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# INDEX TO VOLUME LXXXIII—1909

* indicates illustrated article.
§ indicates editorial comment.
‡ indicates communication.
† indicates a short non-illustrated article or note.

## A

THE PAGE NUMBERS FOR THE DIFFERENT MONTHS OF THE YEAR 1909 ARE AS FOLLOWS:

# DESIGN OF OIL BURNING LOCOMOTIVES.

Harrington Emerson.

A locomotive is an apparatus in which the heat evolved by the combustion of carbon, hydrogen and sulphur with oxygen is transferred to water in an enclosed receptacle, the water being converted into steam under pressure, which by its pressure and expansion drives the steam engine.

To a coal-burning locomotive there are two principal limitations:

(1) The ability of the draft arrangements to furnish sufficient air for combustion.

(2) The ability of the fireman to feed coal properly.

*Draft.*—The draft is created by the escape of steam. Exhaust steam is preferably used and the more work it does in making draft, the greater the back pressure. If live steam is used, to that extent the steam available for the engine cylinder is curtailed. It is evident that with very little draft there will be very little combustion and consequently very little available steam.. If, however, all the steam is used to create a draft there will be none left over for power purposes. The problem, therefore, is to obtain the maximum of draft without using too much of the steam for this purpose. Of the power used for draft, one-third is consumed in drawing the air through the bed of coals, one-third in drawing the air through the tubes and one-third in the resistance in the front end, diaphragm, etc. Dratt, therefore, could be very much increased if there were no bed of coals, if there were no diaphragm and if tubes were larger, fewer and shorter.

*The Fireman.*—There is a limit to the ability of the fireman:

(1) To shovel coal.

(2) To shovel coal so as to reach the further parts of a large grate.

(3) To shovel coal so as to maintain an even bed of fire.

Even when the fireman shovels coal perfectly, if the furnace, the tubes and the front end are not of proper design, the results will fall off.

The draft is often so strong as to lift the bed of coals from the grate and to plug the small flues with big cinders. Very small flues would not do.

The combustion space above the bed of coals must be large enough to complete the combustion of the coal before the gases enter the tubes.

Perhaps the chief faults in the design of the large modern coal-burning locomotives are:

(1) The tubes have been unnecessarily lengthened beyond the length of maximum result, 13 feet.

(2) The fire box has not been enlarged sufficiently to provide an ample combustion chamber.

Nevertheless, modern coal-burning locomotives, both in Europe and America, are well designed and efficient power generators.

When it comes to oil-burning locomotives, every principle of correct power generation has been violated. Oil burning locomotives were not specially designed for oil, but are in fact nothing but coal burners with an oil-spraying nozzle substituted for the grate. It stands to reason that designs and dimensions suited for coal are not suitable for oil. The sole excuse for using a coal-burning furnace and boiler design for oil is that it seems economical to put an oil nozzle in a fire box and to call the locomotive an oil burner. Also when oil becomes scarce it seems cheap to remove the nozzle, put back a grate and rechristen the locomotive a coal burner.

When, however, it is considered that a coal-burning fire box may last from 8 to 15 years, and the same fire box racked by oil combustion will last only from 1 to 5 years, and must then be renewed at a cost of from $2,000 to $5,000, the economy of adaptation proves fallacious, especially as a suitably designed oil furnace and boiler would not prove as inefficient for coal, as a coal furnace is for oil.

The particular limitations which apply to coal burning apparatus do not apply to oil:

(1) Because the oil is pumped in or injected, the limit of the fireman's strength or skill is eliminated.

(2) The limit to the amount of fuel is the amount of air that can be supplied.

(3) As there is no bed of coals through which to draw the air, this source of friction falls away.

(4) As there is no need of a diaphragm or screen to catch cinders, the front end friction is also reduced.

(5) As a consequence of reduced friction a very much larger volume of air can be furnished for combustion than in a coal burner.

(6) This larger volume of combustion requires a larger combustion chamber.

(7) With coal burners the gases enter the tubes at a temperature of about 1,300 degrees F., which 13 to 20 feet away drops to 500 degrees F.

(8) In modern oil burners the temperature of the gases is 2,800 degrees as they enter the tubes. This high heat enormously and rapidly damages the flue sheet and tube ends.

(9) Temperature of escaping gases is no higher than in coal burners.

(10) Therefore in an oil burner more heat is transmitted through the fire box and through part of the tubes near the fire than in a coal burner.

(11) As no cinders are dragged into the tubes to clog them up, tubes could be made much smaller in diameter, probably not over one-half inch.

(12) Tubes could also be limited to the best length for maximum result, about 13 feet.

(13) Many tubes are now 22 feet long. These might be shortened to 13 feet, thus making available 9 feet, a large part of which could be devoted to enlarging the combustion chamber, and the balance to a steam superheating or feed water heating device.

(14) The water spaces around the fire box ought to be much larger and the 9 feet extra length available for combustion chamber will permit water spaces one foot in width without making combustion chamber too small.

(15) With tubes one inch or less in diameter, although only 13 feet long, there will be more tube-heating surface than with tubes 22 feet long but 2½ inches in diameter.

(16) These smaller tubes can be thinner and because the gases have been fully burned in the combustion chamber before reaching the tubes, there will be in operation less deposit of carbon. Carbon deposits are in any case removed by sand and more easily from small than from large tubes.

(17) In consequence of lessened air friction, greater volume of air, unlimited oil supply, big combustion chamber, lower temperatures of gases entering tubes, big water spaces, greatly increased fire box heating surface and tube heating surface for same sized locomotive, the oil-burning combination could provide steam abundantly and economically as to fuel, and operate at low repair cost for furnace and boiler even in the largest Mallet compounds.

## THE USE OF WOOD IN BUILDING CONSTRUCTION

Great as the advance in fireproof construction has been during the last ten years there has been no let-up in the use of lumber, and both architects and builders find themselves so dependent on wood to-day that they are compelled to admit that the forests of the country are likely to be the chief source of building material for many years to come.

"The use of cement, terra cotta, brick and stone, with a framework of steel, will make it possible soon to do away with wood entirely," is a remark often heard. As a matter of fact, the popular idea that fireproof materials will do away with the need of using lumber in a comparatively few years is a very erroneous one. All of the various fireproof materials going into the approved construction of the more substantial buildings are used in greater quantities now than the world dreamed of a few years ago, yet the heavy demand for lumber continues.

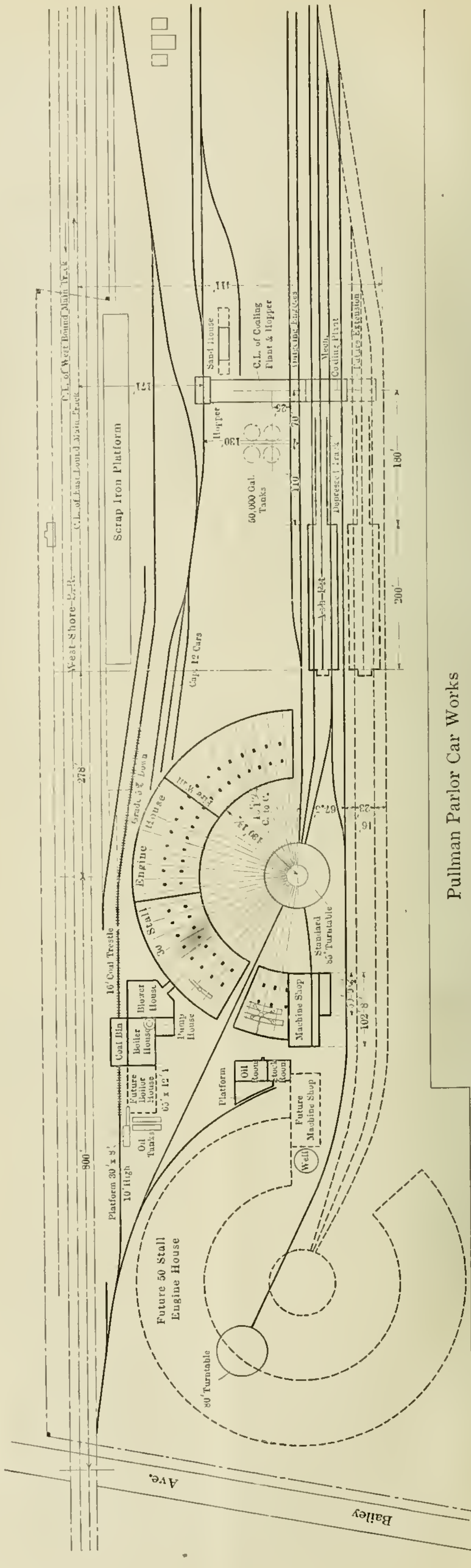
That wood predominates is shown by the annual building records. Of the permits used for buildings erected last year, approximately 61 per cent. were constructed of wood, and the remaining 39 per cent. of fire-resisting material, according to a report issued by the Geological Survey on operations in forty-nine leading cities of the country. These figures are the more significant when it is realized that they only represent the building activities in the largest cities; they do not take into account the construction of dwellings, stores and other buildings in the thousands of small cities and towns scattered over and not included in the forty-nine cities on which the reckoning is made.

In towns and small cities wood is usually the predominating building material and it is safe to say that if the statistics had included figures for all places of whatever size, the percentage of wooden construction would have been much greater.—*From a report of the Forest Service of the U. S. Dept. of Agriculture.*

The Importance of Knowing Costs Promptly.—The accounts showing what is actually spent each day must be in the hands of those in control as soon as possible after it is spent; not a month's nor a week's report at a time, but a day's report at a time, and it must be in the possession of the officer or man in charge of the expenditure as soon as possible. The section foreman must know at the close of to-day what he has spent to-day. The same is true of the shop foreman. The supervisor should know to-morrow what has been spent by his section foreman to-day.

At first thought it may seem that this would involve an immense amount of bookkeeping and complication of accounts, and consequently a large additional force of men. This, however, is not so. It does not involve the putting on of any additional men, as this daily check can be carried out by the present force without difficulty, as the necessary accounts are so simple and are kept by so many that it puts but little work on each, and in the larger offices, such as the division superintendents and master mechanics, it means but a consolidation of figures. This is no theoretical or fanciful scheme whatever, but is a definite practice which has been in actual operation for sufficient time to thoroughly demonstrate its practicability. It simply means system in expending the money for operating expenses and adapting to the railroad business the same rules as to knowing and watching cost that apply to all other lines of business.—*W. J. Harahan, before the New York Railroad Club.*

Freezing of Air Brake Hose.—The reason that air brake hose gets hard in cold weather is generally due to freezing. If we could get some kind of rubber that would not freeze we would be very happy. Crude rubber will freeze at about 20 degrees F., and vulcanized rubber freezes at about zero. All rubber companies have experimented in different ways to prevent this, and they have added oils and all kinds of things that do not freeze so readily, but in this country the temperature gets so low that it frequently gets beyond us.—*A. D. Thornton, general technical superintendent, Canadian Rubber Company, before the Canadian Railway Club.*




GENERAL PLAN OF THE NEW ENGINE HOUSE PLANT AT EAST BUFFALO, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

# EAST BUFFALO ROUNDHOUSE.

New York Central & Hudson River Railroad.

A new 30 stall roundhouse for passenger locomotives has recently been placed in operation by the New York Central & Hudson River Railroad at East Buffalo. It lies between the West Shore Railroad tracks and the Pullman Parlor Car Works, near the old 28 stall roundhouse of the West Shore Railroad.

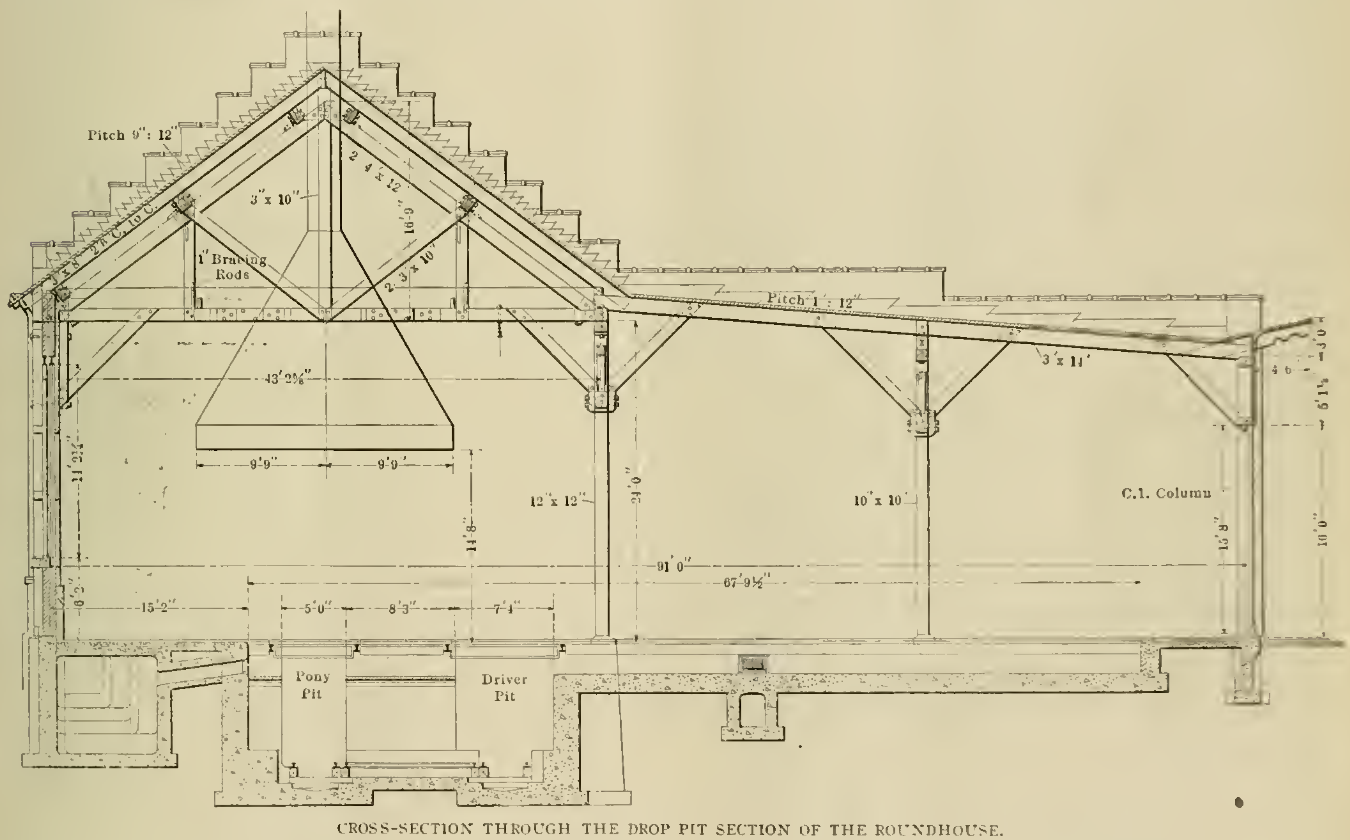
*General Arrangement.*—As shown by the dotted lines on the general plan, provision has been made for the addition of a 50 stall roundhouse to meet future requirements; also for additional ash pits and water tanks and for the extension of the coaling station and the power plant.

Engines enter the plant from the east, on one of the incoming tracks, and take coal and sand, after which they move forward and take water and then move on to the ash pits. The coaling station is about 650 ft. from the turntable and the standpipes are a sufficient distance from the coaling station so that one engine may take water while another is coaling on the same track. Coal for the power house is brought in over the track at the north, the cars unloading into coal bins from a trestle. Coal for the coaling station is also brought in on the track at the north and may be stored on the three tracks just east of the roundhouse. These tracks are on an incline and, as the coal is needed, a car may be started down the grade with the aid of a pinch bar and be stopped over the hopper, into which it is dumped and from which it is elevated to the storage bins above the tracks. The sand, after being dried in the sand house, is elevated to storage tanks in the coaling plant by compressed air.

The tracks over which the coal and sand are brought in do not in any way interfere with the incoming and outgoing tracks for the engines; the only place where there is liable to be any interference is in connection with the cinder cars from the ash pit and this can readily be guarded against. Ordinarily the engines come in and go out at the eastern end of the plant but provision has been made so that in case of emergency engines may be taken out at the western end over the track which separates the main portion of the engine house from that part containing the drop pits, machine shop and offices.

*The Roundhouse.*—The main portion of the roundhouse, consisting of 26 stalls, is divided by two fire walls, with steel fire doors, into three portions. The drop pit section contains three stalls, and the machine shop, which has a common wall with the drop pit section, has a pit which may be used for engines requiring light repairs. Two of the pits in the main portion of the house are equipped with a drop pit for engine truck wheels. The building has a depth of 90 ft., measured from center to center of the wall columns and the distance from the center of the turntable to the inner wall of the house is 130 ft. 1¾ in. The tracks radiate at an angle of 5 deg. 44 min. 52 sec. from the center of the turntable.

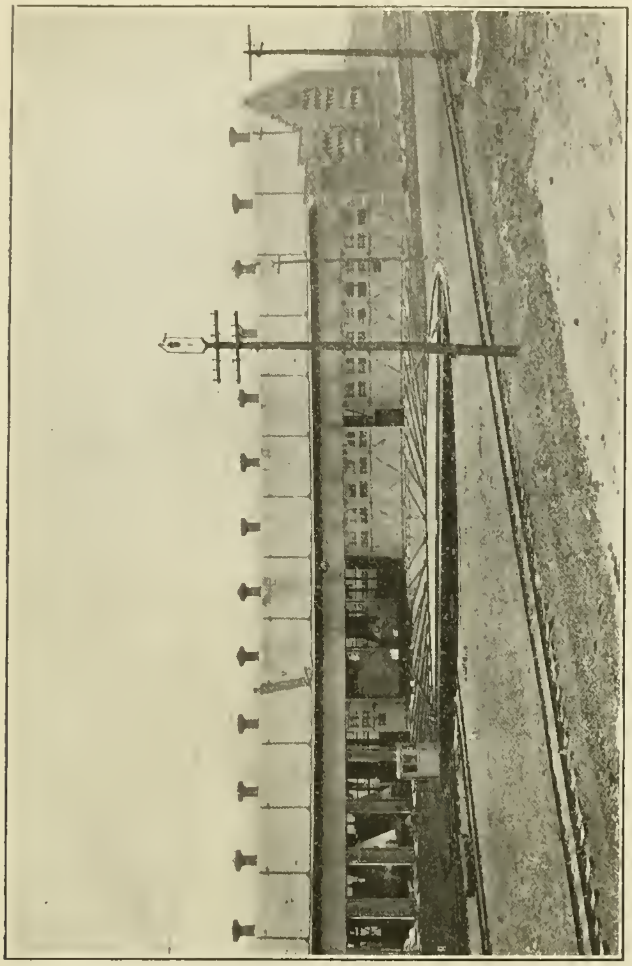
The foundation, pits and floor of the house are of concrete and the walls are of brick. The columns are of yellow pine, of the dimensions shown, and the roof trusses are of timber. The roof consists of 2 in. timbers upon which "Special Brooks Brand" roofing, furnished by the H. W. Johns-Manville Co., is laid.



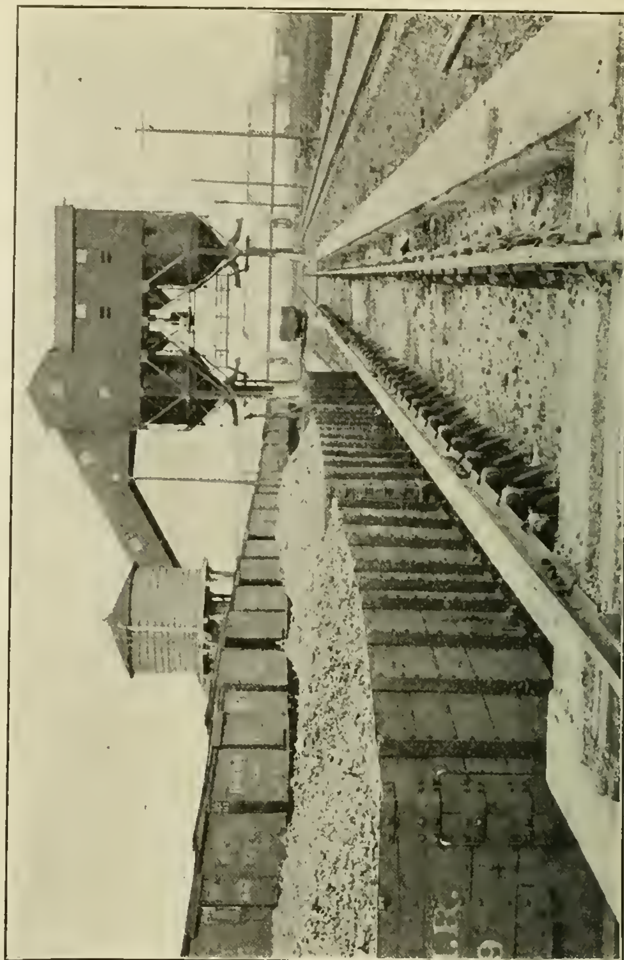
CROSS-SECTION THROUGH THE DROP PIT SECTION OF THE ROUNDHOUSE.

The most noticeable feature of the house is the large amount of window space, which furnishes splendid day-lighting, and the amount of head room. The wall above the windows is supported by two 9 in. I beams, which extend crosswise above the windows. Wooden doors are used; they are held in an open position by bolts which fit in sockets in concrete piers, about 2 ft. square in section.

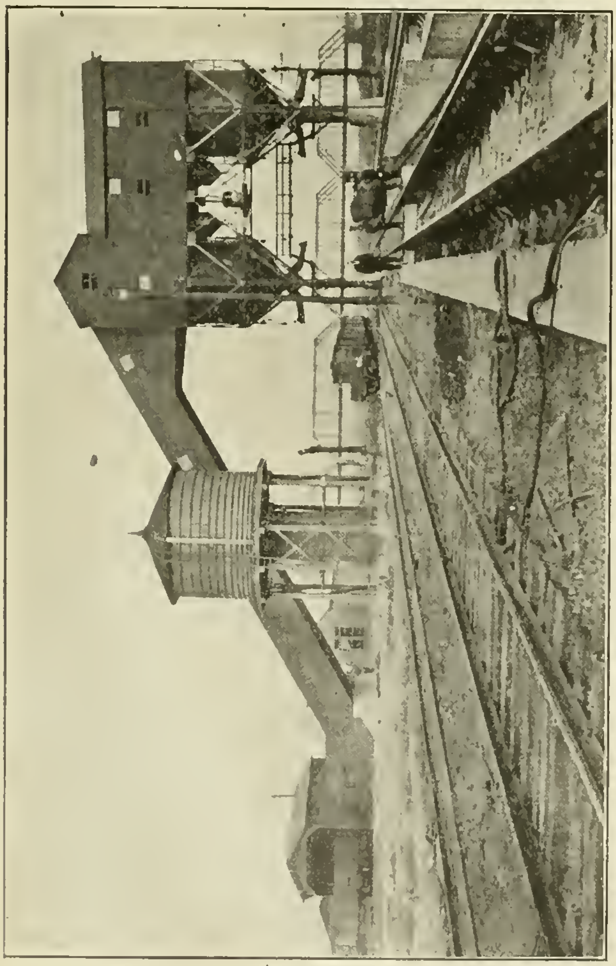
The cross-sectional view of the house shows a section through the drop pits. The pits in the main part of the house are 67 ft. 9½ in. long, extending to within 8 ft. ½ in. of the outer wall. They are 3 ft. 4 in. deep at the inner end and 2 ft. 8 in. deep at the outer end. A 15 in. jacking timber is placed alongside the rails of each pit.



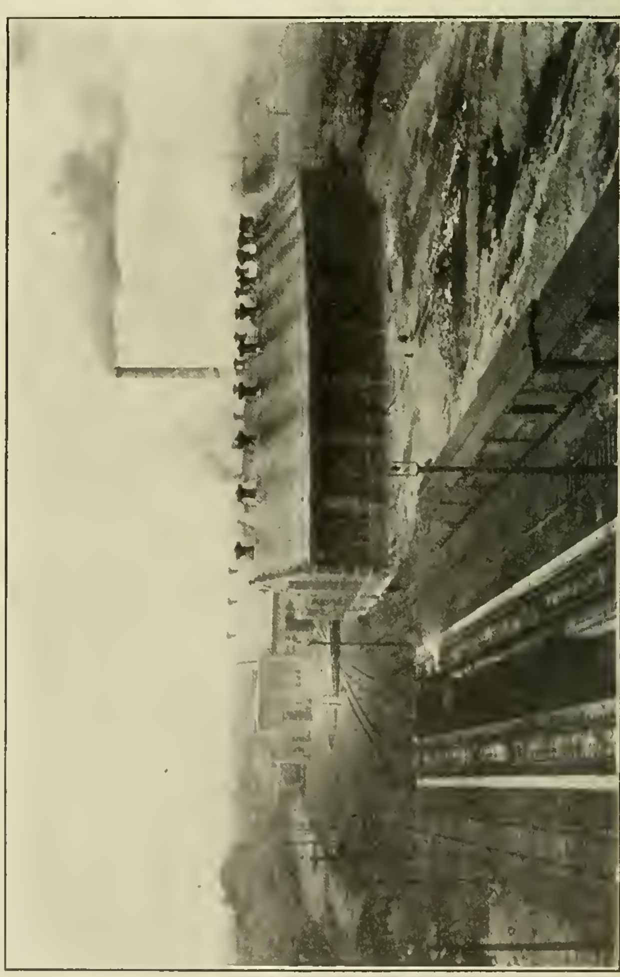
PARTIAL VIEW OF THE END OF THE ROUNDHOUSE NEAREST THE COALING STATION.



CINDER PIT AND COALING STATION.



COALING STATION. CINDER PIT TO THE RIGHT



VIEW OF THE ROUNDHOUSE FROM THE COALING STATION. CINDER PIT IN THE FOREGROUND.

*Smoke Jacks.*—The smoke jacks are of a new type, known as the "Phoenix," furnished by the H. W. Johns Manville Co., of New York. They are fire and acid proof, being made of a compound of asbestos and magnesia, reinforced by galvanized iron cloth, which is imbedded in this material. The material and the moulds were shipped to the roundhouse and the jacks were moulded on the premises in three pieces—the hood, circular part or stack, and the cowl. The plastic material sets hard in a few hours, after which it is very hard and durable and is not affected by fire, acids or moisture.

The jacks are supported by rods which are attached to lugs on the hood. These lugs, which are moulded on the hood, are reinforced by heavy wire cable, the ends of which are unraveled and interwoven with the wire cloth. After the jacks were installed the supporting rods were covered with the "Phoenix" material to prevent deterioration. The interior of the jack is smooth, having no protruding bolt heads or flanges. The average thickness of the material is 5/8 in. and it weighs from 4 to 4½ lbs. per square foot. The jacks shown on the cross-sectional view, over the drop pits, have a hood 19 ft. in length at the bottom, but in the main part of the house this length is only 8 ft. They are 4 ft. wide.

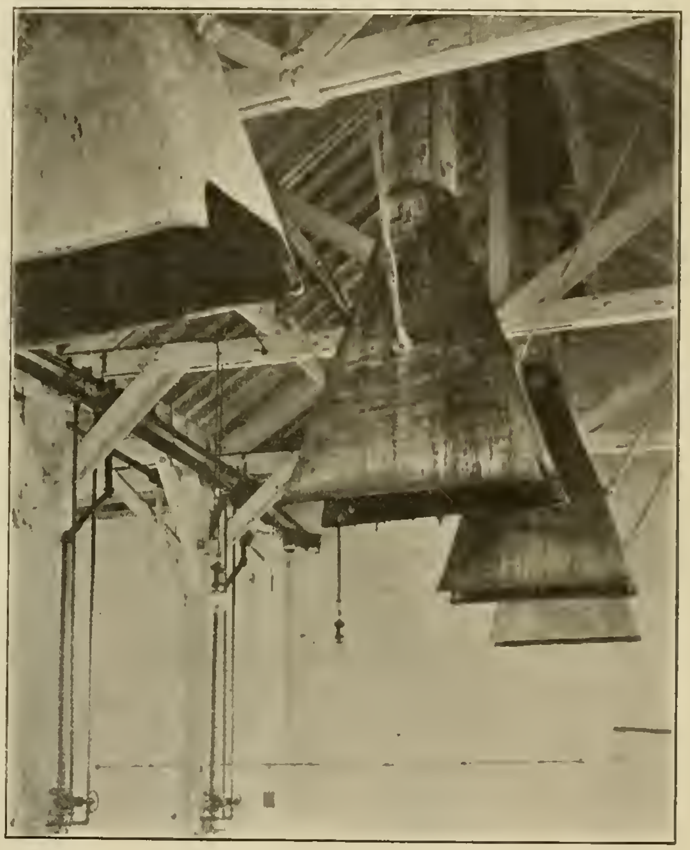
*Locomotive Boiler Water Changing and Washing Out Equipment.*—The W. L. Miller Heating Company's system for changing the water and washing out the locomotive boilers is used. The piping for this system, as well as the air pipes and the live steam pipes for blowing purposes, are carried overhead and have branches extending downward alongside the columns between every other pit. The live steam and hot water pipes are covered to prevent radiation. The Miller heating system consists of a 3 in. hot water pipe, a 4 in. cold water pipe, and a 6 in. blow-off pipe. There is a mixing box and a connection for attaching two hose lines on the columns between every other pit. In the section of the power house containing the heating fans are two large tanks, one above the other, in which the water for washing out and filling the boilers is heated from the exhaust steam from the locomotive boilers, when they are emptied. The larger of the heating tanks is 22 ft. 10 in. long over the heads and 72 in. inside diameter; the inner one is 18 ft. long and 48 in. inside diameter.

This system is guaranteed to give the following results: When water and steam at about 190 lbs. pressure are blown from the locomotive boiler, sufficient fresh water at 55 degs. F. will be heated to 195 degs. F. to fill a similar locomotive boiler to the same level without the use of any steam or hot water, except that supplied by the first boiler and the exhaust steam from the water pump. When water and steam at about 190 lbs. pressure are blown off, sufficient fresh water at 55 degs. F. will be heated to 125 degs. F. to thoroughly wash out a locomotive boiler of the same size. The time required for this operation should not exceed 2 hours. The same operation may be performed on two adjacent pits without affecting the above results.

*Heating System.*—The heating fans are contained in the section of the power house nearest the roundhouse and connected to it by a passageway. Hot air is forced into a duct, or tunnel, which extends around the outer circle of the house. This tunnel is of concrete and is 9 ft. 6 in. wide by 7 ft. deep where it enters, tapering gradually as it extends to either end of the house. Between every other pit a conduit, 36 in. in diameter, leads from the main duct and from either side of this three 18 in. ducts lead to the pits; two of these ducts enter the pit near the ends, and the other one near the middle. The 36 in. duct gradually decreases in diameter, ending in a 10 in. duct which extends upward and opens into the house at the column alongside the doorway. These openings, as well as those leading into the pits, are fitted with dampers. The branch ducts, where they lead from the main tunnel, are equipped with deflectors, so that under normal conditions the same amount of air is delivered to each pit. Pipes, 5 in. in diameter, extend upward, from the main tunnel, underneath the windows at the outer wall of the house and have at the upper ends a T into which perforated pipes 5 in. in diameter, with caps at the ends, are fitted. The upper member of the T thus formed is 9 ft. in length and has several 1¼ in. perforations in the top side, spaced 6 in. apart. A 33 in. galvanized iron pipe extends upward from the end of the heating duct and into the machine shop; branches lead off from it, directing the heated air downward, thus heating this part of the building.

The heating system was installed by the Buffalo Heating Co. and is guaranteed to maintain an even temperature of 65 degs. F. when the external air is 10 degs. below zero, and when fresh air only is supplied to the fans. It is guaranteed to maintain the same temperature inside when the temperature of the external air is 20 degs. below zero and 25 per cent. of the air taken into the heater is from the inside and is recirculated. The temperature of 65 degs. F. is to be obtained after the doors leading from the turntable have been closed five minutes. It is also expected that the house will be kept clear of fog and steam. The fans have a capacity for changing the entire contents of the house every eight minutes, and of the annex every fifteen. Steam for the heating coils is furnished at a pressure of 1 lb. or less.

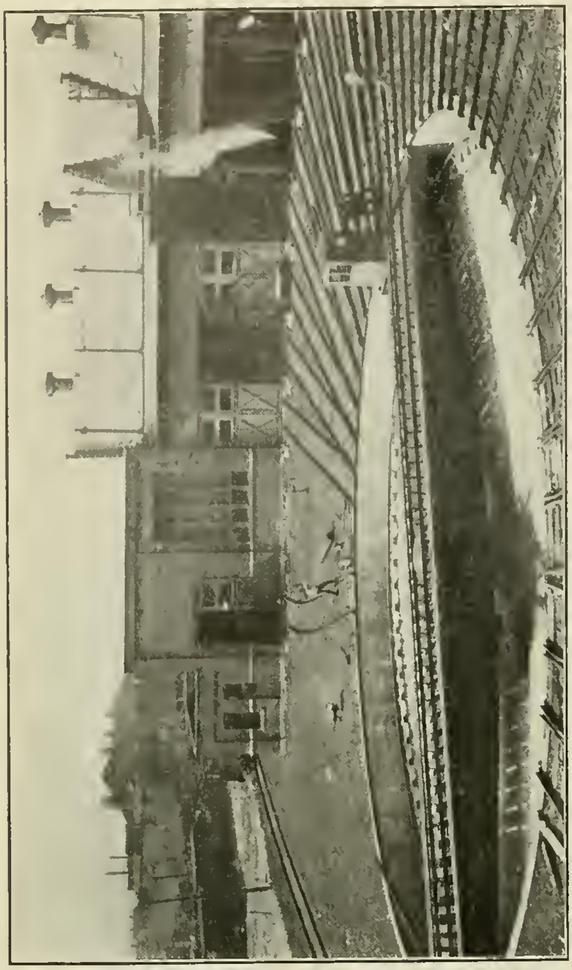
The heating coils consist of two systems of inverted U shaped coils, constructed with two groups in each system. These



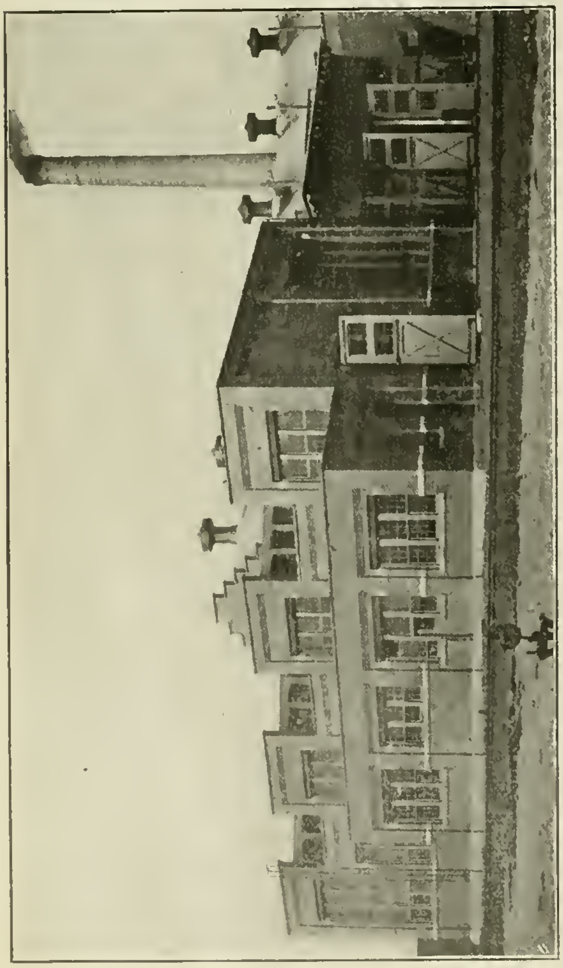
SMOKE JACKS. ALSO SHOWS THE PIPING USED IN CONNECTION WITH THE BOILER WATER CHANGING AND WASHING OUT SYSTEM.

groups are arranged in four divisions, so that the amount of heating surface may be varied to suit conditions. The heaters contain an aggregate length of 14,000 actual lineal feet of 1 in. pipe. The free area in any row of coils is not less than 40 per cent. of the total cross-section through the row nearest the point of admission of cold air. The fans are of the three-quarter housed, steel plate type and have a capacity for delivering 88,000 cu. ft. of air per minute, with a pressure of not less than ¾ oz. at the discharge orifice, and when operating at 140 r. p. m. The fans are driven by 14 x 14 in. direct connected horizontal steam engines, using steam at 80 lbs. pressure and having an indicated horsepower of 52, with a back pressure of not less than 1 lb. and cut-off at half stroke.

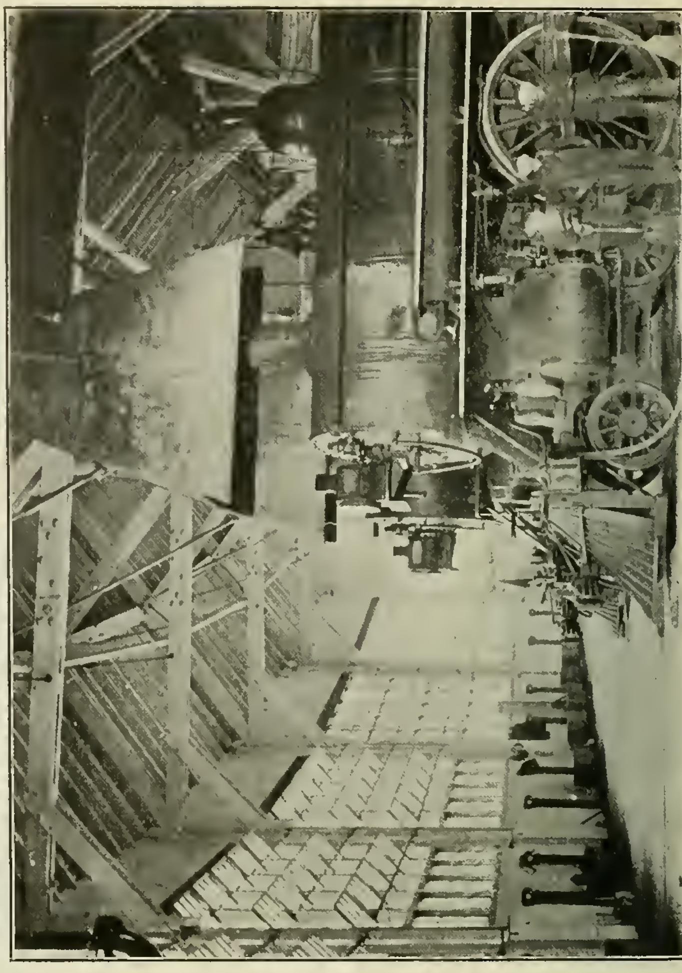
*Lighting.*—The large amount of window space in the outer walls of the house furnishes splendid day-lighting. The electrical power for artificial lighting is furnished by the Niagara Falls Power Co. An Edison two-three wire system provides alternating current at 60 cycles and 104 and 208 volts. A multiple



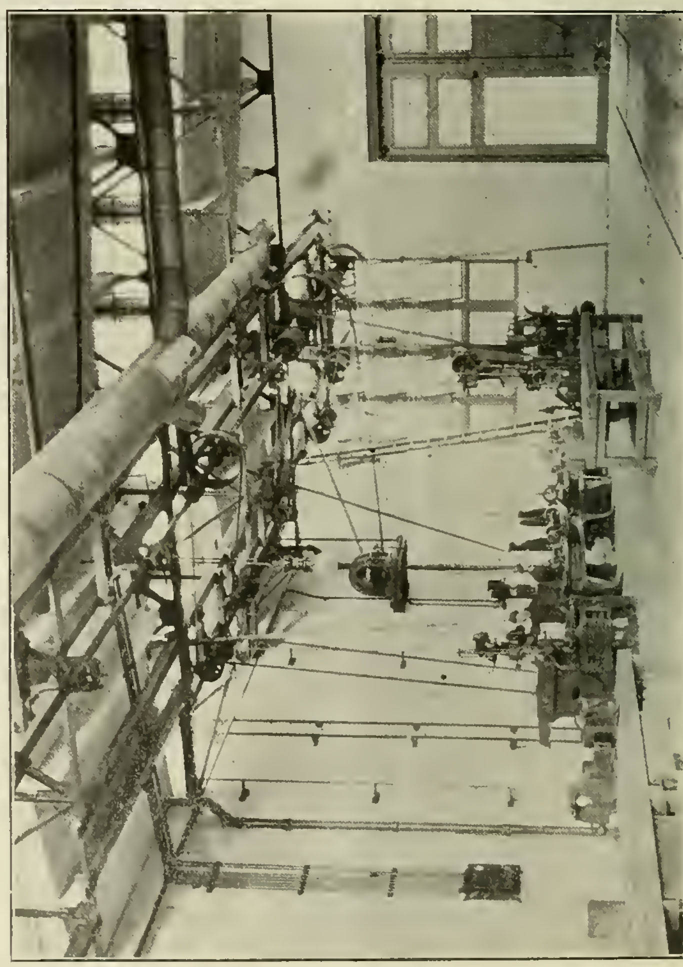
TURNTABLE. ALSO A VIEW OF THE OFFICE—MACHINE SHOP—DROP PIT SECTION OF THE HOUSE.



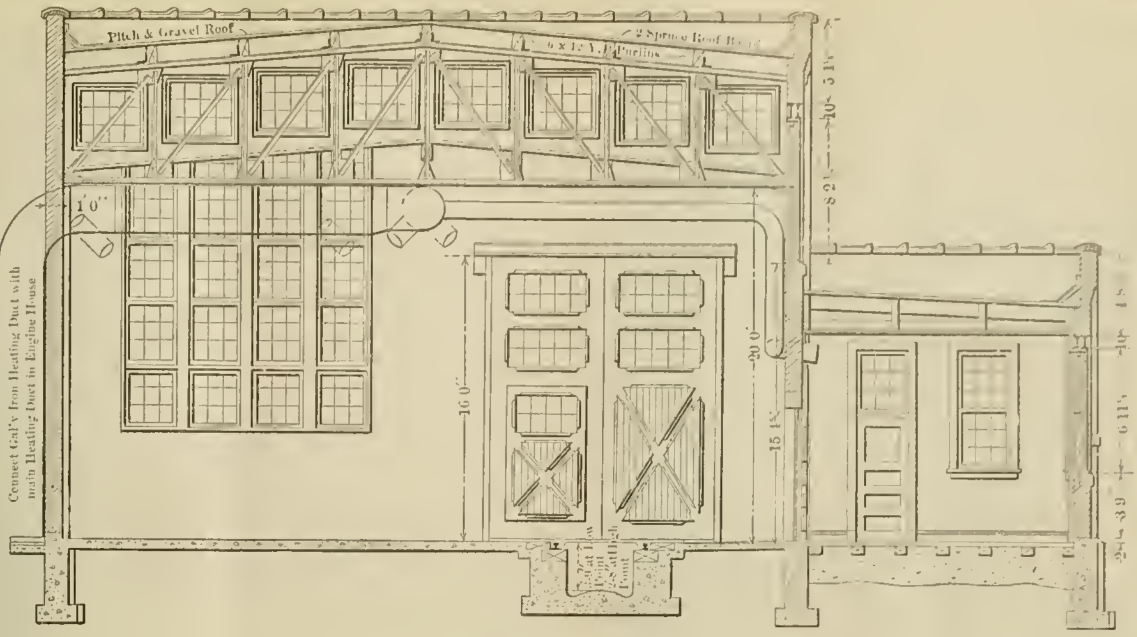
OFFICES AND MACHINE SHOP.



INTERIOR OF THE ROUNDHOUSE.



INTERIOR OF THE MACHINE SHOP.




CROSS-SECTION THROUGH THE MACHINE SHOP AND OFFICE.

enclosed type arc lamp, for six amperes at 110 volts, is suspended between the stalls, except at the ends and at the fire walls. A portable outlet, snap switch and two incandescent lights are placed on each side of the fire walls and at the end walls, and a snap switch and cutout control each pit light circuit. Recesses are placed in the drop pits for incandescent lights. All the wiring is carried in loricated iron conduits.

*Equipment.*—At the head end of each pit an iron block or stop is fastened to the track and prevents the locomotive from running into the wall. It is also the practice to place a heavy chain on the track in front and behind of one of the drivers, so that if for any cause the throttle should accidentally become opened, or leak, it would be impossible for the engine to move out of place. The machinists have portable tool boxes, which are about 3 ft. long, 18 in. wide and 13 in. high and are fastened upon trucks, so that they can easily and quickly be moved to any part of the house. There are also two or three portable vises, which are fastened on trucks. The boiler washer's tools and hose reels are carried on trucks. One of the illustrations shows the simple and substantial method by which a vise bench is fastened to the wooden columns. The table upon which the vise is placed is of cast iron, 20 x 30 in. x ⅝ in. in size and about 30 in. above the floor. The vises are the No. 6 size made by the Howard Iron Works.

At about the center of the middle section of the house, against the wall of the outer circle, is a tool room, 8 by 13 ft. in size. Here all of the heavy and special tools are kept, the mechanics drawing them as they are needed and returning them as soon as the job they are working on is finished. The jacks are stored just outside this room and are looked after and kept in good condition by the man in charge of the tool room.

*Drop Pits.*—That section of the house, consisting of three stalls adjacent to the machine shop, is entirely separated from the main part of the house and is equipped with two drop pits extending under all three tracks, one for driving wheels and the other for truck wheels. These drop pits are 8 ft. 3 in. apart and are connected by three passageways, one of which has a track with a turntable at each end, so that the trucks carrying the telescopic jacks can be transferred from one pit to another. The driver pit is 7 ft. 4 in. wide and the pony or truck wheel pit 5 ft. wide.

In removing a pair of wheels from an engine the pedestal binders are taken down and the rods disconnected. Jacks are placed under the engine frame. The telescopic jack is placed underneath the middle of the axle and the drivers are raised sufficiently to allow the 10 in. I-beams, to which the rails are bolted, to be pulled aside. The wheels are then lowered into the pit. A 6 ton electric hoist will be installed over the drop pits. There is also a pony or truck wheel drop pit extending under two tracks in the main part of the roundhouse, as shown on the plan view.

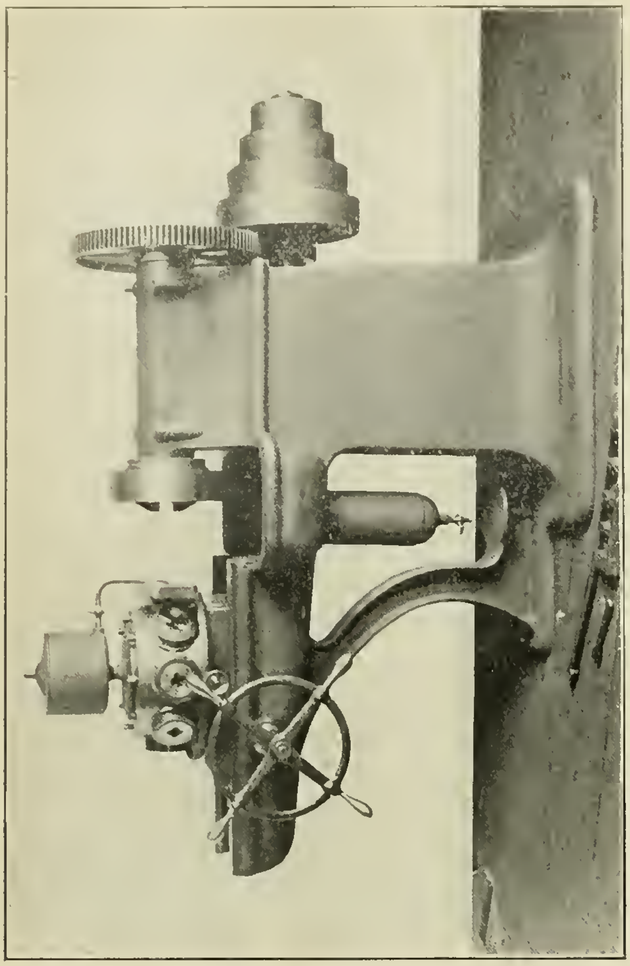
*Machine Shop.*—The machine shop is adjacent to the drop pit section of the roundhouse, having a common wall with it. It is 40 ft. wide inside, 102 ft. long, and has a concrete floor. Along the side nearest the offices is a pit upon which light repairs may be made. The remaining portion of the shop is used for machine tools and a forge and anvil for the smith. The construction of the roof, which is supported by light steel trusses, is shown in the cross-sectional view of this shop, and on the photographs, and furnishes a plentiful supply of daylight. The machine tools are driven by a 40 h.p. alternating current motor, which is mounted on a wall bracket. At the present time the following machine tools are in use:

Lathe, Putnam Machine Co.
Small Drill Press, Bement-Miles & Co.
Shaper, Gould & Eberhardt.
Bolt Cutter, Acme.
Turret Bolt Cutter, No. 4, Pratt & Whitney.
Grinder, Bridgeport Safety Emery Wheel Co.
Drill Press, Cincinnati Machine Tool Co.
Boring Mill, Two Head, Bullard Machine Tool Co.
Lathe, McMahon & Co.

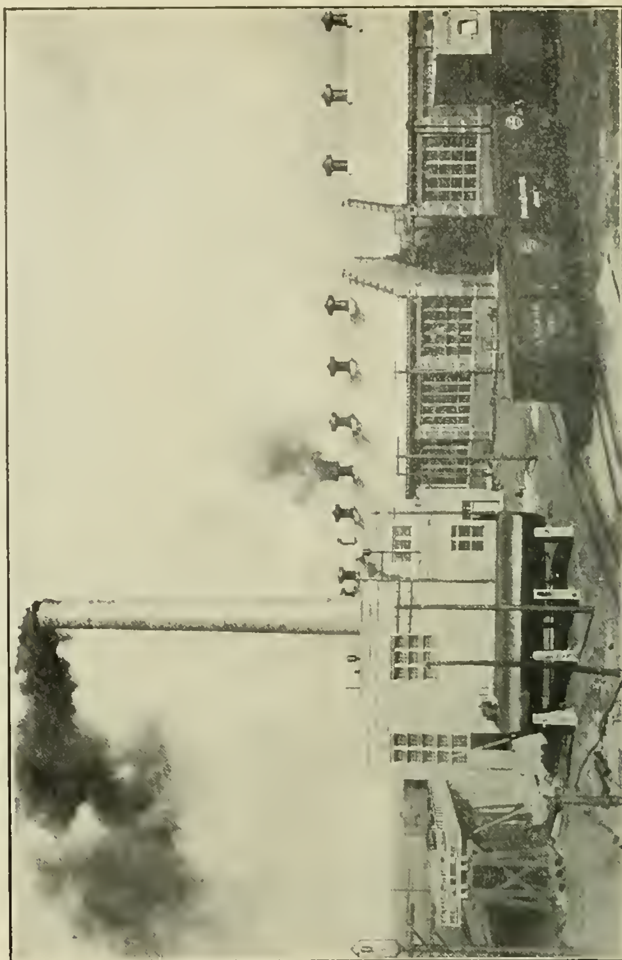
There is also a forge, with a stack to carry off the smoke and gases, and an anvil. A crane will be installed to serve the heavier machine tools.

The Pratt & Whitney No. 4 turret head bolt cutter has a revolving head carrying nine dies, any one of which may be presented instantly to the bolt to be cut. The turret is secured in position by a spring lock-bolt. The spindle is hollow to receive bolts of any length and by removing the die opposite the one that is at work, allowing the bolts to project through the turret, the thread may be cut any length required. The spindle is equipped with a chuck for holding the bolt or tap and is driven by a cone pulley. The chips and oil are caught in the bed and the oil drains free from the chips through a strainer into a receiver, from which it may be drawn and used again. As the machine is fitted with nine different dies, this many different size bolts may be threaded almost as quickly as the same number of one size. Such a machine is especially valuable in a roundhouse, where the number of bolts of one size, to be cut at one time, is small and where changes of size are frequent. The machine is furnished with two nut plates and one nut plate holder, and the following sizes of taps and dies, ½, ⅝, ¾, ⅞, 1, 1⅛, 1¼, 1⅜ and 1½.

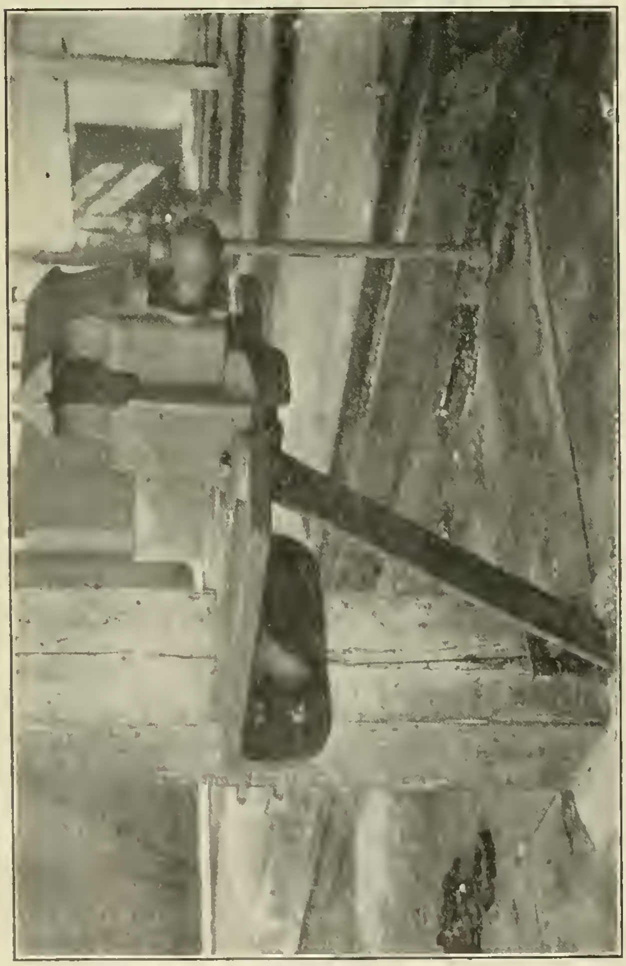
*Offices, Rest Room and Toilet.*—A small addition to the machine shop, 16 ft. wide and about 59 ft. long, is divided into four parts, two of the rooms, with wooden floors, being used as



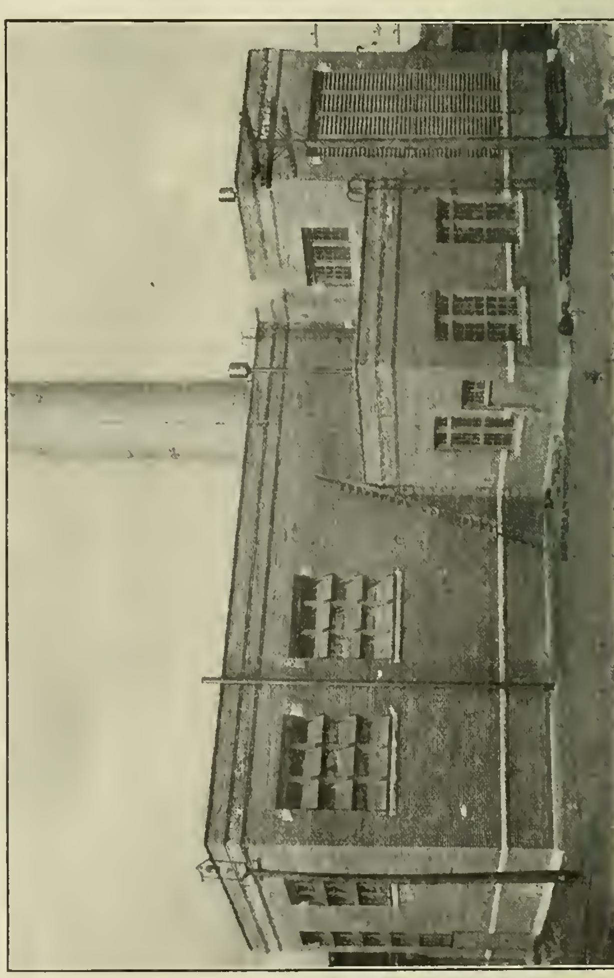
PRATT & WHITNEY TURRET HEAD BOLT CUTTER.



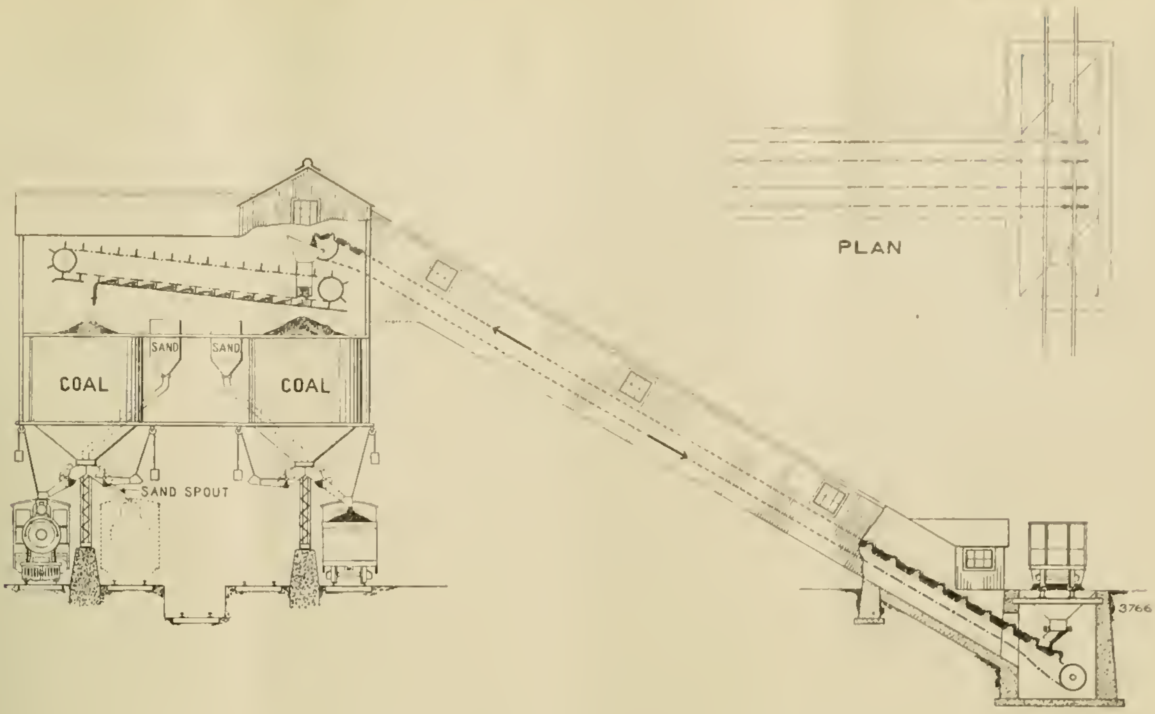
OIL STORAGE TANKS, POWER HOUSE AND A PORTION OF THE ROUNDHOUSE.



VISE BENCH ATTACHED TO WOODEN COLUMN.



POWER HOUSE.




GENERAL ARRANGEMENT OF THE COALING STATION.

offices. The toilet and wash room has a concrete floor and is equipped with iron fixtures furnished by the J. L. Mott Iron Works. The rest room is furnished with a bench around two sides and may be used by the workmen while eating their lunch, or when off duty. A railroad Y. M. C. A. building is located only a few blocks from the roundhouse and is very convenient for the engine crews.

*Turntable.*—The turntable is 85 ft. long and was built by the King Bridge Company, of Cleveland, O. The pit is of concrete construction. The table is driven by electric power. The electrical controlling apparatus is enclosed in a small house, which is heated and lighted by electricity. A hand brake and sanding apparatus are also provided.

*Coaling Station.*—The coaling station consists of two circular pockets constructed of ⅝ in. steel and having a storage capacity of 300 tons. The flow of coal from these tanks to the tenders is controlled by under-cut gates. The conveying apparatus and the storage tanks are covered by a monitor, consisting of a steel frame-work covered with corrugated galvanized steel. The two smaller tanks shown between the larger ones are used for sand. As shown on the general plan, the coal is stored on three tracks near the engine house. As occasion requires the cars are moved down the slight incline and over the hopper, which is covered by a structure 14 ft. wide and 40 ft. long. The coal is unloaded into the hopper, and from this a reciprocating feeder feeds it in regular and uniform quantities to the conveying apparatus.

The conveying apparatus is furnished in duplicate, each unit having an elevating capacity of 100 tons per hour. This apparatus, extending from the feeder to above the first storage tank, measures 127 feet between centers and is placed at an angle of 30 degs. with the horizontal. A horizontal conveyor is used for carrying the coal from the inclined conveyor to the storage hoppers. These conveyors are driven by alternating current motors, operating on 3-phase, 25 cycle, 440 volt service. The plant is heated by steam and lighted by incandescent lights. It was designed and installed by the Link-Belt Company, of Philadelphia.

*Sand.*—The sand house is 55 ft. long by 15 ft. 8 in. wide and is located near the hopper house of the coaling station. The sand is shoveled into the storage space in the house and from there is wheeled up an incline in barrows and dumped above the sand stoves, of which there are two. As it dries it drops into a pit and is fed into tanks, 3 ft. in diameter. It is forced from these tanks to the storage tanks in the coaling station, through 2½ in. extra heavy pipe, by compressed air. The storage tanks above the tracks have a capacity for 190 cu. ft. of sand.

*Water Supply.*—At the present time there is a 50,000 gallon tank which supplies the water columns. As the plant is extended it will be necessary to add additional water tanks, as indicated. The location of the water columns is shown on the general plan.

*Cinder Pits.*—There are two cinder pits, each 200 ft. long, with a depressed track between them. The pits are 26 in. deep and the cinders, after they have been wet down, are shoveled from these into gondola cars. The pits are of concrete construction and the rails are carried on cast iron chairs, as shown in the illustration.

*Store House.*—The store house is 61 ft. 4 in. in length and 30 ft. 8 in. wide. The platform, on two sides of it, is of paving brick, laid herringbone, with a concrete curbing. The building is a steel frame brick structure with concrete floors and fireproof roofing. The doors are covered with metal and the windows are wire glass in galvanized iron frames. One end of the storehouse, about 34 ft. in length, is used for oil and waste, and the other, and smaller part, is used for the storage of other supplies.

In the oil room are four large oil tanks. The oil is unloaded from the cars in barrels, which are rolled across the platform and into a frame work, or basket, shown in the accompanying illustration. This is then raised by means of an air hoist, which is attached to the roof beams inside of the building. When the basket, or frame work, is flush with the opening the barrel rolls by gravity into the building and onto a gallery above the oil tanks; it is then discharged into these tanks by gravity. Kerosene and fuel oil are stored in two large tanks west of the power house, each having a capacity of 10,000 gallons. These are supported on concrete piers and are connected by pipes to the oil house, being high enough so that the oil flows to the house by gravity.

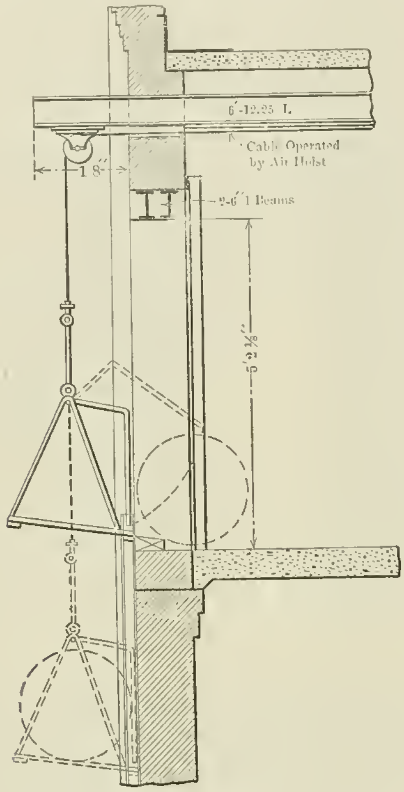
*Power Plant.*—Mention has already been made of that part of the power house which contains the heating apparatus and the equipment for the boiler water changing and washing out system. This part of the building is 51 ft. 6 in. wide by 67 ft. long, except that one corner is cut off and a passage way extends from it to the engine house. It also contains an air compressor, of the Ingersoll-Rand, class H, type, having 16 x 16 and 26 x 16 in. steam cylinders and 16¼ x 16 and 25¼ x 16 in. air cylinders.

Connected to this portion of the building is a pump room, about 25½ ft. square, which contains the fire and service pumps.

The Underwriter's fire pump has a capacity for 1,000 gallons per minute, or four good 1⅛ in. smooth nozzle streams. There are two M. T. Davidson Co., 14 x 8¼ x 14 in. service pumps.

The remaining portion of the building consists of a boiler room, 66 ft. long and 43 ft. 6 in. wide. It contains three 200 h. p. Heine Safety Boiler Company boilers, with space for an additional unit if it should be required. The boilers are designed for 180 lbs. working pressure and are equipped with McClave shaking grates. The feed water heater is the No. 3 size made by The Platt Iron Works Co., Dayton, O. A Worthington 7½ x 4½ x 10 in. feed pump is used.

Along one side of the boiler room are the coal and ash rooms.




DEVICE FOR ELEVATING OIL BARRELS AT THE STOREHOUSE.

The coal is brought in over these rooms by means of a 16 ft. trestle, with a 5 per cent down grade, and is dropped into them by gravity. That part of the trestle leading to the building is supported by timbers resting on concrete piers. The track above the coal and ash rooms is supported by concrete piers, 3 ft. in section and spaced about 16 ft. apart.

The radial brick chimney, 125 ft. high, 12 ft. 4 in. in diameter at the base and 7 ft. 2¼ in. in diameter at the top, was built by the Alphons Custodis Chimney Construction Company, New York. It has a capacity to supply draft for boilers aggregating 800 h. p. and is fitted with an automatic draft regulator.

Correspondence.—Correspondence should not be shifted around simply to relieve desks of the presence of papers, but it should be thoroughly gone into, all questions answered, and, if an answer naturally develops another question, it should also be answered. It is exasperating to receive returned papers in which all questions are not answered, in an effort evidently to easily get rid of the correspondence, and such methods are insensibly treasured against those performing such indifferent service. It should be the pride of a man conducting correspondence to feel that his superior officer did not have to return it for additional facts, if such additional facts could have been reported on in the first instance by a conclusive investigation. Where possible and consistent, definite recommendations should always be made, otherwise a man's office becomes but a clearing house for correspondence, and such clearing houses are not essential or even desirable.—*W. J. Harahan, before the New York Railroad Club.*

## A GOOD MIXTURE FOR CASE HARDENING.

John Buckley, foreman blacksmith at the Burnside shop of the Illinois Central Railroad, uses the following mixture for case-hardening. It gives splendid results and is much less expensive than the method in use at many shops:

Take charcoal broken fine, about one inch in size. Put a two-inch layer of this in the bottom of the box and pack it down with a mallet. Sprinkle about one pound of common salt over the charcoal, one pound of pulverized sal soda over the salt, one pound of pulverized rosin over the sal soda, and one pound of black oxide manganese over the rosin. Lay the material to be case-hardened on this, taking care not to have the pieces too close together nor too close to the sides of the box, where metal boxes are used. Fill in between the pieces with charcoal and pack well, taking care to have about two inches of charcoal between the work to be case-hardened. Repeat the sprinkling of compounds over the second layer of work, the same as in the bottom of the box. Finish off with about two inches of charcoal at the top of the box and sprinkle a little salt over it. Put the cover on the box, calk with clay, and place in the furnace for ten to fifteen hours, according to the amount and size of the work to be case-hardened. Heat to a bright red and cool in cold clear water.

The size of the box used for the above mixture is about twelve inches deep, fifteen inches wide, and forty inches long. It will hold one set of links, blocks, plates and pins.

Teamwork.—The gift of creating harmony is the keystone of the arch of success without which the structure will not sustain itself. True harmony, when carried to a finality, familiarly known as teamwork, engenders enthusiasm on the part of the individuals forming the organization. An organization without harmony disintegrates and soon becomes utterly demoralized, so that a disturber should be ejected from it with little ceremony, or he will prove its undoing. Departmental lines should vanish before the company's welfare. If, by sustaining an expense, another department can be helped sufficiently to justify the expense assumed, there should be not only no hesitancy, but an eagerness to do so, bearing in mind that the ultimate result to the company as a whole is what should govern. Where possible to do so, however, it will be found that the introduction of a friendly rivalry between officers of the same relative grade will, if properly handled, produce far reaching results, without in any manner affecting harmony, because of the incentive thus given them to use their intelligence and ability to accomplish at least as much, and, if possible, more than their fellows.—*W. J. Harahan, before the New York Railroad Club.*

Gold Leaf for Signal Blades, B. & O. R. R.—For some time past the signal and paint departments of the Baltimore & Ohio R. R. have been experimenting with gold leaf as a covering for signal arms, in an effort to retain distinctness of color without having to resort to painting the arms three or four times a year. The signal engineer of the road is reported as greatly pleased with the results of the experiment, which seem to justify its continuance as standard practice, for the reason that under all varieties of background the arm so prepared presents a more distinct aspect, which consequently is favorable to the runner. While the first cost is comparatively high, the results indicate that the reduction in maintenance will more than offset this and make the gold leaf arms cheaper in the long run.

Locomotives with Schmidt Superheaters.—On December 2, 1908, there were 1,898 locomotives in actual operation and 1,743 in course of construction, fitted with Schmidt superheaters. These are distributed over 101 different railway systems. Among the American railways participating are the Canadian Pacific, 33 locomotives; Great Northern, 2 locomotives; Chicago, Burlington and Quincy, 2 locomotives; Northern Pacific, 1 in operation and 2 on order; Pennsylvania, 1 ordered; making a total of 41 locomotives.

# DATA OF SPECIAL INTEREST TO THE DRAFTING ROOM

## PROCESS FOR SQUARING MENTALLY.

*(Furnished by W. E. Johnston, Nor. Pac. Ry., St. Paul, Minn. Taken from Robinson's "Higher Arithmetic," page 236.)*

Rule:—Add to, and subtract from the number (a) to be squared, a number (b) whose square is known and which will make the sum (a + b) or the difference (a — b) a multiple of ten so as to be a convenient multiplier. Multiply this sum by the difference, $[(a+b)\ (a-b)$, and add the square $(b^2)$ of the number added and subtracted. The result $(a + b)\ (a - b) + b^2$ equals the square $(a^2)$ of the number as desired.

For $(a + b)\ (a - b) = a^2 - b^2$

Therefore $(a + b)\ (a - b) + b^2 = a^2 - b^2 + b^2 = a^2$

Arithmetical example:—

(1) $89^2 = (89 + 11)\ (89 - 11) + 11^2$
$(100 \times 78) + 121 = 7921$

(2) $56^2 = (56 - 6)\ (56 + 6) + 6^2$
$(50 \times 62) + 36 = 3136$

(3) $21\frac{1}{2}^2 = (21\frac{1}{2} - 1\frac{1}{2})\ (21\frac{1}{2} + 1\frac{1}{2}) + 1\frac{1}{2}^2$
$(20 \times 23) + 2\frac{1}{4} = 462\frac{1}{4}$

(4) $192^2 = (192 + 8)\ (192 - 8) + 8^2$
$(200 \times 184) + 64 = 36864$

## JIB CRANE DESIGN.

*(From Theo. F. H. Zealand, Whiting Foundry Equipment Company, Harvey, Ill.)*

Frequently motive power officials, when contemplating the purchase of jib crane equipment, prefer to submit designs of their own upon which crane manufacturers are invited to offer quotations; often cranes built from the designs thus submitted would be unsafe in the service for which they are intended, the weak member of the design being the jib C.

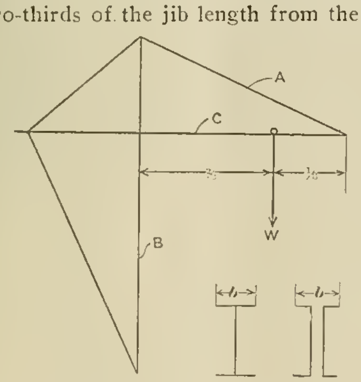
The stresses in this member are imposed as follows:

Bending due to the load W.

Bending due to the weight of the jib.

Compression due to the tension in A.

All these produce compression in the top flange of the beam C, which compression is a maximum when the load is placed approximately two-thirds of the jib length from the mast B. These




calculations are usually made with sufficient accuracy but, when choosing the size of the beam or channel for the jib C, no account is taken of the tendency of the top flange of the beam to deflect laterally due to the compression. To guard against this the allowable compressive stress in this member must be reduced, necessitating the use of a larger size beam than would otherwise be required.

The allowable compression per square inch of cross sectional area is given by the following empirical column formula, where *l* equals the length of the jib from the mast to the extreme end and *b* equals the flange width of the beam, both dimensions expressed in inches; the working compressive stress used throughout the design being 10,000 pounds per square inch:

$$P = \frac{11250}{1 + \frac{l^2}{3000\ b^2}}$$

P is the allowable compression per square inch in the top flange.

No claim is made to originality in connection with the formula given. It is to be found in any good structural steel handbook, as

$$P = \frac{18000}{1 + \frac{l^2}{3000\ b^2}}$$

giving a reduced allowable stress corresponding to a working stress of 16,000 pounds, as used for quiescent loads.

## ARCS EQUAL TO STRAIGHT LINES.

*(Furnished by W. E. Johnston, Nor. Pac. Ry., St. Paul, Minn. From "Elementary Mechanism" by Stahl and Woods, pages 75-76. Rankine's Methods.)*

1.—To find a straight line whose length is equal to a given arc of a circle.

Let AB be the given arc. Draw AC tangent to the arc at A,

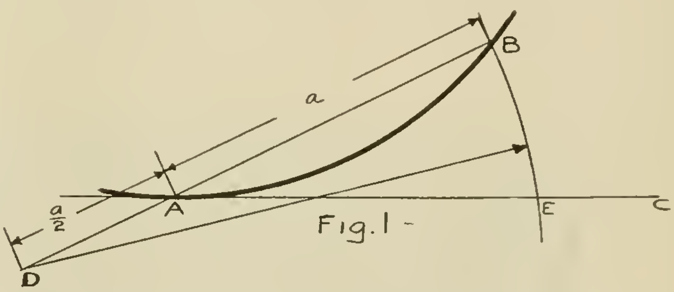



Fig. 1

also draw the chord AB and extend it to D, making AD equal to one-half of the chord AB. With D as a center and DB as a radius, draw the arc CE intersecting the given circle AB at the point E. Then the arc AE equals the line AC.

2.—To find an arc of a given circle whose length is equal to a given straight line.

Let AB be the given circle and AC the given line. Lay off AD equal to one-fourth of AC. With D as a center and DC as a

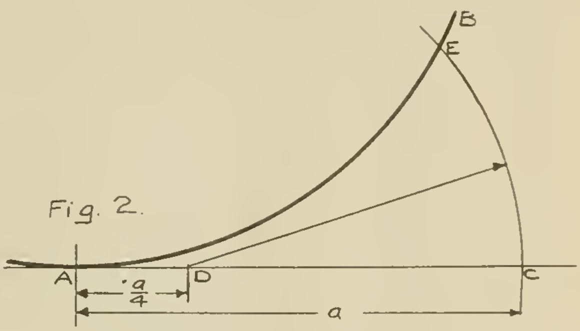
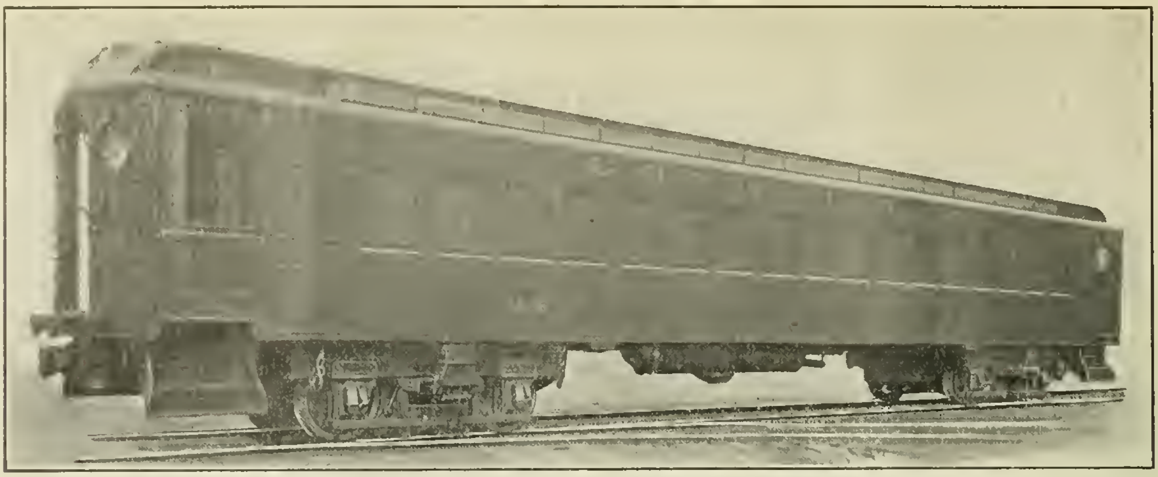



Fig. 2.

radius, draw the arc CE intersecting the given circle AB at the point E. Then the arc AE equals the line AC.

The error in each of the above methods is about 1/900 when the arcs AB and AE in Figs. 1 and 2 respectively are 60°, and varies as the fourth power of the angle so that the error at 30° is about 1/14400, the line being shorter than the arc.



ALL-STEEL SUBURBAN CAR—LONG ISLAND RAILROAD.

## ALL-STEEL SUBURBAN CARS.

LONG ISLAND RAILROAD.

The Long Island Railroad is putting into service the order of fifty all-steel suburban cars, which it recently received from the American Car and Foundry Company. These cars represent the latest development in equipment of this class and are excellent in every particular. While they were designed for and can easily be adapted to electric service, they are for the present to be used in steam service and are being operated out of the Long Island City terminal.

