat treated, or alloy steels, unbalanced forces may be very materially reduced by the use of light reciprocating parts. The reduction of such forces will in turn tend to reduce maintenance of pins, bushings, etc.

Locomotives should be equalized so as to secure the most efficient guiding power from both leading and trailer trucks, or wheels. In general, the best results seem to be obtained by dividing the equalizing system so that the division between the front and back systems is as directly under the centre of gravity of the locomotive as wheel base and other conditions will permit. The spring gear and equalizing system should receive particular attention when being erected and also when being repaired. The tops of the driving boxes should be milled out squarely and in a plane parallel with the journal bearings. The equalizer and saddles should be fitted to their seats squarely with the pin holes so that the engine will ride squarely on her springs and track properly. The same will apply to the trailer truck equalizers and spring rigging. Trailer trucks that do not carry the back of the engine level are responsible for much avoidable tire wear.

A driver brake main fulcrum shaft in two pieces of equal length, the outer ends supported in bushed bearings integral with the main frames and the central portion supported by a sleeve, will give more even distribution of braking power and maximum accessibility for repairs and adjustments. Brake cylinders should be placed vertically, in order to reduce packing wear and provide accessibility. Brake shoe heads and hangers should be so constructed and hung that shoes will swing clear of wheels when pressure is released and permit easy application of new shoes. Safety hangers should be provided to support and prevent sagging of brake rods. The ratio of brake cylinder to brake shoe pressure should be kept as low as consistent, and should not exceed commonly accepted ratios. This will insure that false travel will be kept to a minimum.

The importance in fixing up piping, of strong clamping and provision for expansion cannot be overemphasized. Piping should be as short as conditions will allow. Piping should be so placed that there is no obstruction of washout plugs, arch tube covers, pads, etc. Where pipes pass through the front of the cab, provision should be made for clearance or for sleeve protection to prevent wearing or cutting. The Canadian Pacific Railway has found it a decided maintenance economy to place lubricator piping from cab to cylinders, etc., in a slightly larger wrought iron pipe where the feeds pass beneath the jacket and lagging. By this means the feed pipes can be removed or applied without the necessity of removing any outside covering. Air brake and steam piping should drain themselves and contain no traps in which water can accumulate and freeze. It is desirable that pipes from the sand dome be as nearly vertical as possible, the bottom ends being securely clamped in alignment with the rail.

Ash pans should be as simple as can be, and the sides should have sufficient slope to prevent the accumulation of ash under the grates. Swing doors can be suspended so that their own weight helps to keep them closed. This results in less strain on the door operating rigging. Easy inspection and maintenance results from placing main reservoirs in an accessible location. Where this is impossible and drain cocks are hard to reach, an extension handle, the end of which is easily accessible, makes the reservoir easy to drain.

Removable liners on engine and tender truck pedestals make it easy to take up wear and reduce pedestal renewals. To prevent rapid wear between wheel hub liner face and driving box, sufficient provision for lubrication should be made. Shoes and wedges should be so designed that wear can be easily reduced and wedges kept in their proper place with a minimum of labor. Pilots made of scrap boiler flues cost less to maintain than those of wood. All oiling points should be made accessible. Handholds or small steps, properly placed, in order to make some oil holes accessible, will soon pay for themselves. Lubricator chokes should be placed in proper position and as near to the cylinder, or steam chest, as they can be got. The location of the lubricator in the cab where the feeds may easily be seen and adjusted will result in better lubrication. When located close to the front of the cab, or where the light is poor, proper adjustment is exceedingly difficult. Four pane cab side windows are easier and cheaper to maintain than those containing one large pane. Boiler jacketing should be applied in sections so that panels can be removed with a minimum of labor.

The foregoing are but a few of the multitudinous details which merit most careful thought. But little mention has been made of the possibilities of simplified design by the use of cast steel. It is felt that with the development of the cast steel industry and the production of castings which are practically equivalent to wrought iron that locomotive construction in the future may be greatly simplified. We are today using castings that ten years ago would have been deemed impossible to cast. For example, one-piece locomotive frames are now under consideration and will, we hope, soon be in service. These consist of the two main frames and all cross braces cast in one piece. This is an indication of the degree of simplification that may be obtained. The maintenance of such parts has in turn been made possible by the development of the art of electric and acetylene welding and the advancement of the steel industry.

Good and far reaching results can be obtained by inviting criticism and suggestions from those directly responsible for construction and maintenance. In conclusion, simplicity co-related with efficiency should be one of the keynotes of locomotive design. This principle, which in other words is simply good judgment, will make for that degree of efficiency which will be reflected, not only in reduced maintenance costs, but also in the increased capacity of the locomotive as a whole.

Development of Locomotive Wheel Flange Lubricator

Introduction of the Device—Variety in Designs and Quality of Lubricants

In these days of strict economy it is well that the lesser details of the modern locomotive should be occasionally referred to, to the end that the best results may be obtained, and while it is true that the number and variety of devices applied to motive power and rolling stock have increased, and the proper attention to all of them entails an added amount of work to the enginemen, which it is no easy matter to maintain. It goes without saying that the flange oiler in order to be of real service, must be properly maintained. By its use it is claimed that a saving of 75 per cent. in wear on tender and car wheels has been attained, not only so but the rail wear, particularly on curves, has been greatly reduced by the use of the flange oiler.

Like many other excellent devices its adoption was slow and it is not yet in such general use as it should be. One of the causes of the delay in coming into more popularity is the fact that it is said to require too much attention, and that it was not altogether fool proof. On some roads it is part of the work of one of the roundhouse men to examine the flange oiler, and it is reported that the average time occupied in the inspection does not exceed thirty seconds, so that the attention required, if systematically applied, approaches a negligible quantity. It has also been demonstrated that the success of the device depends much on the kind of oil used. That known as the Kern River oil in California seems to meet the requirements of the service in an eminent degree. That is a very heavy kind of oil, and in that section of the country it is also used for fuel. The merit of this oil for use in the flange oiler consists in

FLANGE LUBRICATOR, CANADIAN PACIFIC.

a certain mixture of asphaltum in the oil, and this heavy base forms a paste and is not separated by coming in contact with the steam, and does not spread over the tread of the rail as some oils do.

Regarding the introduction of the device it may be stated that in a crude form it was used on the Denver & Rio Grande as long ago as 1882 or 1883. Grease inserted in a piece of hose and attached to the frame was a simple contrivance, but the result was that the engine and coach wheels ran about thirteen months, where previously they were operated only for about seven months. Elsewhere it took the form of a piece of waste attached to the frame, with a piece of wire in position so that it would come in contact with the driving wheel flange. When the engineer was oiling around he would drop some oil into the waste, and a small portion of the oil would reach the flange. The crudeness of this method was wasteful in the use of oil, but some benefit was derived. The next advance was a tin can, mounted on a bracket attached to the engine frame. From this can a pipe with a wick in the end was projected to a position over the driving wheel flange. After the can had been filled with black oil, the wicking was supposed to form a circuit between the oil in the can and the driving wheel flange. This helped the flange, but had the drawback of reaching the rail, and so induced slipping.

In 1904 the development reached a higher standard, and a more perfected arrangement of the flange oiler. What was known as the Hydrostatic flange oiler appeared. It worked on the condensation displacement principle. By putting this development through a refining process the successful working of the flange oiler had became an accomplished fact.

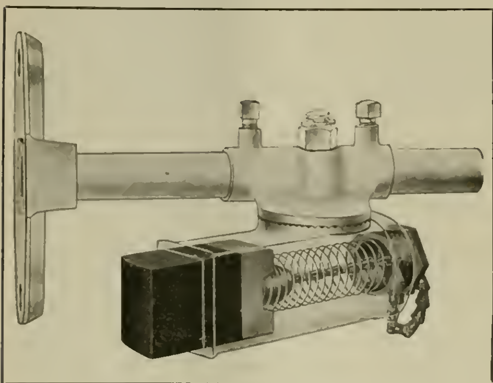
In 1910 the master mechanics' committee on subjects considered the flange oiler of such importance that they appointed a committee to prepare a paper on the oiling of locomotive wheel flanges and the saving that could be accomplished by the use of the flange oiler. Much was accomplished at that time, and the matter was carried over for still further discussion. The reports, as may be imagined, contained variable results, but all agreed on a considerable saving both in tires and in rails. Many instances are on record where the tendency of the locomotives, particularly switching engines, had obtained an unenviable record of leaving the rails at certain curves, and the reports showed that the previous trouble had been entirely eliminated by the use of the flange oiler.

Some of the data is well worthy of repetition; for example on one road ten heavy consolidation freight engines, before flange oilers were applied, could make on an average of 23,033 miles, when flanges were reduced to the limit. These engines in the same service with flange oilers attached made an average of 44,000 miles, when it was necessary to turn tires for tread wear only. Another instance of four heavy Pacific type locomotives without flange oilers could make about 39,770 miles, when flanges were reduced to the limit. These same engines in the same service with flange oilers applied made on an average of 91,850 miles, or an increase of 125 per cent., due to flange lubrication, the tires being turned for tread wear only. Those reports could be added to indefinitely.

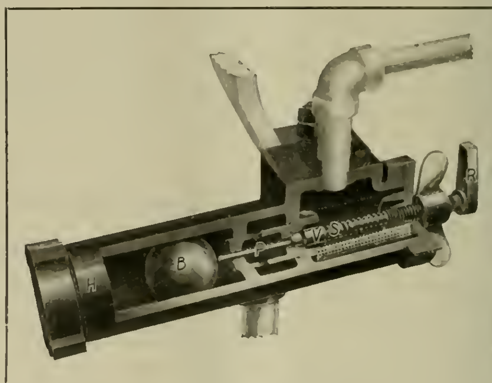
Referring to rail wear it may be mentioned that on one large railway system where they have a majority of their locomotives on one division equipped with flange oilers, the rail wear was reduced so much, due to the use of flange oilers that the supervisor reduced his regular order of three miles of new rails for renewals to one mile, reducing the cost of renewal of rails on curves to a corresponding ratio. As is well known that where there is excessive wheel flange wear there is also excessive rail wear, and the remedy for one is the remedy for the other, and it would be a paying investment for the railroads if they equipped their engines with flange oilers for the saving of the rails only. And not only so but the flange oiler is also an important factor in fuel ecomony. The cause of flange wear is friction. The more friction there is between the wheel flanges and the rail the more train resistance is developed, and the higher this train resistance becomes the greater is the fuel consumption to haul a given amount of tonnage.

Coming to the matter of selecting flange oilers it may be said briefly that all of the different types of lubricators have met with more or less success, but the hydrostatic oil lubricators, in which asphaltum oil is used, are the most popular. The Canadian Pacific has a special device of its own, very successful, and it may be also noted that what is known as the Collins stick graphite lubricator, consisting of an arrangement in which a square stick of graphite is placed in a case supported by a bracket on the frame, and the end of the graphite comes in contact with the flange of the drivers by the action of a spring. It is very effective. Among others also the Detroit Lubricator Company has perfected an appliance, automatic in action, and readily adjustable to meet the variable requirements of the service.

In conclusion it may be stated that roads with a considerable amount of tangent line would not require the flange lubricator as much as those with a large amount of curved line. The resistance due to flange friction on the ordinary piece of road, is not a large percentage of the resistance of the train, but on roads with numerous curves, there can be a great reduction in resistance of the train by the use of the flange oiler, and therefore a considerable saving on wear as well as on fuel consumption. In regard to the exact adjustment and quantity of lubricant and in the various devices, it may be added that the enterprising manufacturers all furnish descriptive pamphlets giving complete details as to the proper handling and care of each particular device.



COLLINS WHEEL FLANGE LUBRICATOR.
THE COLLINS METALLIC PACKING COMPANY.



CONTROL VALVE OF FORCE FEED FLANGE OILER
DETROIT LUBRICATOR COMPANY.

Boston-St. Louis Train.

Through train service has been established between Boston and St. Louis by the New Haven and Pennsylvania railroads. The Hell Gate bridge route through New York, and the Hudson and East River tunnels are being utilized, and New England for the first time in history, is directly connected with the middle west by an all-rail route through the Metropolis. One train is being operated daily in each direction. The westbound train occupies 33 hours and 5 minutes, the east-bound 35 hours and 31 minutes.

Car Shops Reopened

The Delaware & Hudson is about to reopen its car shops at Green Island, New York, near Troy, which have been idle for seven years. The company is now trying to get the 100 men needed to organize a force to repair freight cars at these shops. The hours of labor have been shortened and a considerable increase in the scale of wages has been established; the equipment is of the best and the location ideal.

Automatic Signals and the Automatic Stop

Three Essentials of the Automatic Signal—The D. C. Signal System—Growth of the A. C. System—The Position Light Signal on the P. R. R.—The Speed Control System—The Automatic Stop—Use in Averting Accidents.

In a recently read paper by Mr. L. E. Jones, signal engineer of the San Francisco-Oakland Terminal Railways Co., he said to the assembled members of the Pacific Railway club, that the idea of the automatic block signal is to automatically indicate the presence of a train on a given section of track, known as the block. Continuing, he spoke substantially as follows:

On double track, where train movements on the same track are in the same direction, the track is divided into a number of blocks and the signals so arranged as to provide a space interval between trains corresponding to a given time interval. On single track, train movements are in both directions; a space interval should be provided for trains following each other, the same as on double track and the signal should be so controlled through the block sections as to prevent two opposing trains from occupying single track between passing sidings.

Three things are essential to the successful use of any automatic block system for high speed service. 1st: The apparatus used to detect the presence of a train in the block must be absolutely reliable. 2nd: Distinct and positive indications must be given to keep the motorman or engineman informed at all times as to the condition of the track. 3rd: The indications must be obeyed and the train controlled according to the meaning of indications received. The first essential involves the use of track circuits, the fundamental and most important part of all modern signal systems. The second essential involves the use of various schemes of giving signal indications, and the third, the necessity of enforcing prompt obedience to signals and the means of accomplishing the same.

In applying the track circuit to automatic signaling on electric railways, many difficulties have been encountered. An attempt was first made in 1900 to apply the D. C. track circuit, to signaling on the Boston Elevated, a road using D. C. propulsion. In the track circuit scheme of signaling the track is divided into sections, each section insulated and electrically independent of every other section. The rails are used as conductors, and in the D. C. circuit, energy is fed from a low voltage battery at one end of the section, through the rails to a relay at the other. When the section is unoccupied the current fed through the rails energizes the relay, picks up its armature and holds it up. When a train occupies the section the axles and wheels offer a path of very low resistance to the current, and the relay is shunted out. That is, insufficient energy will reach the relay to hold the armature up. Contact points are attached to the armature to open and close the signal control circuits.

The running rails of an electric road are used as a return for the propulsion current, and it was necessary to give up one of these rails for use as a block rail. The block rail was insulated from the elevated structure and at each end of a section and acted as one side of the track circuit, while the return rail, which was left continuous throughout its length, acted as the other side. The simple D. C. track circuit was a failure for the reason that the fluctuation of the propulsion current in the return-rail interfered with the operation of the low voltage relay. The trouble was partly overcome by polarizing the relay against the flow of return current into its coils but this scheme had its limitations and was not considered adequate.

A track circuit which was absolutely immune to the effects of propulsion current was necessary to make automatic signaling a success on electric railways and such a track circuit was invented by Mr. J. B. Struble. He conceived the idea of a selective relay, one which would respond to an alternating current but would be absolutely immune to the effects of a D. C. propulsion current. The first trial of the alternating current track-circuit was made in 1903 between Sausalito and San Anselmo on what is now known as the Northwestern Pacific Railroad. This circuit involved the use of a block rail and insulated sections similar to the ones first used on the Boston Elevated except that alternating current at very low voltage was used to operate the relay. The circuit is known as the single-rail track circuit presumably because one of the running rails is given up entirely for signaling purposes. Many installations using apparatus similar to that used at Sausalito followed rapidly but the giving up of one of the running rails for signaling purposes was a serious handicap in some cases.

The invention of the impedence bond and its application to the double rail-track circuit in 1907 did away with the necessity of having to give up one of the running rails, made possible the lengthening of track circuits and resulted in other important improvements. This scheme included the use of an A. C. track relay fed from a transformer over the rails as on the Sausalito installation but the track circuit was completely isolated, insulated joints being placed at the ends of the block in both running rails. The function of the impedence bond is to make the rails electrically continuous for the return of propulsion current and at the same time electrically separated for signaling current. In other words the impedence bond permits the free passage of propulsion current around the insulated joints which divide the track into block sections and at the same time impedes or checks back the flow of the A. C. signaling current from one rail to the other. The impedence bond was first designed for applications to track circuits on roads using D. C. propulsion but it has since been used with equal advantage on roads employing A. C. propulsion.

In 1906 when the New York, New Haven & Hartford began the electrification of that part of its system between New York and New Haven, it became necessary to devise a track circuit to operate under new conditions. An 11,000 volt 25 cycle propulsion current was used, and to differentiate between the propulsion current and the signaling current a 60 cycle signaling current was adopted. The principal problem on this insulation was to devise a relay which would respond to a signalling current of 60 cycle frequency and at the same time be immune, not only to the effects of the 25 cycle propulsion current, but also to D. C. current, which came to the rails as a leakage from adjacent trolley lines. The frequency relay working on the induction motor principle was devised and its operation has been thoroughly successful. The track circuit using the impedence bond is known as the double or two-rail track circuit and it is now employed in blocking all electric railways using track circuits greater than 800 ft. in length.

While the rail track circuit is well adapted to short sections as in yards and interlocking plants or where two or more tracks parallel each other, or where the return rail is reinforced by a negative feeder, its length is limited under the best conditions usually met with to about 1,500 ft. The two-rail circuit will operate on medium length sections, under very unfavorable conditions as regards ballast, resistance, propulsion, return drop, etc. Where good conditions prevail, end feed two-rail circuits will operate very successfully up to 12,000 ft. in length, while centre feed circuits of 25,000 ft. are being successfully used.

A. C. signaling on electric railways has resulted in so many advantages in the way of safety and economy that it is fast replacing D. C. systems on steam railways. The controlling of signaling devices through track circuit relays and the display of indications to keep the motorman or engineman informed as to the condition of the track is comparatively simple, until it becomes necessary to signal for the maximum amount of mixed traffic that it is possible to operate over the track.