As can be seen by the illustrations, they are of the standard design for all-steel passenger equipment adopted about a year and a half ago by the Pennsylvania Railroad, which was described and illustrated in the June and July, 1907, numbers of this journal. Reference can be made to those issues for drawings and photographs of all details. The theory on which the designs were based has been fully treated in the series of articles on "Steel Passenger Equipment," by Messrs. Barba and Singer, which has been running in these columns during the past year. Reference can be made to the December, 1907, and June, 1908, numbers for discussion on the design of underframe for suburban cars of this class.

In brief, the structure consists of two 9-in., 15-lb. channels, with a ¼-in. cover plate on top and ⅜-in. plates on the bottom, forming a box girder center sill. The side sills are 5 x 3½-in. angles and transfer the load of superstructure and one-half the lading to the center sills through four special cantilevers, two of which form the body end sills and the others, of heavier construction, being located at the proper points between the center plates. No bolsters are provided, the center plates, which are of a special extension design to reach the same trucks used on heavier equipment, being secured directly to the bottom of the center sill girder. Cross bearers are provided between the sills for horizontal stiffeners, but do not assist in carrying the

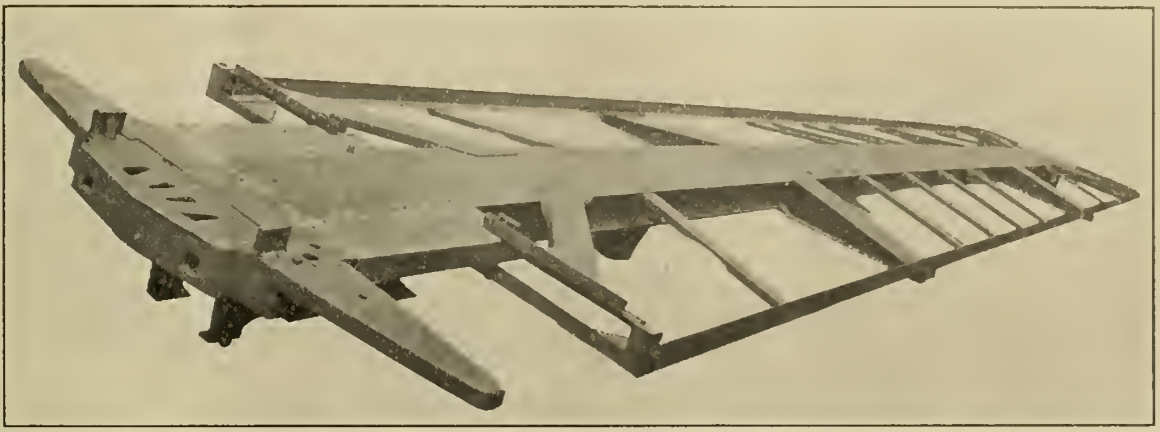
INTERIOR OF ALL-STEEL SUBURBAN CAR—LONG ISLAND RAILROAD.

load coming to the side sills or on the floor. The main side posts are of pressed steel in channel section, with the edges flanged out parallel to the web and riveted to the sheathing. The upper ends are narrowed down and curved inward, forming the lower deck carlines. The upper deck carlines are of the same section. The inside and outside sheathing, roof, etc., is of steel sheets of varying thickness. A combination deck sill and plate of special flanged shape, stiffened by malleable iron posts is an interesting feature of the roof construction. All mouldings for interior finish are pressed steel as are also the guides in the window frames. The window sashes are wood, but the frames are flanged steel in one piece. The floor is formed of plastic cement laid on corrugated steel plates.

The interior finish is unusually attractive, the color being a warm tone of green relieved by a small amount of border stripping. The seats are of the Hale & Kilborn walk-over type with steel frames, wooden arm rests and rattan covering. Hand holds are formed in the outer corner of the backs. A continuous basket rack of substantial design has been provided. All doors are of the sliding type, the vestibule doors being operated by the guard standing on the buffers between the cars. A trap door and step are provided for use where there are no raised platforms.

The trucks are of special design and are arranged for the easy installation of motors. They were fully illustrated and described on page 237 of the June, 1907, issue of this journal. The trucks under these cars differ from those illustrated in having quadruple instead of sextuple elliptical springs under the bolster. They have 36-in. wheels and a 7-ft. wheel base.

The cars have a length of 54 ft. 5¼ in. over the body and 64 ft. 5¾ in. over buffers. They weigh 77,100 lbs., which, of course, is without any electric equipment.



UNDERFRAME OF STEEL SUBURBAN CARS FOR THE LONG ISLAND RAILROAD.

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Keep in Touch With Progress.—He who would seek to develop his capabilities to the fullest extent and keep that proper pace with progress, absolutely required for the continuation of success, should read carefully the literature of the profession. It is as necessary for the successful railroad officer to follow the changed conditions surrounding railway practices, and to know the new and advanced ideas and physical improvements as it is for the lawyer or doctor to do so in his profession. The railway and engineering periodicals and certain books on railroad subjects are the most valuable aid to him and should be freely used. They contain everything that is current and information pertaining to all departments so that a man may inform himself fully as to not only the work of his own department, but as to that of other departments.—*W. J. Harahan, before the New York Railroad Club.*

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Large Saw Mill.—A saw mill at Bogalusa, La., belonging to the Great Southern Lumber Co., has a capacity of 600,000 ft. of sawed lumber boards per day. This is sufficient to build a little town of 40 houses in addition to a good-sized church and a school house.

## AN AIR AND STEAM SUPERHEATER FOR LOCOMOTIVES.

The New Century Engine Company, Ltd., London, is introducing an apparatus for the purpose of combining and superheating air and steam for use on a locomotive, which has been devised by Messrs. Field & Morris and is illustrated and described in *The Engineer.* This apparatus consists of two air compressors which are attached ahead of the cylinders and operated by an extension of the piston rod, or can be operated by connection to the cross head, and furnish compressed air at boiler pressure. A relief valve is provided to prevent excess of pressure. This compressed air is fed into a superheater of practically the Pielock design, except that it is located in the front end and adjacent to the front flue sheet, the boiler tubes being extended to pass through it. The steam from the dry pipe enters near the same points as the air and in passing through the baffles of the superheater they are thoroughly mixed and superheated.

This apparatus has been given a very thorough test on the North British Railway and has indicated a very substantial economy in coal consumption. This economy is explained in two different ways, one being that the air forms an envelope around the steam particles and thus resists the tendency to condensation as the temperature and pressure falls during expansion. Another explanation is that the compressed air itself contains considerable heat and since its temperature is higher than the steam at the same pressure it exerts a superheating action to some degree which allows the superheater itself to give a much higher degree than it would give with steam alone.

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Instrument for Measuring Color.—The difficulty of maintaining a standard by which colors for car bodies, etc., can be accurately gauged is easily understood and an instrument for performing this service has been invented by Frederick E. Ives and is in use in the Arthur D. Little Laboratory in Boston. This instrument is called a colorimeter, and is arranged to give a scale reading. After the standard shade has been determined, a board is carefully painted in the same manner as the paint will be used in practice and the color measured by the instrument, which thus gives a scale reading. This reading being recorded, the same color can be duplicated at any time by preparing sample boards which will be correct only when the instrument will record the same reading as was originally given as the standard. The same procedure is, of course, possible for determining the exact shades of different components which go to make up the composite color desired.

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Air Compressors in Roundhouses.—The air compressor should have a capacity of about twenty cubic feet of air per minute per engine house pit, delivering the air into a receiver or reservoir at a pressure of one hundred pounds per square inch.—*R. D. Smith before the New England Railroad Club.*

# ARTICULATED COMPOUND LOCOMOTIVES

American Society of Mechanical Engineers.

At the annual meeting, held in New York, December 1 to 4, C. J. Mellin, member of the Society and consulting engineer of the American Locomotive Company, presented a paper on the above subject, which was discussed by a number of the best-known locomotive experts. Mr. Mellin stated in part:

"The constantly increasing demand for heavier power, made by most railways in the country during the last decade, and especially by those roads having heavy gradients combined with sharp curves, brought out various designs which on account of rail pressure limitations required so many coupled wheels that the length of the rigid wheel base made them unwieldy to operate with efficiency. This demand for greater power was, of course, greatest in mountain districts where heavy grades and sharp curvatures generally go together, necessitating, for safe operation, comparatively short wheel bases, reduction in engine resistance and wear of wheel flanges and rail, together with moderate weight of the working parts of the engine.

"In striving to meet this demand the locomotive designers and builders were brought face to face with an unsurmountable barrier to further progress in the enlargement of engines on the old lines; and in 1902 the American Locomotive Company decided to work out a design of a heavy, powerful locomotive for the Baltimore & Ohio Railroad, having two sets of engines under one boiler, capable of adjusting themselves independently to the alignment of roads with curvatures up to 30 degrees, on the principle developed by the prominent French engineer, M. Anatole Mallet, of Paris.

"Mr. Loree, then president of the Baltimore & Ohio Railroad, considered the question seriously; but it was first thought that it would be of no advantage to the Baltimore & Ohio Railroad, even if it proved successful, and the subject was left undecided for some time. In the latter part of 1903, on the recommendation of Mr. J. E. Muhlfeld, who in the meantime had become general superintendent of motive power, the Baltimore & Ohio ordered one engine of this type,* which was built at the Schenectady Works of the American Locomotive Company during the winter of 1903 and 1904, to suit the conditions of that railway.

"The Mallet articulated arrangement presents the advantages of enormous tractive power concentrated in the combination of the two sets of engines, with practically no increase in the individual weights of the moving and wearing parts over those of engines of the ordinary types; double expansion of the steam; simplicity and ease in operation and a short rigid wheel base, with the weight distributed over a long total wheel base, resulting in the greatest flexibilty and ease on track and brdges. It was also found possible at the very first to provide an engine under the control and operation of a single crew, having double the power of the largest engines of the ordinary type.

"Opinions on the use of a truck in the articulated engine are, however, divided, but, because of the many objections connected with the application of a front truck in freight service as to the first cost, maintenance, dead weight and unfavorable distribution of the machinery sometimes causing serious obstructions, nothing is gained by this objectionable feature, as it is practically the same as putting a truck ahead of a truck.

"The front engine in going ahead being a truck in itself, the first pair of drivers have a leverage in their favor on entering the curve. The reason for this is that the virtual support of the weight of the rear system, which is carried by the front system, falls back on the latter and in the rear of the sliding bearing; thus allowing a great part of the load of the rear engine to be carried by the hanger bolts between the frames.

"This alone reduces the pressure very materially on the sliding plate, which together with the short arm for friction resistance and long guiding arm for the flanges, reduces the pressure on them to a small fraction of the total friction load on the sliding plate and comparatively light centering springs will therefore suffice for this purpose and still further reduce the flange pressure.

"These same leverages and resistances act equally favorably in backing, as it is simply a reverse operation and the rear drivers have to swing the boiler against these resistances. Therefore, it is important that these should be small and with the shortest possible leverage, which naturally also minimizes the flange pressure on the rear wheel, that is, the last wheel of the engine, which then has to do the guiding.

"With the use of a front truck, the center of support is shifted forward and with it the virtual and actual supporting points of the weight of the rear engine carried on the front system. The weight on this support, must, therefore, be increased with the carrying capacity of the truck and offer little or no opportunity for transferring any of this load to the hanger bolts, practically doubling both the load on the sliding plate and the length of the resistance arm. At the same time, by the application of a front truck, the guiding point is moved forward so that the leverage has been increased to offset the increased side resistance of the engine. The guiding power of the truck, however, is limited to its swing resistance. This, therefore, may leave as much or more guiding to be done by the front drivers as where no truck is used because of the increased moments of resistance of the engine when curving.

"A more serious matter, however, is the backing with a front truck. The high resistance moments in the front must be overcome by the rear drivers, which are doing the guiding, and it is easy to understand how fast the flange pressure is multiplied by this displacement of the load and the safety margin for derailing dangerously reduced. It is, therefore, evident that a rear truck is a necessity when a front truck is used where backing is to be considered, thus curing one evil with another. Even with the application of a rear truck, the objections caused by the application of the front truck will be only partly compensated for; as the following very essential objections still remain:

*a.* The application of a front truck increases the distance of the front buffers from the first pair of drivers by 15 to 20 per cent., and consequently throws the front drawhead of the engine further from the center of the track in curves than with shorter extensions where no front truck is used.

*b.* It increases the total wheel base of the engine about 8 ft. 6 in., requiring an 80 ft. turn-table to take an average sized engine with its tender.

*c.* Additional dead weight to be carried by the truck must be provided and the expenses in maintenance and first cost by the use of it are items that should not be overlooked.

*d.* The long arms for friction resistance on the sliding plate with increased load on them, due to the front truck, will not be lessened by the application of a rear truck.

*e.* When only a front truck is applied, the boiler is necessarily moved so far forward that it leaves scant room for the valve motion on the rear engine. The result of this is that the width of the firebox is necessarily limited to about 72 in.

"In the case of the passenger engines of the articulated type, however, large wheels would be used, and only four pairs of drivers can or need be applied. A four wheel front truck, with rigid center pin and rigid trailing wheels, works in conveniently in the place of a third pair of drivers in each engine front and rear, respectively, which otherwise, with their large diameter, would make the engine unduly long.

"Among the various differences between this class of engines and that of the ordinary type, is the action of this engine when

* See American Engineer, June and July, 1904, pages 237 and 262.

loaded to the slipping point. While the former is less liable to slip than the latter, due to a more uniform pressure on the pistons, they will not be considered loaded to anywhere near their capacity until slipping takes place, and consequently slipping does occur on heavy grades. With the ordinary engine, slipping at such times is a serious matter, as the train is losing speed and may stall on that account after a few repetitions. In the case of the articulated engines, the loss in power by the slipping of one engine is practically gained by the other in the increase of unbalanced pressure that thereby results.

"The effect on cars and draft gears in starting heavy trains by this type of engine, as well as convertible compound engines on the same principle, is a most important feature, as it is accomplished with a so-called dead pull, without the necessity of taking advantage of the slack in the train with its destructive jerks. These locomotives are, therefore, easier on the draft gears than simple engines of half their size loaded to their full capacity. The reason for this is found in the great starting and emergency power, with which these engines are provided, so that the slack is taken up under very slow speed. This is generally done with light throttles. The front cars start successively under a slight acceleration of the engine, gradually going over to a retardation before the last cars get into motion, after which the engine is given full throttle. In other words the train is stretched first and then it is started under direct pull, so that there need not be any but slight shocks or jerks.

"These engines are adaptable to a greater variety of conditions than the older types, rendering it possible to double the engine power on a given rail weight; and their advantages are most pronounced as displayed on heavy grades and sharp curvatures.

"It should also be remarked that, due to the absence of jerks and slack in starting, as well as the more uniform cylinder pressure, the stresses on the machinery and framework are considerably reduced; and, further, that the milder exhaust produces a less intense heat and a better utilization of it, all of which contribute to a reduction in the repairs of the locomotive as a whole, compared with a simple engine, if it were practical to construct one of this type. This has never been advanced as a feature to the credit of the articulated engine because it is difficult to give it any definite value; but is referred to as a reply to the often repeated supposition that these engines are hard to keep in repair. As a matter of fact, the opposite is the case, because on account of sub-division of the work in two engines the parts are lighter and easier to handle in repairs and renewals."

The paper also discussed briefly the distribution of weight in an articulated locomotive, which subject will be fully treated in a special article in the next issue of this journal. There was also included illustrations and descriptions of details of various locomotives that have been built, most of which have been illustrated in these columns. A number of proposed designs, for both passenger and freight articulated locomotives, were included, as well as photographs and general dimensions of all of this type of locomotive that has been built in this country.

DISCUSSION.

In opening the discussion F. J. Cole analyzed the features of construction which differentiate the Mallet from other types and enables it to perform satisfactorily and efficiently its remarkable work in Europe and this country. Among these he mentioned the short rigid wheel base, the fact that the flexible steam connection has only to carry low pressure, the practical impossibility of both engines slipping at the same time and the extreme flexibility of the machine. The possibilities of the designing of enormous locomotives with a reasonable axle load was commented upon and tables given. He mentioned the surprising ease with which these engines were fired and attributed it largely to the use of compounding, which reaches its maximum efficiency at slow speeds and long cut-offs. He stated that, "in ordinary service, especially for helping and pushing, the use of leading truck wheels is entirely unnecessary. It is of great advantage to utilize the entire weight for adhesion and no useful purpose is served by adding the additional complication of truck wheels. No sharp flanges have developed on the Baltimore & Ohio locomotive after four years of service, although this locomotive is operated twenty-four hours a day pushing up hill and backing down over sharp curves. In comparison with ordinary consolidations in use on this road, which do wear their flanges badly, this fact is extremely gratifying, and proves conclusively that the extreme flexibility of this engine is sufficient in itself to move freely around curves without the use of guide wheels. * * * * Except for the possible use in road service, where the speeds exceed 40 or 45 miles per hour and the requirements from the boiler are such as to render it impossible to utilize the entire weight for adhesive purposes, the employment of leading or trailing wheels does not seem to be necessary and it seems to me that the principle justification for their use may be found in cases where the extreme boiler capacity is required and that under such conditions only will their use be justified."

Harrington Emerson stated that a few years ago Bion J. Arnold had remarked that there was no known way of moving freight as cheaply as putting a steam locomotive ahead of the train. In connection with the contention of the electrical engineers during the past few years, who had attempted to prove their case by assuming ideal conditions for electric traction and that the current locomotive practice was the best attainable, he remarked that two things had put the electrification far into the future, one was the panic, which reminded railroad managers very forcibly of the financial situation and the other was the Mallet type of locomotive. He related a few instances in connection with the large Santa Fe type of locomotives which, while operating most economically, had so long a wheel base as to cause considerable trouble with the track, and said that the Mallet type would give all, and more, advantages than the Santa Fe and at the same time would correct the trouble with the long wheel base.

L. R. Pomeroy considered briefly the commercial side of the introduction of the Mallet type of locomotive, which in a number of special cases had proven to be the remedy for present conditions that it has previously been believed could only be improved by the substitution of electric traction. He took up a special instance of a 50-mile mountain section, having a maximum grade of 2.2 per cent., with seven trains per day in each direction. The reduction of one-half in train mileage, with the same tonnage, at 50 cents per train mile, this rate covering the items directly affected and used in computing the saving to be advantageous in grade reduction, would save $65.000 per year, which capitalized at 6 per cent. would equal $1,000,000. In order to obtain this saving electrically the complete electric apparatus would cost considerably more than this capitalized amount, whereas the required number of Mallet compound steam locomotives to perform the service would cost about one-third the amount necessary for an equivalent electric service. Stating the case in another way and basing the saving on the reduction in train crew expense, leaving out all other advantages, it is seen that with a total of 14 trains, which is equivalent to about 700 train miles per day, the cost of the train crews amounting to 12½ cents to 15 cents per train mile, the saving then, in reducing the train mileage one-half, would equal $17,800 per annum, which at 6 per cent. is a capitalization of about $300,000, or more than enough to pay for the required number of Mallet locomotives to perform the service.

This is not meant to be a reflection upon the possibilities of electric traction in general, but was simply a particular case, which was not at all unusual, where the magnitude of the business would not justify an electric proposition, but where the Mallet locomotive could obtain all of the savings that electric traction would obtain on a larger basis, and would serve as a very profitable bridge between the present conditions and the eventual traffic density where electric service would be advisable.

George L. Fowler, on request of Dr. Goss, drew attention to the credit that is due Mr. Mellin for developing Mallet's engine, which was originally designed for narrow-gauge lines and was of light weight, into the enormous and powerful machines that are now being built on this principle.

G. R. Henderson briefly drew attention to the fact that in order to obtain the full advantage of these large locomotives it would

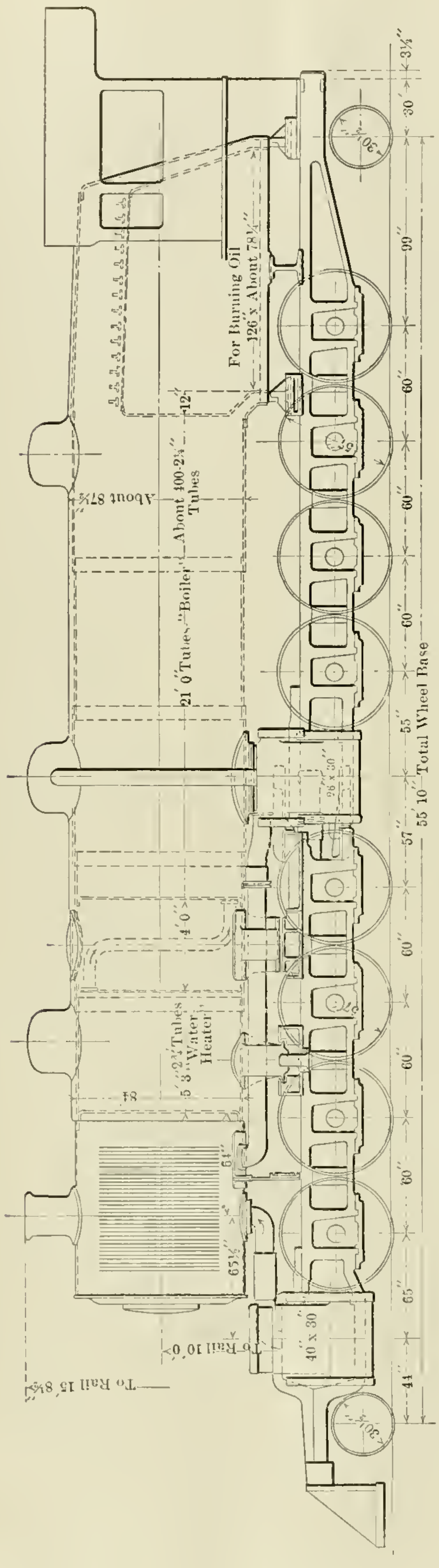
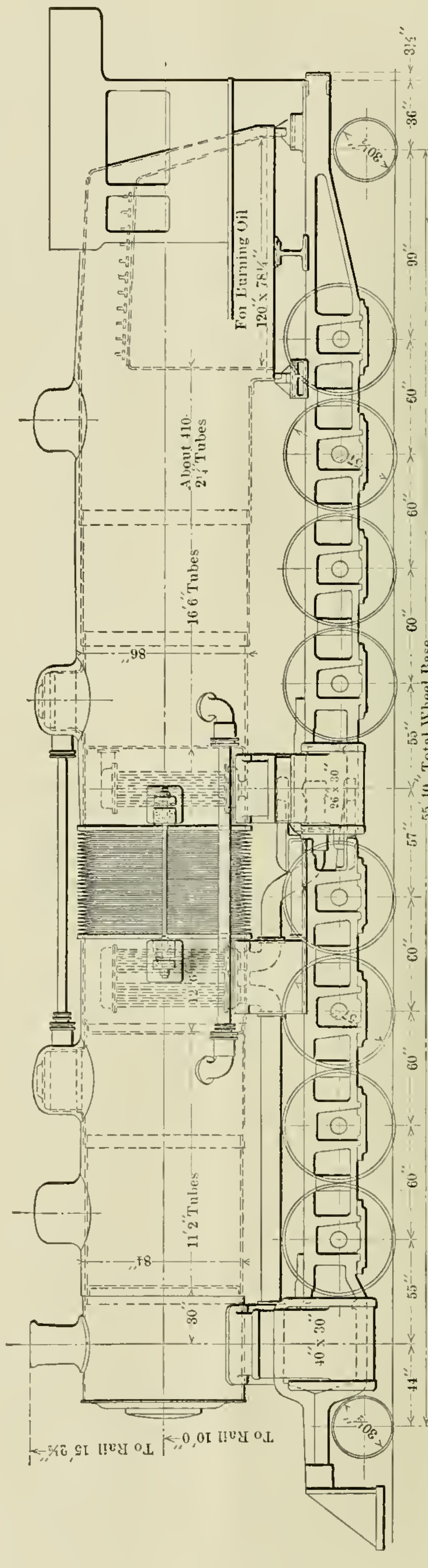
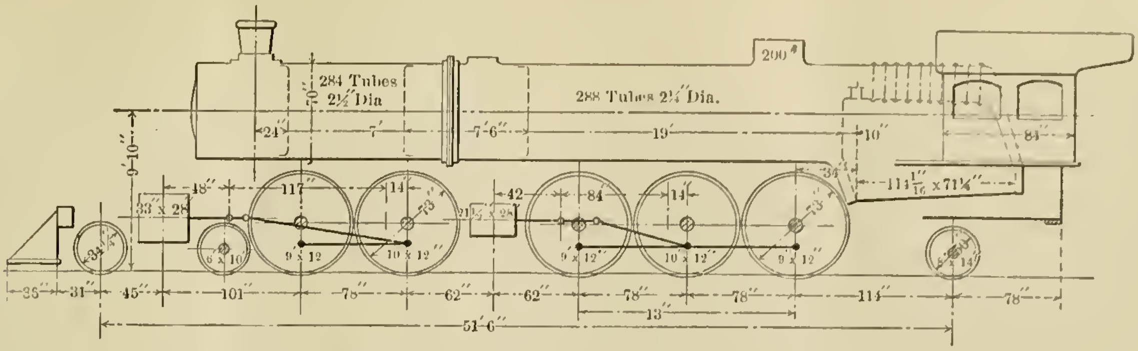


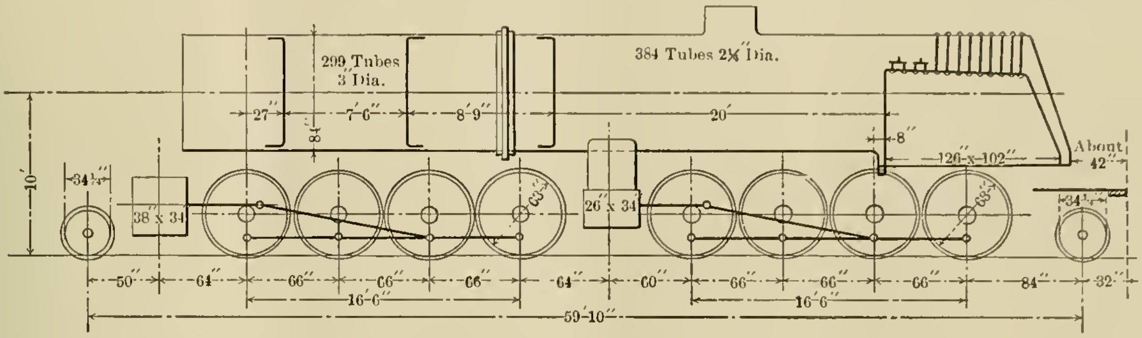

DIAGRAM OF ARTICULATED COMPOUND FREIGHT LOCOMOTIVES NOW BEING BUILT FOR THE SOUTHERN PACIFIC COMPANY BY THE BALDWIN LOCOMOTIVE WORKS.




DESIGN FOR ARTICULATED FREIGHT LOCOMOTIVE WITH FLEXIBLE BOILER, PROPOSED AND DESIGNED BY S. M. VAUCLAIN OF THE BALDWIN LOCOMOTIVE WORKS.




ARTICULATED COMPOUND PASSENGER LOCOMOTIVE FOR THE SANTA FE, UNDER CONSTRUCTION AT THE BALDWIN LOCOMOTIVE WORKS.




ARTICULATED COMPOUND FREIGHT LOCOMOTIVE FOR THE SANTA FE, UNDER CONSTRUCTION AT THE BALDWIN LOCOMOTIVE WORKS.

be necessary to give careful attention to the development of automatic stokers.

S. M. Vauclain, general manager of the Baldwin Locomotive Works, discussed the subject at some length by means of a large number of lantern slides. He showed a photograph of Monsieur Mallet and spoke most highly of his great ability as a designer and expressed regret that owing to the expiration of patents, etc., he would not receive the pecuniary returns which by right should be his. Mr. Vauclain briefly followed the early history of this type of locomotive, showing drawings of the DeCauville Railway locomotive, which he believed to be the first one of the type ever publicly exhibited. He stated that it was in 1877 that Mallet first designed an articulated compound locomotive.

Lantern slides were then shown of a design which was submitted in 1898, by the Baldwin Locomotive Works, to the Erie, but was not accepted. Following this a large number of slides were shown of outline diagrams of studies which had been made for locomotives of this type for use on the Santa Fe. These studies included a great variety of arrangements of cylinders, combustion chambers, re-heaters, feed water heaters, etc., and all of them, except the first, included a leading pony truck and most of them also had a trailing truck. This series of studies was completed by the design of freight and passenger locomotives which are shown in the above illustrations and are now under construction at the Baldwin Locomotive Works. It will be seen that in both of these the boiler proper, with the ordinary firebox and 19 and 20 ft. tubes, ends in a large combustion chamber, ahead of which the shell is continued and tube plates, with a nest of large tubes, are arranged to form a feed water heater, ahead of which is the front end with the exhaust pipe and stack. In the combustion chamber is to be located a superheater, or a re-heater, or possibly both, and the boiler shell is arranged to be easily disconnected at this point for inspection and cleaning of the apparatus. The freight locomotive is of the 2-8-8-2 type and has 63 in. drivers with a 34 in. stroke, the cylinders being 26 and 38 in. in diameter. The passenger locomotive is of the 4-4-6-2 type, with 73 in. drivers.

Following this series of studies, examples were shown, by means of drawings and photographs, of other articulated compound locomotives built by the Baldwin Locomotive Works during the past few years, all of which have been illustrated in these columns.

Mr. Vauclain then showed a series of diagrams illustrating the development of a design of articulated compound locomotive for the Southern Pacific. This started out with a desire to apply the principle to a tank locomotive which would carry its coal and water on the locomotive frames. This however, was finally given up as impractical and after several different steps the design shown on the opposite page was accepted and two of this arrangement are now being built at the Baldwin Works. It will be seen that this is somewhat similar to the Santa Fe freight locomotive, the wheel arrangement being the same, but that the reheater is located in the front end proper, the combustion space being considerably shorter, as is also the feed water heater. In this case the boiler is not arranged to be disconnected at the combustion chamber, but a manhole is fitted for admission to this space from the top. These locomotives have 57 in. drivers and a 30 in. stroke, the cylinders being 26 and 40 in. in diameter.

Mr. Vauclain then threw a design on the screen, which he presented as a proposed arrangement of what he guaranteed would be an entirely satisfactory design for a heavy freight locomotive. This design is also shown on the opposite page. In it there is introduced an entirely new and novel feature and idea; that is, of having a flexible boiler as well as an articulated frame, so that there would be no necessity for the front group of frames to move relative to the boiler in taking curves. Mr. Vauclain is willing to back up this design to the fullest extent. The illustration shows the general features very clearly and it will be seen that it includes both a superheater and a reheater, located in a large combustion chamber, at which point the bellows connection is also placed, and it has the low pressure cylinders attached to the front end in the ordinary manner.

The remarks of the speaker were closed by showing some foreign locomotives of small size which had been equipped with front and trailing trucks.

Mr. Vauclain also briefly referred to a discussion on the paper that had been furnished by Mr. Emerson of the Great Northern Railway, which will be printed in full in the proceedings of the society. Mr. Emerson confined himself to a report of the service that the locomotives on his road, which now number about 68 of two sizes, had given during the past two years. This experience was so favorable that it has been decided to extend the use of this type of locomotive to districts having grades as low as .72 per cent.

On the Cascade division of that road, where the ruling grades vary from 1 per cent to 2.2 per cent the service had previously been performed by consolidation locomotives having 20 x 32 in. cylinders, 55 in. drivers, 210 lbs. of steam and weighing 180,000 lbs. on drivers.

"In the beginning the large Mallets were first introduced on the hill between Skykomisk and Leavenworth on the Cascade division with a consolidation engine used as road engines and the L1* helpers used on the hill only. Up to the present time the tonnage over these mountains has been gradually increased from 1050, with two consolidations, to 1600 tons now being hauled with the L1 engines. The L1 engines have now entirely replaced the consolidation engines and it is the practice to start out from Everett with one L1 engine used as a road engine, taking 1600 tons as far as Skykomisk, over a ruling grade of 1 per cent. At Skykomisk another L1 engine is put on as a pusher and takes the 1600 ton train over the mountain. The tonnage hauled in the opposite direction is the same and the L1 Mallet has proven itself to be not only valuable for helper service but a good reliable road engine and the combination of road and helper service works out admirably on this division, making it unnecessary, going east, to reduce the tonnage at Skykomisk in order to get over the heavy grade. Recent performances show that on a round trip over this division the L1 engines hauled 1600 tons with a total consumption of 43.8 tons of coal, equivalent to 25.13 lbs. of coal per 100 ton miles. The consolidation engines could only handle 1050 tons, with practically the same amount of coal consumed, equivalent to 38.29 lbs. of coal per 100 ton miles. In other words the tonnage on this division has been increased at least 52 per cent with the result due to the Mallet engine of a saving of 34.39 per cent lbs. of coal per 100 ton miles.

"Since putting the L1 engines in road service the performance has been so satisfactory that there are now but four of them used exclusively as pushers, two as helpers over the Cascade mountains and two on the Butte division in transfer service.

"On the Spokane division the 1600 tons delivered at Leavenworth is reduced to 1450 tons and a small Mallet, class L2,† takes this train to Hillyard, a distance of 195 miles. These engines have enabled us to increase the tonnage from 1100 tons hauled by the consolidation to 1450 tons, an increase of 31.8 per cent. The run is so long that this tonnage has been established in order to get the trains over the district in a reasonable time and they handle the tonnage at from eight to ten miles per hour on the heaviest hills and up to 30 miles per hour where the grades are not so heavy. The engines are run straight through but crews are changed half-way at Wilson Creek.

"The performance for the year ending June 30, 1908, shows 22.04 lbs. of coal per 100 ton miles on this district, a saving of 27.5 per cent. over the consolidation.

"On the next division east the L2 engine takes a train of 1700 tons from Whitefish to Essex, where the ruling grade is .8 per cent. At this point an L1 helper is put on to assist the train to Summit, a distance of 18 miles, where the ruling grade is 1.8 per cent. West bound an L2 engine takes a train of 1450 tons through, the ruling grade being 1 per cent. On this district the tonnage has been increased 20 per cent, with a reduction of coal per 100 ton miles of 20 per cent. In the next district, from Cut Bank to Havre, a distance of 125 miles, with a ruling grade of .8 per cent, an L2 engine takes 1700 tons over the division. West the ruling grade is 1 per cent and this engine handles 1450 tons. The round trip on this division, with the L2 engine, is made with 32 tons of coal, or an equivalent of 15.75 lbs. of coal per 100 ton miles. The consolidation previously used handled but 1200 tons west and 1425 tons east and used 18.9 lbs. of coal per 100 ton miles, showing an increase of 20 per cent in tonnage and a decrease of 16.6 per cent. in coal per 100 ton miles.

"At another point, where the ruling grade is 2.2 per cent, the L2 engines have increased the tonnage previously handled by the consolidations from 550 to 700 tons.

"The question of maintenance we would naturally expect to be higher on the Mallet engines and for the year ending June 30, 1908, the cost of repairs on the L2 class was 10.47 cents, which is not considered at all excessive. The cost of maintaining the consolidation engines in the same service has seldom been less than 8 cents per mile.

"Another feature which has been noticed is that the Mallet engines are not at all hard on draw bars, owing to the fact that the train is not jerked by the engine slipping and catching, since both engines do not slip at the same time. The tire wear on these engines is very light and the flange wear is not excessive. In fact the Mallet engines have been put on some divisions where the flange wear on the consolidations was very bad and no wear has been noticed on them.

"We still have in service two of the first L1 Mallet engines which have never yet been in the shop for general overhauling. in fact have never been off their wheels and have been in continual service since October, 1906."

* Large type Mallets. See AMERICAN ENGINEER, Oct., 1906, page 371.
† Small type Mallet. See AMERICAN ENGINEER, June, 1907, page 218.

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COPPER SAFE-ENDS FOR FLUES.—Extensive experiments have been made attempting to use copper flues and iron flues with copper safe-ends; brass flues have also been tried, but it appears that the most serious problem is to prevent the rapid destruction of the beads on account of the abrasive action of the fire-box gases and cinder. This was very well proven in a recent experiment on the Norfolk & Western Railway by putting copper safe-ends in a consolidation freight engine equipped with the reinforced flue sheet (see AMERICAN ENGINEER, June, 1908, page 207). The engine ran but a short time before the flues began to leak, which condition became continuous, the engine seldom going through a terminal without requiring attention. The heads were finally entirely burned off, and the ends of the flues were reduced to practically a knife-edge. The engine was finally withdrawn from service on this account, the flues having made but 9,189 miles, which is about one-fourth of the mileage we should expect to get with iron or steel.—*Alexander Kearney, assistant superintendent motive power, Norfolk & Western Ry., before the Richmond Railroad Club.*

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TIMBER WASTE IN U. S.—We are now cutting timber from the forests of the United States at the rate of 500 feet board measure a year for every man, woman and child. In Europe they use only 60 board feet. At this rate, in less than thirty years all our remaining virgin timber will be cut. Meantime, the forests which have been cut over are generally in a bad way for want of care; they will produce only inferior second growth. We are clearly over the verge of a timber famine. This is not due to necessity, for the forests are one of the renewable resources. Rightly used, they go on producing crop after crop indefinitely. The countries of Europe know this, and Japan knows it; and their forests are becoming with time not less, but more, productive. We probably still possess sufficient forest land to grow wood enough at home to supply our own needs. If we are not blind, or wilfully wasteful, we may yet preserve our forest independence' and, with it, the fourth of our great industries.—*Treadwell Cleveland, Jr., U. S. Forest Service.*

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HONESTY.—What may be designated as the first element, or rather, essential, of success, is common honesty. To state the old maxim: "Honesty is the best policy," is but to reiterate a truism, and to repeat parrot-like the principle that has stood the test of ages. There is, however, a broader honesty than that apparent on the surface, that is a requirement. This consists not entirely in the application of the Commandment, "Thou shalt not steal," but seeks also for its guiding principle the "Golden Rule." In other words, a studious and persistent effort to render just and fair treatment to all alike whether he or it be great or small.—*W. J. Harahan, before the New York Railroad Club.*

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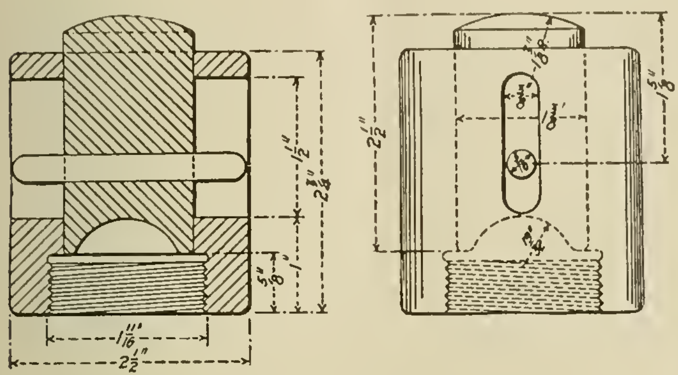
At Altoona, Pa., telephones have been installed in the homes of 517 trainmen of the Pennsylvania Railroad, and all of the trainmen and yardmen of the Middle division are now called to service by telephone, instead of by messenger as formerly. Fifteen callers have been appointed to other positions.

## APPLYING FLEXIBLE STAYBOLTS.*

By R. V. Anderson.

One of the most important jobs on a locomotive boiler is the proper application of flexible staybolts. Every part of the work has to be carefully performed to be successful. The method used at the Rogers Locomotive Works, which has been very successful, is as follows:

The holes in the sheet are punched 1/32 inch smaller than the diameter, of the root of the thread at the point of the sleeve, and reamed with a taper reamer that has a guide on the point which goes through the firebox sheet. There is a collar fastened on the reamer at the proper place near the head which stops the reamer from going in too far, and allows 3/32 inch for thread, and makes all the holes exactly the same size. The tap has also a guide and a stop on it so the holes are tapped the same. We only use one reamer and one tap in the holes and get a perfect thread. The sleeves are screwed in with a stud nut, driven with a ratchet lever. The bolts are run in with an air drill until they are nearly home, then adjusted carefully by hand, taking care to get an equal load on all the bolts without pulling the firebox sheet out of line.



DEVICE FOR HOLDING ON IN RIVETING FLEXIBLE STAYBOLTS.

While riveting the bolt we have a simple device for holding on which may be new to some of you. It obviates all danger of spoiling the thread on the sleeve. It consists of a nipple which is screwed on to the sleeve, and has a sliding plunger inside which fits on the head of the bolt. The holding on is done by a common holding on sledge which backs up on the outside end of the plunger. An order of 60 boilers for the Wabash Railroad recently completed had 298 flexible staybolts in each, making a total of 17,880 bolts. The inspector would not permit any calking on the sleeves, but only 10 of them had to be renewed because of leaks. The most important thing needed in putting in flexible saybolts is good judgment. You can have your holes perfect, your reamer perfect, your tap perfect, your bolts and sleeves perfect, yet an injudicious or careless workman will spoil the whole job.

* A paper presented before the Master Blacksmiths' Association.

## ANALYSIS OF COST OF LOCOMOTIVE REPAIR SHOPS

George A. Damon, of the Arnold Engineering Company, presented the following analysis of the cost of locomotive repair shops in a paper on "Arrangement of Railroad Shops," read before the Canadian Railway Club:

Our records show that locomotive repair shops which are laid out on a basis of the number of pits required equal to 6 per cent. of the number of locomotives served can be built and equipped complete for an expenditure ranging between $50,000 and $65,000 per pit. If one pit will serve sixteen and two-thirds engines per year, the cost of repair facilities will fall some place between the limits of from $3,000 to $4,000 per locomotive. An investment amounting to the lower limit is absolutely necessary if the engines are to be kept on the road. Just how much more than the lower limit should be spent in order to secure the minimum cost of locomotive maintenance, including all the items of not only actual repair expenses, labor, and material, but also interest, depreciation, insurance and taxes upon the plant provided, is a question that should have the most careful consideration.

The following analysis of the total cost will serve to indicate the relative importance of the decisions that must be reached in order to give each dollar expended a maximum earning capacity.

Table of Cost Limits for Locomotive Repair Shops on the Basis of Twenty-Five Erecting Pits.

| DIVISIONS | Limits of Cost —Per Pit— "Low." | "High." | Approx. Proportion of Tot. Cost |
|---|---|---|---|
| SHOP YARDS | | | |
| Tracks, Crane Runways, Transfer or Turn Tables | $ 1,400 | $ 3,000 | 4% |
| Water and Sewer Systems | 1,000 | 1,800 | 2% |
| Piping and Wiring Tunnels and Tunnel Piping | 500 | 1,000 | 1% |
| BUILDINGS. | | | |
| Machine and Erecting Shop | 8,000 | 12,000 | 17% |
| Boiler and Tank Shop | 3,000 | 5,000 | 7% |
| Forge Shop | 1,500 | 2,400 | 4% |
| Storehouse and Offices | 1,000 | 2,500 | 3% |
| Locomotive Carpenter Shop | 500 | 1,000 | 1% |
| Power House | 1,200 | 2,400 | 3% |
| Oil House and Equipment | 400 | 600 | 1% |
| Miscellaneous buildings: Scrap Bins, Material Sheds, Fences | 500 | 1,000 | 1% |
| GENERAL EQUIPMENT FOR ALL DEPARTMENTS. | | | |
| Power House Equipment | 5,000 | 8,000 | 11% |
| Traveling Cranes | 1,500 | 3,000 | 4% |
| Tool Equipment | 10,000 | 15,000 | 22% |
| Heating System | 1,200 | 2,500 | 3% |
| Power and Lighting Systems, including yard, wiring, and lighting | 1,500 | 4,500 | 5% |
| Plumbing and Lockers | 300 | 1,000 | 1% |
| Air, Water, Steam, and Oil Piping in Buildings | 600 | 1,200 | 2% |
| Incidentals, Organization, and Engineering | 2,000 | 7,000 | 8% |
| | | | 100% |

Note.—These figures do not include items for Real Estate and Preparation of the Shop Site, which cost necessarily varies between wide limits. The Foundry building and equipment are not included in these figures.

The sum total of the "low" and of the "high" figures shown will result in grand totals which will show a wider range than the 33⅓ per cent. variation indicated by unit figures of $3,000 to $4,000 per locomotive, but as it is improbable that any shop would be built using either the lowest or the highest estimate for every one of its parts it will be found that only in exceptional cases will the actual total cost fall outside of the limits first given.

Hardening of Steam Hose.—In the case of steam hose the hardening is caused from the fact that there is too much sulphur in the rubber and vulcanization goes on with the heat from the steam, after you commence to use it. If we could get an exact proportion of sulphur this vulcanization would not go on, but this is a very difficult thing to do. The crude rubber is gathered by natives all the world over, and is taken from trees varying from seven years to ten years old, and if you bought ten tons of rubber, you might have ten different qualities.—*A. D. Thornton, general technical superintendent, Canadian Rubber Company, before the Canadian Railway Club.*

Roller Bearings.—There is almost no limitation for the use of anti-friction bearings, but the possibilities can be better appreciated when it is known that such bearings are sold at prices ranging from 2 cents to $7,500 for a single bearing, and are used to carry loads from a few ounces, running at 30,000 revolutions per minute, to loads of 1,500,000 pounds at 100 revolutions per minute and 250,000 pounds at 500 revolutions per minute.

## SIDE SHEETS OF WIDE FIREBOXES.*

C. A. Seley.

The author prefaced his paper with the following remarks:

"I suppose I ought to make an apology for offering a paper to this club on a matter of pure speculation. I have no data to offer; I built up a theory on a set of conditions which I believe represent the result that we are getting in the life of the side sheets of the modern locomotive. The matter is not new, as it was discussed in the Master Mechanics' Association in 1905, the subject in part being covered by the topical discussion by Lawford H. Fry, of the Baldwin Locomotive Works. There is one paragraph of his paper which I would like to read, part of which I agree with for reasons other than are assigned. He says 'As the water in contact with the side sheets is turned into steam, it must be allowed to rise to the steam space and must be replaced by other waters. The water spaces should be so designed that this natural circulation is aided and that the currents of steam and water impede each other as little as possible. This is secured if the firebox sheets are vertical or with a slight slope outward as they rise from the mud ring, so that the steam can rise along the firebox sheets and the water descend along the outside sheets without mutual interference.'"

* * * * * * *

The life of side sheets in the modern wide-firebox locomotives is a problem that is demanding the active attention of motive power officials because of their decidedly shorter life as compared with side sheets in the older narrow-firebox types. A prominent railway mechanical officer recently stated the matter about as follows: "That the old-style deep firebox with ogee† sides was rather hard on staybolts, but the boxes lasted on an average of from six to nine years. The later wide fireboxes, while easier on staybolts, frequently fail in two or three years." On this showing it was thought that the tendency in firebox design would be towards a modified ogee side with very flowing lines.

The above statement presents an effect and a possible remedy, but does not consider the causes. It is unfortunate if we cannot utilize an increase in the width of the grates to secure the area necessary in large locomotives without having such a decided reduction in the life of the side sheets. It has not been noted that the crown sheets are similarly affected, there has been no radical change in the quality of the steel employed, or of the fuel or service demanded of the locomotive, that would account for the trouble, and we are forced to the conclusion that there must be some element in the design or operation of wide fireboxes which has an unfavorable influence not clearly understood.

By the life of side sheets is meant serviceable condition, freedom from cracks, leakage, and other failures that may require renewal. The life is not particularly affected by the pressure carried, as the staying is generally done with a large factor of safety, but is directly affected by the temperature changes, the expansions and contractions, in service under steam as well as when out of service on sidings or over cinder pits and in washing out, and water changing in the roundhouse.

Steel will stand a certain number of stresses before failure, dependent on the degree or amplitude. We can increase the number of applications of a test specimen by decreasing the amplitude. In a firebox it is difficult to decrease the number of the applications as they are dependent on the service of the engine, the number of times it is fired up and cooled off and these conditions are not materially different for the two types of fireboxes under discussion, and thus it may be that the short life of the side sheets of wide fireboxes can be accounted for by the greater amplitude of the movement or increased expansion and contraction.

At first thought one would say that the ogee box presents a series of curves that will adjust themselves to meet those movements in a way not possible in the straight and more rigid side of the wide box. This is true only in part, as the side is straight longitudinally in both designs, and this is the most important direction. Apparently, therefore, the increased amplitude must be accounted for by a higher internal temperature of the side sheets by reason of less perfect heat transmission to the water in the leg.

In the later designs of boilers we find a general tendency towards the use of wider mudrings and water legs than formerly. This has resulted in giving staybolts longer life, as their increased length gives a smaller amplitude of vibration or motion, but it has also decreased the rate of the flow of the water upward proportionally as the volume of water in the leg is increased. This point will be considered later.

In getting away from the ogee form of box and the narrow water leg, it was thought that the circulation of the water would be improved, as the ogee presents a curve adverse to the direct vertical rise of the water as it is heated and displaced by the cooler water coming from the throat. The results, however, would seem to prove this theory wrong, or at least we have only gained in life of staybolts.

The secret of the matter seems to be that, if the rate of flow and its wiping, scrubbing, impinging action can be directed against the side sheets it has the effect of wiping off the steam bubbles as they form, prevents their combining into a film or curtain of steam against the sheet, which is by no means as good a conductor of heat as is the solid water. This theory will account for increased internal temperature of vertical and inwardly inclined side sheets and can be inferentially proven.

It is well known that crown sheets outlast several sets of side sheets, and while this is due in part to the fact that there are not the same variations of temperature at the same time in different parts of the sheet, it is also true that its surface presents no chance for formation of a film of steam and it has practically solid water in contact with it at all times.

This is also true of the Wooten type of furnace, the parts failing being generally a limited portion at the sides, which approach the vertical. It has also been noted that the door sheets of fireboxes which have moderately inclined back heads do not last as long as those that are vertical. The incline forces the wiping action of the circulation against the outer sheet.

It has been stated that in the early days of torpedo boat design a locomotive type of boiler was tried because of its great efficiency and amount of steam produced per foot of heating surface in locomotive service. On the boat, however, it was an utter failure. By way of experiment this boiler was put on a vibrating cradle, which greatly increased the steam production. This could only be accounted for by an increased circulation, facilitating the heat transmission. It has been proven by late Government experiments that increased boiler efficiency can be obtained by increasing the rate of flow of the gases, this action tending to wipe off from the heating surface the partially cooled gases, replacing them with new and hotter gases.

Thus the questions of circulation, whether of water or gases, seems to be a very important factor in boiler efficiency, and while some of the examples quoted may be somewhat remote in their application, yet they seem to point to the circulation in the water leg as being a vital factor in the life of side sheets.

There seems to be no question that if there is a strong impinging circulation against the fire sheet, the heat will be more freely transmitted, steam film prevented, solid water maintained against the sheet, and the internal temperature of the sheet kept down and the amplitude of the sheet movement reduced to the minimum. To effect this the side sheets should not be vertical nor sloped inward, but be sloped or curved outward from above the fire line, but it is obvious that this cannot be extreme without getting into grate area difficulty.

It is quite possible, however, that we have gone too far and are too liberal in that respect, as the reports of successful steaming of some recent engines would seem to indicate, these engines having a much lower proportion of grate area than is at present common. If a reduction of grate area can be made, it will permit the modification of side sheets as proposed.

The question might also be raised as to the width of water leg. Aside from affording sufficient room to hold the accumu-

* Read at the December meeting of the Western Railway Club.

† The form having a reverse curve in section with the convex part above.

lated sediment to a safe height, there seems to be no good reason for a wide leg except from the staybolt point of view. There is no question of a stronger circulation with the narrow leg, and if need be, some form of flexible staybolt could be considered for extreme cases of angular movement.

In the older designs of fireboxes it was often 80 inches from the mudring to the water level above the crown sheet, the water varying in temperature, while in circulation from 150 or 180 degrees at the bottom to the temperature due to the steam pressure at the top. The depth of this column of water in wide firebox designs is very materially decreased, and as the temperature limits are about the same, it is apparent that for an equal width of water space the rate of flow of the circulation as a whole would be decreased about proportionately to the travel. If in addition to this, the width of the water leg be increased, the rate of movement is further decreased.

If rapid circulation and a wiping effect will serve to carry off the steam bubbles, preventing steam film and overheating of fire sheets, this function has been absolutely sacrificed in many wide firebox designs and the short-lived side sheets seem to prove it. The highest duty boilers are those having the most rapid circulation. The water spaces in legs and between tubes of fire engine boilers are very small, but the probabilities are that the rate of steaming and efficiency would be decreased if these spaces were materially increased and the larger volume of water would lower the rate of circulation.

It is quite likely that the rate of movement in the locomotive water leg has much to do with this question. The water next to the fire sheet has an upward tendency. That next to the outside sheet can only rise when heated by conduction through a body of water equal to the entire width of the leg or by the mingling, mixing action set up when the sheets are not vertical. There seems to be a reasonable ground for the belief that there is a very sluggish circulation in a directly vertical water leg of considerable width, contributing to formation of a steam film and overheating of the sheets when fires are forced.

This discussion would not be complete without considering the other end of the temperature scale to which the fire sheets are subjected. As before stated, it is the amplitude of the vibrations or movement of the sheet which are most subject to control. All possible mileage should be made between knocking out of fires. Firing methods can often be improved so that an engine can be returned without knocking the fire. The usual ash pit methods use up much of the life of side sheets and cold water washing and filling, and rapid firing up takes a lot more. It is quite true that the old-time fireboxes had to stand all this, but while considering temperatures and their effects it would be just as well to help on the lower end of the scale if possible.

Improved methods of blowing down and filling up of the boiler at terminals, hot water changing and washout plants are now well demonstrated and these will all help to reduce the amplitude of the temperature scale traversed in locomotive operation as regards the firebox sheets and thus add to their life.

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After considerable discussion the writer's closing remarks were as follows: "I think I have attained my object in getting a discussion on this rather interesting question. The idea that I had in mind was simply to find some reason why the modern wide fireboxes are lasting one-third of the life of the old-time boxes. In seeking for a theory it occurred to me to consider those elements which contribute to ultimate failure, viz: the vibrations or the expansions and contractions or movements of the sheet in the performance of its duty. I do not know that I am right yet, but at the same time, if there is successful performance of fireboxes about sixty inches wide, and boxes wider than that have not given as good performance, it would indicate that the slope of the sheet due to the narrower width had something to do with it. Now, just how that works out; whether I am correct in supposing that that upward circulation against an outwardly inclined sheet assists in wiping off the steam bubbles and combining them with the current, transmitting the heat, warming up the entire body of water in the water leg, instead of permitting a curtain or film of steam which will contribute to over-heating of the sheet, it at least seems to be a reasonable theory or explanation with some foundation for it.

"Whether Mr. Fry's theory of downward circulation or mine of facilitating wiping action of the circulation are used, the result is the same as regards the desirability of outward instead of inward inclination of firebox side sheets.

"As regards Mr. Squire's inquiry about the solid water, it would seem to me that there is absolutely no possibility of a steam bubble combining with another and another and another until there is a film on any portion of the crown sheet which is considerably beyond the vertical. If the volume of the water leg is increased by greater width of water leg, I think it is reasonably sure that the rate of the circulation as a whole is decreased, due to that larger volume, and if the rate of circulation is a factor in keeping down the internal temperature of the sheet, the failures are in accord with my theory.

"What I am trying to find out is this,—you will probably all admit that a firebox sheet has a certain life, it will stand so many vibrations, so many expansions, so many contractions, from the normal and then it will develop that crack that goes off like a pistol shot, or some other way, at any rate there is a failure of the sheet. Now, that being the case, if we can lengthen out the period of time over which that total movement will happen, we get the increased life in our sheet. It seems to me that if the box is designed in such a way that the internal temperature of the sheet is kept down by keeping solid water against it by any means whatsoever, then with all of the fireboxes, even with the despised ogee, we have made a distinct gain. I think this is a matter worth thinking about and possibly of going into our records of firebox failures. Classify the fireboxes of different widths and angles and forms on our roads and go back through our records for years and find out the number of fireboxes and side sheets that have been applied and see what results we obtain. I do not believe that it is due to the quality of firebox steel falling down necessarily, but probably a matter of design.

"As regards Mr. Wickhorst's belief that there is no downward circulation, or at least that there does not seem to be much to support that theory, I agree with that in a great measure. My idea of the circulation is that it is a very rapid, upward, against the inside sheet and less rapid at the outside, so that a number of inclined lines, each of a greater angle, would express the velocity as I understand it. But I can hardly understand why water up at two-thirds of the height of the firebox against the outside sheet should come down. I cannot see why it will not rise, although at a very less rate than that of water that is close to the firebox sheet.

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INSPECTION PITS AT ENGINE HOUSE.—An adjunct to terminal facilities is now being advocated by those giving the matter close attention, and that is having what is known as an inspection pit placed where engines bound toward the roundhouse will pass over it. This pit should be shallow, simply deep enough to permit men to walk under the engine and enable them to examine all its parts. The object of the pit is that engines will be stopped over it on their arrival and will be thoroughly examined by competent inspectors, and in a busy time this is quite an advantage in helping the movement of engines. Many times an engine reaching this pit will be found on inspection to have but a few nuts loose here and there, or in need of some slight repairs that can be made right on the pit; the engine then passing along through its different operations, goes on the table to be turned and is ready for a return trip. This saves its going to the house at all and is an advantage at a busy terminal in busy times when power is scarce.—*R. D. Smith before the New England Railroad Club.*

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A CAR WAS BLOWN FROM THE TRACK of the Union Pacific Ry. near Lone Tree Creek, Wyo., 30 miles west of Cheyenne, on October 19. It was the caboose of a work train bound for Hermosa Junction and carried about 40 laborers. The wind threw the car from the rails, breaking its coupling, and it dropped 30 feet down the embankment. The car was entirely broken up and six men were killed.

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**Advertisements.**—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

**Contributions.**—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

## CONTENTS



The practice of giving away souvenirs at the annual conventions of the Master Mechanics' and Master Car Builders' Associations is to be abolished by the request of the executive committees of those bodies. This action will receive the hearty approval of all who attend the conventions.

## ORGANIZATION.

"You have hit the bull's-eye," "Worth its weight in gold," "The best article ever published in a railroad paper," are some of the many expressions which have been received concerning the article on "Motive Power Department Organization," which appeared in the December issue. The demand for copies of that issue has been so great that we have been forced to reprint the article on "Organization." Additional information concerning this will be found in the advertising section of this number.

## ARTICULATED COMPOUND LOCOMOTIVE

Mr. Vauclain, in discussing Mr. Mellin's paper on Mallet articulated compound locomotives, presented at the annual meeting of the American Society of Mechanical Engineers (see page 14), presented some very interesting designs for locomotives of this type, several of which are now under construction, for different roads, at the Baldwin Locomotive Works. These designs include appliances for increased economy which have never before been combined in a single locomotive in this country, viz.: a superheater, a reheater, a feed water heater and compound cylinders on one engine. Advantage has been taken of the enormous length of the boiler, possible and desirable for freight engines of the 2-8-8-2 type, to install a feed water heater which is the real thing and should prove to be as valuable in increasing the economy as is the double expansion of the steam.

A report from Mr. Emerson, of the Great Northern Railway, which, owing to the shortness of the time, was not read in full at the meeting, contained some very interesting and valuable data and observaions from the result of the operation of 68 locomotives of this type under his supervision. It has been found that on quite a number of different divisions of that road the Mallet locomotive will handle about 50 per cent. more tonnage on the same amount of coal when compared with the large consolidation locomotives. Results as a whole have led to the decision to use locomotives of this type on all grades of .72 per cent. and over.

## OIL BURNING LOCOMOTIVES.

It is beyond successful contradiction to say that any piece of machinery or apparatus will perform the work for which it is specially designed better than will some other machine or apparatus which was designed for a different purpose and has been adapted to this use. This is as true of a locomotive as any other piece of machinery, and there is no doubt that an engine designed especially and exclusively for use with oil fuel will give better results than a coal burning locomotive adapted for using oil. The important points of difference in the design of the locomotive boiler for use with these two fuels is discussed in an article by Harrington Emerson elsewhere in this issue. Mr. Emerson has had excellent opportunities of studying the service of oil burning locomotives, and especially those which were primarily designed to burn coal, and has been impressed with the extra expense in connection with the rapid renewal of fireboxes and flues that is required on such boilers. These locomotives on one road cost between 3 cents and 16 cents more per mile for maintenance than does the same engine when burning coal, which, with a locomotive making 30,000 miles per year, would give from $900 to $4,800 per year. It would seem to be worth while to use this amount for a boiler construction adapted for this fuel rather than for the maintenance of a locomotive designed to burn coal. In considering the subject, however, it should not be forgotten that the importance of having locomotives capable of using both fuels and thus available for use at different points on a large system may be greater than the expense of maintaining fireboxes.

## THE RAILWAY BUSINESS ASSOCIATION

The Railway Business Association (see page 431, November, 1908, issue) is doing a work that is deserving of the active support of every fair-minded man. The efforts of this association are directed toward the restoration of the purchasing power of railroads, which, as every one knows, has been practically exterminated during the past year. This condition is very largely due to the anti-railroad legislation of recent years, which has resulted in making investors apprehensive as to the security of railroad investments. This has, of course, practically destroyed the borrowing power and hence very largely the purchasing power of the roads and compelled them to stop all extensions and improvements. Furthermore, recent legislation has added greatly to the expense of railroad operation, while transportation rates, figured on a ton-mile basis, have been continually reduced, resulting in a narrowing of the margin between cost and revenue. This has become serious and it has become necessary to consider an adjustment of rates exactly as is necessary in all commercial enterprises involving increasing costs.

The members of this association, who represent a capital of about $500,000,000, and employ many thousands of men, believe the agitation should be stopped and the companies should be allowed to readjust themselves to the new conditions and give the new laws on the statute books a fair trial without further handicap. They believe that when the public is educated to view transportation problems without prejudice, agitation against railways will cease for lack of popular support, but meanwhile emergency measures are necessary to prevent further damage. The first effort of the association, and in this it has been surprisingly successful, has been to persuade boards of trade throughout the United States to pass resolutions looking to the discouragement of anti-railroad legislation. It has followed this by starting a campaign of personal demands upon legislatures with the same object and it is in this work that the readers of this journal can be of great assistance. The association is urging everybody to write to legislatures, both state and national, demanding calmness in legislation affecting railroads, and the results of its efforts give promise of the accomplishment of its object. To make the success more far-reaching for the future every one dependent upon railroad activity should join, individually, in raising a voice of protest to those who make our laws; furthermore, all companies manufacturing or dealing in railway supplies should, by all means, identify themselves with this association.

## ROUNDHOUSE CONDITIONS.

An ideally operated roundhouse should have facilities for promptly handling the engines and keeping them in a first-class state of repair. By so doing, and replacing broken and defective parts at once, better service will be obtained and the mileage between shoppings will be greatly increased. Railroads are organized to sell transportation and any feature which will show decided advantages, tending to give better service and bring greater financial returns to the stockholders, should receive the support of the officers and boards of directors. Are the miserable conditions which exist on some roads due to a lack of foresight of these men, or is it because the motive power and operating officials have failed in impressing them with its importance? In some instances it would seem that the motive power and operating departments have been so busy trying to "knock" each other that neither one has had time or energy enough left to carefully analyze this subject as it should be.

While it must be admitted that much is still to be desired in designing and equipping roundhouses to better meet the severe conditions for which they are intended, especially in the northern districts, yet splendid progress has been made in this direction during the past eight or ten years. Those who are somewhat acquainted with the newer roundhouses and the results being obtained from them must receive a severe shock to find the most miserable roundhouse conditions imaginable existing on large and important systems. Houses which were inadequate, even for the times in which they were built, are being used, sometimes at important points. With the newer locomotives it is often necessary to keep the doors partially or entirely open when the engines are in the house. Turntables are in many instances still operated by hand and are in such poor condition that a large part of the roundhouse force is required to operate them during the winter. The coaling station, sand and water supply and the ash pits are arranged so that engines are frozen up before they reach the house, resulting in troubles too numerous to mention. Houses are so full of smoke, gas and steam that it is an outrage to ask men to work in them.

What is the result? Engines are poorly taken care of and are rarely ever ready for service, although they are sent out sometimes to fail miserably on the road; delayed trains and poor service; low mileage between shoppings and increased cost of maintenance. Whose fault is it? Is it reasonable to suppose that any intelligent board of directors would not take prompt action if they knew of these conditions and what it meant financially to the railroad?

## LIFE OF SIDE SHEETS.

The great reduction in the life of firebox sheets on wide firebox locomotives, as compared with those in narrow fireboxes, is by no means a new problem, but that does not lessen its great importance. Mr. Seley in a paper before the Western Railway Club, given on page 20 of this issue, has elaborated a theory for explaining this condition, which seems to be very plausible. In studying the subject, he starts with the fact that a side sheet in a firebox 60 in. wide, having an ogee curve, will last on an average of 7½ years, while in a firebox 80 in. wide, with straight side sheets inclined inward from the mud ring on a locomotive operating in the same service, with the same feed water, and burning approximately the same amount of coal, though at a lower rate per square foot of grate area, they will only last three years, and incidentally will give considerably more trouble from leakage during that period than did the others. It is also known that steel will stand a certain number of stresses of any given amount, which number is varied in an inverse proportion to the amount of the stress. With these conditions as a basis, Mr. Seley presents the theory that the failure of the straight side sheets may be due to their attaining a higher temperature and thus becoming subject to a greater stress, which reduces the number of stresses they are able to resist, and that this increase in temperature is caused by the formation of a film of steam on the outside of the sheet, which prevents the water from coming in actual contact with the sheet and keeping it cooler. The reason the firebox with ogee sides is not subject to the same condition, he figures, is due to the fact that it has an outward inclination and that the circulation in the water leg impinges against the sheet, breaking up the film of steam and thus keeping it at a lower temperature. Further, the narrower water leg in these boilers increases the rate of circulation, and hence this impinging action, thus aiding in the same cause.

The facts in this case are beyond contradiction in most places, and certainly in those where the feed water conditions have remained unchanged since the introduction of the wide firebox locomotives. This condition was forcibly illustrated recently by the building of some large narrow firebox Pacific type locomotives for the Chicago & Alton, illustrated on page 399 of the October, 1908, issue of this journal, which had followed a long series of experiments with the two different types of fireboxes on that road.

If Mr. Seley's theory is correct, and it is the increase in temperature of the sheet that caused its early failure, it would seem that the remedy would be in the shape of some construction which would allow the free expansion of the sheet either in the form of vertical corrugations or provision at the end of the sheet for permitting its expansion. Both of these remedies are now being tried, the former quite extensively on one road. The matter of the narrower water leg has an objection in the reduction of the length of staybolts, but it probably does increase the rate of circulation and hence the steam capacity of the boiler. The objection to reducing the length of the staybolts could be overcome by the use of flexible bolts or some similar provision.

# GOOD TIMES AHEAD FOR THE RAILROADS

*What are you doing to help bring it about?*

*If you are a manufacturer or dealer in railroad supplies join the Railway Business Association,* and PUSH.*

*Whoever you are, sit down at once and write to your Senators and Congressmen at Washington and to your State legislators, asking them for calm and careful consideration of all legislation affecting railroads. Urge your friends to do the same.*

"We want to put back on full time the plants which manufacture materials and equipment for railroads." Thus spoke an official of the Railway Business Association. "When other business picks up, we want our share. And if concerns which sell to railroads do not resume normally, other business cannot and will not become normal. The purchasing power of railroads can only be restored by strengthening their credit with investors. Investors can only be reassured by evidence that the public is ready to consider railroad legislation in a calm spirit. We are laboring to create and to crystallize public opinion favorable to moderation in the restriction of railroads, to acquaint legislators, national and state, with the existence of a widespread demand from business men for constructive legislation, and then to keep investors in touch with what is being done to safeguard their interests."

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That the association is performing this work in an effective manner is evident in many ways. Railroad managers are expressing their hearty appreciation of the methods employed and the results obtained. Resolutions have begun to be adopted by important business bodies looking to legislative calmness; letters in large numbers are going forward from railroad material, equipment and supply manufacturers and other business men to legislators, and encouraging replies are coming back; all of which cheering news is contained in a letter just sent to members of the stock exchanges in the principal cities, asking them to let their clients know what is going on in this direction.

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On December 7 the association issued a "Business Appeal to Business Bodies." This document set forth that the railroads were not buying material or equipment except in meagre quantities, and that manufacturing establishments depending upon the railroads have been wholly or partly idle for a year. "Many men," this circular pointed out, "are out of work, and the loss is extended to those who supply the necessities of life to the men affected." After explaining that the cost of constructing and of operating railroads had greatly increased, and that government officials have urged the railroads not to reduce wages, it was declared that two things are necessary: "First, moderation in legislation, for a while, to allow the great transportation industry to adjust itself to radically changed conditions due to recent enactments; second, an adjustment of rates to permit railroads to add to the price of service to cover increased cost of operation—exactly as do manufacturers and merchants." And the appeal concluded by asking the body addressed to adopt a resolution along the line indicated.

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The response was immediate. On December 8 the Southern Commercial Congress, composed of delegates from 64 business organizations in 14 Southern States, adopted at Washington, D. C., a resolution declaring that the construction of transportation facilities adequate for developing the resources of the South "can be accomplished only by assuring the holders of capital that such enterprises will be safeguarded by conservative and constructive legislation, and we urge upon our Southern legislators the wisdom of such policy and condemn any agitation leading to the contrary." This was passed unanimously amid spontaneous applause.

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The following day, December 9, the New York Board of Trade and Transportation unanimously instructed its committee on railway transportation to issue a resolution declaring it to be of "paramount importance to the commercial interests of our country that the earning power of our railroads shall not be reduced or their credit impaired by legislative acts and decrees of commissions," and deprecating "any action by business bodies, individual shippers or federal and state officials which may tend to aggravate public prejudice against railroads." The resolution also "urges the business men of the country to favor such freight rates as will insure the railroads adequate revenues for maintaining the equipment and roadbed and handling the traffic."

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On December 21, the executive committee of the Merchants' Association of New York, a body which has several times given public expression to similar views, stated in a preamble that the purchasing ability of the railroads, especially that relating to new construction, is largely contingent upon their ability to make such new issues of securities as may properly be needed to cover their financial requirements, and the abiilty to do this is directly dependent in turn upon public confidence in the stability of the conditions which determine the earning power of the railroads." The resolution urges legislators and railroad commissioners "to encourage the return of railroad business to normal conditions by ceasing and discountenancing ill-considered or unjustified censure of existing methods of railroad management, and by limiting proposed new legislation on these matters to such measures as have been so carefully investigated and studied as to determine clearly not only the necessity for their enactment, but also their proper form and scope for the accomplishment of intended reforms."

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Copies of these resolutions have been sent to hundreds of business organizations all over the country together with a second appeal to them to take similar action. Many such associations have notified the Railway Business Association that the matter had been referred to the committee charged with such matters, and vigorous efforts are being put forth, especially in cities where the Railway Business Association has members, to secure the adoption of resolutions.

* Address G. M. Basford, Acting Secretary, No. 2 Rector Street, New York City.

# WITH THE RAILROAD CLUBS.

*Canadian Railway Club (Montreal, Can.)*.—J. A. Kinkead, manager of sales for the Parkersburg Iron Company and formerly engineer of tests for the American Locomotive Company, will present a paper on "Springs and Spring Steel" at the meeting for Tuesday, February 2nd.

Secretary, James Powell, P. O. Box 7, St. Lambert, near Montreal.

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*Central Railway Club (Buffalo)*.—The annual meeting and banquet will be held at the Hotel Iroquois on Friday, January 8th.

Secretary, H. D. Vought, 95 Liberty street, New York City.

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*New England Railroad Club (Boston, Mass.)*.—The next regular meeting will be held at the Copley Square Hotel, January 12th. N. W. Storer, of the engineering department of the Westinghouse Electric & Manufacturing Company, will read a paper on "Single-Phase Railway Systems." Dinner will be served at 6:30 and the meeting will be called to order at 8 P. M.

R. D. Smith, assistant superintendent of motive power of the Boston & Albany Railroad, in his paper on "Terminal Facilities for Handling Locomotives," presented at the Ocotber meeting, considered, in more or less detail, the general arrangement of engine-house plants, as well as the design and construction of engine-houses and their equipment. General plans were shown of three new roundhouses on the Boston & Albany, at Beacon Park, Mass., West Springfield, Mass., and Rensselaer, N. Y. From the very thorough discussion which took place it would appear that there is a great need for better locomotive terminal facilities and that the railroads must awaken to the realization of the fact that the efficiency of the motive power depends largely on having proper engine-house facilities.

Henry B. Fletcher, architect of the Boston & Maine Railroad, in his paper on "Railroad Stations," read at the November meeting, described the various types, from the flag station to the large terminal station, and considered at length the requirements, as well as the best arrangements, for each class.

Secretary, Geo. H. Frazier, 10 Oliver street, Boston, Mass.

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*New York Railroad Club*.—At the meeting for Friday evening, January 15th, J. E. Muhlfeld will read a paper on "The Education and Organization of Railway Engineering Labor."

The annual reports, presented at the October meeting, showed a membership of 1,420, with $14,450.48 in the treasury.

Secretary, H. D. Vought, 95 Liberty street, New York City.

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*Northern Railway Club (Duluth, Minn.)*.—Next meeting Saturday evening, January 23rd. Claude Richards, foreman boilermaker, C., St. P., M. & O. Ry., Itasca, Wis., will speak on "Boiler Repairs in the Roundhouse from the Standpoint of a Boilermaker." N. P. White, roundhouse foreman, N. P. Ry., Duluth, will speak on "Engine Repairs in the Roundhouse from the Standpoint of a Machinist."

At the annual meeting held at Superior, Wis., November 28th, one hundred and seventy-nine members were present with their wives. The annual reports showed that 244 members had been added during the year, bringing the total membership to 529. There was $588 in the treasury, with considerably more still due. The following officers were elected: President, J. W. Kreiter, supt., D., M. & N. Ry., Proctor, Minn.; vice-presidents, J. H. Hicken, chief dispatcher, Gt. N. Ry., Superior, Wis., and J. E. Goodman, div. supt. motive power, N. P. Ry.; treasurer, S. F. McLeod, purchasing agent, D., M. & N. Ry., Duluth; secretary, C. L. Kennedy, commercial agent, C. M. & St. P. Ry., Duluth, Minn.

This meeting was the third anniversary of the club. Dinner was served at 8:30. The business meeting followed, after which there was a short musical program, the rest of the evening being given over to dancing.

Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

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*Railway Club of Pittsburgh*.—At the meeting for Friday evening, January 22nd, Wm. Elmer, Jr., master mechanic of the Pennsylvania Railroad, will read a paper on "Some Engine-House Auxiliaries."

At the December meeting Col. B. W. Dunn, chief inspector of the Bureau of Explosives of the American Railway Association, gave an illustrated talk on the proper way to handle explosives and other dangerous articles in shipment.

Secretary, C. W. Alleman, General Offices, P. & L. E. R. R., Pittsburgh, Pa.

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*Richmond Railroad Club*.—Next meeting, Monday evening, January 11th.

At the annual meeting in November the following officers were elected: President, H. M. Boykin, division freight agent, Seaboard Air Line Ry.; first vice-president, E. H. Lea, agent, Southern Railway; second vice-president, A. H. Moncure, master car builder, R. F. & P. R. R.; third vice-president, W. H. Owens, master mechanic, Southern Railway; secretary and treasurer, F. O. Robinson, C. & O. Ry. The club has 236 members and a balance of about $1,650 in the treasury.

Secretary, F. O. Robinson, 8th and Main streets, Richmond, Va.

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*St. Louis Railway Club*.—At the next meeting, January 15th, E. F. Kearney, supt. transportation, Missouri Pacific System, will address the club on "Ethics of Railroading."

Judging from the souvenir program of the Christmas Smoker, held December 11th, the members had a pretty lively time. Over five hundred were present.

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

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*Western Railway Club (Chicago)*.—At the next meeting, Tuesday, January 19th, Eugene McAuliffe, general fuel agent of the Rock Island Lines, and president of The International Railway Fuel Association, will address the club on "The Purchase and Handling of Railroad Fuel."

J. J. Hennessey, in his paper on "The Abuse of the M. C. B. Repair Card," at the December meeting, directed attention to the annoyance and expense caused by the non-application of repair cards. A portion of his paper appears on another page of this issue. C. A. Seley presented a paper on "Life of Side Sheets of Wide Fireboxes," suggesting a theory to account for the long life of the side sheets of the narrow firebox. This paper will also be found in this issue.

Secretary, Jos. W. Taylor, 390 Old Colony Building, Chicago, Illinois.