Three fundamental signal indications are essential to the operation of high-speed trains in any system of signaling. They are, first, Stop; second, Proceed with caution; third, Proceed. These fundamental indications are sufficient to take care of ordinary conditions, but on some roads, where traffic is dense, with some trains operating at high speeds, while others must operate at low speeds, the track capacity may be considerably increased by the use of supplementary indications, as follows: First, Proceed at low speed; second, Reduce to minimum speed; third, Proceed at medium speed. The above mentioned indications in standard signaling are conveyed to the motorman (or engineman) by means of visual signals which are given either by semaphores in combination with colored lights alone, or by position light signals. The semaphore scheme is the oldest and is familiar to most railroad men.

The colored light for day and night indications came into use first in the subways of New York, Boston and Philadelphia, and was later applied to interurban and trunk lines. The three-position colored light signal consists of three colored lenses, red for stop; yellow for caution, and green for proceed. The lenses vary in size up to 10 ins. in diameter, are illuminated by incandescent lights, and, where exposed to sunlight, are hooded. The indications displayed by colored light signals under the most unfavorable conditions of sunlight can be seen clearly at a distance of from 2,000 to 2,500 ft.

The colored light signal is small and it is extremely simple. Its freedom from moving parts and its instantaneous action make it very desirable from an operative standpoint. The chief objection to it is the difficulty in obtaining three absolutely distinctive colors and, unless the signals are mounted very low, the close indication is not satisfactory; however, the fact that the signal is being made satisfactory for high speed service on heavy trunk lines is proved by its use on such lines as the electrified divisions of the Chicago, Milwaukee & St. Paul; The New York, New Haven & Hartford railroad have made a trial installation and other trunk lines are considering its use.

The position light signal invented jointly by Mr A. H. Rudd, signal engineer of the Pennsylvania Railroad, and Dr. Churchill of the Corning Glass Works, came into use on an electrified division of the Pennsylvania Railroad in 1915, and according to various reports made since that time it has been thoroughly successful. In this scheme, a three-position signal consists of three rows of uncolored lenses, arranged with one row horizontal, one row diagonal (at 45 degs.) and one row vertical, to correspond to the positions of the blade in the semaphore scheme. The illumination of the horizontal row of lights indicates stop; that of the diagonal (45 deg.) row caution, and that of the vertical row, proceed. The row of lights against a dark back ground presents a beam of light that can be seen at a greater distance in the day light than a semaphore and according to the results of ballots cast among the enginemen on the Pennsylvania Railroad the indications are greatly preferred to those displayed by the former semaphore signaling.

The colored light cab signal has been in use on European railways for a number of years, but has only recently come into use in this country. It consists of small colored lights in the engineman's cab, red being used for stop; yellow for caution, and green for proceed. The train is equipped with a contact shoe which makes contact with a short section of an auxiliary rail. The circuits are so controlled that when the contact shoe passes over the auxiliary rail, the proper signal will be displayed in the cab.

The ideal way to secure maximum track capacity for trains which move in the same direction on the same track would be to have a device on each train which would measure the safe braking distance of that train to the rear end of the preceding train and cause the train to be so controlled that the space interval equal to exactly this braking distance would be maintained at all speeds. In using automatic block signals to approach the ideal condition of maximum traffic, the braking distance at the various speeds, the grade and curvature of track, station stops, train length, time required for motorman to adjust his vision to the signal and time required for the signal indication to change, must all be taken into consideration. The original opinion was that a block signal indicating stop while a train occupied the block would prevent a following train from passing the stop signal, provided a caution signal could be given a sufficient distance away to enable a stop to be made. Now in order to make full use of the track, the caution signal must be placed just as close to the stop signal as safe braking distance will permit. A caution signal under these conditions requires prompt action on the part of the motorman or engineman and at high speeds a very narrow margin of safety will result. This narrow margin of safety was found to be too dangerous and expensive on the elevated and underground railways of Boston and New York, where the demand of the traffic first made high speed, and signalling to approach maximum traffic necessary. Automatic stops were adopted and have been used successfully on the Boston elevated for about 16 years. After five years' use of the automatic stop on the Interborough and on the Hudson & Manhattan Railroads. It was adopted in the Pennsylvania tunnels and in the London tubes. The automatic stop in all these installations consists of a small arm, electro-pneumatically controlled, which when set to stop a train engages a small valve arm on the under part of the train.

In applying the simple automatic stop to automatic signaling an overlap equal to the safe braking distance of the heaviest train at maximum speed must be provided. That is, a danger signal must not only control through one block, but in addition the control must overlap into the next block a distance equal to safe braking distance. This of course causes the sacrifice of track equal to the braking distance which would not be necessary if the train could otherwise be controlled according to signals. A system of signaling which eliminates the overlap by the use of an automatic speed control has been devised and placed in service on the subway lines of the New York Municipal Railways. The principal features of the system are: An automatic visual and audible signal in the motorman's cab. An automatic speed control. An automatic stop.

The system requires that a train approaching an occupied block or a danger point be brought to a certain predetermined speed. The speed must be reduced in accordance with the determined braking power until the required minimum speed is reached, after which the minimum speed can be maintained. The indications are given by two lights, a green light indicating "proceed" when the next two blocks ahead are clear and a yellow light indicating "caution" when the next block ahead is clear and the second block occupied. An audible signal in the cab is so connected that it sounds sufficiently in advance of the automatic speed control application of the brakes to permit the motorman or engineman to control his train so as to avoid this automatic application. An indication is also given in the cab to show the maximum allowable speed and the distance within which, succeeding the giving of a caution signal, the train must be reduced to the prescribed speed. When an absolute stop is required, as at an interlocking plant, the emergency brakes are applied if a train should attempt to pass without receiving the proper signals The speed control does not interfere with the operation of the train so long as the motorman runs according to the indications of the cab signal; but if he fails to obey the caution signal the brakes will be automatically applied at such distance from the danger zone as to reduce the train to a safe minimum speed before reaching it. In other words a train approaching a danger point will have its brakes applied at varying distances back of that danger point, dependent upon the speed.

The system makes use of stationary contact ramps and a mechanical and electrical device in the cab; the device being controlled through standard A. C. track circuits, with all circuits operating on the closed circuit principle. In order to secure predetermined braking distances, a weighing device had to be placed at the car doors. This device weighs passengers in and out and automatically adjusts the braking equipment so that the braking distance is uniform regardless of the weight of the train. This system promises to more nearly approach the ideal for maximum traffic than any yet devised and its two years of use in the New York Subways is reported to be very satisfactory. It is doubtful whether the system would be successful on outside roads where snow and ice are encountered unless the electrical contact feature of the ramp can be replaced with an inductive coupling of some sort.

To my knowledge there are only two roads in this country using the overhead automatic stop to any extent. These are the Washington Water Power Railway Company operating into Spokane and the San Francisco-Oakland Terminal Railways. The stops were used on the Washington Water Power Company to enforce the obedience to signals on a dangerous piece of single track, maximum traffic not being a consideration. The signal equipment is of the standard A. C. semaphore type. Each signal being provided with an auxiliary arm mechanically connected to and moving in unison with the semaphore blade. When the blade is in the danger position, the auxiliary arm is in position to be struck by a glass tube mounted on the top of the motor car of a train attempting to pass the signal. The glass tube when broken discharges the train line pressure into the atmosphere and results in the application of the brakes. Two extra glass tubes are carried on each motor car and after a train has been automatically stopped, the broken tube must be replaced before the brakes can be released. A strict accounting is made of all broken tubes and the system is very effective in enforcing the obedience to signals. In case a signal is out of order and at stop through error, the auxiliary arm may be raised up by means of a keying device and the signal passed, by orders from the dispatcher. Automatic block signals equipped with automatic stops were installed on three and one-half miles of the S. F.-O. T. Rys. double track Pier Line in 1910. Some kind of an automatic stop was considered necessary for the safe operation of trains under the headway and at the speeds demanded, heavy fogs being encountered making it sometimes difficult to see more than a few feet ahead.

The signal system as adopted in 1910 was reconstructed and added to last year when the tracks were moved from the trestle structure to a solid fill but the system is essentially the same as originally adopted. It consists of standard A. C. equipment, single rail track circuits, three-position semaphore signals supplemented by the automatic stop equipment. An auxiliary arm is attached to the signal blade and when the blade is in the danger position the auxiliary arm is in position to engage the arm of a valve on the roof of each car.

The action of the stop valve is essentially as follows: When a train running in the normal direction of traffic undertakes to pass a danger signal, the valve is tripped by the stop arm on the signal, applies the brakes and is automatically restored to its normal position after the required stop has been made, whereas if a train is running against the normal direction of traffic, which is sometimes necessary, the valve if tripped in the against traffic directions, remains down, without applying the brakes and is restored to its normal position by a reduction in train line pressure, which is made when the train stops to reverse direction. In case a signal is out of order or it is desired to use a cross-over, it becomes necessary to pass a signal in the danger position, provision being made for this by means of a keying device. By inserting a key in the lock located at the base of the signal pole, the trainman unlocks the stop arm and is enabled to raise it. The key cannot be taken out of the lock until the stop arm is returned to the danger position thereby insuring its return after a train has passed under the signal. The system provides for the movement of trains under a 45-second headway at the average running speed of 36 miles an hour.

In arranging the signal spacing to provide the required headway, 350 ft. was allowed for the average train length, 4½ seconds time for the motorman to adjust his vision to the signal and 10 seconds for the signal to change from the stop to clear position. Trains running at speeds of 36 miles an hour under a 45-second headway are spaced approximately 2,026 ft. apart, which requires a signal spacing of 420 ft. The full block overlap with the automatic stop used provides a braking distance of 420 ft. while the actual braking distance of a loaded 7-car train operating at 36 miles an hour ranges from 300 to 350 ft. when the automatic stop is applied. Time element relays were used in connection with the automatic signals near the Pier Terminal to permit a closer train spacing of trains approaching or leaving the terminal at low speed. Their function is to cut off the overlap, but first to cause the train to reduce speed to 10 miles an hour before closing up on a preceding train. The satisfactory results obtained by the use of automatic stops on the block signals during six years of constant use caused their application to the interlocking signals of the terminal last year when it was reconstructed. The terminal is located entirely on trestle structure where the customary derails cannot be used, therefore automatic stops to check against the disobedience of signals are very desirable.

The terminal stops have been in use now for about a year, and have made a good record of performances, saving at least one serious accident by applying the brakes to a train on which the motorman had a lapse of mind, overlooked a signal and was headed toward a heavily loaded train at a speed of about 25 miles per hour. Automatic stops serve but one purpose, and that is to enforce the obedience to signals.

If motormen (or enginemen) were 100 per cent. efficient at all times, automatic stops would not be necessary, but no human being is 100 per cent. efficient at all times. Why spend so much energy in perfecting the apparatus to detect the presence of trains and then trust to luck that the human element will not fail? After all, the obedience to signals is the most important thing to be considered, and the fact that automatic stops are extensively and successfully used for certain classes of railway service, especially since the speed control device promises to increase, rather than decrease, the track capacity where it is applied.

Goggles.

The best form of goggles for use by chippers is that in which the glass is held securely in a metal frame under tension, so that when fractured, the pieces of glass are gripped together by the frame. Rubber frames will sometimes be broken by heavy chips and destroy the protection entirely. Colored glasses for welding operators have not always been adapted to the temperature involved and accidents to eyes have resulted from the wrong color of glass being employed. Too much care cannot be exercised in adapting goggles to each line of work.

It is understood that the North-Western Railway of India is to use oil fuel in future, a decision arrived at after some lengthy experiments. Large oil tanks have been installed at Kiamari connected to a pipe line from Karachi. The supply is said to be abundant and the quality unusually free from impurities so common in many mineral oils.

Large Type of Locomotives for the Wabash Railway

Marked Increase in Weight and Tractive Power

Twenty-five large 2-10-2 type locomotives have recently been delivered to the Wabash Railway by the American Locomotive Company. These new engines are being operated on the Decatur Division from St. Louis to Chicago. The ruling grade northbound, the direction of the heaviest traffic, is 0.4 per cent. and the stretch of the longest single grade is four miles. The average northbound train for the new 2-10-2 type engines is 5,000 tons as against 3,500 previously handled by Mikado engines. The new 2-10-2 type engines have cylinders 29 x 32 ins., a total weight of engine and tender of 591,900 lbs. and a tractive power of 69,700 lbs. The Mikados formerly used had cylinders 26 x 30 ins., a total weight of engine and tender of 423,800 lbs. and a tractive power of 50,360 lbs. Thus with an increase in weight of 39.6 per cent., an increase in tractive power of 38.4 per cent. and an increase in train load of 42.8 per cent. were obtained.

Generally, an increase in weight will give a proportionately greater increase in power. In this case, the percentage increases in weight and tractive power are approximately the same, because of the particular attention which was given to the boiler. It is of the extended wagon top type. At the first course the barrel measures 87 9/16 ins. in diameter outside, while the outside diameter of the largest course is 98 ins. The barrel is fitted with 253 tubes, 2¼ ins. in diameter, and 48 flues, 5½ ins. in diameter and 23 ft. long. A combustion chamber 61 ins. long is included. The firebox is 120⅛ ins. long and 96¼ ins. wide. A total heating surface of 5,370 sq. ft. and a superheating surface of 1,129 sq. ft. are obtained. The total length of boiler is 45 ft. 11⅛ ins.

According to the boiler ratios employed by the American Locomotive Company a 29-in. cylinder with 195 lbs. pressure of superheated steam has a cylinder horsepower of 2,954. Since each horsepower requires 20.8 lbs. of superheated steam per hour, this engine working at maximum capacity requires 2,954 x 20.8 or 61,443 lbs. of steam per hour. The firebox, combustion chamber, and firebox water tubes, will evaporate 55 lbs. of steam per sq. ft. of heating surface. The tubes with 2¼-in. diameter, 23 ft. long, ¾ in. spaces will evaporate 8.03 lbs. of steam per sq. ft. of heating surface. The flues, 5½-in. diameter, 23 ft. long, ¾ in. spaces, will evaporate 9.18 lbs. of steam per sq. ft. of heating surface. The total evaporation of each engine, therefore, equals:

Firebox and combustion chamber heating surface......	346 sq. ft.	
Firebox water tubes heating surface.................	33 sq. ft.	
Total..........................	379 sq. ft. × 55 =	20,845
Tubes, heating surface..........................	3,410 sq. ft. × 8.03 =	27,382
Flues, heating surface..........................	1,581 sq. ft. × 9.18 =	14,514
Total..........................		62,791

The total evaporation obtained is 62,791; divided by the total evaporation required is 61,443, which equals a 102 per cent. boiler.

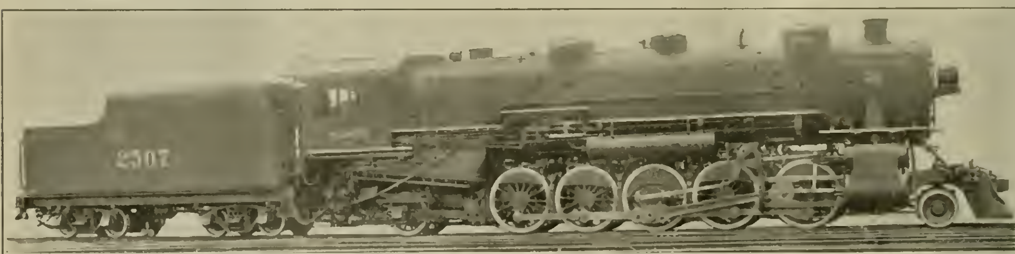
A particularly interesting feature is the American Locomotive Company's latest type of Mellin reverse gear. This gear has a positive lock obtained by a friction clamping device which joins the crosshead of the motor between the regular guide and a hinged bar (guide) on the opposite side of the crosshead. The clamping is actuated by a spring giving a clamping pressure on each side of the crosshead of about eight times the crosshead working capacity. The clamping is relieved by means of a small pressure cylinder situated in the rear of the spring. Pressure enters this small cylinder from either end of the reversing cylinder through an automatic shifting valve. The clamping is again obtained by the exhaust of the pressure on the spring at the completion of the motion.

A Commonwealth Steel Company's cradle casting is used. This casting combines the two rear frame slabs, foot plate, trailing truck spring yoke bracket, and the trailing truck radius bar fulcrum.

Other interesting features are the Locomotive Superheater Company's superheater, Security brick arch, The Duplex stoker, lateral motion box on front drivers, long main driving box, Woodard engine truck, Cole trailing truck, Woodard throttle, Foulder solid back end main rod, radial buffer, O'Connor firedoor flange, and vanadium frames. Some of the principal dimensions are here given for reference as follows:

Fuel, bit. coal; cylinder, type, piston valve, diameter 29 ins., stroke 32 ins.; tractive power, simple, 69,700 lbs.; factor of adhesion, simple, 4.5; wheel base driving, 22 ft. 10 ins.; rigid, 16 ft. 9 ins.; total, 42 ft. 4 ins.; wheel base total, engine and tender, 78 ft. 4¼ ins.; weight in working order, 395,000 lbs.; on drivers, 314,000 lbs.; weight on trailer, 52,500 lbs.; on engine truck, 28,500 lbs.; weight, engine and tender, 591,900 lbs.; boiler, type extension wagon top, O. D. first ring, 87 9/16 ins.; boiler working pressure, 195 lbs.

Firebox, type, wide, length 120⅛ ins., width 96¼ ins.; combustion chamber, 61 ins.; thickness of crown ⅜ ins.; tubs ⅝ ins., sides ⅜ ins., back ⅜ ins.; water space, front, sides and back(6 ins.; depth (top of grate to center of lowest tube), 27⅞ ins.; Crown staying, 1 in. radial; tubes, material, spellerized steel, No. 253, diameter, 2¼ ins.; flues, material, cold drawn seamless steel, No. 48, diameter, 5½ ins.; thickness, tubes No. 11, flues No. 9; tube, length 23 ft., spacing ¾ ins.; heating surface, tubes and flues, 4,991 sq. ft.; firebox, 346 sq. ft.; arch tubes, 33 sq.



2-10-2 TYPE LOCOMOTIVE FOR THE WABASH RAILWAY.

E. F. Needham, Supt. Loco. & Car Dept. American Locomotive Company, Builders ft.; total, 5,370 sq. ft.; superheater surface, 1,129 sq. ft.; grate area, 80.2 sq. ft.