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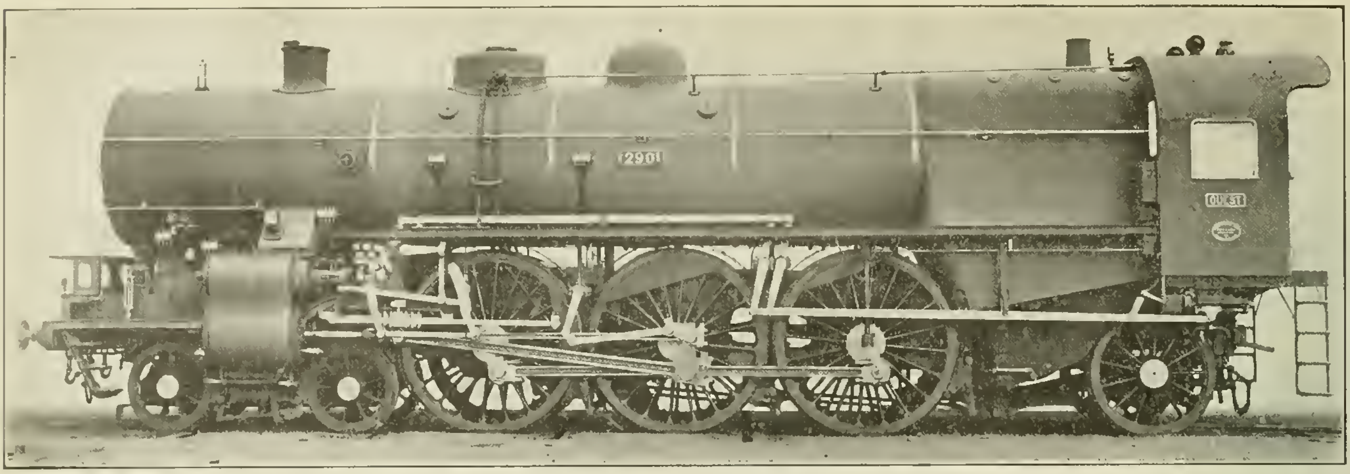
Value of Railroad Clubs.—Membership in such clubs as this, and kindred associations, is also a most fruitful method of obtaining information as to the progress of the profession not only from participation in the formal proceedings but in the chance to meet his colleagues, discuss his difficulties and take advantage of their ideas and impart his to them. The human mind is so constituted that often what may be a serious stumbling block for one individual will be readily solved by another of equal or even of inferior capacity.—*W. J. Harahan, before the New York Railroad Club.*



## BALANCED COMPOUND PACIFIC TYPE LOCOMOTIVE.

WESTERN RAILWAY OF FRANCE.

The Western Railway of France has recently completed in its own shops two very large and powerful Pacific type passenger locomotives, which slightly exceed in total weight those recently put into service on the Paris-Orleans Railway (See AMERICAN ENGINEER, Sept., 1908, p. 339), and are believed to be the heaviest passenger locomotives in that country. They are of the four-cylinder balanced compound type, the cylinders being arranged, relative to each other, the same as on the Cole compounds in this country, *i.e.*, the high pressure cylinders are between the frames and located some distance ahead of the low pressure cylinders, which occupy the same position relative to the engine truck and stack as do the cylinders of the simple locomotive. The high pressure cylinders drive on the first driving axle, which is cranked, and the low pressure connect to the second pair of drivers. This arrangement of cylinders is different from what has heretofore been used in France on four-cylinder compounds and was caused by the large diameter of the low pressure cylinders making it impossible to conveniently locate them between the frames. Since they must be placed outside it is preferable to have as direct passage as possible to the exhaust nozzle which locates them over the center of the front truck. This location also improves the distribution of weight. The high pressure cylinders are then set sufficiently far ahead of the front drivers to give a satisfactory length of main rod.

The arrangement of the valve gear is very unusual, being so constructed that both sets of gears on each side are operated entirely from a return crank on the second pair of drivers. The eccentric rod from the usual return crank pin drives the outside link in the ordinary manner, and the inside link through a rocker extending over the guides and frame, as is shown in the illustration. The combination levers are not connected to the cross heads as is usual, but are driven by an extension on the return crank, which carries a pin 180 degrees from the main crank pin, from which a rod extends to a rocker located between the first and second pair of drivers. From this, inside and outside, there are rods connecting to the ends of the combination levers. The outside gear is arranged with the combination lever extending downward in the usual manner and the inside gear has it extending upward. The reversing mechanism is separate for each of the two sets of gears, having two reach rods and two sets of power reversing gear, both located on the left side. This arrangement gives a valve gear that is practically all on the outside of the locomotive, and allows the elimination of eccentrics on the cranked axle, the latter being the controlling reason for arranging it in this manner. Eccentrics on a cranked axle must of necessity be very narrow and compel the use of a narrower driving journal than would otherwise be desirable. With this arrangement the journals can extend practically to the face of the cranks, giving a liberal bearing, and the crank pin can also be allowed a wider surface. The inside and outside cranks on the same side are set 180° apart.

The guides, as well as all of the valve gear mechanism in the vicinity of the cylinders, are supported by a single large steel casting which extends over and between the frames just ahead of the forward driving wheel. The guides are of the single bar type, the inner pair being supported directly between this steel casting and the H. P. cylinder heads. The position of the outside guides is such, however, that the supporting casting comes opposite their center, and they are supported at either end by another steel casting, which shows in the illustration, being connected to the back cylinder head and the guide yoke or casting and extending far enough to the rear to carry the reversing link.

The frames are of the plate type and are securely braced and stiffened by vertical stiffeners between each set of drivers as well as a very substantial cross bracing for both the horizontal and vertical direction, just in front of the fire box. The cast steel guide yoke just mentioned also acts as a valuable frame brace and stiffener and in connection with the H. P. cylinder castings and the saddle gives a very rigid and strong construction at the front end. The driving springs are overhung, being located just inside the frames and above each journal box. The system of equalization on each side includes the trailing truck, giving a three point suspension for the whole locomotive.

The coupling between the locomotive and tender has been given careful attention, because of its distance back of the rigid wheel base of the locomotive, which gives it a large lateral movement. This movement has been cut down as much as possible by bringing the buffer forward underneath the cab for a considerable distance and provision has been made for the lateral displacement of the tender underframe by using a front tender truck fitted with swing links.

The boiler is of the Belpaire type, telescopic in the arrangement of the barrel sheets, being about 63½ in. in diameter at the front end. Its center is raised sufficiently high to give a deep throat without an excessive slope to the grate. The fire box extends over the frames, giving a grate 5.9 ft. wide and 7.32 ft. long. The back head is sloped from the mud ring to the level of the crown sheet, above which point it is vertical, being stayed by rods which extend forward and connect to the barrel with two exceptions, which are continued forward to the front tube sheet. The tubes, 19 ft. 8 in. long, are of a smooth type, Servé tubes not being used because of the extreme length. The dome is located on the center of the three barrel sheets and contains a balanced throttle valve, taking steam from the top only. The heating surface, grate area, etc., are given in the table of dimensions. The front end, which it will be observed is extremely long, contains a re-heating drum or receiver, into which the steam from the high pressure cylinders is exhausted and from which the supply to the low pressure cylinders is taken. This drum is not very large and is secured in a longitudinal position at the top of the front end ahead of the stack. The pipes leading to and from it, however, give considerable heating surface and the result, no doubt, will be at least perfectly dry steam for the L. P. supply.

The design of the trailing truck, which has inside journals, is interesting. It is of the radial type, both journal boxes forming part of a single casting that is continuous over the axle and includes the radius bar. The weight is transferred from each journal box through two swinging links to a casting which forms the guide for the boxes and is itself in turn guided by the jaws of the pedestal, thus having motion only in the vertical direction. The semi-elliptical springs are carried from the bottom of this casting, being connected to the equalizers at one end and the frame at the other.

As can be seen, a speed recording apparatus is applied, being driven by a gear from the back driving axle. The indicating pointer is located in the front wall of the left side of the cab or directly in front of the engineer, who sits on the left-hand side. All of the controlling gear of the locomotive is arranged in front of the driver, the reversing gear being controlled by a hand wheel arranged like the steering gear of a motor car, *i. e.*, vertical instead of horizontal, and operates either or both sets of valve gear, as desired; the throttle lever projects down alongside of the fire box, within convenient reach of the right hand; the simpling valve, brake valve, sanding apparatus, blow-off cocks (operated by compressed air), etc., are located at convenient points in the same vicinity. The appliances operated by the fireman are placed on the right hand side.

The ash pan is divided into three parts by longitudinal partitions and is fitted with one inner and two outer doors, which insure a proper distribution of air underneath the grate.

The facts concerning this locomotive have been drawn very largely from a very complete descriptive article in the *Revue Generale des Chemins de Fer.*

Some of the more important general dimensions and ratios are given in the following table:

| | |
|---|---|
| GENERAL DATA. | |
| Gauge | 4 ft. 8½ in. |
| Service | Passenger |
| Fuel | Bit. coal |
| Tractive effort | 27,874 lbs. |
| Weight in working order | 200,000 lbs. |
| Weight on drivers | 118,020 lbs. |
| Weight on leading truck | 49,380 lbs. |
| Weight on trailing truck | 32,600 lbs. |
| Wheel base, driving | 13 ft. 3 in. |
| Wheel base, total | 34 ft. 6 in. |
| RATIOS. | |
| Weight on drivers ÷ tractive effort | 4.25 |
| Total weight ÷ tractive effort | 7.18 |
| Tractive effort × diam. drivers ÷ heating surface | 700.00 |
| Total heating surface ÷ grate area | 70.00 |
| Firebox heating surface ÷ total heating surface, per cent | 4.93 |
| Weight on drivers ÷ total heating surface | 39.00 |
| Total weight ÷ total heating surface | 66.00 |
| Volume equiv. simple cyls., cu. ft | 10.00 |
| Total heating surface ÷ vol. cylinders | 302.95 |
| Grate area ÷ vol. cylinders | 4.32 |
| CYLINDERS. | |
| Kind | Bat. comp. |
| Diameter and stroke | 15¾ and 26 x 25.2 in. |
| Kind of valves | Piston |
| WHEELS. | |
| Driving, diameter over tires | 76¼ in. |
| Engine truck wheels, diameter | 37.8 in. |
| Trailing truck wheels, diameter | 51½ in. |
| BOILER. | |
| Style | Betpaire |
| Working pressure | 228 lbs. |
| Outside diameter or first ring | 63 in. |
| Firebox, length and width | 87.84 x 70.8 in. |
| Tubes, number and outside diameter | 283—2.16 in. |
| Tubes, length | 19.6 ft. |
| Heating surface, tubes | 2880 sq. ft. |
| Heating surface, firebox | 1495 sq. ft. |
| Heating surface, total | 3029.5 sq. ft. |
| Grate area | 43.2 sq. ft. |
| Center of boiler above rail | 114.1 in. |
| TENDER. | |
| Weight, light | 53,000 lbs. |
| Water capacity | 5,280 gals. |
| Coal capacity | 9 tons |

THE EMPLOYMENT OF MEN.—One of the most important duties of an officer entrusted with it is the employment of men, and it is one which he should weigh well, and, should seriously appreciate the gravity of. In hiring the inferior grade of employees he should reflect that he is hiring the future section or shop foreman, the future dispatcher, the future engineer, the future conductor, and if the true principle is carried out the future officer of whatever grade; it therefore requires rare discrimination to do that which is the proper thing.—*W. J. Harahan, before the New York Railroad Club.*

## RESULTS OF OPERATION OF THE ELECTRIFIED SECTION, N. Y., N. H. & H. R. R.*

W. S. MURRAY.

The duty assigned to the engineers of the New York, New Haven & Hartford R. R. was to provide for the electrical operation of their trains. At the early period of April 1, 1905, when we settled down to this responsible task, the data in the field, upon which to base real conclusions, were about 5 per cent, in comparison with the experience now available. To those who may be interested in my conclusion in regard to the electrification, I can simply say that if I was in favor of the use of the present system three years ago, that now, standing on the more stable ground of experience, particularly in regard to the department of faults, I am doubly in favor of it.

In the conception of the form of power house, line, and locomotive to be used on the New Haven system, those pertinently interested in its success believed that while the chain of power generation, and its transmission and utilization for traction, was of a new character, its links, however, were made up of principles long recognized and reliable. They were right in this conclusion, except that it did not include certain phenomena which could not have been anticipatd, due to the combination of these old principles in the form of this new chain. For example, there was nothing particularly disturbing about an 11,000-volt 25-cycle, three-phase power house from which was to be taken most of the power from one of the phases generated; or of a 300-ft., 11,000-volt, single-phase transmission line, from the terminals of which the same voltage was to be distributed, east and west, along the right-of-way of a railroad; or of a locomotive with a transformer installed upon it to take 11,000 volts and step it down to 600 volts to supply 300-volt single-phase railway motors. Power houses of this character have been designed the world over, except perhaps that single-phase current in the amount to be utilized had not been used elsewhere. Transmission lines ot 60,000 volts had been in constant use. And except that there was a moving contact in connection with the current that was to go to the step-down transformers on the locomotives, transformers of many times the capacity and voltage were in universal use. The single-phase motor indeed, may be said to have been new so far as the size required for the New Haven service is concerned, but tests made upon smaller units demonstrated beyond peradventure its tractive qualities and showed its characteristic curves to be closely similar to those of its prototype, the direct-current motor.

This reasoning, in close consideration of each class of apparatus, *per se*, proved itself correct, and such irregularities as have existed in the initial electric service, which the New Haven road offered to the public have been due to the ramification of a series of faults that have developed entirely outside the zone of previous experience. The delays (and public criticisms of them) have followed even into this late day, when the electric service is far better than the steam service it has replaced. It has occurred to me that certain engineers, who are unbelievers in the single-phase system, may interpret this paper as an apology. To them I would say, as I do to the public, it is an apology for having delayed any of their appointments. To others, it is needless to add that the citation of these troubles is given in the hope that they will, as they easily can, avoid them in the future.

### POWER HOUSE.

The electric power supply for the New Haven road is derived from four 11,000-volt steam turbine generators, three of which have an electric capacity of 3750 kilovolt-amperes single phase; the fourth unit consisting of a 6000 kilovolt-ampere, three-phase generator which can also supply single-phase current to the system. Although the generators as originally designed were made exceptionally strong, and particular attention paid to their insulation due to the necessity of grounding one phase it was found that the utilization of so much single-phase current from a three-phase star-wound generator produced a stray magnetic field com-

* From a paper presented before the Amer. Insti. of Electrical Engineers.

pletely out of the path of normal lamination. As a result is was impossible to develop for continued operation more than 66 per cent of the normal rating of the generators. Overloads of any character produced abnormally rapid heating, making such operation dangerous, although the generators were guaranteed to carry 50 per cent overload for two hours, and 100 per cent overload for two minutes in order to meet the sudden drafts of currents required for a schedule such as exists on the New Haven road. Indeed, at the very start the actual drafts of current showed that the generators must meet imperatively the guarantees as to normal and overload capacities if the electrification was to be successful.

I trust it is not to be my pleasure to meet the prophet, who says, "This could have been anticipated." Suffice it to say that after three unsuccessful attempts at complete correction, each, however, affording some constructive results—months being absorbed in the dismantling and readjusting of the parts of these generators—the final attempt was successful and the generators are to-day operating in the power house, fulfilling the guarantees mentioned previously. But this last mentioned fact is insignificant when compared with the valuable information that has been derived, which will permit all other generators to be manufactured without the fault described.

### Line Insulation.

The years of experience which we have had in the study of insulating various voltages led to what was considered a very conservative insulation in the various parts of the line. Messenger cables had to be insulated from the intermediate trusses and at their anchor-bridge termini. The trolley copper conductor was suspended from the messengers and had to be insulated at points where it entered the oil switches on the anchor bridges. Trolley wires had to be insulated from each other at section breaks. On curves both messengers and trolley wires had to be strained over the center of the tracks through the agency of pull-off posts at the side of the tracks, the pull-off wire being insulated between tracks and the pull-off column itself. Feeder wires had to be insulated from their supporting cross-arms and at points where they pass under highway bridges. None of these problems in insulation had the appearance of an especial character and indeed, did the roadbed provide traffic only for electric trains the problem would have been simplicity itself. A pressure of 11,000 volts being the prevailing dielectric strain, the problem was to provide sufficient insulation at all the points mentioned above.

Of the effect of steam locomotive discharges upon insulators, there was no initiative by which to be guided, and it became necessary to decide upon the factors of insulation that would be required. It was thought that ample provision had been made; it proved otherwise. Experience has proved that, in places, just double the amount is required. It was quickly noted that the greatest number of insulator failures occurred wherever the insulation was subject to the direct blast of the steam locomotive. To correct the difficulty, therefore, it was found necessary to double up on anchor insulators. The intermediate messenger insulators proved adequate and it was not found necessary to increase the impregnated stick insulation between trolley wires at curves, but wood stick insulators had to be added in series with the moulded material insulator between the pull-off wire and pull-off post. The original insulators on the anchor-bridge switches were made of moulded material and for them was substituted porcelain. It was not necessary to change the feeder insulators on the catenary bridge struts. While very little trouble has been experienced with the form of insulation used for supporting the feeders under highway bridges it is anticipated that trouble will follow if this is not changed. The present form consists of the corrugated spool-type insulator, for which there will be substituted a regular porcelain double-petticoat insulator. To-day instead of line failures being the rule they have become the exception.

### Circuit Breakers.

The momentary energy involved in a short-circuit produced upon a line fed by high power high speed turbines is very great. Under the subtitle "Power house" it has been stated that the generators were operating under their guaranteed capacities. Internal heating, due to stray magnetic field, was the cause of the generators failing to meet their designed capacity. This heating was completely cured by the simple addition of a short circuited winding surrounding the rotating member of the generator, similar to that used in the well-known squirrel cage type of induction-motor rotors. It is interesting to note here, however, that while the heating is entirely eliminated by this short circuited winding, its effect on the occasion of a short circuit is to allow more current to flow. This tendency, however, is controlled by a method later to be described. In the New Haven system, as the current from the power house was fed directly to the line and from there to the locomotives without transformation of voltage by transformers, the inductive element to counteract the surging current was practically negligible; under these conditions there resulted short circuits which no circuit breaker apparatus then designed could be relied upon to take care of.

The failure of circuit brakers, either in the power house or on the line, naturally produced train delays of large or small magnitude. It was difficult to believe that these large circuit-breakers were incapable of taking care of the short circuits, and some time was wasted in thinking this way. Therefore, we reluctantly but surely arrived at the conclusion that the conditions would have to be changed.

The remedy was simple. Instead of feeding the main line with a direct transmission straight from the power house bus-bars to the trolleys directly opposite the power house, the current was fed into the line over feeders connected to it at Port Chester and Stamford. By the introduction of this ohmic resistance, amounting to not more than 2 per cent normal drop on the system, we were immediately released from the disastrous effect of short circuits on our circuit breaker apparatus. Instead of losing as many as half a dozen circuit breakers in a day, not that many were reported out of commission for a month, and, of course, they were not damaged to the extent of the others nor did they cause any serious delays.

For the feeder resistance, above described, there has since been substituted impedance coils installed in the leads of the generators. These coils act as shock absorbers, protecting the generators. Later, it is to be expected that there will be installed a circuit breaker across the terminals of these impedance coils, which, for normal operation, will shunt the current through them, the breakers opening under stress of abnormal flow of current and automatically closing when normal conditions are restored.

### Trolley Wire.

In the month of May, 1908, it became evident to us that within at least one month from that date, if some change were not effected in the contact wire, that the New Haven electric service would cease. While this truth was so plain, it may be best described by the fact that daily reports were showing that the copper trolley wire was breaking at various points; and where it was not broken it had become so badly kinked at the hanger points that it was impossible to operate electric locomotives upon the line without serious arcing. This resulted in violent surging on the locomotive transformers, and, at times, on account of the extremely poor contact of overhead shoes on the line, in reducing the voltage to such a low value as to prevent a sufficient supply of power to enable the locomotive to perform its schedule. An examination of the hard-drawn copper trolley wire throughout its length proved that even after only a few months' operation upon it, its cross-section had been so materially reduced as to point to its short life with a continuance of operation upon it. Especially was this true in the vicinity of the many low highway bridges where the trolley wire approaches the bridge on a two per cent gradient. This fault and dilemma were indeed serious. The cause of the difficulty was perfectly apparent; namely, the hard spots in the line which existed at the hanger points.

Many suggestions were offered. None of them, however, offered the speedy installation that was paramount. Mr. McHenry, vice-president of the New York, New Haven & Hartford Railroad Company, made the suggestion that an auxiliary wire be suspended from the present copper wire by clips at its midpoint between the hangers, and followed up the suggestion that this auxiliary wire be made of steel, of the same cross section as the 0000 grooved hard drawn copper above it. It took two weeks for the manufacturer to draw two miles of this wire. It was installed immediately upon its receipt on the main line between Port Chester and Harrison. On the night of its completed erection a special seven-car train with two locomotives was operated upon it for several hours. Previously to the installation of the steel wire there had been installed a section of hard alloyed wire suspended in a manner similar to that of the steel. The electric train was operated upon them both, officials from both the railroad company and the contracting company being on hand to note their comparative merits.

It was the general consensus of opinion that there was less sparking on the hard wire, and the general tendency was towards adopting that rather than the steel. Though admitting that the operation was better, the steel seemed to be of an entirely satisfactory commercial nature, and all present finally concurred in this conclusion. It is undeniably true that hard alloyed wire would, from a purely operative point of view, be the better of the two, and yet the commercial aspect, which would naturally include its cost, had to be considered, particularly in reference to so large an immediate order as one involving 100 miles of single-phase electric trackage. Again it is important to note that the steel, besides having the advantage of being a cheaper, harder, and stiffer wire, also possesses a lower coefficient of expansion and higher elastic limit, especially valuable characteristics for the service desired.

The auxiliary wire construction on the main line, as described, prevails throughout the whole system, except at the approaches of and under a few very low highway bridges, where the contact system consists of two wires strung in the same horizontal plane. The New Haven trains have been operating now on the auxiliary wire for several months, and absolutely no kinking has been noted at the hanger points, with the attendant result of a smooth and almost sparkless overhead contact.

### Locomotives*

There were originally purchased 35 locomotives, which was considered an adequate number to take care of the passenger service. These locomotives, considered *per se*, were rated on a half-unit basis. That is to say, the half unit was designed to handle about 75 per cent of our trains, the remaining 25 per cent to be handled by two units. Only a short experience in commercial operation revealed two important facts. The first one of a very encouraging nature, the second, decidedly otherwise. The first was the proof that the two main parts of the locomotive; namely, the transformer and motors, had sufficient capacity to more than handle the manufacturer's guarantees. The second was the discovery that many of the auxiliary electrical and mechanical parts of the locomotive equipment were not of equivalent capacity. The strength of the chain being measured always by its weakest link, it was immediately seen that the locomotives would be able to handle trailing loads in excess of their guarantees if the auxiliary parts were made of sufficient capacity to furnish the necessary current for the overload conditions. It was simultaneously apparent that more locomotives would be required to provide for an increase of train service and the reduction of time schedule, and an order was promptly placed for six additional ones. Before accepting their design, however, a careful survey was made of all the component parts of the locomotives at hand, in order to determine the changes necessary to be incorporated in the six new engines. To accomplish this it was found necessary to make a number of electrical and mechanical changes.

The most important electrical changes made were in the switch groups and brush holders of the motors. The former lacked carrying capacity and the latter sufficient insulation. To these shortcomings were due the greatest number of our first train delays. The most important mechanical changes necessary were the reinforcement of the truck bolsters and installation of pony wheels. The especial reference to these electrical and mechanical changes must not be construed as diminishing in any way the force of necessity of the others, as they were all considered absolutely necessary in order to preserve a low cost of electrical and mechanical maintenance.

With the exception of the installation of pony trucks,† the six new electric locomotives arrived within five months of the date of their order. To be noted here is the marked value of the spring type of armature and field suspension begun with the New Haven locomotive motors, thus making flexible the entire motor suspension. Indications already predict that this arrangement in combination with the pony trucks will reduce materially the track and locomotive maintenance and repairs. Today the reconstruction has been effected on over 90 per cent of our locomotives. This last and serious fault with which we had to contend completes the major difficulties that were constantly threatening the regularity of electric service.

It seems to be the time and place, here, to draw attention to a point in design concerning the New Haven locomotives that has been so persistently misrepresented by those who seem to have been ignorant of the facts. The specifications upon which the locomotive units were purchased, as stated hereafter, were that each unit would handle a normal trailing load of 200 tons. The writer, by careful measurement of the weights of all the trains (trailing loads) in the New Haven service, found that they averaged 212 tons. It seemed good engineering that if 75 per cent of the service could be handled by locomotives rated upon a basis of 200 tons trailing load, that that would be the correct locomotive unit size; using two units for the remaining 25 per cent of the trains. Today, three years after this decision, we find that 72 per cent of our trains can be handled with single units, 27 per cent requiring two units. The percentage is slightly different from the original, as the service is slightly heavier.

### Locomotive Current Collectors.

An efficient pantagraph shoe has proved itself a very difficult problem. The present cost is about .06 of a cent a locomotive-mile. We have made various experiments with aluminum, phono, copper, and steel rigid and spring-supported pantagraph shoes. While this feature does not present a serious aspect, it is none the less a most interesting study. Shoe life is also seriously affected by the amount of soot deposited by the locomotives upon the overhead wire. While we have obtained mileages varying between 600 and 1500 miles per shoe with various types used, other roads of lesser speed and not subject to the effect of locomotive stack discharges, have obtained as high as 25,000 shoe-miles.

* See American Engineer, Oct., 1907, page 397.
† See American Engineer, Dec., 1908, page 489.

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The Poor Roundhouse Foreman.—I doubt if there is any more abused individual than the engine-house foreman. It seems to be his lot to receive complaints, knocks when they get worse than complaints, from his superiors, from the engineers and firemen and from everybody anywhere nearly connected with the movement of trains or power. If there is a delay the engine-house foreman is held responsible, whether he is responsible or not. Sometimes it is practically impossible to get the power into the house. That makes no difference, the engine-house foreman gets it just the same. The master mechanic relieves himself of the responsibility largely by throwing it on to the engine-house foreman. The engineer, in the case of any delay occasioned by repairs or getting engines out of the house, will throw it on to the engine-house foreman. I said some months ago when this question came up that I believed that the most important individual on a road was this same engine-house foreman, and I have to further add to that, that he is the most abused.—*W. B. Leach before the New England Railroad Club.*

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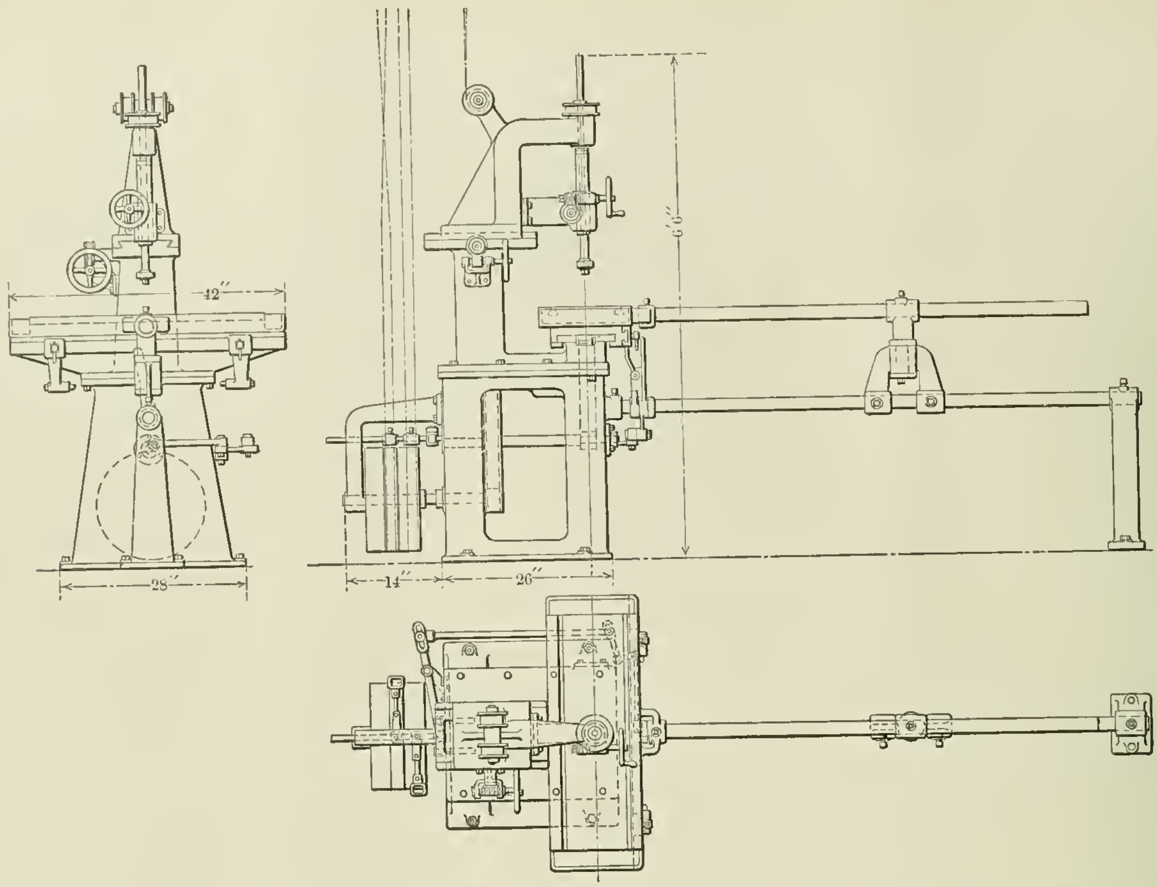
Engine Failures and Roundhouse Service.—It is the place to stop engine failures on the road, and good roundhouse service will be quickly reflected in better train movements and in reducing overtime on the road.—*R. D. Smith before the New England Railroad Club.*

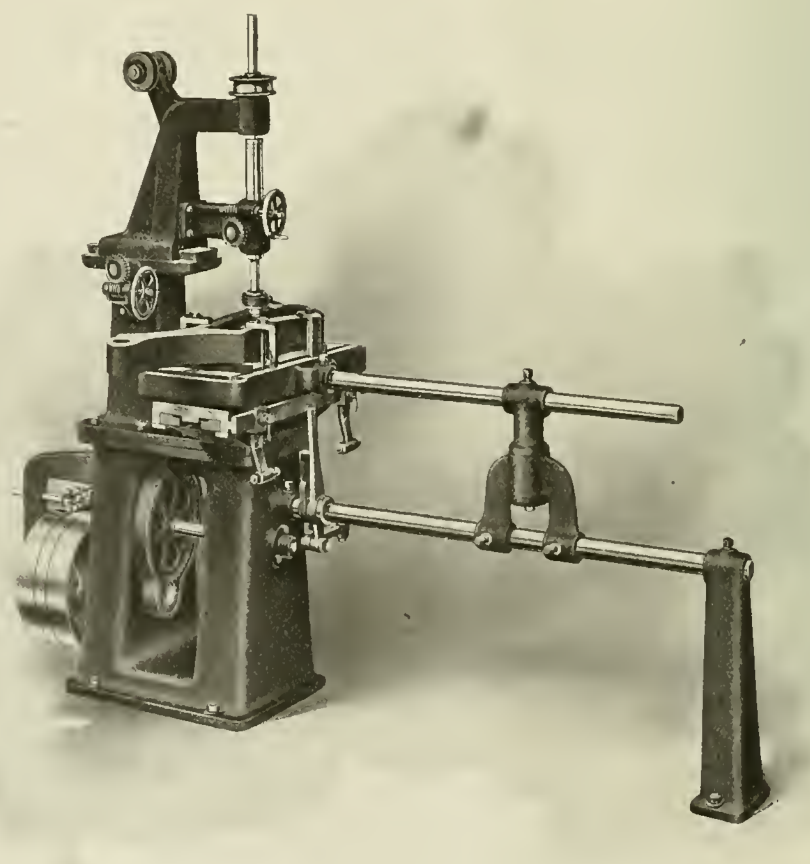



RADIUS GRINDER FOR VALVE GEAR LINKS.

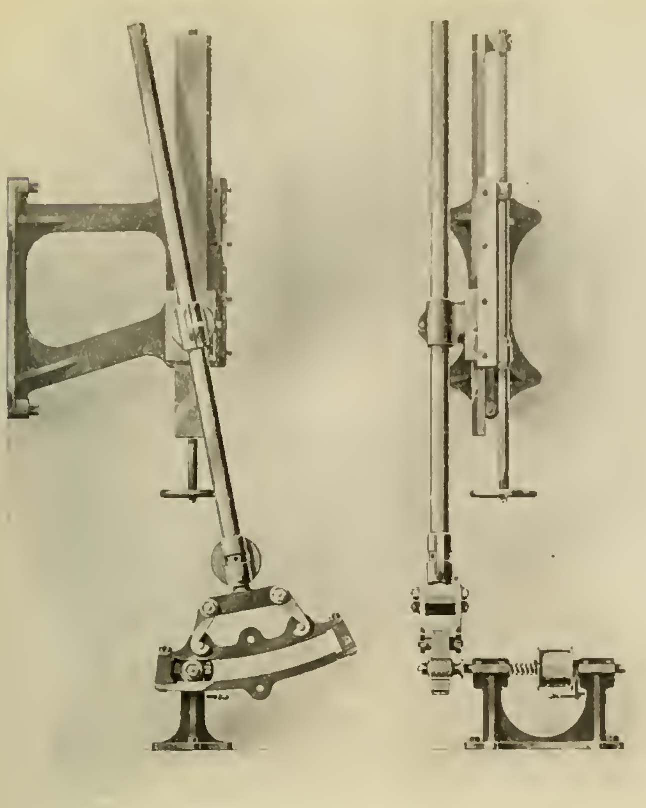
## LINK GRINDERS.

The advent of the Walschaert valve gear has made it necessary to devise a machine for grinding and truing up the links, the devices ordinarily used for the Stephenson links not being suitable. A simple and substantial machine, especially adapted for this purpose, as well as for any radius grinding, and which may be readily converted into a surface grinder, is shown in the illustrations. To give some idea of the efficiency of this machine, a worn Stephenson link with a slot 18 in. long and 2¼ in. wide, was trued up in 35 minutes actual grinding time, exclusive of the time required to place the link on the table and adjust the machine. After the link was trued, 1/32 in. was ground off one side of the slot in 45 minutes.

The machine has two tables, the lower one being driven by a gear and rack and having an automatic reverse motion actuated by the same method as used on an ordinary planer. The length of the travel is adjustable, the dogs, which control the shifting mechanism, being clearly shown in the illustrations. The upper or floating table receives its motion from the lower table by means of a pivot block, which fits in a slot on the upper table; the radius described by this table is governed by the position of



RADIUS GRINDER SPECIALLY ADAPTED FOR GRINDING THE LINKS OF THE WALSCHAERT VALVE GEAR.

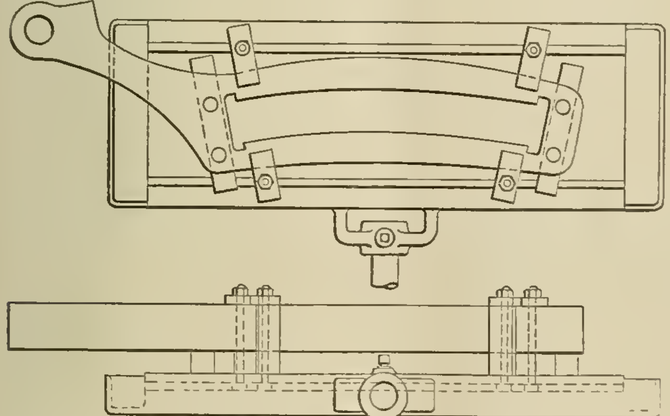


LINK GRINDER FOR STEPHENSON LINKS.

the swivel bracket on the radius bar. This radius bar is ordinarily furnished about 7 feet long, although it may be made longer if desired. The radius bar has graduations every 3 in., and by using a scale in connection with this, it is possible to quickly and accurately adjust it for any radius.

The work is placed on parallel strips and is clamped to the table, as shown in one of the sketches. If a large number of the links to be ground are of a standard design the setting of the work may be greatly facilitated by providing a special chuck for these. Link blocks may also be easily clamped to the table and ground.

Vertical and horizontal motions to the grinding wheel are obtained by means of the two hand wheels. The machine may be converted into a surface grinder by removing the radius bar and inserting an additional pin, thus fastening the two tables together.



METHOD OF CLAMPING WALSCHAERT LINKS ON TABLE OF GRINDER.

The upper table is 36 in. long, exclusive of the end pockets, 14 in. wide and has two "T" slots for ⅝ in. bolts. The floor space required, exclusive of the radius bar, is 4 ft. 4 in. by 3 ft. 6 in. The machine weighs 2,200 lbs. and is manufactured by H. G. Hammett, Troy, N. Y.

For a number of years Mr. Hammett has also manufactured a link grinder, which is especially adapted for grinding Stephenson links. As shown in one of the illustrations, it consists of a wall bracket at the end of whch is a long vertical bar upon which the carriage, carrying the pivot upon which the radius bar swings, may be adjusted. The grinding wheel frame is placed on a bench. The link is hung on the two hooks, as shown. To make sure that the bolts which these hooks engage are centrally located in the holes, taper washers are used and these are bored 1/32 in. off center, making it possible to adjust for uneven wear in the link, or warping due to case-hardening. The operator swings the link back and forth and by means of the small lever, underneath the pulley on the grinder shaft, works the grinding wheel sidewise, thus grinding the link evenly. The radius bar is adjusted by means of the large hand wheel, and a slight adjustment may also be obtained by the sleeve just above the hooks which engage the link. Arrangement is also made for taking up the wear of the wheel without affecting the radius of the work. The link blocks may also be ground on this machine.

## METAL GRAIN DOOR.

The railroads are under a heavy expense in maintaining grain doors on box cars. The temporary wooden doors, in general use, are often broken while being removed, or are not replaced on the car after it is unloaded, or are lost in transmission. The shippers often use heavy spikes for holding the doors in place, and it is not unusual for the door posts to be injured in prying the doors off at the elevators. More or less time, often as much as thirty minutes, is required in loosening and raising the grain doors at the elevators. Knot holes in the wood and opening of seams in the door under a heavy load are responsible for the loss of considerable grain, especially while the cars are being switched.

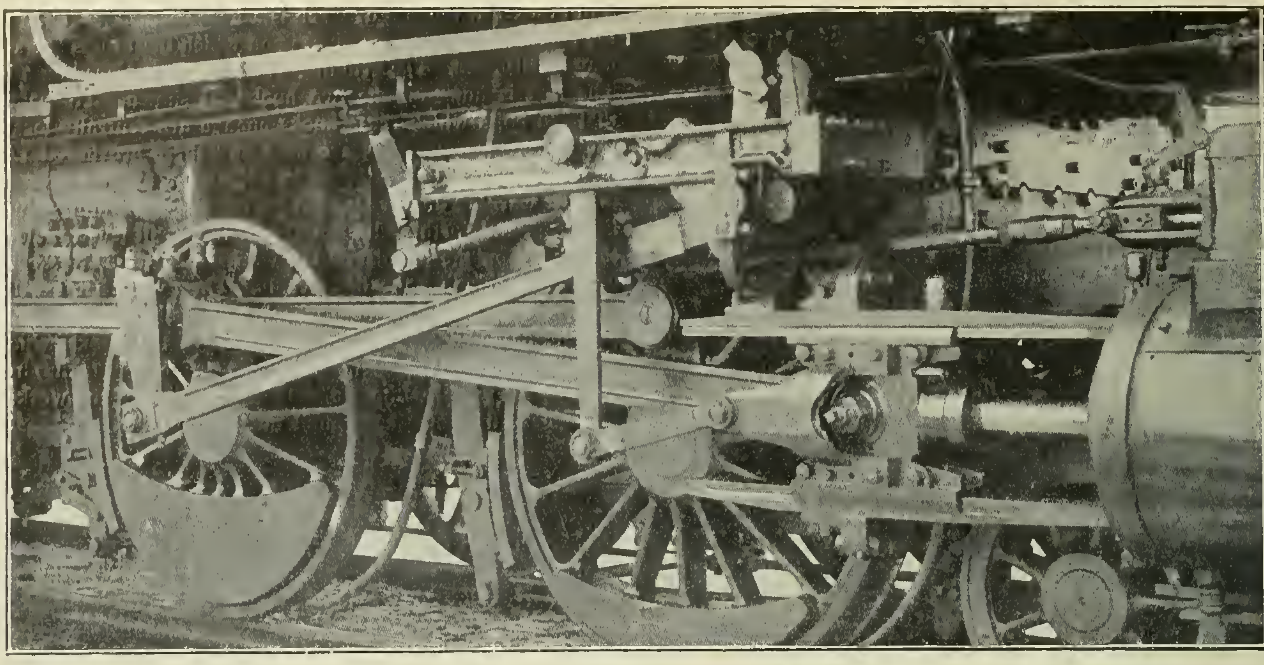
The logical solution would seem to be to have a substantial door, preferably of steel, which would be a permanent fixture

and be controlled by some mechanism by which it would be possible to easily and quickly raise the door.

The grain door, shown in the illustration, was devised by J. B. O'Neil and M. Voorhees, general foreman of the C., R. I. & P. Ry. at Peoria, Ill. It consists of two parts, the lower or smaller part being made of 5/16 in. boiler plate and the upper part of 3/16 in. steel reinforced on the inside by two 1¼ in. angle irons. The small door is controlled by a 2 in. shaft, to which it is securely attached, and which is operated through a worm and worm-wheel by an 18 in. bar or crank on the outside of the car. The lower door is first raised about 10 in., allowing the grain to start running and cave away from the top part of the door, after which both doors are raised and turned back flush with the door post, where they are practically locked in position.

In tests recently made at the Central City elevator in Peoria the door of a car was raised and the unloaders were in the car in four minutes.

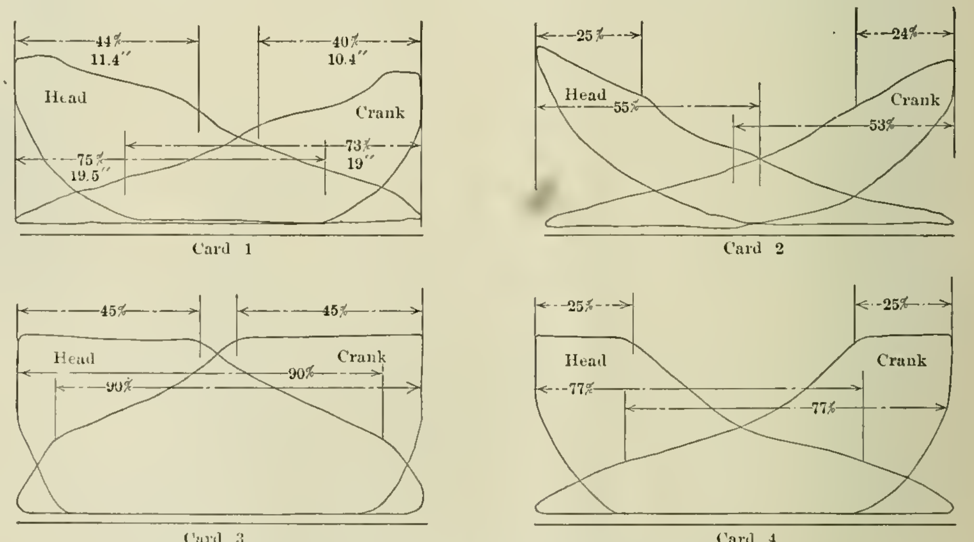
ROUNDHOUSE FACILITIES.—A good roundhouse foreman and a good yard master can go a long way towards running a railroad, but neither of them can do very much unless he has men and facilities to work with.—*J. A. Droege before the New England Railroad Club.*



APPLICATION OF THE BAKER-PILLIOD VALVE GEAR.

## BAKER-PILLIOD LOCOMOTIVE VALVE GEAR

During the past four or five years more attention has been given to the proper movement of the valves of the locomotive for obtaining a greater economy, both of steam and maintenance, ease of action of the locomotive as a whole and simplicity of construction than was the case during its entire previous history. In this time a number of valve gears, which offered improvements in one way or another over the previously standard Stephenson gear, have been introduced and are being given extended practical trials on a large scale. Among these, of course, the Walschaert valve gear has passed beyond the experimental stage and is now the most popular gear for heavy power. Other valve gears, notably the Young and the Alfree-Hubbell, are being used to some extent very successfully. The latest development in this field is a new gear which, during the past year, has been applied to a number of locomotives with results that seem to indicate it will fulfil all the claims of its inventors. This gear is called the Baker-Pilliod and is shown in the accompanying illustrations. It is being applied on various railways throughout the country, notably on the Chicago & Alton, where, after a careful trial, it has been specified for use on twenty consolidation, five Pacific type and five six-wheel switching locomotives now being built by the American Locomotive Company.

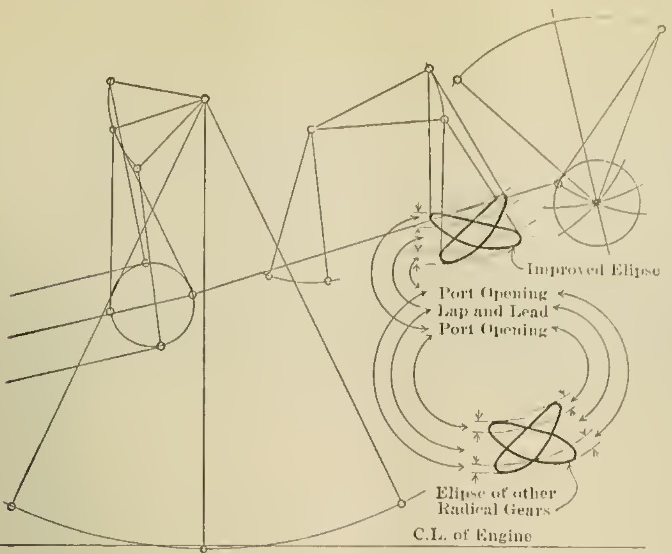



Cards number 1 & 2 taken from engine equipped with the Walschaert Valve Gear
Cards number 3 & 4 taken from engine equipped with the Baker-Pilliod Valve Gear

The mechanical construction of the gear consists of a return crank, from the main crank pin, similar to a Walschaert gear, but having considerably less throw. From this the eccentric rod transfers the motion to the point A, where a link is connected from a bell crank having unequal arms, which is operated from the cross head. This combination of motions gives the point A a circular or elliptical path, depending on the ratio of the arms of the combination lever bell crank. From A the continuation of the eccentric rod is carried to the point C, which is supported by a link swung around the point D, which in turn is swung around the point G by the movement of the reverse lever. When the gear is set, the point D is stationary and the point C follows a radial path, the location and inclination of which depends upon the location of the point D. Thus the link between A and C is given a circular or elliptical motion at one end and a radial motion at the other, which combined gives point B, from which the movement of the valve is taken, a distorted elliptical path, the shape, size and location of which depends on the movement of the point C, and thus the position of the reverse lever. The motion from point B is transferred from the vertical to the horizontal direction by means of the bell crank fulcrumed at E, the downwardly extending arm of which, as is shown in the illustration, operates the valve stem.

All of the motion is carried in a cradle similar to that often used in Pacific type locomotives equipped with Walschaert valve gear, which, in this case, is supported between the guide yoke and the cross tie extending continuous across the frames just back of the first driver and supported by knees secured to the main frame. This cradle carries all of the weight of the gear proper. The pins throughout are hardened steel and run in hardened bushings.

One of the illustrations shows the valve ellipse given by this gear in comparison with the ellipse given by other radial gears, from which it can be seen how this combination of motions




COMPARISON OF VALVE ELIPSES.

works to correct inaccuracies of other designs of radial gears. The indicator cards, shown in another of the illustrations, illustrate these points even more clearly and give a comparison between the Walschaert and the Baker-Pilliod gears, from which the points of superiority of the latter, in the matter of steam distribution, are evident. These cards were taken from engines of the same class, make, and on the same railroad, working in similar service. The most noticeable features illustrated by these cards are the quick opening of the Baker-Pilliod gear, which gives a full port opening on 5 per cent. piston travel in full gear operation, and thus carries full steam pressure up to the point of cut-off; the delayed release which occurs at 90 per cent. of the stroke in comparison with 75 per cent. with the Walschaert, and gives a much longer expansion line; the free exhaust, due to the same cause as the full steam line, *i. e.,* quick movement of the valve at this point; the delayed compression and absence of pre-admission.

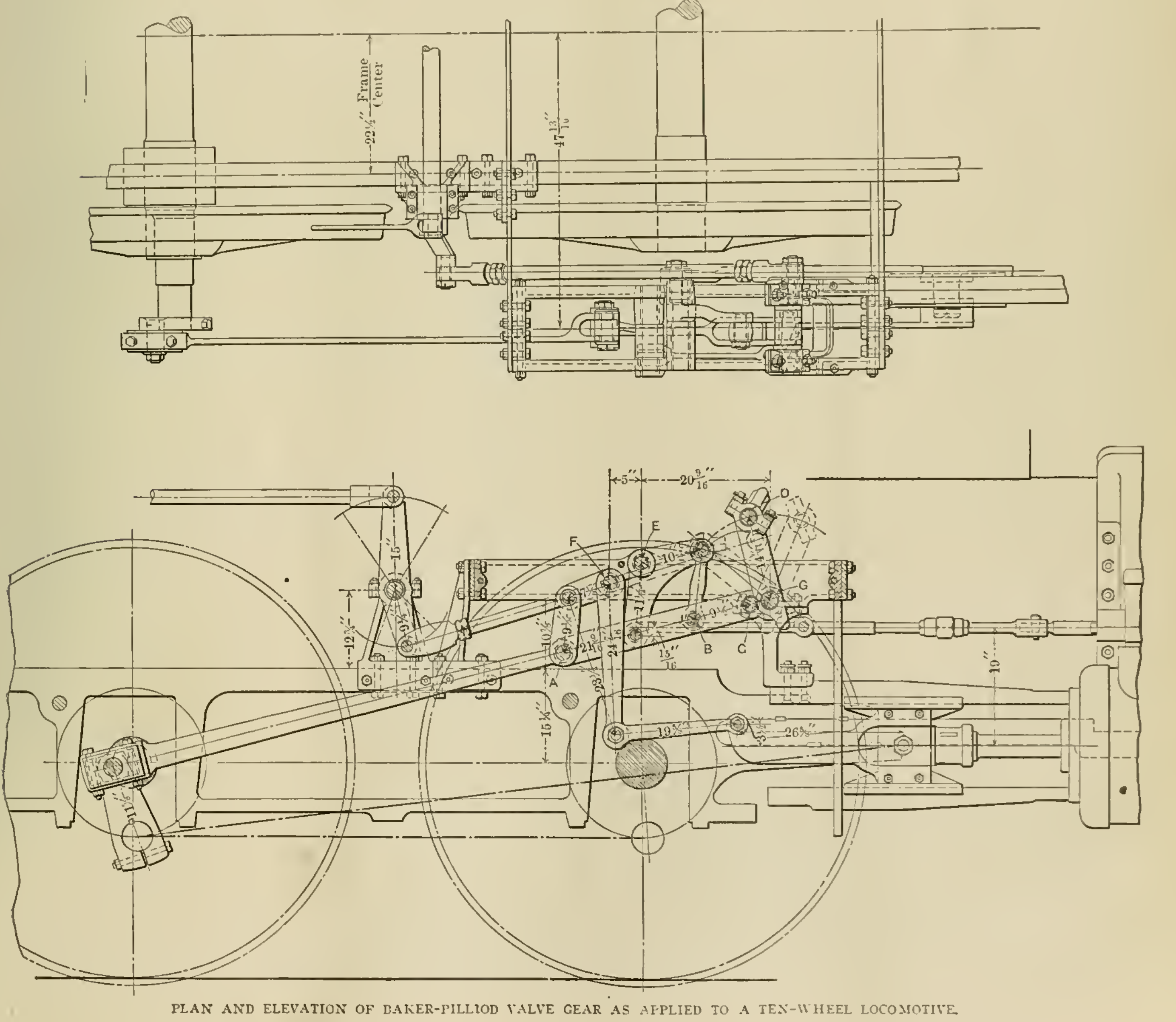
The gear gives a constant lead the same as the Walschaert and weighs 3,236 lbs. total, of which the moving parts on both sides of the engine give but 1,028 lbs. for the locomotive shown in the half-tone. This locomotive (No. 42, T. S. & L. & W. R. R.) was run opposite No. 40 for several months, and during the month of July the comparison of coal consumption is given in the following table:

TOLEDO, ST. LOUIS & WESTERN RAILROAD CO.

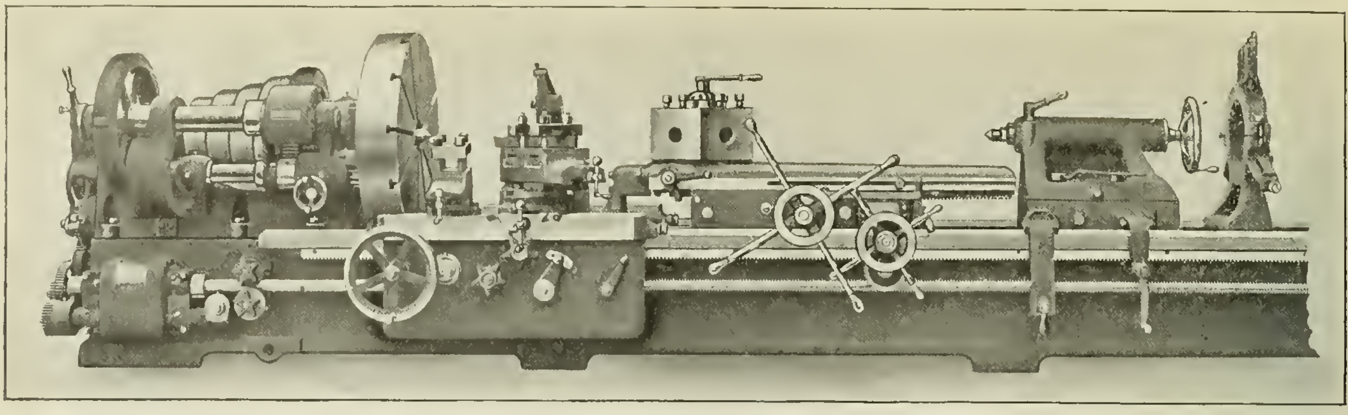
PERFORMANCE OF ENGINES 40 AND 42 FOR THE MONTH OF JULY, 1908.

| | 40 | 42 |
|---|---|---|
| Miles traveled | 4,914 | 5,587 |
| Passenger car miles | 17,286 | 23,151 |
| Tons coal consumed | 280 | 256.5 |
| Average miles run per ton | 17.5 | 21.7 |
| Pounds of coal consumed per engine mile | 111.4 | 91.8 |
| Pounds of coal consumed per passenger car mile | 32.3 | 22.1 |

Engine 40 equipped with Stephenson Link. Engine 42 equipped with Baker-Pilliod Valve Gear.




PLAN AND ELEVATION OF BAKER-PILLIOD VALVE GEAR AS APPLIED TO A TEN-WHEEL LOCOMOTIVE.



AMERICAN TRIPLE GEARED LATHE WITH TURRET ON THE SHEARS.

## 36-INCH TRIPLE GEARED AMERICAN LATHE WITH TURRET ON THE SHEARS.

The American Tool Works Company, Cincinnati, has recently built one of the thirty-six inch, heavy pattern, triple geared lathes with a turret on the shears, as shown in the illustration. The back gears are automatically disengaged when slipping the pinion into the internal gear. The longitudinal feed of the carriage is controlled by a friction, and the cross feed by a saw-tooth clutch, operated by the "star" handle on the apron. The rack pinion in the apron is withdrawn while thread cutting.

The feed box, on the front of the machine, below the head-stock, supplies three instantaneous changes for feeding and screw cutting for every change of gears in the quadrant at the head end of the lathe. The compound rest is fitted with a "four stud" tool holder, the tool resting on a serrated steel base. This rest may also be equipped with a double T slotted top-slide and with regular tool posts set in tandem, which prevents the cutting tool from slipping under heavy duty.

The turret is of new design and is equipped with an indexing mechanism which is self-compensating for wear. This mechanism is located at the front of turret top-slide, bringing the locking-pin very near to the tool. The turret may be tripped or revolved automatically, or by hand; the mechanism may be set so as to be inoperative, when it is desired to run the slide back to extreme limit, without withdrawing the locking-pin or revolving the turret. This is accomplished by the small lever shown near the large pilot wheel. The turret top-slide is supported on its outer end by a gibbed bracket attached to the front of the slide, which travels along the V's of the bed. This support eliminates all tendency to spring under a long reach. The bracket may be removed should the work require that the turret slide pass over the carriage of the lathe. The bottom-slide of the turret is moved along the bed by the pilot wheel shown at rear end. It is clamped to bed by two eccentrics, one at the front end and the other at the rear. It is further secured from slipping, due to severe end-thrusts, by a pawl, which, dropping from the turret, engages a rack cast in the center of the lathe bed.

The turret is supplied with eight carefully selected feeds, ranging from .005 in. to .162 in.; these are entirely independent of the regular carriage and apron feeds. The turret feeds are controlled by the two "star" knobs, carrying index dials, which are shown one directly above the other to the right of the feed box. The dials and pointers indicate at once the feed in inches, as set; all changes may be made while the lathe is running. The "star" knobs operate through shafts, extending through the bed to the quick-change turret feed-box at the rear of head-stock, which is provided with a neat and substantial cover.

Provision is made to quickly attach the turret top-slide to the compound rest slide. This is valuable when it is desired to impart the feeds of the carriage to the turret, such as in large tapping operations. In such cases the taps get a "positive lead," since the screw cutting mechanism may be engaged in the apron and the proper lead thereby transmitted to the turret slide, carrying the tap. This feature relieves the tap of all "dragging at the start" and the "positive lead" prevents the reaming tendency of the tap on the hole, at the start, which would spoil the work. This feature is also of value in ordinary jobs of chasing internal threads with a turret tool.

The turret feeds may be reversed, a valuable feature when it is necessary to "back face" or "counter-bore." Reversal of feeds is controlled by a lever, conveniently located on the driving sprocket of the quick-change turret feed-box.

The taper attachment is of heavy and substantial construction and is designed to eliminate all binding tendencies of the parts, thereby insuring smooth and uniform action. It is given a support on the bed and is supplied with a vernier attachment to facilitate fine adjustment. It is graduated and the entire attachment is bolted to and travels with the carriage. It may be quickly engaged or disengaged at will, without disturbing the taper, as set.

## PORTABLE OXY-ACETYLENE WELDING AND CUTTING MACHINE.

André Beltzer.*

The large advantages which the oxy-acetylene process of welding and cutting offers to manufacturers, railroads and contractors are now pretty generally understood and it is not necessary for me to discuss them in a general way. So I will confine my discussion to a new portable equipment which makes it possible to take advantage of the wonderful possibilities of this new method much more generally than has previously been the case.

Practically all of the welding machines which have been installed in the United States are stationary, that is to say, it is necessary to bring near the machine the pieces which are to be welded or cut. In many cases (repair of a leak in a power plant, repair of a locomotive, etc.) this transportation is impossible, or it means a big cost of handling, and it is necessary to forego the advantages of the process. It is for this reason that the Beltzer-Delcampe Welding Co., Bridgeport, Conn., who are manufacturing welding machines of all sizes, have invented and are manufacturing a portable oxy-acetylene welding and cutting machine weighing not more than 750 lbs., which can be installed on a wagon four by eight feet.

A portable machine can be easily imagined in connecting a tank of oxygen and a tank of acetylene with a blowpipe, but everybody knows that the expense of the two gases compressed in tanks would render the process impracticable, especially for cutting work or repairing of big castings, where considerable quantities of gases are used.

The machines as manufactured by the Beltzer-Delcampe Welding Co. are, however, really small portable welding factories. The two gases, oxygen and acetylene, are liberated in special generators from a cheap powder called "oxyvite" and calcium carbide. The oxyvite has the property of liberating 100 per cent. pure oxygen at a low temperature and absolutely free of any gas

* Chemical Engineer, Bridgeport, Conn.

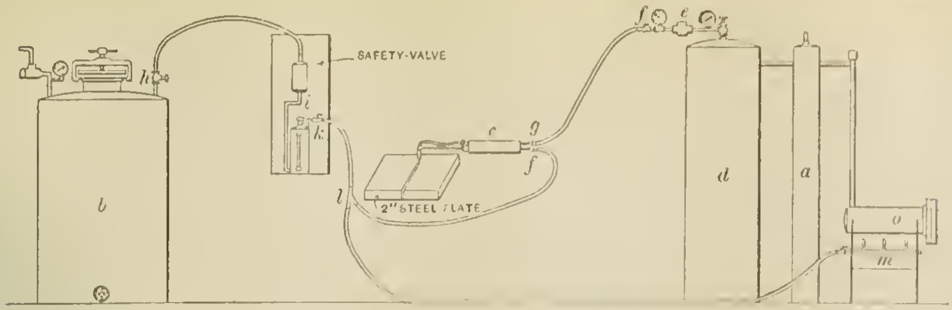



FIG. 2.—DIAGRAM OF CONNECTIONS OF A PORTABLE OXY-ACETYLENE WELDING OUTFIT.

which could corrode the metals and deteriorate the welding machine, as is ordinarily the case with oxygen liberated from chemicals. It is also entirely free of poisonous gases which would incommode the welders.

These machines offer special advantages to a railroad company in connection with the repairing of broken locomotive frames or cracked cylinders without taking them down and makes it possible to do this work in the engine house very conveniently.

A general view of this equipment is shown in Fig. 1 and a diagram of its connections in Fig. 2. The oxygen generator (a) produces, continuously, compressed oxygen gas in the most simple manner from oxyvite which liberates the gas without the slightest danger of explosion. The acetylene generator (b) is of most substantial construction, being specially made for rapid and rough handling. The blowpipe (c) with its set of nozzles, permits the welding of any thickness of sheets up to 1¼ inches, and repairing of castings of any dimensions. The same blowpipe by changing the nozzle, is used for the cutting of steel up to 4 inches thick.

The oxygen pressure tank (d) is fitted with a reducing valve (e), and the exit pipe of the tank connects with the oxygen pipe (g) of the blowpipe. The exit pipe (h) of the acetylene generator is connected with a safety-valve (i), the purpose of which is to prevent the forcing back of oxygen toward the acetylene generator, as for instance in case the exit nozzle of the blowpipe should be stopped by molten metal. The exit pipe (k) of the safety-valve is finally connected with the acetylene cock (f) of the blowpipe. There is a branch at (l) on the acetylene line connecting with acetylene bunsen burners which supply the heat required by the oxyvite retort (o). The acetylene generator is loaded with 12 lbs. of carbide, and the oxygen retort with a corresponding amount of oxyvite. In twenty minutes after the lighting of the burners the oxygen tank is filled with pure oxygen gas at 100 lbs. pressure, and the machine is ready for welding and cutting.

It may be interesting to consider the cutting process in detail, as this is not so well known or easily understood as the welding, and in many cases is the more important use of the equipment.

The principle of the process is very simple. The metal is heated to a red heat by means of the oxy-acetylene flame and a pure jet of oxygen, directed on the red spot, burns the iron to a mixture of the two oxides FeO and $Fe_3O_4$, which flows down, and leaves the narrow part. The great heat liberated by combustion of iron in pure oxygen makes the cutting very rapid. According to Dulong, a French savant, one atom of oxygen 16 grammes liberates, on combining iron, 8,040 calories of heat. The carbon which evidently does not play any active part in the cutting, and is contained in steel only in small quantities, liberates only half of the heat which iron gives: 16 grammes oxygen liberates with carbon but 4,710 calories of heat.

The oxy-acetylene flame which accompanies the jet of oxygen has only a secondary function which is to start the process by heating the iron to the necessary temperature for its quick combustion in oxygen.

It seems very peculiar that all kinds of steel can be cut with this process and that cast iron, whose main component is iron, is cut but very slowly. The reason of this is probably a physical one, i.e., cast-iron melts with the oxy-acetylene flame to a very thick liquid and the jet of oxygen seems to slide on this molten metal without penetrating it.

The following table gives the expense for gases in cutting steel plates of various thickness by the machine under discussion:

| Thickness of Plate, Inches. | Time Required to Cut 1 Foot, Minutes. | Oxygen Required, Cu. Ft. | Acetylene Required, Cu. Ft. |
|---|---|---|---|
| ¼ | 0.6 | ... | .. |
| ½ | 1.0 | 1.5 | 0.5 |
| 1½ | 3.8 | 10. | 2.5 |
| 1¾ | 4.2 | 10.8 | 2.7 |
| 2 | 6.0 | 15.5 | 4.1 |
| 2¼ | 6.6 | 17.1 | 4.5 |

When the metal to be cut is first heated the expense is considerably reduced. For instance, a plate 1¾ inches thick, heated to such a temperature that it begins to become red, can be cut at a speed of 2 ft. per minute, which is eight times faster than for cold metal, and with the cheap oxygen supplied by this machine the cost of cutting a foot of 1¾-in. steel plate is but 3.3 cents.

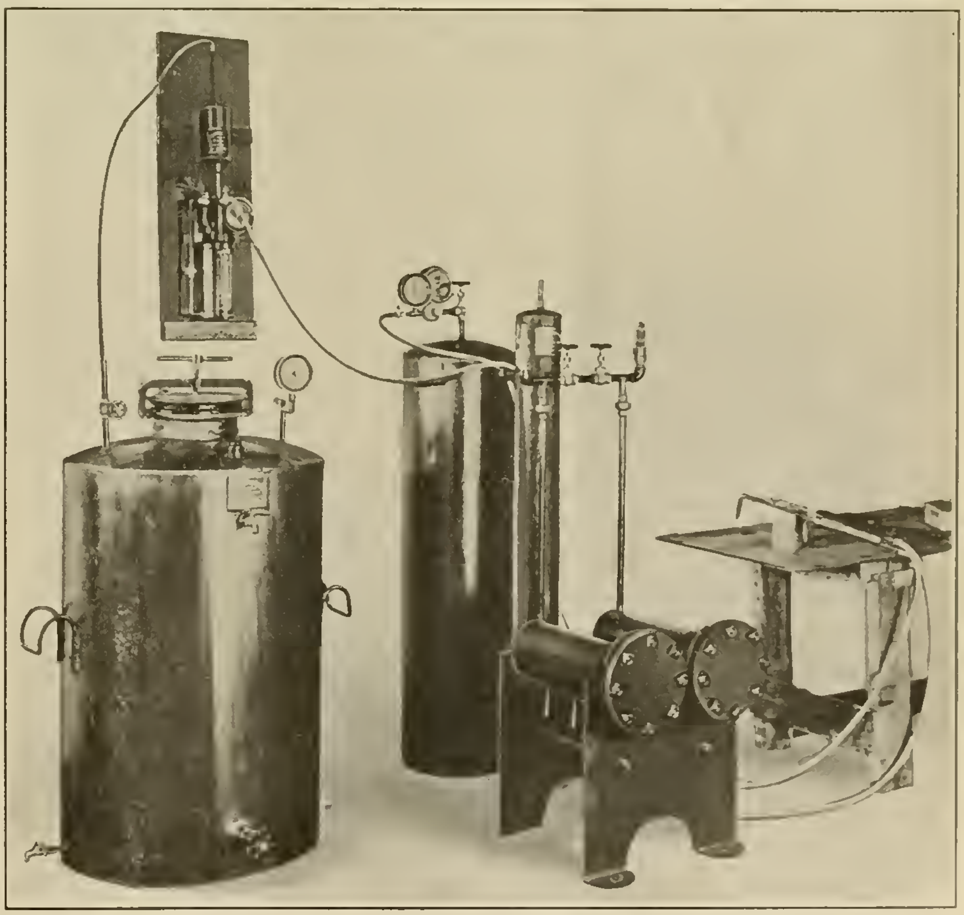
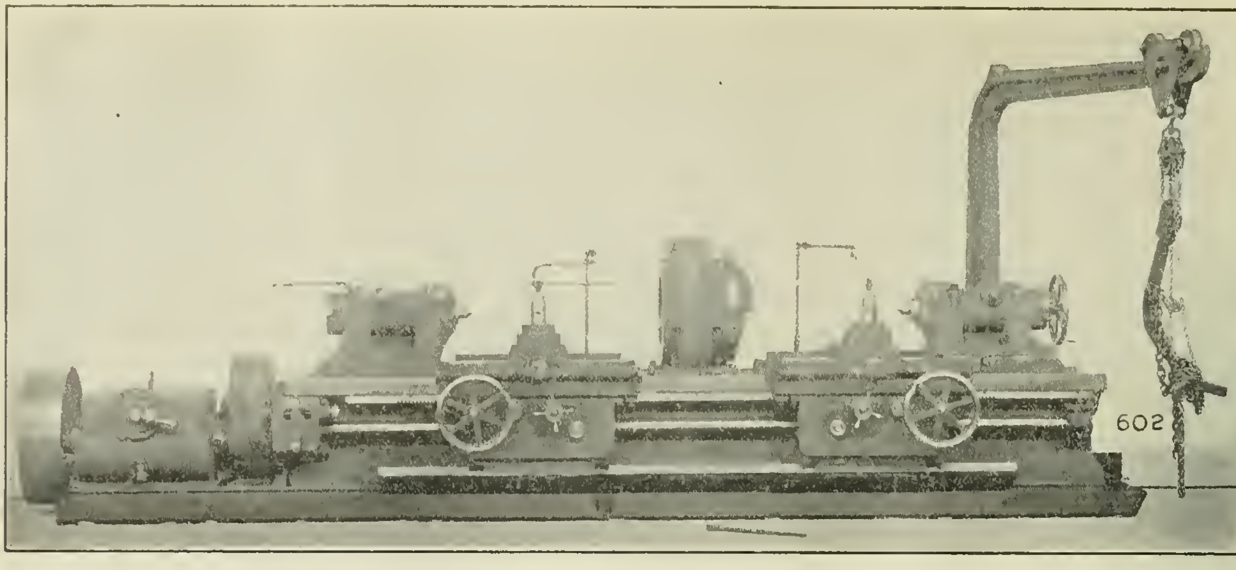


FIG. 1.—PORTABLE OXY-ACETYLENE WELDING OUTFIT.




LODGE & SHIPLEY HEAVY AXLE LATHE.

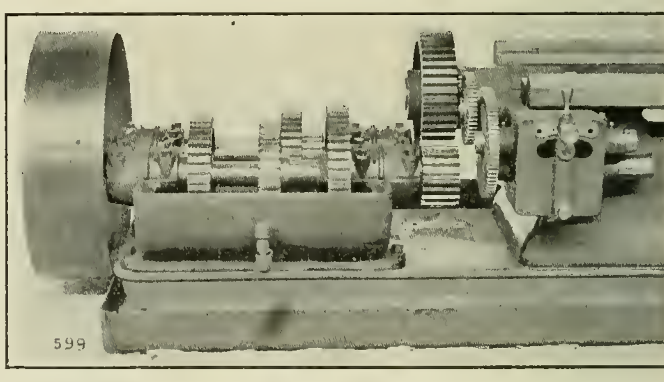
## HEAVY PATTERN AXLE LATHE.

An extra heavy axle lathe, manufactured by The Lodge & Shipley Machine Tool Company of Cincinnati, is illustrated herewith. It is of rigid construction, has a powerful drive and is equipped with all the conveniences which are desirable for this class of work.

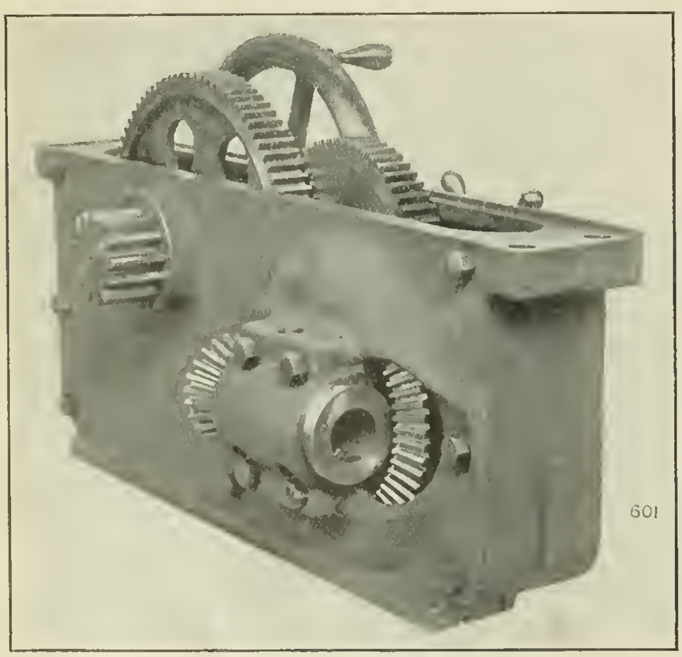
The bed is of massive construction, the cross girths being of box section. A longitudinal member, of box section, is cast in the center of the bed, extending its length, parallel to the outer walls, and is for the purpose of further stiffening the cross girths. The walls of the bed are heavy and the metal on the upper and lower edges is as nearly equal as possible. The ends of the bed are cut away to facilitate the removal of the tailstock, or permit of a reasonable overhang for unusual lengths of work. In addition to the front and rear V's, with the inner flat tracks, an additional 45 degree plain surface has been machined upon the bed to support the carriage apron at the bottom.

The drive is simple and powerful. Power is applied to a constant speed pulley of large diameter and wide face, running at a high velocity. The variation in speed is obtained by sliding gears, which run in a bath of oil. All shafts are carried in bushed, positive ring oiled bearings. All gearing is of steel. The driving shaft is of large diameter and is held in alignment by a number of journal blocks bolted to the bed. There is no overhang of the pinion of the main driving gear, the shaft being supported on either side of it in long bearings. The large gear, meshing with this pinion, is placed in the center of the drivng head, and like the pinion has a double bearing. A powerful compensating driver is secured to the gear in the head by dogs which are faced with steel plates.

All feed gears are of steel. The speed of the splined feed rod is governed by the gear train driving from the main shaft through a change gear box, giving three feeds which may be changed while the lathe is in operation.




DRIVING AND FEED GEARS.

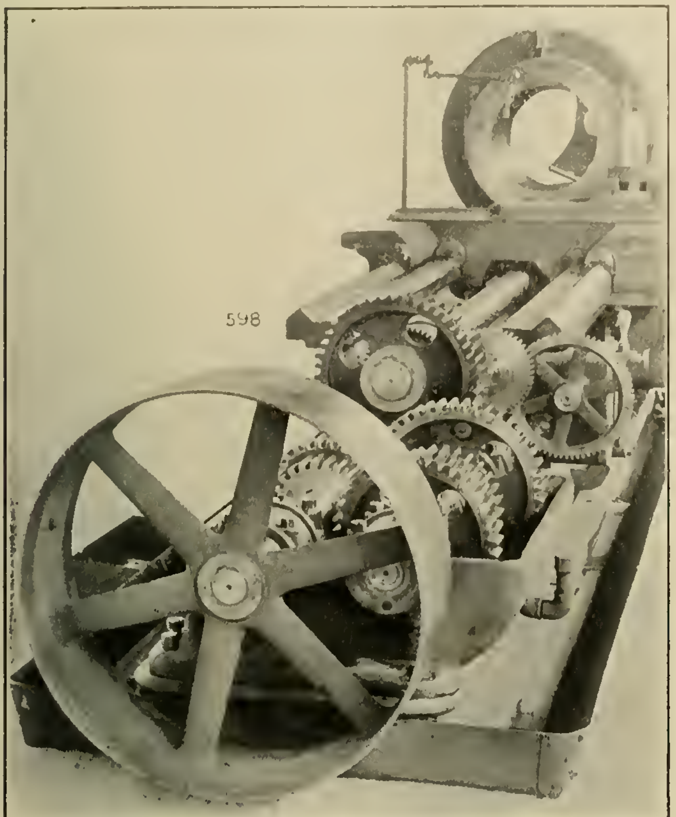



DOUBLE, OR BOX APRON.

The apron is of compact box construction, which is tongued and grooved into the carriage. In addition to the clamping arrangement of the apron to the carriage, the apron is further supported by a third V cast on the bed, and in such position as to be directly under the apron. The purpose of this is to support the apron at the bottom for both vertical and transverse stresses. The spring of the apron due to the thrust from the rack pinion is thus effectively overcome.

In addition to the bearing on the V's, on the front and rear shear of the bed, the carriage also has a flat bearing, or track, on the inside of the front shear. A further angular bearing of 45 degrees tends to secure a permanent alignment of the carriage with the bed. The carriage bearing upon the bed is of importance because of the great thrust from the burnisher, as well as from heavy cutting. Water troughs are provided around the tool slide and wings of the carriage. The tool posts are arranged with hardened toothed plates interlocking with the tool and effectively preventing any possibility of the tool swiveling, or slipping, under the heaviest cuts. The tool slide is of steel.

The tailstocks are of massive construction and firmly bolted to bed. A pawl, engaging with a rack, cast in the bed, is attached to each tailstock, this design tending to relieve the strain on clamping bolts and overcome the thrust of heavy cutting, when blunt cutting tool angles are used. The tailstock, at the driving end, has a stationary spindle with no transverse adjustment, the necessary adjustment being obtained from the spindle of the second tailstock, which is provided with a transverse adjustment. The plug clamps for binding the tail spindles are of




END VIEW OF AXLE LATHE WITH GEAR CASE REMOVED.

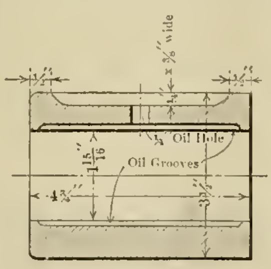
improved design; there are two instead of one for each tailstock, and they are placed at the top of the spindle barrel.

Provision is made for delivering an adequate supply of water to the tools; all journals are copiously supplied with oil by means of positive automatic oil rings.

## 22-INCH CINCINNATI PLANER.

Until recently The Cincinnati Planer Company, Cincinnati, Ohio, has not built planers smaller than 24 inch. A short time ago, however, it added to its line a machine which planes 22 in. wide, 22 in. high and 5 feet in length, with two cutting speeds, 24 and 50 ft. per min.