Wheels, driving diameter, outside tire, 64 ins., center diameter 56 ins.; wheels, driving material, main, cast steel, others, cast steel; wheels, engine truck, diameter, 33 ins., kind, rolled steel; trailing truck, diameter, 44 ins., kind, cast steel; tender truck, diameter, 33 ins., kind, rolled steel; axles, driving journals main, 12 x 20 ins., others, 10 x 19 ins. and 10 x 13 ins.; engine truck journals, 6½ x 12 ins.; trailing truck journals, 9 x 14 ins.; tender truck journals, 6 x 11 ins.; boxes, driving, main, cast steel, others cast steel; brake, driver, American; tender, Westinghouse, 2-3½ ins. cross; air signal, Westinghouse, 1-24½ x 120 ins.; pump, compound; reservoir, 1-24½ x 72 ins.

Engine truck, Woodard; trailing truck, Cole; exhaust pipe, single, nozzles, 6⅜, 6½, 6⅝ ins.; grate, style, Rocking; piston, rod diameter, 5 ins.; piston packing, snap rings; smoke stack, diameter, 19 ins.; top above rail, 15 ft. 9 ins.; tender frame, cast steel: tank, style, water bottom; capacity, 10,000 gallons; capacity fuel, 18 tons; valves, type, 14 ins.; piston travel, 7 ins.; steam lap, 1 3/16 ins.; extra lap clearance, ⅛ ins.; setting, ⅛ ins.

Various Small Economies.

A regular meeting of one of our prominent railways at which the mechanical department had been convened, took up the subject of using pressed steel shapes for car repairs. Those connected with the work, admitted that the then employed methods of, and facilities for, handling these parts and the getting of dies to and from the hydraulic press, were crude and ineffective, but that the improvements which had been made lifted the whole transaction in each case, to the level of a commercial proposition. In other words to do this work and to it properly saved money.

It was stated that up to a given date, a saving of $1,350.00 had been effected, and if all the parts, for which the railroad had dies, had been made of pressed steel shapes, at least $1,500.00 would have been the monetary reward. A saving of over $2,500.00 had been brought about by the use of pressed steel boiler fronts and doors instead of employing cast iron. More dies for car parts were under way and a still larger saving was contemplated. This railway has had enough experience to see the advantage to them, of the manufacture by themselves, of pressed steel shapes, and the amount they gain in this way justifies them in expending the price of an efficient hydraulic press and of installing the same. The saving also encouraged them in purchasing a crane for handling the dies, and now a full set of dies has been made in the shops to enable them to replace all the car parts with pressed steel shapes.

The making of Prosser flue expanders was also discussed at this meeting. A 3¼-inch turret lathe was bought for this purpose, and it was expected to work on air-hammer tools, machine punches, rivet set, machine punch dies, grease plugs, bushings, etc. It was anticipated that the saving produced by the railway doing this miscellaneous work for itself, will probably reach the sum of $2,135.00 for the year. It must be remembered that the outlay for the hydraulic press, spoken of above, and also the turret lathe, when paid for, is a charge wiped off the books, but the yearly saving effected, goes on indefinitely, so that in the long run the ends of economy are effectively and permanently served.

At this meeting two Prosser flue expanders were shown. The sections of these expanders had been drop forged, ready for use. They had been tested and tried, and had proved to be very satisfactory. A neighboring railway, it appeared, was using Crescent steel for this work, and had experienced every satisfaction. This and other steels recommended by supply firms were decided upon for test, so that reliable data could be placed before the meeting at a subsequent date, and information would be accumulated in such a form as to guide the formation of a rational opinion as what was best to use. Difficulty had been experienced in getting suitable material for this and other work and it was determined to obtain samples and subject them to test before a final decision was arrived at.

Tool holders was given some thought at this meeting as a result of the fact which was brought out by one of the members, that owing to the advanced price of high speed tool steel, it had become necessary that something be done to economize. The proposal was made and agreed to, that where small tools were used, holders be supplied, so that the scrap ends of the high-speed tool steel, used in larger machines might be made available. This scrap high-speed steel was to be forged down into small bars, and these could be cut into suitable lengths as required. The company had already effected some economy in dealing with wheel lathe tools and those used in other heavy machines.

In this matter, the company had welded a holding end to the high speed tool steel, and this end was made out of scrap tire steel, electrically welded to the working short end of the high-speed steel tool. It was decided to experiment with the tool holders, and the home-made bars of scrap high-speed tool steel, and report progress at the next meeting.

Some very satisfactory economics are thus brought about in railway repair shops, as the proposals here spoken of, are gone into without prejudice and stand on their merits as veritable savings. While the constant pursuit of better and cheaper ways of doing work, does not put any heavier burden on the men and the company reaps a substantial benefit. The meetings are productive of good, not only by bringing out a kindly and good-natured rivalry in the thinking out of ways and means, but the men get to know one another with mutual profit and with corresponding benefit to the department and railway they all serve.

Early Railroads.

It is amazing to find how little the more intelligent class of railroad men in the United States know about the genesis of our great railroad system. Most of them believe that railway construction began in England about 1830, and that the United States followed that example about the same time.

The fact is that crude forms of railroads were used in connection with coal mines for two hundred years before the Stephensons introduced steam locomotives on the Liverpool and Manchester Railway, from which event most historians date the beginning of railway history.

As early as 1630 an inventor named Beaumont introduced wooden ways, consisting of cross sleepers placed about two feet apart upon which were spiked wooden rails about six feet long, for carrying coal from the pits. Four-wheel wagons or cars were placed on this crude tramway and carried their loads at less expense than could be done on the system of highways then prevalent in the British Isles. This was a very crude beginning, but it persisted and prepared the way for the steam operated railway.

The first real improvement made on the wooden railway was to cover the rails with iron plates to lessen the wear of the iron wheels. These plates were applied by "platelayers," and the trackmen of the British Isles are to-day known by that appellation. The next move was to put cast-iron rails in place of the wooden ones, which in the course of time gave place to wrought iron and then to steel.

A decided improvement was effected in 1789 by William Jessop, who built a railway in Leicestershire. Before his day the rails were made with a flange to keep the wheels on the track. Jessop made the rail heads plain and put a flange upon the car wheels.

Shutting Off Valves.

Do not leave a valve just cracked as this will surely lead to scoring, and, with steam at 180 to 200 pounds, it will be ruined in a short time with the attendant waste and loss of time. The injector primer, the air pump throttle, and the drain cock to the water glass are great offenders in this respect, probably costing the railroads many times their value in needless grinding simply because they are not properly handled.

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Pioneering a By-Product of Enterprise.

In glancing over the consular reports published by the Government a railroad man would naturally be struck with the evidence that the trade door for this country by which it might easily enter Brazil is certainly opening. The coal fields of that republic have not yielded a uniformly suitable fuel for locomotives as they may now be made to yield, through the legitimately self-seeking interest of the Loco. Pulv. Fuel Co. and its Brazilian agents. These companies succeeded very satisfactorily in dealing with a native Brazilian coal found in the Jacuhy district (Rio Grande du Sol). This coal does not burn economically in the lump form. For this reason many of the smaller railroads have burned wood.

There is no doubt that coal is a very desirable form of locomotive fuel, but in Brazil although it is easily get-at-able, it did not produce the effect necessary to put it in the directly usable class. It was like an invention which is mechanically possible, but not commercially feasible. It is there, but it does not pay to use it. In adding to their business, the Loco. Pulverized Fuel Co., through its foreign agency, the International Pulverized Fuel Corporation, made this coal commercially attractive, of which we give a full account of in another column in this issue and this fact will probably lead to an extention of the present lines of railway and bring others into being. In this way the enterprise of an American firm may be found to have done, as a by-product of their enterprise, the necessary pioneer work from which they and others may reap much operating and financial benefit.

Our merchants have been often beaten by foreign competition. At this time, when it is possible to see the future establishment of railway lines in Brazil and the rehabilitation and improvement and extension of existing lines; the door for the entry of all kinds of railway supplies, appears to be ajar and the latch string held out to us, and it only requires a vigorous well directed and business-like push to swing the door full open.

Our locomotive specialties which have achieved such good results at home, can be made to give the same measure of dollar and cent success to the railways in Brazil, if they are once successfully marketed.

Superheaters are as good there as here, so are Westinghouse Air Brakes, so are Economy Devices of all kinds, and Brick arches. Pulverized fuel has proved its success, and the field for feed water heaters is yet untrodden. Car couplers are required, trucks, wheels, electric devices, headlights, valves, staybolts, valve gear, tubes, steel cars, pipes, cast iron and steel, and the hundred and one appliances that we now practically consider as almost indispensable, ought to be brought forward and the merits and practical advantages explained and demonstrated to a people who are highly and technically trained and only require to be told and shown, to manifest a ready appreciation.

The technical press has its friends and readers in the South American countries, and it stands ready and willing to do its part in helping these people to a working knowledge of what we do, and are, from an engineering standpoint, in this country. A favorable impression has been created by the work of our fellow laborers with the pulverized coal, it only remains for us to go in and, in a friendly spirit, make legitimate use of the feelings that are entertained toward us. Pulverized coal is no secret now, and while we may have commercial rivalry from Great Britain and her vast self governing dependencies, it may be rivalry indeed but competition will be fair and honest and square. There is another nation, however, which does not respect treaties, and overrides patent rights without scruple, and respects not the place legitimately won by another. We must look to our own laurels if we would keep them.

The cold, clear, light of applied science, in the hands of competent men, has illumined the darkness which partly enshrouded a Brazilian economic problem, and the people fully appreciate the work done. Is it not our duty to fearlessly go forward on the path so ably blazed by our pioneer friends of the powdery and dust-like coal, which has in it all the potency of Nature's gift to man, in the days when the earth was young?

Smelling Danger Ahead.

There are many curious expressions in current use, which while they put forth an idea with considerable accuracy, are not strictly to be taken with the formal meaning of the words. Such an expression used to indicate an indefinable certainty, is the phrase. "I felt it in my bones." Bone is not found at the surface of the body and moreover bone is not affected by feeling of any kind. Such an expression as we have used at the head of this article may appear as one of the figurative sentences to which we have made allusion, but it is not one of this kind. It is an accurate statement of a particular occurrence. Some time ago a contemporary printed the everyday life of a locomotive runner, and in it the engineman says:—

"The sense of smell also comes in play. I was running a special tea and silk train with orders to make the best time possible. I was making 45 miles an hour, around curves, and it was a very foggy morning. My nostrils commenced to tell me that a train was close ahead. I could smell the smoke, which is cognizable a long distance in such weather. I got my train under control; and suddenly out of a bank of fog I came upon the rear end of a slow moving extra freight. I followed this train into a water station, 3 miles, without the crew in the caboose knowing I was near." Here is an actual case, and the authority for it, is the man who did it. There is no question that it took place, exactly as described.

The morning was foggy and it is fair to presume that the signals were obscured, or one or more of them had been passed without conscious observation. Most psychologists are agreed that the sense of smell is of practically no interest in their science, as almost nothing is known about it. The engineman giving the testimony before us now, was probably a man with what might be called an alert mind, an all round vigorous man, in fact an exception. He smelt smoke, and deduced from that, with Sherlock Holmes reasoning, that the cause of the smell was engine smoke, the smoke must come from a working engine, and that engine was on a train in front of him. Facts subsequently coming to light, proved the correctness of his forecast.

This brings us to the use of senses in directly informing the brain of conditions around us, and does not take into account the slim use of the reasoning faculties, and the ability to put two and two together, however simple the process. Prof. George, M. Stratton, formerly professor of experimental psychology at Johns Hopkins University, referring to the difference between the color value, and the space quality of what we see, such as the night and day indications of railway signals, makes out a good case for the position indication of the semaphore blade, and throws some doubt on the value of colors, by tracing back to remote ancestral usage, the facility with which position reacts through the eye and the uncertainty with which color pushes its impression in.

He says:—"The sense of space is of one blood with habits and instincts deep within the individual and the race, it is not easily thrown into disorder. Our power to notice differences of form and position is one which, through the common needs of life, has developed wonderful stability and strength. The recognition of places, noting the form and tracks of animals, the shaping of tools, and countless other matters depend upon and encourage an interest in the spacial character of things, an interest which informs and guides not only us, but uncivilized man and the higher animals as well. Compare with this power, the general steadiness and fidelity of which is thus guaranteed by long habit and long inheritance, our color sense seems only an upstart and an idler."

We have now before us two pieces of testimony, each of a different character. One from an active engineman, the other from a student of psychology. The engineman was debarred from the sight of a signal, we believe, owing to the state of the weather. He successfully called into play a hitherto unused sense, that of smell. The student of psychology casts doubt on the color observation as an unerring guide and upholds the observation of position. The one was throw back as it were to elemental or race habit. Where he could not see, he smelt, as primitive man, or as an animal would do. Prof. Stratton goes also back to the race habit of uncivilized man or animal and shows what each looks for and desires to see. In each case, though circumstances are widely apart, engineman and professor does and wishes for what a savage or an animal would do, under similar circumstances. There is a lesson in these facts for the thoughtful man, aside from any momentary amusement or love of the sensational or the bizarre. The lesson for us, or rather one might say, the powerful suggestion for thought is, whether our mode of procedure is in accordance with the known trend of Nature, or not.

Have our signal systems been devised so that the safe thing to do is the natural thing to do? Are we absolutely right in the development of a system the observation and interpretation of which, Nature may permit a serious lapse? There is no question but that the signal system we have is good, though is it possible to devise one more perfect? With what merits our present system possesses, whole railway systems in this country have not made the first move to adopt any system. It may seem like idle talk to speculate upon that which may or may not seem to be a defect in our present system, when no system is employed by many railway managers. The appeal is here intended first for those who fully believe in, and practice the art of signaling—that method of imparting foreknowledge, to the man who urgently needs it, the engineman on duty, but the appeal is also intended most strongly for the user of no system at all, so that he may be aroused to the position he is in, and may see the dangerously illogical method under which his trains are run, when information as to the track ahead is denied to the man who would look for it, if it was there.

The best method of conveying the information, how far easy or otherwise, how natural or non-natural it may appear to some? These are matters for judicious and thoughtful debate by those qualified to discuss them, but the man who has not been affected by the stark-staring, unshaded, glaring, prominence of the idea that a signal system is now part of a railway as much as the track, has not only automatically ruled himself out of the consideration of such facts and views as we have mentioned, but he takes the lives of trusting travelers in the hollow of his hand, without a just appreciation of the grave and ever-present responsibility he has so thoughtlessly assumed, and the threatening consequences of this mental lethargy hang above him, by a thread, like Damocles' sword in boding air that trembles menacingly over his official life.

Tractive Effort and Horse Power.

The tractive power of a locomotive is easily calculated and reliable. The horsepower is elusive because variable. Occasionally a layman, as distinguished from a railroad man, asks about the horsepower of a locomotive, and the railroad man is at a standstill, for while that particular unit of measurement is easily applicable to stationary engines, it is not entirely satisfactory when applied to locomotives which instead of exerting any fixed rate of power continuously works under conditions varying almost every minute, from those exerting the full maximum power or pull to those requiring little or no effort, as when the engine is drifting or doing light work.

If the work of the locomotive were continuous, on a perfectly level track at a fixed speed with a certain load, the rated horsepower would be of some value. The rated tractive power is simpler, as it indicates correctly the pull at the start. Experiments have shown that it takes about 16 lbs. of tractive effort to start one ton on a level track, and as the speed increases the tractive force necessarily diminishes to as low as 6 lbs. per ton. When fully loaded, steam is admitted to the cylinder nearly the full stroke of the piston, and the consequent large use of steam is very great, and it is exhausted at a high pressure. As the speed and momentum increases the supply of steam is cut off at less than one-third of the stroke, and the amount of steam used is reduced to a minimum, so that while the speed is increased the power exerted is diminished. This is in accordance with a well known law of physics. At curves or grades, a greater power is brought into action. In the early days of the locomotive, when steam pressures were low and slide valve gear was constant, the indicated horsepower had a more stable value, because the power exerted was almost constant.

Under certain conditions and at certain speeds it may still be calculated. Several years ago an Atlantic type passenger locomotive, while running 70 miles per hour, developed 2,000 horsepower, which at that time was the greatest power developed, the heavy freight engines of that time having fallen far short of that performance because of their slow movement. However, with the introduction of superheating appliances and the consequent development of the present day locomotive, it is not now uncommon to find locomotives developing several times that amount. But in the majority of cases the amount of tonnage which ought to be assigned to a locomotive is more easily grasped by the mind when referred to the starting effort and capacity at 6 or 8 miles an hour rather than upon its power at higher speeds.

In calculating the drawbar pull or tractive effort of a locomotive at starting speeds the following is the formula in general use: Multiply 85 per cent of the boiler pressure in pounds per square inch by the square of the diameter of the cylinders in inches, and multiply this amount by the length of the stroke in inches, dividing the product by the diameter of the driving wheels in inches. For example, supposing the boiler pressure is 200 lbs. per square inch, diameter of cylinder 27 ins., length of stroke 30 ins. Then $170 \times 729 \times 30 \div 63 =$ 59,000 lbs. tractive power.

It may be added that while much more could be said on the subject, it has been found that the tractive power of a locomotive is more readily applicable than the horse power, and an approved ratio between the two calculations is about 18 to 1 so that a tractive effort of 54,000 lbs. would be about 3,000 horse power, at a particular speed.

Air Brake Department

Improved Triple Valve Test Rack—Questions and Answers

Improved Triple Valve Test Rack.

Last month's issue contains a photographic view of the improved Westinghouse 3-T triple valve test rack, with a few remarks relative to the necessity for an improved test rack. It will be observed that the differential valve has been eliminated and that instead the resistance of the triple valve piston and slide valve is ascertained with a friction measuring device.

It will be understood that the two most important conditions of a triple valve are in respect to frictional resistance of the triple valve piston and slide valve to movement, and leakage past the triple valve piston packing ring. The friction, or resistance to movement, may arise either from the surface of the slide valve on its seat or from the piston and packing ring, and it is well understood that the present standard test rack does not distinguish betwcen the two, although it is important that such distinction be made, since the friction of the piston ring depends upon the character of the workmanship done and is therefore controllable, while that of the slide valve on its seat is inherent in design and uncontrollable. Owing to the impossibility of differentiating between these two factors, valves may be condemned when they should not be, as for example, when there is a high slide valve friction in combination with low piston friction and an "air tight" ring. Such a triple valve would apply and release in service independent of what the slide valve friction may be within the limits made possible by the design of the valve; or the valves may be passed when they should be condemned, as an example, if there is a low slide valve friction and high piston friction, the piston friction would cause the valve to fail to apply under service conditions or a valve might pass the test, having a combination of low friction and excessive ring leakage, but if the slide valve resistance increased when placed in service, which is very likely to happen in a very short time, the valve would fail to apply.