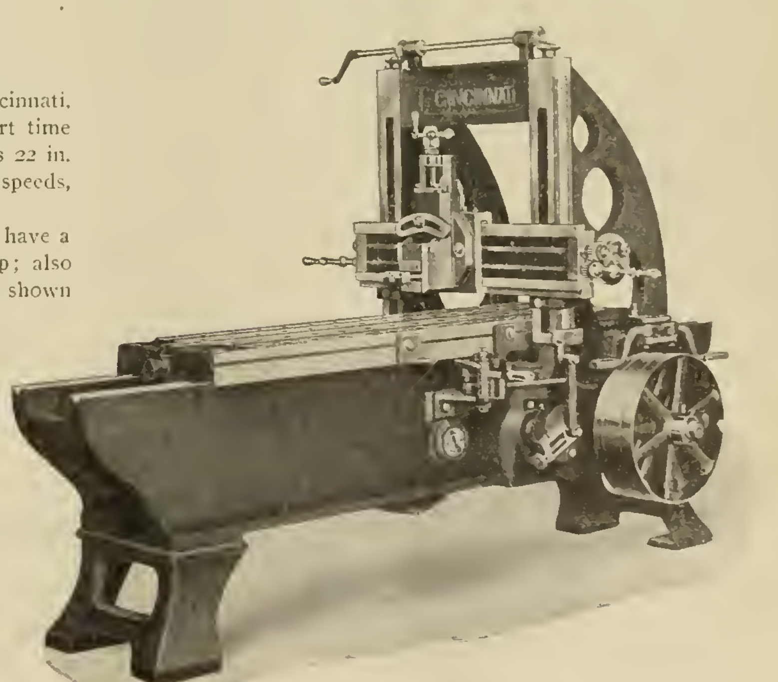
The bed is bored for shaft bushings and these bushings have a groove milled on the outside about ⅜ in. wide and deep; also an oil groove cut on the inside, both on top and bottom, as shown




in the sketch. This method insures positive lubrication and prevents the scoring of the shafts. The bed is fitted with oil rollers for automatically oiling the ways.

The shifting device is of a new and simple construction and is designed with special reference to high speed and short stroke work. It is provided with a safety locking device and with a handle on the rear side of the bed so that the machine may be operated from either side. The crank handles on the rail are fixed in their places and the handle itself is fitted loose so that the operator can retain a tight hold on it while turning the screw or rod rapidly.

The saddle is graduated to 360°, or a full circle, so that the angles may be read from both sides of the machine. The down feed screw is fitted with a collar graduated to thousandths. The gearing is very powerful and cut from solid stock; the large gears and rack are made from semi-steel castings, and the pinions from steel forgings. While all of the parts of the machine have been made very rigid for heavy service, special attention has been given to facilities for rapid handling.



CINCINNATI 22-INCH PLANER.

## STOPPING BLOCK FOR ENGINES IN ROUNDHOUSE.

There is a point which I wish some one might bring out, and that is a means of preventing locomotives from passing through the outer walls of the house occasionally. In the modern houses we have large air ducts under the floor around the outer walls of the house, and if this thing, which has happened so frequently in the past, continues to happen, the results will be somewhat serious to the structure and, incidentally, to the record of the output of the locomotives from the roundhouse for the time being.

We experimented with a cast iron chock to prevent the engine from going too far, using one that would allow the pilot to pass over it, bolting it securely to the rails. By repeated trials it was quite conclusively shown that any chock that would allow the pilot to pass over it would not be sufficient to stop an engine if it got beyond control even to a moderate extent only. From the result of these experiments a chock was made and used in one house, and will be used in at least one other, which stands up about ten inches above the rail, fitting the shape of the ordinary wheel which will strike it, but, of course, before the wheel gets to it the pilot will be broken or, in case the engine backs against it, some of the brake gear may suffer. We concluded that it was better to run the chance of some slight damage of that kind than the more serious damage that would result from breaking into the air duct and through the wall, at the same time probably causing serious injury to the locomotive.—*William Parker before the New England Railroad Club.*

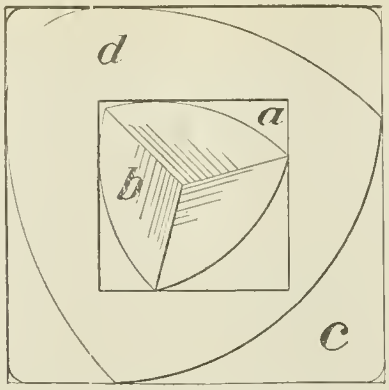
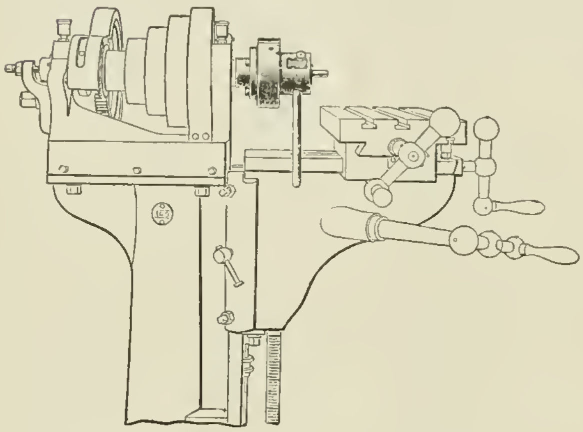
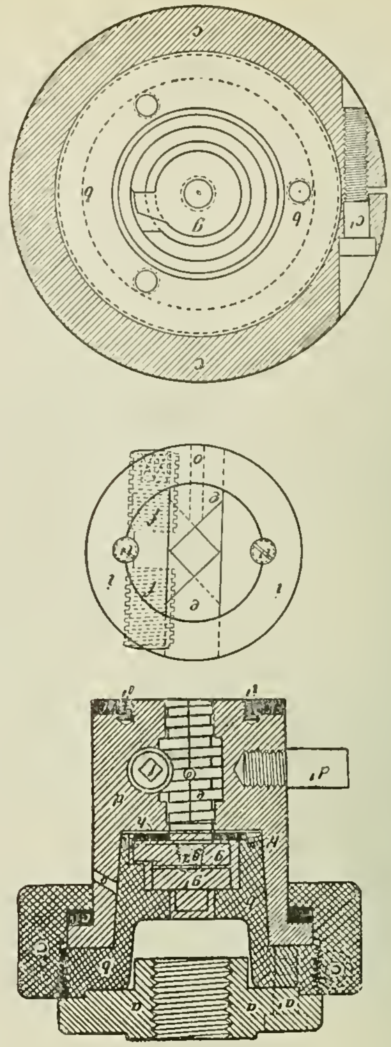



DIAGRAM ILLUSTRATING THE WORKING OF THE DEVICE.



APPLICATION OF CHUCK TO MILLING MACHINE.



DETAILS OF CHUCK FOR BORING ANGULAR HOLES.

## BORING SQUARE HOLES.

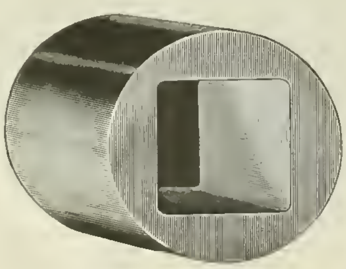
An attachment, or chuck, which may be used on a lathe, milling machine, or drill press, for boring square or angular holes in metal, has been used with success in Germany during the past two years.

The chuck, which is shown in the illustrations, consists essentially of three parts; first, a driving part, which is screwed to the spindle of the machine; second, a stationary part, which may either ride upon the first part by means of a bearing, or be fastened directly to the frame of the machine; and third, a part into which the shank of the drill is screwed and which is caused to rotate by the first part, but is also free to move sidewise to a certain extent. This sidewise motion is limited by a guide or matrix in the second or stationary part, the exact amount and form of the motion being determined by the shape of the guide and by the shape of the shank of the tool.

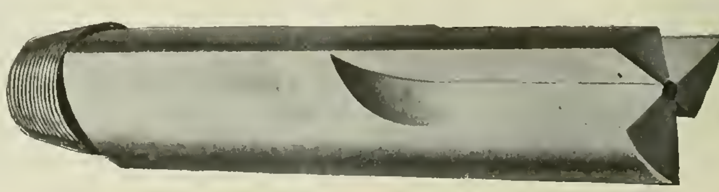
The tool for boring square holes has a three-cornered shank, the sides being segments of circles struck from the opposite angles or edges as centers, and the radius of all three circles being the same or equal to one side of the square guide in which the shank turns. By reference to the diagram, it will be seen that when one side of the shank is either rolling or sliding upon one side of the square guide, the opposite edge of the shank will move in a straight line. This holds true for all positions of the shank except for a very small distance at the corners. If it is desired to bore a square hole with sharp corners a special tool is employed having a shank considerably larger than the cutting head, one of the corners of the shank being rounded instead of angular. The exact form of this shank has been worked out empirically and standards have been made for all the sizes of holes likely to be needed in practical work.

The cutting edges of the tool are on the end, as in the case of either flat or twist drills. To do commercial work with this device, it is necessary to have as many different drills as there are sizes of holes to be bored, but the matrix or guide in the stationary part of the chuck can be adjusted to a considerable range of sizes, making only one chuck necessary. Where it is desired to bore triangular, pentagonal, or hexagonal holes, or other forms of holes, a corresponding tool and matrix may be supplied.

For grinding the drills a special attachment is used, which may be applied to any grinder.



AN EXAMPLE OF THE WORK DONE.



AN ANGULAR DRILL FOR DRILLING SQUARE HOLES.

The Radical Angular Drill & Tool Company control the patents for this country, and are demonstrating the working of these drills at 114 Liberty street, New York, with a view to introducing and manufacturing the device in this country.

## THE ABUSE OF THE MASTER CAR BUILDERS' ASSOCIATION REPAIR CARD.*

J. J. Hennessey.

If, as required by the Master Car Builders' rules, the road which did the incorrect work applied a M. C. B. repair card covering the items objected to, its identity would of course be immediately known, and the adjustment of the account would be a very easy matter. The application of the repair card in all cases of repairs to foreign car equipment as required by the M. C. B. rules, is not, I am very sorry to state, being done, and the fact that these repair cards are not being applied, brings to us a very difficult problem for solution. The road with which I am connected has cases coming up every day where our cars are offered home to us with wrong repairs to sills, trucks, draft gear, and other very expensive parts of our equipment, and the expense of correcting these is enormous, and we cannot afford to bear it. The repair card is invariably missing, and we are then forced to the only method of ascertaining by whom the repairs were made, and this leads us to that same old story of tracing with its attendant voluminous correspondence, loss of time, and expense, to say nothing of the burden placed upon the office forces of our motive power and car accounting departments. This difficulty has been growing worse from year to year, until now it presents a very serious condition with no apparent relief in sight. It is to be deplored that this particular rule is so flagrantly violated.

In the regular course of business our cars drift hundreds of miles from home and we have to depend upon the honesty of the foreign lines in the matter of repairs and the rendition of bills. There are instances without number where foreign roads have noted upon their repair cards that wheels were renewed account of sliding, axles renewed account cut journals, air hose renewed account missing, and numerous other parts repaired or renewed, for which the possessing road assumes the expense of such repairs because of the manner in which the defects were brought about. If the foreign lines were dishonest they could have reported such defects as the result of ordinary wear and tear and rendered bills for the work. It would not, therefore, be consistent for us to assign dishonesty as the cause of non-application of the repair card when repairs are made to foreign cars.

My personal opinion is that it is due to indifference on the part of our repair men. I have heard it said that the application of the repair card is not really necessary in view of the fact that the stub of such card reaches the car owner with the repair bill, or when sent through the mails in case no bill is rendered. This we all know is a grave mistake, as it is necessary to know immediately, when the car reaches home, where the incorrect repairs were made in order to avoid the objectionable tracing. It has also been stated that insufficient time is given to execute and apply repair cards when making up trains or when trains stop for only a brief period at repair points. I have looked into this and found that by having repair cards dated and signed, that it requires only a trifle more additional time to fill in the other necessary data and apply the card, as it means only minor repairs such as air hose, journal bearings, brake shoes and the like. I am therefore satisfied that this objection can be overcome if only an effort is made.

The road with which I am engaged has what we term a traveling inspector, who is continually traveling over our system. It has been made part of his duties to look over foreign cars taken off our various repair tracks; also such foreign cars as receive minor repairs in the yards. If he finds any repairs made to such cars and no repair card attached covering the items, he reports it to headquarters and also to the foreman in charge at the local point, and the party at fault is easily located and disciplined. Headquarters also censure the foreman for allowing such violation, so that there is considerable incentive for the foremen to be vigilant in this regard. We have found this to be productive of very good results, and we have also found that the mere issuance of an order to apply repair cards in all cases of foreign car repairs, does not bring about the desired result; there must be something done to show that you mean to have the order obeyed.

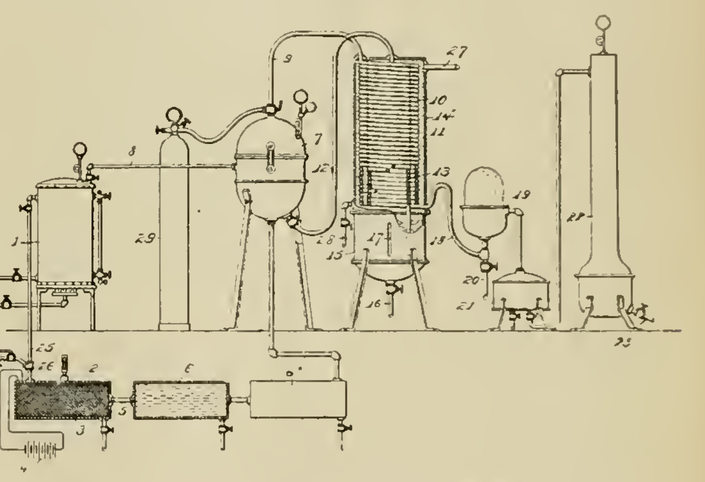
* Extracts from a paper read before the December meeting of the Western Railway Club.

## DENATURED ALCOHOL FROM NATURAL GAS.

The production of denatured alcohol from natural gas can be made at a cost which permits it to compete successfully with gasoline or other petroleum products for light, heat or power. The apparatus for this distillation is shown in the accompanying illustration, being patented by the Continental Natural Gas Alcohol Company of Wheeling, West Virginia.

The percentage of methane contained in natural gas varies with the locality, but on an average it is about 94 per cent. The percentage of alcohol which may be produced from the gas varies with the percentage of methane. The processes consist of subjecting the natural gas to an electrically heated German silver, closely woven, fine wire gauze coiled and enclosed in an enamel retort. By subjecting the gas to heat and combining it with oxygen in the presence of steam, which prevents complete combustion and maintains the temperature below the decomposition point of alcohol; destructive distillation or oxidation of the gas is induced, resulting in the latter being converted into a fluid containing alcohol, benzol, nitric acid and prussic acid in varying proportions.

Referring to the illustration, the German silver gauze, electrically heated, is contained in retort No. 2, from which distillate



APPARATUS FOR DISTILLATION OF ALCOHOL FROM NATURAL GAS.

goes to retort No. 6, where it is partially cooled and condensed and by specific gravity the products of condensation are partially separated. These are then passed directly to an airometer 7. From the airometer the volatile products are passed under pressure, through a pipe 9 to the outer coil 10 of a water cooled distillator 11, while the condensed or liquid portion of the product is passed in the form of alcohol and dehydrogenated alcohol, through a pipe 12 to the inner coil 13 of the distillator, thence directly conveyed into a manometer 15, and then drawn off through an outlet tube or faucet 16, a specific gravity meter 17 being employed, whereby the separation of the liquid into its various constituents is facilitated. For further refining, the product of distillation, which has passed to the overflow vessel 19 of a vacuum type with an outlet tube 20 may be conducted through a filter 21, and thence through a hydrometer 22 connected with pipe and faucet 23. 24 and 25 respectively indicate the gas and steam pipes, which are connected or united at 26 for directing the gas and steam together into the retort 2. The connections shown illustrate but one of various methods which may be employed.

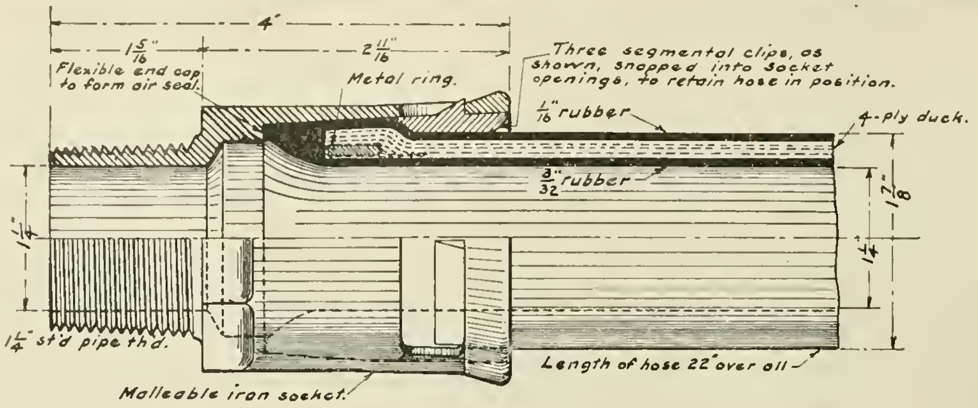



FIG. I.—METHOD OF ATTACHING "NB" CONNECTION TO AIR BRAKE HOSE.

## "NB" AIR BRAKE AND SIGNAL HOSE CONNECTION.

The George M. Newhall Engineering Co., Ltd., of Philadelphia, Pa., are putting on the market a device designated as the "NB" air brake and signal hose connection. This was designed by E. D. Nelson, engineer of tests, Pennsylvania Railroad, and W. L. Brown, his assistant.

The objects sought in designing this coupling were to overcome injury to the soft inner tube of the hose by the nipples used in the ordinary form of mounting and to secure a method of fastening the hose to the metal parts which would be free from the danger of a hose pulling off the fitting.

The "NB" coupling is so designed as to avoid any contact of the metal parts with the soft rubber lining of the hose, and, therefore, preserves it against injury, thus leaving it free to perform its function of sealing the hose structure against small leaks, which eventually may cause bursting. (When the hose is inserted in the coupling the clip, as shown in the illustration, is driven against the shoulder of the hose until the lug on the clip springs into place through the aperture in the coupling. The hose is thus securely mounted without having anything in contact with the inner tube.)

Every railroad man, who has made a study of hose failures, knows that while the strength of the hose depends primarily upon the ability of the duck wrapping or jacket to hold the pressure, the safety of the hose against bursting depends absolutely on the integrity of the inner tube. A defect in the rubber lining permits air to find its way between and into the layers of duck, breaking through one or two of the inner layers and leaving only the outer layers to sustain the inner pressure. The pressure then, having only the remaining layers left, causes a rupture, and the result is a burst hose. The effect in freight service may be disastrous, due to the emergency application of the brake.

The internal nipples now generally used are responsible for a large percentage of such failures, because the constant swinging of the hose is resisted by the end of the nipple against the soft rubber tube, cutting into it and permitting the air to escape through and into the duck wrappings.

Carefully kept records show that about 60 per cent. of the hose failures in freight service are due to the bursting of hose at the nipples, and in passenger service the percentage is still higher. As will be seen from the cut, the use of "NB" couplings absolutely eliminates failures from this source.

Hose mounted with the present standard fittings and with this improved form of fitting have been pulled apart in the same way as occurs in service when cars are separated, but the air brake coupling not uncoupled by hand. The result of repeating this a very large number of times showed marked cutting of the nipple in the inner tube with the standard fitting, and no injury whatever to the inner tube with the improved form of fitting.

As to security against pulling off, repeated trials have demonstrated that when mounted with the "NB" coupling the body of the hose has torn apart in every case, leaving the end of the hose still attached to the fitting.

The form of air brake and signal couplings and threaded nipples is the same as that in common use, so that there is no change in standard so far as the couplings and car fittings are concerned. "NB" hose and couplings can be mounted as quickly and as easily as the present M. C. B. standard.

This new coupling has the decided advantage of being practically indestructible. All the parts can be used over and over again, whereas with the present system it is always necessary to have new bolts and nuts, and in most cases new bands for every mounting.

Arrangements have been made with several of the largest hose manufacturers to make this special end on the M. C. B. or individual railroad specifications hose. It can also be obtained from the manufacturers of the coupling if desired.

"NB" AIR BRAKE AND SIGNAL HOSE CONNECTION.

## FOLDING DOORS FOR ROUNDHOUSES.

The accompanying illustration shows a roundhouse on the Cincinnati, New Orleans and Texas Pacific Railroad at Ferguson, Ky., in which there are twenty-one Ritter folding doors in use. This type of door has proven to be very successful for use at freight and store houses and would seem to be even better adapted for roundhouses.

One great advantage is, of course, that it occupies no ground

space when open and requires very little clearance up to a point as high as the top of a tank. Again, it cannot blow closed like a swinging door; it allows a maximum of clearance between cab and post, equalling a rolling door in this respect; it closes tightly and keeps the house warm; is easily operated by one man and thus will be kept closed in cold weather, and finally it permits a maximum of lighting area. All of these points are of great importance in a roundhouse in cold climates.

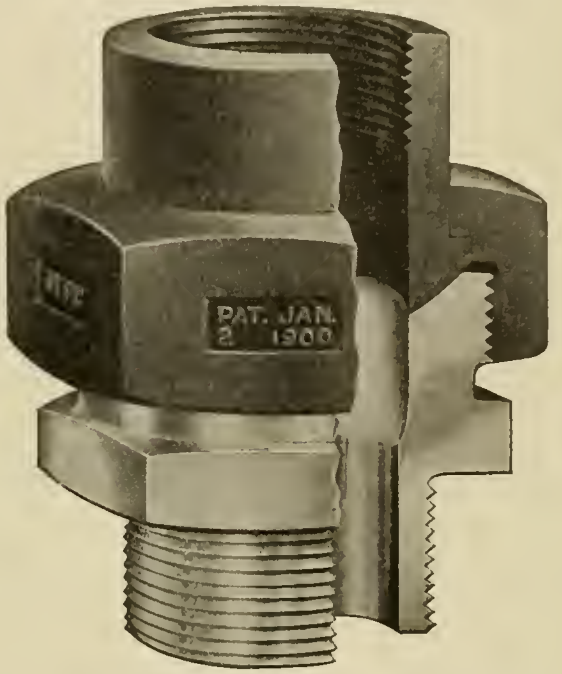
The construction is evident from the illustration. The operation is by an endless chain over a chain wheel at the top, which is direct connected to a drum operating the chains attached to both sides of the door at the bottom and carrying counterbalances at the other end.

Doors of this type are also in use in roundhouses on the Cincinnati, New Orleans & Texas Pacific Railway and the Cincinnati, Hamilton & Dayton Railway and have been specified for some other roads. It has also been used in machine shops on quite a number of roads with entire satisfaction.

This design of door, in either steel or wood, is manufactured by the Ritter Folding Door Co., Cincinnati, O.

## KEWANEE AIR PUMP UNION.

The National Tube Company, 1608 Frick Building, Pittsburgh, Pa., has recently brought out a new union for use in connection with locomotive air pumps. This design has a number of advantages over the type in ordinary use, principally due to the fact that it does not require the use of a gasket and the thread




connection is between brass and iron and hence not liable to corrosion. It has a ball seat arranged as shown in the illustration, which forms a tight joint without packing. These unions are thoroughly tested under 100 lb. pressure of compressed air before being put on the market and are guaranteed to be absolutely tight.

## PERSONALS.

Manual Parra has been appointed master mechanic of the Mexican Ry. at Apizaco, Tlax, Mex., to succeed J. B. Cozart.

J. B. Cozart, master mechanic of the Mexican Railway at Apizaco, Puebla, Mex., has resigned to go to the Pan-American Ry.

W. A. George has been appointed superintendent of shops of the Atchison, Topeka & Santa Fe Ry., with office at Albuquerque, N. Mex.

Edward C. Cole has been appointed traveling engineer of the Iowa Central R. R., with office at Des Moines, Iowa, succeeding W. B. Ferris.

F. H. Reagan has been appointed assistant superintendent of shops of the Lake Shore & Michigan Southern Ry. at Collinwood.

Clarence Lessels has been appointed mechanical engineer of the Guayaquil y Quito R. R. of Ecuador, S. A., with office at Guayaquil.

J. K. Witman has been appointed superintendent of materials and supplies of the Philadelphia and Reading Ry., vice John H. Rankin, deceased.

Calvin Schreck has been appointed head foreman of engines of the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Bellefontaine, Ohio.

A. West has been appointed master mechanic of District 1 of the Canadian Pacific Ry., with office at Kenora, Ont., succeeding A. H. Eager.

B. H. Lent has been reappointed road foreman of engines of the Arizona division of the Atchison, Topeka & Santa Fe Ry., with office at Needles, Cal.

B. F. Kuhn has been appointed general foreman of the Collinwood shops of the Lake Shore & Michigan Southern Ry. vice F. H. Reagan, promoted.

T. N. Ely, chief of motive power of the Pennsylvania R. R., has been granted a protracted leave of absence to visit Italy, France and Egypt. He sailed December 12

George K. Anderson has been appointed road foreman of engines of the Albuquerque division of the Atchison, Topeka & Santa Fe Ry., with office at Winslow, N. Mex.

W. L. Hudson has been appointed road foreman of engines of the Pittsburgh division of the Pennsylvania R. R., succeeding J. K. Russell, retired, with headquarters at Pittsburgh.

The offices of M. S. Monroe, master mechanic, and J. P. Callahan, master car builder, of the Chicago, Lake Shore & Eastern Ry., have been moved from South Chicago, Ill., to Gary, Ind.

E. J. Shoffner, foreman of the frog and rail mill of the Norfolk & Western Ry. at the Roanoke shops, has been appointed general foreman at Cleveland, Ohio, succeeding H. F. Staley.

Daniel Royce, formerly assistant editor-in-chief of the *Railway Age,* has been appointed assistant to W. V. S. Thorne, director of purchases of the Harriman Lines, with office in New York City.

A. W. Horsey has been appointed master mechanic of the Chalk River section of District 4 of the Canadian Pacific Ry., with headquarters at Smith's Falls, Ont., succeeding G. T. Fulton.

W. H. Thorn has been appointed general storekeeper of the Chicago, St. Paul, Minneapolis & Omaha Ry., with headquarters at the St. Paul, Minn., shops, succeeding G. A. Gipple, assigned to other duties.

W. J. Spearman has been appointed general foreman of the Missouri Pacific and St. Louis, Iron Mountain & Southern Rys., with office at Kansas City, Mo., succeeding A. Hewitt, assigned to other duties.

W. D. Knott has been appointed purchasing agent of the Atlanta, Birmingham & Atlantic Ry., with office at Atlanta, Ga. The duties of purchasing agent have previously been performed by Alex Bonnyman, general manager.

Frederick Regan, formerly with the Chicago & Alton R. R. in the motive power department, has been appointed master mechanic of the southern division of the Kansas City Southern Ry., with headquarters at Shreveport, La.

H. F. Staley, general foreman of the Norfolk & Western Ry. at Bluefield, W. Va., has been appointed master mechanic of the Carolina, Clinchfield & Ohio Ry., with office at Johnson City, Tenn., succeeding H. L. Hobbs, transferred.

P. C. Staley, foreman of the Mifflin shops of the Pennsylvania R. R., has been transferred to the Altoona car shops. E. H. Newbury, assistant engine house foreman at Derry, Pa., succeeds Mr. Staley. G. C. Schneider, inspector at Renova shops, succeeds Mr. Newbury.

T. P. Dunham, foreman of the Holidaysburg shops of the Pennsylvania R. R., has been transferred to roundhouse No. 3 at Altoona. P. C. Kapp, foreman of the State Line shops, succeeds Mr. Durham. C. D. Barrett, inspector on the New Jersey division, succeeds Mr. Kapp.

J. T. Robinson, master mechanic of the Seaboard Air Line at Savannah, Ga., has been appointed master mechanic at Jacksonville, Fla., succeeding H. P. Latta. He will have charge of all mechanical matters on the Seaboard Air Line in Florida. J. W. Sasses, general foreman of shops at Raleigh, N. C., succeeds Mr. Robinson.

John Reed, of the mechanical department of the Oregon Short Line at Salt Lake City, Utah, has been appointed general superintendent of the Salt Lake & Ogden Ry. at Salt Lake City, in place of A. D. Pierrson, resigned. Mr. Reed is succeeded by George Wilson, chief clerk of the master mechanic at Pocatello, Idaho.

J. E. Hickey, master mechanic of the International Ry. of Mexico, has been appointed superintendent of shops of the Mexican Central R. R., at Aguascalientes, Aguas., Mex., succeeding G. F. Tilton, assigned to other duties.

Joseph Bryan, owner of the Richmond (Va.) *Times Dispatch,* died at his home just outside the city of Richmond, on Friday, November 20th, after an illness of only a few days. Mr. Bryan was president of the Richmond Locomotive & Machine Works from 1898 to 1901, when the company was purchased by the American Locomotive Company, and at the time of his death was a director of the American Locomotive Company and managing director of the Richmond plant.

J. D. Harris has been appointed general superintendent of motive power of the Baltimore & Ohio R. R., succeeding J. E. Muhlfeld, resigned. Mr. Harris began railway work as a machinist apprentice on the Pennsylvania Lines West in October, 1889. He later became a locomotive fireman, and in March, 1895, was made assistant foreman and later foreman of the machine shops of the Pittsburgh, Fort Wayne & Chicago Ry. In February, 1897, he was made assistant road foreman of engines, and five months later became assistant engineer of motive power of the Northwest System of the Pennsylvania Lines West. In January, 1898, he was made master mechanic of the Eastern and Toledo divisions, with headquarters at Crestline, Ohio, and the next year was made master mechanic of the Cleveland & Pittsburgh, now part of the Pennsylvania Lines West. In 1901 he was made assistant to the general superintendent of motive power of the Baltimore & Ohio R. R., which position he held for two years, and then became assistant chief engineer and works manager of the Westinghouse Co., holding this position until his recent appointment.

Richard H. Soule, for thirty years active in railway work, died at his home, Brookline, Mass., December 13. He was born in 1849 at Boston, Mass., and began railway work in 1875 as draftsman in the mechanical engineer's office of the Pennsylvania Railroad, at Altoona, Pa. Two years later he became assistant in the test department. In 1879 he was made superintendent of motive power of the Northern Central. In 1881 he became superintendent of motive power of the Philadelphia & Erie division of the Pennsylvania, and a year later was made superintendent of motive power of the Pittsburgh, Cincinnati & St. Louis, now part of the Pennsylvania Lines West. In 1885 he was made superintendent of motive power of the New York, West Shore & Buffalo, now part of the New York Central & Hudson River, and later in the same year became superintendent of motive power of the New York, Lake Erie & Western, now the Erie, and two years later was made general manager. In 1888, leaving railway work, he became general agent for the Union Switch & Signal Co., but returned to the railways in 1891 as superintendent of motive power of the Norfolk & Western. From 1897 to 1899 he was with the Baldwin Locomotive Works, traveling for one year in South Africa and Russia, and for a year and a half was Western representative at Chicago. In 1900 he opened offices in New York as consulting engineer, retiring in 1905. Mr. Soule's series of articles on the arrangement and design of railway shops, which appeared in The American Engineer and Railroad Journal during 1903 and 1904, are regarded as classics on that subject. He was very active in the work of the Master Mechanics' and Master Car Builders' Associations.

George W. West, superintendent of motive power of the New York, Ontario & Western Railway, died on the evening of December 24, 1908, at his home in Middletown, N. Y. He had been in poor health for some time, suffering from kidney trouble and a weakened heart. Mr. West was born April 3, 1847, at Troy, N. Y., and hence was over 61 years of age. He has long been one of the best known and foremost motive power men of the country and has done his full share in advancing the science and practice of rolling stock design and maintenance. For many years he has been one of the most valuable members of the Master Mechanics' and Master Car Builders' Associations and has prepared some of the most important reports and discussions that have been presented. He was president of the Master Mechanics' Association in 1902 and 1903. He has also been very active in the New York Railroad Club, of which he was a member for nearly 20 years. He was elected a member of the executive committee in 1892 and for the past seven years has been its chairman, having been re-elected at the last annual meeting. He was president of this club in 1894. He was also a member of the executive committee of the Central Railway Club and was president of that organization in 1901 and 1903. His character and manners were such as to compel admiration and to win him a very large circle of most loyal friends.

Mr. West was educated in the public schools at Troy and entered railway service as a machinist on the New York Central & Hudson River R. R. at Schenectady, in 1865. In 1867 he was transferred as foreman at Syracuse where he remained until 1873. For the following ten years he was master mechanic of the Chenango Valley R. R. and on its absorption by the West Shore Railroad was appointed general foreman at East Buffalo and the following year was appointed master mechanic of the Buffalo Division, where he remained until 1886 He was then appointed master mechanic of the Mahoning division of the New York, Lake Erie & Western R. R., with which he remained as master mechanic at different points until 1890, when he was appointed superintendent of motive power of the New York, Ontario & Western Railway, which position he has since held.

## BOOKS.

Earth Slopes, Retaining Walls and Dams. By Chas. Prelini. 6 x 9. 129 pages. Cloth. Published by D. Van Nostrand Co., 23 Murray street, New York. Price, $2.00 net.

This book is largely given up to a consideration of the graphical methods of solving problems concerning the slopes of earth embankments, the lateral pressure of earth against a wall and the thickness of retaining walls and dams.

The Proper Distribution of Expense Burden. By A. Hamilton Church. 116 pages, cloth bound, 5 x 8 in. Published by *The Engineering Magazine*, 140 Nassau street, New York City. Price, $1.00.

Because railroad repair shops have not been in active competition, the matter of accounting has not been given the attention which its importance deserves. During the past few years, however, a distinct advance has been made in this respect, on several roads, thus making it possible to better direct the work of improving the shop efficiency. While Mr. Church's book describes principles which are applicable to manufacturing organizations, and especially to the machine shop, the broad principles may be studied and used to advantage in connection with railroad repair shop management. The contents by chapters follows: Interlocking general charges with piece costs, distributing expense to individual jobs, the scientific machine rate and the supplementary rate, classification and dissection of shop charges, mass production and the new machine rate, apportionment of office and selling expense.

Design of High-Way Bridges. By Milo S. Ketchum, C. E. 6 x 9. 531 pages. Cloth. Published by the Engineering News Publishing Company, 220 Broadway, New York. Price, $4.00.

The author of this work, in his position as Dean of the College of Engineering of the University of Colorado, was impressed by the comparatively slight attention that has been given to the design of high-way bridges by the many excellent books on bridge design. As a consequence many high-way bridges are very poorly designed, as is evidenced by the failures that have taken place in the past few years. A noticeable feature of this work is the attention given the subject of the sub-structure, a feature which is not always fully considered in works on bridges. A section of the book discusses the details of cost of different parts of high-way bridges, and should assist greatly in leading to economical design. The work is very completely illustrated and many sections are in the form of problems with the complete solution accompanying them.

Westinghouse Diary for 1909. Published by The Westinghouse Companies' Publishing Department, Pittsburg, Pa.

This is the fifth edition of this little vest pocket diary. Its 96 pages contain considerable new data. The section on "Electric Railway Data" devotes several pages to the single phase railway system. Nine pages are given to a consideration of the application of motors to machine tools. Following this are sections on electric heating; power transmission; meter testing; steam turbines, including high and low pressure turbines and the Leblanc condenser; gas engines; mechanical stokers; storage batteries, weights, measures and materials; Nernst, incandescent, tungsten and Cooper-Hewitt lamps; Union Switch and Signal Co. appliances; Morse chains, and gears. In addition to this technical information there are several maps, as well as considerable handy information; also a diary and pages for addresses and other memoranda.

Patents as a Factor in Manufacturing. By Edwin J. Prindle. 134 pages, cloth bound, 5 x 8 in. Published by *The Engineering Magazine*, 140 Nassau street, New York City Price, $2.00.

The author's aim has been to lay down the fundamental principles concerning patents so that they may easily be grasped fully enough to direct the inventor, patentee or manufacturer in the early steps which are usually taken before the advice of counsel is secured. In the words of the preface the plan "is rather to convey an idea of the nature of a patent, the protection it may afford, the advantages it may possess for meeting certain commercial conditions, the safety which may be secured in relations between employers and employees, and the general rules by which the courts will proceed in upholding the patent and in thwarting attempted infringements, to show the manufacturer, in a general way, what may be accomplished by patents, but not to lead him to attempt such accomplishment without legal advice." Mr. Prindle is especially well fitted to discuss this subject and he not only brings out the information clearly but does it in a most interesting manner. The contents by chapters follow: Influence of Patents in Controlling a Market, Subject, Nature and Claim of a Patent, What Protection a Patent Affords, Of Infringemens, Patenting a New Product, Patent Relations of Employer and Employee, Contests Between Rival Claimants to an Invention.

Railroad Construction, Theory and Practice. By Walter Loring Webb, C. E. Fourth edition, revised and enlarged. 4½ x 6¾ in. 754 pages. Published by John Wiley & Sons, 43 E. 19th street, New York. Price, $5.00.

This standard work on the theory and practice of railroad construction, designed principally for use as a text book by students in colleges and technical schools, is too well known to require any extended comment. The fourth edition, now being issued, has been subject to some revision, especially in the chapter on "Earth Work," where several tables have been added. The chapter on "Economics" has also been revised to conform with more recent estimates of cost of operation. While this book is undoubtedly thoroughly modern and up to date in all of the features considered most essential by the author, yet to one acquainted with the progress in the motive power department of railways in recent years and its direct effect on roadway and economic problems, it seems peculiar that chapter fifteen, devoted to rolling stock, has evidently not been given any attention since the book was first prepared in 1899. While, of course, this chapter is not intended to be a course in the design of locomotives and cars, it would seem that it should, at least, give the modern practice in the features which it considers. For instance, it is odd to read that it is practically impossible to operate a consolidation type locomotive with all the drivers flanged and that such locomotives have only the front and rear drivers flanged. Again, in the second section, on the classified types, we find the "Columbia" type given, but do not discover the Pacific, Prairie, Santa Fe or any of the articulated types. The further statement that

37 square feet is about the maximum grate area obtainable except in a Wooten firebox, gives an indication of the date at which this chapter was written. We trust that the author in his next revision will bring this chapter up to the same standard as those on earth work, tunnels, ties, etc.

## CATALOGS.

Technical Books.—The Norman W. Henley Publishing Company, 132 Nassau street, New York, is issuing a new catalog of its varied assortment of practical technical books.

Friction Clutches.—The Carlyle Johnson Machine Company, Hartford, Conn., has issued its 1909 catalog of the Johnson friction clutch. The different applications of the clutch are described and illustrated in detail.

Radial Drills.—The Fosdick Machine Tool Co., Cincinnati, O., is issuing a number of sheets, in a loose leaf binder, describing its 4, 5 and 6 ft., half and full universal radial drills.

Transformers.—The Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa., is issuing circular No. 1157, descriptive of type S distributing transformers for single phase power. The transformer is very completely illustrated and described in detail.

Folding Doors.—The Ritter Folding Door Company, Cincinnati, O., is issuing a standard size catalog very largely given up to illustrations of railway buildings which have recently been equipped with this type of door. These include freight and store houses, engine houses, round houses, shops, garages, and illustrate doors of wood, combination wood and glass or steel applied to either wood, masonry or concrete buildings.

Electrical Apparatus.—Among the bulletins recently issued by the General Electric Company, Schenectady, N. Y., are included No. 4633, devoted to the subject of motor generator sets in capacities of from .2 to 1500 k. w., No. 4631 on the subject of series alternating enclosed arc light system, No. 6430 on the subject of direct current portable instruments and a very attractive catalog on fan motors.

Chain Blocks, Electric Hoists, Trolleys and Cranes.—The Yale & Towne Mfg. Co., 9 Murray street, New York City, have issued an attractively arranged and illustrated catalog, describing their triplex, duplex and differential chain blocks and parts; trolleys and cranes, also triplex trolley blocks, overhead track and crabs and winches; electric hoists, including triplex electric hoists and trolleys with current collectors for use with electric hoists.

Valves.—The American Steam Gauge & Valve Mfg. Co., Boston, Mass., is issuing its 1909 standard size catalog containing 89 pages, which gives illustrations and brief descriptions of a very full and complete assortment of pop valves and relief valves for both pressure and vacuum. These include muffled pop safety valves for locomotives of the latest improved pattern, as well as valves for use at any point where pressure of either gas or liquid is found.

Reamers.—Cleveland Twist Drill Co., Cincinnati, O., is issuing catalog No. 36, devoted exclusively to the "Peerless" high speed steel reamers, the construction of which was described on page 449 of the November issue of this journal. The catalog contains an illustration of each style, which is accompanied by a table giving the dimensions and prices of each size. The sizes maintained in stock vary by 1/32 in. from ½ to 3 in. in most cases. These reamers are made as hand, core, chuck, shell core, and shell chucking types, any of which can be furnished in solid or expansion styles.

Packing and Hose.—The Revere Rubber Company, 77 Bedford street, Boston, Mass., is issuing two very attractive catalogs, one on packing and the other on rubber hose. The former, which is printed in two colors, shows the great variety of packings for valve stem, pipe fittings, etc., including many special forms for unusual conditions. Each of the large number of styles is illustrated and described and the price is given in each case. The other catalog, which is also printed in two colors, fully describes the construction of the "Revero" hose, which is made in all the usual sizes for water, steam, air, chemical, sand, gas, vacuum, oil, etc. Hose fittings are also shown.

Ball and Roller Bearings.—The Standard Roller Bearing Company, of Philadelphia, is issuing catalog No. 24, 5 x 8 in. in size and containing 187 pages. It contains very fully illustrated descriptions of the ball and roller bearings which are designed and manufactured by this company for use in almost every conceivable point where friction occurs. The results of many tests of these bearings in use on various pieces of machinery are given. These include a test of a street car in Syracuse which has been successfully equipped with roller bearing journals. Views of the very complete plant operated by this company in Philedelphia are scattered through the catalog. Both ball and roller bearings, in standard patterns, are maintained in stock and tables are included giving the dimensions, loads to be carried and prices of each size.

Friction Clutches.—The Hill Clutch Company, Cleveland, O., is issuing a very attractive catalog devoted exclusively to its friction type of clutches, which are shown in a number of different arrangements. Each type is illustrated and tables are included giving prices for each style and size. This company manufactures friction clutches ranging from 12 in. in diameter, with a capacity of 5 h. p. at 100 r. p. m. to 84 in. in diameter, with a capacity of 1,300 h. p. at 100 r. p. m.

## NOTES.

The Ritter Folding Door Co.—The shops of the Carolina, Clinchfield & Ohio Ry., at Erwin, Tenn., are to be equipped with Ritter folding doors of wood and glass construction.

Electrical Show.—The Western-Southern Electrical Show will be held in Cincinnati March 13 to 27, 1909. Space for this exhibit can be obtained by addressing Western-Southern Electrical Show, 408 Fourth National Bank Building, Cincinnati, O.

American Specialty Company.—John L. Walker, formerly auditor for The Buda Foundry & Mfg. Co., has resigned to accept a position as manager of the "Use-Em-Up" socket department of the above company, 834 Monadnock Bldg., Chicago, Illinois.

Dearborn Drug and Chemical Works.—Herbert E. Stone, formerly president of the National Association of Steam Engineers and recently manager of the Pittsburgh office of the Chapman Valve Co., has accepted a situation as manager of sales in the eastern department of the above company, with headquarters in New York City.

Falls Hollow Staybolt Co.—The above company announces that Willis C. Squire, 209 Western Union Bldg., Chicago, has accepted the agency for its products for the railway trade in the Chicago territory. Also that Alex S. Mitchell, 45 Broadway, New York, will be agent for the railway and boiler trade in the New York territory.

Memorial Tablet to Ampere.—A bronze and tile memorial tablet in honor of the great French scientist, Andre-Marie Ampere, has been set up at the Lackawanna Railroad station at Ampere, N. J., by Dr. Schuyler Skaats Wheeler and was unveiled by the French Ambassador on December 3. Monsieur Ampere was born in 1775 and died in 1836, and this tablet forms probably the only memorial raised in his honor in America.

Snow Plows.—The Russell Car and Snow Plow Company, Ridgeway, Pa., announces that among its recent shipments were a double track, size 2, plow for the Buffalo, Rochester & Pittsburgh Railroad, and electric plows, size 6, for the Bangor Railway & Electric Company and the Lewiston, Augusta & Waterville Street Railway and a combination car and snow plow, with double track steel noses, for the Ottawa Electric Company.

Meeting of the A. S. M. E.—The January meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, New York, on Tuesday evening, January 12. The paper will be by Carl G. Barth of Philadelphia, upon the "Transmission of Power by Leather Belting," which will be illustrated by lantern slides. Valuable charts have been prepared by the author for the solution of belting problems and will be given in the paper.

Oil Fuel on Hydraulic Dredges.—The U. S. Army has just placed in commission the second of two very large hydraulic dredges required for service in the Gulf of Mexico. The first one built, the "General C. B. Comstock," was placed in commission six years ago and was fitted for burning oil for fuel, the entire fuel equipment being furnished by Tate, Jones & Co., Inc., of Pittsburg. The service of that vessel has led to the equipping of the new one, the "Galveston," which has four boilers and 2,000 indicated horse power, in the same manner, the apparatus being furnished by the same company.

A New Correspondence School.—The Modern System Correspondence School Company, with offices at 6 Beacon street, Boston, Mass., has been organized and Oscar E. Perrigo has been elected president and educational director. This school will give practical instruction in the subjects of modern cost systems; shop methods and systems; shop construction, development, organization and management; factory and commercial office systems; foundry systems; mechanical drawing and engineering systems, and such other allied subjects as may be added from time to time. The New York office is at 132 Nassau street.

Termination of Receivership.—The Westinghouse Electric & Mfg. Company again became the property of the stockholders on December 5, after having been in the hands of the receiver since October 23, 1907. It is stated that this is the most successful receivership that has ever taken place, the operations of the company during the time of receivership showing a net profit of over $1,000,000. The newly elected officers consist of, president, George Westinghouse; temporary chairman of executive committee, E. C. Converse; first vice-president, E. M. Herr; second vice president, L. A. Osborne; secretary, Chas. A. Terry, and treasurer, T. W. Siemon.

# THE HAMMER BLOW FROM INCORRECT COUNTERBALANCE

H. H. Vaughan.

The generally accepted solution of a consideration of the action on the rail of a wheel containing counterbalance is that of a variable pressure between the rail and the wheel equalling the static weight on the wheel, added to or reduced by the vertical force due to the action of the unbalanced weight. Thus in Fig. 1 if OA represents the time of one revolution, BC the pressure between the rail and the wheel due to the weight on the wheel, OB and ODAE the vertical force due to the action of the overbalance, the result and pressure between the rail and the wheel is shown by the line BFG and equals the ordinate of the shaded area at any time.

Should the overbalance be excessive and the speed so high that the vertical force caused by the overbalance exceeds the weight on the wheel, there may be a negative pressure between the wheel and the rail, or in other words, a force tending to lift the wheel, which condition is shown in Fig. 2, where the cross hatched portion below OA represents an upward force which tends to lift the wheel and attains a maximum value TP at

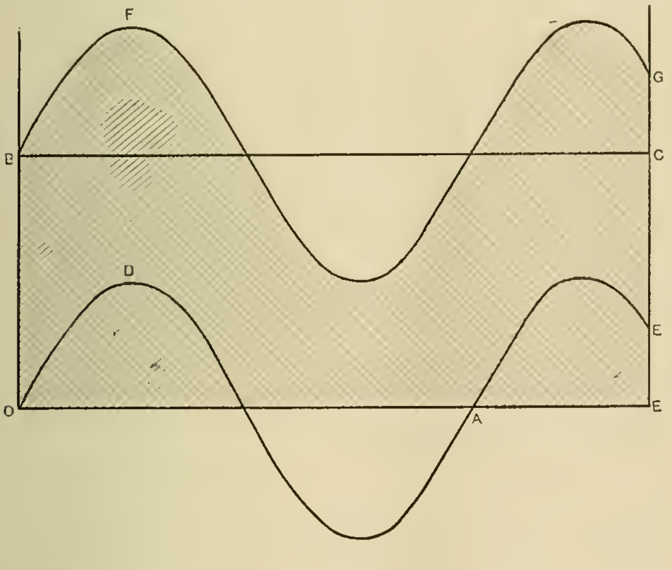



FIG. 1.

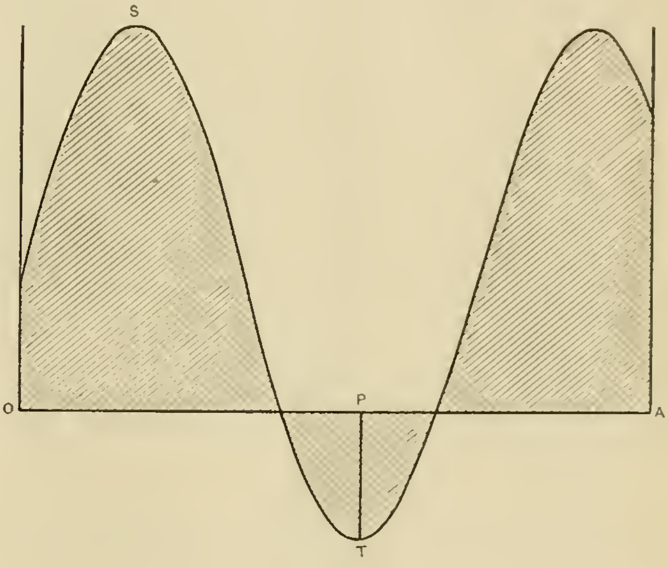



FIG. 2.

the instant when the counterbalance is vertically upwards. For a numerical example suppose the weight on the wheel is 20,000 pounds and the maximum vertical effect of the overbalance is 25,000 pounds. The pressure on the rail will become 45,000 pounds at the point S, while at T there will be a force of 5,000 pounds tending to lift the wheel, and that the wheel does lift under the action of this force is well shown from the experiments on the Purdue and St. Louis testing plants. The greatest pressure on the rail occurs when the counterbalance is vertically downwards, and as this in many cases of improperly balanced engines reaches such figures as 50,000 to 60,000 pounds, the damage that has occasionally been caused to the rail when such engines have run at specially high speeds, has been ascribed to this great downward force. A consideration of the diagrams shows that however great this force may be at this point, its application is entirely gradual and it cannot possibly partake of the nature of a blow given by a falling weight, however high the speed, as the pressure between the rail and the wheel gradually increases from nothing or a comparatively small amount until it reaches its maximum and then decreases, and it has therefore become usual to regard the hammer blow, so often mentioned in connection with counterbalance, as a misnomer, and to ascribe the damage that may occur, to the high pressures which exist, rather than to the effect of an actual fall of the wheel on the rail.

In the early part of 1908 a serious case of damaged rails occurred on the Canadian Pacific Railway, the rails being sharply bent for about a mile, on both sides at intervals about equal to the circumference of a driving wheel. The damaged spots were carefully measured over a considerable distance, averaged, and the diameter of the wheel so found corresponded with that of an engine which had made a very fast run over the damaged track the day previous. The wheels of this engine were taken out and the main drivers found to contain an excessive amount of overbalance, actually amounting to about 1,000 pounds. As the weight on these wheels was 22,000 pounds, the force on the rail at the speed estimated varied from 57,000 pounds to an upward force of 13,000 pounds. A portion of the rail was experimented with in a testing machine and it was found impossible to bend it in the same manner as had occurred on the track, with different centers of supports and with loads as high as 200,000 pounds While the cause of the damage was thus located, the method by which it was effected was still not apparent, and a general disbelief in the calculations of the forces caused by the unbalanced weights on the wheels was the natural result. It then occurred to the writer to investigate the action of the wheel when lifted from the rail by the upward force caused by the overbalance, with results that are interesting and to a large extent explain the action which takes place.

The wheel is taken as a mass of 3,200 pounds weight, pressed down by the spring with a force equal to the static weight on the rail, less its own weight, running on rigid track and acted upon by the forces caused by the overbalance. As an example the speed was assumed to be 300 revolutions per minute, the weight on the rail 20,000 pounds and the force due to the overbalance 25,000 pounds, so that the force tending to lift the wheel attained a maximum of 5,000 pounds. The mathematical discussion which applies to any set of conditions is given below, and the results are shown in Fig. 3 for this particular example.

The horizontal dimensions in this diagram indicate the movement of the wheel in degrees, 0° being the position of the wheel

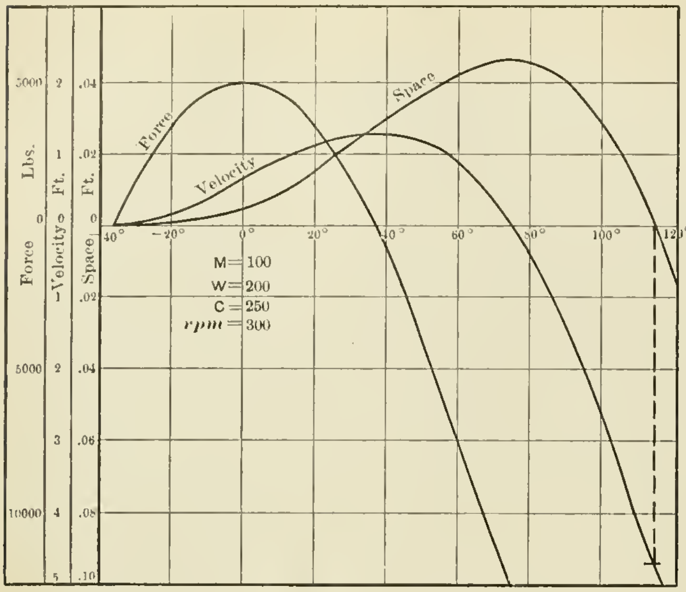



FIG. 3.

when the counterbalance is vertically upwards, while the vertical dimensions indicate to three different scales, the forces acting on the wheel, the velocity of the wheel upwards and its upward movement. Thus, at about — 37½°, or when the center line of the counterbalance makes that angle with the vertical, the upward force due to the overbalance equals the weight on the wheel, and beyond that exerts an upward force on the wheel, tending to lift it, which becomes a maximum of 5,000 pounds at 0° and zero again when the counterbalance has moved 37½° past the center. The wheel then commences to be acted upon by a downward force due to its weight and the force of the spring which becomes greater than the effect of the counterbalance. Since the latter continues to decrease and at 90° becomes zero and later in its turn acts downward, this force increases rapidly. Further consideration indicates that the upward velocity of the wheel, zero at —37°, gradually increases until the wheel has turned to 37°, when its upward velocity is a maximum, since, while the forces acting on it upward have been decreasing from 0°, they have still been acting to increase its upward velocity. As the downward forces become reversed they first destroy this upward velocity which becomes zero at about 75°, after which they impress on it an increasing downward velocity until the wheel reaches the rail. To find the point at which this takes place, it is necessary to plot the space line or that showing the movement of the wheel vertically upwards from the rail. This commences with zero at —37°, gradually increasing to 0.0465 feet or about .55 inch at 75°, at which point the upward velocity is zero and the upward movement has attained its maximum. The wheel then begins to return to the rail, its movement becoming zero again, or in other words, striking the rail at 115°, and by referring to the velocity curve, it will be seen that at the point the downward velocity is 4.7 feet per second. This velocity corresponds to that gained in dropping freely through a height of 0.36 foot, or about 4½ inches, and as the weight is 3,200 pounds, there is an actual, but not severe, blow.

It is interesting to note that this diagram explains completely the results obtained on testing plants, and with wire run under the drivers, in which W. F. M. Goss has noted that the wheel appeared to drop more quickly than it went up, and at a considerably greater distance from the center, and it is evident that this should be so. The movement of the wheel does not coincide with the variation in the force. As long as the force is upwards the wheel is acquiring an upward velocity and this velocity does not become zero until the downward forces have acted on the wheel for a sufficient time to destroy it. In the same way, the upward movement goes on increasing not only until the upward velocity decreases, but until it is destroyed and the wheel does not return to the track until the downward velocity has attained a very considerable amount.

The diagram in Fig. 4 shows similar curves plotted at 320 revolutions for the engine mentioned as having caused the damage to the rail on the Canadian Pacific. This is of course an exceptionally bad case, but it will be seen that the wheel did not return to the track for 177°, when it had a downward velocity of 17½ feet per second, corresponding to a free fall of 4¾ feet, from which height a weight of 3,200 pounds would certainly deliver a blow of sufficient energy to account for the effects observed.

In an extreme case of this nature, however, the method of analysis employed gives results that are greater than would actually occur, since the force acting down on the wheel is not constant, but would increase as the wheel moved upwards and deflected the spring. For instance, if the latter had a deflection of 0.2 foot under the working load of 18,800 lbs., the downward force with any upward movements of the wheel would equal

$$3200 + 18800 \left( \frac{s + 0.2}{0.2} \right)$$

in place of a constant amount of 22,000 pounds, and the acceleration equation would then become

$$\frac{d^2s}{dt^2} = C \cos kt - \left[ 3200 + 18800 \left( \frac{s + 0.2}{0.2} \right) \right]$$

This expression involves $s$ and becomes exceedingly complicated to integrate, but the effect of including it would be to diminish the upward movement and slightly reduce the striking velocity. In the first case its influence is inappreciable as the upward movement is small, but in the second it would certainly reduce this, and account for the box not striking the frame. An exact solution would in addition allow for the elasticity of the track, and this in its turn would apparently increase the velocity of the blow, although an equation involving it would probably be too complicated to treat mathematically except by an expert.

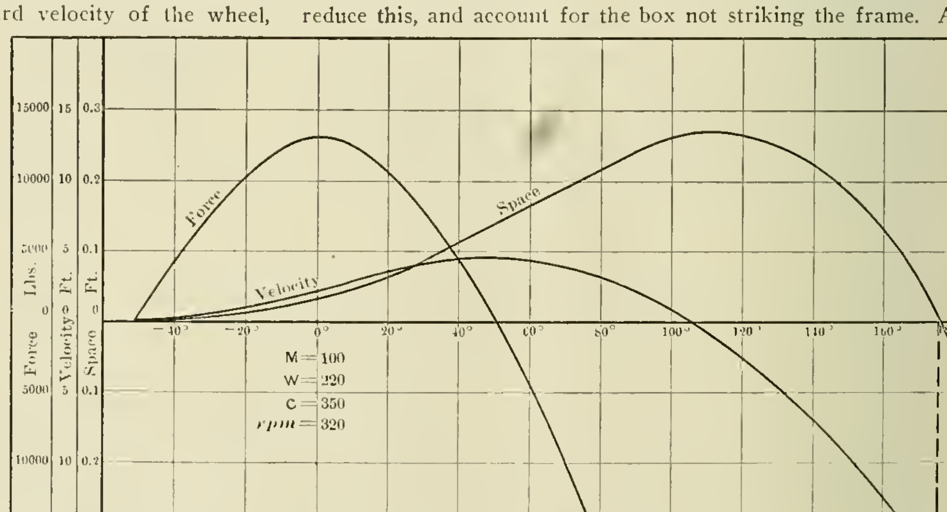



FIG. 4.

While, however, the solution here given in Fig. 4 may not be exactly correct, the actual striking velocity being lower than that calculated, there is no doubt that it is of considerable magnitude and probably from 12 to 15 feet per second, and an absolute hammer blow is therefore accounted for which is of sufficient intensity to explain the damage that has occurred.

It is interesting to note that in extreme cases the wheel does not return to the track or the blow occur until the wheel has moved to a position where the counterbalance is within 20° or 30° of being vertically downwards and the popular connection of this blow with the downward movement of the counterbalance is thus explained.

The result of these calculations would emphasize the danger of an unbalanced force which could equal the weight on the wheel. On the usual assumption that the maximum speed in miles per hour equals the diameter of drivers in inches, this would restrict the overbalance in any wheel to 2½ per cent. of the weight on the wheel and to be entirely safe the practice on the Canadian Pacific Railway is now to limit it to 1¼ per cent. and to make it 1 per cent. if possible.

### MATHEMATICAL ANALYSIS.

When counterbalance is vertically upwards $t = 0$

Let $w$ = acceleration due to downward force of spring and weight of wheel, acting on mass of wheel

$c$ = acceleration due to maximum value of force caused by overbalance, acting on mass of wheel

$s$ = vertical movement of wheel, from rail, feet

$t$ = time, seconds

$kt$ = angular movement of wheel, radians

Then, $$\frac{d^2s}{dt^2} = c\cos kt - w$$

$$\frac{ds}{dt} = \frac{c}{k}\sin kt - wt + C$$

$$= 0 \text{ when } t = -t_1, \text{ when } \cos kt_1 = \frac{c}{w}$$

Then $$C = \frac{c}{k}\sin kt_1 - wt_1$$

And $$\frac{ds}{dt} = \frac{c}{k}\sin kt + \frac{c}{k}\sin kt_1 - wt - wt_1,$$ from which the velocity curves are plotted

$$s = -\frac{c}{k^2}\cos kt + \frac{ct}{k}\sin kt_1 - \frac{wt^2}{2} - wtt_1 + C$$

$$= 0 \text{ when } t = -t_1$$

Then $$C = \frac{ct_1}{k}\sin kt_1 + \frac{c}{k^2}\cos kt_1 - \frac{wt_1^2}{2}$$

and $$s = \frac{c}{k^2}(kt_1\sin kt_1 + \cos kt_1) - \frac{wt_1^2}{2} - \frac{wt^2}{2} + t\left(\frac{c}{k}\sin kt_1 - wt_1\right) - \frac{c}{k^2}\cos kt_1$$

from which the space curves are plotted.

## RAILROADS WANT FAIR TREATMENT.

The railroad system of the country has been built up by individual energy working with capital that was invested because it expected a profit in the enterprise. Capital has ceased to be generally available for this work at a time when its co-operation is greatly needed. The return of prosperity to the transportation business and to all other business, since the connection between them is direct and intimate, is conditioned upon such a restoration of confidence as will again permit and promote liberal investments. And that will happen only when the public is convinced that capital put into railroad securities will have the same protection against unjust or unfair attack, the same right to earn a proper return, as capital invested in other occupations enjoys.

The country, in fact, is waiting to see what is to be the attitude of public authorities, legislatures, commissions and courts toward the railroad interest. It needs and asks no favors; it is entitled to fair play, and the capital employed in it to a reasonable profit. When this appears certain, and public policies are framed accordingly, not only transportation, but all other industry, will experience a real return of prosperity. The material welfare of the nation will be promoted by every expression of determination on the part of individuals and associations representing great interests to secure that just treatment and that security without which capital withdraws itself, every form of industry declines, and all the people suffer loss.—*From a letter by J. J. Hill to the Hoboken Board of Trade.*

## CARS AND LOCOMOTIVES BUILT IN 1908.†

To understand the condition of the car and locomotive building business fully during the past year, it is necessary to study both the number of orders placed for equipment during this period and also the number built. The orders placed, which are fully reported in another column of this issue, reflect both business conditions throughout the year 1908 and expectations of better conditions during 1909. The amount of equipment actually built during the year, on the other hand, shows only actual conditions unlightened by hope of the future, since actual recovery of business started too late in the year to show in the form of completed cars and locomotives. The following figures are also interesting in that they are compiled from returns from equipment building companies only, and do not include the output of railway companies' shops, the operation of which through the year has helped in giving somewhat of a market for labor and makers of railway supplies.

In 1907, car and locomotive builders worked at full capacity throughout the year on orders placed in the early part of that year. By the end of the year, however, the full effects of the depression were being felt, and comparatively few orders were carried over into 1908. Last December, officials of representative companies estimated that their orders on hand would keep them busy at full capacity for from two to four months only. Where possible, working time and forces were cut down so as to keep plants running on part time for as long a period as possible on completing such orders as could be delayed.

During the past year 35 car building companies in the United States and Canada built 78,271 cars, which is only 27 per cent. of the number built in 1907. These figures include subway and elevated cars, but not street railway and interurban cars. Of the cars built in the United States, 66,751 were freight cars for domestic service, 1,206 freight for export, 1,566 passenger cars for domestic service and 71 passenger for export. Canada built 8,593 freight cars for domestic service, 5 freight for export, and 79 passenger cars for domestic service. In 1907, Canada built 9,159 freight cars and 106 passenger cars.

The following table shows the cars built during the last 10 years:

| Year. | Freight. | Passenger. | Total. |
|---|---|---|---|
| 1899 | 119,886 | 1,305 | 121,191 |
| 1900 | 115,631 | 1,636 | 117,267 |
| 1901 | 136,950 | 2,055 | 139,005 |
| 1902 | 162,599 | 1,948 | 164,547 |
| 1903 | 153,195 | 2,007 | 155,202 |
| 1904 | 60,806 | 2,144 | 62,950 |
| 1905 | 165,455 | 2,551 | *168,006 |
| 1906 | 240,503 | 3,167 | *243,670 |
| 1907 | 284,188 | 5,457 | *289,645 |
| 1908 | 76,555 | 1,716 | *78,271 |

* Includes Canadian output.

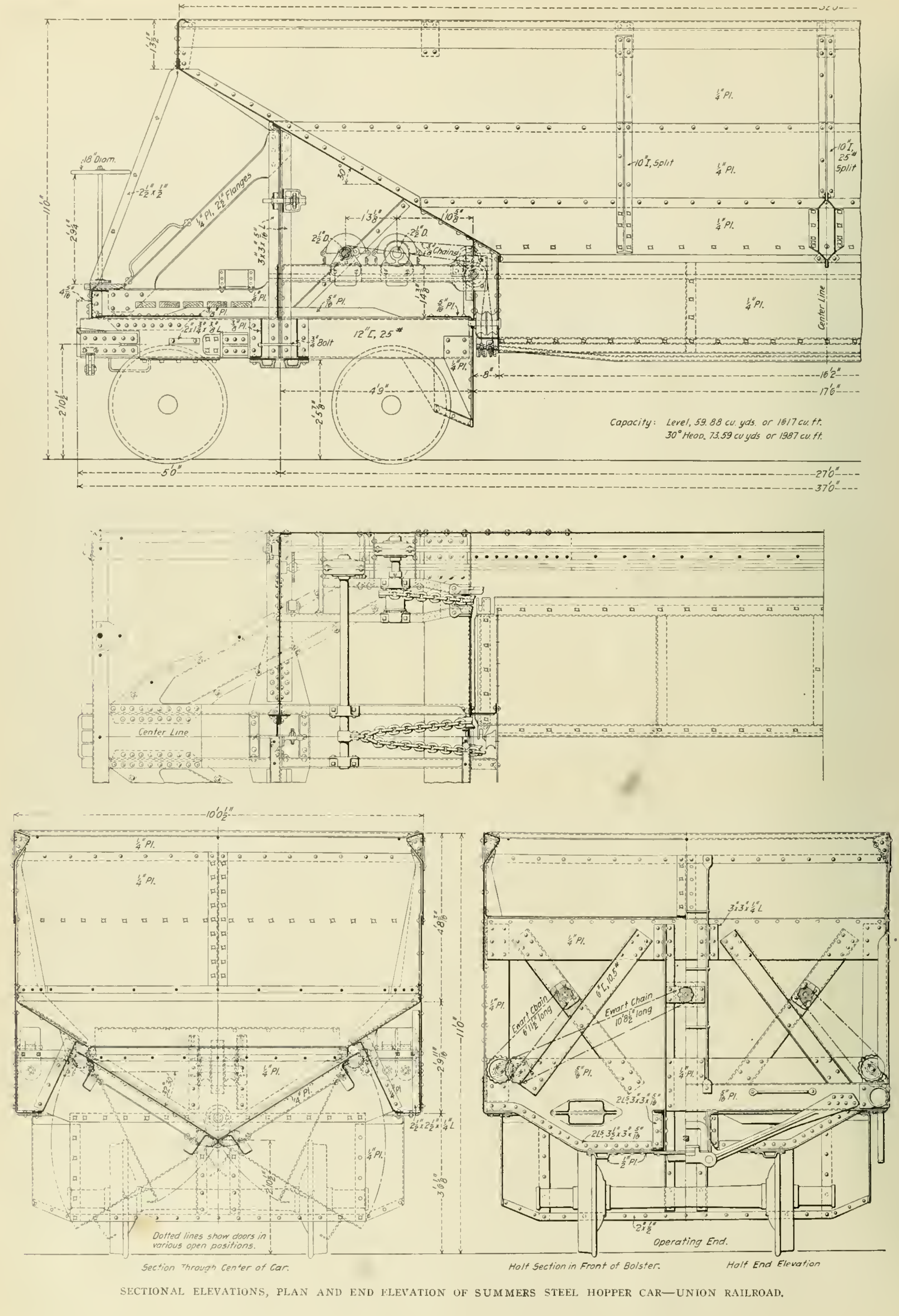
Returns from 11 locomotive builders in the United States and Canada show a total of 2,342 engines, about the same relative falling off as in the cars built. Of the 2,124 built in the United States, 1,668 were for domestic use and 456 for export. These figures include 245 electric and 79 compound locomotives. The Canadian engines, 218, were all for domestic service. Of these 20 were compound.

Comparisons for the last 16 years are given in the following table:

| Year. | No. built. | Year. | No. built. | Year. | No. built. | Year. | No. built. |
|---|---|---|---|---|---|---|---|
| 1893 | 2,011 | 1897 | 1,251 | 1901 | 3,384 | 1905 | *5,491 |
| 1894 | 695 | 1898 | 1,875 | 1902 | 4,070 | 1906 | *6,952 |
| 1895 | 1,101 | 1899 | 2,475 | 1903 | 5,152 | 1907 | *7,362 |
| 1896 | 1,175 | 1900 | 3,153 | 1904 | 3,441 | 1908 | *2,342 |

*Includes Canadian output.

† From the Railroad Age Gazette, Dec. 25, 1908.



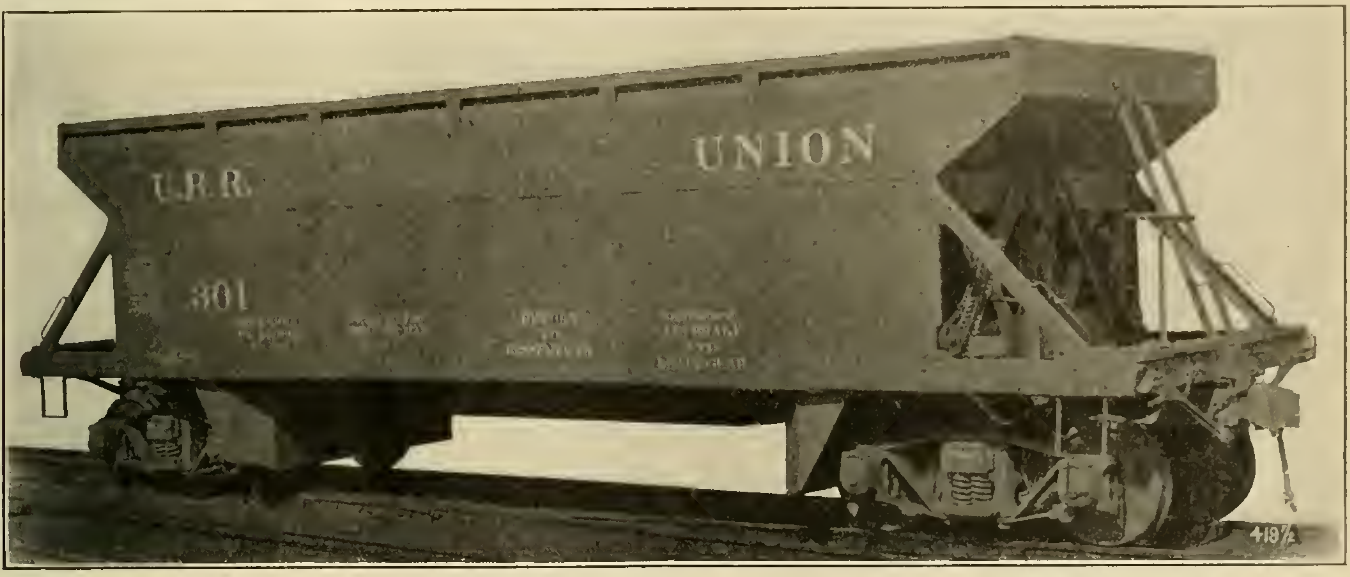

SECTIONAL ELEVATIONS, PLAN AND END ELEVATION OF SUMMERS STEEL HOPPER CAR—UNION RAILROAD.

# SUMMERS' STEEL HOPPER CAR

These cars are of the hopper type and have door openings 16 ft. 2 in. long and varying in width, depending upon the conditions of unloading, as shown by the sketches, but in some cases amounting to as much as two-thirds of the width of the car. These doors are controlled from one end of the car, and by the proper manipulation of three cranks the combinations of unloading shown on the sketches may be obtained. All of the load may be discharged clear of the track on either side of it, or part of it may be discharged on either side, or all of it may be dumped in the center. The amount of the flow, in any of these cases, may be regulated by stopping the doors in a partially opened position, where it will remain without locking.

The cars were designed to carry a load of 100,000 lbs. and have a cubic capacity, when loaded level, of 59.8 cu. yds., or 1,617 cu. ft. With a 30 deg. heap they have a capacity for 73.59 cu. yds., or 1,987 cu. ft. With this capacity, and the above mentioned the cross-sectional view, the metal is so distributed as to accomplish the desired results with a comparatively small amount of metal. The peculiar shape given to the top of the side sheet makes this member very stiff at a point where many of the steel hopper cars have proved defective in the past. The sides are tied together at the middle by the pressed steel stiffeners. The vertical side stiffeners are placed on the inside and consist of 10 in., 25 lb., I-beams split, thus forming a T with the projecting part shaped to give the greatest strength where it is most needed.

The drop doors are of ¼ in. plate and are carefully reinforced to stand up under the severe service to which they are subjected. The guards at the ends of the doors and in front of the trucks are used to spread the material which may be dumped between the tracks, and to push it out from the track when dumped at the side.




SUMMERS STEEL HOPPER CAR, 100,000 LBS. CAPACITY—UNION RAILROAD.

advantages for unloading, it is remarkable to find that the car weighs only 45,000 lbs., although it is as strong, and probably stronger, than most of the 100,000 lb. hopper cars in service. While it is especially adapted for construction work and for handling coal and ore, and material of this kind, it may be used advantageously for any purpose to which the ordinary hopper car is suited.

The features of construction are clearly shown on the drawings. The design is unique from the fact that the car has no center sills, the draft sills extending from the end sills to the hopper only. These sills transmit the pulling and buffing stresses to the side girders through the pressed steel diagonal braces. The side construction is very strong and rigid, and, as shown by

The draft sills are 12 in., 25 lb., channels; Westinghouse friction draft gear is used, the draft lugs being of cast steel. The extension of the side sills and the ends of the end sills receive additional support from the diagonal brace which extends upward to the side sheets. The coupler carrier iron is of cast steel and is secured by pins to two cast steel arms, which are riveted to the end sill channels.

The Union Railroad Company (a constituent of the Carnegie Steel Company) has over 600 of the cars now in operation and a number of other steel-producing concerns are also using them and increasing their number by additional orders from time to time.

The Union Railroad made a fill in the past year, raising the

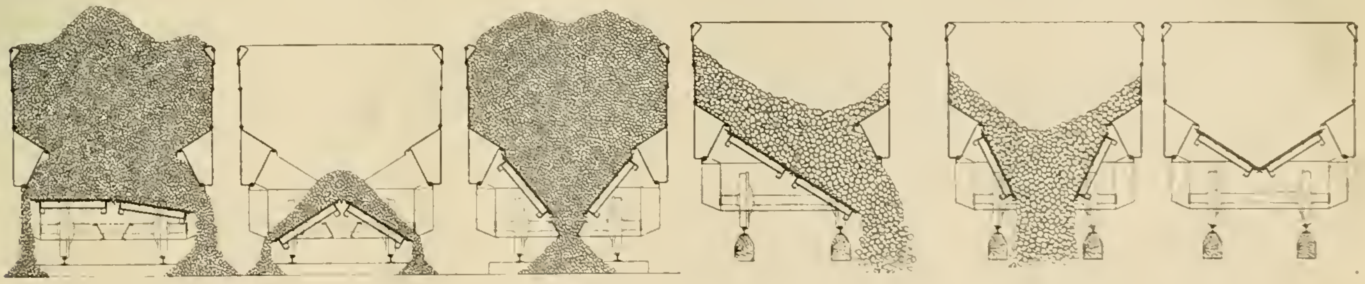
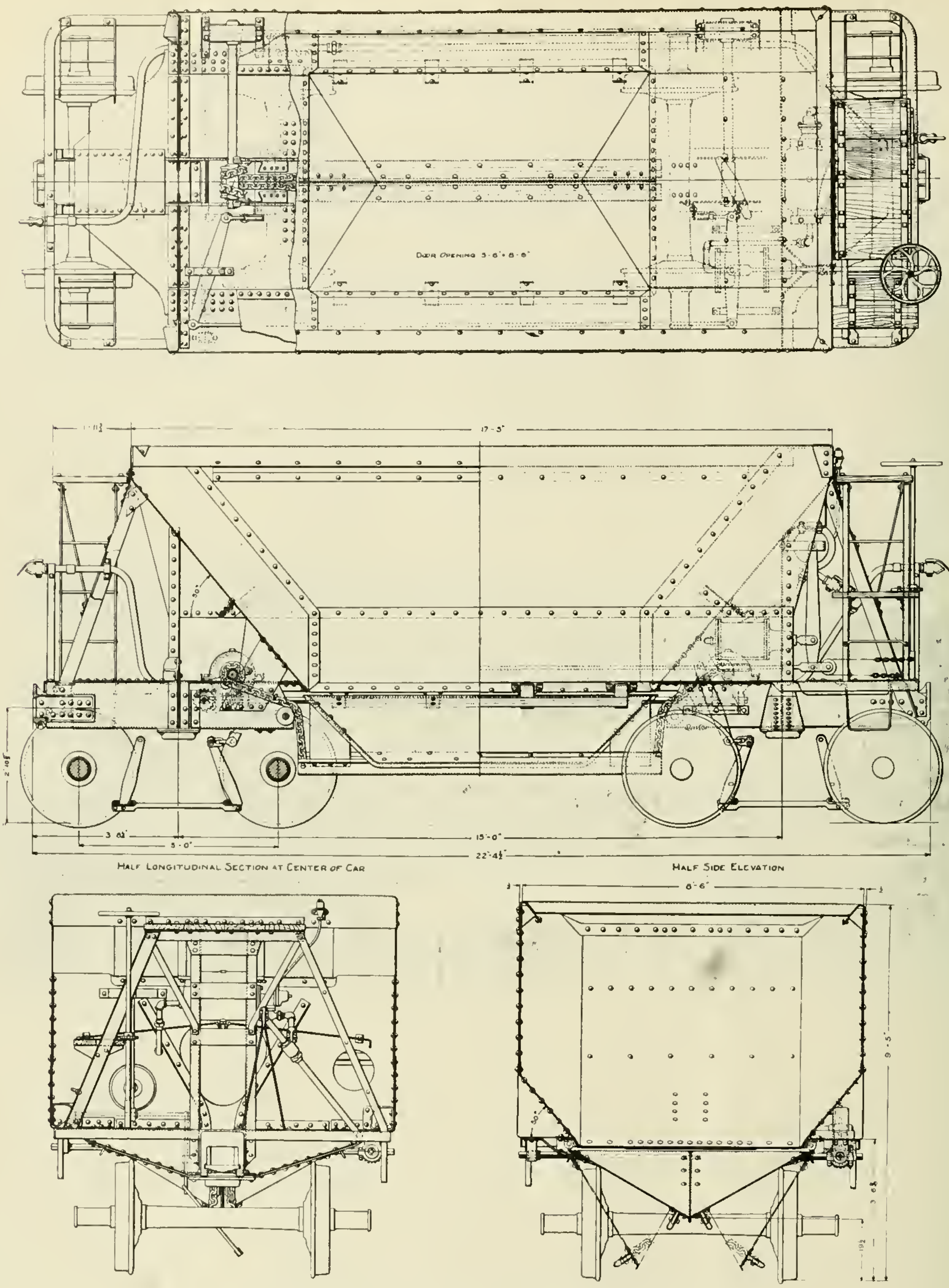


ILLUSTRATION OF WAYS IN WHICH THE SUMMERS STEEL CARS CAN BE UNLOADED.