Such a test has been omitted in the new code or with the new rack, a resistance test being made by means of a friction indicator before the triple valve is placed on the stand for test, the indicator being a simple device which measures the resistance in pounds required to move the triple valve and piston to the applied and release positions in the bushings.

It will not be necessary to outline the former codes of tests for packing ring leakage, suffice to say that it was made (or is being made) with but about 1¼ lbs. differential between the brake pipe and auxiliary reservoir pressure, while with the new rack the piston and ring are blocked in their correct position in a manner to preclude the possibility of damage and the ring is tested under a 6-lb. differential or more nearly that obtained in actual service or under service conditions. Valves in a defective condition as regards workmanship can pass the former test, as it is possible to make the packing ring temporarily tight by the use of a lubricant, also, the ring may be too narrow in the groove, and on account of the low differential used in the test it may pass, where if the differential were equal to the service condition or that provided by the new rack, the seal made with the lubricant would be broken and the actual condition of the ring would be manifested. Briefly, the new test provides a maximum useful life for the valve in service. In other words, the test contains one set of limits for passing valves into service and another for condemning valves out of service, and this feature is absolutely necessary if valves that are passed are not to be condemned after a week or so of service. The former set of limits accurately determines the fitness of new and repaired valves to be placed in service. This test is necessarily as severe as it is commercially practicable to make it, although the degree of severity does not exceed that intended in the old tests. The set of limits for condemning valves out of service, as might be inferred, applies to valves removed from service for test as to condition. The requirements of this test are as lenient as possible, being limited only by the requirements of service, hence the margin between these two sets is as large as possible; therefore a new or repaired valve that will pass the test provided for it is assured of a maximum useful life in service.

This test also contains a third specification, by means of which it can be determined whether the valve removed from service under suspicion as to condition has deteriorated beyond the actual point where it cannot be expected to operate satisfactorily under the characteristic conditions of service.

Another change is made in the old quick service port capacity test, which required that proper allowance be made for the variance of slide valve friction varying strength of graduating spring, and since this was not actually provided for there were three variables involved instead of one. With the present test, this is made in an entirely different manner, and by virtue of its nature it will accurately determine the condition of the quick service port, as a "blow down" test is the most positive and reliable method for determining the capacity of any port.

In the old code, the service port capacity test, is to determine whether the service port is of the proper capacity to expand the auxiliary reservoir volume into the brake cylinder pressure at the required rate, and in the new code of tests this has been divided into two separate tests, termed service stability and emergency tests. The purpose of the first is to determine whether the valve possesses a safe margin from undesired quick action and the second is to determine whether the factor of safety is such that the valve can be depended upon to operate in emergency when desired. Service Stability and Emergency tests are remarkably simple, direct and efficient, both being conducted in practically the same manner. The brake pipe pressure is reduced at predetermined rates depending upon the valve under test. In one case the valve must not move to emergency position before brake pipe pressure has reduced 20 lbs. in the other, it must move to emergency position before 20 lbs. reduction has been made. This method of test is familiar to those who have operated the Control valve and Universal valve test racks.

This rack has been in the course of development for several years, and embodies improvements which have been found by experience and sound analysis to be desirable, and while the old type of test rack has been the best that could be provided up to the present time, any air brake repairman is aware of the fact that a great deal of unnecessary time and labor has been spent in repairing and testing triple valves, solely for the reason that accurate tests could not be obtained, but at the present time there is no reason why racks cannot be modified and reliable tests be obtained.

Locomotive Air Brake Inspection.

(Continued from page 365, Nov. 1917.)

112. Q.—When are air gages out of date for test?

A.—Three months after the last date shown on the proper form in the cab or on a paper tag under the glass of the gage.

113. Q.—When are the brake cylinders out of date for cleaning and testing?

A.—Six months from the time shown on the tag attached to the brake pipe near the automatic brake valve, or from the date shown on a form in the cab.

114. Q.—When are distributing valves or triple valves out of date for test?

A.—At the end of six months.

115. Q.—When are triple valves and high speed reducing valves out of date?

A.—At the end of six months.

116. Q.—When are feed valves and reducing valves out of date?

A.—There is no time for cleaning them as they are to be maintained in a condition to properly perform their functions at all times.

117. Q.—When are brake valves to be cleaned?

A.—Whenever required, from any defective action of the equalizing piston or from hard handling and are always to be maintained in a condition to operate properly in all of their positions.

118. Q.—What action is taken if there are no dates on a form in the cab showing the last date of compressor test and if there is no tag on the steam pipe?

A. The compressor is reported out of date for test.

119. Q.—What if the tag under the automatic brake valve is attached to the reservoir pipe or the gage pipe tee?

A.—The tag is improperly applied and the brake equipment is out of date for cleaning and test.

120. Q.—What information must be stenciled on the brake cleaning tag?

A.—The date of day and month, and the initial of the shop at which the work was performed, and the letters A. B. to indicate the work.

121. Q.—What particular kind of stencils must be used for this purpose?

A.—Stencils that will make letters and figures not less than ⅜ of an inch high.

122. Q.—What if the letters are smaller than ⅜ in.?

A.—It is a violation of the Federal Regulations and must be reported.

123. Q.—If inspecting an engine and no form was found in the cab, and no tag attached to the brake pipe near the automatic brake valve, what would you observe before reporting the brake equipment out of date?

A.—Examine the brake cylinders and operating valves to see whether the dates were stenciled on these parts.

124. Q.—Is this permissible?

A.—Yes, this information may be shown on a form under glass, or by a tag attached to the brake pipe near the automatic brake valve or be legibly stenciled on the various parts.

125. Q.—What if the glass of the form in the cab is broken or missing?

A.—It must be reported, as the Regulations specify "displayed under glass."

126. Q.—What attention is to be given the pump governor at this time?

A.—It is inspected for leakage, and it must be noticed that the vent port is open, and that there is no unusual waste of air or steam from the waste port.

127. Q.—What is the cause of leakage from the vent port after the compressor has been shut down for some time?

A.—A leaky diaphragm valve.

128. Q.—What would be the effect of the vent port being closed tightly or stopped up?

A.—If the governor piston packing ring was a good fit the governor would not be sensitive to open after a reduction in main reservoir pressure.

129. Q.—Why not?

A.—The pressure above the governor piston would tend to remain bottled up after the diaphragm valve has closed, and thus hold the steam valve closed at a time when the compressor should be in operation.

130. Q.—What is the cause of a leak of air from the waste port?

A.—A leaky governor piston packing ring.

131. Q.—What is the cause of steam leaking from the waste port when the pump is running?

A.—A defective joint between the back of the governor steam valve and the governor cylinder.

132. Q.—What is the cause when the pump is shut down or just at the point of shutting down?

A.—It is due to a badly worn steam valve stem or to a poor fit of the steam viave stem through the governor cylinder.

133. Q.—What would be the effect of a closed or stopped up waste port?

A.—The governor could not stop the compressor.

134. Q.—Why not?

A.—Steam pressure equal to that carried on the boiler would accumulate under the governor piston, and it would require a higher air pressure to move the governor piston and close the steam valve.

135. Q.—What is the effect of a steam leak from the waste port?

A.—It tends to drain away the oil that is passing from the lubricator to the steam cylinders of the compressor, and sometimes results in a stopping of the compressor in service.

136. Q.—How can such a comparatively small waste of steam drain away enough oil to cause a dry air compressor?

A.—The oil tends to follow the swiftest moving jet of steam and with the governor steam valve closed or partly closed, the flow through the steam pipe almost stopped allows the oil to follow the flow of steam through the leak.

137. Q.—Does this same thing apply to a compressor steam pipe leak?

A.—Yes, if the leak is between the lubricator connection and the compressor.

138. Q.—After the leakage tests have been made and the pipes and valves in the cab tested for leakage, and last dates of cleaning and test noted, what should be observed?

A.—The brake cylinder hand of the small air gage.

139. Q.—Which hand is this?

A.—The red one.

140. Q.—What are the names of the black hands of the gages?

A.—Brake pipe on the small gage and equalizing reservoir hand on the large gage.

141. Q.—Why are they named in this way?

A.—Because they show these pressures.

142. Q.—What would you think wrong, if the black hand of the small gage was indicating brake cylinder pressure and the red hand brake pipe pressure?

A.—That the gage pipes were wrongly connected.

143. Q.—Would you report this as a disorder?

A.—Yes, the red hand is supposed to register brake cylinder pressure.

144. Q.—Why do you notice the brake cylinder gage hand after completing the leakage tests?

A.—To see if the brakes are still applied.

145. Q.—Will five minutes time have elapsed since the closing af the distributing valve supply pipe cock?

A.—Yes it will require at least 5 minutes time to inspect the brake apparatus under the running board and make the leakage tests in the cab.

146. Q.—Why should the leakage tests be made with the distributing valve supply pipe cock closed, or before it is again opened?

A.—So that while the brake valve handle is on lap position, brake pipe leakage cannot operate the distributing valve and cause a flow of air from the main reservoir into the brake cylinders and thus interfere with the main reservoir leakage test.

147. Q.—If the brake has leaked off before the 5 minutes has elapsed, what should be done?

A.—If the source of leakage has not been discovered during the inspection and test of the brake cylinders and piping, the brake should be reported as having leaked off within 5 minutes time.

148. Q.—What should then be done in following the regular course of inspection?

A.—Both brake valves should be placed in running position, the pump throttle should be opened and the stop cock in the distributing valve supply pipe should be opened.

149. Q.—What parts now remain to be inspected and tested?

A.—The brake valves and air gages.

(To be continued.)

Train Handling.

(*Continued from page 366, Nov., 1917.*)

134 Q.—About how much of a brake pipe reduction from the brake valve would be required to run through and apply all of the operative brakes in a 100 car train if all were type H triple valves?

A.—It would require about 12 lbs. to obtain any material braking force at the rear end of the train.

135. Q.—How much if about one half were K triple valves?

A.—About 7 or 8 lbs.

136. Q.—If all were K triple valves?

A.—A five pound reduction will run through a 100 car train.

137. Q.—What is the most important observation to be made with reference to slack action on the initial brake pipe reduction of the first brake application on any train?

A.—To note in which direction the slack runs.

138. Q.—What do you conclude if it runs out or to the rear?

A.—That the greater percentage of braking ratio or what is generally termed braking power is at the rear end.

139. Q.—Why is there generally a run in of slack when the brake is first applied?

A.—Because the brake pipe reduction is effective on the cars at the head end of the train first.

140. Q.—What do you conclude if the slack runs in on the first reduction and there is no run out following this?

A.—That the greater percentage of braking force is on the cars at the head end of the train.

141. Q.—What is meant by the term percentage of braking power?

A.—The pounds pressure on the brake shoes as compared with the weight of the car and its load.

142. Q.—What is meant by nominal percentage of braking power?

A.—The calculated brake shoe pressure as compared with the weight of the car when empty.

143. Q.—What is the actual percentage of braking ratio on a car?

A.—The actual retarding force ob-obtained between the shoe and the wheel as compared with the actual weight of the wheel on the rail.

144. Q.—What is meant by the term coefficient of friction?

A.—The actual pull of the shoe tending to stop the rotation of the wheel, or in other words the pull in pounds obtained on the brake beam hanger.

145. Q.—How does this frictional force vary?

A.—With a constant pressure on the shoe, it can increase only with a decrease in the speed of the wheel, but it decreases with an increase in the force pressing the shoe against the wheel, and with an increase in the length of time the shoe is held against the wheel and with an increase in the speed of the wheel.

146. Q.—Does this mean that the braking force is less when a higher pressure is applied to the brake shoe?

A.—No, but it means that a lower co efficient of friction is obtained when the brake shoe pressure is increased under ordinary conditions of service braking.

147. Q.—What causes this?

A.—Generally the higher temperature as a result of the higher shoe pressure.

148. Q.—Does this hold good for all temperatures from the beginning to the end of the brake application in all classes of service?

A.—No, in high speed train service, the maximum coefficient of friction obtainable is not reached until a high temperature is reached at the contact of the shoe and the wheel.

149. Q.—With two 100,000 capacity cars, one empty and the other loaded, about how much more percentage of braking power has one car than the other, the same brake shoe pressure being applied in both cases?

A.—About 400 per cent.

150. Q.—Why?

A.—Because the weight of the load on such cars is 3 or 4 times the weight of the car when it is empty.

151. Q.—If such cars are braked at 60 per cent of their light weight, what is the per cent of braking power when loaded?

A.—From 15 to 17 per cent.

152. Q.—If two of such cars, one loaded the other empty, are started off at the same rate of speed, and the brake applied with the maximum force, about how much further would the loaded car run than the empty before it could be stopped?

A.—At least 4 times as far.

158. Q.—What does this indicate in descending grades?

A.—That the empty car in descending the grade may be stopped in a certain distance from a full application of the brake, while the loaded car might not be stopped until after it has passed the foot of the grade.

154. Q.—Considering the piston travel of the brake cylinder of a car, does the difference in travel create a difference in retarding effect and what is termed the percentage of braking power?

A.—Yes.

155. Q.—Which has the greater retarding effect, the long or short travel?

A.—The short travel.

156. Q.—Why?

A.—Because a higher brake cylinder pressure will be obtained for the same number of pounds brake pipe reduction.

157. Q.—How is the higher cylinder pressure obtained?

A.—Through the short travel having less brake cylinder volume for the auxiliary reservoir pressure to expand into.

158. Q.—Considering all the difficulties encountered in obtaining uniform action of the brakes in a train, what is the most difficult make up of train to handle without serious shock when operating on a level track?

A.—One of mixed loads and empties, with the empties behind the loads

159. Q.—Why?

A.—Because of the change of slack that would take place as the result of the differences in percentage of braking forces that would be obtained between the empty and loaded cars.

160. Q.—Which way would the slack be expected to run under the influence of a brake application?

A.—Out or to the rear.

161. Q.—Knowing from the make up of the train that the harshest run of slack will be toward the rear, what can be done to minimize the effect of the run out?

A.—The initial reduction could be made before closing the engine throttle.

162. Q.—What is the object?

A.—To keep the train stretched as much as possible so the slack cannot run out hard.

163. Q.—From an air brake point of view, could the train be made up in a manner to facilite smoother handling than would ordinarily be obtained?

A.—Yes, by placing a certain per cent of the empty cars ahead of the loads.

164. Q.—How would this assist in making a smoother stop?

A.—There would be less empty cars at the rear to run the slack out.

165. Q.—Is there another reason?

A.—Yes, the empty cars placed at the head end would assist very materially in holding the loads against the empty cars at the rear.

166. Q.—Just why is a heavy brake pipe reduction recommended when the train is within an engine length or about 40 ft. from the point at which the train will stop?

A.—To obtain all of the braking power possible on the loaded cars as the train stops and to have the head end stop before the influence of reduction becomes fully effective on the brakes of the rear cars of the train.

167. Q.—Can this method be used with any make up of freight train?

A.—Yes, if the worst make up of train can be handled successfully in this manner, it will naturally serve for a better make up of train under ordinary conditions, and no trouble of any kind need be anticipated from that source.

(To be continued.)

Car Brake Inspection.

(*Continued from page 367, Nov., 1917.*)

137. Q.—If a car has two independent sets of brakes, how is the car considered if one of the brakes is cut out?

A.—It must be counted as a non-air car or the car is considered to have an entirely inoperative brake in figuring the percentage.

138. Q.—Does it make any difference whether this car has two independent sets of brakes one controlling a single truck, or whether it is a unison brake, that is, either cylinder operating the brakes on both car trucks?

A.—No, in either event the car is considered as having an inoperative brake.

139. Q.—Could such a car, or one with the universal equipment and the stop cock in the brake cylinder pipe closed, be the first one in a train?

A.—According to the letter of the law it could not, but it could still be the first car in the train and comply with the spirit of the law, provided the proper percentage of brakes are still operative.

140. Q.—What is to be done with the first car in the train if it is a non-air car?

A.—The defect must be repaired or the car shifted to some other portion of the train, but not next to another car with an inoperative brake.

141. Q.—Is a car with an inoperative air brake ever placed on the rear of a passenger train?

A.—No such cars must be shifted into the train, if it is absolutely necessary to move them before repairs can be made.

142. Q.—If such a car is on the rear end of a freight train, must the air brake hose be connected.

A.—In all cases, unless the hose connections cannot be made.

143.Q.—What if the air pipe is bursted at the rear of the front angle cock of this rear car?

A.—The hose are to be connected and the angle cock on the rear car left closed and the other opened.

144. Q.—For what purpose?

A.—So that if the rear car breaks loose, the brake on the train will apply.

145. Q.—What is usually done if it becomes necessary to place a non-air car on the rear of a freight train?

A.—A trainman is designated to ride the car

146. Q.—Why is this?

A.—To operate the hand brake in case the car becomes uncoupled.

147. Q.—Would a car with an inoperative hand brake ever be the rear car of a train?

A.—As a general proposition a car with an inoperative hand brake is never permitted to be in service, but the rear car of a train must never be without an operative hand brake, regardless as to the condition of the air brake

148. Q.—If, during the terminal test of brakes on a passenger train, it is found that another application of the brake is necessary, how may the signal to apply brakes be given?

A.—With the communicating signal, or a hand signal.

149. Q.—If all brakes applied properly, and the signal to release was given and the brakes did not release?

A.—The engineer may not have received the signal, or may have received the wrong number of blasts.

150. Q.—What would be done if no air pressure was found in the signal pipes?

A.—The train signal line would be inspected for uncoupled hose, or closed stop cocks.

151. Q.—What would be done if no disorder of this kind could be found?

A.—The signal hose between the tender of the engine and the first car would be disconnected to see that there was air pressure flowing back from the engine.

152. Q.—If there was none?

A.—The signal pipe stop cock on the pilot of the engine would be examined to see that it was closed, if it was, the Engineman would be notified that the signal equipment of the locomotive was defective.

153. Q.—Could the train be permitted to proceed without a signal whistle?

A.—At the present time it is being permitted, however, the Federal Regulations specify that when an engine is equipped with the train signal apparatus, it must be known to be tested, and in a safe and suitable condition for service before each trip.

154. Q.—What would be wrong if there was a strong flow of air from the car discharge valve of the rear car and the whistle did not sound?

A.—It would indicate a defect on the locomotive.

155. Q.—What would be done?

A.—The Engineman would be requested to release brakes, and be notified that the train signal system was inoperative, the Conductor would also be notified of the fact after it has been ascertained that all brakes have released properly the train would be ready to proceed.

156. Q.—What would be wrong if the whistle could be operated from the forward portion of the train but not from the rear portion, there being air pressure throughout?

A.—That the train signal valve of the locomotive was defective.

157. Q.—What would be done if the proper blasts were received and the Engineman moved the brake valve to release position and the brakes did not release on the rear cars?

A.—The angle cocks would be examined to see that none were closed between the cars that did release and the cars that failed to release.

158. Q.—How could brakes apply on the rear cars if the angle cocks were closed at some point in the train?

A.—Through brake pipe leakage.

159. Q.—What would be done if the brakes released on all cars except one in the train?

A.—The brake on that one car would be examined.

160. Q.—What would first be looked for?

A.—A set hand brake or if the car is equipped with a pressure retaining valve to see whether if was turned up to retain air pressure in the brake cylinder.

161. Q.—What else would be examined?

A.—The brake rigging to see that it is not fouled in any manner.

162. Q.—What then?

A.—Another signal would be given to apply and then to release brakes, and it would be noted whether any air pressure escaped from the triple valve exhaust port or the retaining valve when the signal to release was given.

163. Q.—What would be indicated if air pressure escaped from the triple valve exhaust port?

A.—That the release spring of the brake cylinder was too weak to return the brake cylinder piston to its release position, or that the brake levers had fouled.

164. Q.—What should be done in a case of this kind?

A.—If the brake shoes are sufficiently free on the wheels, the car may proceed until proper repairs can be made, but such things are usually manifested before a car is made up in a train.

165. Q.—What should be done if the brake failed to release or brake cylinder pressure failed to escape on the second application and release?

A.—The brake must be cut out or repairs made.

166. Q.—What if the required percentage of operative brakes will not then be obtained?

A.—The car must be cut out or enough cars added to make up the percentage or the defective brake must be repaired.

167. Q.—What would such an action indicate?

A.—Defective triple valve or defective car brake operating valve.

168. Q.—Could it not be due to an overcharge of the brake pipe from the locomotive or through a graduated release type of brake graduating?

A.—It might but the Engineman would be in a position to know whether such was the case and would make the brake application accordingly and in either event it would be remembered that all of the other brakes in the train released and naturally the one failing should also have released if not defective.

(*To be continued.*)

Mikado or 2-8-2 Type Locomotive for the Fort Smith & Western Railroad

Our illustration this month shows one of two Mikado or 2-8-2 type of locomotives, recently built by The Baldwin Locomotive Works for freight service on the Fort Smith & Western Railroad. This line is laid with rails weighing 75 lbs. to the yard, and the wheel loading of the new locomotives is conservative for rails of this weight. These locomotives exert a tractive force of 37,400 lbs., and with 154,000 lbs. on the driving wheels, the ratio of adhesion is 4.12.

The Mikado type is well fitted for service on a line of this character, as the wheel base is flexible, and liberal steaming capacity can be provided without using heavy wheel loads. The present engines are similar to three which were constructed by the same builders for this road in 1916. An excellent opportunity was thus afforded to fit the new engines for the special conditions to be met.

The boiler is of the straight-top type, and is fitted with a 24-element superheater and a brick-arch supported on four tubes, each 3 ins. in diameter. The front end of the firebox crown sheet is supported on two rows of Baldwin expansion stays, and 300 flexible stays are placed in the breakage zones. Labor saving devices include a power operated firedoor and a coal pusher on the tender. The ash-pan, as specified by the railroad company, is supported from the engine frames instead of from the mud ring.

The cylinders are equipped with bypass valves of the Sheedy type, and there is a separate valve in the cab for admitting a small quantity of steam while the engine is drifting. The piston valves are 13 ins. in diameter, and are driven by the Southern valve motion. The Ragonnet power reverse mechanism is applied. Flanged tires are used on all the wheels and the driving wheel centers are of cast steel with brass hubliners. The driving-boxes and spring saddles are also of cast steel. Flange oilers are applied to the leading drivers. Some further interesting features include the Hodges design of trailing truck, and a radial buffer between the engine and tender.

As compared with the tenders of the previous locomotives, referred to above, the tank capacity has been increased from 6,000 to 7,000 gallons. The height of the tender has not been increased, but the tank has been lengthened to provide additional capacity. The new tenders are carried on 850-lb. chilled wheels, and have equalized pedestal trucks and 10-inch channel frames.

The locomotives are excellent examples of medium weight power, equipped with modern appliances and designed to develop maximum efficiency. Further particulars are given in the table of dimensions, as follows:

Engines—Cylinders, 22 ins. x 28 ins; valves, piston, 13 ins. diam.

HEAVY 2-8-2 LOCOMOTIVE FOR THE FORT SMITH & WESTERN.

J. Miscampbell, Mast. Mech. Baldwin Loco. Wks., Builders.

Boiler—Type, straight; diameter, 66 ins.; thickness of sheets, 11/16 ins.; working pressure, 185 lbs.; fuel, soft coal; staying, radial.

Fire Box—Material, steel; length, 102⅜ ins.; width, 65⅞ ins.; depth, front, 67½ ins.; depth, back, 56½ ins.; thickness of sheets, sides, 5/16 in.; thickness of sheets, back, 5/16 in.; thickness of sheets, crown, ⅜ in.; thickness of sheets, tube, ½ in.

Water Space—Front, 4 ins.; sides and back, 3½ ins.

Tubes—Diameter, 5⅜ ins; and 2 ins.; material, steel; thickness, 5⅜ ins. No. 9 W. G., 2 ins. No. 12 W. G.; number, 5⅜ ins. 24, 2 ins. 172; length, 19 ft. 3 ins.

Heating Surface—Fire box, 165 sq. ft.; tubes, 2,373 sq. ft.; firebrick tubes, 28 sq. ft.; total, 2,566 sq. ft.; superheater, 562 sq. ft.; grate area, 46.8 sq. ft.

Driving Wheels—Diameter, outside, 57 ins.; journals, main, 9 ins. x 12 ins.

Engine Truck Wheels—Diameter, front, 33 ins.; journals, 5½ ins. x 10 ins.; diameter, back, 40 ins.; journals, 7½ ins x 12 ins.

Wheel Base—Driving, 15 ft.; rigid, 15 ft.; total engine, 31 ft. 8 ins., total engine and tender, 63 ft., 8½ ins.

Weight, Estimated—On driving wheels, 154,000 lbs.; on truck, front, 18,500 lbs., on truck, back, 26,500 lbs.; total engine, 199,000 lbs., total engine and tender, 330,000 lbs.

Tender—Wheels, number, 8, wheels, diameter, 33 ins.; journals, 5½ ins. x 10 ins.; tank capacity, 7,000 U. S. gals., fuel capacity, 14 tons; service, freight.

Electric Welding.

Reporting on electric welding, Mr. Hugh Montgomery, superintendent of motive power and rolling stock, Rutland Railroad, states that they had a number of failures when they first started to use electricity for welding, but they kept at it, the failures being due to the lack of knowledge as to how to handle the apparatus properly. They are now able to repair anything that breaks, if it is possible to do so by welding. On flues alone there is a great saving. The resultant delay when brick arches have to be removed to caulk the flues has been all done away with. Last winter was a very severe one in the North, but the mileage of the locomotives was increased on account of doing away with the leaking flue troubles. The saving in this alone, of dumping fires and taking out arches to caulk flues, would pay in a short time to install an electric welding machine in every engine house. A great deal of work also that was formerly done by blacksmiths is being done by the electric welder, saving much in material and time. They are also building up all worn parts of valve motive gear, guides and crossheads and other parts.

Electrical Department

Electrical Transformers—Three Different Styles—Pennsylvania Electric Locomotive—Chicago, Milwaukee and St. Paul Extension, Etc.

We have learned in the preceding articles that there are two general types of transformers, namely, the "core" and the "shell" types. Both of these types were described and the construction explained in detail. We learned that in the case of the shell type transformer, spacing strips were placed between the coils, so that ducts are formed for the circulation of air or oil for the purpose of cooling the transformer coil, which become heated by the passage of electric current through the copper conductors making up the coils.

There are three styles of transformers in general use, namely, the Air Blast, the Oil Insulated Self-Cooled (O. I. S. C.), and the Oil Insulated Water-Cooled (O. I. W. C.). Last month we described the Air Blast transformer, and outlined why it was necessary to have the transformer perfectly dry and free from moisture, before connecting it to the source of electric power. There are three methods which may be followed in drying a transformer and these were covered in detail.

The length of time required for thoroughly drying depends largely upon the condition of the transformer. Unless the transformer is in very bad shape, a week's run should be sufficient. Precautions must be taken not to raise the transformer to such a temperature that the heat will affect the insulating materials used on the copper conductors. The temperature should not exceed a temperature of 95 degs. Cent., which corresponds to 203 degs. Fahr. To keep a check on this temperature, thermometers should be placed well in between the coils near the

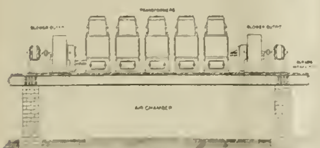


FIG. 1. METHOD OF INSTALLING AIR BLAST TRANSFORMERS.

top of the transformer and screened from the air currents so that the maximum temperature will be indicated.

Air blast transformers should be so installed that there is sufficient air for cooling. A method in general use is shown in Fig. 1. The transformers are set above, and form the top of an air chamber. The chamber allows an easy inspection of the coils of the transformer, since the whole underside of each transformer is open, and also gives easy access to the leads entering and leaving the transformer at the bottom. The chambers are usually

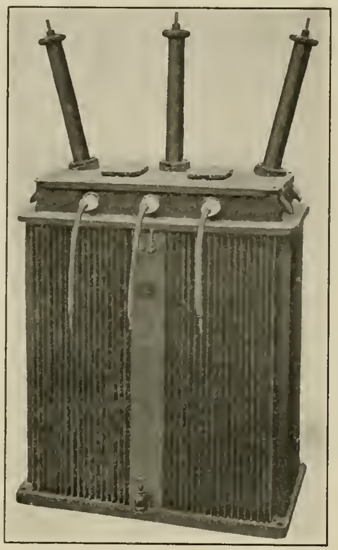


FIG. 2. CORRUGATED TANK.

approximately 7 ft. high and are constructed air tight, so that the air which is blown in, can only leave the chamber through the air ducts in the transformers.

A convenient location for the blowers, supplying air to the chamber, is shown in Fig. 1. The air is discharged directly downwards into the chamber. It is very important that the blowers are of the proper size.

Air blast transformers, properly installed, will operate successfully for years. Certain care is necessary, however. Dampers, used in regulating the amount of air, should be examined every day. The temperature of the outlet air should be noted at frequent intervals. This temperature is an indication of whether the transformer is receiving its proper supply of air. If the outlet air is more than 15 degs. Cent. higher than the inlet air, when operating under normal conditions, an immediate inspection should be made.

The air taken for cooling purposes should be clean and dry. Even with careful screening of the air going to the blowers, dirt will be carried into the chamber and will collect in the transformers. It is therefore necessary to clean the air ducts at frequent intervals of at least once a month, depending on the amount of dirt and dust in the air. The best way to clean out the dirt is by blowing dry compressed air of 20 lbs. pressure approximately, into the bottom of the ducts.

The other type of transformer is the Oil Insulated. There are two sub-divisions of the Oil Insulated transformers—namely, the self-cooled (O I S C), and the Water Cooled (O I W C).

In the case of the oil insulated transformer, the windings, assembled with the iron core, and all complete, is placed in a tank filled with some transformer oil. This oil surrounds the transformer and also fills all the ducts. The heat found in the coils, heats up the oil in the ducts and a circulation of oil takes place, through the ducts. The heat of the coils is taken up by the oil and dissipated. A continuous circulation of oil exists so that cool oil is entering the ducts at the bottom, which becomes warm and passes out at the top.

As far as the construction of the transformer and the circulation of oil is concerned, the oil insulated transformers are all similar. It is only the method used for cooling the oil, which distinguishes the self-cooled (O I S C) from the water cooled (O I W C).

In the case of the self-cooled transformer no attendance is needed. The

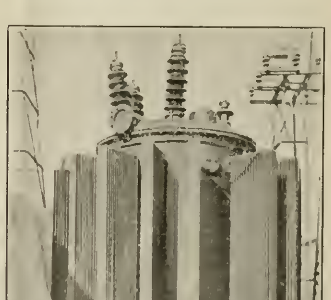


FIG. 3. RADIATOR TYPE TANK.

transformer can be connected to the power supply and practically forgotten. There are no moving parts to get out of order, and there can be no dirt nor moisture reach the inside of the tank. Self-cooled transformers are made in many sizes ranging from 1 or 2 up to 5000 K.W.

In the self-cooled transformer the heat of the oil is carried to the tank and radiates its heat into the air. In the small sizes, the tanks are made smooth and no special provisions are made to facilitate a more rapid dissipation of the heat. As larger sizes are encountered, a greater radiating surface is required to dissipate the heat than is possible with a smooth tank, so that the sides of the tanks are heavily corrugated, affording a maximum radiating surface. A tank so constructed is shown in Fig. 2.

As the capacity increases it is still necessary to increase this radiating surface and the Westinghouse company has developed and built what is known as the "radiator type tank." The tanks are

FIG. 4. DRYING TRANSFORMER.

made of heavy boiler-iron plate welded together. The cooling radiators are securely fitted to the tank, and connect to the main tank by an opening at the top, and bottom. A tank of this type is shown by Fig. 3. With the radiator tank type a maximum cooling effect is obtained and self-cooled transformers of 5000 K.W. capacity have been built.

With the development of the electrical industry there is an increasing demand for transformers of greater capacity. Beyond a certain size the cost of construction of a self-cooling transformer is excessively great, and other means of cooling must be provided.

Water has been used for cooling in many instances and this principle has been applied to the transformer. The heat generated in the coils and transferred to the oil is not dissipated by a radiator, but is absorbed by water circulating in several coils of pipe located at the top of the transformer tank and surrounded by the oil. The location of these pipes is shown by Fig. 4. A steady stream of cold water circulates in the pipes which are made of high grade tubing with all the joints brazed or welded. The heated oil rises to the top and is cooled, and returns downward along the side of the tank.

Pennsylvania Electric Locomotive.

Unusual interest has been manifested in railway engineering and operating circles in the recent tests near Philadelphia of the first of a standard type of electric locomotive for main line freight service built by the Pennsylvania railroad and the Westinghouse Electric & Manufacturing Company, and which was fully described and illustrated in the July issue of RAILWAY AND LOCOMOTIVE ENGINEERING. This locomotive is the most powerful electric engine ever built, and exceeds by 50 per cent. the locomotives which heretofore have held that distinction. In the tests referred to it has been shown that while the nominal one hour rating is 4,800 h. p., approximately 87,000 lbs. tractive effort at a speed of 20.8 miles per hour, the locomotive is capable of exerting a starting tractive effort of 130,000 lbs., or equivalent of 7,000 h. p. The continuous capacity at a speed of 20.85 miles per hour enables a trailing load of 2,300 tons to be hauled up a 1 per cent. grade; 4,100 tons up a .5 grade; or 11,000 tons on level tangent track. In service between Altoona and Johnstown it operates trains with one locomotive at the head and one pushing. Two of these engines will handle 3,900 tons west-bound, where the ruling grade is 2 per cent., and 6,300 tons east-bound, with a ruling grade of 1.33 per cent. The speed chosen is considered to be about the maximum desirable for the operation contemplated, being governed by the size of trains as well as characteristics of profile and alignment.

The cab, 72 ft. 6 ins. long, is mounted on two pivoted trucks which are articulated in a unique manner. The total weight of the locomotive is 240 tons. The voltage of the locomotive is 11,000.

Electrification on the Chicago, Milwaukee & St. Paul Railroad.

Reports that the Chicago, Milwaukee & St. Paul Railroad was proceeding with its electrification, not because that method of operating had proved satisfactory or economical, but because they had gone so far and could not stop, is officially denied. It is claimed that electrification has not only proved to be highly efficient, but economical and satisfactory in every way. It has solved the problem of reliance and cheap mountain operation, especially in the winter, and has demonstrated that the cost of repairs is much less than steam operation, while the capacity of the electric engines, both as regards speed and tonnage, is practically double that of steam locomotives. Electric engines placed in service in December, 1915, are still doing full service and have never had a general overhauling.

It has been decided to rush the electrification of its Cascade Mountain section, running from Othello, Washington, to Seattle and Tacoma. The present urgent necessity for conserving the nation's fuel resources is the reason for the speeding up of this work. Hundreds of thousands of barrels of fuel oil will be saved annually, since under electrification the railroad will use power generated by the water falls of the Cascade Mountains; and to save this fuel as soon as possible contracts for the locomotives and the power transforming apparatus have been divided between the Westinghouse Electric & Manufacturing Company and the General Electric Company, so that the great resources of these two large companies will be available for the most rapid completion of this undertaking. This section of the railroad is 211 miles long and is in addition to the 440 miles already operated electrically over the Bitter Root, Rocky and Belt Mountains, between Avery, Idaho and Harlowton, Montana.

The Stop Signal.

This month we have the pleasure of printing as a digest—though it is practically word for word—the paper on the stop signal read by Mr. L. E. Jones, signal engineer of the San Francisco-Oakland Terminal Railway. In this paper, Mr. Jones explains some systems of signaling and he makes a few remarks on the general idea of the automatic stop signal. The paper throughout is a calm and dispassionate review of facts and the conclusions drawn are without bias and are quite logical.