SUMMERS STEEL ORE CAR—DULUTH AND IRON RANGE RAILROAD.

level of a classification yard some 20 feet with over two million cubic yards of filling material. The use of these cars for this work materially reduced the cost of handling refuse material over that of other years notwithstanding they were operating at a great disadvantage on account of having to do the work and keep traffic open through the yard at the same time.

A fill which can be made by discharging the load all at one side and follow up the fill by moving the track over, is where this design of car is especially advantageous, and under such conditions will save its cost in a comparatively short time.

This type of car has also proven itself to be specially adapted for ore traffic and the illustration above shows a design, 800 of which are now under construction, for the Duluth & Iron Range Railroad. This order followed a long experience with a sample car.

Of course, the ore car, while following the same general features, differs from the regular car in many details. The most noticeable feature is in the slope of the sides, which are at an angle of 50 degs. instead of 30 degs. The cubical contents, of course, is considerably smaller for the same weight capacity, giving both a shorter and a lower car and one which, in the case of the sample car, weighed but 32,100 lbs.

The cars of both types are equipped with standard arch bar trucks and were designed by E. W. Summers, president of the Summers Steel Car Company, Farmers' Bank Building, Pittsburg, Pa.

# WEIGHT DISTRIBUTION OF MALLET ARTICULATED LOCOMOTIVES

H. M. Sloat.

The calculation of the weight distribution of any type of locomotive involves the center of gravity and the calculation of the center of gravity involves the knowing or estimating the weight of each part and its distance from some assumed point. On account of the articulated feature of Mallet design, the two systems require separate consideration.

The center of gravity of each system is found in the usual manner, the front system being considered as comprising all the parts forward of the point of articulation, such as the low pressure cylinders, front frames, front bumper, guides, etc., and the rear system as comprising the remaining parts, including the boiler. In these calculations only the weights above the springs are considered, *i. e.*, the live load.

Since the design of an articulated compound locomotive calls for the same tractive effort from each set of cylinders, which means that the same adhesive weight should exist in each system, it is, of course, necessary that the total weight should be divided equally between the two groups of wheels, and since the rear system is by far the heavier, the front system must, therefore, support one-half of the difference between the two to ensure this distribution.

The point where this weight is to be supported on the front system is readily located by determining a lever arm of such length that the moment obtained by multiplying it with the weight will equal the moment obtained by multiplying the weight of the front system by the distance of its center of gravity from the center of the wheel-base of this system. This point may be called the "Virtual Supporting Point" of the rear system on the front engine, and is shown at distance $z$. Thus $Xz = Dc$ (Fig. 1.). As the moments are equal, the tilting effect of the system produced by its center of gravity falling so far ahead of the middle point of the wheel-base will now be balanced.

Figure 1 shows clearly how the weight is distributed through the system. The balls represent weights, the various sizes being indicative of the amount considered as acting at that particular point. Thus, D is the weight of the front system shown at its center of gravity; X is the proportion of the weight brought over to the front system to equally divide the total weight of the engine; G equals the sum of D and X; F is the weight carried by the rear system; B equals the sum of F and X, and T represents the total weight of the engine or the sum of $F + \frac{H}{2} + G + \frac{H}{2}$, where $\frac{H}{2}$ equals the dead weights of each system.

It is obvious that in order to obtain the desired weight at the virtual point of support, the center of gravity of the rear system can be located in but one place. To determine this location we divide the moment of the rear system—obtained by multiplying the weight falling on the virtual point of support (X) by its distance from the center of the wheel-base of this system ($y$)—by the total weight of the system (B). The result is the distance ahead of the center of the rear wheel-base at which the center of gravity acts.

But it is also evident that the actual center of gravity may not coincide with this point, and when such is the case, the location of the boiler is shifted, or the position of the other heavy parts, such as the cylinders, frames or castings is moved, or the wheel-base changed until the center of gravity is moved sufficiently. An approximate plan is laid out and then modified until the desired conditions are reached.

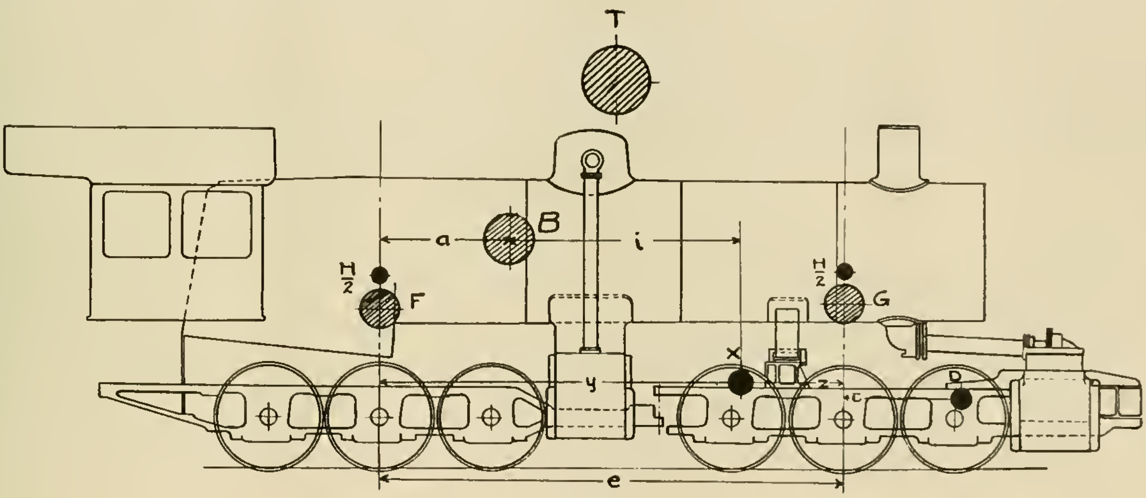



FIG. 1.

The proportion of the total weight supported by the front and back systems is readily found by considering the rear system as a beam carrying a concentrated load and resting on two supports, *i. e.*, the load is divided according to the respective distances of the supporting points from its point of application. This is shown by the following equation:

$$\text{Front system,}\quad X = \frac{B}{y}a \text{ and } G = X + D$$

$$\text{Back system,}\quad F = \frac{B}{y}i$$

This, when added to the dead weight of the respective systems, will equal the total rail load of that system and one-half the total weight of the engine.

The actual or sliding support through which the weight is brought on the front system, is shown in Fig. 1 located between the second and third pairs of drivers; it is not practical to place this support coincident with the virtual point of support, because then the front engine would be unstable and tip one way or the other by changes due to inertia in stopping or starting or the slightest disturbance due to change of grade. It should be placed a sufficient distance ahead of the virtual point to insure stability. But since the lever arm from this support to the center of the rear wheel-base is now lengthened, the weight carried to the front system is reduced and thus actually Xz will not equal Dc and the front engine will consequently tend to tip forward. To correct this disturbance, a pair of vertical hanger or suspension bolts is applied just forward of the point of articulation, between the upper member of the frame at the extreme rear end of the front engine, and the lower member of the frame at the extreme front end of the rear engine. By tightening these bolts, the proper alignment of the front engine may be adjusted and the actual supporting point brought back, so that in effect it coincides with the virtual. This reduces the pressure on the sliding support and imposes load on the bolts in proportion to the respective distances of the two supports from the virtual supporting center. These bolts are shown in Fig. 2. The disturbance due to grade or inertia may also be reduced by providing two supports, one on each side of the virtual.

The application of both front and rear trucks will not disturb the position of the centers of gravity, for they will take a certain percentage of the load depending on the position of their equalizing arms, a like amount being taken off the drivers on each system. In case, however, only a front truck be added, this will necessitate shifting the boiler or cylinders ahead in order to keep a sufficient weight on the front drivers thus compensating for the weight taken off by the truck. The proportion of weight falling on the truck is determined by the same method used when considering a mogul or a consolidation type of locomotive.

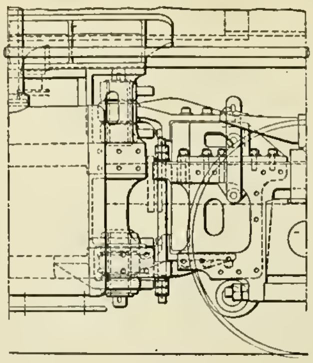


FIG. 2.

# BALANCED COMPOUND PASSENGER LOCOMOTIVE

NASHVILLE, CHATTANOOGA AND ST. LOUIS RAILWAY.

About three years ago the Baldwin Locomotive Works completed an order of three balanced compound passenger locomotives of the ten-wheel type for the Nashville, Chattanooga and St. Louis Railway which gave so good an account of themselves that a fourth engine was ordered from the same drawings in 1906 and a further order of three more have recently been delivered. The last order differs from the previous ones in the substitution of the Walschaert valve gear for the Stephenson, but in other respects is practically a duplicate. The design throughout is conservative and represents a modernized example of the type of passenger locomotive which was very popular ten years ago and is still being successfully operated in large numbers, principally on branch lines, with probably a smaller maintenance cost per engine mile than any later type of passenger power. The modernizing process consists in applying balanced compound cylinders and Walschaert valve gear together with some minor features, as electric headlight, pneumatic sanders and bell ringer, etc. The compound cylinders permit a very desirable increase in capacity while still retaining the narrow firebox, wagon top boiler with its many advantages from a maintenance standpoint. The advantages of the Walschaert valve gear over the Stephenson, particularly on a locomotive with a cranked axle, are so evident that its application needs no explanation. The other features are, of course, improvements without any counteracting disadvantages and the net result is a locomotive which retains the best features of the old with some of the best features of the new era of design.


PROFILE OF THE CHATTANOOGA DIVISION OF THE NASHVILLE, CHATTANOOGA & ST. LOUIS RAILWAY.

These locomotives are now operating over the Chattanooga division, a profile of which is shown in an accompanying illustration, where the ruling grade negotiated by a single locomotive is 53 ft. per mile and the maximum grade, between Stephenson and Cowan, where a helper engine is used, is 105 ft. per mile. The division is 151 miles long. Train No. 1 makes the run in five hours and ten minutes, including 27 stops. The regular train consists of a baggage car, mail car, express car, four coaches and two sleeping cars and has a weight of 420 tons. Train No. 3 makes the run in five hours and fifteen minutes, with 12 stops, and normally weighs 450 tons. Extra sleepers, however, are frequently added, giving a 12 or 13-car train, but the locomotives have sufficient reserve capacity to still maintain their schedule, which was altogether out of the question with simple engines under these conditions. Mr. F. H. Scheffer, superintendent of machinery at Nashville, states that in a general way the running repairs are about one-third more than for a simple engine, although some small changes made in the last order will probably largely reduce this percentage, but, since the engines save coal and satisfactorily perform the service demanded, there is no objection to the increased maintenance cost, and balanced compounds are very popular in that district.

This design of balanced compound cylinders has been illustrated and described several times in these columns and is too well known to require further description. The present example contains no unusual features. The piston valves are 15 in. diameter and are located directly over the frames. This requires the introduction of a rocker to transfer the motion from the plane of the valve gear to the valve. It is placed just back of the cylinders and has two upwardly extending arms, the outer one connecting to the combination lever at the same point the valve stem connection is made in the usual design on simple engines.

The crank axle is of the built up type with a cast steel center web which was illustrated in this journal in August, 1906, page 308. The main rods are approximately 75 inches in length.

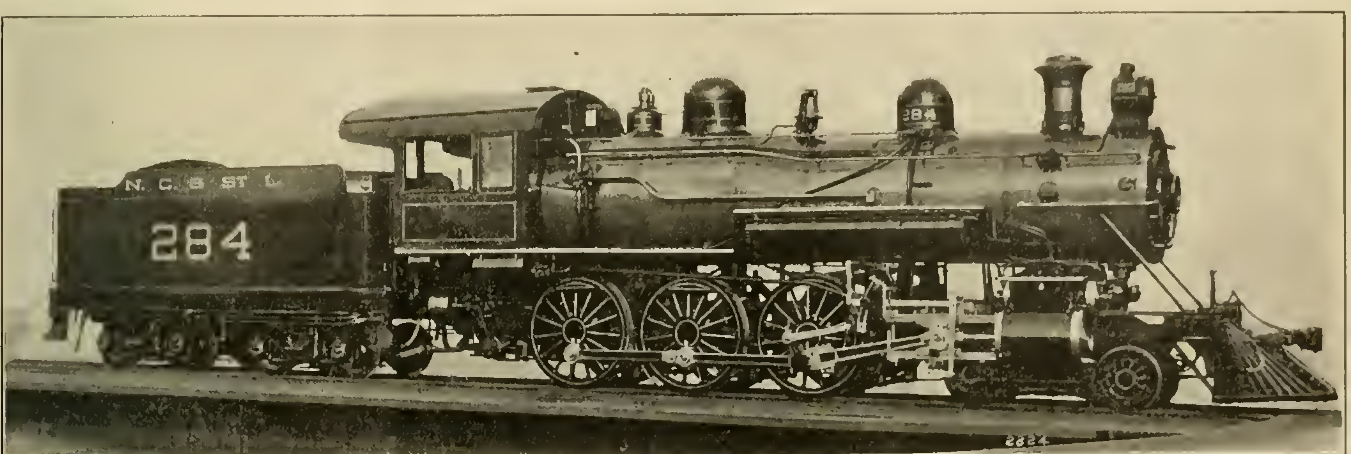
The main frames are cast steel 4 inches wide and the single bar front frames are iron with a comparatively light section made possible by the use of balanced cylinders which very decidedly reduce the stress in them as compared to what it would be with simple cylinders.

The boiler is of the well-known narrow firebox, wagon top type and measures 64 in. outside diameter at the front ring. The mud ring is but 3 in. wide at the sides and back and the side water legs are narrow throughout, widening to only about 4 inches at the crown sheet. In the back water leg the space is increased to 6¼ inches at the crown sheet.

The O'Connor firedoor flange is used and flexible staybolts have been fitted in the breakage zones. The tubes number 256 and are 2¼ in. diameter and 17 ft. long. The bridges are approximately ¾ in. The tube heating surface gives a ratio of 73.2 to the grate area.

The general dimensions, ratios and weights are as follows:

| | |
|---|---|
| **GENERAL DATA.** | |
| Gauge | 4 ft. 8½ in. |
| Service | Passenger |
| Fuel | Bit. Coal |
| Tractive effort | 29,200 lbs. |
| Weight in working order | 170,000 lbs. |
| Weight on drivers | 125,000 lbs. |
| Weight on leading truck | 45,000 lbs. |
| Weight of engine and tender in working order | 280,000 lbs. |
| Wheel base, driving | 12 ft. |
| Wheel base, total | 26 ft. |
| Wheel base, engine and tender | 55 ft. 2 in. |
| **RATIOS.** | |
| Weight on drivers ÷ tractive effort | 4.28 |
| Total weight ÷ tractive effort | 5.81 |
| Tractive effort × diam. drivers ÷ heating surface | 705.00 |
| Total heating surface ÷ grate area | 78.50 |
| Firebox heating surface ÷ total heating surface, per cent | 6.80 |
| Weight on drivers ÷ total heating surface | 45.80 |
| Total weight ÷ total heating surface | 62.00 |
| Volume equiv. simple cylinders, cu. ft | 10.20 |
| Total heating surface ÷ vol. cylinders | 268.00 |
| Grate area ÷ vol. cylinders | 3.40 |
| **CYLINDERS.** | |
| Kind | Bal. Comp. |
| Diameter and stroke | 16 & 27 × 26 in. |
| Kind of valves | Piston |
| Diameter of valves | 15 in. |
| **WHEELS.** | |
| Driving, diameter over tires | 66 in. |
| Driving, thickness of tires | 3 in. |
| Driving journals, main, diameter and length | 10 x 10 ½ in. |
| Driving journals, others, diameter and length | 9 x 12 in. |
| Engine truck wheels, diameter | 30 in. |
| Engine truck, journals | 5½ x 12 in. |
| **BOILER.** | |
| Style | W. T. |
| Working pressure | 210 lbs. |
| Outside diameter of first ring | 64 in. |
| Firebox, length and width | 120 x 41⅞ in. |
| Firebox plates, thickness | S. & B. ⅜, C. 7/16, T. ½ in. |
| Firebox, water space | F. 4, S. & B. 3 in. |
| Tubes, number and outside diameter | 256—2¼ in. |
| Tubes, length | 17 ft. |
| Heating surface, tubes | 2,550 sq. ft. |
| Heating surface, firebox | 185 sq. ft. |
| Heating surface, tubes | 2,735 sq. ft. |
| Grate area | 34.8 sq. ft. |
| Smokestack, height above rail | 14 ft. 11 in. |
| Centre of boiler above rail | 8 ft. 11 in. |
| **TENDER.** | |
| Tank | U shape |
| Frame | 10 in. chan. |
| Wheels, diameter | 33 in. |
| Journals, diameter and length | 5 x 9 in. |
| Water capacity | 5,500 gals. |
| Coal capacity | 9.5 tons |



BALANCED COMPOUND TEN-WHEEL PASSENGER LOCOMOTIVE—N., C. & ST. L. RY.

## COALING ARRANGEMENTS AT ROUNDHOUSES.

The coal pocket should be located so that engines can take coal inbound or outbound, as on modern engines the flues must be cleaned from the firebox end, and this cannot well be done when the tender is full of coal. A locomotive with modern front end appliances is so arranged that it is impossible to clean out stopped-up flues from the front without removing the draught appliances, and these in many cases have to be so carefully arranged that it is expensive, and many chances are run in getting them back just right, so as to insure the engine steaming; it has been found that on wide firebox engines, with the best arrangements of front end, stopped-up flues must be cleaned from the back end.

If from ten to twenty tubes are stopped up (and this is not exaggerated), it means that the heating surface of the engine is diminished by about 150 square feet, and this has a very material effect on the steaming of the engine, especially as the stopped-up flues are very likely to be at the bottom of the boiler, where the water is coldest.

A terminal that is so arranged that an engine must take its coal inbound, or block traffic if taking it outbound, is not arranged to give the best and most economical service, because, for the reasons given above, it is important that the tenders be clear of coal when the engine comes into the house, for the double purpose of first permitting the flues to be blown out, and second, that the tank may be lightly loaded and thus easier handled in case work is to be done on either the tender, its frame, or the trucks.—*R. D. Smith before the New England Railroad Club.*

THE PROBLEM OF TO-DAY is not only to develop the inanimate mechanical forces, methods and materials, many of which have been, and all of which may be, standardized, but to study, select, train and manage the animate human element, which cannot be standardized, and is the potent and controlling factor in the man-machine unit.—*J. E. Muhlfeld, New York Railroad Club.*

WHAT IS STEAM?—What would you give, off-hand, as the definition of steam? Is it a simple element to define? At an examination of firemen for promotion, held by one of the roads in Texas recently, this question was put to a fireman: "What is steam?" He hesitated for a moment and then replied: "Steam is water gone crazy with heat." He was promoted.—*Railway Journal.*

# HANDLING LOCOMOTIVE SUPPLIES*

BY E. FISH ENSIE.

PART III.—STANDARDIZATION.

*Introductory.*—In the January, 1908, issue of this journal (page 7), the writer gave a general outline of the whole problem of handling and maintaining locomotive tool and supply equipments from its several aspects; for example, costs involved, minimum expectable expenditures, variations in cost on different roads and with different degrees of supervision, the primary Interstate Commerce Commission prescribed accounts covering all the expenditures involved, handling requisitions, standardizing equipment, checking for equipment, caring for and repairing equipments, with a summary of the results to be expected.

In the March, 1908 issue (page 90), the accounting and detailed costs were dealt with at some length, sufficient perhaps to give any mechanical transportation or accounting officer material for effectively applying the necessary basic accounting measures to secure full and reliable data for intelligent supervision of this item of expense.

It is the writer's purpose to conclude this series of articles with a chapter dealing with the standardization of the various articles constituting the locomotive equipments, and with the inspecting system by which alone the complete results as to low costs (the words "maintenance cost" would be misleading, as the I. C. C. charges are under the Transportation Accounts, and not under the Maintenance Accounts) can be secured.

OBJECTS OF STANDARDIZATION.

Standardization is a two-fold process: it determines in a general way what articles shall constitute a locomotive equipment, considering the purposes for which the equipment is needed, whether the need is real, whether it may be fulfilled in some other way, or by some substitution; and it specifies in minute detail as to design and quality, the construction of each item or article.

The objects of standardization are:

To give the best practical service of each article, and of the equipment as a whole; in other words, to bring the efficiency of the equipment to the highest point.

To give equipment so well designed, and so durable that it will last the longest per dollar expended, and not require the trouble and care of replacement, thus providing the greatest economy consistent with the greatest efficiency in the use of the supplies and equipments.

To promote the lowest yearly costs for the totals of each item used.

To reduce to a minimum the amount of equipment on an engine and hence the trouble of taking care of it as well as the first investment cost.

To set such uniform standards and specifications for all articles that there will not be confusion and variation in the ordering, and that purchases in large quantities at best quotations may be arranged for.

And to have such a uniform arrangement of the equipment on all engines, that inspection and care may involve the least amount of labor, and that records and supervision will be reduced to the greatest simplicity.

An outline will here be given of the method of such standardization, illustrating in detail a few of the articles thus standardized.

The locomotive of the olden time was fortunate in having its individual captain and attendant; the personalities of the engineer and fireman were wrapped up with the individual peculiarities of the locomotive, and the one responded to the sympathetic and skilful handling of the others. The engineer was largely his own mechanic, and when the locomotive went to the shop he laid off, too, and saw that a good job was done on his engine. His oil cans, hammers, wrenches and other tools and appliances also partook of his individual idiosyncrasies; in fact, he probably bought most of these from his own pocket money, just as the average machinist of to-day buys his own rule and calipers. The engines were small, the parts were light, and the engineer was able to effect emergency repairs with his tools on the road, or at a turning point off on a small branch line. He was a machinist as well as an engineer.

The pooled locomotive service, resulting from the use of heavier and more expensive units of motive power, has quite changed this situation, yet we find that the average locomotive equipment list of to-day savors of the character of a traveling machine shop, rather than of that of a set of appliances for the mere purpose of getting an engine over the road. Some articles are archaic, and serve a by-gone usefulness; others are duplications of articles carried elsewhere in the train; and still others were best left behind in the roundhouse or shop. The ax and saw have in modern days become an anachronism on a locomotive like the polished brass bands about the boiler jackets, and the luxuriant landscape views on the tenders, of former days. Extra air and signal hose are usually carried attached to the train and signal lines at the forward end of the locomotive, and may be detached from this position, where they are seldom used, in case of mishap to the hose and couplings at the tender end; jacks, bars and wrecking chains may be usually found as part of the equipment of a baggage car or a caboose car, and often only serve to be in the way and to get in uselessly bad condition when carried on the locomotive tender and mixed up with the coal. Sledges, soft hammers, various sizes of screw and pipe wrenches, keys, cotters, and other like parts, exhaust nozzles, and spare bells and whistles, had better remain in the tool room, or in the stock room, than to be carried around for some remotely (im)possible exigency on the road.

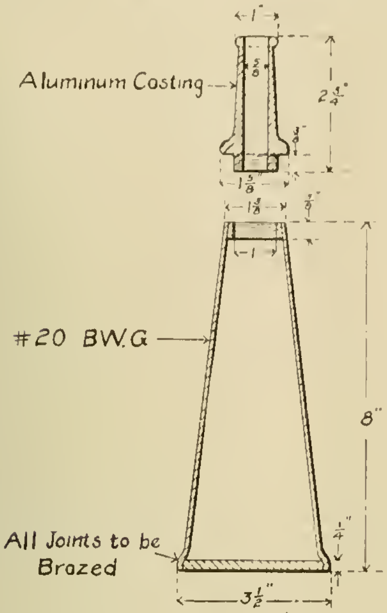
STANDARD ARTICLES.

A list of standard equipment which will fulfil satisfactorily the average needs on American railways, with of course some changes here or there to fit particular circumstances, is given herewith. It would be beyond the space permitted in this paper to give detailed specifications, drawings, photographs, prices, and names of manufacturers, of each item of this standard equipment, and a few typical instances only will be chosen to illustrate the way in which standardization is handled.

The first case chosen will be that of the engineer's torch, because it combines the functions of several different kinds of equipment (namely, of tool, of lamp, of oil receptacle, and of an indispensable article). The function of the torch is primarily to give light to the engineer when oiling around, both outside and inside the frame; the torch should not be too heavy to hold, nor too bulky; it should stand up solidly, or lie down without leaking or going out; it should be of such proportion as to have its light easily thrust into restricted quarters; and it should be durable, and of such distinctive design that shopmen may not appropriate it without detection; it should burn well, and hold sufficient, but not too much oil. When engineers had their torches specially made, they used to be made of polished brass tubing, fitted with a large screw cap at the bottom, or possibly an end piece soldered fast, and a screw top with wick nipple

* Continued from page 95 of the March, 1908, issue.

at the other end, for holding the torch wicking. These torches were quite expensive, but the engineers took great pride in them, often keeping them highly polished, and jealously guarding them as their personal property for many years. At the present time the torch is either a tin pot torch, of the teapot pattern, or a malleable iron pot or hand torch (the latter of similar dimensions to the old-time brass torch), or more rarely a sheet iron



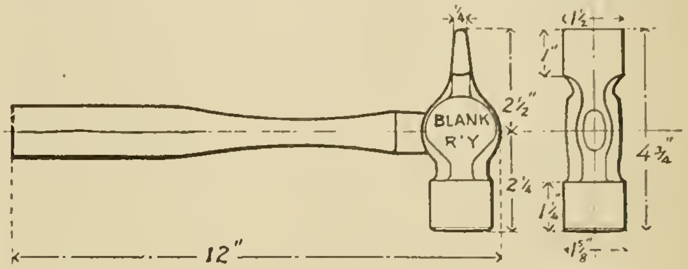

STANDARD ENGINEER'S TORCH.

torch of a lighter, more handy, and more durable construction. The objection to the old-time brass torch was, of course, in its cost to make, though, if well taken care of, there is no question but that the brass torch at $2.00 or $3.00 each, is more economical than some of the cheaper torches that are bought to-day, as they will last years, where the others do not last weeks. But it is of course true that if the equipment is not carefully looked after the indiscriminate and wasteful use and abuse of brass torches will prove a great extravagance. Lack of care and restraint in the use of property always results in wasteful extravagance.

The tin pot torch largely in use to-day, although suitable for shop use, is altogether unfitted for the rigors of service out on the road. The seams become unsoldered, the torch upsets and leaks, it is crushed, dented, and handle and spout broken off; the oil cap is lost, the spout cannot be thrust far in between the motion work of an engine in close quarters; and it is light and upsets easily. The average life of such a torch, even under good practice and care, and taking advantage of the resoldering and re-using of second-hand torches, is less than two months; and the average cost is over 25 cents for even the cheapest grade of the article that will give service at all. Compare this with the more efficient, serviceable and satisfactory brass torch, that will cost ten times as much, but last twenty times as long, with the same proportionate amount of care and attention.

The malleable iron torch is a very durable affair, and some examples of it, especially in the hand torch, are very well designed. These torches are much handier to use than the pot torches, but in practice they are found to have the following disadvantages: they are so heavy that the engineer finds them difficult to handle, becomes disgusted with them, gets rid of them at the first opportunity, and prefers even the much less suitable tin torch, because of its lightness; the malleable iron torch in the hand form will not stand up well, and when it lies down it almost always leaks—in practice, that is; but for these disadvantages the malleable iron hand torch would be almost ideal for use. It costs but slightly more than the tin torch.

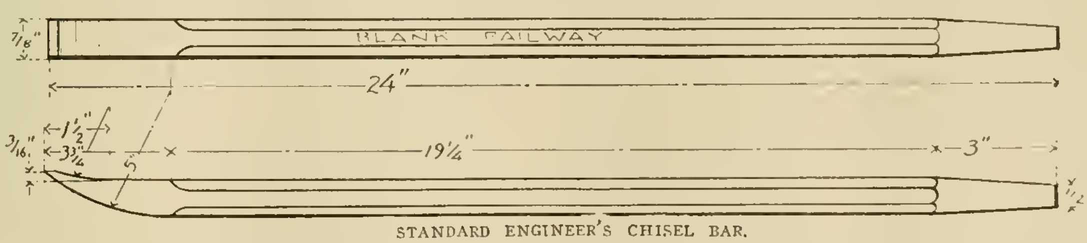
Several supply firms handle a form of sheet iron torch, with a brazed seam, substantial bottom, attenuated shape, and efficient wick nipple. A design is here shown that represents the best features of the best of these torches, but that is not the product of any particular supply company. Its construction may be briefly described: the main body of the torch is a piece of sheet metal (iron, brass, or even aluminum), formed in the shape of a cone, brazed together substantially at the seam, flanged at the base, brazed to a ¼-in. iron bottom of sufficiently wide proportions to make the torch stable, and tapering to about an inch and a half in diameter at the upper end. An aluminum, or a very light steel nipple, of considerable length, is used for the wick, and screws into a ring that is brazed inside of the upper taper end. This torch will sit up, because it has a concentrated weight at the bottom; it is of a simple, durable, strong and substantial construction; it will not leak; it is light and handy in use; and it can be thrust into the narrowest quarters. Its cost very little, if at all, exceeds that of the cheaper torch just quoted, yet a much smaller number are required to be supplied to engines each year.




STANDARD ENGINEER'S HAMMER.

An example has been quoted of a large railway that used a new torch on an average of each week to ten days for each engine in service; the standards on this railway were the malleable iron hand, and tin pot torches. Hammers, used by the engineers, which cost about the same price, were not used up nearly so fast. The extraordinary consumption of these torches was due, not so much to general carelessness of enginemen, as to the carelessness resulting from their disgust with unsatisfactory articles.

We shall next consider a standard hammer. This hammer should be designed for use by engineer on the road. An ordinary machinist's or boilermaker's hammer will not do. The machinist's hammer is too light, the handle is too long for the work in contracted quarters under an engine, and the design, being identical with that of the shopman's hammer, offers a needless temptation to roundhouse men and others to purloin these from the engine. Moreover, the ball pein is of no use practically to an engineer. An engineer's hammer should weigh about two pounds, so that he can strike an effective blow with it to knock out a pin or bolt, should have a handle about twelve inches long, and should be equipped with a wedge pein so that it may be used in lifting the lids of cellar boxes, and to distinguish it completely from the shopmen's hammer. A hammer fulfilling these conditions, which may be economically made of malleable iron, is shown in the illustration.




STANDARD ENGINEER'S CHISEL BAR.

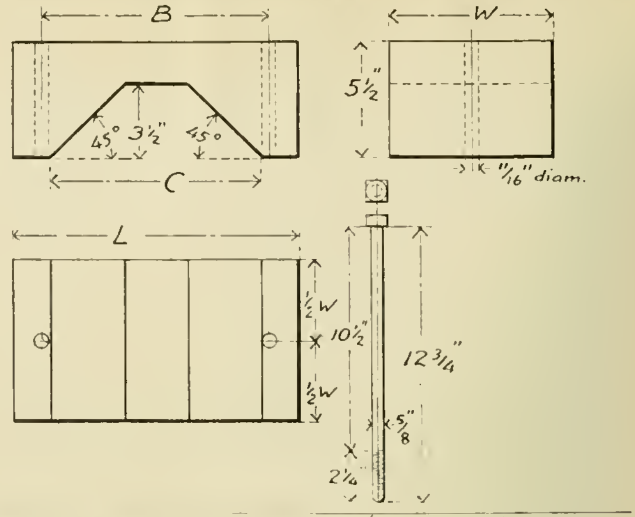
The chisel, too, ought to be radically different and distinguishable from the shopmen's tools, and for this reason should be made of hexagon, instead of octagon steel. The flat chisel is all that is required in this direction on a locomotive, as a cape chisel, or round-nose, are of little use in the hands of an engineer of to-day, who is not a machinist in a specialized sense. This chisel serves also as a set, or as a wedge.

Next is shown a small chisel bar, which serves the purpose of bar, of cold chisel, and of jack lever, where a jack is carried. As this article has no duplicate in the shop, it can be made of the customary octagon steel.

It is sometimes advocated that it is economy to use up on the locomotives all the old brooms that have served one period of usefulness already in the various offices, stations, shops, and elsewhere on the railroad. This idea is all right, but it does not go far enough. There are not nearly enough brooms to go around, as one broom is consumed per locomotive every two to six weeks. This case is not like that of the torches, due to indifference, and flagrant carelessness, but is due to legitimate wear in actual sweeping service, and is unavoidable, so long as brooms are used. To a limited extent, the second-hand brooms can and should be used, but it will be found that they will not supply more than from three to twelve per cent. of the locomotive needs, and will then of course not last as long as new brooms. It is true that a short and stubbly broom is more suited for use on an engine than a nice long resilient house broom. A special design of broom embodying the characteristics needed for locomotive use, and wearing from two to three times as long as the average finer broom can be made, the first cost being practically the same.

The next article, an emergency valve stem clamp, normally carried bolted on the valve stem, should be on every engine, and the design shown will fit almost every locomotive valve stem in existence, the screw lengths on the bolts permitting of this wide variation in size. The upper loop of the clamp, is of course attached under the gland nut. This is a very useful and convenient article in case the engine has to be disconnected.

Another emergency article is the crank-pin block. These blocks are often made to closely fit the crank pin of the particular engine to which they are to be applied, being nicely sawed round for this purpose. This care in fitting is unnecessary. Usually




| Size | B | C | L | W |
|---|---|---|---|---|
| 1 | 11⅞ | 10 | 13 | 7¾ |
| 2 | 7⅜ | 7⅛ | 10 | 5⅝ |
| 3 | 5⅝ | 5¾ | 8¼ | 4⅛ |

STANDARD CRANK-PIN BLOCK.

two or three sizes will take care of all classes of engines, these sizes being determined by the length of pin, a half-inch play being permissible. The diameters of the openings need only be such as will permit of the crank pin collar holding the block in place. One standard size bolt serves all blocks. Great economy in manufacture and in stock carried is attained by these standard blocks. Cross-head blocks may be reduced to similarly few standard sizes.

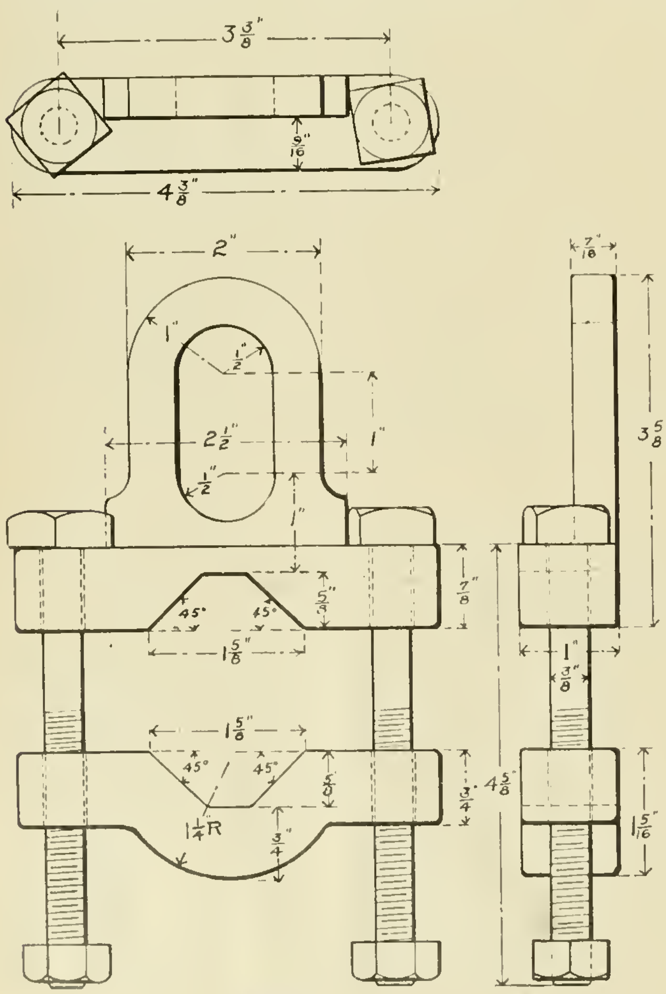
In discussing standard articles of equipment connected with handling locomotive supplies, mention should be made of the importance of having standard measuring cups at the oil houses, so that the oil allowances may be accurately given out. By the working out of this plan under the direction of one of the most progressive motive power men in this country, it was found that many thousands of dollars were saved annually by the deterrent thus provided against excessive oil issues. A standard design of can is here shown, together with full dimensions.

STANDARD LIST.

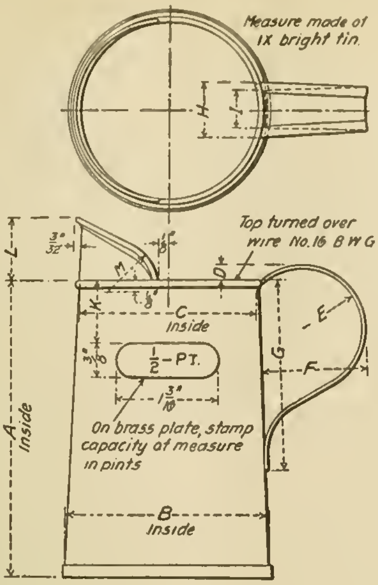
The accompanying list is nearly complete as regards the necessary movable equipment carried on a locomotive. The writer would welcome any comments, amendments, changes, additions or subtractions that readers may be interested enough to offer. Articles prefixed by an "S" should be reduced to one standard for all engines where used. Those marked "X" may be used according to special characteristics of the service or at the discretion of the officials of each road considering the proposition.

*Standard for all engines in every class of service:*

X 1 Medical box
S 1 2 lb. wedge pein hammer
S 1 21" screw wrench
S 1 12" screw wrench
S 1 Grease cup wrench
1 Double end set screw wrench
1 Air pump spanner wrench
S 1 Flat chisel
S 1 Valve stem clamp
S 1 Red lantern
S 1 White lantern
S 2 Classification lamps
S 1 Steam gauge lamp
S 1 Water gauge lamp
1 Headlight case and reflector
S 1 Water cooler
S 2 Drinking cups
S 1 Tank bucket
S 1 Broom
1 Set of flag staffs and flags, as prescribed by operating rules
X 4 Short hot box hose
S 1 Sprinkler hose
1 Bell cord (preferably cotton)
S 1 Torch
S 1 2 gal. valve oil can
S 1 2 gal. engine oil can
S 1 1 gal. headlight oil can
S 1 1 gal. signal oil can
2 Complete sets spare wicks for each lamp and lantern
S 1 Extra white lantern globe
1 Set of slides, as required by operating rules for classification lamp (colored glass)
S 1 Long engine oiler
S 1 Valve oiler
S 1 Emergency knuckle
2 Seat cushions
2 Back cushions
2 Arm rests
X 1 Back curtain
X 2 Side curtains
X 3 Lubricator glass tubes where used
X 2 Water glasses where used
X Guards for above
1 Oil can box
2 Clothes boxes
S 2 Clothes hooks
S X 1 Key hook
S 1 Small tool box
S 1 Supply box
S 1 Large emergency tool box
S 1 Set of instructions for handling lubricator, air brake, fuel, supplies and tools, reporting boiler troubles, handling injectors, reporting engine troubles, and electric or acetylene headlight, operating rules, handling compound locomotive, and superheater locomotive, handling oil burning locomotive
X 2 Flue plugs
S X 1 Compound bucket, where needed
X 2 Plugs for cylinder relief valve




STANDARD EMERGENCY VALVE STEM CLAMP.




| Line No. | Size in Pints | A | B | C | D | E | F | G | H | I | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1/8 | 2 3/16" | 1 9/16" | 1 5/16" | 1/8" | 5/8" | 1" | 1 3/4" | 1/2" | 1/4" | 1/2" | ... | .. |
| 2 | 1/4 | 2 3/4 | 1 15/16 | 1 11/16 | 3/16 | 3/4 | 1 1/4 | 2 1/4 | 5/8 | 3/8 | 3/4 | ... | ... |
| 3 | 7/16 | 3 3/8 | 2 11/32 | 2 | 3/16 | 3/4 | 1 1/4 | 2 1/4 | 5/8 | 3/8 | 3/4 | ... | ... |
| 4 | 1/2 | 3 1/2 | 2 7/16 | 2 3/32 | 3/16 | 3/4 | 1 1/4 | 2 1/4 | 5/8 | 3/8 | 3/4 | 3/4" | 5/8" |
| 5 | 3/4 | 4 | 2 13/16 | 2 13/32 | 3/16 | 3/4 | 1 1/4 | 2 1/4 | 5/8 | 3/8 | 3/4 | 13/16 | 3/4 |
| 6 | 1 | 4 3/8 | 3 3/32 | 2 5/8 | 1/4 | 1 | 1 3/4 | 3 | 1 | 1/2 | 1 | 15/16 | 13/16 |
| 7 | 1 1/4 | 4 3/4 | 3 5/16 | 2 27/32 | 1/4 | 1 | 1 3/4 | 3 | 1 | 1/2 | 1 | 1 | 7/8 |
| 8 | 1 1/2 | 5 1/16 | 3 17/32 | 3 1/32 | 1/4 | 1 | 1 3/4 | 3 | 1 | 1/2 | 1 | 1 1/16 | 15/16 |
| 9 | 2 | 5 9/16 | 3 7/8 | 3 11/32 | 1/4 | 1 | 1 3/4 | 3 | 1 | 1/2 | 1 | 1 3/16 | 1 |
| 10 | 2 1/2 | 5 15/16 | 4 3/16 | 3 5/8 | 1/4 | 1 | 1 3/4 | 3 | 1 | 1/2 | 1 | 1 1/4 | 1 1/16 |
| 11 | 3 | 6 5/16 | 4 7/16 | 3 13/16 | 1/4 | 1 | 1 3/4 | 3 | 1 | 1/2 | 1 | 1 5/16 | 1 1/8 |
| 12 | 4 | 6 15/16 | 4 7/8 | 4 7/32 | 5/16 | 1 1/2 | 2 1/2 | 4 1/2 | 1 1/4 | 3/4 | 1 1/2 | 1 7/16 | 1 1/4 |
| 13 | 5 | 7 1/2 | 5 9/32 | 4 1/2 | 5/16 | 1 1/2 | 2 1/2 | 4 1/2 | 1 1/4 | 3/4 | 1 1/2 | 1 9/16 | 1 3/8 |
| 14 | 6 | 8 | 5 19/32 | 4 13/16 | 5/16 | 1 1/2 | 2 1/2 | 4 1/2 | 1 1/4 | 3/4 | 1 1/2 | 1 11/16 | 1 7/16 |

STANDARD OIL MEASURING CUP.

*In addition to above, all road engines:*

S 1 Long oiler
X 1 Recorder
S 1 Torch
1 Wrecking wedge
S 1 Pinch bar
2 Guide blocks
2 Crank pin blocks
1 Engine truck brass
2 Tank brasses
S 1 Red lantern globe
Extra flags and staffs, as required by operating rules
S 6 Torpedoes
6 Fusees
S 1 Packing hook
S 1 Packing spoon
S 1 Chisel bar
S X 1 Extra steam heat hose
S X 1 Extra mica headlight chimney, or
S X 6 Extra carbons, and
S X 1 Extra electrode, or
S X 1 Extra acetylene tip
S 1 Time card holder

*Cool burners only:*

S 2 Coal scoops (1 second-hand)
1 Fire hook
S 1 Coal pick
1 Ash hoe
1 Grate shaker bar

*Oil burners only:*

1 Tank oil gage
1 Carbon bar
S 1 Sand funnel (built in fire door)
S 1 Engine cab sand box for sanding flues

*Yard engines only:*

S 1 Push pole
S 2 Re-railing frogs
X Fire extinguishing apparatus

CHECKING LIST.

These articles should be listed upon a convenient manila card form arranged in such a way as to furnish a ready means of checking by the tool checker or inspector at terminals. If the standard tools are placed according to a standard arrangement in the standard cab and tank boxes, and the list is made up so as to follow a natural and convenient order for inspecting the various articles, it is the work of but from two to six minutes to completely inspect the equipment of an engine. With a well-worked-out arrangement of this kind, the cost of inspection and supervision is reduced to a minimum.

The list may better be checked by the items found missing than by those found intact, and the checking may be done either with pencil and carbon copy, or preferably by punch or pinhole. A copy should be retained by the checker; one sent to the master mechanic in charge of the engine, and with some comment or explanation as to missing articles; and one sent to the equipment or supply supervisor responsible for the efficient handling of these supplies and tools. From these sheets valuable records of the habits of the various engine crews may be compiled.

It has been often suggested that tools and other articles may best be guarded on the engines to which issued, if they bear the stamp of the engine number to which originally issued. Simple as such a plan would seem to be, it is found open to many objections in practice. Stencils must be kept at every store or supply house; there is delay in issuing; the number stamps must be such as to be proof against easy alteration, abrasion, or counterfeiting. It is difficult to stamp oil cans and some other articles, such as red lantern globes or wrecking frogs. Articles may become mislaid or duplicated when engines are shopped. What is one to do when a duplicate number is issued and the original turns up? On the whole, it will be found best to avoid this degree of refinement in keeping track of equipment—at least, until a system of checking and looking after the tools and articles in question has been very thoroughly worked out, and has already reached a high state of efficiency and economy. Then it will be time enough to consider whether the extra cost of numbering all articles, and keeping track of them interminably will be worth while in view of the further savings practicable.

RELIABILITY OF COMPARATIVE ACCOUNTS OF COSTS.

In connection with this whole matter of checking and accounting for the engine equipments it has been suggested, since the chapter in the March, 1908, issue on "Accounting," that reliable comparisons are not to be had in view of the wide diversity of practice in accounting for these articles; and that such comparisons are especially meaningless with the still greater diversity of past years in accounting practice. The suggestion is perhaps well taken, although full consideration may not be given to the weight or value of each of the elements entering into the charges for equipment and supplies. A careful examination of the accounts on pages 90-92 of the March issue will make clear beyond almost any reasonable doubt where the various charges for the various items making up an engine equipment *should* go according to the only legal and prescribed classification of accounts promulgated by the Interstate Commerce Commission. To make the matter still clearer, I am adding another list apportioning various classes of articles in respect of their proper accounts.

According to the Interstate Commerce classification of operating expenses, the following items, attachments to the engine, should be charged to the cost of repairs:

Flag brackets
Classification and marker lamp brackets
Gauge lamp brackets
Headlight bracket
Boxes
Coal boards
Fire door chains
Grease cups
Gauge cock drip trough
Permanent piping for hot tender boxes
Hooks
Front and back coupler knuckles in place
Air signal hose, front and back, in place
Air hose, front and back, in place
Steam heat hose, back, in place
Water hose between engine and tender
Oil hose between engine and tender
Lubricator
Tank scoop (water scoop)
Cab windows
Electric cab block signals
Recorder
Built-in-sand funnel
Whistle lever
Bell
Bell ringer
Gongs

The following articles also should be charged to the account, "Repairs to Locomotives":

| | |
|---|---|
| Arm rests and cab cushions | Cab lamps |
| Cab curtains and awnings | Classification lamps |
| Crosshead blocks | Extra signal, brake or steam hose |
| Guide blocks | Extra brasses |
| Flue plugs | Extra rod packing |
| Valve stem clamps | Emergency knuckles |
| Headlight | |

The following items, although attachments, should be charged to the accounts covering other supplies to yard and road locomotives:

| | |
|---|---|
| Guard for water and lubricator glasses | Fire hose |
| Bell cord, extra only | Switch chains |
| Grate shakers | Switch ropes |
| Squirt hose | Switch poles |
| Hot box hose connection | Thawout hose |
| Hose reels | Water coolers |

Locomotive operating tools:

| | |
|---|---|
| Ash hose | Picks |
| Ash pan rods | Pokers |
| Clinker hooks | Scoops |
| Graphite can | Shovels |
| Packing hooks | Slash bars |
| Packing spoons | |

Oiling tools:

| | |
|---|---|
| Oilers | Grease cup wrench |
| Long oilers | Packing hooks |
| Tallow pot | Packing spoons |

Locomotive adjustment and repairing tools:

| | |
|---|---|
| Buggy and chisel bars | Plugging bars |
| Chisels | Punches |
| Crowbars | Scrapers |
| Drifts | Sledges |
| Files | Sets |
| Hammers | Wrenches |
| Pinch bars | |

Emergency tools:

| | |
|---|---|
| Axes | Saws |
| Hand saws | Pinch bars |
| Hatchets | Wrecking frogs |
| Jacks | Switch chains |
| Jack screws | Medical box |

Locomotive cleaning appliances:

| | |
|---|---|
| Brooms | Pans for soap and lather |
| Brushes | Sponge |
| Buckets | Sponge holder |
| Soap | Front end scrapers |
| Tripoli | Headlight reflector chamoix |

Signalling apparatus:

| | |
|---|---|
| Headlight chimneys | Torpedoes |
| Flags and flag staffs | Fusees |
| Classification lamps and slides | Bell cord |
| Lanterns and parts | |

Consumable stores:

| | |
|---|---|
| Headlight oil | Soap |
| Signal oil | Putz |
| Wicking | Matches |
| Graphite | Sand |

For carrying tools and supplies:

| | |
|---|---|
| Portable boxes | Soap box |
| Oil supply cans | Tripoli can |
| Match case | |

Lubricants for locomotives: Accounts 77 and 86.

| | |
|---|---|
| Valve oil | Dope |
| Engine oil | Waste |
| Car oil | Lubricating compounds |
| Grease | |

Examination of the tables of "Approximate Apportionment of Detail Expenses" shown on page 92 of the March issue will show still further just definitely where each class of expenses in connection with handling locomotive supplies and tool equipments, belongs, and the approximate proportion of each to the whole. These tables, which are a thorough analysis of the charges in question, show that even including all kinds of charges to accounts other than those prescribed by the I. C. C., for "Other Supplies for Locomotives," such as tool checkers, supervision, accounting, stationery, inspector's traveling expenses, hostlers on this work, etc., etc., the total of all charges of this nature should not exceed $77.50 per locomotive per year in any case, and should reasonably fall to $35 per engine per year with proper supervision and systematic handling. At the latter rate a road owning 1,000 locomotives should cost all told from $35,000 to $77,500 a year for all expenses connected with locomotive supplies and equipments, only some $18,500 to $37,000 of which properly belong under the accounts prescribed for these expenditures; if the road owned some 1,400 locomotives, the total cost should in no case exceed $107,500, especially if it were an eastern road, and if the expense according to the prescribed account alone were more than this, such excess would be a certain indication of avoidable waste which by reasonable attention and economy ought to be saved. As a matter of fact, in the latter hypothetical case, an additional $60,000 should also be cut off the annual expenditure.

In conclusion it should be stated that all the methods, forms and standards indicated in this series of papers are taken from practice, and represent practical and not theoretical propositions. In no sense are the economies sought and attained a paper showing—a mere shifting of accounts. It used to be that any one with sufficient ingenuity could "make a showing" by shifting burdensome changes to accounts not connected with the activities concerned in the "showing." But now such a course would be illegal, and future comparisons of railroad statistics will be more reliable than they have been.

## A CHICAGO PLAN FOR JOINT SHOP AND SCHOOL WORK

According to the *Iron Age* Chicago machinery manufacturers and the Lewis Institute are co-operating in a plan of joint shop and school instruction for boys, somewhat similar to that which has been carried out by Cincinnati manufacturers and the University of Cincinnati for several years. A modification of the plan has also been in operation at Fitchburg, Mass., since the fall of 1908, though in the latter the school does not have any shop equipment. The Chicago arrangement, after a short period of experiment, has recently been put in effect. Under it the manufacturers send their apprentices to school at the institute half the time, one week being spent in the shop and the next week in the school. The course extends over two years, but it is not the idea of the manufacturers or of the instructors at the Lewis Institute that a boy can become a skilled workman in that time. The expectation is that he will get a more intelligent grasp of his trade than he could otherwise obtain. The age limits are 16 and 20 years. Each manufacturer may be represented in the school by a unit, or two boys, or by two units—four boys. The employer pays the tuition fee of $50 a year for each pupil and pays the boy $5 for each week he works in the shop. In this way the boy receives his instruction free and $2.50 a week for two years. Two weeks' school vacation are given in the summer, but 26 weeks a year are spent in the shop.

The Lewis Institute will give instruction to the boys eight hours a day five days in the week. Two hours a day will be spent on each of the following lines of study: 1. Physical science and the principles of mechanics. 2. Mechanical drawing. 3. Shop work, supplementing that done in the metal working establishments. 4. English, history and mathematics. Twenty-seven boys are now taking the metal working course in the institute, and some of them are sufficiently advanced to be sent to shops at once. Several boys serving apprenticeships in shops are being tried out, and will probably prove good enough to be sent to the institute. The boy who puts in the full course at the institute will still have to learn his trade, though the term of his apprenticeship may be reduced as a result of his better education. The Lewis Institute has equipment for the instruction of 60 boys in the course provided in the metal trades.

WINDOWS IN ROUNDHOUSES.—One of the engine house details which is constantly in sight are the windows. These get dirty very easily and are a constant expense to keep clean. With the usual construction involving a high wall to let in lots of light, it is often necessary to clean the upper sash by ladders or long-handled brushes. A scheme which has been found very satisfactory is an arrangement of four sash in a single frame, the top one balanced against the lower and the two intermediate ones balanced against each other. This does away with sash weights, and any sash may be pulled down to the window sill level and the glass easily and cheaply cleaned. It also has the advantage of giving a clear opening of 75 per cent. of the frame area in summer time. A 12-inch I beam makes a very good frame as it never rots out and is stiff and rigid. Short sections of the parting strips are removable at the bottom so the sash can easily be slipped in and hung.—*Wm. Elmer, before the Railway Club of Pittsburg.*

# DATA OF SPECIAL INTEREST TO THE DRAFTING ROOM

## SEMI-ELLIPTIC SPRINGS.

*(From the American Locomotive Company's Standard Practice.)*

CALCULATIONS.

In obtaining the net static load, the actual weights of the parts constituting dead load, such as wheels, axles, boxes, etc., should be deducted instead of taking a certain arbitrary percentage.

Maximum fibre stress allowable, 80,000 pounds. The figures given on Spring Card in "Load" column are the calculated loads which springs will carry at 80,000 pounds fibre stress and are the maximum loads for which springs should be used.

### SPRING TABLES.

#### SEMI-ELLIPTIC SPRINGS.

| LENGTH BETWEEN CENTERS | ONE PLATE 1″ WIDE. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ¼″ PLATE | | 5/16″ PLATE | | ⅜″ PLATE | | 7/16″ PLATE | | ½″ PLATE | |
| | LOAD | DEFLECTION | LOAD | DEFLECTION | LOAD | DEFLECTION | LOAD | DEFLECTION | LOAD | DEFLECTION |
| 20 | 167 | .98 | 260 | .78 | | | | | | |
| 22 | 152 | 1.19 | 235 | .95 | 341 | .79 | | | | |
| 24 | 139 | 1.41 | 217 | 1.13 | 312 | .94 | | | | |
| 26 | 128 | 1.66 | 200 | 1.32 | 288 | 1.10 | 393 | .95 | | |
| 28 | 119 | 1.92 | 186 | 1.53 | 268 | 1.28 | 365 | 1.10 | | |
| 30 | 111 | 2.20 | 173 | 1.76 | 250 | 1.47 | 341 | 1.26 | | |
| 32 | | | 163 | 2.00 | 234 | 1.67 | 319 | 1.43 | | |
| 34 | | | 153 | 2.26 | 220 | 1.88 | 301 | 1.62 | | |
| 36 | | | 144 | 2.53 | 208 | 2.12 | 284 | 1.81 | 372 | 1.58 |
| 38 | | | | | 197 | 2.35 | 269 | 2.03 | 350 | 1.76 |
| 40 | | | | | 187 | 2.60 | 255 | 2.24 | 333 | 1.95 |
| 42 | | | | | 178 | 2.87 | 243 | 2.47 | 317 | 2.16 |
| 44 | | | | | 170 | 3.15 | 232 | 2.71 | 303 | 2.37 |
| 46 | | | | | 163 | 3.45 | 222 | 2.96 | 290 | 2.58 |
| 48 | | | | | 156 | 3.75 | 213 | 3.22 | 277 | 2.82 |
| 50 | | | | | | | 204 | 3.49 | 266 | 3.06 |
| 52 | | | | | | | 197 | 3.78 | 256 | 3.30 |
| 54 | | | | | | | 189 | 4.08 | 247 | 3.57 |
| 56 | | | | | | | | | 238 | 3.83 |
| 58 | | | | | | | | | 230 | 4.12 |

**FORMULAE USED IN COMPUTING TABLE**

$$P = \frac{53333\ H^2}{L}$$

$$F = .000611\ \frac{L^2}{H}$$

P = net static load
F = deflection
H = thickness of plate
L = length between centers

AMERICAN LOCOMOTIVE COMPANY'S STANDARD PRACTICE CARD.

It is advisable usually to make the capacity of springs slightly more than the net actual load, as given below.

REQUIRED CAPACITY.

DRIVING AND ENGINE TRUCK SPRINGS: Use calculated static load plus 500 to 1,000 pounds, or about 5 per cent.

UNDERHUNG DRIVING SPRINGS: For passenger engines use calculated static load plus 20 per cent.

TRAILING SPRINGS: Use calculated static load plus 15 per cent.

TENDER SPRINGS: Use calculated static load taken with maximum load of coal and water.

The spring tables for semi-elliptic springs give the capacity of one plate one inch wide and different thicknesses.

To obtain the required number of plates, multiply the figure given in "Load" column by the width of spring in inches and divide the required capacity by the result. The quotient gives the number of plates required. Where quotient gives decimal more than 3 add one plate to the whole number.

The number of full length plates must be 25 per cent. of the whole number required. The last full length plate must be tapered at ends and the remaining plates must be regularly shortened and tapered. The length of the shortest plate must not be less than twice the length of the spring band.

The deflection given in table is the difference between free and loaded height, irrespective of width or number of plates: for full-elliptics the number of plates and deflection given is for each half of spring.

*(From an article by William H. Mussey, American Engineer & Railroad Journal, June 1906. page 233.)*

Careful tests made in actual service showed that the greatest value for a live load on a locomotive driving spring was about 65 per cent. above the static working load, and the minimum was 45 per cent. less than the static working load.

Reauleaux formula for semi-elliptical springs is as follows:

$$P = \frac{Snbh^2}{6L}$$

P = Static load on one end.
L = ½ span in inches less ¼ width of band.
S = Fibre stress per square inch.
b = Width of plate in inches.
h = Thickness of plate in inches.
n = number of plates.

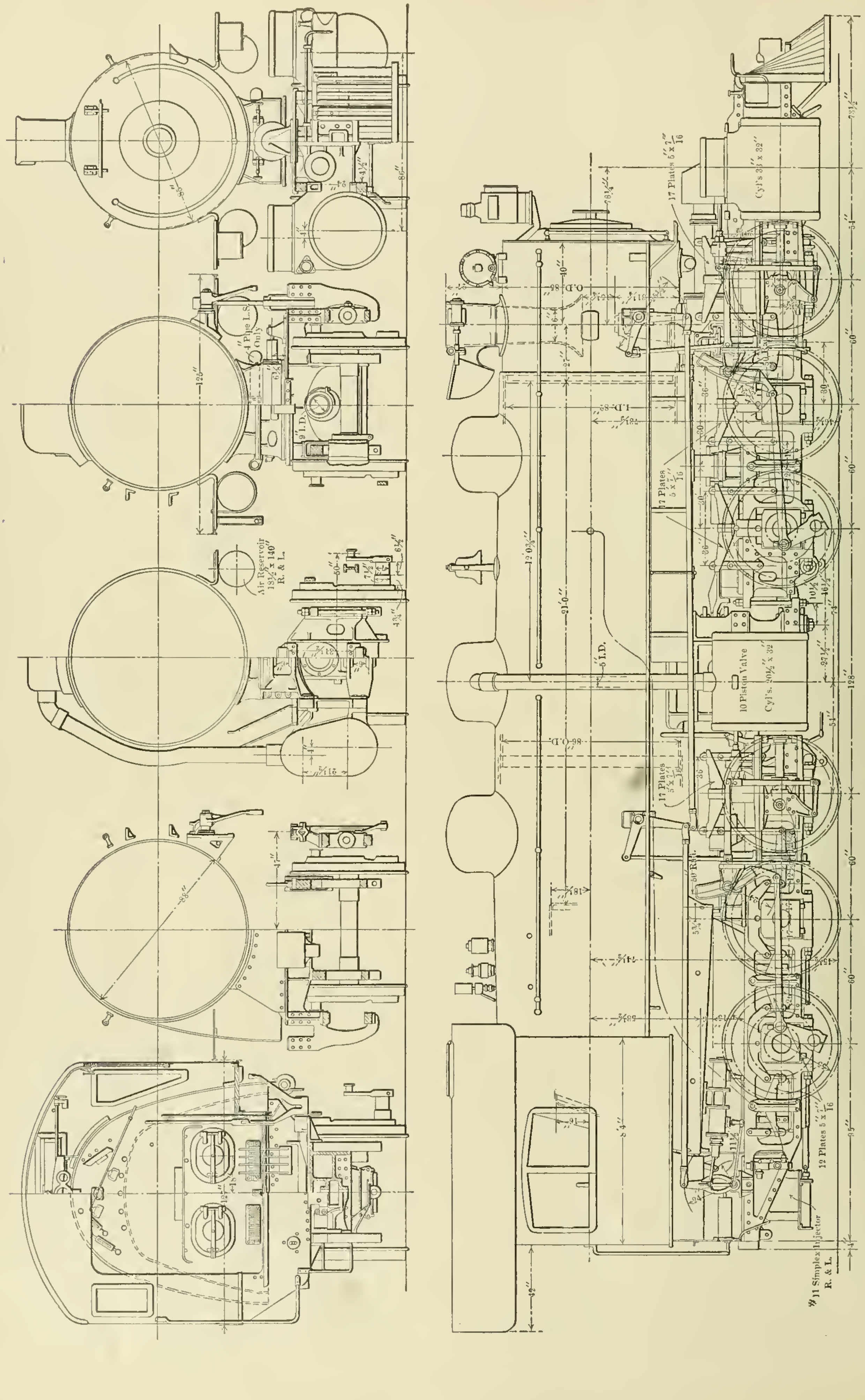
$$D\ (\text{deflection}) = \frac{SL^2}{Eh^2}$$

E = Modulus of elasticity = 29,400,000.

There may be some question about the deduction from L of one-quarter the width of the band, but this is theoretically correct, as a study of the action of the leaves of the spring will show.

Where possible short springs should be avoided and also narrow ones. Long springs with wide plates give the most even deflections, taking up shocks most effectively. Springs equalized together should have equal deflections under the same working loads as far as possible. An example is given in the case of a spring with a span of 26 in. and ⅜ in. leaves which was equalized with a spring having a 38 in. span and 7/16 in. leaves. This short spring gave very poor service. However, by reducing the thickness of the plate, with still about the same fibre stress, much better results were obtained. The aim should be to increase the deflections for given loads on short springs and decrease them on long springs which are equalized together. The formula for deflections shows that it varies directly as the square of the length of span and inversely as the square of the thickness.

Canada requires passenger cars to be lighted by Pintsch gas, acetylene or electricity.




GENERAL ELEVATION AND SECTIONS OF ARTICULATED COMPOUND FREIGHT LOCOMOTIVE—DENVER, NORTHWESTERN & PACIFIC RAILWAY.

# ARTICULATED COMPOUND LOCOMOTIVE 0-6-6-0 TYPE

DENVER, NORTHWESTERN & PACIFIC RAILWAY.

The American Locomotive Company has recently delivered to the Denver, Northwestern & Pacific Railway, generally known as the Moffatt road, a Mallet articulated compound locomotive, which is shown in the accompanying illustration. The topography of this road would seem to be particularly well adapted for the articulated type of locomotive, and judging by experience on other roads, under similar conditions, this will probably prove to be the forerunner of further equipment of the same kind.

The district in which these engines will be put in operation has a deep sag at Boulder, Colo., on either side of which there is a continuous grade for about 17 miles, which reaches a maximum of four per cent., the line being practically a continuous series of curves. Trains of 500 tons are now being operated in good weather by two and in bad weather by three consolidation locomotives. It is expected that this Mallet engine will alone handle these trains at a speed of about 12 miles per hour.

This locomotive is also to be experimented with in a service for which it would appear to have special advantages, *i. e.*, pushing a rotary snow plow. This region has very long winters, with very heavy snows, and the line is kept open only by the continuous use of rotaries.

The plows have heretofore been pushed by as many as five consolidation locomotives, and because of the large number of engines, which makes it difficult to control the starting and stopping as quickly as is desired, it is believed that the Mallet, capable as it is of exerting a very large tractive effort at slow speed and with its non-slipping ability, will prove to be a great success in this service.

The design in general follows very closely that used on the first locomotive of this type built in this country for an American railway, *i. e.*, the Baltimore & Ohio 0-6-6-0 type. There are, however, a number of small differences; as will be noticed by comparing the list of dimensions below with those used on the B. & O. locomotive, which were given in the table of dimensions published in the June, 1908, number of this journal.

The weight has been reduced from 334,500 to 327,500 lbs., a reduction of 7,000 lbs. Part of this was obtained by reducing the number of flues from 436 to 409 and the rest by the re-design of a number of the heavier parts. The size of the cylinders has been changed, the present engine having 20½ and 33 in. diameter cylinders in place of 20 and 32 in. The steam pressure has been reduced from 235 to 225 lbs. and the tractive effort increased to 73,900 lbs. The general arrangement of the boiler and machinery is shown in the illustration on the opposite page and the dimensions, weights and ratios are given in the following table:


MALLET ARTICULATED COMPOUND LOCOMOTIVE—DENVER, NORTHWESTERN & PACIFIC RY.

| | |
|---|---|
| **GENERAL DATA.** | |
| Gauge | 4 ft. 8½ in. |
| Service | Pushing |
| Fuel | Bit. Coal |
| Tractive effort | 73,900 lbs. |
| Weight in working order | 327,500 lbs. |
| Weight on drivers | 327,500 lbs. |
| Weight of engine and tender in working order | 487,300 lbs. |
| Wheel base, driving | 10 ft. 10 in. |
| Wheel base, total | 30 ft. 8 in. |
| Wbcel base, engine and tender | 64 ft. 4 in. |
| **RATIOS.** | |
| Weight on drivers ÷ tractive effort | 4.43 |
| Total weight ÷ tractive effort | 4.43 |
| Tractive effort x diam. drivers ÷ heating surface | 773.00 |
| Total heating surface ÷ grate area | 72.60 |
| Firebox heating surface ÷ total heating surface, per cent | 3.90 |
| Weight on drivers ÷ total heating surface | 62.20 |
| Total weight ÷ total heating surface | 62.20 |
| Volume equiv. simple cylinders | 19.45 |
| Total heating surface ÷ vol. equiv. cylinders | 270.00 |
| Grate area ÷ vol. equiv. cylinders | 3.70 |
| **CYLINDERS.** | |
| Kind | Mellin Compound |
| Diameter | 20½ and 33 in. |
| Stroke | 32 in. |
| **VALVES.** | |
| Kind, H P | 10 in. Piston |
| Kind, L. P | Allen-Porter Slide |
| Greatest travel H. P | 6 in. |
| Greatest travel L. P | 6⅛ in. |
| Outside lap H. P | 1⅛ in. |
| Outside lap L. P | 1 in. |
| Inside clearance | ¼ in. |
| Lead iu full gear | 3/16 in. |
| Gear, kind | Walschaert |
| **WHEELS.** | |
| Driving, diameter over tires | 55 in. |
| Driving, thickness of tires | 3½ in. |
| Driving journals, main, diameter and length | 9 x 13 in. |
| **BOILER.** | |
| Style | Straight |
| Working pressure | 225 lbs. |
| Outside diameter of first ring | 84 in. |
| Firebox, length and width | 108 & 96 in. |
| Firebox, plates, thickness | C—7/16, T—9/16, S & B—⅜ in. |
| Firebox, water space | F—5, S & B—4½ in. |
| Tubes, number and outside diameter | 409—2¼ in. |
| Tubes, length | 21 ft. |
| Heating surface, tubes | 5035 sq. ft. |
| Heating surface, firebox | 206 sq. ft. |
| Heating surface, total | 5241 sq. ft. |
| Grate area | 72.2 sq. ft. |
| Smokestack, diameter | 16½ in. |
| Smokestack, height above rail | 15 ft. 9½ in. |
| Center of boiler above rail | 120 in. |
| **TENDER.** | |
| Tank | Waterbottom |
| Frame | A. L. Co. Standard |
| Wbeels, diameter | 33 in. |
| Journals, diameter and length | 5½ x 10 in. |
| Water capacity | 9000 gals. |
| Coal capacity | 12 tons |

RAILWAY STOREKEEPERS' ASSOCIATION. The sixth annual meeting of the above association will be held in Chicago, May 17 to 19, inclusive, 1909. The headquarters will be at the Auditorium hotel.

(Established 1832).

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**Advertisements.**—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

**Contributions.**—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

## CONTENTS



## BRICK ARCHES AND SMOKE.

The reduction of smoke from locomotives in itself, except possibly in the immediate vicinity of stations, is of no particular importance to a railroad company, but because of its effect on popular opinion, in more thickly settled sections, it is given attention and more or less serious attempts are made, by means of instructions and orders, to reduce it to a minimum in those regions. This, of course, is a wrong view to take of the matter, for while the effect of the smoke may not be sufficiently serious to be worthy of attention, as an indicator of what is going on in the fire box it is of considerable importance and from that standpoint should be given the most careful attention.

It has long been known in a general way that a brick arch will reduce smoke, but in many districts they were more trouble and expense than it was considered worth while to incur and largely disappeared after a short trial. The Chicago smoke inspection department, however, decided to find out for itself exactly to what extent they were useful in this way, especially when used in connection with blowers, and have carried out an elaborate series of tests in connection with the Chicago, Burlington and Quincy Railroad. The results as far as smoke is concerned are very convincing, as is clearly shown by the curves on another page. That this really means a saving that is worth while is shown by tests on the Lake Shore given in the same article.

## OXY-ACETYLENE WELDING.

Rapid progress is being made in the adoption of the new oxy-acetylene process of cutting and welding to railway uses. While, like all other new things, it does not come up to all expectations or claims at first trial, it is proving to be a valuable resource in many ways. On one road where a plant has been in experimental use for some time, it is now planned to weld the tubes in the back tube sheets of locomotive boilers, which evidently will cure the continual trouble with leaky tubes. Broken cylinders are being repaired by its aid, and while no large frames have so far been welded by this process it is expected that eventually this can also be done. For cutting risers off from large castings and holes in boiler plate it has been found especially useful.

There would also seem to be a wide field for its use in steel passenger car construction, especially in connection with roof sheet joints, where expensive riveted construction is now necessary entirely for the purpose of tightness. The sheets in many places have to be small and the joints are numerous and must be water-tight.

## BRIQUETS FOR LOCOMOTIVES.

As is well known, the limited coal supply in foreign countries, with the accompanying high price, has led the railways there to give the most careful attention to fuel economy on locomotives. The most important feature, which is quite general in many parts of Europe, is to base the enginemen's wages almost entirely on the amount of coal they burn. Another method, which sooner or later will have to be considered in this country, is the use of low grade fuels that in their natural form are not suitable for locomotives. This is being, and has for some time been done, by means of briquetting and on many railways, particularly in France, briquets form a large proportion of the locomotive fuel.

While this is a subject that has been discussed more or less in this country, the condition of our natural resources has not reached a stage that makes it imperative to carefully investigate the question and it is only within the past few years that any really serious investigation or tests have been made with briquets from American coal. The organization of a fuel testing plant by the U. S. Geological Survey at the St. Louis Exposition included in its program an investigation of this subject, and while the study was first made in connection with stationary plants, later tests of briquets for locomotive use were made. The full report by W. F. M. Goss has just been issued by the Geological Survey and is quite largely reprinted in this issue.

The results are very interesting and valuable, although many of the extravagant claims that have been made for briquets were not proven. The tests were made by means of a comparison between a first rate grade of fuel in its natural state and the same fuel briquetted; the briquets included four or five varieties in two different shapes, the varieties differing in the amount of binder used. They were carried out on the Pennsylvania locomotive testing plant at Altoona and hence give results that are capable of accurate analysis and perfect confidence.

The conclusions reached by Dr. Goss are, that the evaporative efficiency of the boiler was increased by the use of briquets over natural coal and that they gave a marked increase in the efficiency of the locomotive and a slight reduction in the amount of smoke. They increased the facility with which an even fire over the whole area of the grate may be maintained. The briquets suffered little by handling; stood exposure to the weather very well and while there was no noticeable reduction in the amount of cinders and sparks the amount of heat lost in this manner was less. The tests made in actual service on several different railways showed them to be a satisfactory fuel, although there was no noticeable increase in the efficiency of the locomotive.

It is to be hoped that the experiments will be continued and that tests will be made with briquets from coal which in its natural state is not suitable at all for locomotive use, particularly the lignites of the far west.

## CIRCULATION IN FIRE BOX WATER LEGS.

It seems to be pretty generally agreed that the failure of side sheets in wide fire box legs is due to a sluggish circulation in the water legs or at least that it can be cured by an increase in the rate of circulation. In the January issue we presented Mr. Seley's theory of the subject in that the circulation should impinge against the sheet and thus prevent the formation of a film of steam which would keep the temperature in the sheet much higher than is desirable. Elsewhere in this issue we give a discussion by Mr. Johnston on the same subject, in which he suggests the use of a circulating plate, which would form a division in the water leg of a wide fire box locomotive having inwardly inclined side sheets and prevent the cross currents and eddies now probably existing and caused by the steam tending to rise along the outside sheet. Such a plate would give a free passage for the downward circulation of the colder water along the outside sheet and, by making a narrower space for the rising of the steam along the inside sheet, would tend to increase the rate of circulation and thus prevent the formation of a film of steam on the side sheet by simply bringing the water to the sheet so rapidly as to prevent its formation. The fact that a scheme of this kind was discredited a long time ago in connection with very narrow water legs should not condemn it without trial under the present conditions. The idea is capable of application with small cost to the present locomotives and certainly is worthy of trial.

## ALLOY STEELS.

The use of the so-called "alloy" steels has not been as general on railroad equipment in this country as would naturally be expected or as it has on foreign railways. This is particularly noticeable when a study is made of present day automobile construction where alloys of vanadium, chromium, nickel and manganese with steel or iron are widely employed. The service of an automobile in many ways is very similar to that of a locomotive, and if it pays to use these expensive materials there, it would seem to be advantageous to use them on railway rolling stock.

The foreign railways have recognized their value and have been using them for a number of years. A striking example of this is found in an order of large simple passenger locomotives recently built for a German railway in which the reciprocating parts were made so light as not to require any counterbalance in the wheels. Such tests as have been reported, particularly in connection with vanadium in cast iron car wheels, axles, frames, tires, etc., all indicate that there are great possibilities in this direction of decreasing wear, reducing weight, increasing safety and lowering maintenance charges.

## BEST METHOD OF TRAINING RAILROAD MEN.

The often discussed subject of the value of a college or university training as a preparation for a career in railroad work, particularly in the motive power department, again came up at the January meeting of the New York Railroad Club. Some of the old arguments pro and con were again advanced with the usual conviction on the part of the speakers and the usual result on the audience, viz., each one's ideas were influenced by the experience he, personally, had had with college men and while the vital importance of the subject was more or less generally recognized the conclusions were based on individual experience.

In view of the history of the development of mechanic arts of all kinds, it seems rather odd at first thought that it should be considered worth while to discuss this subject, or in fact that it should be capable of discussion at all. It would seem to indicate that there was an idea existent that education or learning is not valuable or worth while. Actually, however, that is not the point at all. All are agreed that the successful man must have both technical learning and experience and that he cannot be fully successful unless he is able to properly combine them and bring the combination to bear on every problem. The argument is really all on which of the two is the more important and should be given the preference. On the one side is advocated the crowding of the technical training all into a few years to be followed by an equally concentrated dose of practical experience, and on the other the obtaining of experience to be the principal object and the picking up of technical information to be by individual effort at odd times.