In the course of his remarks Mr. Jones comments on the fact that no man is 100 per cent. efficient all the time. He records the fact that an accident was averted by the automatic stop. The man in charge of the train had suffered from a temporary lapse of mind. The automatic stop is, therefore, not a luxury, and it should be looked at as a necessity. It is not a refinement of signaling put on by those who have money to spend on frills. It is an imperative demand of to-day. It can only be diregarded at the price of deadly risk. No one denies that mental lapses occur, yet why do we still trust to luck and seem to believe that because a signal system is good that therefore it will be obeyed. What we require now is to lift the difficult science of train operation from the didn't-know-it-was-loaded level and bring it up to the exalted position it should occupy in the United States of America, to-day. Not mere preference invites, duty calls, and the general adoption of the device is inevitable.

Train Lengths and Volume of Air Required for Brake Operation

By WALTER V. TURNER, Manager of Engineering, Westinghouse Air Brake Co.

Particular mention has been made of the air volume limit, in the capacity of the single capacity brake to control modern freight trains. As equipment, both freight and passenger, has become heavier and trains longer, the volume of air required for the control of these trains has increased proportionately and the difficulty in supplying it in greater proportion. So it may be said that the ability to run long trains depends almost entirely upon the devices which permit the supply of air to reach the brakes on the rear end. The difficulty always comes in releasing and recharging the brake system, for it is ever a simple matter to make the reduction necessary to apply brakes; in other words, it is easy to allow pressure to escape, but always difficult to build it up.

In answer to the suggestion that a larger brake pipe be introduced, it can be said that, while a larger brake pipe would facilitate the transmission of air and utilize to advantage the increased air compressor and main reservoir capacity on the locomotive, it would be impossible to increase the size of the brake pipe materially without disorganizing the whole air brake service as much as the introduction of the 6-foot gauge would disrupt our transportation service in general. There could be no satisfactory interchange of equipment during the transition period, and the advantages of the enlarged brake pipe would not appear until practically every car in the train was so equipped. To obtain adequate main reservoir capacity for the present size of brake pipe requires the utilization of every available space on the modern locomotive. To increase this capacity in order to realize the advantages of a larger brake pipe would be to present serious difficulties in the way of locomotive design. It is relevant to consider the 50 per cent reduction in air consumption on a train when equipped with the empty and load freight brake, in connection with the subject of increased brake pipe capacity.

Modern passenger brake equipment is so designed that the pressure restored to the brake pipe serves to release the brakes only until the last stages of recharging are reached. With the old equipment, which serves admirably for short trains of vehicles with small air requirements, the brake pipe recharged each brake immediately after it released, or after releasing it. As train lengths and air consumption per vehicle became greater, the head end equipments had more and more the tendency to bleed the brake pipe of air as fast as it was supplied, with the result that the head end was released and almost recharged before the rear end brakes started to release. Modern brake equipments employ a supplementary storage reservoir, which is used for recharging the auxiliary reservoir during a release of brakes and for obtaining high brake cylinder pressure in emergency applications.

With the modern freight brake equipments, both empty and load and single capacity, the high pressure in the head end of the brake pipe, when releasing the brakes, causes the release of the head brakes to be retarded, so that the rear brakes, starting to release at a later time, complete their release in practically the same time that is required for the head

TRAIN STOPS AND CONTROL ON GRADES.
FORMULAE.

$$S = 1.467\,Vt + \frac{WV^2}{30\left(\frac{p}{C}PW_eef - GW\right)} \quad (1)$$

$$= 1.467\,Vt + \frac{V^2}{30(Pef - G)} \quad (2)$$

when $p = C$ & $W = W_e$.

$$= \frac{V^2}{30\,Pef} \quad (3)$$

when $G = 0$ (level track) & "t" is neglected.

$$G = \frac{pPW_eef + rTC}{CW} \quad (4)$$

$$p = \frac{(GW - rT)C}{PW_eef} \quad (5)$$

$$R = \frac{pPW_eef}{CW} - G \quad (6)$$

LEGEND:

R = retardation factor, percent

S = stop distance, feet

V = initial velocity, m.p.h.

G = gradient; + downhill, − uphill

P = braking ratio, based on

C = basic cylinder pressure for C Lbs per sq in.

p = average cylinder press. (for grade computation) = actual cylinder press. (for stop computation)

W_e = empty weight of car, basis for P and C.

W = actual weight, lbs.

T = actual weight, tons.

r = internal resistance of car, lbs per ton.

e = efficiency of brake gear averaging 85%.

f = coefficient of brake shoe friction, averaging from 10% to 20%.

t = average time, sec., train may be considered running free before the brakes get into action

P_LW_L may be substituted for PW_e when E&L brake is used

P_L, W_L = loaded car braking ratio and weight.

FORMULAE FOR CALCULATIONS OF TRAIN STOPS, AND CONTROL OF TRAINS ON GRADES.

brakes to release. This prevents the head cars from fully releasing ahead of, and running away from, the rear cars when a release of brakes is made, before the train is brought to a standstill. A retarded recharge for the head brakes permits the brake pipe air to pass back to operate the rear brakes in a manner very essential to the successful operation of long freight trains. The importance of the ability to release and recharge the brake system promptly can only be appreciated by those who have had to contend with delay reports occasioned by control equipment used on trains of length and size beyond its capacity.

Where seconds are golden in the operation of trains, as on the New York subway system, the prompt release of a full application of the brakes on an entire train in 5 seconds with the new electro-pneumatic brake, as compared with the 10 and even 17 seconds with preceding equipment, will prove to be a boon to the operating officers of that very important railway system. As retardation does not cease, or full acceleration take place, until all the air is exhausted from the brake cylinder, this saving of from 5 to 12 seconds time, and even more when retardation is taking place, means much to snappy movements of trains. It is well to mention that graduated release flexibility has not been impaired in this shortened time for a complete release.

In the attached formulas for calculations of train stops and control of trains on grades, it will be noted that the speed does not appear in the gradient formula. This is because no more retarding force is needed to hold a train down a grade at a speed of 40 miles per hour, than at 10 miles per hour, but it is more difficult to get this retarding force at 40 miles than at 10 miles per hour, because brake shoe friction is much less at the higher speed, due to the higher velocity of wheel surfaces and the greater brake shoe heating, therefore the allowance for speed must appear in the value of the coefficient of brake shoe friction used.

It has been summed up that the locomotive capacity, length of sidings, station platform lengths (for electric traction service), train control and draft gear capacity determine and limit the number of cars that can be satisfactorily operated in one train. The relation of train control to length of train has been enlarged upon, and investigation reveals the fact that the air brake art has kept abreast of—and, indeed, practically in advance of—developments in all the many other phases of railroad activity.

It is well that this has been so, for the other developments would have been impossible of full realization otherwise. A concrete example is seen in the case where the empty and load freight brake is responsible for the postponement for 25 years of double tracking a single track line. The importance of reduced time of serial brake action has been made clear, it is hoped, and the part played in this by the development of the first type of automatic brake to those types employing the quick service feature, and finally, to the perfected electro-pneumatic brake, which has reduced the time element and therefore the shock to zero for trains of any length, and for any rate of retardation set up to the limit of the adhesion of the wheel to the rail, and which is a time saver of the first order in the way of getting the brakes on and getting them off. Increased weights of vehicles and increased velocity differences between these vehicles in the ever increasing train lengths of today, make it imperative that modern types of brake apparatus be utilized to realize more fully the opportunities at hand for increasing the efficiency of railroad operation.

I have also dwelt upon the extreme necessity of employing a foundation brake rigging which will permit the full realization of locomotive capacity and economical performance of the locomotive as enhanced in all of the features embodied in modern brake apparatus and the smooth handling of trains with a minimum of expense and delay, in short, the best brake is one which, in setting up the maximum retardation, creates the least velocity differences between vehicles in a train, and which has the greatest flexibility in providing any degree of retardation from the very minimum to the maximum.

Weights Carried by Chilled Iron Wheels

No Limit Beyond the Track—New Design for New Conditions—Actual Experience Relied on

By F. K. VIAL, Chief Engineer, Griffin Wheel Company, Chicago, Ill.

I have seen an article in connection with a description of the 120-ton capacity gondola car for the Virginian Railway. The axle load, according to this article, is determined as follows:

Normal capacity	218,000 lbs.
10 per cent. overload	21,800 "
Weight of car	73,900 "
Total carried on 6 axles	313,700 "
Load per axle	52,283 "
Wheel load	26,141 "

The above are the figures indicated by the stencilling on the car. The original calculation, of course, would be as follows:

Axle capacity	50,000 lbs.
Weight of axle	975 "
Weight of 2 wheels	1,700 "
Total axle load	52,675 "
Total wheel load	26,337 "

In regard to the safe load for chilled iron wheels, I may say that there is no indication at the present time of having reached, or even approached, the maximum wheel load as far as chilled iron is concerned. In fact, now that the stresses within the wheel are being better understood the newly designed wheels for the heaviest loads are likely to give less trouble in service than the older designs under light equipment, in which the relation between the service and the factor of safety were entirely unknown. The wheel loads under the Virginian 120-ton car are not the maximum contemplated by railroads at the present time. This is indicated by an axle of 60,000-lb. capacity used by the Pennsylvania and Union Pacific Railroads. In comparison with the axle used under the Virginian Railway car we have the following data:

Axle capacity,	50,000 lbs.	60,000 lbs.
Size of journal	6 x 11 ins.	6½ x 12 ins.
Diam. of wheel-seat,	7-5/8 ins.	8-1/8 ins.
Diam. at Center	6-7/16 ins.	6-7/8 ins.
Wgt of finished axle,	975 lbs.	1,100 lbs.
Corresponding wheel load,	26,300 lbs.	31,000 lbs.

The question now arises, is the chilled iron wheel capable of carrying 31,500 lbs., which from all indications at the present time is the maximum which the bearing power of the rail will permit? If the chilled iron wheel is unequal to the burden, there must be an indication in some part of the wheel of a tendency to yield on account of the magnitude of stresses developed in service. If we examine the bearing power of chilled iron, we find that there is no indication whatever of a limiting value anywhere within the realm of possible railway practice. Under heavy concentrated loads that sometimes occur under turntables, swing bridges, etc., loads of 100,000 lbs. or more per wheel are sometimes encountered, and in every case of excessive loading, it is the rail which fails on account of insufficient bearing power, and not the wheel.

As far as the plate of the wheel is concerned, it certainly is an extremely simple matter to design any factor of safety required. There is no difficulty in the design of the hub that will take care of all pressures which originate from axle fit. The maximum flange pressures are easily calculated and there is no difficulty whatever in providing a section of flange that will safely take care of maximum thrust. The only possible failure in chilled iron is the tremendous amount of heat developed on the tread, when maximum shoe pressures are constantly applied on heavy descending grades, but where the braking power is uniformly distributed to all wheels within the train, the amount of heat developed is not sufficient to injure the metal at the tread of the wheel. We have had extended experience with chilled iron wheels under engine tenders having 26,000 lb. wheel loads, which are quite frequent under modern engine tenders. The experimental stage has been passed, and there is no hesitancy whatever in the use of chilled iron wheels under the maximum load which the rail can carry, provided the design corresponds with the stresses which it is known that the service will develop.

It is an error to assume, however, that maximum loads can be carried without any consideration whatever of modified designs in order to meet new condition. The Master Car Builders have recently adopted the 850 lbs. chilled iron wheel as standard for the 50,000 lbs. capacity axle, which is used under cars of 70-ton capacity —4 axles per car. This is the same service as that contemplated in the Virginian 120-ton car having six axles. These designs of chilled iron wheels, of which we here write, were adopted only after the observation of chilled iron wheels under even greater loads during the past five or six years. Large quantities of 850 lbs. wheels have been in service under ore cars, in which the axle fit was 8 ins. This corresponds to a gross load of 240,000 lbs. for four axles.

As far as I am able to see from experience and from many tests of chilled iron, there is no load-limit for the chilled iron wheel, assuming always that the design has been intelligently made.

Motive Power Condition.

By W. A. JEX, Bucyrus, Ohio

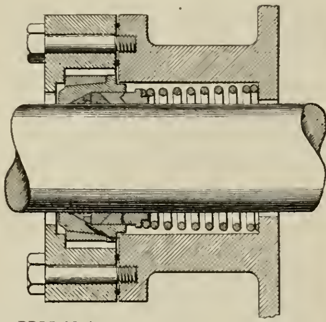
The railroads have been well organized and there is a general co-ordination which has resulted in the movement of both freight and passenger business in a volume hitherto unheard of, but it should be generally known that in order to accomplish this great end, sacrifices have been necessary. Engines that have given first-class service for a period extending over 12 to 24 months are in need of overhauling; the failure of which will result in decreased efficiency. Cars have been kept in service until the majority of them are in a condition that requires continuous repairs in order to keep them in service, and even with this attention, are in danger of breaking down and requiring a general rebuilding. Road beds have been given only such attention as would keep them serviceable and safe. Shops have been unable to get the normal number of locomotives overhauled due to a decrease in the number of skilled mechanics and the inability of the railroads to compete with manufacturers in the matter of wages. Notwithstanding this condition, the railroads have been responding to the Nation's call and are giving the country a service that cannot be criticized from the standpoint of efficiency.

Fifty per cent. more locomotives are in need of general repairs than one year ago. Shops are crowded with work and are inadequate to accommodate the locomotives now due for shopping. Due to the unprecedented high cost of operation, the railroads have been compelled to practice economy where other industries simply added such increases to the selling price of their commodities. The time has come when the railroads must be given the privilege of adding this increased cost to the price of transportation or the nation will suffer the consequences. Let us give the railroads the opportunity to go into the open market in the matter of labor by so adjusting the freight rates that transportation companies can pay at least the same as the manufacturer.

Locomotive Piston Packing.

A new design of locomotive piston packing has been tried on a locomotive on the Chesapeake & Ohio railway, and the results are said to be of the most satisfactory kind. In running 10,000 miles the packing has not been changed in any way. It is the invention of Mr. Albert C. Brignoni, machinist, Covington, Ky., and it will be observed from the accompanying illustration that the cylinder head has the usual inner casing, and has the gland or outer casing bolted with tap bolts thereto. The packing in the gland is a combination with a vibrating cup seated in the gland, the bore of the vibrating cup terminating in an inclined shoulder, a split brass ring abutting and fitting against the inclined shoulder of the vibrating cup, and having internal annular lubricant receiving grooves, and an external ring receiving groove, a split soft metal ring fitted within the ring receiving groove and breaking joint with the brass ring. There is also a secondary split ring abutting the brass ring and the soft ring, and breaking joint with both and having an inclined inner face. There is also a tertiary split ring abutting the inclined face of the secondary ring and breaking joint with the secondary ring, the secondary and tertiary rings being arranged between the vibrating cup and piston and engaging both, the tertiary ring having a V-shaped groove in its inner edge and a spring presser follower having a correspondingly shaped projection fitting on the groove.

It will thus be seen that in this arrangement of packing, the beveled surfaces hold the packing rings firmly against the piston rod, and that the packing ring having a series of circumferential grooves, and which is made of brass, and which retains a certain amount of lubricant, has the effect of reducing friction and assist the usual swab cup in maintaining lubrication.

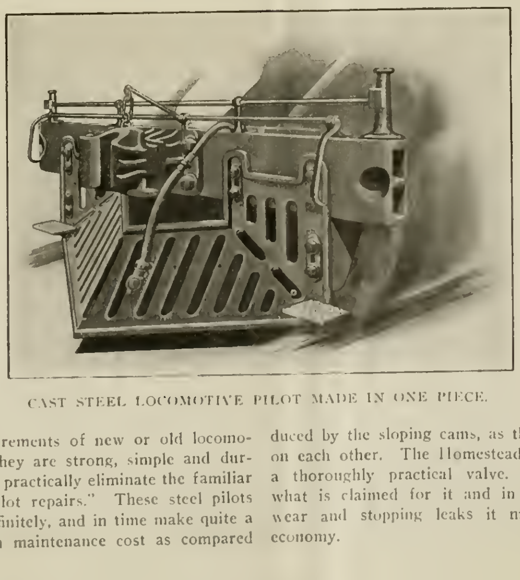


BRIGNONI'S LOCOMOTIVE PISTON PACKING.

Steel Pilot.

The cast steel pilot manufactured by the Commonwealth Steel Company, has now been in use on a number of railroads for several years. It can be quickly applied, removed, raised or lowered. One means provided for raising or lowering it is what may be called a rack. Bolts are passed through slotted holes in the pilot; this construction permits the alteration in height to be had with little effort. These racks on the backs of the pilots are made to fit corresponding racks on the pilot beams, or on separate brackets fastened to the pilot beams. The pilot meets all Government requirements.

These adjustable pilots are cast in one piece, and can readily be made to meet the requirements of new or old locomotives. They are strong, simple and durable, and practically eliminate the familiar item—"pilot repairs." These steel pilots last indefinitely, and in time make quite a saving in maintenance cost as compared with other types. The steel pilots are easily repaired when bent, in case of wreck, or other mishap. One of the designs embraces the requirements for both road and switch engines, a long step being placed at either side, to meet switch engine requirements, when a road engine is used in yard switching.



CAST STEEL LOCOMOTIVE PILOT MADE IN ONE PIECE.

Homestead Valves.

There is no secret about it. The design of the Homestead Blow-off Valves is to prevent leaks. This valve is so made that when it is closed it is at the same time forced firmly to its seat. This action is secured by means of a traveling cam, through which the stem passes. The cam is prevented from turning with the stem by means of the lugs, which move vertically in slots. Supposing the valve to be open, the cam will be in the lower part of its chamber and the plug will be free to be easily moved. A quarter of a turn in the closing direction causes the cam to rise and take a bearing on the upper surface of the chamber, and the only effect of further effort to turn the stem in that direction is to force the plug more firmly to the seat. A slight motion in the other direction immediately releases the cam and the plug turns easily. It is stopped at its proper open position by the contact of the fingers of the cam at the other end of its travel.

The Homestead valve is a taper plug valve, and the whole idea of its design is that if loose, it can most easily be turned; when tight it can be secured so as not to leak as if by a tap of a hammer. This tap of the hammer is never given, because it is not necessary. The same, and better tightening effect is produced by the sloping cams, as they work on each other. The Homestead valve is a thoroughly practical valve. It does what is claimed for it and in reducing wear and stopping leaks it makes for economy.

The Theory of the Clasp Brake

Requisite for Safe, Fast Train Operation—The Laws of Friction—What the Clasp Brake Is and What It Does—Its Economies and Advantages

The key to the safe and efficient operation of railway trains is the ability to stop. This is particularly true in regard to fast passenger service. A railway train capable of being run at high speed, yet with defective stopping facilities would not only be dangerous for traffic, but would be a menace to the safety of all on the train. The form of brakes now used gives the train the power of deceleration much superior to the acceleration provided by a modern, powerful high speed locomotive. To be able to run fast is good, but to be able to stop quickly is better.

The air brake in its evolution has not only reached a high state of efficiency, but it has thrown a side light on the subject of friction, which we have been able to get in no other way. The Westinghouse-Galton tests made in England in 1878 on brake friction brought out the fact that it was possible to apply to a rapidly revolving wheel a brake shoe pressure that would have skidded the wheel if it had been revolving slowly. Thus, one of Moran's laws, that the coefficient of kinetic friction is independent of the velocity, was disproved and the new knowledge thus gained paved the way for the invention of the high speed brake. The theory involved is that the skidding or sliding of the wheel on the rail fuses a portion of the tread and the fused material actually acts as a lubricant on the rubbing surfaces and reduces the retarding power of wheel on rail.

Another step forward has been taken by the introduction of the clasp brake, which is the use of two brake shoes to each wheel instead of one. It is well known that the energy of a moving train must be disposed of in some satisfactory manner if the train is to be brought to a halt. This is done at the brake shoes by transforming motion into heat. Those who have followed the subject know that the generation of heat at the tread of a moving wheel, when the brake is applied, is believed to be one of the harsh causes which operates to damage the wheel-tread and shorten the life of the wheel. We must stop a train quickly and safely in any case. To do this we must be able to freely generate brake-shoe heat, and yet reduce the destructive action of the rapid generation of the heat that we are compelled to have. We must not impair the train-stopping quality of the shoe. It requires thought on the subject of design to avoid inefficient train-stopping, and as protective thought to prevent the rapid accumulation of wheel destroying heat.

A way out of the difficulty has been found by the use of the clasp brake. Here with two shoes on each wheel the total brake shoe pressure is equally divided, and while the work of retarding the train remains the same, the wear of shoes is reduced one-half for each shoe, and the generation of heat is divided in the same proportion. No excessive wear or deleterious heat action on the tread is brought about, yet the train stops as effectively as it did with one brake shoe per wheel.

We have seen that it is distinctly advantageous to increase from one to two brake shoes on a car wheel. If it was possible to put three brake shoes to a wheel, one on each side and one on top, there would be a further advantage. It is not easy to do this, and it is not desirable, but from that conception of the principle we may legitimately reason that the addition of four, five, six or more shoes, if such were not hampered by physical conditions, would be all right. By this reasoning we are able to comprehend the fact that a large number of shoes if applied would make a sort of approximation to the band brake, such as is used on automobiles. Everyone realizes the power of the strong, gripping band brake on a motor car. The band brake may mentally be resolved into a series of closely packed brake shoes all round the drum. The original expenditure of money for an additional set of brake shoes is compensated for by less wear on each shoe and less heat generation for each shoe, and consequently increased ability to more quickly radiate what has been generated. In this way the possible destruction of the wheel is delayed.

Another form in which economy is evidenced is that of using more effectively the brake equipment which may be on hand. Suppose a passenger coach to weigh about 118,000 lbs. The braking proportion of this weight is taken at 90 per cent. of the light-weight of the car. This on four axles gives each a load of 26,550 lbs., or 106,200 lbs. as a total. The push on the piston rod of a 16-in. air brake cylinder at 60 lbs. pressure at the point of auxiliary and brake-cylinder equalization is 12,063 lbs., and this gives a total leverage of about 8 to 1. Total leverage is defined as the number of times brake cylinder pressure is divided into the total brake power. Proper leverage proportion insures proper brake shoe clearance from the wheel when the brakes are off and good braking when they are on. If 106,200 lbs. be the allowable total braking pressure, and it be distributed equally among eight brake shoes, each brake beam, of which there are four, will have 26,550 lbs., and on the eight shoes on the four beams each shoe will carry half this amount, viz., 13,275 lbs. per shoe, because the pressure on the shoe at each end of a brake beam is the same.

If, now, eight brake beams and sixteen shoes are put in service, the new resultant pressure on each shoe will only be 6,637 lbs. per shoe, half of what it was before. The push from a 16-in. brake cylinder at 60 lbs. is 12,063 lbs., and by a system of levers this is made to reach the proper pressure at the brake shoe. If the pressure at the brake shoe has dropped from 13,275 lbs. to 6,637 lbs. by the use of two shoes where there was one before it is manifest that a smaller brake cylinder (perhaps of a series in stock on a railway and used on older cars), is available, and this smaller cylinder can be used with a proportional economy of air and so reduce the work of the air pump and the coal burned to operate it, and at the same time no reduction in brake efficiency will have marred the result of the change. If higher brake shoe pressure is desired, owing to the greater weight of newer cars, it can be had by the use of larger brake cylinders, or an alteration of the levers, with advantage. The whole case resolves itself into a question of higher brake shoe pressure gained by the use of the same brake-cylinders as were formerly found to be small, or the same brake shoe pressure may be secured by the use of smaller brake cylinders. The brake leverage affords another opportunity to do either of these things.

Each railway judging its own most economical course has here a double choice, enabling it to eliminate the purchase of new material, yet with an undoubted advantage to match against the growing needs of fast train service with heavier cars.

An incidental economy that comes with the use of the clasp brake is the chance to use comparatively light brake beams or even to adopt the beamless system. A further very satisfactory economy which reduces trouble on the road, is found in the fact that the clasp brake has no tendency to displace journal bearings and therefore does not tend to produce a hot box on the road. The single shoe brake, by reason of its constant push on one side tends to shove the journal out from under the wedge, and it has been known to so far displace a brass as to leave it tilted on one edge and bearing on one narrow area, while the rest of the brass dug down into the packing and lay partly on one side of the journal, and so gradually became hot enough to cause delay.

A further incidental advantage probably appreciated by the traveling public, is the fact that the tendency of the truck frame to tilt under the action of the clasp brake is largely reduced if not entirely eliminated.

The single shoe brake hung outside of each wheel, when under brake strain, is carried down at the front end of the truck and up at the back end. When the train stops the effort of the truck frame to right itself, and become level again, produces a most unpleasant shock to the occupants of the car, to say nothing of the jerking or the jarring effect on the truck frame. The single shoe system tends to tilt the truck frame and rotate it about a point in the center of the frame. It thus compresses one, and relieves the other spring on each end, with an unpleasant jerk at the moment when the car stops. With the clasp brake the tendency is to rotate the truck-frame about two points each above the center of the wheels, and beyond the springs. This very satisfactorily reduces the tendency of the truck frame to tilt, leaves the springs with little to do in the way of readjustment, and does away with the shock to passengers. The truck frame encounters no sudden strain and normal action can only have a beneficial effect on the life of the frame.

The whole question of the use of the clasp brake opens up a fascinating and useful field of inquiry. Its comfort and economies make it well worth careful study by the progressive railroad man. He will be rewarded for his thought on what the clasp brake is capable of doing by finding a new agency to apply to the betterment of the service of his company. At the same time he will not be forced to make any very serious demand upon the treasury of his road.

Government Control in England.

On the day that war was declared (August 4th, 1914) the railways of England, Wales and Scotland—not Ireland—were taken over by the Government. The managers opened sealed instructions which had previously been sent to them and proceeded to carry them out. It had been provided in the Act of 1871 that full compensation should be paid to the owners for any loss incurred. The Government, however, did not at the beginning announce any terms with the companies. This was left for a later date. Government control, it is important to note, did not mean Government ownership. The lines remained the property of the companies. They retained the management of their own concerns, subject to the instructions of the Executive Committee, and the whole machinery of administration went on as before. The sole purpose at the beginning was to facilitate the movements of troops. But as the war developed, as economy became more and more essential, the scope of the Railway Executive Committee, now in supreme control, became greatly extended.

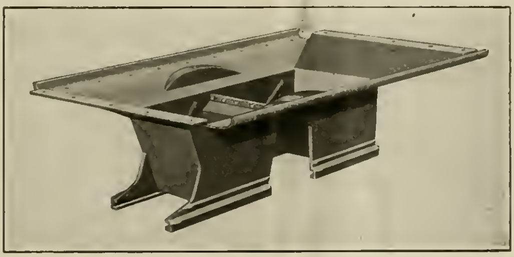
Among the most important economies in handling traffic was, first, the establishment of the "common user," of railway companies' open goods wagons. Under the old system the wagon received loaded by one company from another had to be promptly returned to the owning line, even though there was no freight for it on its return. Under the "common user" arrangement it became available for loading in any direction, thus reducing the haulage of empty vehicles to a minimum. This system of pooling luggage cars or as we would call it, interchange, came into force on January 2, 1917. The pool did not include the very large number of privately owned wagons, estimated from 600,000 to 700,000, which are a distinct feature of British railways; but the benefits of the pool were soon seen to be so real that steps were at once taken to supervise the control of the private wagons also.

A minor economy introduced early in the war was an agreement by the railways to accept each other's "paid" and "to pay" stamps and labels on parcel traffic. This saved very much labor, and it led to a further development in January, 1917, when the Railway Executive Committee announced that from a given date "the carriage charges for all descriptions of traffic for conveyance by passenger train or other similar service must be paid by the sender at the forwarding station." The whole system of bills and accounts for passenger goods traffic was thus swept away. Some reformers even proposed that the railways should go further, and insist upon the prepayment of all small traffic by goods trains. Still another step was a decision that claimants for the loss or damage of goods traffic should be dealt with by the company on which the claim was made without any division, such as had formerly taken place of the amount paid between the companies concerned in the route over which the traffic had been conveyed.

The saving in printed matter was so extensive that at least one large company was able to turn out many tons of paper which had been stored for office use and to put this on the market at a time when paper was scarcest.

Cast Steel Ash Pans.

One of the original devices of the Commonwealth Steel Company, which has now been in service several years, is the complete cast steel ash pan designed for single and double hoppers. These ash pans do away with the frequent and expensive renewals and repairs characteristic of other types, as they are so designed that they do not burn out; consequently they last almost indefinitely. They also prevent live coals from being scattered on the roadway, and causing fires. The pans do not warp; and this insures a tight door that retains the coals. They have only a few parts, compared with many pieces, with washers, rivets, bolts, etc., which compose the built up types. This steel type is a help in safeguarding forests from fires. It practically eliminates maintenance costs, and it will outlast several of the other types. It has been extensively tested under the severest conditions, and in every instance has been found not only reliable, but in point of first cost is less expensive than the older types of ash pans.



ONE-PIECE CAST STEEL ASH PAN.

A Call for Skilled Workmen.

A call has been issued by the Chief Signal Officers of the War Department for certain classes of skilled workmen, and we have been asked to direct the attention of our readers to the fact that the Air Service is in need of picked men who will be gladly welcomed and given special training, according to their vocations on airplane motors, trucks, airdrome construction and other work. Among others, machinists, blacksmiths, draftsmen, tool makers, pattern makers, coppersmiths, and metal makers generally are specified. The applicants must be physically sound, and from 18 to 40 years of age. Full particulars may be had on application to the Volunteer Bureau, 119 D Street, N. E. Washington, D. C.

Items of Personal Interest

Mr. William Kelly, formerly assistant superintendent of motive power of the Great Northern at Spokane, Wash., has been transferred to St. Paul, Minn.

Mr. J. J. Byrne has been appointed eastern representative of the Locomotive Stoker Company of Pittsburgh, Pa., with office at 30 Church street, New York.

Mr. A. J. Mitchell, formerly engineer of tests of the Spokane, Portland & Seattle has been appointed general superintendent, with office at Portland, Ore.

Mr. B. H. Davis has been appointed master mechanic of the Delaware, Lackawanna & Western, with office at Scranton, Pa., succeeding Mr. F. H. Reagan, resigned.

Mr. W. B. Perkins has been appointed roundhouse foreman of the Santa Fe, with office at Belen, N. M., succeeding Mr. J. V. Stevens, resigned to join the army aviation service.

Mr. M. J. Flanigan, formerly general master mechanic of the Central district of the Great Northern, at Great Falls, Mont., has been promoted to superintendent at Whitefish, Mont.

Mr. T. M. Price, formerly assistant master mechanic of the Seaboard Air Line at Andrews, S. C., has been appointed master mechanic at Hamlet, N. C., succeeding Mr. T. L. Reed.

Mr. J. J. Modyman has been appointed division foreman of the Santa Fe shops at Deming, N. M., and Mr. J. W. Wilcox has been appointed roundhouse foreman at Albuquerque, N. M.

Mr. M. K. Walsh has been appointed road foreman of engines of the Wheeling division of the Baltimore & Ohio, with office at Benwood Junction, W. Va., succeeding Mr. W. F. Ross, deceased.

Mr. W. S. Spieth has been appointed manager of the Davis Wheel Department of the American Steel Foundries, with office at Chicago, succeeding Mr. F. A. Lorenz, Jr., who resigned to go into another field.

Mr. S. J. Hungerford, formerly superintendent of rolling stock of the Canadian Northern, has been appointed general manager of the eastern lines, with office at Toronto, Ont., succeeding Mr. L. C. Fritch, resigned.

Mr. C. H. Creager, formerly road foreman of engines of the Baltimore & Ohio, at Cincinnati, Ohio, has been appointed road foreman of engines of the Illinois division, with office at Flora, Ill., succeeding Mr. F. Hodapp, promoted.

Mr. John J. Harty, formerly vice-president and general manager of the Canadian Locomotive Company, Kingston, Ont., has been elected president of the company. Mr. Harty is also director of the Dominion Foundries & Steel Company.

Mr. George F. Kempf, formerly air brake superintendent of the Chicago, Milwaukee & St. Paul, has been appointed master mechanic at Dubuque, Ia., succeeding Mr. M. M. Smith, transferred as master mechanic to Milwaukee, Wis.

Mr. O. B. Schoenky, formerly superintendent of shops of the Southern Pacific at Los Angeles, Cal., has been appointed master mechanic of the Tucson division of the same road, with office at Tucson, Ariz., succeeding Mr. W. C. Petersen.

Mr. W. H. Farrady, formerly assistant purchasing agent of the Pennsylvania, has been granted leave of absence to join the American expeditionary force in France. He will be attached to the railway military forces under Brigadier General W. W. Atterbury.

Mr. E. W. Smith, formerly assistant engineer of motive power of the Pennsylvania, has been appointed master mechanic with office at Harrisbury, Pa., succeeding Mr. C. L. McIlvaine, appointed superintendent of motive power, northern division, with headquarters at Buffalo, N. Y.

Mr. M. M. Meatyard has been appointed examiner and instructor of the operating department and rules and machinery for enginemen on the Chicago & Alton, and Mr. James J. Butler has been appointed assistant to the general manager, both with offices at Bloomington, Ill.

Mr. U. P. Meredith, formerly master mechanic of the Maryland and Delaware divisions of the Philadelphia, Baltimore & Washington, has resigned to accept the position of engineer in charge of mechanical maintenance and shop methods with the E. I. du Pont de Nemours & Co., Wilmington, Del.

Mr. H. A. Macbeth, formerly master mechanic of the New York, Chicago & St. Louis at Conneaut, Ohio, has been appointed superintendent of motive power on the same road with headquarters at Cleveland, Ohio, and Mr. T. W. Coe has been appointed master mechanic at Conneaut, succeeding Mr. Macbeth.

Mr. Edward Lawless, formerly general foreman of the locomotive department of the Illinois Central at Freeport, Ill., has been promoted to master mechanic, with the same headquarters, and Mr. E. C. Roddie, formerly district foreman at New Orleans, La., has been promoted to master mechanic, with office at McComb, Miss.

Mr. Clement F. Street, inventor of the locomotive stoker bearing his name, and vice-president of the Locomotive Stoker Company, has extended his engineering activities and announces that his services are available as consulting engineer, with office at 30 Church street, New York. Mr. Street has had a wide experience in designing and testing railway mechanical appliances.

Mr. U. E. Gillen, of the Grand Trunk, has been selected as the head of Canada's Railroad War Board, and Mr. W. A. Kingsland, of the Canadian Northern, as head of the Car Service Committee. The members of the executive committee in active charge comprise Lord Shaughnessy, Canadian Pacific; Mr. Howard C. Kelley, Grand Trunk; Sir William Mackenzie, Canadian Northern, and Mr. Alfred H. Smith, president New York Central. The main office is in Montreal, with sub-committees in each province.

Mr. F. Hodapp, formerly road foreman of engines of the Baltimore & Ohio, has been appointed supervisor of locomotive operation of the Southwest district with headquarters at Cincinnati, Ohio; Mr. B. F. Crolley, formerly superintendent of locomotive operation at Cincinnati, has been appointed supervisor of locomotive operation of the Northwest district with headquarters also at Cincinnati; Mr. T. B. Burgess has been appointed supervisor of locomotive operation of the West Virginia district, with headquarters at Wheeling, W. Va., and Mr. J. M. Mendall has been appointed road foreman of engines at Cincinnati.

Mr. A. C. Deverell succeeds Mr. R. D. Hawkins, who is a member of the mission to Russia, as superintendent of motive power of the Great Northern, with offices at St. Paul, Minn. Mr. William Kelly and Mr. Henry Yoerg have been appointed assistant superintendents of motive power, with headquarters at St. Paul, and Mr. R. Wood succeeds Mr. Yoerg as mechanicical engineer at St. Paul. Mr. J. J. Dowling has been appointed master mechanic of the Central district, with headquarters at Great Falls, Mont., and Mr. T. J. Clark has been appointed general master mechanic of the Western district, with headquaters at Spokane, Wash.

Mr. Charles Lee McIlvaine has been appointed superintendent of motive power of the Northern division of the Pennsylvania, with headquarters at Buffalo, N. Y. Mr. McIlvaine is a graduate of the Mechanical department of the University of Pennsylvania and entered the service of the Pennsylvania Railroad as apprentice in the Wilmington shops in 1899, and was transferred to Altoona in 1901. In 1905 he became assistant master mechanic at Pavonia shops, Camden, N. J. He was transferred to other points on the system, and for several years served as master mechanic of the New York, Philadelphia & Norfolk Railroad, and returned to the Pennsylvania in May, 1917, as master mechanic of the Philadelphia division, which position he held when promoted as stated above.