That the later method is not proving successful under present conditions is shown by the general introduction of shop schools, apprenticeship systems, trade schools, etc., which is now going on. That the former is faulty is indicated by the very fact that the subject is so often up for discussion.

These facts indicate the true condition. Neither method is fully successful and neither technical training nor experience is the more important or should be given the greater attention. They must be given equal care to attain the best results. This is beginning to be recognized at a few points and special courses are being given in mechanical engineering in the colleges in connection with practical work in the shops of manufacturing plants in the vicinity which alternate the school and shop work at equal intervals. The best railroad apprenticeship systems are doing the same thing to a less extent, giving greater emphasis to the shop training.

This movement is excellent and should be extended. While its success to a large extent depends on the location of the proper manufacturing shops in the same vicinity there are many places which offer the proper combination for its immediate installation. The course which seems to be the most successful requires attendance in the shop and school room on alternate weeks and includes the full curriculum of a technical course leading to the degree of mechanical engineer except the shop work and some of the experimental laboratory work usually included in these courses.

The application of this idea to a special railroad training is a little more difficult as very few colleges offering the properly trained teaching staff and laboratory facilities are located in the same locality as large railroad shops. The apprenticeship systems now being organized, however, give a first-class start, including, as they do, all the elements of this idea. A form of post-graduate course could probably be arranged with some of the technical schools which would produce the result desired with a comparatively small expenditure of time.

# ARE RAILROAD CLUBS WORTH WHILE?

We regret that space does not permit reproducing in full the splendid address on this subject, made before the St. Louis Railway Club, by its president, J. J. Baulch. After considering in detail the aim and the work of the St. Louis Railway Club, he directed attention to some of the special features of the other clubs, among which the following may be mentioned:

New York Railroad Club has 1,400 members.

New England Railroad Club has a dinner before each meeting. Recently celebrated its twenty-fifth anniversary.

Northern Railway Club has a half-hour's entertainment each night, different districts having charge of the program for the various meetings.

Richmond Railway Club has special programs two or three times a year, the ladies being invited; also contributes to the Railroad Y. M. C. A.

Western Railway Club maintains a library and each year presents its members with a bound volume containing the proceedings for the year.

Central Railway Club endows a bed in the Brooks Hospital at Dunkirk and contributes to a home for newsboys and bootblacks in Buffalo.

Canadian Railway Club maintains a scholarship at McGill University.

St. Louis Railway Club in the past ten years has paid for the education of a young man at the Blees Military Academy at Macon and another at Purdue University. At present it has a young man at the University of Missouri.

"The railway club is educational. We are living in a rapidly advancing age; to-day's standards are discarded for something newer to-morrow, and the superintendent or traffic officer of the railroad to-day may be operating an airship line to-morrow; and, by attendance at our meetings, will keep abreast of the times, know what is going on in the world of thought and action, and be prepared, not surprised, at the many changes in methods of construction, maintenance, machinery, operation, accounting, and the legal attitude of the Government towards the railroads.

"The meetings of the club, the fraternal intercourse of man as man, employers and employees meeting on a common level, discussing those questions always arising in our work, offering suggestions for the betterment of the service makes for us the general democratic feeling which is the foundation of our success, and increases our ability to consistently perform our duties. That club men are frequently diffident about getting up and expressing themselves on the various questions cannot be gainsaid, but attendance at meetings often wears this diffidence off.

"It is only natural that we should make this organization the medium through which to communicate our ever advancing thoughts and ideas to each other, and to the railroad world generally, for the railway club here, as elsewhere, is an educator for the members and for those who peruse the proceedings, making the mingling together, the exchanging of views as to best methods of accomplishing good results in railway work, an educational feature tending to make the club a power for good and a permanent institution.

* * * * * * *

"It, however, indicates, as we all know, that much friction exists between the various departments of the railroad. The operating and traffic departments do not agree, nor do the mechanical or the audit, or the road or the claim, or the repair or the inspection. They are often further apart—than if they were employed on rival lines. Bickering and crossfiring do not tend to the betterment of themselves or the service. Let these same men join a railway club, attend the meetings, write a paper occasionally, join in the discussion, take interest in the papers on topics covering departments other than their own, and I'll guarantee the practical elimination of department friction, and the upbuilding of the service.

"Here arises the time-honored excuse, too busy to attend, and entirely too busy to prepare a paper. That is the fellow we are after, the busy man. Glance over the 150 or more papers prepared for and read before this club since its inception, and see who has furnished, not only the papers, but from the discussion, who has read them. The answer is, the busy man. Again I say, the busy man is the fellow we are after, and as the railroad fraternity, and the men associated with railroad work and railroad supplies, etc., furnish but few drones, we are pretty sure to hit a busy man every time we shoot. Hence, I repeat, it's the busy man who prepares the papers and discusses them. The very fact that they are busy men shows that their interest, their thoughts are in the work, and they are ready to impart such information as they may, and to absorb all that they can, but the more railway clubs that we have and the larger the membership, the greater the good, and the more efficient the service.

"There is more or less misconception as to the value of the club. The acquaintance and association with men in every department of the railway and with supply men and others connected with the railroads in every day affairs, cannot be overestimated, and the mingling together removes friction, brightens up ideas, strengthens the membership generally, keeps up the interest in the meetings, and all to the end that we are better in every way for a membership in any railway club. Permit me here to quote from President Vreeland of the New York Club: 'It is conceded by practical railroad men of experience that there is no better school for the younger men in the service than the opportunity given by the various railroad clubs of the country for membership, which secures to them instruction from papers and discussions thereof.'"

The foregoing is to prove that railway clubs are worth while, and that there are not enough such organizations. With at most not over a dozen clubs in existence, some of them dormant, it does seem that more of the employees of the 227,000 miles of railroad in this country ought to get together, and that every city of any size should have a railway club, and railroad men attend it, not only for its value educationally, but for the social and fraternal features that are sure to arise, all of which go to make railway clubs worth while.

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The Need of Good Engine-House Facilities.—A generous appropriation for engine-house repairs saves money in the long run, by reducing the periods between shopping, insuring larger mileage, and giving a superior quality of service. The statistics of engine-house expense are usually based on the number of engines handled outward over a turntable, and an engine-house foreman sometimes, when urged to reduce that unit cost, does so to the detriment of the service by slighting some of the repairs.—*W. J. Cunningham before the New England Railroad Club.*

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Train Delays.—The report of the New York Up-State Public Service Commission for October shows that 77 per cent. of the steam railway trains operated in New York State were on time during this period, while the average delay of the remaining 23 per cent. of the trains was 26.3 minutes per train. Nearly two fifths of the aggregate delays for the month were due to trains waiting for trains on other divisions. The chief causes of delay and the percentage which each represented in the aggregate were: Engine failures, 5.6 per cent.; failures of other equipment, 1.7; wrecks, 6; unfavorable conditions of tracks, 2.1; waiting for trains on other divisions, 39.4; waiting for train connections with other railroads, 10.5; meeting and passing trains, 6.8; signals, 1.3; trains ahead, 7.1; waiting for orders, 4; train work at stations, 15.2; storms, 2; all other causes, 3.7.

# RAILROAD CLUB NEWS

*Canadian Railway Club (Montreal, Can.)*—At the regular monthly meeting, held on January 5, a very interesting lecture, illustrated with stereopticon views, was given by Professor J. A. Bancroft, of McGill University, the subject being "Western Canada." The speaker explained how the prairies, mountains, etc., had been formed by the icefields and volcanic eruptions of pre-historic times and explained why certain localities and grounds were the best suited for certain crops.

The annual dinner of the club is scheduled to have been held at the Windsor Hotel on January 29.

At the December meeting the paper was presented by Mr. Gutelius on the subject of "Steel Rails in Canada." The author handled his subject in a very simple and interesting manner, pointing out how various difficulties, particularly in regard to the extremely low temperature found in Canada, had been overcome by the steel makers and how they had continually kept up with the increasingly difficult requirements of the railways. The specifications for rails from the Canadian Pacific Railroad were given in full. The discussion was general and included some interesting matter in connection with the effect of flat spots and counter-balance on rails.

At the same meeting a discussion of the paper presented at the November meeting, on "Freight Car Brakes" was continued.

The paper scheduled for the meeting of March 2 is on "Shop Time Keeping," by E. C. Lloyd.

Secretary, James Powell, P. O. Box 7, St. Lambert, near Montreal, Can.

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*Central Railroad Club (Buffalo, N. Y.)*—At the meeting on January 8 a paper on "A Modern Method of Cutting Steel" was presented by Cecil Lightfoot. This paper explained briefly the method of cutting steel by means of a jet of oxygen, the material previously having been raised to a high temperature by means of an oxy-acetylene or other flame of great heat. A demonstration was given of the method described. The author states that no progress has been made in the cutting of cast iron by this process.

The annual banquet of the club was held at the Hotel Iroquois on the evening of the same date.

Secretary, H. D. Vought, 95 Liberty street, New York.

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*New York Railroad Club.*—At the meeting held on January 15, J. E. Muhlfeld presented a paper on "The Education and Organization of Railway Engineering Labor," in which the subject of the proper training of young men for railroad work was considered most carefully in a broad way. The relations of the employer to the employee, as concerned railways, were discussed and the great value of harmony was pointed out. The discussion of the paper was largely along the lines of the value of college training for men in the motive power department. Mr. Basford drew attention to a new idea in the training of apprentices for industrial plants, which is beng tried by the University of Cincinnati.

The paper for the meeting of February 19 will be by Col. B. W. Dunn, chief inspector of the American Railway Association Bureau for the Safe Transportation of Explosives and other Dangerous Articles.

Secretary, H. D. Vought, 95 Liberty street, New York.

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*New England Railroad Club (Boston, Mass.)*—At the December meeting, William F. Garcelon, of Newton, a member of the Massachusetts House of Representatives, presented a paper on "Railroad Men in Politics," in which he called upon railroad employees to take a more active participation in politics, and praised the various organizations, such as The Railway Business Association, for the work which they were doing, stating "that the creation of public sentiment by open and fair means is proper and justifiable and generally very effective. With a more active participation in politics by all classes of honest men our legislative bodies will be more conservative; they will better express the wishes of the people and the business interests will have less cause to complain of the evils of politics and legislation." During the discussion W. B. Leach explained in detail what the Railway Business Association was organized to do and called upon all supply men to join it and aid in the work.

The next regular meeting of the club will be held at Young's Hotel, Boston, February 9, when Henry C. Boynton of the John A. Roebling's Sons Co., of Trenton, N. J., will present a paper on "Steel Rails." Dinner will be served at 6:30 P. M., to be followed by the regular business session at 8 P. M.

Secretary, George H. Frazier, 10 Oliver street, Boston, Mass.

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*Northern Railroad Club (Duluth, Minn.)* Next meeting Saturday evening, February 27. The paper will be by W. H Siedel, chief dispatcher Great Northern Railway, Superior, Wis., on the subject of "Dispatching of Trains by Telegraph or Otherwise."

At the December meeting the discussion of Mr. Seddon's paper on "Locomotive Boiler Washing" was continued. All of the members participating spoke most highly of the hot water washing out system. Those who had experience claimed great savings in the mater of time, as well as reduction in boiler repairs. The paper of the evening was on "Steel and Concrete Ore Docks," by W. A. Clark. The paper briefly touched upon the most important features in ore dock construction and gave a short description of a new dock recently built at Two Harbors. A topical discussion on the subject of "Causes of Sharp Flanges on Driving Tires" was briefly considered.

Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

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*Railroad Club of Pittsburg.*—At the meeting of February 26 a paper will be presented by R. G. Manning, engineer, American Bridge Company, Ambridge, Pa., on the subject of "Steel Railroad Bridges."

At the January meeting Wm. Elmer presented a paper on the subject of "Steam Engine House Auxiliaries." The author begins with an engine which has just finished its run and is on its way to the ash pits and follows it through each step until it is again coupled to an out-going train. Each feature of work on the engine is clearly and carefully treated and the best methods of doing the work, in the author's estimation, are illustrated. The paper is filled with valuable suggestions for expediting terminal work and was quite extensively illustrated.

At the January meeting resolutions were passed complimenting the Railway Business Association on its work for better sentiment on the part of the public toward the railroads and pledging the hearty support of the club to the movement.

Secretary, C. W. Alleman, General Offices, P. & L. E. R. R., Pittsburg.

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*Southern and Southwestern Railway Club (Atlanta, Ga.)*.—At the quarterly meeting, held January 21 at the Piedmont Hotel, the subject of "Head Lights" was discussed. The next meeting will be April 15, subject not yet announced.

Secretary, A. J. Merrill, Prudential Bldg., Atlanta, Ga.

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*St. Louis Railway Club.*—At the next meeting, on February 12, W. E. Harkness will present a paper on the subject of "Train Dispatching by Telephone," which will include an actual demonstration of the workings of the selector in connection with the telephone.

The January meeting was very largely attended and was greatly entertained by George A. Post, president of the Railway Business Association, who spoke on the subject of "The Smile Combine."

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

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*Western Railway Club (Chicago).*—At the next meeting, February 16, a paper will be presented by R. B. Dole, assistant chemist of the Water Resource Branch of the U. S. Geological Survey. This department has been making a mineral analysis of surface water all over the U. S. and this paper will discuss the waters in the middle-western states through which the roads running out of Chicago are located.

Mr. McAulliffe in his paper on "The Purchase of Railway Fuel Coal" made a plea for some provision which would prevent the present biennial shut-down of the mines, caused by the readjustment of labor conditions in the mines every two years and usually occupying about ten weeks. Previous to this shut-down extra efforts are put forward by the miners and a stock of coal has accumulated and incidentally he acquires sufficient money to tide him over the strike period. The paper suggested the formation of an arbitration committee and law similar to that now in force in Canada, which would prevent this shut-down. It contains some very striking figures on the consumption of coal by railways in the U. S. and made a strong argument for basing fuel contracts on quality and introduce competition rather than make them a reward for commercial tonnage. The mechanical and fuel departments should have a closer relation.

The subject was not given a very extended discussion.

Secretary, J. W. Taylor, 390 Old Colony Bldg., Chicago.

# FULTON BILL DANGEROUS TO RAILROADS.

## HOW YOU CAN HELP.

So many are asking concerning the Fulton Bill as to indicate the importance of an explanation of the proposed enactment, giving its nature and its possible effects if made into a law.

Under the present laws a railroad, wishing to increase rates may file the new rate schedule with the Interstate Commerce Commission and after thirty days, under normal conditions, the new rates will go into effect. Should a shipper complain of unfairness of a rate to his interests, the case comes before the Interstate Commerce Commission for investigation and adjudication. Meanwhile, the shipper is paying the advanced rate and when the case is decided, if this rate is judged to be unfair to the shipper the railroad refunds to the shipper the difference between the amount he has paid and the amount the Interstate Commerce Commission judges that he ought to have paid.

This method seems, all things considered, to be most satisfactory and equitable. Shippers complain because in the event of a new rate case being decided adversely to the railroad, the shipper's funds may be tied up pending a trial of the case. The Interstate Commerce Commission is a busy body of men and it naturally requires time to investigate complicated cases of rates, frequently rendering the process of decision rather slow. The shipper, however, loses no money by the delay.

The Fulton Bill would change all this. It would reverse matters with respect to the operation of a new rate. In its original form the bill provides that a shipper may protest against a new rate and prevent it from being put into effect until the new rate has been investigated by the Interstate Commerce Commission, and judged to be fair. This would mean that shippers could through unlimited accumulation of protests prevent a railroad indefinitely from obtaining from the commission the right to put a given increase into effect, or even a hearing. If this principle should be applied to a merchant it would deprive him of any voice in the price which he should charge for his goods. Senator Fulton was impatient concerning the delay in reporting his bill from the Interstate Commerce Committee of the Senate, and on January 6 that committee reported it unfavorably.

Mr. Fulton, undoubtedly realizing the difficulties in securing the passage of the bill, has amended it, putting it in such form as to be more likely to become a law The most important change is to make it discretional with the Interstate Commerce Commission whether or not it will allow the new rate to go into effect pending the decision of the Commission as to whether or not it is reasonable.

The amendment also carried into the bill a new feature which looks in the general direction of promoting pooling by the railroads, under the control of the Interstate Commerce Commission.

The bill is now upon the calendar of the Senate and with the amendment is likely to be brought up for debate. This bill should not become a law for the following reasons:

In the interests of all concerned, the investor, the shipper and the public, it is necessary that the railroads should have the right to raise a rate which is found to be too low, subject to protest by a shipper, adjudication by the Commission, and refund by the railroad in case of an adverse ruling, because such a method is just, right and fair to all concerned.

This bill, becoming a law, would prevent the increase of a rate upon one protest or without a protest until the busy Interstate Commerce Commission reaches its decision.

Such a law would swamp the Commission, which is already hopelessly behind in its work. Before a rate could be decided the conditions might change and the decisions in such delayed cases, while they might be fair on the main issue, might lead to injustice because they might not apply to the changed conditions.

Such delays would render the rate problem exceedingly inelastic, and the difficulty of raising a rate would have the effect of preventing the roads from ever making a reduction.

Rate discrimination, covering large sections of the country, might result from such a law, because of the certainty that rates would not be reduced anywhere, whereas it would be discretionary with the Commission whether or not rates should be raised.

Our national legislators can probably be induced to give the railroads a fair hearing before voting upon this bill, if all who appreciate the situation will at once write their Senators and Representatives requesting intelligent study of its probable effects upon the people. Will you who read these paragraphs write your Senators and Representatives at once before you lay this paper aside? Will you also notify the Railway Business Association (No. 2 Rector street, New York City), that you have done so? In writing about the Fulton bill please also urge calmness and fair-mindedness in the consideration of all other measures affecting public interests through the transportation interests.

The bill has aroused vigorous protest from many interests. Telegrams and letters were poured in on the Senate Committee from financial, labor and industrial leaders. The Railway Business Association on January 5 sent about 250 telegrams from its members and others in sixteen States, and this influence is said at Washington to have had a potent effect. The next day the adverse report was made, the vote in committee having been 6 to 5.

# COMPARATIVE TESTS OF RUN-OF-MINE AND BRIQUETTED COAL ON LOCOMOTIVES*

W. F. M. Goss.

INTRODUCTION.

For the purpose of procuring data that could be used in estimating the value of the briquetting process as applied to American fuels, the United States Geological Survey, in co-operation with other interests, began in 1904, at the Louisiana Purchase Exposition, certain experiments involving the production and use of bituminous-coal briquets. It installed at St. Louis, and later at Norfolk, machines for the manufacture of such briquets, and the output of these machines has been tested in locomotive service on several different railroads in comparison with natural fuels. An elaborate and carefully executed series of tests involving the use of natural coals and of briquets made from the same coal, previously crushed, has been carried out on a locomotive mounted at the testing plant of the Pennsylvania Railroad Company at Altoona, Pa.; and some preliminary experiments involving the use of briquets in marine service have been made in connection with one of the Government's torpedo boats. A description of these tests is presented herewith. The results sustain the following general conclusions:

1. The briquets made on the Government's machines have well withstood exposure to the weather and have suffered but little deterioration from handling.

2. In all classes of service involved by the experiments, the use of briquets in the place of natural coal appears to have increased the evaporative efficiency of the boilers tested.

3. The smoke produced has in no test been more dense with the briquets than with coal; on the contrary, in most tests the smoke density is said to have been less when briquets were used.

4. The use of briquets increases the facility with which an even fire over the whole area of the grate may be maintained.

5. In locomotive service the substitution of briquets for coal has resulted in a marked increase in efficiency, in an increase in boiler capacity, and in a decrease in the production of smoke. It has been especially noted that careful firing of briquets at terminals is effective in diminishing the amount of smoke produced.

COMPARATIVE TESTS OF LLOYDELL COAL AND BRIQUETS.

The tests of Lloydell coal and briquets here reported were made under the direction of A. W. Gibbs, general superintendent of motive power of the Pennsylvania Lines, by E. D. Nelson, engineer of tests, at Altoona, Pa.

PURPOSE OF THE TESTS.

Many low-volatile coals, such as those mined in the vicinity of Johnstown, Pa., are semi-smokeless and therefore very desirable for use in locomotives at or near terminals; nevertheless, on account of their low evaporative efficiency, they have not been found altogether satisfactory when used as locomotive fuel. Their tendency to disintegrate rapidly on the grate during combustion causes large quantities of cinders and sparks of high calorific value to be discharged. These cinders accumulate in the smoke-box of the locomotive, obstruct the draft on the fires and reduce the capacity of the boiler. The investigation here reported, therefore, was undertaken to determine in what measure, if any, the process of briquetting will serve as a remedy for these defects and to discover the effect of the process on efficiency and capacity.

COAL TESTED.

The coal selected for the tests was taken from a mine working the Lower Kittanning coal bed near Lloydell, Pa., on the South Fork branch of the Pennsylvania Railroad. This coal was practically the same as that mined in the Scalp Level district of Pennsylvania, which was used in all the locomotive tests made by the Pennsylvania Railroad Company at the Louisiana Purchase Exposition in 1904. Its characteristics as a locomotive fuel were therefore well known. The Lloydell coal is a very friable, low-volatile, bituminous coal, and the carloads selected for the tests consisted of run-of-mine. The coal was exposed to the weather for thirty days on the way to the St. Louis testing plant, before being briquetted. It showed but little change due to this exposure except a decided increase in moisture, which, however, was eliminated in the briquetting process.

BRIQUETS TESTED.

The briquets tested were of two sizes, and the amount of binding material in them ranged from 5 to 8 per cent. The larger size, called in the tests "square," was rectangular in form, about 3 by 4¼ by 6¾ inches, with slightly rounded corners, and weighed about 3½ pounds. The smaller size of briquet, called "round," was cylindrical with convex ends, had a diameter of about 3 inches and a length over the convex ends of 2 inches, and weighed about one-half pound.

The binding material in all the briquets was water-gas pitch. This material was furnished at the briquetting plant of the United States Geological Survey, in St. Louis, at $9 per ton, or 0.45 cent per pound. The least amount in binding material that would make perfect briquets was found to be 5 per cent. of the weight of the coal. The cost of the binder in one ton of the 5 per cent. briquets was therefore 45 cents.

The cost of briquetting, including all charges, is estimated to be about $1 per ton of briquets; that is, the briquetting added approximately $1 per ton to the cost of the coal. The briquets were made, however, in an experimental plant, and the price is for this reason probably not so low as if they had been made on a much larger scale.

The briquets were made by the fuel-testing plant of the United States Geological Survey at St. Louis. After the coal was made up into briquets it was returned to the locomotive testing plant at Altoona, Pa., for the tests. The method of making the briquets is described in detail in previous reports of the Geological Survey.* In this process the binding material is mixed with the crushed coal, the mass is softened by contact with steam as it passes to the briquetting press, and the briquet is finally formed in a compressing machine.

The locomotive used for all tests was a simple Atlantic type passenger locomotive of the Pennsylvania Railroad Company's class E 2a.

TEST CONDITIONS.

In order to obtain results covering all practical rates of evaporation up to the limit of the boiler capacity, tests were made with each style of briquets and with the natural coal under the following conditions of running: First, a low evaporation test at 80 revolutions per minute and 15 per cent. cut-off; then a higher evaporation test at 120 revolutions per minute and 20 per cent. cut-off; next a still higher evaporation test at 160 revolutions per minute and 25 per cent. cut-off; and finally a test made at the maximum possible evaporation. With the briquetted coal this maximum-capacity test was at 200 revolutions per minute and 32 per cent. cut-off. Four or at most five tests were thus sufficient to cover the range of boiler capacity.

EVAPORATIVE EFFICIENCY.

Figure 1 shows the equivalent evaporation per pound of dry

* Extracts from Bulletin 363 of the United States Geological Survey.

* Report on the operation of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, St. Louis, Mo., 1904: Prof. Paper No. 48. See also Bulletins 290, 332, and 343.

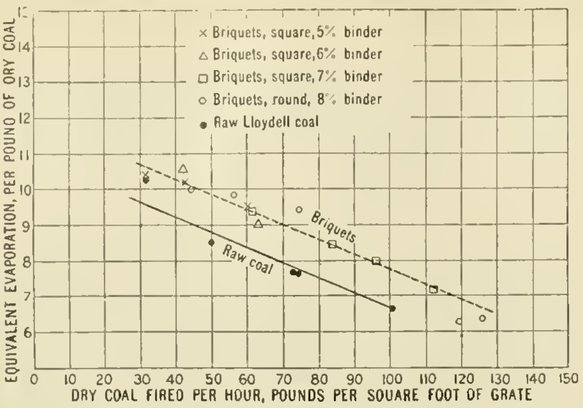



FIG. I.

coal plotted against the rate of combustion. The figure represents a comparison under the same test conditions between the natural Lloydell coal and the same coal briquetted. It shows that a well-defined improvement in the evaporation per pound of fuel is obtained by briquetting. Figure 2 shows the same relation as Fig. 1, expressed in per cent.

In a comparison made on the basis of evaporation per square foot of heating surface, the better results for briquetting are further emphasized. The maximum evaporation possible with the natural Lloydell coal was 16 pounds per square foot of heating surface per hour, but with the same coal briquetted the evaporation was more than 19 pounds.

The ultimate measure of locomotive efficiency is expressed, of course, in terms of coal per dynamometer horse-power hour. This value, plotted against dynamometer horse-power, is given in Fig. 3, which shows that whatever may be the power devel-

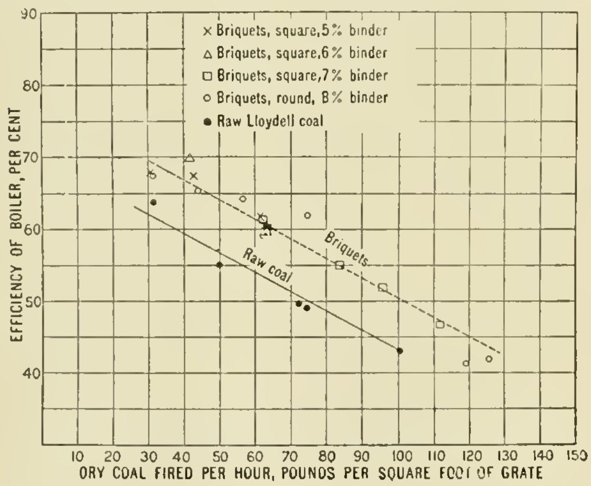



FIG. 2.

oped, the briquets give the greater efficiency, but that when the power is extremely low or extremely high the difference is small. At the point of maximum efficiency the difference amounts to nearly 35 per cent. It should be remembered, however, in dealing with dynamometer horse-power that several variable factors, such as machine friction and engine efficiency, are introduced into the equation; and that the only true comparison to disclose the relative values of different fuels is that which is based on boiler performance alone.

### CINDERS.

There appears to be little or no difference in the weight of cinders obtained from the natural coal and the briquetted coal at any particular rate of combustion. The sparks from the stack, when the locomotive was fired with briquets, were in the form of flakes of a size considerably larger than those discharged when coal was fired.

The calorific value of the cinders collected in the smoke-box and the sparks discharged from the stack is, in general, higher for the natural coal than for the briquetted coal. That is, the heat loss due to the sparks and cinders is greater for the natural coal, though the quantities in pounds of cinders may be the same.

The amount of heat lost in the form of cinders and sparks, expressed as a percentage of the total heat supplied, is shown graphically by Fig. 4, in which the solid line represents the average cinder and spark loss for raw Lloydell coal at varying rates of combustion, and the broken line the same loss for the briquetted Lloydell coal. The points representing the former lies extremely close to the average line, but those representing the latter do not fall in such close alignment. It is a fact worthy of note, however, that those points which represent tests with briquets

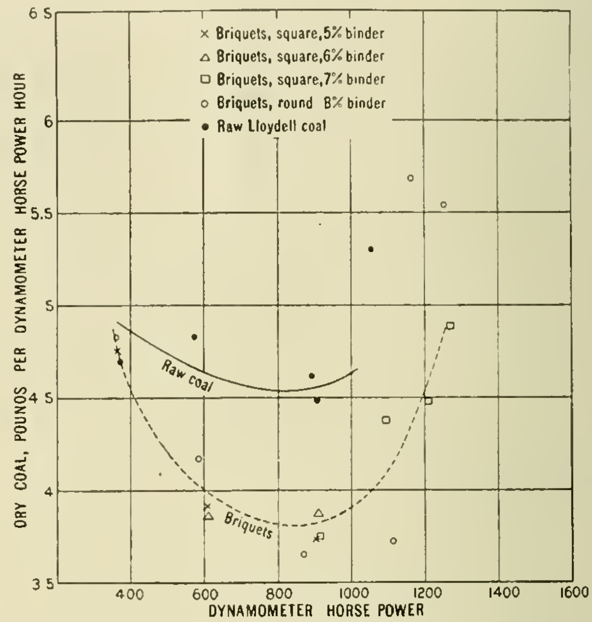



FIG. 3.

having the larger percentage of binder generally fall below the average line, whereas those for the smaller percentage of binder generally fall above the average line. The curve therefore shows that, (a) the loss due to cinders and sparks is greater when raw coal is used than when briquets are used, and the difference increases as the rate of evaporation increases; (b) the loss due to cinders and sparks decreases slightly as the percentage of binder used in the briquets is increased.

### SMOKE.

The density of smoke from the locomotive was compared with the Ringelmann charts. These charts are usually designated as follows: No. 0, no smoke; No. 1, light gray; No. 2, darker gray; No. 3, very dark gray; No. 4, black; No. 5, very black.

In Fig. 5 the smoke density is plotted against boiler capacity, and average lines are drawn through points representing tests

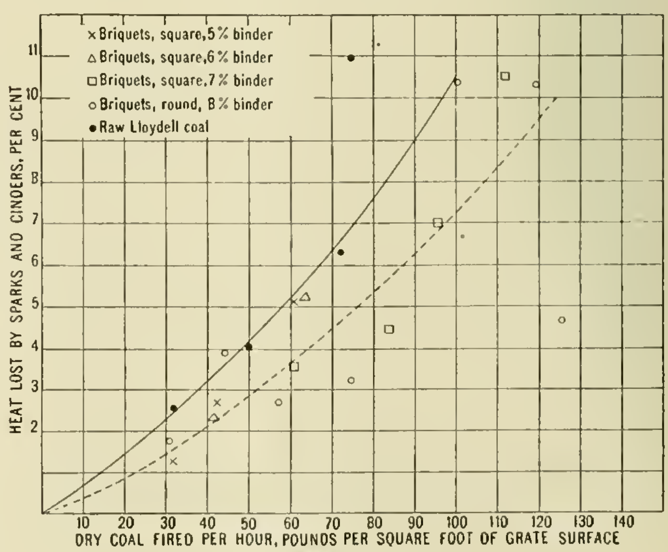



FIG. 4.

with raw coal and briquets with 8, 7, and 5 per cent. of binder. As there are but two points representing tests with briquets having 6 per cent. binder, and as their position seems to be contradicted by the position of the other points, no line has been drawn through them. The curves show that the smoke density is nearly constant for all capacities under 90 per cent. of full load, but that for capacities beyond this point the density increases rapidly. It appears that for all tests with briquets the density of the smoke is less than for corresponding tests with raw coal, but more smoke is produced with briquets having 8 per cent. binder than with those having 5, 6, or 7 per cent. Whether this fact is to be explained by the varying amounts of binder used or by the difference in size and shape is a question. However, as the binding material employed consists largely of volatile matter, it is reasonable to suppose that the varying amounts used in the several briquets cause the varying density of the smoke shown in Fig. 5.

SMOKE DENSITY IN INTERMITTENT RUNNING.

At the end of test 13, with the locomotive standing, the blower was put on, and after two minutes the smoke cleared. Immediately after the close of test 14, with a very heavy fire, the engine was again started at a slow speed and with partly open throttle. With these conditions of running, the smoke cleared entirely after eighteen minutes. These conditions are not dissimilar to the intermittent operation to which a locomotive is subjected as it enters a terminal, and the results show the degree

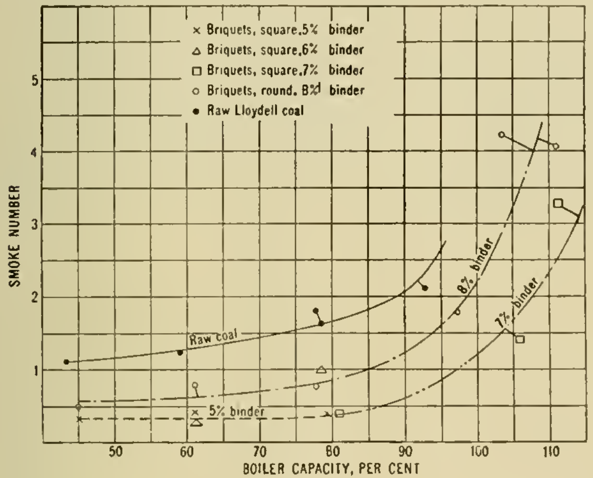



FIG. 5.

of smoke control which the use of briquets makes possible under adverse conditions.

BEHAVIOR OF COAL AND BRIQUETS DURING COMBUSTION.

Briquets of both small and large size were fired with the ordinary shovel and were handled in much the same manner as coal. In all tests they were fired alone without mixing with coal. It was not necessary to break the briquets in order to handle them readily with the ordinary scoop shovel, and the unbroken briquets burned freely and completely. They disintegrated slowly from the heat of the flame and became more or less porous as they swelled and opened under the action of the heat.

In the process of starting a fire with briquets no difficulty was experienced, the ordinary blower arrangements at the engine house being sufficient. The natural coal was finely divided when fired and did not form so open a mass in the fire-box as the briquets. Much of the finer portion was drawn, unburned, through the tubes by the force of the draft.

EFFECT OF HANDLING AND WEATHERING ON BRIQUETS.

To observe the effect on briquets of exposure to the weather, a number of the round and square briquets were placed on the roof of the testing plant. After four months of exposure for the round and three months for the square briquets, no change whatever from their original condition was noticed. They appeared to be entirely impervious to moisture and were still firm and hard.

The briquets were little affected by handling. They were loaded at St. Louis in open gondola cars and shipped to Altoona, where they were unloaded by hand and stacked. They were handled a third time in taking them to the firing platform of the test locomotive. After these three handlings they were still in good condition, very few were broken, and the amount of dust and small particles was practically negligible.

CONCLUSIONS.

The results of the tests justify the following conclusions:

(*a*) The evaporation per pound of fuel is greater for the briquetted Lloydell coal than for the same coal in its natural state. This advantage is maintained at all rates of evaporation.

(*b*) The capacity of the boiler is considerably increased by the use of briquetted coal.

(*c*) Briquetting appears to have little effect in reducing the quantity of cinders and sparks; the calorific value of these, however, is not so high in the briquetted as in the natural fuel.

(*d*) The density of the smoke with the briquetted coal is much less than with the natural coal.

(*e*) The percentage of binder in the briquet has little influence on smoke density.

(*f*) The percentage of binder for the range tested appears to have little or no influence on the evaporative efficiency.

(*g*) The expense of briquetting under the conditions of the experiments adds about $1 per ton to the price of the fuel, an amount which does not seem to be warranted by the resulting increase in evaporative efficiency.

(*h*) With careful firing, briquets can be used at terminals with a considerable decrease in smoke.

(*i*) The briquets appear to withstand well exposure to the weather, and suffer very little deterioration from handling.

COMPARATIVE ROAD TESTS OF COAL AND BRIQUETS.

ATLANTIC COAST LINE RAILROAD.

In the following table are presented the results of comparative tests of run-of-mine New River coal and of briquets of the same fuel, made in December, 1907, on a locomotive in the regular passenger service of the Atlantic Coast Line Railroad. These tests were conducted under the supervision of R. E. Smith, general superintendent of motive power of the railroad, in co-operation with the United States Geological Survey. Sixteen complete test trips were run between Rocky Mount and Wilmington, N. C., with the same engine, crew, and trains. An equal number of tests were made with run-of-mine coal furnished by the railroad company and with round and rectangular briquets made at the Geological Survey fuel-testing plant at Norfolk, Va., from the same coal, with 6 per cent. of water-gas pitch binder.

| | Coal. | Briquets. |
|---|---|---|
| Number of test trips | 16 | 16 |
| Total pounds consumed | 172,700 | 161,980 |
| Average pounds consumed per trip | 10,794 | 10,124 |
| Average tons consumed per trip | 5.387 | 5.062 |
| Total engine miles | 1,984 | 1,984 |
| Total car miles | 10,912 | 12,896 |
| Pounds consumed per car mile | 15.8 | 12.8 |
| Average cars per train | 5.5 | 6.5 |

It is reported that from a practical standpoint the briquets thus tested were very satisfactory. Their use was found to eliminate all black smoke. No objectionable clinker was formed and the fuel seemed to burn completely.

CHESAPEAKE AND OHIO RAILWAY.

In December, 1907, the United States Geological Survey cooperated with the Chesapeake and Ohio Railway in making a series of comparative road tests of the performance of run-of-mine coal and briquets of the same coal on locomotives in regular service.

No attempt was made in these tests to make careful measurements of fuel and water; however, during the tests the following facts were developed. The briquets ignited freely, made an intensely hot fire, and when the engine was working emitted very little smoke. It was found that a comparatively heavy fire could be carried without danger of clinkering. Few ashes were left in the fire-box or ash pan, and the cinder deposit in the front end was small. The results do not show that any apparent improvement in evaporative efficiency was obtained by the use of briquets, as compared with that obtainable from the natural fuel.

# FAILURE OF SIDE SHEETS ON WIDE FIREBOX LOCOMOTIVES

W. E. JOHNSTON.

It appears to be the general opinion that the trouble from cracked side sheets in wide fireboxes is due to defective circulation. Assuming this to be true, it must be the result of one of two causes, viz: excessive resistance to the circulation or the lack of a sufficient impelling force. The wide water legs now in use offer much less resistance to a free circulation than the narrow ones used on old narrow firebox boilers which gave no trouble in this respect. The lack of a sufficient impelling force must therefore be the true reason for the defective circulation.

Steam liberated in a body of water tends to move vertically upwards. In the water leg of a wide firebox boiler as shown

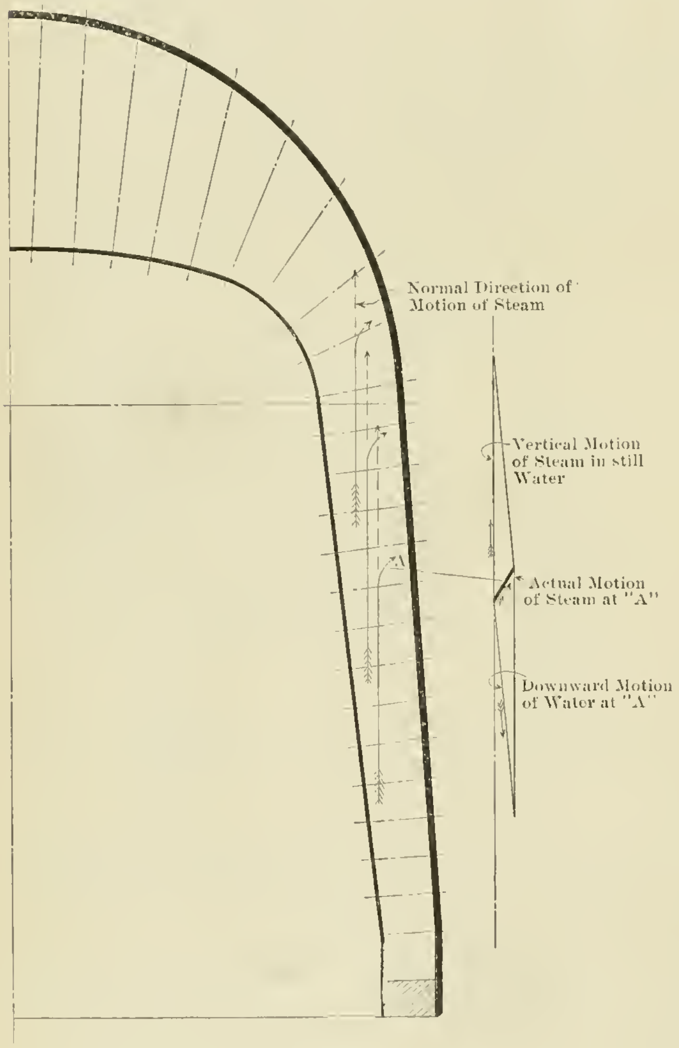



FIG. 1.

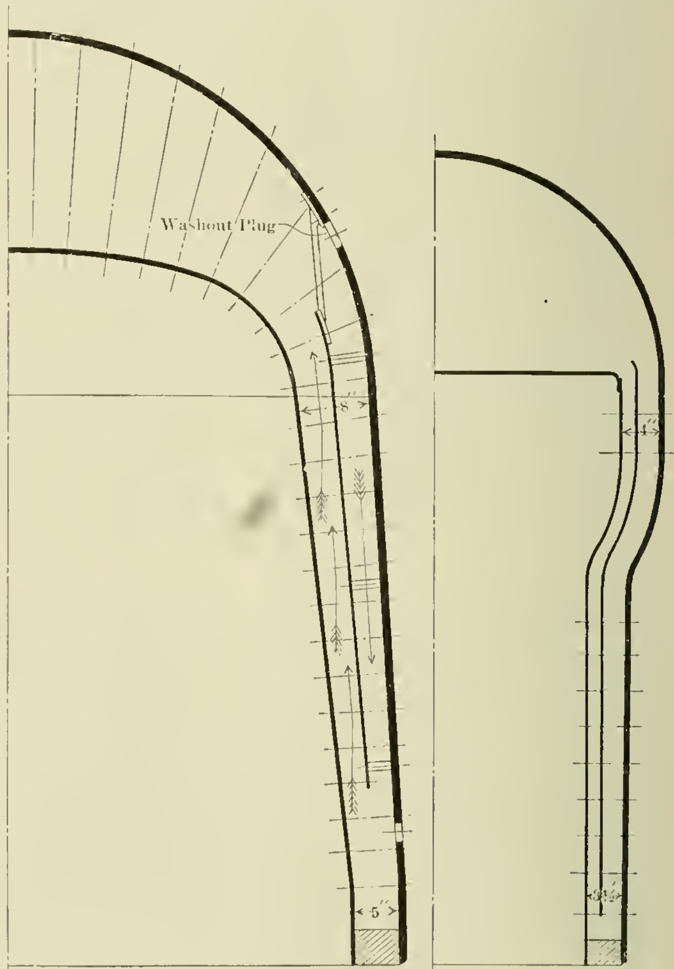



FIG. 2.

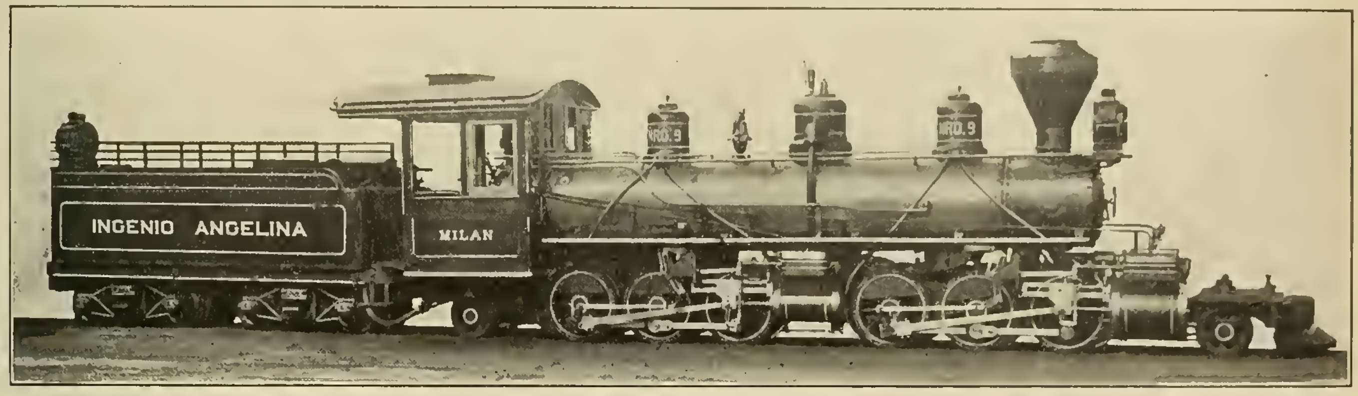
in Fig. 1, this movement carries it towards the outside sheet as indicated by the arrows, the actual movement of the steam (indicated by the solid arrows) being a combination of this natural vertical tendency and the downward motion of the water near the outside sheet. If the water near the outside sheet be at a sufficiently low temperature the steam will be condensed and will give up its latent heat of evaporation. By this action, all the water in the leg tends to become of uniform temperature. If the water near the outside sheet is not cool enough to condense all the steam the remainder will rise along the sheet in opposition to the desired direction of circulation. In either case, the impelling force which should cause the general circulation up the fire sheet and down the outside sheet is very materially reduced. To produce a rapid circulation, the heat and steam must be kept in the water close to the fire sheet, so that there may be as great a difference as possible between the specific gravities of the water near the fire sheet and that near the outside sheet.

With a sluggish circulation, the water at the fire sheets evidently reaches a much higher temperature than with a brisk circulation, and the amount of steam liberated in the water leg probably varies nearly inversely as the rapidity of the circulation. The pressure seven feet below the surface of the water in a boiler carrying steam at 200 pounds pressure is about 2½ pounds greater than at the surface, and the temperature at which steam will be formed at this increased pressure is about 1 degree Fahr. higher than that of steam at 200 pounds pressure. Assuming some rate for the transmission of heat through the fire sheet to the water, the calculation of the point at which the water will reach the boiling temperature as it flows up the fire sheet at assumed velocities shows at once that the point at which steam begins to form on the fire sheet moves downward rapidly as the velocity of the circulation is diminished. With the sluggish circulation existing in the water leg, shown in Fig. 1, it is probable that steam begins to form at such a low point that the sheets are exposed to the direct flame with nothing but steam to protect them, leading inevitably to burnt and cracked sheets.

The solution of the difficulty may lie in the old so-called "circulating plates" used many years ago, but abandoned on account of trouble from clogging up, etc. With the new designs of boilers using wide water legs, there seems to be ample room for such a plate without danger of clogging. Fig. 2 shows a plate in the boiler shown in Fig. 1. This may be suspended independently of the staybolts, if desired, with holes sufficiently large so as not to interfere with their free deflection with the movements of the fire sheet. A little steam might leak through these holes, of course, but the amount would be so small as to be negligible. With this plate the steam leaving the surface of the fire sheet would be compelled to follow its proper course upward on the inside of the plate and the water on the outside of the plate would be kept cool and free from steam and therefore heavy until it got to the proper point near the bottom of the water leg, from which point it would be drawn up between the fire sheet and the circulating plate.

By stopping off the circulating plate at the top where the fire sheet begins to curve and below the washout plugs usually located even with the crown, any possibility of trouble from inability to thoroughly wash out would be avoided. As no steam will be formed very near the bottom of the water leg with a brisk circulation, the bottom of the circulating plate may be kept some distance up from the mud ring, say 18 inches, depending on the inward slope of the sheets.

Figure 3 shows a circulating plate applied to the boilers of some standard engines built in 1882. It is evident that the trouble experienced with the plates in these or similar boilers is no indication that the plate as applied in Fig. 2 would not be entirely satisfactory. On the new designs of wide firebox boilers where the steam and hot water by following their natural tendency to rise vertically, mix with the water which should stay cold, the case is entirely different, especially as the wide water legs give ample space for the application of the plate.




## NARROW GAUGE MALLET ARTICULATED TYPE LOCOMOTIVE.

The locomotive shown in the accompanying illustration has recently been finished by the Baldwin Locomotive Works, and is to be used on a plantation in Santo Domingo. The gauge is 2 ft. 6 in., and although the locomotive weighs 60,200 lbs. total it will be operated over a track laid with 25 lb. rails, and having curves of 175 ft. radius. A tractive effort of 11,630 lbs. can be exerted, which, considering the track conditions, is very large.

The locomotive is, in general, a miniature of the engines built at these works for road service on the Great Northern Railway, illustrated in this journal June, 1907, page 213. The weight on drivers is 51,900 lbs., which gives an average weight per axle of 8,650 lbs. The front set of frames are connected by an articulated joint having the pins in the center of the high pressure saddle, which is cast separately from the cylinders. The frames throughout are of cast steel and are in one piece on each side of each group of wheels. The leading truck is center bearing and is equalized with the front group of drivers, while the trailing truck is side bearing and is equalized with the rear group. All four cylinders have slide valves operated by Walschaert valve gear. The reverse shaft for the high and low pressure gears are connected by a single reach rod, placed in the center line of the locomotive and passing through a slot in the high pressure cylinder saddle. It is provided with a knuckle joint immediately in front of the articulated frame connection. The reversing is effected by the usual lever and also by a hand wheel and screw, either of which may be used.

The boiler is of the straight top type, with a radially stayed fire box set on top of the frames. The grate is arranged for wood burning, as is also the front end and the stack. The boiler is fed by two injectors and has an auxiliary duplex feed pump located on the left hand running board, immediately in front of the cab. Steam brakes are used. The tender has a capacity of 1,200 gallons of water and 1½ cords of wood. The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Service | Freight |
| Fuel | Wood |
| Tractive effort | 11,630 lbs. |
| Weight in working order | 60,200 lbs. |
| Weight on drivers | 51,900 lbs. |
| Weight on leading truck | 4,550 lbs. |
| Weight on trailing truck | 3,750 lbs. |
| Weight of engine and tender in working order | 85,000 lbs. |
| Wheel base, driving | 6 ft. |
| Wheel base, total | 27 ft. |
| Wheel base, engine and tender | 43 ft. 9½ in. |

RATIOS.

| | |
|---|---|
| Weight on drivers ÷ tractive effort | 4.44 |
| Total weight ÷ tractive effort | 5.18 |
| Tractive effort × diam. drivers ÷ heating surface | 700.00 |
| Total heating surface ÷ grate area | 58.30 |
| Firebox heating surface ÷ total heating surface, per cent | 9.80 |
| Weight on drivers ÷ total heating surface | 94.00 |
| Total weight ÷ total heating surface | 110.00 |
| Volume equiv. simple cylinders, cu. ft. | 2.48 |
| Total heating surface ÷ vol. cylinders | 220.00 |
| Grate area ÷ vol. cylinders | 3.77 |

CYLINDERS.

| | |
|---|---|
| Kind | Mallet Comp |
| Diameter and stroke | 10 & 15 x 16 in. |
| Kind of valves | Bal. Slide |

WHEELS.

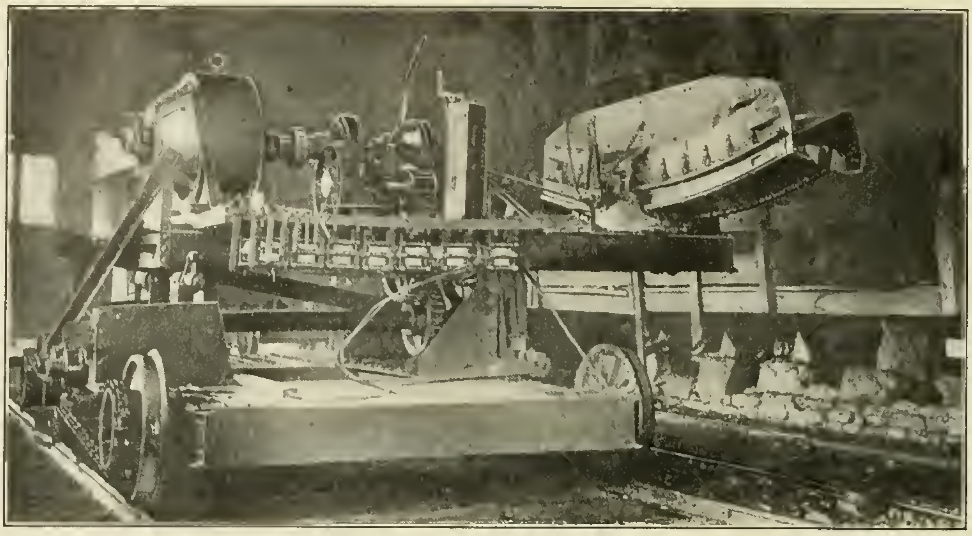
| | |
|---|---|
| Driving, diameter over tires | 33 in. |
| Driving, thickness of tires | 2½ in. |
| Driving journals, diameter and length | 4½ x 6 in |
| Engine truck wheels, diameter | 20 in. |
| Engine truck, journals | 3½ x 6 in. |
| Trailing truck wheels, diameter | 20 in. |
| Trailing truck journals | 3½ x 6 in. |

BOILER.

| | |
|---|---|
| Style | Straight |
| Working pressure | 180 lbs. |
| Outside diameter of first ring | 36 in. |
| Firebox, length and width | 67¼ x 20½ in. |
| Firebox plates, thickness | 5/16, 3/8 & 7/16 in |
| Firebox, water space | F-3, S & B-2 in. |
| Tubes, number and outside diameter | 88—1¾ in. |
| Tubes, length | 12 ft. 6 in. |
| Heating surface, tubes | 531 sq. ft. |
| Heating surface, firebox | 49 sq. ft. |
| Heating surface, total | 580 sq. ft. |
| Grate area | 9.4 sq. ft. |

TENDER.

| | |
|---|---|
| Frame | 6 in. chan. |
| Wheels, diameter | 24 in. |
| Journals, diameter and length | 2¾ x 5 in. |
| Water capacity | 1200 gals. |
| Wood capacity | 1½ cords |



MACHINE FOR LOADING COAL INTO BOX CARS.

## LOADING COAL IN BOX CARS.

It has long been known by coal dealers and others that much coal is stolen from shipments made in open cars, not alone when the cars are standing on sidings, but even when the cars are moving; sometimes by boys and men who steal a ride and throw off gunny sacks filled with coal, and even by the railroad employees themselves, who shovel off coal near their homes. Naturally the customer who receives the shipment is short by the amount of coal thus lost, for it is seldom that a man weighs his carload lots, and even if he does, he still has to pay for the amount shipped.

To overcome this, many customers have advocated that the coal be shipped in box cars, but in many cases the extra cost of the labor for loading and unloading was sufficient to prevent such shipments being made, except where there was no alternative. Mechanical loaders have been used to some extent to reduce the cost of handling, but in most cases they throw the coal to the ends of the cars, causing considerable breakage, especially in soft coal.

To overcome these difficulties a number of coal companies have installed the type of box car loader shown in the illustration which pushes the coal into place even to the ends of the cars, and hence avoid breakage. The example shown has recently been installed at the Silver Creek colliery of the Philadelphia & Reading Coal & Iron Company at New Philadelphia, Pa., and is the first installation of the kind in the anthracite region. This type of loader, however, is used quite generally in the bituminous region.

Coal is supplied by chutes from overhead bins to the hopper of the loader from which it is distributed alternately to the ends of the car, the hopper being entirely inside the car when at work. The hopper rocks up and down and at the same time moves back and forth from one end of the car to the other. As it passes the door in each trip it receives coal from the chute and carries it to the end of the car, here it is emptied by the movement of a scraper which moves through the hopper, pushing the coal ahead of it. The motion of the hopper is reversed by reversing the motor, but a mechanical reversing device is used on the scraper. All the movements of the scraper, of the hopper inside as well as out of the car, and of the entire loader from one car to another are obtained from a single motor, and are under the control of a single operator by means of various clutches and reversing gears, all conveniently arranged for rapid operation. The loader is also used for moving the cars, loaded or unloaded, as required, and for this purpose a hook is provided on the truck, into which a rope may be fastened.

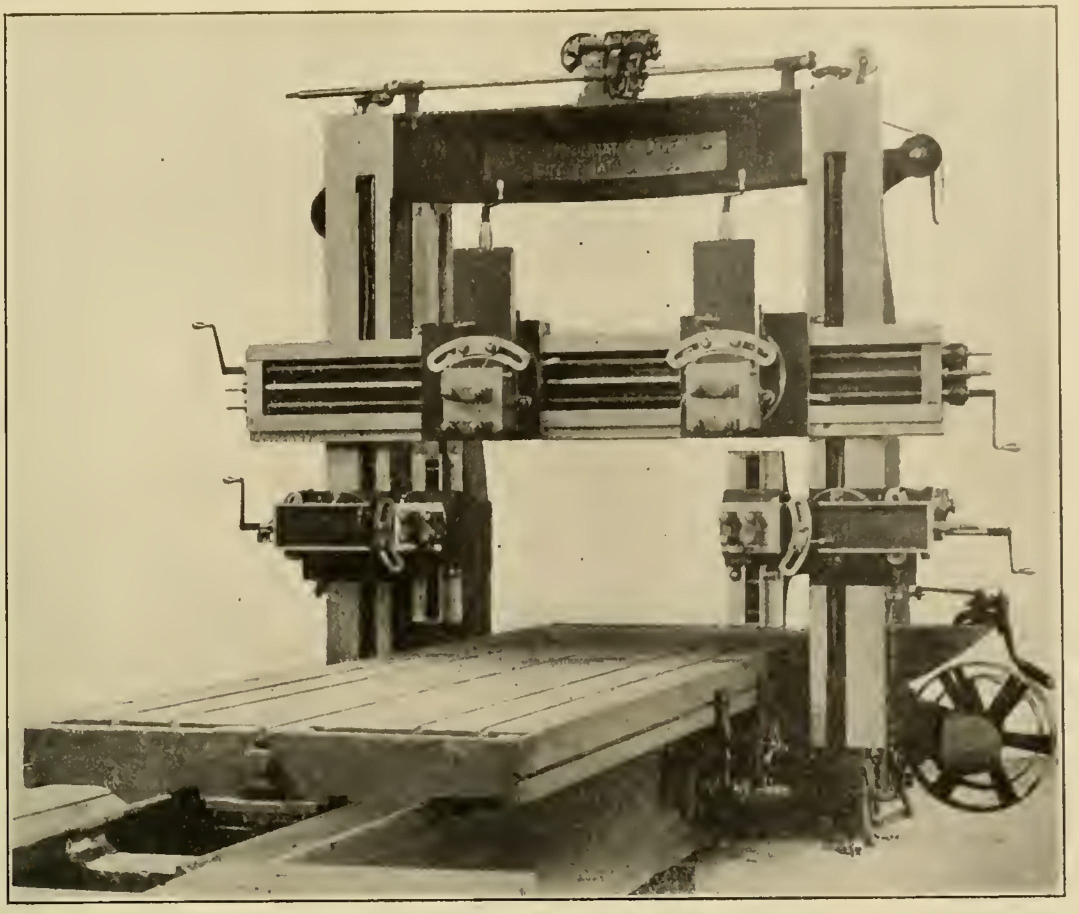
The motor is a Westinghouse direct current type "S" series wound design, running at 450 r. p. m. at full load. Power is supplied at 220 volts through two trolley wires (not shown in the illustration), as the track circuit is not used for return. The motor is controlled by a standard Westinghouse R-32 controller with grid resistance. It is necessary to reverse the motor at frequent intervals and to run at different speeds; hence the resistance has sufficient capacity to carry the current for an indefinite period. The motor has a rating of 75 h.p. on an intermittent service basis, which meets the requirements of this case, and is, in fact, capable of developing far greater torque.

This loader at the present time is used for loading chestnut, stove, egg and broken coals, and can handle all other sizes of anthracite coal with equal success. Thirty box cars are being loaded by this equipment in a nine-hour day, and sixty can be handled when conditions require it. The loader puts all but the last few tons into the car, and these are filled in directly from the chutes.

## PNEUMATIC DESPATCH TUBE AT ENGINE HOUSES.

When the inspectors have completed their examination at the inspection pit each man writes his report on the proper form and sends it by pneumatic dispatch tube to the engine house office. By this means the reports covering the condition of the engine will reach the work distributor's desk almost as soon as the engine reaches the ash pit. The tube can easily be installed by any competent pipe fitter and is usually constructed of two-inch pipe laid in a box underground or carried on the ends of the ties. The fins should be smoothed off the inside of the pipe and a simple carrier can be made of an old air brake hose. When the reports are ready they are slipped into the carrier and the latter pushed into the open end of the tube. A hinged flap valve is then held against the tube and the air pressure turned on, a distance of several hundred feet requiring only a few seconds. As almost all of the larger engine houses are provided with air compressors, it is easy to secure the motive power needed by using a reducing valve set to a few pounds. The carriers as they come out of the tube strike against a spring buffer a foot or so away and drop into a basket. The man at the receiving end then signals to the other end by means of a bell or incandescent lamp and the air is shut off and the flap valve allowed to fall.

The usefulness and value of this simple and inexpensive tube system can hardly be appreciated by those who have never used it. The condition of an engine is known to the engine house force within a few minutes after it reaches the inspection pit, and they know at once whether the engine can be marked up for a run and a crew called or whether it will require shop attention which may take several hours. The condition of inspection pits and pneumatic tubes will save their cost many times over at nine-tenths of the large engine terminals of the country.—*Wm. Elmer, before the Railroad Club of Pittsburg.*



PLANER SPECIALLY ARRANGED FOR LOCOMOTIVE CYLINDERS.

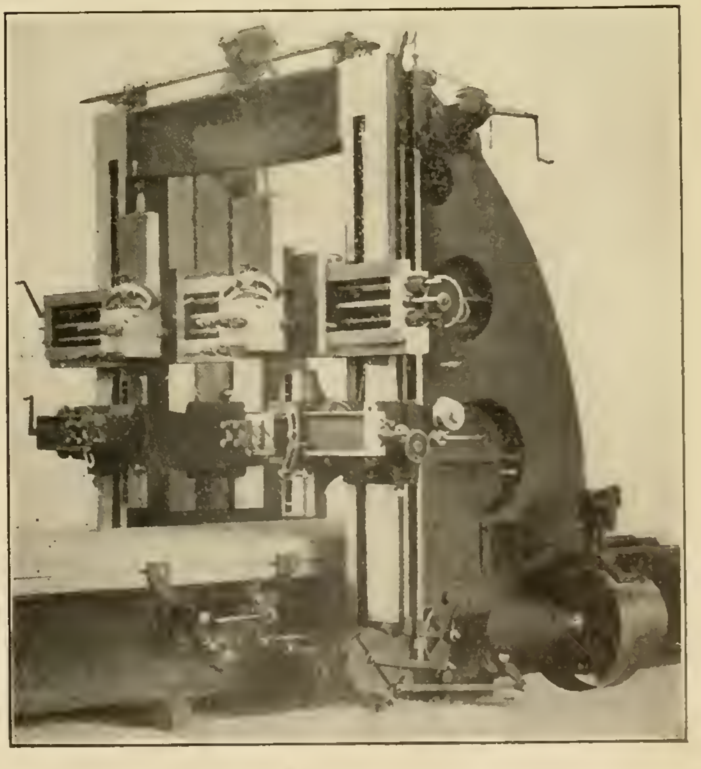
## LOCOMOTIVE CYLINDER PLANER.

The accompanying illustrations give two views of a 72 x 72 in. x 18 ft. planer built especially for machining locomotive cylinders and particularly for cylinders with piston valves. The machine itself is a regular planer as manufactured by the Cincinnati Planer Co., and is arranged for a parallel drive. The changes making it particularly adapted for cylinders are in the arrangement of the side heads, which are a radical departure from the usual practice.

The planer housings are machined on the inside with a guide having a dovetail toward the front and a square face to the rear. A specially shaped bracket, counterweighted by a chain and weight (the latter not being shown in the illustration), fits in this guide and extends inward and forward toward the front of the housing. This bracket is secured to the housing at any point by tightening a taper gib on the straight side, which forces the bracket against the dovetail and draws it to a tight bearing. It is lifted up and down by means of a sprocket wheel, which carries the chain from the counterweight and is arranged with a crank for raising and lowering the bracket to suit the various cylinders. The front end of the bracket has a considerable height and is machined and scraped parallel to the front of the housing. This face carries a special shoe which has a dovetail on its forward side that fits the cross slide of the side head and is in line with it. This shoe slides up and down on the guide on the face of the bracket.

After the slide has been run on to the shoe the latter is adjusted to the bracket by means of two taper gibs and the shoe then becomes a part of the side head, so that when the latter is moved up or down it carries the shoe with it sliding on the face of the bracket. Thus when it becomes necessary to reach out, say twenty-four inches, from the housing edge, this bracket offers additional support to the side head and greatly diminishes the strain which usually takes place on work of this kind. The bracket is made of a length to clear the projection on all sizes and makes of cylinders and yet have sufficient bearing to give the greatest desirable vertical movement to the side head.

Whenever the machine is to be used for other purposes than cylinders the slide can be run back in the usual way on the side head and the bracket raised up out of the way, the machine then having the usual full capacity for ordinary planing. This machine is being manufactured by the Cincinnati Planer Co., Cincinnati, O.



## EFFECT OF BRICK ARCHES AND BLOWERS ON SMOKE FROM LOCOMOTIVES.

The Department of Smoke Inspection of the City of Chicago recently made some quite extensive tests for obtaining accurate information on the possibilities of reducing the amount of smoke caused by locomotives within the city limits. A bulletin which has been issued by the department contains a complete account of the tests and a general discussion of the subject.

In considering the matter of blowers for forming artificial draft when the steam is shut off the bulletin states, "much smoke is caused in locomotive operation by inefficient blower arrangements, either in the cab or in the smoke box, or by carelessness on the part of the engine crew in not putting whatever blower arrangement their locomotive is equipped with into operation. The only function of the blower as a smoke preventative is to induce a draft to draw air into the fire box in order that there may be enough oxygen supplied, in the absence of a draft produced by exhaust from the nozzle, to completely burn the coal. The best blower arrangement, therefore, is the one that gives results approaching as nearly as possible the conditions which exist when the engine is working steam."

Tests were made on a number of different types of blowers by the department and it was found that a combination blower and exhaust tip, adaptable to locomotives having a single nozzle, gave the best results. This consists of a special exhaust tip having an annular chamber into which the blower steam pipe is led. Sixteen ¼ in. openings or jets from the chamber are arranged in a circle around the outside of the nozzle and so directed that the steam from them forms a single hollow jet, filling the stack near the top. The advantages claimed for this blower are that it induces sufficient draft, is economical in steam consumption and is comparatively noiseless.

On locomotives having a double exhaust tip this arrangement of blower is not practical and a double blowing arrangement, consisting of two pipes extending up from the nozzle on either side and ending at about the base of the stack, being inclined inward, so as to cause their combined jets to fill the stack near the top is advocated. The tips of these blowers are flattened down to give a wide thin jet of steam, the opening being but ¼ in. wide from a 1 in. pipe.

In discussing this subject the bulletin states that, "in order to obtain good results no blower connection should be less than 1 in. pipe and the blower itself should have an aggregate opening of the same size as the pipe. In order to facilitate the operation provision should be made for the engineer and firemen to open the blower independently of each other, or better, to make the means of opening the blower partially or wholly automatic. If it is arranged to be automatic it should open when the throttle is closed and remain open after the throttle has been opened, until the engine has required speed enough for the exhaust from the cylinders to furnish sufficient draft." An illustration and description of an automatic blower valve which operates in this manner and is being very successfully used by one of the railroads in Chicago is given.

The effect of brick arches on the amount of smoke given out by a locomotive in regular operation was most carefully studied and the writer of the bulletin states that all of the reports of tests with brick arches, as compared with no arch, have been most favorable to their use. "Whether their use is economical or not, provided their expense is not so great that it would be prohibitive, should not stand in the way of their adoption, for they are efficient as smoke preventors. Many tests have been made to determine the value of arches in the saving of fuel. Among these a series of very comprehensive tests has recently been made by the Lake Shore & Michigan Southern Railway. In this investigation a very careful record was kept of the fuel used, the miles run and the tonnage hauled, together with all expenses incident to the arches. Four engines were used in the tests, each one running on the same train for ten days without the arch and ten days with the arch. The results given in the table above show a very gratifying saving of fuel, which amounts to approximately 9 per cent. The net saving in dollars and cents per thousand miles varies from $2.58 to $4.89, or an average of $3.44.

COMPARATIVE BRICK-ARCH TEST

| | No Arch | Arch | No Arch | Arch | No Arch | Arch | No Arch | Arch |
|---|---|---|---|---|---|---|---|---|
| Engine number | 4676 | | 4664 | | 4668 | | 4650 | |
| Duration of test | 10 da. | 10 da. | 10 da. | 10 da. | 10 da. | 10 da. | 10 da. | 10 da. |
| Train numbers | 10 & 5 | 10 & 5 | 28 & 23 | 28 & 23 | 37 & 4 | 37 & 4 | 50 & 3 | 50 & 3 |
| Average number cars per trip | 9.1 | 9.2 | 8.8 | 8.9 | 6.2 | 6.9 | 5.3 | 5.3 |
| Average tonnage per trip | 479.5 | 495.8 | 457.5 | 459.9 | 299.3 | 311.5 | 226.8 | 228.0 |
| Total number of miles | 2680 | 2680 | 2680 | 2680 | 2680 | 2680 | 2770 | 2770 |
| Total number of ton miles | 1,285,060 | 1,328,744 | 1,226,100 | 1,230,120 | 802,164 | 834,820 | 628,236 | 617,710 |
| Total tons coal consumed | 130.5 | 118.7 | 140.2 | 129.6 | 119.8 | 110.9 | 111.2 | 100.6 |
| Lbs. coal consumed, 1000 ton mi | 203 | 181 | 228 | 210 | 298 | 265 | 353 | 325 |
| Cost coal consumed, 1000 ton mi | $ 0.179 | $ 0.159 | $0.200 | $0.184 | $0.262 | $0.232 | $0.310 | $0.286 |
| Average steam pressure per sq. in. | 196.6 | 198.3 | 190.3 | 196.6 | 194.1 | 196.5 | 195.5 | 197.2 |
| Number of times flues cleaned | 15 | 6 | 19 | 9 | 17 | 12 | 16 | 10 |
| Total cost of cleaning flues | 0.43 | 0.21 | $0.71 | $0.31 | $0.59 | $0.18 | $0.56 | $0.21 |
| Number of times netting cleaned | 16 | 7 | 19 | 9 | 18 | 10 | 18 | 10 |
| Total cost of cleaning netting | 0.37 | 0.11 | $0.58 | $0.23 | $0.46 | $0.24 | $0.40 | $0.21 |
| Material and labor cost cost, installing first arch | 0.00 | 8.36 | 0.00 | 8.36 | 0.00 | 8.36 | 0.00 | 8.36 |
| Cost of materials for replacing broken brick | 0.00 | 0.00 | 0.00 | 0.70 | 0.00 | 1.44 | 0.00 | 0.74 |
| Cost of labor for above replacement | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.12 | 0.00 | 0.06 |
| Cost of material for replacement on acct. flue work | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cost of labor for above replacement | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Number of times brick cleaned off | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total cost of cleaning brick | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total cost for maintenance per 1000 miles | 0.00 | 3.10 | 0.00 | 3.41 | 0.00 | 3.66 | 0.00 | 3.30 |
| Gross amount saved by use of arch over no arch, 1000 mi | 0.00 | 7.99 | 0.00 | 7.16 | 0.00 | 8.20 | 0.00 | 5.88 |
| Net amt. saved by use of arch over no arch, 1000 mi | 0.00 | 4.89 | 0.00 | 3.75 | 0.00 | 4.55 | 0.00 | 2.58 |

The department undertook, some time ago, an extensive series of observations to determine as nearly as possibly, the relative value of different arrangements of blowers and arches as smoke preventers. Through the courtesy of the Chicago, Burlington & Quincy R. R., the observations were made with locomotives on that road. These locomotives were in suburban service between Chicago and Downers Grove. The observations were made by A. J. Cota, master mechanic of the Chicago terminal division, simultaneously with, but independently of, G. E. Ryder, deputy smoke inspector of the city of Chicago, the results checking very closely.

The object of these observations was to obtain some definite data upon which could be based a comparison of various arch and blower arrangements. To make this comparison fair to each arrangement, care was taken to eliminate as much as possible any features that would give any one equipment an advantage over any other; and at the same time select power that would not class any part of the results as observations made under special conditions. Four locomotives were selected and the equipment changed from time to time as follows: Engine No. 110, no arch, with ¾-in. straight blower; engine No. 1143, no arch, with 1-in. double blower; engine 1110, solid front arch, with ¾-in. straight blower; engine No. 1143, solid front arch, with 1-in. double blower; engine No. 1112, double solid arch, with ¾-in. straight blower; engine No. 1143, double solid arch, with 1-in. double blower; engine No. 1112, double hollow arch, with ¾-in. straight blower; engine 1175, double hollow arch, with 1-in. double blower; engine No. 1143, broken arch, with 1-in. double blower; engine No. 1143, broken arch, with 1-in. double blower.

By the straight blower is meant the ordinary blower pipe in the smoke box directed vertically toward the center of the stack, the form most commonly used in locomotives. The double blower consists of two pipes, one on each side of the exhaust nozzle. The tip of this blower is somewhat above the exhaust nozzle and is flattened to give an opening about ¼ in. in width.

The double solid arch arrangement is identical with the solid front arch except that a crown is added as shown in C on the chart. The double hollow arch is the same as the double solid arch, differing only to the extent that it is made hollow for the purpose of admitting air over the fire. Air is admitted through combustion tubes in the sides of the fire box, conveyed through the arches and delivered to the fire box from the nose of the front arch and the lower side of the crown arch. This arrangement is shown in D on the chart. The broken arches shown in E and F on the chart are made in the form of the solid front arch with the top brick placed in a horizontal position. The object of this arrangement is to change the direction of the gases, part of them passing through the opening in the arch and the remainder passing around the nose of the arch. This horizontal course of brick has somewhat the same action in the fire box of a locomotive that a mixing pier has in the combustion chamber of a stationary boiler setting.

Prof. Ringleman's method for classifying the smoke into six grades according to its density or percentage of blackness is the one most commonly used in observations of this kind. This method is explained as follows: In making observations of the smoke proceeding from a chimney, four cards ruled with different thicknesses of lines, together with a card printed in solid black and another left entirely white, are placed in a horizontal row and hung at a point about 50 feet from the observer and as nearly as convenient in line with the chimney. At this distance the lines become invisible, and the cards appear to be of different shades of gray, ranging from very light gray to almost black. The observer glances from the smoke coming from the chimney to the cards, which are numbered from 0 to 5, determines which card most nearly corresponds with the color of the smoke, and makes a record accordingly, at once noting the time.

The width of the lines and area of the spaces are so arranged that the black covers respectively 0 per cent., 20 per cent., 40 per cent., 60 per cent., 80 per cent. and 100 per cent. of the white surface of the card. This is graded for convenience into 0, 1, 2, 3, 4 and 5. By this means, for example, smoke proceeding from the stack which corresponds to card 3 is 60 per cent. black. Readings of the smoke on these observations were taken every fifteen seconds during the time of each run.

The results of these observations were plotted on charts for each run with each equipment. The chart, shown here, is the performance of each equipment on train No. 105. On the vertical scale the grade or per cent. black is plotted. The horizontal scale is the time. A second horizontal scale shows the number of shovels of coal at each firing and the time of the firing. The effect of heavy firing is evident from the smoke occurring after such a fire had been made.

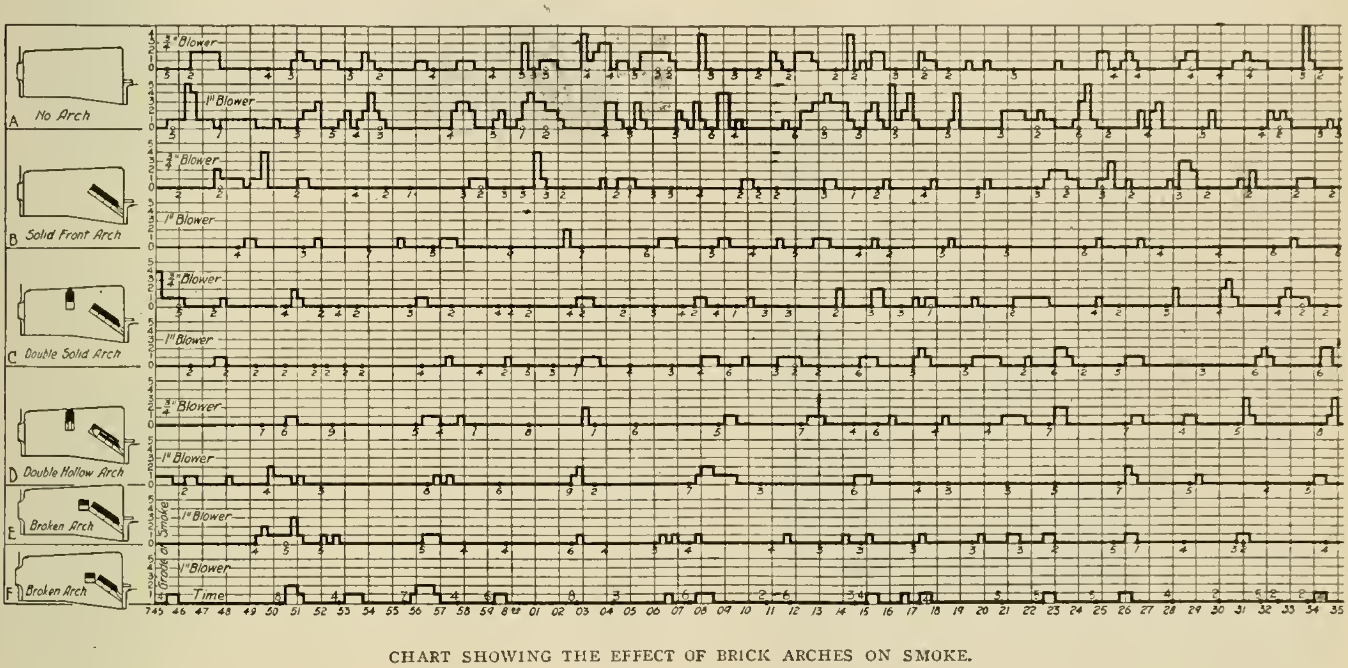



CHART SHOWING THE EFFECT OF BRICK ARCHES ON SMOKE.