Mr. Robert S. Parsons, assistant to the president and chief engineer of the Erie, has been appointed assistant to the president and general manager of the Erie, and affiliated lines, and will continue to have charge of maintenance and construction. Mr. Parsons is a graduate of Rutgers College. He began his railroad career in the engineering department of the Erie in 1895, and was appointed division engineer of the New York, Susquehanna & Western in 1899. In 1903 he was engineer of maintenance of way of the Erie and in 1906 was general superintendent. In 1913 he was appointed general manager of the lines east of Buffalo. In 1914 he was general manager of the Erie Lines west, and in 1916 chief engineer, and latterly assistant to the president and chief engineer, until appointed as above announced.

New York Railroad Club.

"The Woman in Railroad Work" was the subject of a paper presented before the members of The New York Railroad Club, on November 16, by Mr. Stuart Brady, special agent of the Philadelphia, Baltimore & Washington Railroad. Mr. Brady evidently had made a very comprehensive study of the subject, and submitted lists showing to what extent Britain has developed along the line of female labor in relation to railroad and other work, and while we in America could not hope to succeed at once in adopting means and methods that it has taken many years elsewhere to accomplish, still there is no reason why women should not be responsible for the whole domestic condition of the railroads, including the cleaning of cars, selling of tickets, dispensing of information, marking of bulletin boards, performing of minor, semi-important and important clerical duties of all so-called indoor departments. The technical, mechanical and working side, Mr. Brady claimed, was another question. It is on the technical side that most study will have to be made. If the parts to be handled are not too heavy, or the work does not require too much physical strength, a woman can do the work as well as a man and frequently she can do certain manual operations with greater ease and dexterity. Britain has spent much time and effort on the problem of woman in mechanical labor. America is coming to it, and it is more than likely that trained, skilled, disciplined women will be in greater evidence in railroad work in the near future and it is also more than likely that they will retain the positions for which they show particular adaptability after the war is over.

Railroad Mileage.

The mileage of American railroads aggregates 270,000, and forms forty per cent. of the railways of the entire world. Russia comes next with 50,000 miles. The other countries and their respective mileage in order being Germany, 40,000; India, 35,000; France, 32,000; Canada, 30,000; Austria-Hungary, 29,000; Great Britain, 25,000; Argentina, 21,000; Australia, 20,000; Mexico, 16,000; Brazil, 16,000; Italy, 11,000; British South Africa, 11,000; Spain, 10,000; Sweden, 9,000; Japan (including Korea), 7,000; China, 6,000; Belgium, 6,000, and Chile, 4,000.

Of the world's railways outside the United States slightly more than one-half are government owned or controlled; of the telegraphs outside this country approximately two-thirds are government owned and operated.

Decrease in Running Repairs.

It is reported that in addition to increasing transportation efficiency through intensive loading, the railroads are also waging a vigorous campaign to reduce the number of cars and locomotives under repair. The July report just issued shows that the average number of freight locomotives in shop or awaiting repairs was 4,122 against 4,460 in the same month last year. Freight cars under repair in July numbered 135,831, which was 8,647 less than in July, 1916 This in the face of an increase of traffic speaks well for economy. Some speak gloomily of the future, but, as usual, the future will provide for itself.

Economy in Powdered Fuel.

Careful attention is being called to powdered coal as an excellent form in which to use lignites or low grade coal generally. Experiments made by the General Electric Company show that coal can be pulverized more cheaply than it can be gasified. The first cost of a plant for drying and pulverizing is less than for a producer gas plant. When thoroughly mixed with a blast of air in correct proportions powdered coal is practically a gaseous fuel, and has most of the advantages of gas or oil fuel under steam boilers.

Extending the Age Limit on the New Haven.

On the New York, New Haven & Hartford Railroad the age limits of employing new men were 21 years to 35 years. Under the new plan the limits for firemen will be 18 to 45 years; for trainmen, 18 to 50 years, and for other employes, 18 to 60 years. The new limits take in men not subject to the draft act, and will tend to reduce to a minimum applications for exemption due to industrial occupation that would otherwise prevail in respect to railway men. The change is commendable in every way.

Superheated Engines in South Africa.

Recent reports state that the use of superheated steam in locomotive boilers in South Africa have been considerably extended of late with marked economy in the consumption of fuel. Between Pretoria and Johannesburg, with a tenth-class locomotive, as a result of two trials, there was an average consumption of 29.3 lbs. of coal per 100 ton miles. A new engine with a feedwater heater added gave an average consumption of 29.9 lbs. of coal per 100 ton miles. By using superheated steam on an exactly similar kind of locomotive, and on the same section of line, the average consumption of coal was reduced to 22.2 lbs. of coal per 100 ton miles. Similar tests were made in the Orange Free State. On the same section of line, and under similar conditions, the old tenth-class of engine consumed 23.2 lbs. of coal per 100 ton miles, whilst the superheater engine of similar class consumed only 13.9 lbs. It is estimated that by using superheated steam an increased efficiency of 20 per cent. is obtained. Experience also shows that a boiler pressure of 200 lbs. per square inch in a well-designed boiler does not add to repairing costs, as was formerly urged by many locomotive engineers.

Objection to Bells and Whistles.

The Hamilton, Ontario, City Council has been complaining of the ringing of bells and whistling by locomotives on the Toronto, Hamilton & Buffalo railway. The company claims that the enginemen are only obeying the Dominion regulations, and that if less noise is desired an amendment to the laws will have to be made. In this event the city would be liable for damages if an accident happened through the failure of a locomotive engineman to give the usual warnings. The authorities can choose either horn of the dilemma.

Concrete Railway Ties.

It appears that the difficulties in the way of a more extensive adoption of concrete ties are the attachment of the rail to the tie and the tendency of the concrete to crack and disintegrate. The present is a favorable time for further trial of the concrete, or the steel and concrete tie, as the high price of timber has increased the cost of wooden ties. The Pennsylvania has over 4,000 concrete ties in use, and other railways have a very considerable number of different kinds in service. The Italian, Swiss and French railways use them extensively, but they have not yet become standard anywhere.

Railroad Equipment Notes

The Pennsylvania Railroad is reported in the market for material and specialties for 1,000 70-ton coal cars.

The Italian Government is reported placing an order for 20,000 tons of rails with the Lackawanna Steel Company.

The Egyptian State Railways have ordered 70 ten-wheel (4-6-0) type locomotives from the Baldwin Locomotive Works.

The Louisville & Nashville will soon commence the construction of a new roundhouse and shop at Paris, Tenn., to cost about $60,000.

The New York Central has had plans prepared for the construction of a new power plant at Curtiss street, Buffalo, N. Y., to cost about $30,000.

The Lehigh Valley has awarded the contract for a one story brick and steel power plant addition to be 50 by 120 feet, to the G. W. Rogers Company, New York.

The Chicago, Milwaukee & St. Paul has ordered 10 electric locomotives from the Westinghouse Electric & Manufacturing Company and 7 from the General Electric Company.

The Atchison, Topeka & Santa Fe is building additional repair shops at Ottawa, Kan., at a cost of about $60,000. Swanson Bros. Contracting Company, Topeka, Kan., has the contract for the work.

The Western Pacific has ordered 1,500 steel underframe box cars from the Mt. Vernon Car Manufacturing Company, and 400 composite 50-ton general service cars from the Western Steel Car & Foundry Company.

The Gulf, Colorado & Santa Fe, according to report, will expend $150,000 for improvements at Temple, Texas, to include additional brick machine and boiler shops, freight depot, transfer wharf and freighthouse.

The Atchison, Topeka & Santa Fe has ordered from the General Railway Signal Company the materials for an electric interlocking plant at Kelker, Colo.; 28-lever machine model 2, with 21 working levers and 7 spare spaces.

The Atlantic Coast Line has let contract to rebuild its round house and engine repair shops at Wilmington, N. C., which collapsed some time ago. The work will be done by Rhodes & Underwood, of Wilmington, at a cost of about $10,000.

It is reported that the United States Government has placed order for 10,000 or 15,000 more cars for the use of the army in France, raising the total number of cars which it has purchased to between 50,000 and 60,000.

The Great Northern has ordered from the General Railway Signal Company, Rochester, N. Y., 200 type 2A automatic block signals with the necessary batteries, relays, wires and other apparatus. These signals are to be installed by the railroad company's forces.

The Pennsylvania has begun work near Punxsutawney, Pa., on the construction of a new engine terminal, a 16-stall roundhouse and auxiliary facilities. The work includes changing the course of a highway from the east to the west side of the tracks for a distance of over one mile and ten miles of additional yard track will be constructed. It is expected that the work will be finished by January next.

The Illinois Central has ordered 500 50-ton composite gondola cars from the Haskell & Barker Car Company, and 500 of the same type from the Pullman Company, and has also issued orders for 300 flat cars, had previously put out inquiries for 1,000 hopper cars, and will be in the market for additional cars, including 1,500 general service, 300 to 1,000 stock, 500 refrigerator and 25 caboose. Some of these may be built in the company's own shops.

The United States Government is reported ordering 300 large freight locomotives from the Baldwin Locomotive Works. These locomotives, it is said, are a portion of 2,000 for which the government now is arranging. Official statements are quoted to the effect that to date 353 locomotives have been constructed under contract for the United States and foreign governments. Contracts for 2,490 locomotives have been let, which, with those constructed, will consume the full capacity of all plants to the middle of 1918.

It was reported last month that the United States war purchasing board has approved the request made by the Russian purchasing board, for 30,000 four-wheeled freight cars for Russian railroads, contracts being awarded to American builders on practically the same divisions. A former request for 10,000 freight cars was approved some time ago. Of these 10,000 cars, all shipped knocked down, about 6,000 have been, it is said, landed in Russia, the other 4,000 being held up at some Pacific port, awaiting transportation.

Books, Bulletins, Catalogues, Etc.

Year Book of the Bureau of Mines.

The Bureau of Mines has issued its annual report and it is interesting to observe the marked increase in activity in mining since the last report was issued. In 1915 the production of coal amounted to 531,618,487 tons. In 1916 the amount was 597,500,000 tons. A statement is advanced that if this coal had been used with the highest efficiency, it is probable that 25 per cent. of the amount would have been saved. The proper method of burning fuel is by no means a simple process, and the misconceptions that have resulted from a rather casual study of the phenomenon has led engineers to construct uneconomical and ineffective devices. The clearing away of these misconceptions can only be done by a knowledge of the actual facts, and for that reason the Bureau of Mines has been making a careful study of the combustion process. The variety of coal-burning equipments now existing is the result of ill advised experimentation rather than knowledge, and the engineer has been unable to find quantitative figures that would enable him to design a furnace for a given fuel with the same assurance of success that he has in the design of a bridge or other like structure. Studies of this kind are beyond the possibility of private investigation, and it is proper that the government should make liberal provision for this laudable work.

A limited number of copies of the book will be distributed free. When these are exhausted the price will be 30 cents. The work is issued at the Government Printing Office, Washington, D. C.

Locomotive Hand-Book.

The American Locomotive Company has just issued a hand-book containing 195 pages of matter, furnishing a mass of data that has been found to be useful in the designing of locomotives. The locomotives range in size from the four-wheel tank engine (0-4-0 T type), having a total weight of 14,500 lbs. and a tractive effort of 2,630 lbs., to the 2-10-10-2 type Mallet engine, having a total weight, engine and tender, of 875,000 lbs., a tractive power of 147,200 lbs., working compound, and of 176,600 lbs., working simple. An experience extending over 82 years of continuous locomotive building and the construction of over 55,000 locomotives, has given ample opportunities for furnishing data that is at once reliable in point of accuracy and complete in point of detail. At the present time the company operates seven separate plants covering over 356 acres with an annual output of 3,000 locomotives and furnishing employment for over 20,000 men.

It would be impossible in our limited space to furnish even a selected list of the subjects treated of in the work, suffice it to say that every part of the modern locomotive is touched on in a way that is the result of wide experience and condensed into the briefest and clearest mode of record. A series of tables, easily understood, are adapted to the varying types and dimensions of locomotives. The constants used are such as could only be gathered from a wide experience and a systematic method of observation, and by their use, lengthy and involved calculations are avoided. The services of special authorities have been engaged on special subjects, and comparisons between American and foreign methods of experiment and calculation are given, and summaries are appended, showing in many instances the need of fuller information on many important subjects. For example it is clearly demonstrated that the resistance of passenger cars has in the past been over-estimated; while the decrease in available power of a locomotive at high speeds, due to the decrease in mean effective pressure in combination with the energy absorbed in moving the engine and tender, generally has been under-estimated. The importance of the use of superheated steam is pointed out, the increase in volume and the decrease of condensation in the cylinders being conservatively estimated as saving 23 per cent, showing that a boiler may be proportioned with 23 per cent. less evaporating heating surface for superheated steam than for saturated steam. Diagrams and drawings are used where necessary, and the hand-book is altogether a valuable contribution to railroad literature. It has been compiled with rare skill and ability. Copies may be had from the company's main office, 30 Church street, New York. Price 75 cents.

Conservation in Use of Coal.

The Committee on Coal Conservation has issued Bulletin No. 2. It points out briefly and clearly the conditions that make it imperative to every owner or manager of a power plant to examine into the cost of the power his establishment uses, and the increase in efficiency that is possible. It may not be generally known that in the proper covering of boiler surfaces and steam pipes as much as 80 per cent of saving may be made. Railways have made substantial progress in firing locomotives. Manufacturing plants can show great results in the aggregate. The Government has gathered a great deal of information about the use of coal and has an abundance of expert advice to give regarding means of economy. In many instances state agencies have data and suggestions which are to be had for the asking. Full information and lists of publications may be had from the Committee on Coal Conservation by addressing the General Secretary, Riggs Building, Washington, D. C.

Heating Locomotive Feedwater.

An illustrated bulletin describing the advantages of locomotive feedwater heating has been issued by the Locomotive Feedwater Heater Company, 30 Church street, New York. Charts showing the results of repeated experiments demonstrate clearly that a considerable amount of saving can be made by using waste heat in applying it to the feed water. The idea is not new, but the method of application is new, and like many other promising innovations, it bids fair to reach a complete fulfilment in the atmosphere of American engineering enterprise. Copies of the bulletin may be had on application to the company's office.

Western Electric Year Book.

The Western Electric 1918 Year Book is being distributed, and extends to 1,160 pages, presenting full details of electrical supplies and will be found very useful to buyers in placing their orders for winter stocks. The previous editions of the book attained much popularity, and were especially notable in furnishing manufacturers' list prices for the benefit of all who preferred to make their purchases with the added advantage of buying at the manufacturers' discount price, or who desire an independent means of checking invoices. Copies may be had from the Western Electric Company, Chicago, Ill.

Dixon's Pencils.

The November issue of *Graphite* contains a cluster of testimonials to the surpassing merits of Dixon's pencils, The Eldorado, so-called, seems to be a prime favorite with draftsmen. Opinions from all sorts and conditions of men agree that they surpass anything made in Germany or anywhere else. We have given similar testimony before, and again take pleasure in joining in the universal chorus. Since we felt their velvet touch our fountain pen lies unheeded. The line of least resistance may be found in Dixon's pencils. Send for a sample from the Joseph Dixon Crucible Company, Jersey City, N. J., and be convinced.

Ragonnet Power Reverse Gear.

Bulletin No. 115, issued by the Economy Devices Corporation, 30 Church street, describes and illustrates the type "B" Ragonnet power reverse gear. The gear has several marked improvements, and was fully described in the November issue of RAILWAY AND LOCOMOTIVE ENGINEERING. As is well known, even with the best types of valve gear, a power reverse gear is a growing necessity on the heavy high powered locomotives of the present day, and its universal adoption in the best class of locomotives will be rapidly established. Copies of the bulletin will be sent to all interested.

Roll of Honor.

A Roll of Honor has been published by the General Electric Company containing the names of nearly twenty-five hundred employees formerly in the company's service and who have joined the United States Army or Navy. The list includes those who joined the forces allied with this country. A large number of them already hold commissions.

Women in Railroad Service.

A special Bulletin issued by the New York, New Haven & Hartford announces that the company has taken a new step along the lines of employing women in railroad service by opening a school in the South Station, Boston, where telegraphy, ticket and freight accounting are being taught free. The school is having a rapid enrollment. The pupils, as they become proficient, are assured positions with the company. The experiment appears to the railroad officers to be an excellent one. The plan is well worthy of imitation.

Poor's Manual.

A new edition of Poor's Intermediate Manual of Railroads has just been issued. It extends to 1,200 pages and furnishes revised statements of the leading railway companies and in its chosen sphere of furnishing reliable financial reports it is the only work of its kind. Published by Poor's Manual Company, New York. Price $7.50.

Railroad War Bulletins.

Official war bulletins showing some of the feats accomplished by the American railroads during the five months of the war are of marked importance as showing their possibilities under united management. They have hauled 116,000 carloads of freight to national camps; have handled 17,000 carloads of freight for the Shipping Board; have moved 750,000 carloads more of coal than in 1916, while the general freight traffic was 50 per cent heavier than in 1915. They have transported 1,200,000 soldiers to training camps. They will move 75,000 carloads of supplies a month to these camps.

Is Grease Better Than Oil?

A machine shop foreman allowed a grease salesman to put a couple of new cups on a line shaft, and the foreman forgot all about it. The salesman came back in two months. He examined the cups and found there was a little over one-fourth inch of grease gone. He sold the firm cups and grease for the entire line-shafting and they proved a great money-saver. Since then they have tried grease in a number of places, such as the step in the lathe, bearings on the self-feed rip saws and even planers, and have never had one burn out. Now they are testing it out on a rod or dowel machine. On the line-shaft they use the copper pin in grease cups.

Smoke.

Smoke is a mixture of various gases colored by particles of solid carbon. Since this carbon is passing away unconsumed, its heat value is lost, and it also becomes a public nuisance. When carbon is given off from the coal so quickly that oxygen is not being supplied in at least equal volume (double the volume is better) some of the carbon forms smoke. In order to prevent as much as possible the formation of smoke, the fire should be built up to the required thickness before starting with train, and that thickness maintained by firing light and often.

Removal.

The New York sales offices of the Edison Storage Battery Company have been located at 209 West Seventy-sixth street, New York, near the old offices of the company, at 206 West Seventy-sixth street. The rapidly growing business of the company has necessitated the removal to larger quarters. Mr. John Kelly is manager in charge as formerly.