## A NEW PIPE JOINT CEMENT.

It has been customary to furnish pipe joint cements and red or white lead for the same purpose already mixed with either water or oil, and no doubt a customer buying these cements pays as high a price per pound for the water or oil as for the cement itself. To obviate these disadvantages the H. W. Johns-Manville Company, New York, has recently placed on the market a pipe joint cement put up in powder form, which can, of course, be kept in stock indefinitely and does not dry up or deteriorate. It is simply necessary to mix this powder with water or linseed oil to make it ready for use.

The chemical properties of this cement are such that it expands after the joint is made up and does not harden like red or white lead, which permits the joint made with it to be easily broken at any time without danger of breaking the fittings. It is not poisonous and will not taint water. The manufacturers claim that one pound of this powdered cement, which has been given the name "H-O Pipe Joint Cement," is equal to four pounds of the usual ready mixed cement.

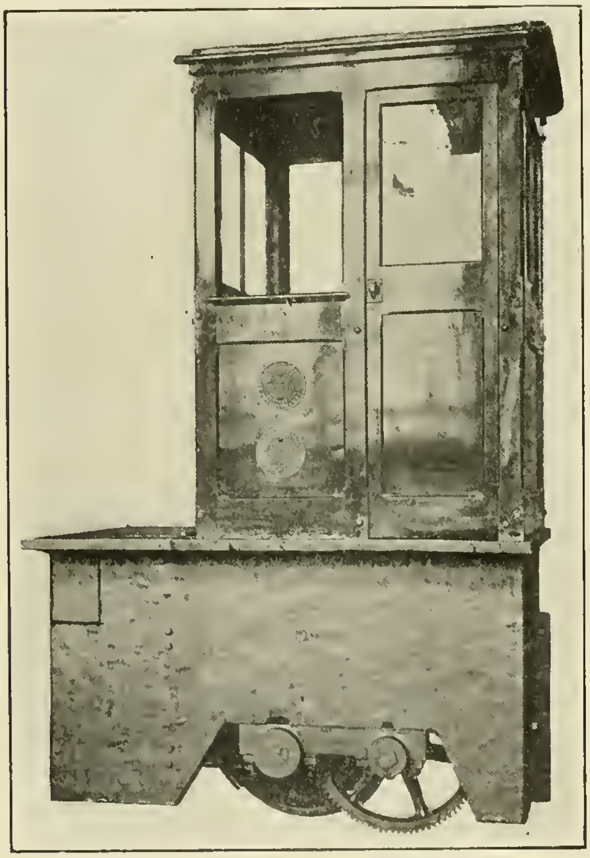
DIRECT CURRENT ON THE PENNSYLVANIA.—The Pennsylvania Railroad has adopted the direct-current system of electric traction, with third rail conductor, for its New York and Long Island tunnel extension. This decision was reached after making its own independent experiments, and is the result of mature consideration of the entire subject in view of the special requirements of its tunnels, station and yards. This system of electric traction is now in use on the lines of the Long Island Railroad, with which lines the tunnel extension will be directly connected.

## ELECTRIC TURNTABLE DONKEY.

It has long been known that for doing work of a purely laborious sort, that is, requiring merely strength, the human animal is a very inefficient piece of apparatus when compared with a mechanical power producer such as an electric motor, inefficient both in point of size, weight and cost of operation. Nevertheless it has long been a very general custom to operate the turntables and often transfer tables on steam railroads by man power. A striking example of the economy and convenience which results from the use of electric power for this service is shown by the installation of a motor on a turntable on one of the railroads in New York state.

This turntable was formerly operated by hand, requiring the time of a number of men at intervals, which averaged the continuous service of two men for 24 hours a day. The donkey was equipped with a standard Westinghouse induction motor, known as type "F" high torque, rated at 20 h.p., 200 volts, two-phase, 60 cycles. This reduced the labor required to one man per day of 24 hours.

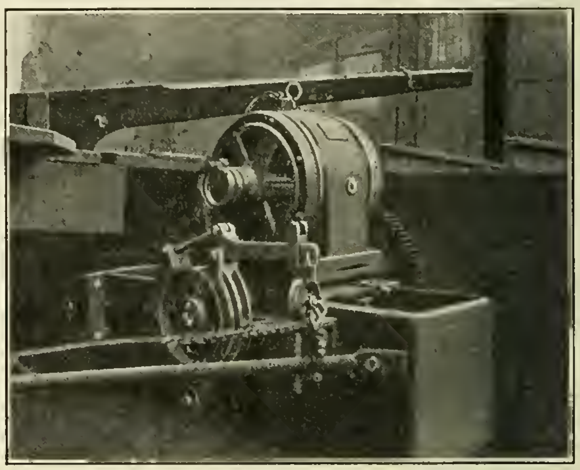
Inasmuch as the men were paid 15 cents an hour in each case this motor produced a saving of $3.60 a day, or $1,314.00 per year of 365 days. As the cost of power for the motor has averaged but $8.00 a month, or a total of $96.00 a year, the net saving is $1,218.00 a year. The total cost of the electrical equipment, including the cost of installing the outfit, was approximately $1,500.00, which is but slightly greater than the actual saving in one year.



ELECTRIC TURNTABLE DONKEY WITH CAB.

The economy is not, however, the most important point in the advantages of the electrical equipment, although it makes a very good showing. The work of a turntable is intermittent and is usually rushing for a short time and then at a standstill, especially at terminals, where many locomotives often come in at the same time. The length of time required to turn a locomotive by hand depends largely upon the number of men available to do the turning, but even with the handles full, which condition requires from four to eight men, it is impossible to do the work as rapidly as with a motor. Hence the saving in time at such periods is of great importance as the congestion at the turntables is relieved and the movement of traffic is expedited.

The electric donkey forms a separate piece of apparatus consisting of a very heavy cast iron frame carrying a wheel which runs on the circular rail. The electric motor is mounted on this frame and drives the wheel through a reduction gearing of large ratio. The frame is securely connected and braced to the table in such a manner as to allow it to be free to move independently in a vertical direction. A band brake is provided on an extension of the shaft of the driving wheel.



ELECTRIC TURNTABLE DONKEY SHOWING MOTOR AND BRAKE.

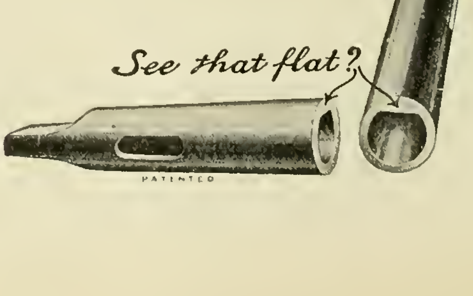
The method of supplying the electric power has some interesting details. A bridge is used with overhead wires, which run to an overhead collecting switch. This switch is constructed with brushes and collector rings so that contact is made at all times and in all positions of the turntable. It is so constructed that there is no strain on the line wires, as the cross arm to which they run does not move with the table, but is stationary while the table revolves.

In this installation the cab is mounted on the center of the turntable, so that the wires run directly from the bridge to the cab and then to the motor. In many instances the cab is mounted at one end, but instead of being directly on the table, it is mounted on the donkey directly over the motor, to overcome the jolting which the cabman would get when the locomotives run on and off. The type of cab which the Westinghouse Company has adopted as a standard for this work is shown in the accompanying illustration.

In many cases, especially in a new installation, the feed wires are run underground in conduit and brought up through the king pin in the center of the table. The same type of switch mentioned above is placed between the tracks and the connections made from this point in the usual manner.

## "USE-EM-UP" DRILL SOCKET.

The advent of the expensive high speed drills has brought before all drill users more strongly than ever before the problem of the loss occasioned by twisted tangs and broken shanks. With the ordinary carbon steel drills, notwithstanding the fact that the loss was considerable from this source, it was generally neglected, and considered as an unavoidable evil. However, when



the tang was twisted off, or the shank broken on a high speed drill of approximately four times the value of an ordinary drill, and this expensive tool thereby rendered useless, the men in charge of such matters began to give the subject some serious thought.

A cure for this trouble has been devised by the American Specialty Company, Chicago, Ill., in the shape of a new type of drill socket, which is illustrated herewith. It will be noted that this socket is similar to the standard taper socket, with two exceptions. One, that it has a flat on its inside surface, and the other that the drift slot is somewhat longer than on the ordinary socket. to facilitate the driving out of tangless drills.

With this socket it is only necessary to grind a flat on the remaining portion of the shank after it has been broken off, or the tang twisted off, in order to put the drill into immediate use, or if a flat is ground on a new drill the liability of trouble from this source is entirely eliminated. Several of the standard drill makers are now furnishing their drills flatted to fit this socket at the same price as the ordinary drill.

It will be noted that flattening drill shank to fit this socket does not in any way interfere with its use in the standard taper socket.

## A NEW HIGH DUTY DRILL.

A 24-inch drilling machine, especially adapted for handling high speed drills of from ½ to 1¾ in. in diameter, when drilling in solid steel to their full cutting capacity, has just been designed and is being manufactured by The Foote-Burt Company, Cleveland, O. In addition to the size shown in the illustration a smaller size of the same type is being manufactured and it is planned to build two larger sizes in the near future.

This machine contains a number of improvements and the design throughout is marked by extreme simplicity. It is single speed pulley driven, all speed changes being made by a quick change gear device located in the foot of the column. The levers for starting and stopping the machine and for changing speeds and feeds are conveniently located within easy reach of the operator.

All bearings are bronze bushed and are provided with liberal oil grooves. Throughout the machine spur gears are used, except one pair of slow running 2-to-1 bevel gears at the driving end, and one worm and worm gear for the feed. The spindle is of forged high carbon steel fitted with a ball thrust bearing.

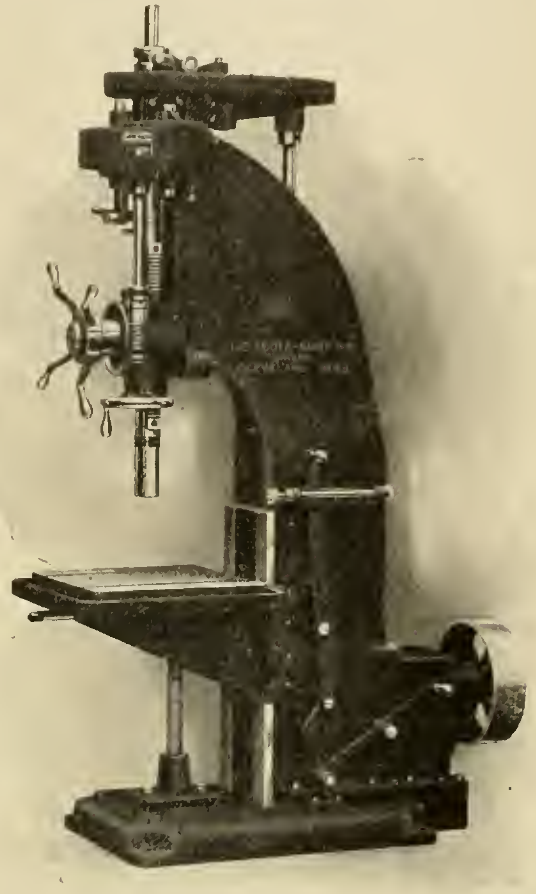
Three changes of geared feed are provided, any one of which is instantly available by shifting a lever at the front of the machine. All of the feed changes can be made without stopping the machine. The power feed is equipped with an adjustable automatic stop and a hand stop. The hand feed is through a worm and worm wheel, and quick traverse of the spindle in either direction is afforded through the spider hand wheel at the front of the machine which is engaged or disengaged automatically.

Nine spindle speeds are available through a double train of gearing, which is always in mesh and runs in a bath of oil. The device employs a lock bolt engaging any one of three gears, in each of the two trains, thereby giving the nine different speeds, any one of which is instantly available by shifting the levers at the side of the machine, directions for the use of which are given on the index furnished. At the end of the speed box is the pair of 2-to-1 bevel gears inside of the column, making the connection to the vertical driving shaft. Between the latter and the spindle gear is an idle spur gear, making it unnecessary to employ any more bevel gears.

When desired, a tapping attachment can be furnished which consists of a positive steel clutch, located on the idle gear on the top of the machine. It obviates the necessity of driving and leading the spindle through the keyed member of the clutch. The attachment reverses at a ratio of 2 to 1.

The table is of the bracket knee type and has a large square lock bearing surface on the upright, to which it is securely gibbed. It is further supported and elevated by a square thread jack screw beneath it, slightly back of the center of the spindle, to permit boring bars or other tools passing through the table. It is also provided with a liberal oil groove and T-slots.

This machine has the following dimensions: The distance from the center of the spindle to the face of the column is 12 inches. The maximum distance from the nose of the spindle to the top of the table is 28 inches; the length of power feed is 16 inches; the spindle has a diameter of 3 inches at the nose, and is provided with a No. 4 Morse taper. The spindle driving gear is 8⅞ inches in diameter with a 1½-inch face. The table has a vertical adjustment of 20 inches. The nine spindle speeds range



HIGH DUTY DRILLING MACHINE WITH SINGLE SPEED DRIVE PULLEY.

between 71 and 306 revolutions per minute. The three feeds are 0.007, 0.016 and 0.033 inch respectively. The net weight of the machine is 2,450 pounds.

As an extra attachment, a compound table can be furnished, with a knee specially built for supporting it. This compound table has a longitudinal adjustment of 14 inches, and a cross adjustment of 8 inches. The working surface is 16½ × 30 inches. When the compound table is furnished, the maximum distance from the nose of the spindle to the top of the table is decreased by 3¾ inches.

Frank Thomson Scholarship Examination.—The General Managers of the Pennsylvania Lines East and West of Pittsburgh announce that the examinations of applicants for the Frank Thomson scholarships will be held in June, 1909. These scholarships, amounting to $600 a year, were established in 1907 by the three children of the late Frank Thomson. After 1910 there will be eight holders of scholarships, and this number is expected to be maintained in succeeding years. The examination will be open to the sons of all employees of the Pennsylvania and its controlled lines. The College Entrance Examination Board of New York City will conduct the examinations. Applications are to be sent before June 3 to Thomas S. Fiske, Secretary.

It is reported that the Pullman Co. is experimenting with a view to discover some material to replace the plush which covers the seats of its cars.

## ECONOMY SOCKETS AND SLEEVES.

Every user of Taper Shank Drills has had a number of them made useless because of broken or distorted tangs, caused usually by worn or poorly fitting sockets. Such drills are in most cases consigned to the scrap pile which is necessarily a very expensive practice.

To meet the growing demand for a device to utilize such drills,

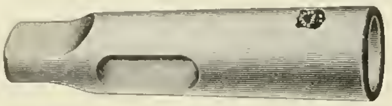


FIG. 1.

The Standard Tool Co., Cleveland, O., is making a special type of socket shown in Figs. 1 and 2. These are similar to the regular sockets and sleeves on the market, but with the slot for driving lower down and of larger dimensions.

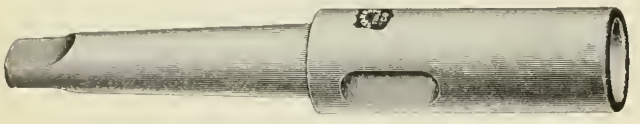


FIG. 2.

To provide a new tang to fit these sockets, the Economy Tang Gauge is used. By slipping it over the shank of the broken drill as shown in Fig. 3, a new tang can be marked of the correct size and position, which is then shaped either by milling,

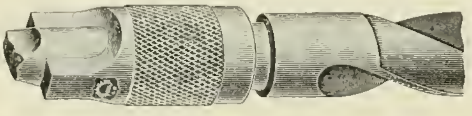


FIG. 3.

planing, filing or grinding. The new tang is heavier and stronger than the old one, as will be seen in Fig. 4, and insures an accurate and powerful drive.

The shanks of the "Economy" sockets and sleeves are made to

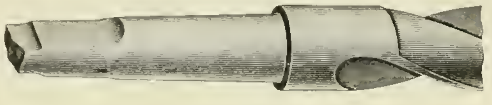


FIG. 4.

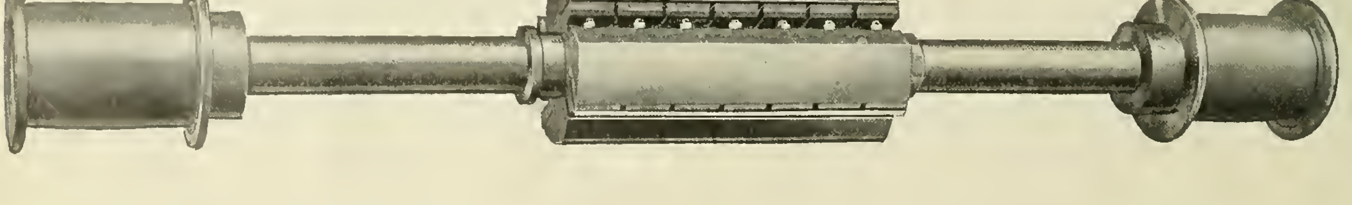
standard dimensions and will fit the spindles of all the leading makes of power drill presses.

## HIGH SPEED STEEL CUTTERS FOR SURFACING.

The advantages of high speed steel for cutting either metal or wood are generally appreciated, but its use, by simply replacing the present cutters with the new steel, is made impossible in a great majority of cases by the great expense and the difficulty in properly working and tempering it in such large sizes. The general, and most satisfactory, method of surmounting this difficulty is to use what amounts to a tool holder of proper design and first-class material, arranged to carry a comparatively small piece of high speed steel, which simply forms the cutting edge.

Among the most recent applications of this idea is the blade's cylinder for surfacing, beading and siding, shown in the accompanying illustration. This tool has been designed and is being manufactured by Samuel J. Sheimer & Sons, Milton, Pa. The new cylinder provides for the use of thin blades of high speed steel, which fit snugly in knife holders of high grade tool steel, which in turn fit in the grooves in the cylinder. The knife holders form part of the chip-breaker and when worn or injured may be replaced without discarding the cutter head. The high speed steel blades when properly tempered and treated will serve for one or two days' work on hard maple, oak or hickory.

This new type of cylinder has many advantages in point of simplicity and durability. The blades may be kept in good working order with less grinding and less trouble in setting and fastening to the head and are also less liable to get out of balance owing to their lighter weight. The chip breakers are easily renewed and the thin blades of the high speed steel being so carefully reinforced with the holding clamps are entirely free from the possibility of breakage.



Water Softening and Leakage of Flues.—Experience would indicate that the amount of hard scale present is a true index to flue leakage. In our Ohio district we encountered extremely hard water which resulted in overcrowding our shops with power on account of flue failures; but after the installation of water-softening plants at all of the important stations, a decided reduction was obtained, which at once improved the general efficiency of the power. There is hardly a question but that the presence, to an extent, of hydrates and carbonates in treated waters decreases the tendency towards corrosion, leaving to be controlled the amount of total solids and excess of reagents so as to prevent boiler foaming. The use of soda ash in waters containing free acid, or any dissolved salts, such as magnesium chloride, decreases corrosion, thereby increasing the life of the flue material.—*Alexander Kearney, assistant superintent motive power, Norfolk & Western Ry., before the Richmond Railroad Club.*

Automatic Block Signals in 1908.—According to the *Railroad Age Gazette* over 900 miles of railway were equipped with automatic block signals during the year 1908 and it is probable that 2,000 miles will be equipped in 1909.

## BOOKS.

Spring Tables. By Egbert R. Morrison. 6 x 9 in. 84 pages. Bound in cloth. Published by E. R. Morrison, Sharon, Pa. Price, $2.00.

This book, which is designed as a handbook for engineers, students and draftsmen, is practically entirely given up to tables giving data in connection with various types of springs. The formulae for springs of the usual types are given in the first few pages, following which are a number of very handy tables giving the fractional parts of $\pi$, and another of the 5th powers from 1-16 to 2, and a table giving the cubes from 1-16 to 3½, advancing by sixteenths. The most useful information in connection with helical springs takes up the next 52 pages, there being one table for light steel springs and tables for heavier springs with a diameter of bar varying from 1-16 to ½ in. by sixteenths. A section is then given to rectangular sections of helical springs and the remainder of the book is taken up by similar tables for elliptic springs.

Proceedings of the American Railway Master Mechanics' Association. Forty-first annual convention. Atlantic City, June 22 to 24, 1908. Published by the association. J. W. Taylor, Secretary, 390 Old Colony Building, Chicago.

The full report of the committees and the discussions thereon on the floor of the convention are given in this volume. Very valuable reports were given at the 1908 convention by committees on the following subjects: Apprenticeship system; Blanks for reporting repairs on engines; Castle nuts; Four-cylinder compound locomotives; Mallet compounds; Mechanical stokers; Revision of standards; Safety valves; Superheating; Washing-out and re-filling boilers, and Widening the gauge of track on curves. In addition to the committee reports topical discussions were given on the following subjects: Alloy Steel; Standardization of Locomotive Parts; Smoke Nuisance; Ball Joint Unions for Steam and Air Line Connections and Non-combustible Engine House Jacks.

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Proceedings of the International Railroad Master Blacksmiths' Association. Sixteenth annual convention. Cincinnati, August 18 to 20, 1908. Published by the association. A. L. Woodworth, Secretary, Lima, O.

The subject discussed at the last annual meeting of this association included committee reports on Tools and formers; Flue welding; Case hardening; Piece work; Locomotive frames; Thermit welding; Frogs and crossings; High speed steel and Manipulation of tool steel. This association now has a membership of 280 and will hold its next convention at Niagara Falls.

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Tables of Quantities for Preliminary Estimates. By E. F. Haugh and E. D. Rice. 4½ x 7 in. 92 pages. Cloth. Published by J. Wiley & Sons, 43 E. 19th St., New York. Price, $1.25.

This book is practically entirely given up to tables of earthwork, which have been designed primarily for the requirements of the locating engineer, and are published in compact and convenient form for field use. The formulae and methods of calculation are given in the first few pages. A few other tables of interest and value to the locating engineer are included.

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Proceedings of the Master Car Builders' Association. Forty-second annual convention. Atlantic City, June 17 to 19, 1908. Published by the association. J. W. Taylor, Secretary, 390 Old Colony Building, Chicago.

A large number of unusually important subjects were reported upon at the last convention by various committees, standing and temporary, and were given very energetic and interesting discussion. Among some of these reports might be mentioned the ones on the revision of the various rules of the association; Standards and recommended practice; Steel passenger cars; Ventilating and heating passenger cars; Cast iron wheels and Automatic connectors. Definite action was taken on a number of the most important recommendations and others will be brought up at the next convention for further discussion. The volume includes a full list of drawings, showing the standards and recommended practice of the association, as well as a list of members with their addresses, the constitution, etc.

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Proceedings of the Traveling Engineers' Association. Sixteenth annual meeting. Detroit, Mich., August 25 to 28, 1908. Published by the association. W. O. Thompson, Secretary, Buffalo, N. Y.

The proceedings of this association continue to increase in size and value each year and the last one is filled with suggestions and reports on appliances for locomotives, all tending towards better locomotive service on American railways. The subjects considered by the association are, in general, those with which they are more familiar and better informed than any other railroad men and hence the ones on which the opinion of the members is of the greatest value. Among the subjects discussed are reports on The amount of territory a road foreman of engines should cover; Tests to locate defects of the new types of locomotive brakes and remedies for them; Service of superheaters on locomotives; Best method for training firemen in the proper methods of firing; Discussion on electric locomotives; How road foremen can best assist in increasing railway net earnings; Influence of education on engine men; Steam reversing gears; Size of air pump exhaust, etc. This association now has a total membership of 656. The proceedings include a list of all members with their post office addresses.

## PERSONALS.

H. Carrick has been appointed assistant division master mechanic of the Oregon Short Line, with office at Pocatello, Idaho.

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Frank Rusch has been appointed master mechanic of the Chicago, Milwaukee & St. Paul lines west of Butte, with office at Seattle, Wash.

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James McBrian has been appointed district car inspector, Choctaw district, of the Chicago, Rock Island & Pacific Ry., with office at Argenta, Ark.

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E. F. Jones, acting master mechanic of the Chicago & Western Indiana Ry., has been appointed master mechanic, with office at Chicago, succeeding P. H. Peck.

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G. W. Rink, chief draughtsman of the Central Railroad of New Jersey, has been appointed mechanical engineer, with office at Elizabethport shop, succeeding Mr. Flory.

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F. C. Fosdick, assistant master mechanic of the Chicago and Northwestern Ry. at Chicago, has been appointed master mechanic of the Iowa and Minnesota divisions at Mason City, Ia.

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R. Emerson, assistant engineer of methods of the Santa Fe at Topeka, has resigned to become assistant to the general manager of the Lehigh Valley, with headquarters at So. Bethlehem, Pa.

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William Hutchinson, master mechanic of the Iowa and Minnesota divisions of the Chicago and Northwestern Ry., at Mason City, Ia., has been appointed master mechanic of the Ashland division at Kaukauna, Wis.

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S. C. Graham, master mechanic of the Ashland division of the Chicago and Northwestern Ry. at Kaukauna, Wis., has been appointed master mechanic of the lines west of the Missouri river at Missouri Valley, Ia.

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E. W. Pratt, master mechanic of the Chicago and Northwestern Ry. lines, west of the Missouri river at Missouri Valley, Ia., has been appointed assistant superintendent of motive power and machinery, with office at Chicago.

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E. A. Walton, division superintendent of motive power of the New York Central and Hudson River R. R. at Albany, has retired, and his duties have been assumed temporarily by Mr. Daniel R. MacBain, assistant superintendent of motive power at that place.

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Edgar B. Thompson, assistant superintendent motive power and machinery of the Chicago & Northwestern Ry., has been appointed superintendent of motive power and machinery of the Chicago, St. Paul, Minneapolis & Omaha Ry., succeeding John J. Ellis, retired on account of having reached the age limit provided for in the pension system of the company.

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D. Gallaudet, master mechanic of the Chicago division of the Baltimore & Ohio R. R., has been appointed master mechanic of the Grand Junction Terminal of the Denver & Rio Grande Ry., with jurisdiction over the second district, second division; also that portion of the second district of the third division between Grand Junction, Somerset and Montrose, with office at Grand Junction, Col.

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The office of superintendent of motive power, second division, of the Atlantic Coast Line, has been moved from Savannah, Ga., to Waycross. N. E. Sprowl, master mechanic at Savannah, has been appointed shop superintendent at Waycross, and W. J. Pamplin has been appointed master mechanic of the Savannah and Waycross districts, with office at Waycross, and jurisdiction over the forces at Savannah, Ga., Jesup, Brunswick, Thomasville, Albany and Waycross, including enginemen and firemen assigned to these districts.

J. F. Bowden, master mechanic of the Baltimore & Ohio R. R. at Parkersburg, W. Va., has been appointed master mechanic of the Chicago division, with office at Garrett, Ind., succeeding D. Gallaudet.

B. P. Flory, mechanical engineer of the Central of New Jersey, has been appointed superintendent of motive power of the New York, Ontario & Western Ry., succeeding G. W. West, deceased. Mr. Flory was born at Susquehanna, Pa., on November 9, 1873. He graduated from Cornell University in the class of 1895, and before beginning railway work was for about three years a draftsman for the Anaconda Copper Mining Co. His first railway position was that of inspector on the Lehigh Valley, which position he took in 1899. He was later made chief draftsman, and in November, 1902, was made mechanical engineer. In 1903 he was transferred to a special staff, doing work pertaining to the, at that time, new shops at Sayre, Pa. In March, 1904, he was appointed mechanical engineer of the Central of New Jersey, which position he held until his recent appointment. Mr. Flory has designed and invented a number of motive power and rolling stock improvements now in successful operation.

## CATALOGS

### IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Car Interchange Manual.—The McConway & Torley Company, 48th Street and A. V. Ry., Pittsburgh, are issuing a car interchange manual which contains a complete epitome of all the decisions of the arbitration committee of the M. C. B. Association up to date. Supplements are issued from time to time to cover the latest cases.

Pipe and Boiler Insulation.—A new catalog being issued by the H. W. Johns-Manville Company, 100 William street, New York, is devoted to a thorough presentation of the problems of insulating all kinds of heated and cold surfaces, such as pipes, boilers, flues, ducts, etc. as well as insulation for refrigerating and cold storage work.

Ventilating Dining Cars.—The General Railway Supply Company, 922 Marquette Building, Chicago, is issuing a leaflet discussing the proper ventilation of dining and private cars so as to overcome the serious objection of the kitchen odors permeating the other parts of the car. This problem has been solved by this company and the method is illustrated and described in this leaflet.

Electrical Apparatus.—The General Electric Company is issuing a number of new bulletins, each being the usual complete and satisfactory description of some particular electrical appliance manufactured by it. Among these might be mentioned No. 3647 on the subject of Tungsten lamps for battery service. These lamps are specially suitable for train lighting. No. 4638 is a guide for the design of medium and small capacity central station switchboards. No. 4628 describes the company's new mercury arc rectifier, which will operate on any frequency from 40 to 140 and can be supplied for operating on frequencies from 25 to 60.

Anvils and Vises.—Fisher and Norris, Trenton, N. J., are issuing a small catalog largely given up to illustrating and describing anvils of various kinds. Many of these are for special purposes and arranged for handy and accurate work. Under each is included a table giving the general dimensions for various sizes, with the weight in pounds and in some cases the prices. The same catalog also contains an illustration and a brief description of the Fisher double screw parallel leg vise which has many advantages for heavy work. A circular is also being sent out by the same company showing the new Fisher-Brooks bench vise which is made of the finest quality of cast iron with jaws of cast tool steel welded on by a patented process and properly tempered. This vise is made in various sizes, as shown by the list in the circular.

Finished Locomotive Parts.—A very attractive, standard size, catalog, is being issued by the Locomotive Finished Material Company, Atchison, Kans. This company is engaged in a new departure in the railroad field and are in a position to furnish finished locomotive castings of any size from a packing ring to a cylinder without delay and at a price which can compete with practically any existing railway shop. The catalog is largely given up to illustrations of the work turned out by this company and views of the shops and machinery owned by it. Parts which require fitting are left with sufficient material at that point to permit the proper adjustment being made. For instance, cylinders are finished complete except the saddle. Solid piston heads are left ¼ in. large in diameter and ⅛ in. small in rod fit. Shoes and wedges are finished except the box face, and so on for other locomotive parts. The catalog contains many convincing arguments on the advisability of procuring work in this manner instead of doing it in the regular locomotive shops.

## NOTES.

Errata.—It was erroneously stated in the January issue of this journal that the Cleveland Twist Drill Company was located in Cincinnati, O., instead of Cleveland.

Chicago Car Heating Company.—W. H. Hooper, formerly general agent of the Safety Car Heating and Lighting Company, has been appointed assistant to the president of the above company, with headquarters at the general office, Railway Exchange Building, Chicago.

Mrs. Frances A. W. McIntosh, formerly advertising manager of the Buffalo Forge Company and associate companies, has resigned that position to open an office at 103 Anderson Place, Buffalo, N. Y., where her services in the preparation and printing of advertising literature can be secured.

Dearborn Drug and Chemical Works.—Edward C. Brown, manager of the Hawaiian office of the above company at 42 Queens street, Honolulu, is making an extensive oriental trip during which he will visit Japan, China, Australia, Philippine Islands, Java and other important islands in the Pacific Ocean.

New Shops.—Large shops are being erected by the Caroline, Clinchfield & Ohio Railroad at Johnson City, Tenn. These will be the principal shops of the road and are to be equipped with modern machinery capable of handling the largest motive power. This road has been making a number of improvements and building large extensions during the past year and is contemplating other large extensions.

Tate, Jones & Company.—The large new works of the National Sanitary Mfg. Company, at Salem. O., have been equipped throughout with the "Kirkwood" system of fuel oil burning manufactured by the above company at Pittsburgh. This installation presented a number of unusual and difficult conditions for the burning of fuel oil and the satisfactory performance of the equipment has been very gratifying.

Joseph Dixon Crucible Company.—The December, 1908, issue of "Graphite" completed the tenth annual volume of this very interesting publication, which first appeared as a small sheet of four pages and has continued to grow in size and interest up to the present twenty and more pages, standard size, publication, which is welcomed by 15,000 subscribers and friends. It was one of the pioneers of the high grade house organ idea, that has lately become so popular.

American Steam Gauge & Valve Mfg. Co.—It is announced that John B. Guthrie is the sole representative of this company in the Pittsburgh district, having been appointed January 1, 1909. His offices are in the Columbia Bank Building, corner 4th avenue and Wood street, Pittsburgh. It is also announced that the southern branch of this company, which for several years has been located in the Equitable Building, Atlanta, Ga., has been removed to No. 524 Candler Building, in that city.

American Brake Shoe & Foundry Company.—Chas. R. Herron of Chattanooga, Tenn., late southern sales manager of the above company, died at his home on December 6, 1908. Mr. Herron was a highly respected citizen and well known business man of Chattanooga, with a host of friends throughout the south. He was born in Ireland in 1844 and came to America with his parents in 1848. His connection with the brake shoe business began in 1899, when he took charge of the Ross Mehan foundry at Chattanooga. He later became connected with the American Brake Shoe Company and in 1902 with the American Brake Shoe & Foundry Company, where he continued as southern sales manager until the time of his death.

American Locomotive Company.—This company has purchased a plot of 150 acres of land at Gary, Indiana, from the Gary Land Company, a subsidiary company of the United States Steel Corporation, and plans are being drawn for a new plant which it is said will be the most complete and best equipped locomotive works in the world. The land purchased is twice the extent of that occupied by the largest of its present plants and when fully occupied will give employment to from 12,000 to 15,000 workmen. The land adjoins that of the new plant of the United States Steel Corporation. This site was selected at Gary, 24 miles from Chicago, to provide for the territory where the largest number of railroads converge to a single commercial center. The Chicago district is a great railroad center and that district is rapidly developing in manufacturing importance, which renders it favorable as a location for securing material for building locomotives. This company now operates plants in Schenectady and Dunkirk, New York; Pittsburgh and Scranton, Pennsylvania; Richmond, Virginia; Paterson, New Jersey; Manchester, New Hampshire; and Montreal, Canada. At present there is no large locomotive plant west of Pittsburgh, and the selection of a location in the Chicago district provides additional locomotive building capacity where it is most needed for prompt and direct delivery to a large number of railroads. The size of the new plant will be sufficient to provide liberally for the growing needs of the railroads for years to come.

# MAINTENANCE AND REPAIR OF FREIGHT CARS.

## With Special Reference to Steel Equipment.

## PENNSYLVANIA RAILROAD AT ALTOONA.

### INTRODUCTORY.

During the past few years there have been many inquiries from railroad officials concerning the advisability of introducing steel underframe or all-steel freight equipment on their lines. As the price of lumber has advanced the difference between the first cost of the wooden and the steel car of the same type and capacity has steadily decreased. The weight of the all-steel equipment for the same capacity is less; its life is considerably greater and as far as the body of the car is concerned the cost of maintenance is very much less. To demonstrate how simple it is to maintain and repair steel freight cars an extensive study of the methods in use on the Baltimore & Ohio Railroad at Mt. Clair was presented in the May, 1907, issue of this journal, and of the McKees Rocks plant of the Pittsburgh & Lake Erie Railroad in the January, 1908, issue.

The Pennsylvania Railroad adopted modern all-steel freight cars somewhat earlier than the Baltimore & Ohio. The methods of repairing and maintaining these cars were considered on the latter road first, because it was doing the work with very few special facilities, thus making it possible to demonstrate to the officers, having the adoption of steel equipment under consideration, that the work could be done successfully with very little special equipment. As a matter of fact, although the Pennsylvania Railroad has a shop at Altoona for making the heavier repairs to steel cars, which is very convenient and greatly facilitates the repairing of these cars, yet a large proportion of the heavy repairs are being made successfully in the repair yards under conditions which are no more favorable than those on the Baltimore & Ohio at Mt. Clair. At the present time only a small part of the steel shop is being used for repairs, the greater portion of it being devoted to the building of underframes for new freight and passenger equipment. The number of steel cars repaired in the shop per month fluctuates, depending upon the new equipment which is under construction.

Freight cars are repaired at four different places in Altoona; *i.e.*, at the east and west bound repair yards, the steel shop and the freight shop. While the heavier and the greater part of the repairs to the steel cars are made at the west bound repair yard and in the steel shop, light repairs are also made to these cars at the east bound repair yard and in the freight shop.

Synopsis.



### THE ALTOONA YARDS.

To understand more clearly the relation of these four repair points to each other, it may be well to briefly study the general arrangement of the Altoona yards and the car shops, general plans of which are shown in Figs. 1 and 2. The Altoona yards consist of thirteen yards having 206.82 miles of track with 1,075 switches and a capacity for 10,500 cars. There are four humps, two on the west bound and two on the east bound tracks. As many as 169 trains, having 9,027 cars have been passed through the Altoona yards in one day.

The prevailing direction of heavy traffic is eastward, a large percentage of the west bound trains being made up of empties. West-bound freight trains enter the west-bound empty receiving yard, the loaded trains passing along the track at the north side of this yard and into the west-bound loaded receiving yard. After entering the receiving yard the locomotives and cabin cars are cut off and the cars are carefully examined by the inspectors. The hump between the receiving and classification yards for empty trains is ordinarily in operation about sixteen hours out of every twenty-four, and as many as 1,773 cars, requiring 654 cuts, have been passed over it from 6 A. M. to 6 P. M.

The operation of these yards has been improved and the number of damaged cars reduced by placing a searchlight at the hump, with a lens specially ground to include an angle to cover the extreme ladders at the head of the yard. The cars requiring repairs are shifted to special tracks in the classification yard, from which they are removed to the west-bound repair yard. After the west-bound trains are made up they are pulled to the west-bound advance tracks, where locomotives from the East Altoona roundhouse are attached and the air brakes are tested.

The cars in the loaded receiving yard, after they have been inspected, are shifted over a hump into the loaded classification yard. Cars requiring repairs are placed on a special track, from which they are taken to the west bound repair yard. The loaded trains, after they are made up, are taken to the west bound advance tracks, where the road engine is attached and brakes tested.

The east bound freight trains are handled in a similar manner. Certain tracks in the receiving yard are reserved for trains which are to be weighed, while others are used for trains

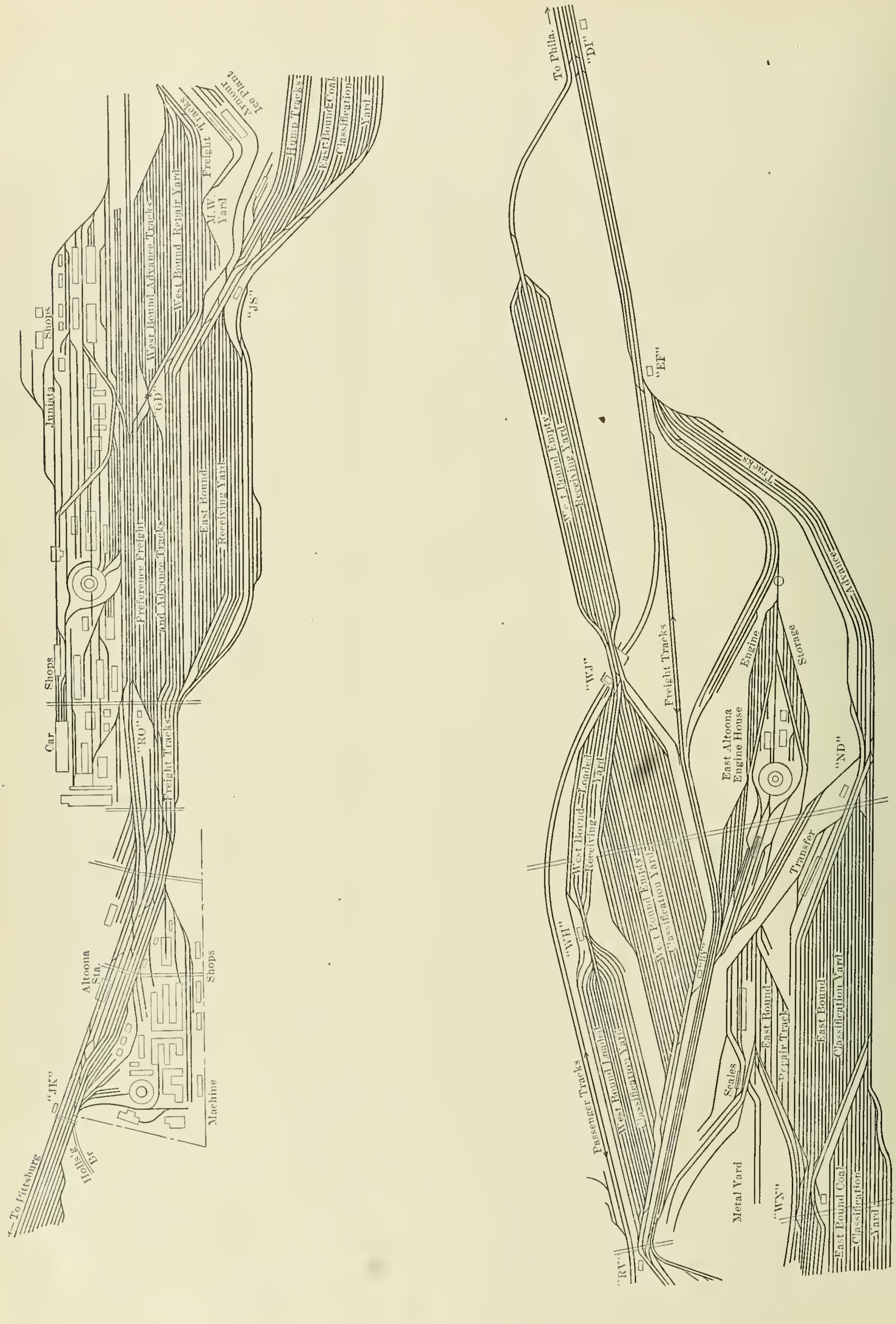


FIG. 1.—THE ALTOONA YARDS OF THE PENNSYLVANIA RAILROAD.

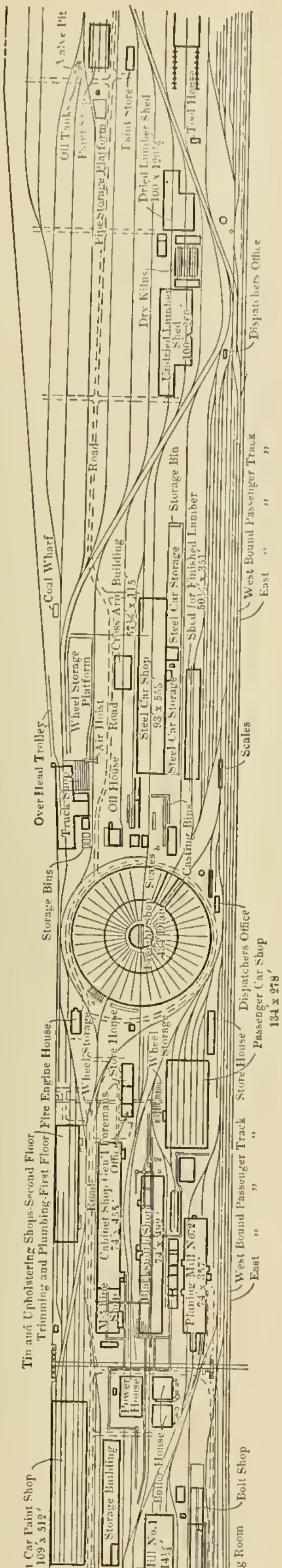


FIG. 2.—PLAN OF THE ALTOONA CAR SHOPS, PENNSYLVANIA RAILROAD.

that it is not necessary to weigh. The trains to be weighed are passed over a hump, and the scales, into what is designated as the east bound coal classification yard. The trains that it is not necessary to weigh are passed over a hump into the east bound classification yard. From the classification yards the cars are taken to the advance tracks and forwarded in the same way as the west bound trains. Cars requiring repairs are shifted to special tracks in the classification yards and are taken to the east bound repair yard.

Preference trains use the main freight tracks and are inspected and forwarded as quickly as possible. Cars in these trains requiring repairs are either shifted to a special track in the repair yard or are taken to the freight shop. The wrecking gang has its headquarters at the freight shop and takes care of the repairs of cars in preference trains which are received during the night.

As practically all of the cars going east are loaded, the east-bound repair tracks are specially equipped for handling loaded cars or transferring the loads. Ordinarily only slight repairs are made to the bodies of steel freight cars at this yard. If a car is received which requires heavy repairs the load is usually transferred and the car is forwarded to the steel car shop.

The heavier repairs to steel cars are supposed to be made in the steel shop, but at the present time it is being used largely for the building of new equipment. A large number of steel cars, many of them requiring comparatively heavy repairs, are being handled on the west-bound repair tracks. This work is done there very successfully, although, as will be shown, very little special equipment is used and conditions generally are not very favorable, since the yard is being used temporarily for this work and was not designed for repair yard purposes. Eventually the west-bound repair yard may be transferred to the space east of the Altoona roundhouse, between the main tracks and the advance tracks for the east-bound freight trains.

The freight shop is built in the form of a roundhouse, with a turntable at the center, and because of the difficulty in shifting cars in and out is used mostly for the heavier repairs to wooden cars and for repairing cars from the preference trains received during the night. Repairs to the trucks of steel cars may be made on any of the tracks in this house, but repairs to the body, or repairs requiring the driving of rivets, can be made on only a few of the tracks, alongside of which rivet heating furnaces have been placed.

## PENNSYLVANIA RAILROAD STEEL FREIGHT CAR EQUIPMENT.

The first steel cars built by the Pennsylvania Railroad were the special flat cars constructed in 1887 for carrying wire cables for cable railroads. These are known as the Fd class and were designed to carry a concentrated load of 120,000 lbs. The Fe cars, built in 1889, were similar except that the capacity was 20,000 lbs. less. The Fg cars were built in 1892 and were designed for transporting heavy guns. One of these cars has a capacity for carrying 140,000 lbs. and consists of two small four-wheel cars with a bridge. The other has a capacity for 285,000 lbs. and consists of four small four-wheel cars with three bridges (American Engineer, May, 1893, page 218).

In 1896 the Pennsylvania designed the Gm steel gondola cars (American Engineer, October, 1903, page 352). Five of these cars were built by the Schoen Pressed Steel Company and delivered in June, 1898. As it is necessary to shovel part of the load through the drop doors these cars have not been very popular, although from the standpoint of maintenance they have given splendid results. No side sills were used, the sides acting as trusses to assist in carrying the load.

In July, 1898, the first Gl steel hopper cars went into service. This design was the result of conferences between the mechanical officials of the Pennsylvania Railroad, the Pennsylvania Lines West and the Schoen Company. The details of the car were largely developed by the Schoen Pressed Steel Company and were mostly of pressed steel. A large number of these cars were built during the following four or five years and were carefully watched and studied by the railroad officials. Based

## ALL-STEEL FREIGHT CARS—PENNSYLVANIA RAILROAD

DECEMBER 31, 1908

| Kind. | Class. | Capacity | 1887 | 1889 | 1892 | 1898 | 1899 | 1900 | 1901 | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | Total | No Cars Destroyed Since Placed in Service | Described in "American Engineer" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flat Cars, Special. | Fd | 120,000 | 1 | | | | | | | | | | | | | | 1 | | |
| | Fe | 100,000 | | 1 | | | | | | | | | | | | | 1 | | |
| | Fg[1] | 140,000 | | | 1 | | | | | | | | | | | | 1 | | |
| | Fg[2] | 285,000 | | | 1 | | | | | | | | | | | | 1 | | May, 1893, p. 218. |
| | Fn | 120,000 175,000 | | | | | | | 2 | | | | | | | | 2 | | June, 1904, p. 209. |
| Flat Cars. | Fl | 80,000 | | | | | | | 498 | | | | | | | | 498 | | Oct., 1903, p. 354. |
| | Fm | 100,000 | | | | | | | | 38 | 769 | 71 | | | 7 | | 885 | 2 | Dec. 1905, p. 436. |
| Hopper Cars. | Gl | 100,000 | | | | 819 | 441 | 532 | 2831 | 4437 | 2711 | | | | | | 11,771 | 5 | Oct. '03, p. 352; Dec., '03, p. 435. |
| | Gl | 110,000 | | | | 251 | 104 | 118 | 392 | 537 | 437 | | | | | | 1,839 | | |
| | Gla | 100,000 | | | | | | | | | | | 1498 | 778 | 6077 | 235 | 8,588 | | May, 1905, p. 148. |
| | Gla | 110,000 | | | | | | | | | | | 2 | | 1 | | 3 | 1 | |
| | Gm | 100,000 | | | | 5 | | | | | | | | | | | 5 | | Oct. '03, p. 352; Nov. '03, p. 402. |
| Long Gondola. | Gsa | 100,000 | | | | | | | | 480 | 486 | 497 | 137 | 60 | | | 1,660 | | Jan., 1906, p. 11. |
| | Gsd | | | | | | | | | | | | 270 | 15199 | 1450 | | 16,919 | 2 | |
| Coke Gondola. | Gp | | | | | | | | | | | | | | | | | | Oct., 1905, p. 359. |
| | Gpa | 100,000 | | | | | | | | | | | 200 | | | | 200 | | Oct., 1905, p. 359. |
| | Gsa | 100,000 | | | | | | | | 13 | 46 | 39 | 3003 | | | | 3,101 | | Jan., 1906, p. 11. |
| | Gsd | | | | | | | | | | | | 30 | 1270 | 1000 | | 2,300 | | |
| Total | | | 1 | 1 | 2 | 1075 | 545 | 650 | 3723 | 5505 | 4449 | 607 | 5140 | 17307 | 8535 | 235 | 47,775 | 10 | |

Fd and Fe were specially designed for carrying wire cables.

Fg[1] and Fg[2] were designed for carrying large guns, Fg[1] has two small four-wheel cars connected with a bridge, and Fg[2] has four small four-wheel cars, connected with three bridges.

Fn is a special car with a well-hole.

The main difference between the Gl cars of 100,000 lbs. capacity and those of 110,000 lbs. capacity is that the former have cast iron wheels and the latter rolled steel wheels. This is also true of the Gla cars.

## GENERAL DIMENSIONS OF ALL-STEEL FREIGHT CARS—PENNSYLVANIA RAILROAD.

| Class | Fd | Fe | Fg[1] | Fg[2] | Fn | Fl | Fm | Gl | Gla | Gm | Gsa | Gsd | Gp | Gpa |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capacity | 120,000 | 100 000 | 140 000 | 285,000 | 120,000 175,000 | 80,000 | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 |
| Weight | 51,800 | 51,000 | 72,900 | 175,000 | 43,300 | 31,500 | 39,000 | 39,200 | 39,050 | 33,800 | 40,200 | 40,000 | 52,950 | 50,355 |
| Face to face of coupler | 42′ 2″ | 42′ 2″ | 57′ 10″ | 89′ 4″ | 39′ 11″ | 41′ 11½″ | 41′ 11″ | 34′ 11½″ | 34′ 2″ | 32′ 2″ | 41′ 11″ | 41′ 11″ | 43′ 11″ | 43′ 11″ |
| Extreme Width | 7′ 11″ | 7′ 11″ | 8′ 3½″ | 9′ 10″ | 10′ 0″ | 9′ 11½″ | 9′ 11½″ | 10′ 1½″ | 10′ 1⅜″ | 10′ 1″ | 9′ 11½″ | 9′ 11½″ | 10′ 0″ | 10′ 0″ |
| Height from rail to top of sides | Flat | Flat | Flat | Flat | Flat | Flat | Flat | 10′ 0″ | 10′ 0″ | 10′ 0″ | 7′ 2″ | 7′ 2″ | 12′ 0″ | 12′ 5″ |
| Length inside body | " | " | " | " | " | " | " | 31′ 6¼″ | 30′ 5″ | 28′ 6″ | 38′ 2½″ | 37′ 2½″ | 40′ 2⅛″ | 40′ 2⅛″ |
| Width inside body | " | " | " | " | " | " | " | 9′ 6″ | 9′ 6″ | 9′ 5½″ | 9′ 3½″ | 9′ 3½″ | 9′ 4⅝″ | 9′ 4⅝″ |
| Length outside body | 39′ 2″ | 39′ 2″ | 55′ 7″ | 87′ 7″ | 38′ 0″ | 40′ 0″ | 40′ 0″ | 32′ 1″ | 31′ 0½″ | 29′ 0″ | 38′ 3″ | 38′ 3″ | 40′ 9⅝″ | 40′ 9½″ |
| Width outside body | 7′ 11″ | 7′ 11″ | 7′ 6″ | 9′ 10″ | 10′ 0″ | 9′ 3″ | 9′ 0″ | 10′ 1½″ | 10′ 1⅜″ | 10′ 8″ | 9′ 4″ | 9′ 4″ | 10′ 0″ | 10′ 0″ |
| Height of sides above floor | Flat | Flat | Flat | Flat | Flat | Flat | Flat | 6′ 6″ | | 6′ 2¼″ | 3′ 9″ | 3′ 9″ | | |
| Total wheel base | 35′ 0″ | 35′ 0″ | 48′ 3″ | 80′ 3″ | 33′ 6″ | 34′ 6′ | 35′ 6″ | 28′ 9″ | 27′ 9″ | 25′ 7″ | 35′ 6″ | 35′ 6″ | 37′ 6″ | 37′ 6″ |

## FREIGHT CARS WITH STEEL UNDERFRAMES—PENNSYLVANIA RAILROAD

DECEMBER 31, 1908

| Kind. | Class | Capacity | 1901 | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 | Total | Number Cars Destroyed Since Being Placed in Service | Described in the "American Engineer" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Box | Xl | 100,000 | 986 | 3,172 | 1,529 | 891 | 701 | 5,308 | 3.652 | 3,441 | 19,680 | 51 | Oct. '03, page 354. Jan. '04, page 3. |
| | Xla | 100,000 | | 748 | | | | | | | 748 | 2 | |
| | Xlb | 100,000 | | | | | 10 | | | | 10 | | |
| | Xlc | 100,000 | | | | | | 100 | | | 100 | | |
| | Xm | 100,000 | | | | 4 | 3 | 5 | 4 | | 16 | | |
| Long Gondola | Gr | 100,000 | | 6,315 | 4,093 | 227 | 3,149 | 134 | | | 13,918 | 2 | Dec. '05, page 436. |
| | Gra | 100,000 | | | | | | | | 1,000 | 1,000 | | |
| Tank | Ad | | | | | | | | | | | | |
| Stock | Kf | 100.000 | | | | 44 | 94 | | 14 | | 152 | | |
| Refrigerator | Rf | 100.000 | | 1 | | 542 | 781 | 1,155 | 169 | 27 | 2,675 | 6 | Jan. '04 page 3. |
| Cabin | Nd | | | | 1 | 29 | 219 | 281 | 279 | 59 | 868 | 5 | June, '04, page 210. |
| Total | | | 986 | 10,236 | 5,623 | 1,737 | 4,957 | 6,983 | 4,118 | 4,527 | 39,167 | 66 | |

NOTE—Gra is 40 feet long inside, holding two lengths of 20-foot tube. It was specially designed for this purpose.

## GENERAL DIMENSIONS OF STEEL UNDERFRAME FREIGHT CARS—PENNSYLVANIA RAILROAD.

| Class | Xl | Xla | Xm* | Gr | Gra | Ad | Kf | Rf | Nd |
|---|---|---|---|---|---|---|---|---|---|
| Capacity | 100,000 | 100,000 | 100,000 | 100,000 | 100.000 | 12,000 gal. | 100,000 | 90,000 | |
| Weight | 45,300 | 44,200 | 53,200 | 44,000 | | 41,000 | 47,100 | 56,900 | 28,000 |
| Face to face of coupler | 40′ 5″ | 40′ 5″ | 40′ 5″ | 41′ 11″ | 44′ 11″ | 38′ 11″ | 40′ 5″ | 40′ 5″ | 27′ 10¼″ |
| Extreme width | 9′ 10″ | 9′ 10″ | 9′ 10″ | 9′ 11⅞″ | 9′ 11⅞″ | 10′ 0″ | 10′ 0⅝″ | | 10′ 5⅝″ |
| Height from rail to top of sides | | | | 6′ 4⅜″ | 6′ 4⅜″ | | | | |
| Length inside body | 36′ 0″ | 36′ 0″ | 32′ 5¼″ | 37′ 8¼″ | 40′ 8″ | 33′ 5¼″ | 35′ 11¼″ | 30′ 0¼″ | 20′ 4¼″ |
| Width inside body | 8′ 6″ | 8′ 6″ | 8′ 6″ | 8′ 9″ | 8′ 9″ | 7′ 11⅝″†† | 8′ 5¼″ | 8′ 4″ | 8′ 2¼″ |
| Length outside body | 37′ 1½″ | 37′ 1½″ | 37′ 1½″ | 38′ 3″ | 41′ 3″ | 37′ 0″ | 36′ 11¾″ | 37′ 1½″ | 21′ 0″ |
| Width outside body | 9′ 4½″ | 9′ 4½″ | 9′ 4½″ | 9′ 4″ | 9′ 4″ | 10′ 0″ | 9′ 4½″ | 9′ 4½″ | 9′ 1¾″ |
| Height of sides above floor | 8′ 0″† | 8′ 0″† | 7′ 6⅓† | 2′ 6″ | 2′ 6″ | | 8′ 0¼″† | 7′ 6″† | |
| Total wheel base | 34′ 0″ | 34′ 0″ | 34′ 0″ | 35′ 6′ | 38′ 6″ | 32′ 6″ | 34′ 0″ | 34′ 0″ | 13′ 6″ |

* Produce. † Height inside. †† Diameter of tank.

(*See page 85 for Freight Car Classification.*)

FIG. 3.—OLD WOODEN FREIGHT CARS BEING DISMANTLED AT THE METAL YARD PREPARATORY TO BEING BURNED.

upon the experience thus gained the Gla and the other types of all-steel and steel underframe cars were designed.

The weakest point on the Gl cars proved to be the center sills, which were of pressed steel, 10 in. deep at the bolster. The cross-sectional area through the center sills at that point is only 12¾ sq. in. On the Gla and other types of cars which followed the cross-section was never allowed to be under 23 sq. in., and in most cases is considerably higher. The center sills on the Gl cars give considerable trouble directly back of the bolster. The rear draft lugs of the Westinghouse friction draft gear practically reach to the bolster and there is thus no opportunity for the sill to buckle in front of it.

The Gla cars (American Engineer, May, 1905, page 148) are built principally of structural steel, the center sills being 10 in. channels, in place of the fish-bellied pressed steel sills used on the Gl. The center sills are reinforced by cover plates and also by angles at the lower flanges between the bolsters. There are no side sills between the bolsters, the sides being utilized to assist in carrying the load, as on the Gm cars. The Gla cars, although much stronger than the Gl class, weigh less. The increased strength lies mainly in the increased sectional area of center sill. They are seldom to be found upon the repair tracks for heavy repairs, but when this occurs, they are not so easily repaired as if of pressed shapes since the latter are more easily restored to their former shape while the structural shapes are inclined to break.

FREIGHT CAR CLASSIFICATION.

Each class of car is designated by a primary letter and the different styles of each class are designated by affixing to the primary letters other letters in alphabetical order. The primary letters used to designate freight cars are as follows:

A—Tank
F—Flat
G—Gondola
K—Stock
N—Cabin
R—Refrigerator
X—Box

The center sills are reinforced by diagonal braces extending from the end sill, near the center, to the side sills at the bolster (American Engineer, May, 1905, page 148). It is customary on some roads to have this brace extend from the corner of the car to the center sill at the bolster, but since it is a comparatively simple matter to repair the corner it is believed to be better practice to place it so that it will reinforce the center sills.

It is practically impossible to design a steel car which cannot be damaged by rough handling and it would not be economy to do so if it was possible. Heavier power and the introduction of hump yards have greatly increased the severity of the service to which freight cars are subjected. Trainmen should be made to realize that the careful handling of equipment is an important factor in keeping down the cost of repairs. Poorly designed car unloading machines and careless handling of cars upon them is responsible for much damage. It would be folly for the designer to attempt to design cars to stand all the abuse which they might receive from these causes. The best interests of the railroad will be conserved by the removal of such abuses rather than by trying to build a car which will stand them. The later Pennsylvania cars are designed to stand end shocks of 300,000 lbs. every day, and occasional end shocks of 500,000 lbs. Thus far no serious defects have developed in any of the steel cars other than the Gl hopper cars.

A detail description of the design of the different types and classes of steel cars will be found in connection with a series of articles on "Steel Car Development on the Pennsylvania Railroad,"[1] which appeared in the American Engineer during 1903, '04, '05 and '06. Particular reference to these articles will be found in the accompanying tables, which show the number of cars of each type of both all-steel and steel underframe cars in service on the Pennsylvania Railroad at the beginning of this year; also the year they were placed in service and the total number of each class which have been destroyed.

The Pennsylvania Railroad has 157,823 freight cars, of which 47,775 are of all-steel construction; 39,167 are wooden cars with steel underframes and the remainder are of wood. Thus 30.3 per cent. of the equipment is of all-steel construction and 24.8 per cent. has steel underframes. General dimensions and data for these cars[2] will be found on page 84.

## THE PASSING OF THE WOODEN CAR.

The high capacity steel car has proved to be much more economical than the lower capacity wooden car. The steel cars are much stronger and may be handled more roughly without injury. The lower capacity wooden cars are not only more liable to injury when mixed in a train with steel cars, but they increase the chance of damage to the steel equipment. For these reasons the Pennsylvania Railroad decided a few years ago to destroy 12,000 wooden cars which, although in good condition, were of low capacity.

In addition the larger capacity wooden cars which require re-

[1] A study of the development in the design of steel cars on the Baltimore & Ohio Railroad will be found in the May, 1907, issue, page 163.
Some suggestions as to improvements in the construction of steel cars will be found on page 402 of the October, 1908, issue. These were made by G. E. Carson in a paper read before the Railway Club of Pittsburgh.

[2] Similar data for steel cars on the Baltimore & Ohio will be found on page 161 of the May, 1907, issue.

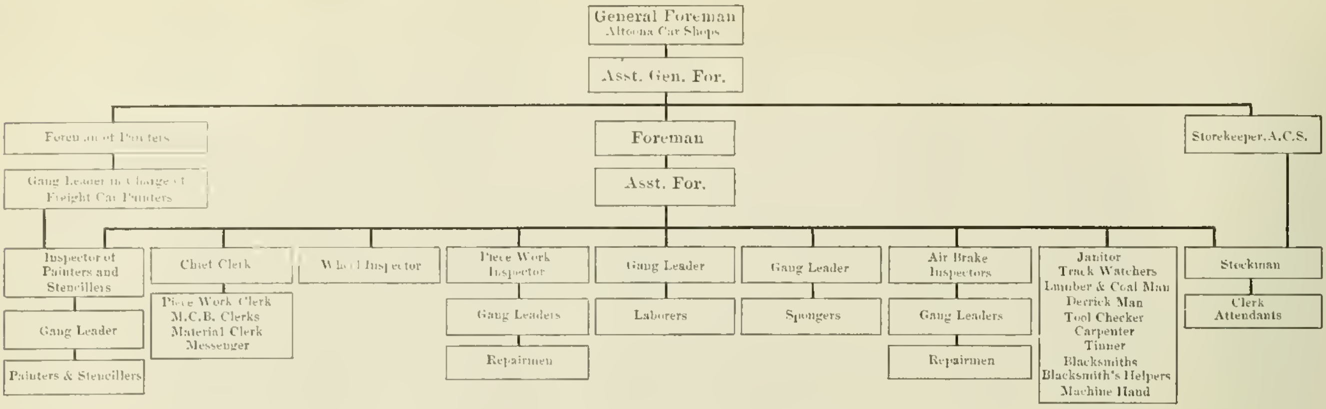


FIG. 5.—DIAGRAM SHOWING THE ORGANIZATION OF THE WEST-BOUND FREIGHT CAR REPAIR YARD.

pairs are looked over very carefully, and if the estimated repairs are considered too high they are destroyed. During the past three years over 18,000 of the wooden cars have been removed from service and destroyed. At Altoona such cars are taken to the metal yard and the air brakes, draft rigging, trucks and metal roofing are removed. If any of the longitudinal sills are in first-class condition they are removed and the remaining portion of the car is then burned, the metal scrap being gathered afterward. One of the illustrations, Fig. 3, shows a number of these cars which have been or are being stripped and are to be burned during the night.

### THE LIFE OF STEEL CARS.[3]

It is practically impossible to obtain figures which will give a fair comparison as to the life and the cost of maintenance of steel and wooden cars.[4] In the first place, although steel cars have been in general use since 1898, they are, generally speaking, still in first-class condition, and while the cost of repairing the bodies of the Gl hoppers may be quite large, because of the weak design of center sills, this defect has been remedied on the later designed cars.

Thus far the matter of corrosion[5] has not become serious. While a number of the hopper sheets near the drop doors have rusted through, this is about the only part of the cars that has given serious trouble in this way, and such cases have been comparatively few. The cause of this corrosion seems to be that the moisture in passing down through the coal combines with the sulphur in the coal, forming a dilute sulphuric acid, which attacks the sheets and eats them much more rapidly than a stronger solution would. Where the cars are in constant service and are not allowed to lie on the side tracks the matter of corrosion is so slight as not to warrant consideration, but if the cars are not kept in constant use or are allowed to stand for any length of time with loads of coal or cinders, and these become damp, the sheets become more or less badly corroded. As all of the moisture in the cars drains off through the hopper doors, it does not come in contact with the underframes, and on all classes of steel cars these are practically in as good condition as when the cars were placed in service, as far as corrosion is concerned.

The life of a car will, of course, depend upon the service in which it is used. The floor and hopper sheets, in addition to being subjected to the above conditions, causing corrosion, receive more or less severe treatment while the cars are being loaded, especially where coal or ore is dropped from a tipple. It is estimated, however, that these sheets will not require renewal inside of 12 or 15 years from the time they are placed in service. Some of the more recently designed cars have floor sheets ¼ in. thick, while the side sheets, which do not deteriorate so rapidly, are only 3/16 in. thick.

It is variously estimated that the steel car will last from 1½ to 2 times as long as the wooden car and that during the life of the car the repairs to the body of the steel car will be less than those to the body of the wooden car during its life.

The indestructibility of the steel car may be judged from the fact that of the 47,775 all-steel cars now in service, 1,075 of which have been in use since 1898, only seven cars have been destroyed.[6] Two of these were lost in a flood in Kansas and most of the others were destroyed on foreign lines. It is quite probable that they would have been repaired and again placed in service if the damage had occurred on a road with facilities for handling steel car repairs. Of the 39,167 cars with steel underframes 66 have been destroyed. A large portion of these were box cars. Where the superstructure is badly damaged and catches on fire the underframe is often in such condition as to make it unwise to rebuild the car.

While the bodies of the steel cars cost less to maintain than do the bodies of the wooden cars, the wheels are much more expensive to maintain, because of the higher capacity of the steel cars. The limit of the cast iron wheel, at least as it is at present constructed, has been passed for the high capacity car, and there is an imperative need for a much better wheel. The steel car, because of its high capacity and the fact that it is handled more roughly than the wooden car, and that it is less elastic in itself than a wooden car, requires a stronger draft gear of high capacity.

### THE PENNSYLVANIA SYSTEM FREIGHT CAR POOL.

On August 1, 1891, the various lines composing the Pennsylvania System formed a freight car pool. Each road keeps an accurate record of the amount of money spent for repairs to cars in the pool and the freight car mileage. Based on this mileage the cost of repairs is prorated among the different lines. In December, 1908, the Pennsylvania System had about 130,000 all-steel and steel underframe cars in service. This is about 53 per cent. of its equipment.

### ORGANIZATION OF THE CAR DEPARTMENT AT ALTOONA.

The Altoona car shops and repair yards are in charge of a general foreman who reports to the division superintendent motive power. The various foremen reporting to the general foreman and his assistant are shown on the accompanying diagram, Fig. 4.[7]

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[3] See page 157 of the May, 1907, issue.

[4] The Union Pacific System and the Southern Pacific Company have records of the cost of maintenance of a large number of steel and wooden cars of about the same age and capacity. These statistics, covering a period of 2½ years, will be found on page 270 of the July, 1907, issue. They show a large difference in favor of the steel car.

The comparative cost of repairing certain parts of steel and wooden cars on the Baltimore & Ohio is given on page 172 of the May, 1907, issue.

Data showing the relative cost of heavy repairs to steel and wooden cars on the Pittsburgh & Lake Erie Railroad will be found on page 403 of the October, 1908, issue.

Interesting data concerning the cost of repairing 50-ton steel hopper cars is given on page 17 of the January, 1907, issue.

[5] See page 157 of the May, 1907, issue.

[6] Similar information for the B. & O. is given on page 159 (second column) of the May, 1907, issue.

[7] This organization covers, in addition to the work of freight car repairs, the building of new freight equipment and the construction and repairs of passenger and other equipment cars, as well as the preparation of a large amount of supplies and repair parts for other shops.

In the steel car shop the foreman has an assistant and the force is divided into gangs, the various gang foremen reporting to the foreman and his assistant. This is also true of the freight shop.

The organization of the west bound repair yard, which is quite similar to that of the east bound, is shown on the accompanying diagram, Fig. 5. It will be noted that while both the foreman painter and the storekeeper report direct to the general foreman, their representatives at the repair yard are also under the jurisdiction of the local foreman and his assistant, as is indicated on the diagram.

General Foreman — Assistant General Foreman —

- General Office Force
- Shop Clerk
- Storekeeper
- Foreman East Bound Repair Yard
- Foreman West Bound Repair Yard
- Foreman Metal Yard
- Foreman Lumber Yard
- Foreman Steel Car Shop
- Foreman Truck Shop
- Foreman Freight Shop
- Foreman Passenger Shop
- Foreman Blacksmith Shop
- Foreman Cabinet Shop
- Foreman Machine Shop
- Foreman Plumbing Shop
- Foreman Upholstering Shop
- Foreman Tin Shop
- Foreman Paint Shop
- Foreman Buffing Room
- Foreman Bolt Shop
- Foreman Planing Mill No. 1
- Foreman Planing Mill No. 2
- Foreman Laborers
- Foreman Carpenters
- Foreman Car Inspectors
- Yard Master of Car Department
- Chief P. R. R. Fire Department
- Head Watchman
- Police Officers
- Two Inspectors attached to General Foreman's Office.

FIG. 4.—GENERAL ORGANIZATION OF THE ALTOONA CAR SHOPS.

CARS REPAIRED AT ALTOONA DURING DECEMBER, 1908.

| | Steel Cars | | | | Wooden Cars | Total of All Cars |
|---|---|---|---|---|---|---|
| | Hopper | Gondola | Steel Under-Frame | Total | | |
| East Bound Repair Yard | 1,164 | 302 | 352 | 1,818 | 1,809 | 3,627 |
| West Bound Repair Yard | 1,106 | 195 | 326 | 1,627 | 1,898 | 3,525 |
| Freight Shop | 116 | 84 | 206 | 406 | 1,420 | 1,826 |
| Steel Shop | 226 | 35 | 9 | 270 | 24 | 294 |
| Total | 2,612 | 616 | 893 | 4,121 | 5,151 | 9,272 |

## STEEL CAR SHOP.[8]

The steel car shop is directly east of the freight shop, as shown on the general plan of the car shops, Fig. 2. It is 93 ft. wide by 553 ft. long, and has a steel frame, the roof consisting of slate on white pine sheathing, supported by 12 in., 25 lb. channels. The sides and ends of the building are covered with corrugated galvanized iron. As may be seen from the drawings and photographs, the windows form a large part of the side and end walls, furnishing splendid lighting. Additions near the middle of one side of the building contain the office, tool room and store room. The building is arranged so that, if necessary, extensions may be added on each side in the future. There is ample space for the storage of castings, steel parts and dies and formers at the ends and side of the shop.

### THE EQUIPMENT.

There are three Shaw electric traveling cranes of 12½ tons capacity each. The width of the crane span is 87 ft. and the distance from the floor to the top of the crane run-way is 26 ft. Along one side of the shop and extending about two-thirds of its length a number of tools are arranged, which are used for new work only; these include two hydraulic riveters with a 10 ft. 6 in. gap, made by the Chambersburg Engineering Company. Also two hydraulic riveters of 50 tons capacity, with a 24 in. gap and a 6 in. stroke, made by the same company. There are three portable riveters of different types used in connection with a jib crane attached to one of the wall columns.

Two electric traveling hoists, having a capacity of 3 tons each and a lift of 16 ft. 6½ in. furnished by Pauling & Harnischfeger, operate on a run-way placed alongside the wall and underneath the large traveling crane run-way. These handle the material for the gap riveters. On the other side of the shop is a No. 2 rapid action, automatic stop Hilles & Jones punch, having a 20 in. throat and with a jib crane above it. Located near this is a radial drill. At one corner of the shop is an accumulator and a triple plunger single acting pump made by the Chambersburg Engineering Company, and having a capacity of 60 gallons per minute at a pressure of 1,500 lbs. per square inch. It is driven by a 65 h.p. motor geared direct to it. This pump and accumulator furnish hydraulic pressure for the riveters and also for a large press which has just been installed south of the shop (Fig. 10). This press is used to form the larger pressed parts used on both the freight and passenger car equipment. It was furnished by the Chambersburg Engineering Company and measures 10 ft.

[8] See January, 1908, issue for a description of the steel car repair shop at McKees Rocks on the P. & L. E. R. R.

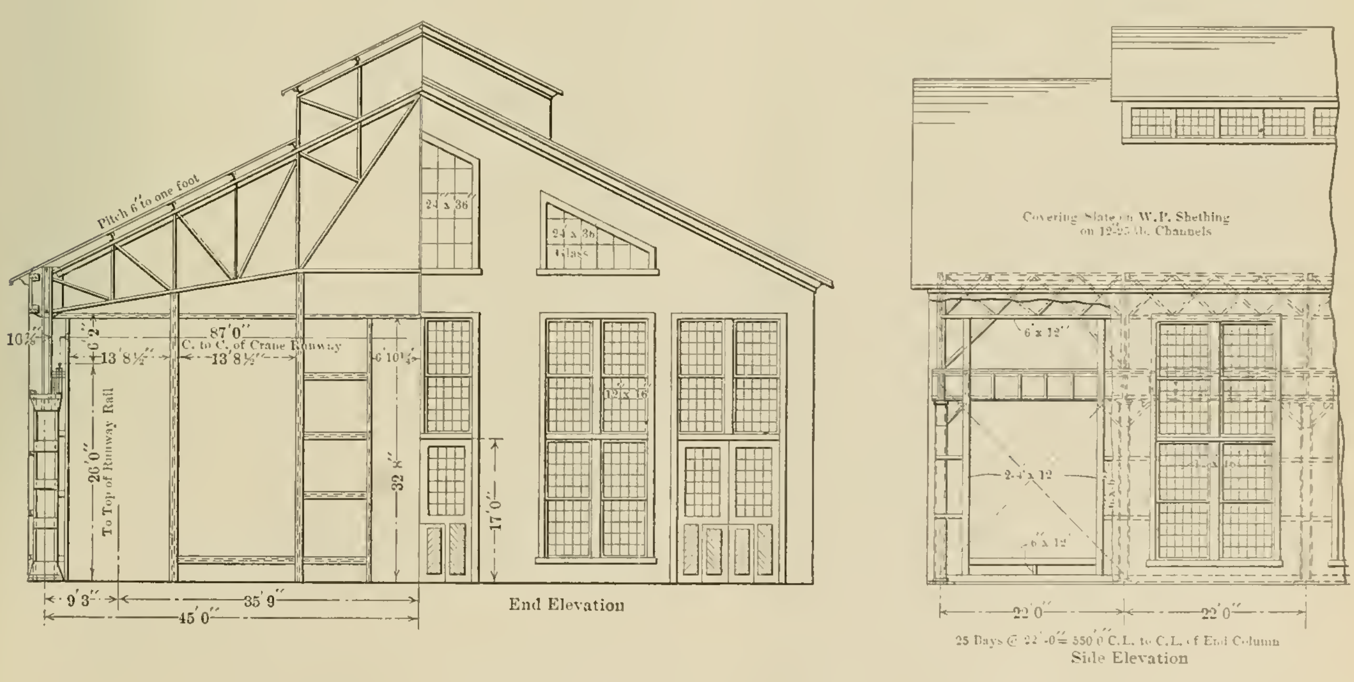



FIG. 6.—STEEL CAR SHOP AT ALTOONA.

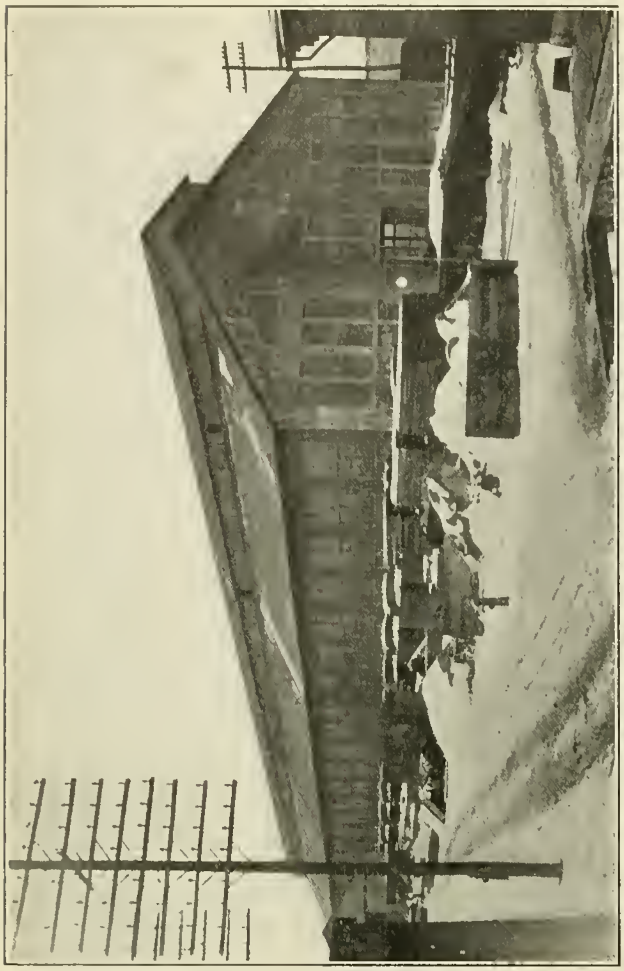


FIG. 7.—THE STEEL CAR SHOP, LOOKING FROM THE TRUCK SHOP.

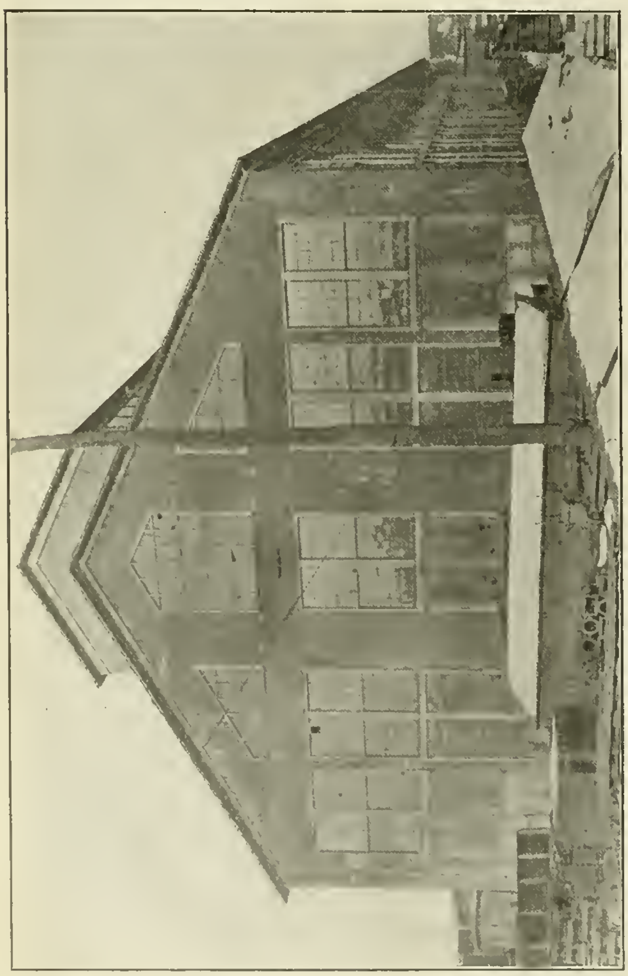


FIG. 8.—THE STEEL CAR SHOP, LOOKING FROM THE FREIGHT SHOP.

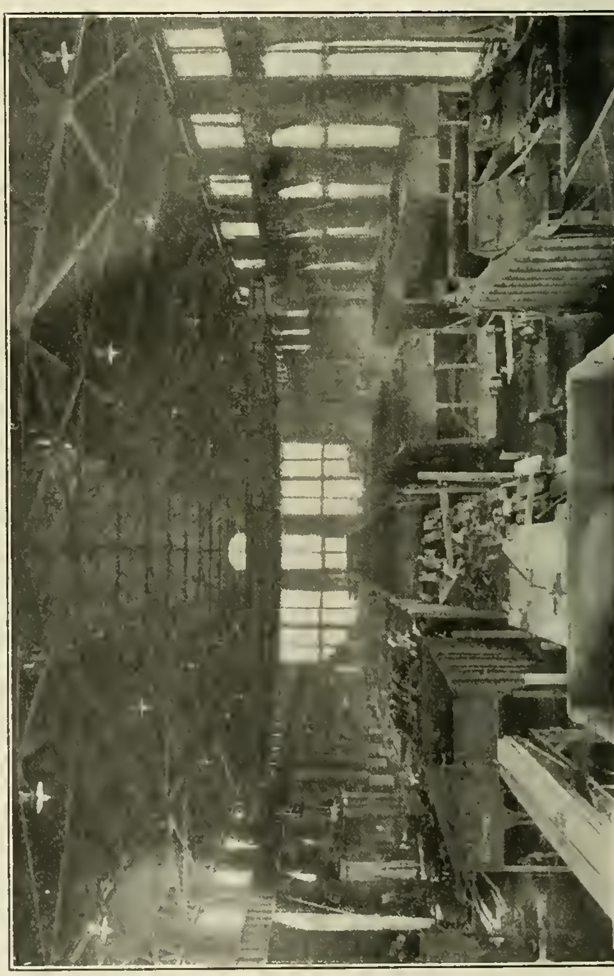


FIG. 9.—INTERIOR OF THE STEEL CAR SHOP.

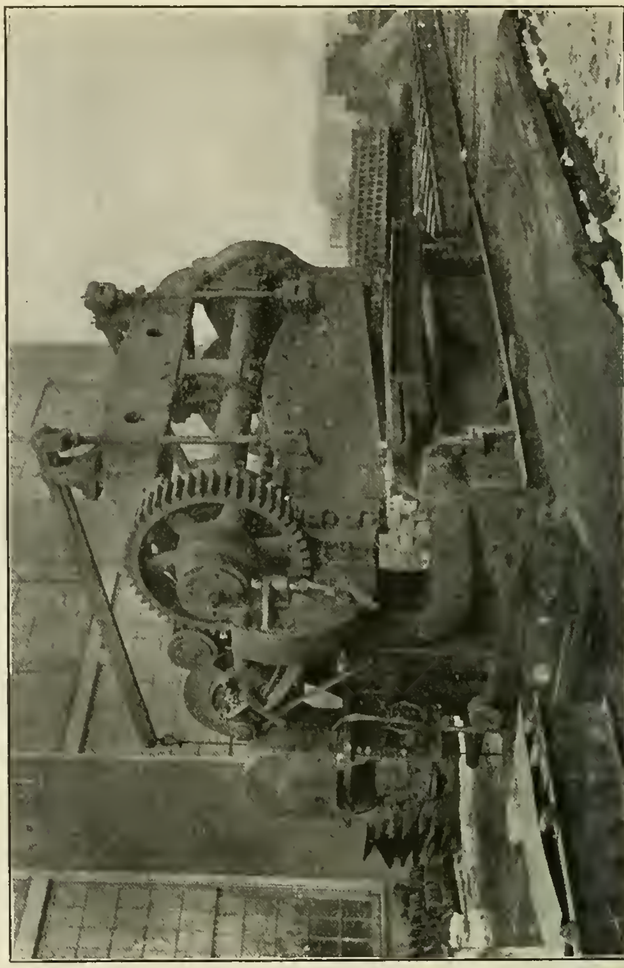


FIG. 11.—125-INCH GATE SHEAR FOR CUTTING LARGE SHEETS.

FIG. 14.—HOPPER CAR OVERTURNED AND MEN AT WORK ON CENTER SILLS.

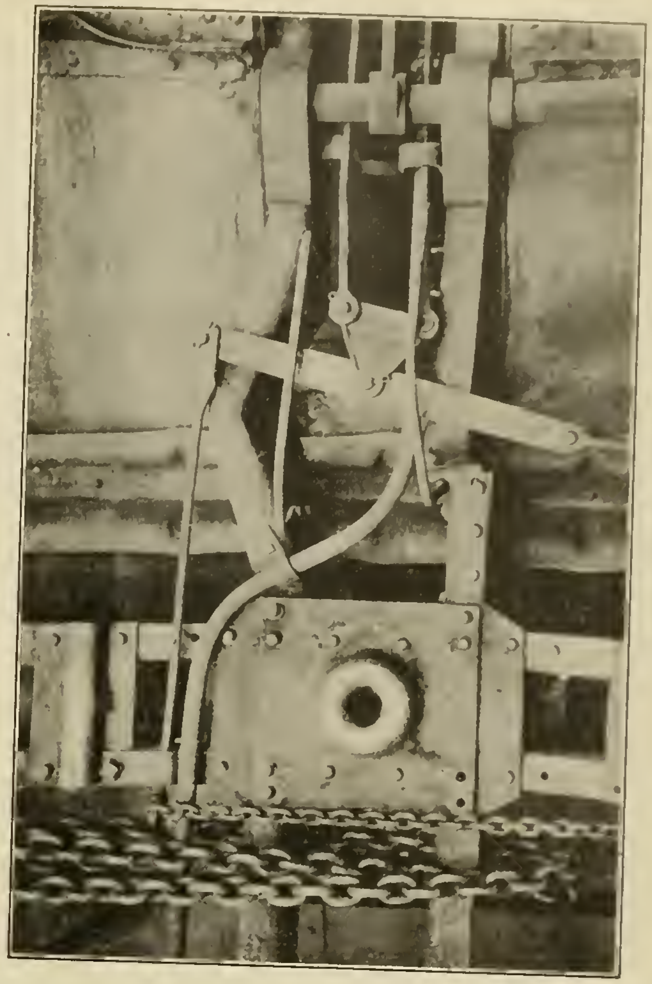


FIG. 15.—BUCKLED CENTER SILLS ON GL HOPPER CAR.

FIG. 12.—FIRST OPERATION IN OVERTURNING A HOPPER CAR IN THE STEEL CAR SHOP.

FIG. 13.—SECOND OPERATION IN OVERTURNING A HOPPER CAR.

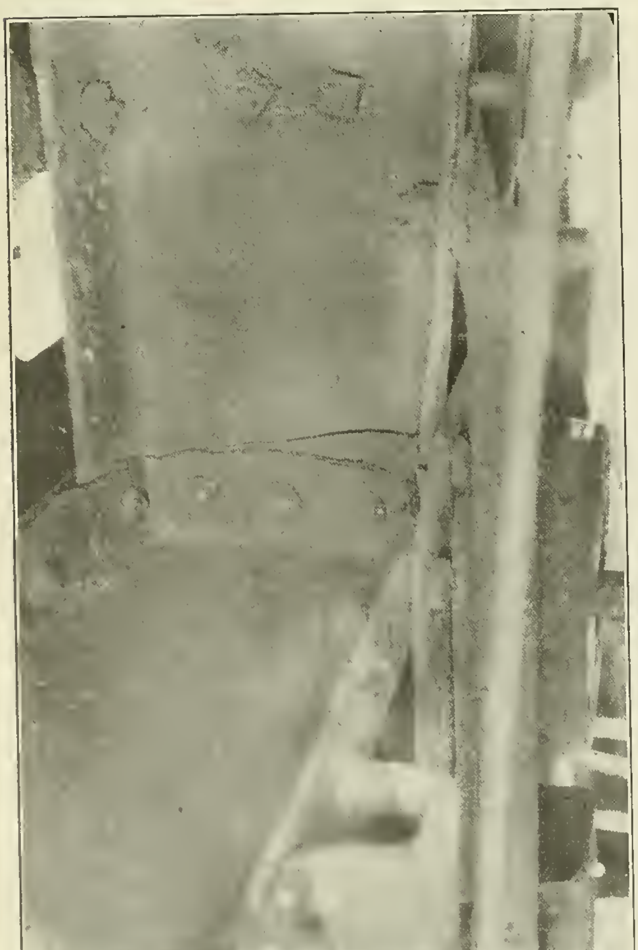


FIG. 16.—CRACKED CENTER SILL ON GL HOPPER CAR.

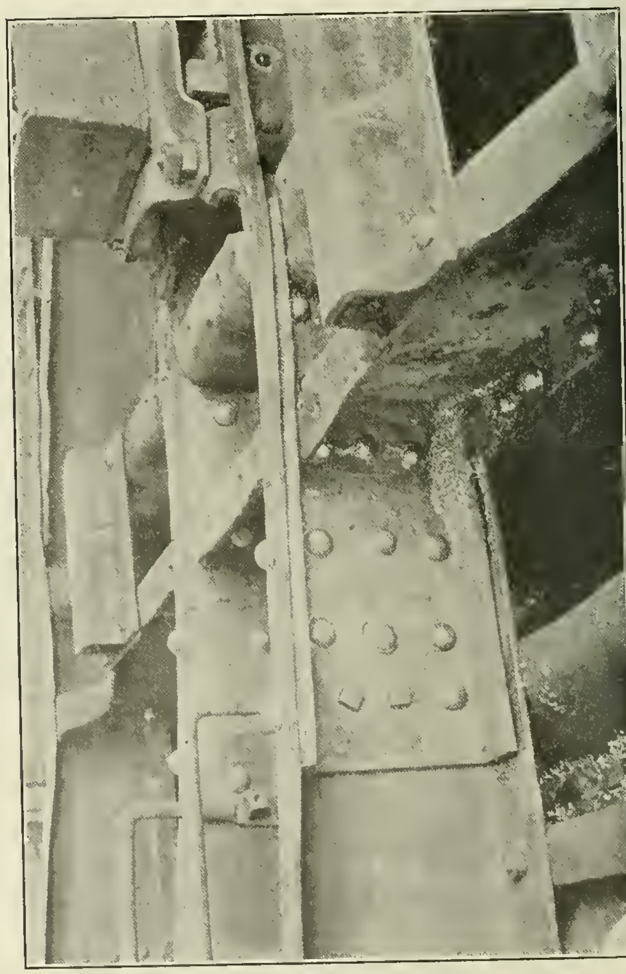


FIG. 17.—CRACKED CENTER SILLS REINFORCED ON A GL HOPPER CAR.

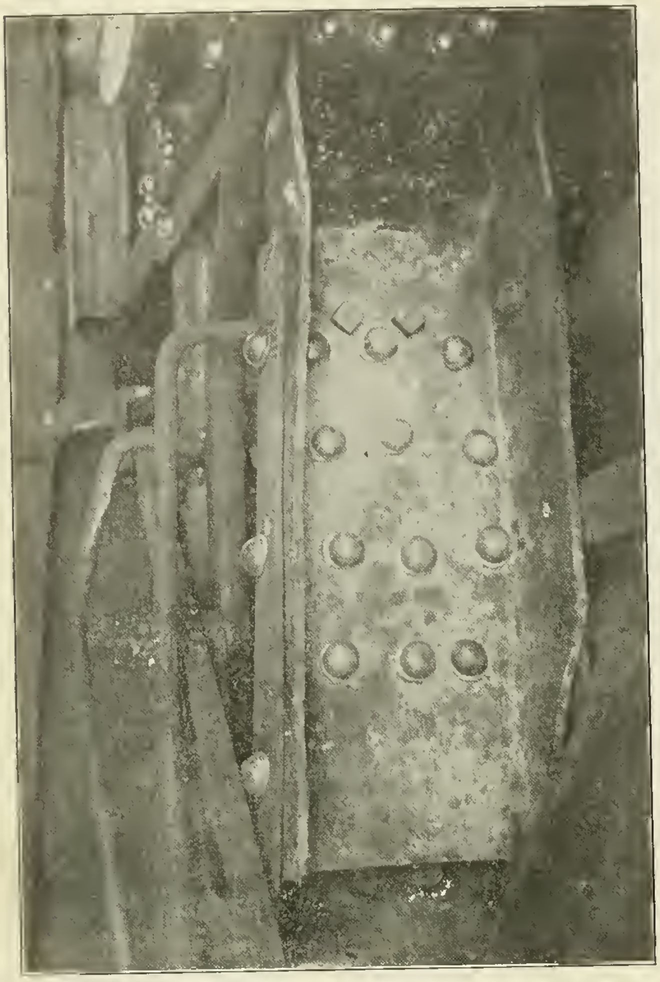


FIG. 18.—CENTER SILL SPLICED ON GL HOPPER CAR.

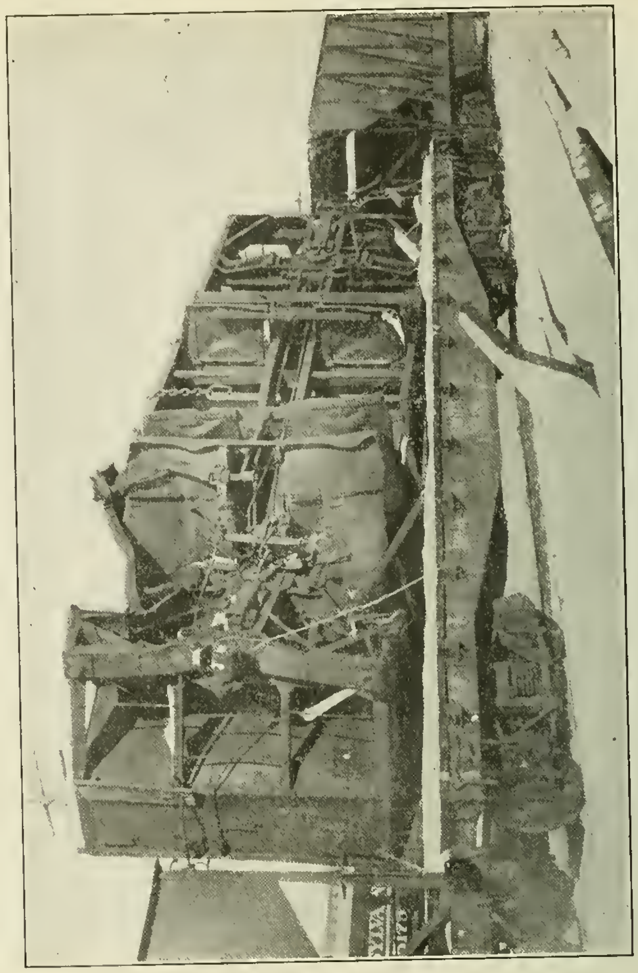


FIG. 19.—CAR BADLY DAMAGED AT ONE END WHICH WAS REPAIRED AT A REASONABLE EXPENSE.

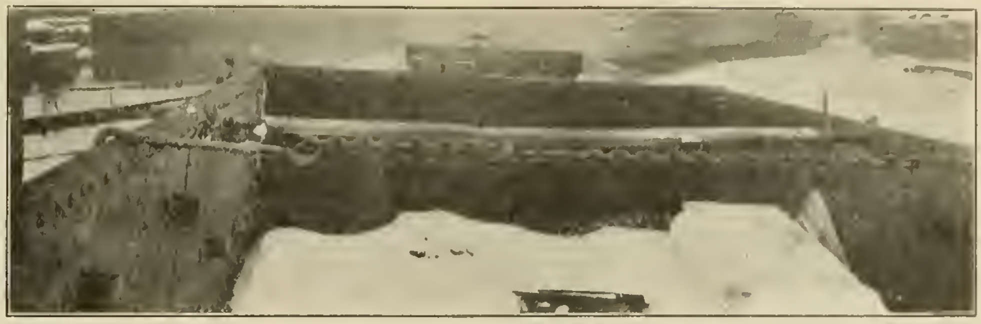


FIG. 21.—PULLING AND PUSHING DEVICES.

2 in. and 7 ft. 10 in. between the centers of the columns. It has a 42 in. stroke and is provided with a stripping ram having a diameter of 10 in. The press has three plungers, each of which exerts a pressure of 500 tons. The center one may be used alone, furnishing 500 tons pressure, or the two outside ones may work together, furnishing 1,000 tons pressure, or all three may be used at the same time, furnishing 1,500 tons pressure. The operating levers are so arranged that it is impossible to operate the plungers in any but these three combinations. Located near it is

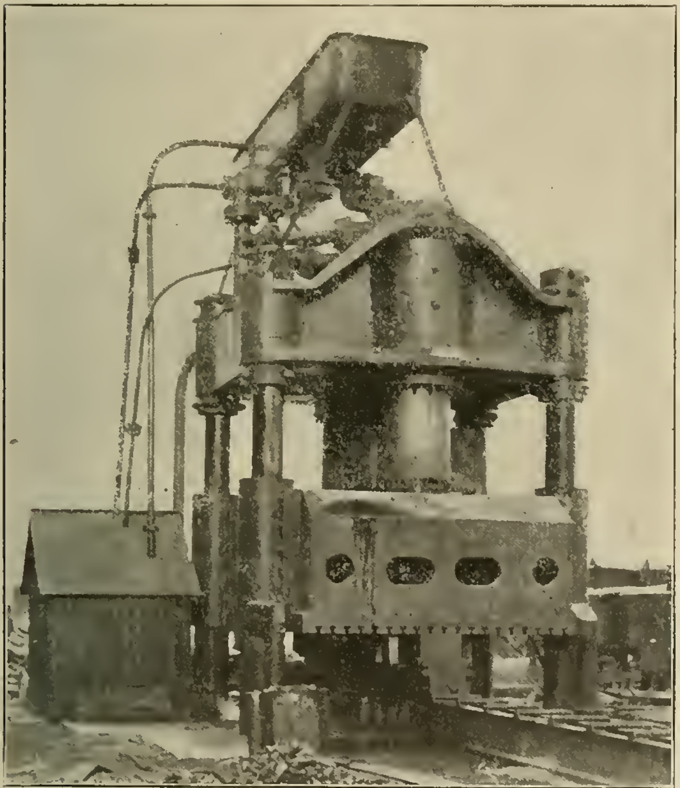


FIG. 10.—1,500-TON PRESS OUTSIDE OF STEEL CAR SHOP.

a Hilles & Jones No. 6, 125 in., gate shear (Fig. 11), used for trimming large size sheets to shape, such for instance as the pressed steel underframes for freight equipment.

### How the Repairs Are Made.

As has been stated, only the heavier repairs to steel freight equipment are made in the steel shop. These consist quite largely in repairing buckled or cracked center sills on the Gl hopper cars. In cases of this kind, or where extensive repairs are to be made to the underside of a car, it is turned up-side down, as shown by the accompanying photos. If the center sills are to be spliced the end sills and draft rigging are removed before the car is turned, as this work can be done to better advantage while the body of the car is in its normal position. Two of the traveling cranes are used to turn a hopper car. Chains are connected to one of the side sills at the bolsters and the car is turned over on its side (Fig. 12). The chains are then placed around the center sills (Fig. 13) and the car is lifted upward and is placed up-side down on blocks, as shown in Fig. 14 The workmen then climb to the top of the car and cut out the rest of the rivets and remove or splice the center sills, or repair the bottom of the hoppers with comparative ease.

The center sills of the car, which is shown being turned in the illustrations, were badly buckled back of the bolster. This is more clearly shown in the detail view, Fig. 15. The sills back of the other bolster were in practically the same condition. The two center sills were cut out and replaced with new sills, the old sills being sent to the blacksmith shop to be straightened out and cut into lengths suitable for splicing sills on other cars.

In many instances the center sills crack directly back of the bolster, as shown in Fig. 16. This is the weakest part of the sill and apparently the metal gradually gives away under the repeated stresses and finally cracks, starting at the bottom through the flange, which is weakened by the rivet hole, and gradually extending upward. In cases of this kind the body bolster is removed after the car has been turned up-side down and a ½ in. stiffening plate is riveted to the sill, as shown in Fig. 17. This, of course, means that the bolster diaphragm, extending from the center to the side sill, needs to be shortened to make up for the width of the plate. It is possible to do this by hand, but dies are being constructed so that it may be done better and more quickly. Where the sills are buckled back of the bolster the end of the sill is cut off and a new piece is spliced on as shown in Fig. 18.

A car, one end of which has been badly damaged, is shown in Fig. 19. The plates were straightened, new ends were spliced to the center sills and the other parts straightened, or repaired, and replaced. This was done at a very reasonable cost.

An interesting design of bolt is used for drawing up parts preparatory to riveting. The pitch is very large and the top and bottom of the thread are rounded off and are much broader than the standard thread. The nuts can be drawn up, or removed, much more quickly than on a standard bolt and the threads are not easily damaged. The ⅞ in. bolts have four threads to the inch and the ⅝ and ¾ in. five threads to the inch.

On repair work ten men work in a gang and two cars are assigned to each gang. On new work six men work in a gang. The tools used on the repair work will be considered at length in connection with the work of the west-bound repair yard.

When it is desired to turn a gondola car up-side down to do work on the under-side, three cranes are used. Chains from two of the cranes are passed about the draw bars at each end and the third crane catches a hook underneath one side of the car. When the two cranes have lifted the car a sufficient distance from the ground the third crane turns it over.

Most of the drawbar yokes used at Altoona are riveted to the couplers just outside the end of the steel shop. After the yoke has been placed over the end of the coupler a band is slipped over the yoke and a wedge is driven between it and the yoke, forcing the sides of the yoke tightly against the coupler. A block and screw jack are then placed between the coupler and the end of the yoke and the lugs are drawn tightly against the coupler. The rivets are driven while the coupler and yoke are held in this position.

FIG. 20.—CRUDE OIL TORCH FOR HEATING DAMAGED PARTS.

Where sheets, or other parts of a car, are bent it is often possible to straighten them in place without removing them from the car. The parts may be heated locally by a crude oil torch,[9] shown in Fig. 20, and can usually be hammered back into place if not too badly damaged.

Fig. 21 shows two devices which are often used to advantage. The one in front consists of a chain with hooks which slip over the sides of the car, as shown. A turnbuckle at the left side, not shown very clearly, allows the sides of the car to be pulled inward. The device shown in the rear performs the opposite function and consists of a piece of heavy pipe with a screw jack arrangement at each end. With this it is possible to force the sides of the car outward and to hammer out any kinks. These devices may be used either separately or in connection with one another.

Parts which are badly bent or torn, and that cannot easily be hammered out straight on a face plate, are sent to the smith shop, where they are straightened under an air press, as will be described later. Meanwhile new parts are taken from stock for use on the damaged car. When the repaired parts are returned they are placed in stock.

The amount of steel freight car repair work done in the steel shop varies. If, as is the case at the present time, a large amount of new steel or steel underframe equipment is being built, only a comparatively small part of the shop is used for repair purposes.

### WEST-BOUND REPAIR YARD.

#### General Arrangement.

The west-bound repair yard was not designed for this purpose, the distance between the track centers being only about 12 ft.; it is being used for this work temporarily, the idea being to transfer it later to a more convenient point near the East Altoona engine house. To provide room for buildings for the necessary offices, shops, storehouses and men's rooms, two of the tracks near the middle part of the yard are covered over. To one side of these temporary buildings is a running track and three tracks which are used for light repair work. On the other side are two tracks, used for heavy repair work, and a running track. To these may be added the parts of the two tracks not covered over at either end of the row of buildings. This provides room for over 300 cars.

The temporary buildings include a tool room and lumber storage shed; the office with a room for inspectors connected to it by a window; three rooms for the men, containing lockers, wash basins and time clocks; a room for storing paints and stencils; an oil room for the oil and waste; an air brake room; a blacksmith shop and a storehouse and storeyard.

#### How the Work is Carried On.

At one time when a large number of steel cars were regularly being brought in for repairs special gangs were detailed for this work, but during the past year or two this class of work has been lighter and at the present time there are only three steel car gangs, and they work on wooden cars as well. In event of a rush of steel cars they could be handled to advantage by the men in the other gangs. Each gang works under the direction of a gang leader and is composed of from 12 to 18 men.[10] The gang leader's duty is largely to order the necessary material and get it promptly to the cars, and to otherwise direct the work of the gang.

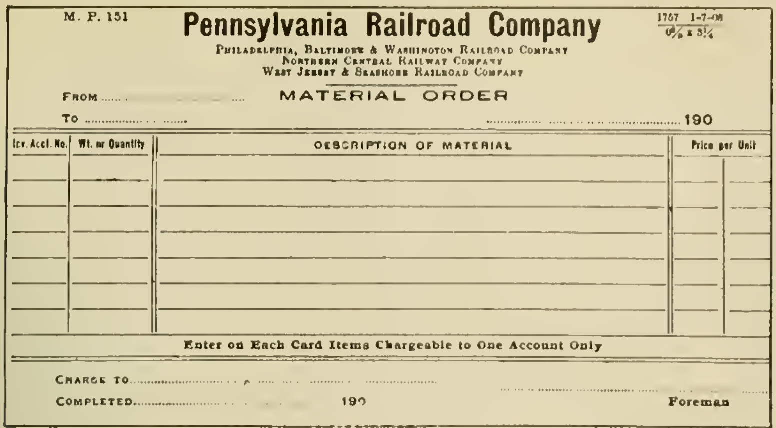
The men who work on steel car repairs are not boiler makers; in many instances they were repairmen on wooden cars, but after a little experience were able to do first-class work on the steel cars. Most of the work on the bodies of steel cars is done on a piece work basis, a certain amount being paid for each rivet which is cut and removed and for each new rivet driven and for each hole drilled or reamed. Where parts are slightly bent or damaged it is often possible to heat them with a torch and hammer them back into place without removing them from the car. Where it is necessary to remove the distorted parts they may often be repaired on a straightening press[11] in the repair yard and be replaced on the car. Where the parts are thus treated the men are paid on a time basis. Badly damaged parts which it is not thought advisable to try to straighten are loaded on a car and sent to the blacksmith shop. Here they are straightened[11] under a large air press, the men being paid on a piecework basis, at so much per 100 lbs. of material straightened.

When a car is placed in the repair yard an inspector makes note of the repairs which should be made on a form, known as M. P. 124, shown in Fig. 22. Any other work which may afterwards be found necessary must be referred to the inspector. On one side of this card he fills in the date, car number, initials and kind, the light weight, size of axles, and the account to which the repairs are to be charged, such as pool, foreign or M. C. B. On the other side he fills in the date and all of the columns except those showing the value of the material. The card is then placed alongside the springs on one of the trucks.

[9] In the repair yard of the B. & O. at Mt. Clair a fire is built about the damaged part, scrap wood being used (see page 167 of the May, 1907, issue). On the P. & L. E. R. R. at McKees Rocks a natural gas burner is used for this purpose, as shown on page 4 of the January, 1908, issue.

[10] The practice in this respect on the B. & O. and P. & L. E. R. R. is described on page 161 of the May, 1907, and page 6 of the January, 1908, issues, respectively.

[11] See page 162 of the May, 1907, issue.


M. P. 151 — Pennsylvania Railroad Company — 1767 1-7-08 6¾ x 3¼

Philadelphia, Baltimore & Washington Railroad Company
Northern Central Railway Company
West Jersey & Seashore Railroad Company

FROM ....... MATERIAL ORDER

TO .................................................... 190

| Inv. Acct. No. | Wt. or Quantity | DESCRIPTION OF MATERIAL | Price per Unit |
|---|---|---|---|
| | | | |

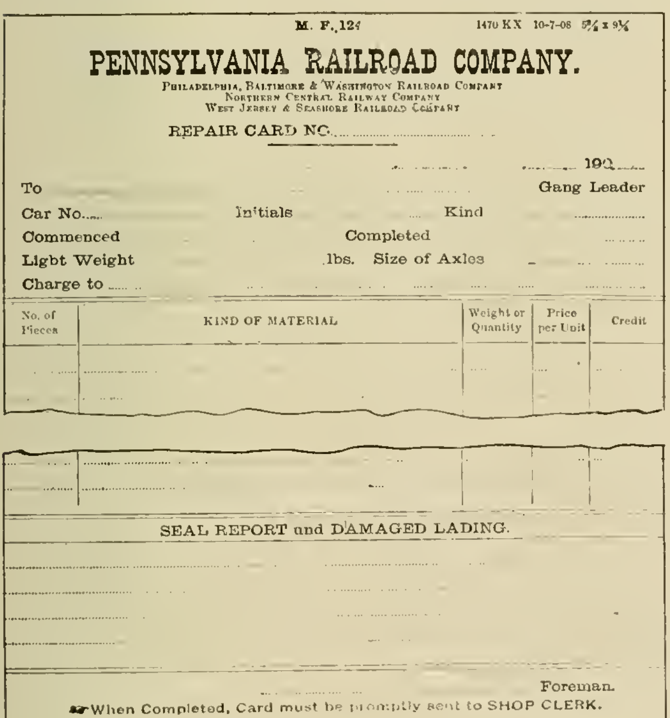
Enter on Each Card Items Chargeable to One Account Only

CHARGE TO ..........

COMPLETED .......... 190 Foreman

FIG. 23.—MATERIAL ORDER FORM, M. P. 151.

The gang leader, to whose gang the car is assigned, orders the necessary material on form M. P. 151, which is reproduced in Fig. 23. When the work on the car has been completed he fills in his name on M. P. 124 and also the time the work was commenced and completed. The card and the work are then examined by the inspector and if found O. K., the card is signed and turned in to the shop clerk. Formerly it was the practice to enter all of the material used for repairs on the front of the card, but at the present time this is only done in the case of foreign cars. After the store department has checked the forms M. P. 151 and posted them on their books the originals are returned to the shop clerk and fastened to forms M. P. 124, to which they refer, after which they are filed. As may be seen,


M. F. 124 — 1470 KX 10-7-08 5¾ x 9¾

PENNSYLVANIA RAILROAD COMPANY.

Philadelphia, Baltimore & Washington Railroad Company
Northern Central Railway Company
West Jersey & Seashore Railroad Company

REPAIR CARD NO. ..........

.......... 190 ....

To .......... Gang Leader

Car No. .... Initials .... Kind ....

Commenced .... Completed ....

Light Weight .... lbs. Size of Axles ....

Charge to ....

| No. of Pieces | KIND OF MATERIAL | Weight or Quantity | Price per Unit | Credit |
|---|---|---|---|---|
| | | | | |

SEAL REPORT and DAMAGED LADING.

.......... Foreman.

When Completed, Card must be promptly sent to SHOP CLERK.

FIG. 22.—FORM M. P. 124.

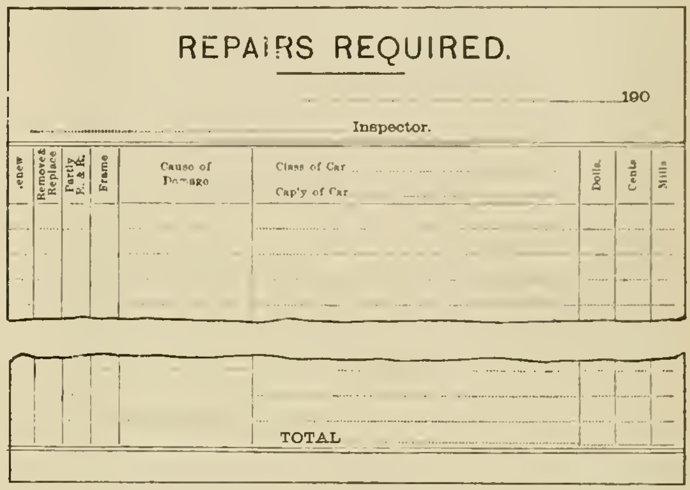
there is space on M. P. 124 for the seal report and notations as to damaged lading.

Time clocks are placed in the men's quarters, furnishing a record of each man's time. The gang leader is required to make out a summary card, Form M. P. 130, Fig. 24, from which the pay-rolls are made up. These summary cards must be turned in every few days and the shop clerk checks them up with the M. P. 124 forms. On the summary card is shown the number of the gang, the date, the name of the gang leader, the car number, initial and kind, or class; also the account to which it is charged, *i. e.*, pool, foreign, or M. C. B.; and the total amount due the gang for each car. At the lower part of the card the names of the members of the gang are shown, the number of hours put in by each man during the time covered by the summary report and the rate of each man per hour. From this data the shop clerk calculates the amount due each man. The rates of the men in the gang do not differ very greatly, except in the case of new men who are being broken in and have not yet become proficient, and of the gang leader, whose rate is slightly higher than that of the others.

TOOLS AND DEVICES USED FOR REPAIRS TO STEEL CARS.

The tool room is in charge of a man, who in addition to checking the tools in and out, keeps them in good condition and proper repair. There is also a man in the tool room who does the carpentry work, including the making of wheel-barrows, handles for various tools, etc. An interior view of a portion of the tool room is shown in Fig. 24a.

Hanging above the board, upon which the tool checks are placed, is a list of the classes of tools which are used, each one being numbered. The board is marked off by a number of ver-

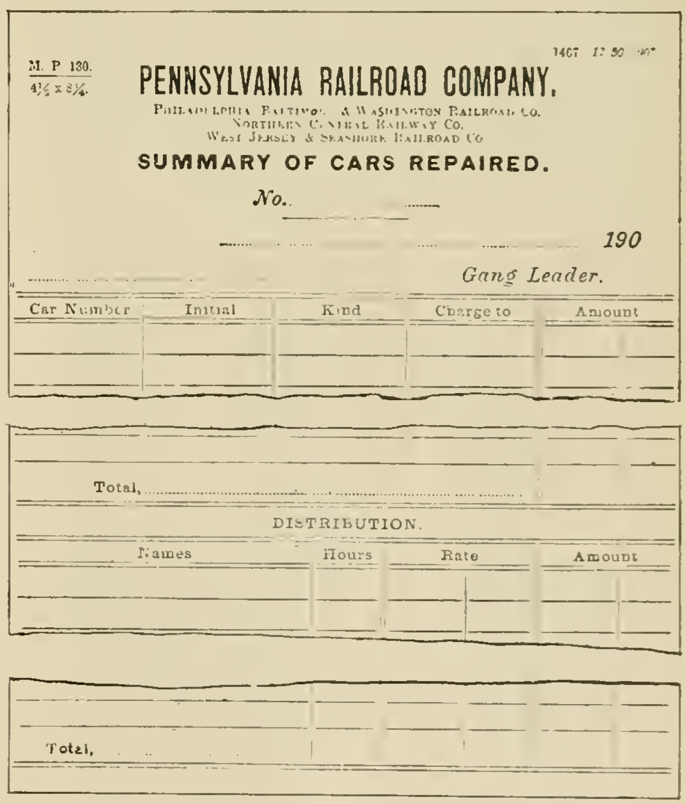

REPAIRS REQUIRED.

.......... 190

.......... Inspector.

| Renew | Remove & Replace | Partly R. & R. | Frame | Cause of Damage | Class of Car / Cap'y of Car | Dolls. | Cents | Mills |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | TOTAL | | | |

FIG. 22A.—BACK OF FORM, M. P. 124.


M. P. 130. 4½ x 8¼. — 1407 12 30 '07

PENNSYLVANIA RAILROAD COMPANY.

Philadelphia, Baltimore & Washington Railroad Co.
Northern Central Railway Co.
West Jersey & Seashore Railroad Co.

SUMMARY OF CARS REPAIRED.

*No.* ..........

.......... *190*

.......... *Gang Leader.*

| Car Number | Initial | Kind | Charge to | Amount |
|---|---|---|---|---|
| | | | | |
| | | | Total, | |

DISTRIBUTION.

| Names | Hours | Rate | Amount |
|---|---|---|---|
| | | | |
| Total, | | | |

FIG. 24.—SUMMARY REPORT FORM, M. P. 130.

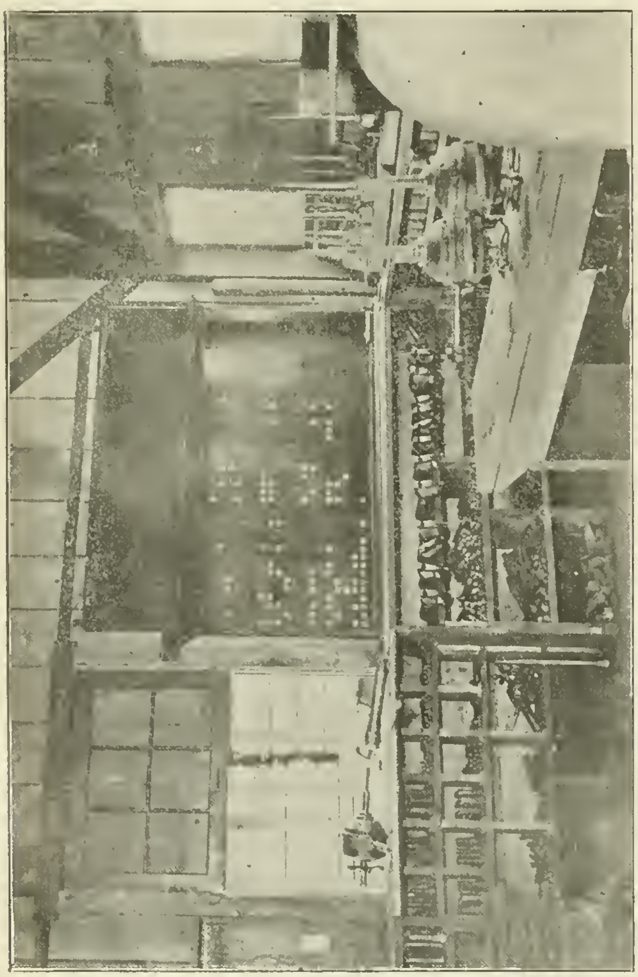


FIG. 24A.—INTERIOR OF TOOL ROOM AT WEST-BOUND REPAIR YARD.

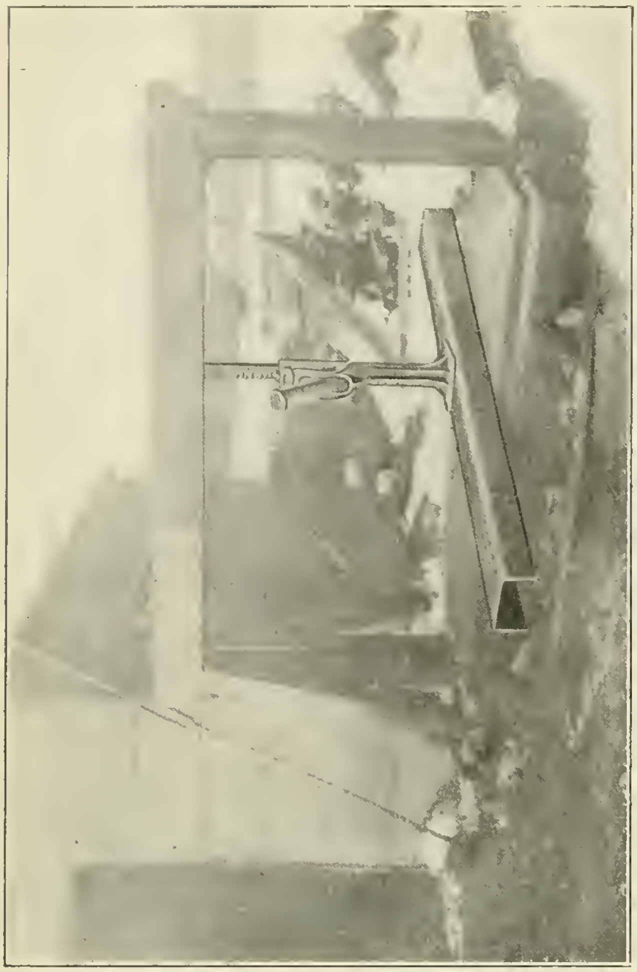


FIG. 28.—STRAIGHTENING PRESS AT THE WEST-BOUND REPAIR YARD.

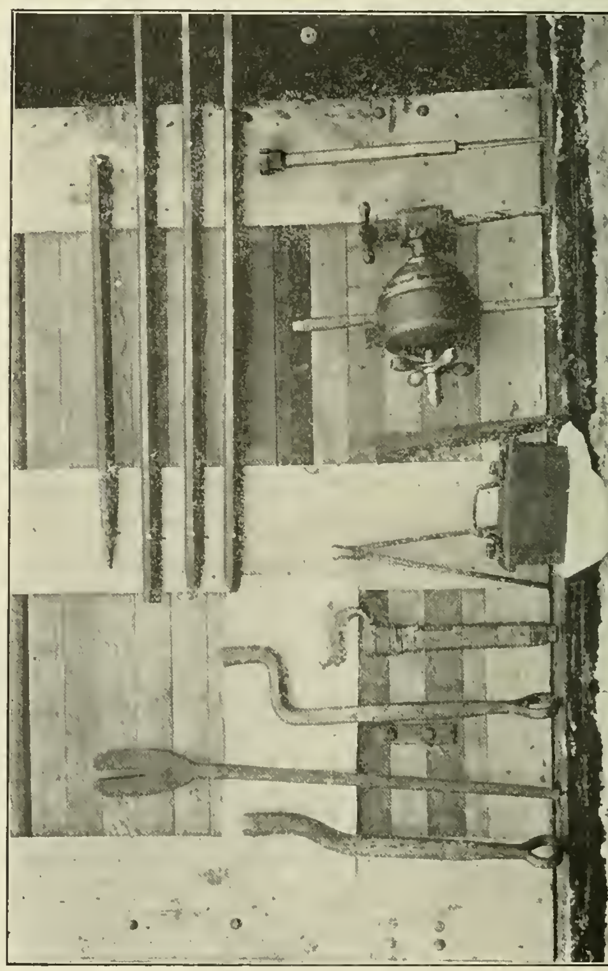


FIG. 25.—SOME OF THE TOOLS USED FOR REPAIRING STEEL CARS.

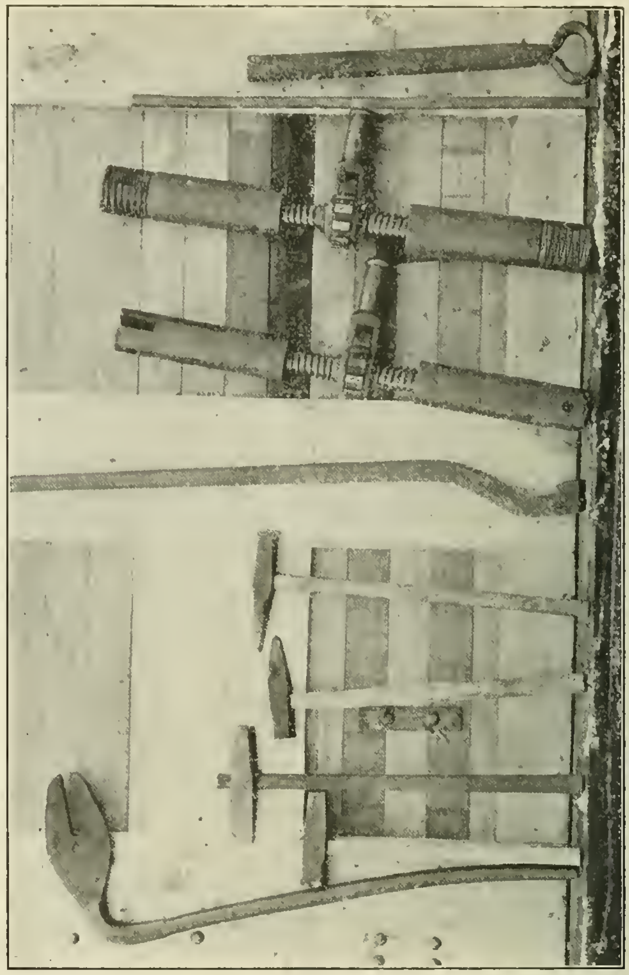


FIG. 26.—SOME OF THE TOOLS USED FOR REPAIRING STEEL CARS.

tical and horizontal lines, the spaces between the horizontal lines being numbered and designating the gangs and the spaces between the vertical lines also being numbered and designating the class of tool, as above referred to. In this way it is possible to find quickly how many and what tools each gang has. The tools are expected to be turned in every night. In addition to the tools which are listed in this way each man is furnished with a ball pein hammer and the necessary cold chisels, drifts and wrenches. These he keeps in a small tool box which he carries about with him.

The tools which are kept in the tool room and are used for steel car repairs are as follows:

*Pneumatic Drills,* for drilling and reaming holes, with the necessary drills and reamers.

*Pneumatic Hammers* and the necessary dies for driving rivets.

*Air Hose* for the pneumatic tools and for connecting the portable rivet heaters to the air line.

*Sledges,* 6 and 10 pounds.

*Cutting Bars* of various lengths and with different shaped cutting edges, as shown in the upper right-hand corner of Fig. 25.

*Center Punches* on handles as shown in Fig. 26.

FIG. 27.—A SIMPLE AND CONVENIENT DEVICE.

*Straightening Irons* for grasping and bending sheets. One of these with a crooked handle is shown at the left in Fig. 26, and the other with a straight handle is shown near the left in Fig. 25.

*A Block and Wedge,* shown in Fig. 25. This is used for holding against the counter-sunk heads on the rivets used to fasten the draft castings to the sills on certain hopper cars. By means of the handle the block is held between the sills and the wedge is driven down, holding against the rivet head while the rivet is being driven.

*Cutters* on handles as shown near the left in Fig. 26.

*Tongs* for handling rivets, etc.

*Rivet Punches* for driving out rivets.

*Drop Door Wrenches* of various sizes for operating the drop doors.

*Torches* for lighting purposes and similar to those used on a locomotive.

*Hydraulic Jacks* of 15 tons capacity. These are kept in repair and issued from the tool room. There are also a number of ratchet jacks used.

*Chucks or Expansion Bars* for pneumatic drills, as shown to the right of the pneumatic drill in Fig. 25.

*Pup or Journal Box Jacks.*

*Blowers or Torches.* One of these is shown in operation in Fig. 20. They are used for heating parts of the car which may be repaired or straightened without removing them from the car. The end or burner is made of a piece of 3 in. pipe about 8 in. long, which is screwed into a 3 in. to ¾ in. reducing sleeve. The ¾ in. pipe or nipple, fastened to this sleeve, connects to a ¾ x ⅜ x ⅜ in. T. The air, controlled by the globe valve, passes through the ⅜ in. pipe, which is reduced to ¼ in. at its upper end inside of the T, and syphons the oil through the other ⅜ in. pipe from the can, which is placed on the ground.

*Clubs or Dolly Bars,* also called holding on bars. Several shapes of these are shown in Figs. 25 and 26.

*Cans with a Soda Solution* for lubricating the drills and reamers.

*Pulling and Pushing Jacks,* as shown in Fig. 26. By using wooden blocks the side sheets may be pressed outward with the jack shown at the right, in the same manner as performed by the device shown in Fig. 21. Chains may be fastened by pins at each end of the jack shown to the left and the chain hooks may be thrown over the sides of the car and the sheets pulled inward.

FIG. 29.—A SIMPLE BRACE FOR PNEUMATIC DRILLS.

*An Angle Device* used in connection with the pneumatic drills, making it possible to drill at right angles in places where it is impossible to use the standard drill.

These tools are used exclusively for steel car work and are in addition to the hand hammer, cold chisels, wrenches and drifts with which each man is furnished. As may be seen, some of the tools are of a very special nature and are only used occasionally, so that it is not necessary to have more than two or three of them for several gangs. In other cases, such for instance as pneumatic hammers, it would be necessary to provide one for every four or five men in a steel car gang.

Inasmuch as the number of steel cars in the repair yard varies greatly, so that often there is not enough work to keep more than one or two gangs engaged, while at other times there may be sufficient to keep several gangs going, it is impossible to make an estimate as to just what the tools for this work would cost per man, or per gang, but it is safe to say that a gang of five or six men could be very fully equipped with the necessary tools for less than $500.

In addition to the tools mentioned above there are several

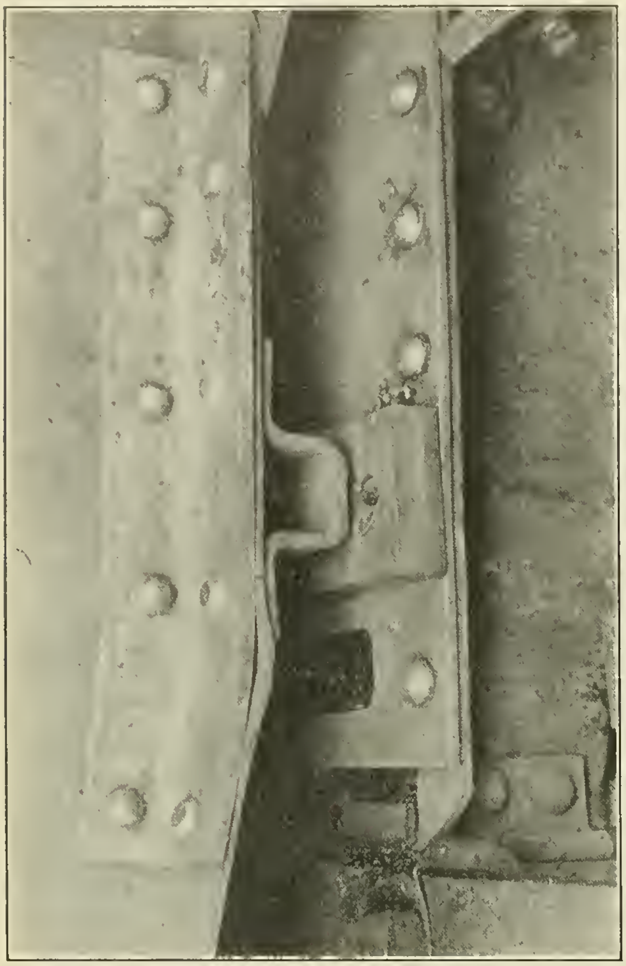


FIG. 34.—REINFORCED BODY BOLSTER ON GL HOPPER CAR.

FIG. 30a.—STOREYARD—WEST-BOUND REPAIR YARD. MEN'S ROOM AT THE FAR END.

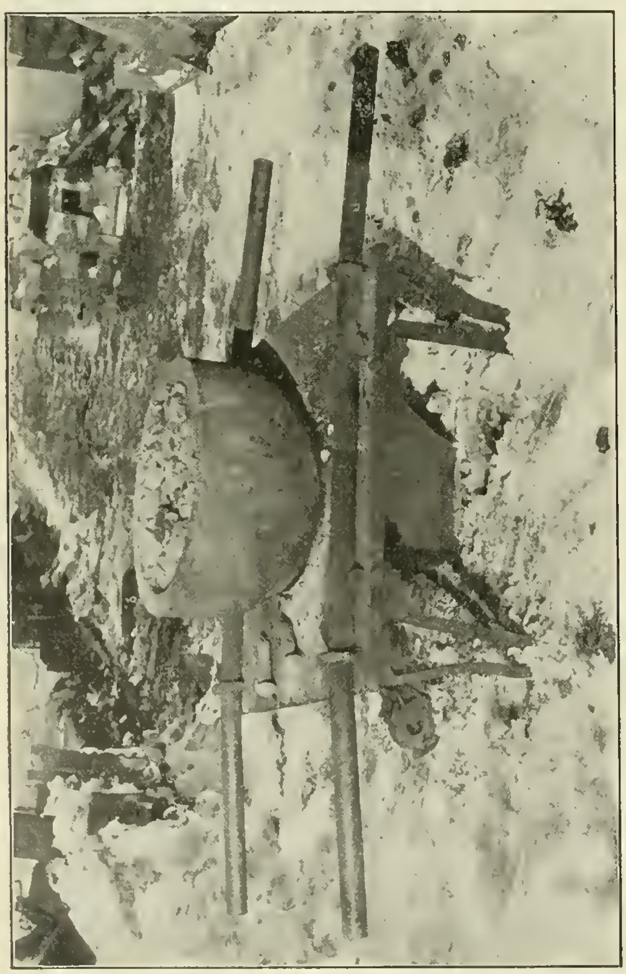


FIG. 30.—PORTABLE RIVET HEATER.

FIG. 31.—CENTER SILL SPLICE MADE AT THE WEST-BOUND REPAIR YARD.

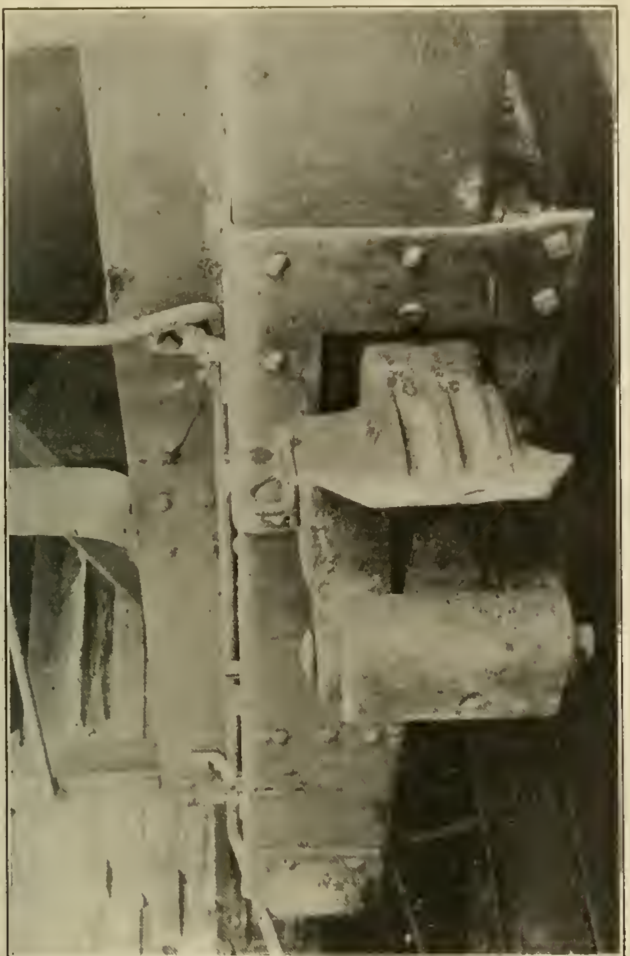


FIG. 33.—REINFORCED END SILL ON GL HOPPER CAR.

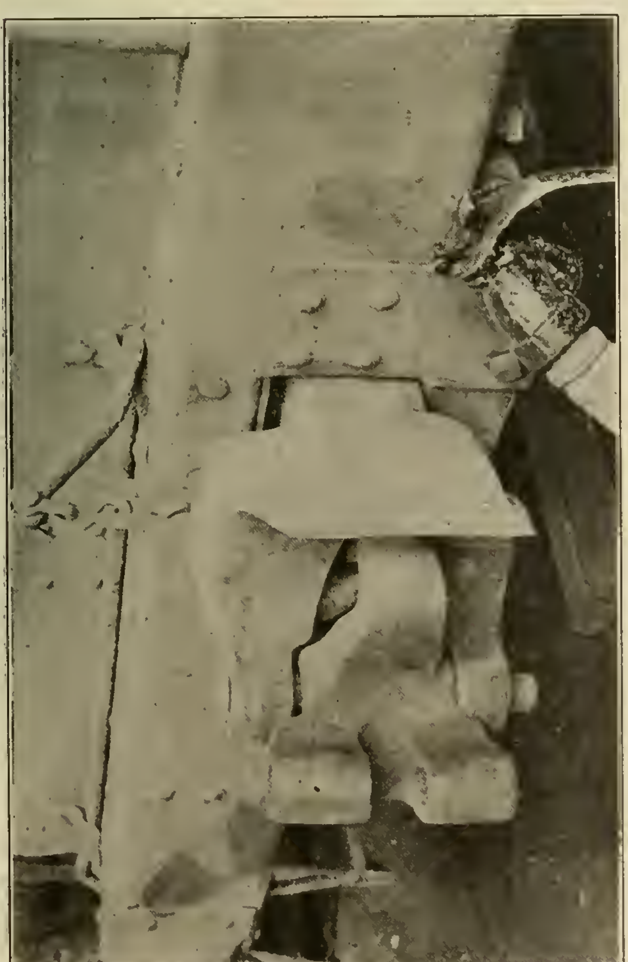


FIG. 32.—END SILL ON GL HOPPER CAR.

other special devices used in the repair yard in connection with the repairs to steel cars. One of these, shown in Fig. 27, is made of wrought iron, the top fitting over the side of the car. The workman is holding a "dolly bar" or "holding on bar" against a rivet, which is being driven from the other side of the sheet. By using two or more of these brackets and placing planks upon the horizontal portions a platform may be erected along the side of the car.

In the west-bound repair yard are two straightening presses, one of which is shown in Fig. 28. These consist of a wooden framework reinforced and tied together by iron rods and attached to a base of timbers upon the top of which a cast iron plate is placed. Bent or distorted pieces may be pressed into shape by the use of ratchet jacks, as shown, and by hammering the pieces into shape with sledges. An open forge, not shown in the photo, is at the left and is used for heating the parts.

Fig. 29 shows a brace that is very convenient for drilling or reaming holes. These braces are made in a variety of shapes for getting at inconvenient places on the car.

A portable rivet heater[12] is shown in Fig. 30. The cast iron pot is about 1½ in. in thickness and measures 12 in. inside diameter at the top. It has a hole 6¼ in. in diameter at the bottom in which a small grate fits. The plate upon which the pot rests is 2 ft. square and is of cast iron. The lower portion, cast integral with the plate, has a cavity 5 in. square and 9 in. deep, near the top of which the air enters from the air hose and into which the ashes fall, being removed by a slide at the bottom.

### THE STOREHOUSE AND THE PARTS CARRIED FOR STEEL CARS.

Because of the temporary location of the west bound repair yard the store room is only large enough to hold the bolts, rivets and smaller material. The larger material is arranged on a platform just outside. A tin pocket is attached to each box or bin containing material and in it is a card showing the date and the amount of material received at various times; also the amount and date of all lots of material issued. It is thus possible to find quickly the exact amount of material on hand and also the rate at which it is being withdrawn.

Very little new material is required for repairs to the bodies of steel cars, but a certain amount is carried in stock to replace parts which are sent to the blacksmith shop for straightening, or to reinforce or strengthen the weak parts on the Gl cars. In examining the store house stock the following parts for bodies of steel cars were found:

*Center Sill Splices.*[13] These are for the Gl cars and are similar to those described on page 91, in connection with the work in the steel car shop. It is interesting to note that the Gl cars are the only ones on which the center sills give trouble, the Gla cars, which were designed later, giving splendid results in this respect. This is probably due to the increased sectional area of the center sills of the Gla cars; the trouble with breakage was one of the main reasons for making the increase. Gl cars with cracked or buckled center sills are very often received in the west bound repair yard and the sills are spliced in the same way as in the steel shop. A center sill splice made in the repair yard is shown in Fig. 31.

*End Sills.* The end sills of the Gl hopper cars are damaged when the center sills are buckled. If badly damaged they are straightened on the straightening press in the yard or sent to the blacksmith shop. In the latter case an end sill is taken from stock, so as not to delay repairs to the car.

*End Sill Stiffening Plates.*[14] On the Gl hopper cars the coupler carrier iron is supported by two plates riveted to the end sill, each side of the coupler, as shown in Fig. 32. Where the end sill is damaged at the center these plates are often removed and replaced by a large single plate, as shown in Fig. 33. This reinforces and strengthens the sill.

[12] See page 4 of the January, 1908, issue for a portable rivet heater used on the P. & L. E. R. R.

[13] The method of splicing center sills of steel hopper cars on the B. & O. is shown on page 171 of the May, 1907, issue.

[14] The application of end sill reinforcing plates to B. & O. cars is shown on page 168 of the May, 1907, issue.

FIG. 36.—LOCOMOTIVE CRANES USED IN REPAIR YARDS.

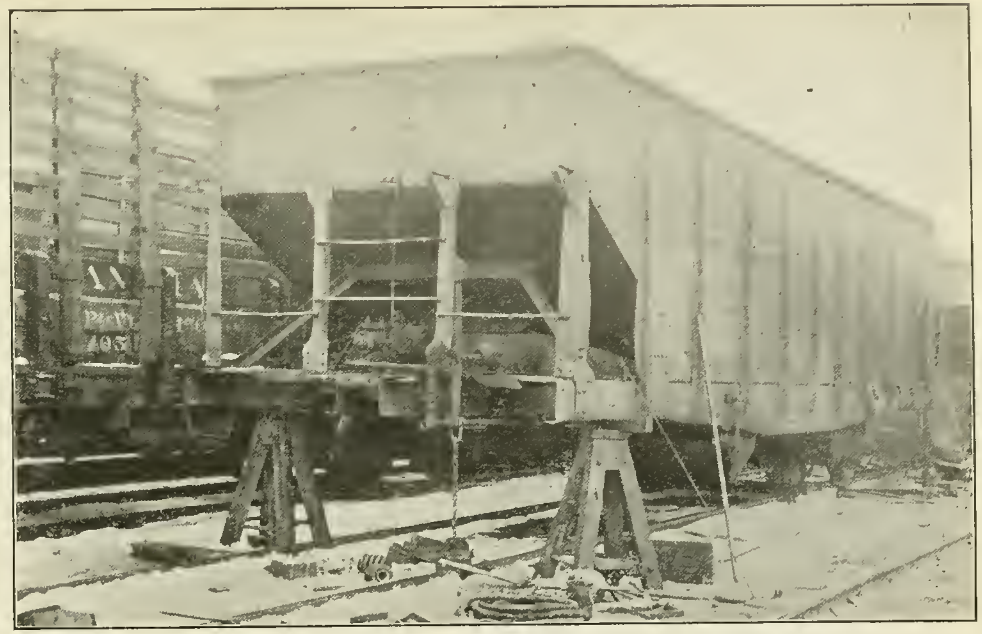
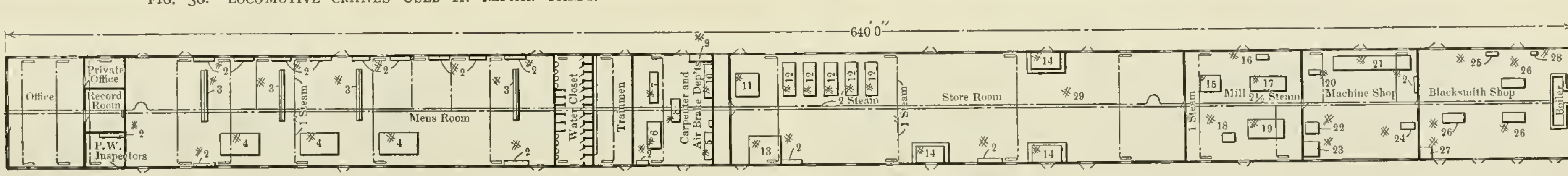


FIG. 35.—SUBSTANTIAL TRESTLES FOR SUPPORTING CAR BODIES.

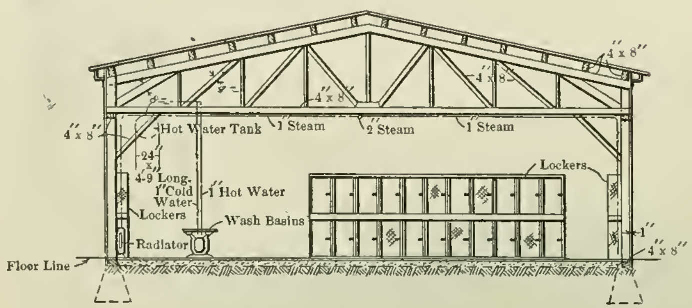


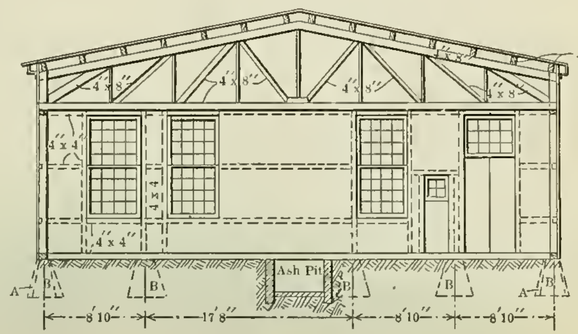

※ 2 Single Lockers
3 Double Lockers Back to Back
4 Wash Basin, Concrete Foundation
5 Bench for Jack Repairs
6 Bench for Carpenter Repairs
7 Bench for Tool Repairs
8 Bench for Air Brake Repairs
9 " " " "
10 " " " "

※ 11 Rack for Iron
12 Bins for Bolts and Nuts
13 Office
14 Counter
15 Band Saw
16 Grind Stone
17 Planer
18 Boring Machine
19 Rip Saw

※ 20 Emery Wheel
21 Pit for Journal Turning Lathe and Wheel Grinding Machinery
22 Threading Machine
23 Hammer
24 Drill Press
25 Grind Stone

※ 26 Forge
27 Hydrant and Concrete Floor
28 Air Pump
29 Steam Line




ARRANGEMENT AND CONSTRUCTION OF THE BUILDING AT THE EAST-BOUND REPAIR YARD.

*Side Stakes.* These are sometimes damaged or torn off when a car receives side swipes or is otherwise badly damaged.

*Corner Posts.* These are sometimes badly damaged on the hopper cars and a small supply of new ones is carried in stock.

*Bolster Stiffeners.* The Gl cars were equipped with trucks having pressed steel bolsters. The center plate was pressed in the top cover plate. This plate was not properly reinforced underneath the center and after the cars had been in service for several years the center plate was forced downward, thus bringing the side bearings down and throwing the greater part of the weight of the body on them. This tears or distorts the lower flanges of the body bolster members to which the side bearings are riveted. When a car comes to the repair track in this condition the top member of the truck bolster is cut off and is replaced by a new plate and a cast steel center plate. The distorted flanges of the body bolster, are forced back into position and are reinforced by ½ in. angle plates, as shown in Fig. 34.[15] In some instances the side bearings are badly damaged and a stock of these is carried at the store house. This trouble has been corrected on the later cars by a change in the design of the bolsters.

*The Cross Ties* connecting the sides of the Gl hoppers consist of corrugated plates, the ends being riveted to the sides. They are placed vertically so as to offer the least resistance to the coal or other material which may be dropped into the car. This construction is not very strong and it is often necessary to replace the plates. On the Gla cars this cross tie is made up of two plates, with a V pressed in them, riveted together, thus forming a box section which is much stiffer and not so easily damaged as the plate on the Gl cars. (See page 148, May, 1905, issue).

*Hopper Doors* are sometimes badly damaged and the various parts of these doors are carried in stock. The same may be said concerning certain parts of the draft rigging.

### Other Equipment.

An important and commendable feature in the repair yard is the trestle for supporting the car, shown in Fig. 35. These are about 40 in. high and are made of 4 x 4 in. planks with a 2 in. plank, 10 in. square, at the top. The timbers are securely bolted together. These trestles eliminate any possibility of such accidents as sometimes occur when cars are supported on barrels or where a lighter trestle is used, or where the ratchet jacks, with a narrow base, are left to perform this duty.

Two 15-ton locomotive cranes, one with a boom 45 ft. long and the other with one 29 ft. long, are used for handling the wheels and axles in and out of the trucks and for the lifting back and forth of heavy parts. These cranes are shown in Fig. 36 and were furnished by the Browning Engineering Company, of Cleveland, O., and the Bay City Industrial Works, of Bay City, Mich.

The blacksmith shop contains a 100-pound Shaw & Justice power hammer and a two-spindle 1½ in. bolt cutter.

## EAST BOUND REPAIR YARD.

### General Arrangement.

Most of the repairs made at the east bound repair yard are to loaded cars or cars from which it has been necessary to transfer the lading. Only light repairs are made to steel cars. The yard has been carefully arranged and equipped to handle the work to the best advantage. The building in which the offices, store house, men's quarters and shops are placed is substantially built and splendidly arranged, both as to facilities for performing the work and for the comfort and convenience of the workmen.

The repair tracks are laid out with plenty of distance between centers and a system of narrow gauge tracks extends throughout the yard, over which supplies may be carried on push carts. The tracks are spaced about 16 ft. center to center; between every other track is the narrow gauge track for carrying supplies, the repair track centers in this case measuring about 19 ft. center to center. There is a narrow gauge cross track, with turntables, near the center of the yard. The space between the tracks throughout the yard is covered with heavy planking, the timbers being taken from cars which were destroyed at the metal yard, which lies just west of the repair yard.

For transfering coal, coke or similar material from damaged cars there is an unloading trestle with capacity for holding five cars. For transferring loads in box cars two tracks are placed so that there is only about 22 in. space between the cars. One of the tracks is placed about 14 in. lower than the other, so that heavy pieces of machinery, or other material, may be more easily transferred. A depressed track into which gondola cars are run makes it possible to conveniently and cheaply load the scrap and refuse material.

### The Building.

The building containing the offices, men's rooms, shops, etc., is of special interest, since, although it is substantially built and conveniently arranged, the timbers from which the frame is made were practically all taken from wooden cars which were assigned to the metal yard for destruction. The ground upon which it is built is filled in and it rests upon concrete piers. Underneath the floor is a layer of ballast and the floor timbers are planks taken from old freight cars. The roof is covered with four-ply slag, and the sides with white pine sheathing and battens. The building is 45 ft. wide and 640 ft. long.

Referring to the plan showing the arrangement it will be seen that a large office is placed at one end, having a private office and a record room in connection with it. The piece work inspectors' room is next to the office and has three small openings connecting into it. On each side of these windows, or openings, are wire baskets. The piece work inspectors pass the repair cards, M. P. 124 (see page 93), through the first one of these openings when they refer to repairs which are to be billed against foreign roads. The clerk, in the office on the other side, makes out the M. C. B. cards and attaches the ones which are to be placed on the cars to the repair cards and passes them back through the second opening. When the inspector has checked these and placed the M. C. B. cards on the car the repair cards are returned through the third opening.

The most interesting part of the building is the men's room, which is 176 ft. long, an interior view being shown in Fig. 37. In this are placed large expanded metal lockers. A number of long tables, with benches, are provided at which the men eat their lunches. These tables are fitted with drawers, in which the gang leaders may keep the material for the reports which they must make out. There are a number of wash basins with hot and cold water faucets. Underneath and about these basins the floor is of concrete, draining toward the center. Near either end of the room are two time clocks, where the men register. This room, like the rest of the building, is well heated, steam for the radiators being furnished from the boiler at the end of the smith shop.

Adjacent to the men's room is a lavatory. A room is provided for the trainmen who may be stationed in or near the repair yard. Next to the room which contains the carpentry and air brake departments is an opening or tunnel through the building through which material may be carried over a narrow gauge track. All of the stock material is kept under cover, the store room being 144 ft. in length. It is very neatly and conveniently arranged, as shown by the photograph, Fig. 39.

The next section contains the wood working machinery, including a band saw, planer, boring machine, rip saw and grind stone. The machine shop contains two gap lathes for turning the journals without removing the wheels and also a Norton grinding machine for grinding out the flat spots on cast iron car wheels. There is also an emery wheel, a bolt threading machine and a drill press. In the blacksmith shop are several forges and a boiler which supplies heat and power for the plant.

Located a couple of hundred feet from the main building is a smaller one for the use of the painters and stencilers and for the storage of oil and waste.

[15] On page 170 of the May, 1907, issue is shown the method of repairing and reinforcing the body bolsters, as used at the Mt. Clair shops of the B. & O.

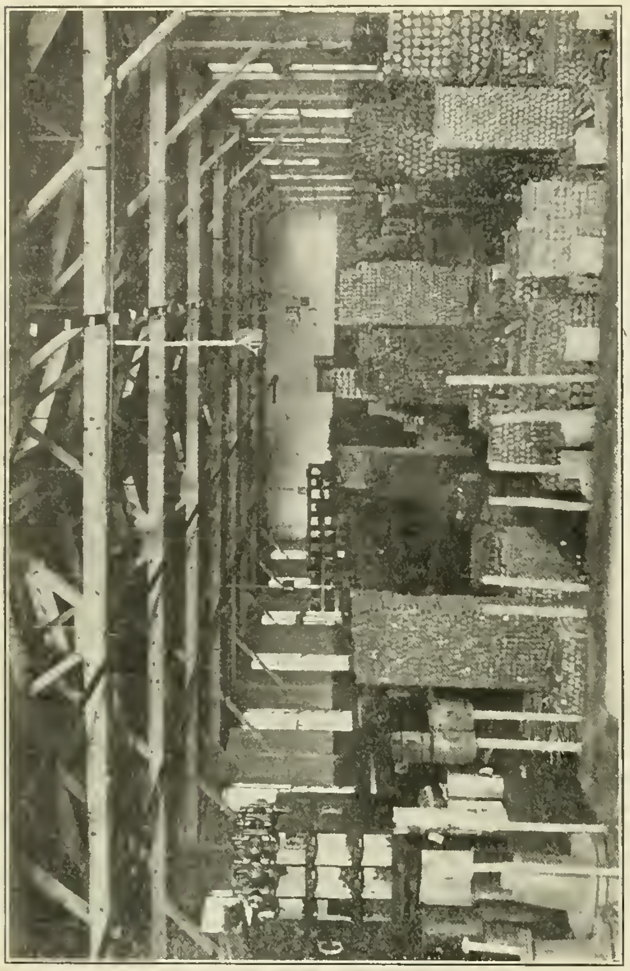


FIG. 39.—STOREROOM, EAST-BOUND REPAIR YARD.

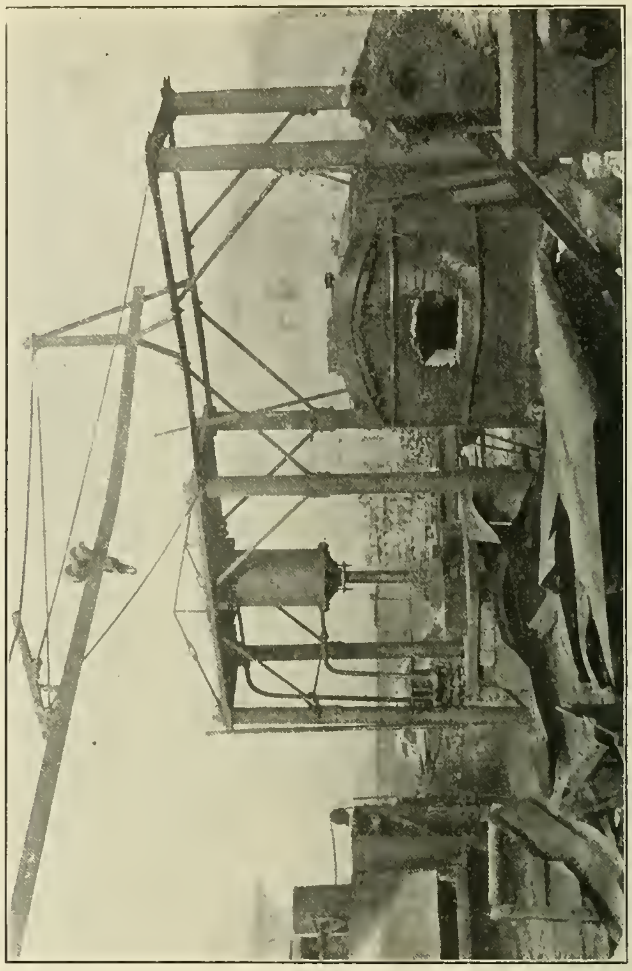


FIG. 40.—ONE OF THE STRAIGHTENING PRESSES, BLACKSMITH SHOP.

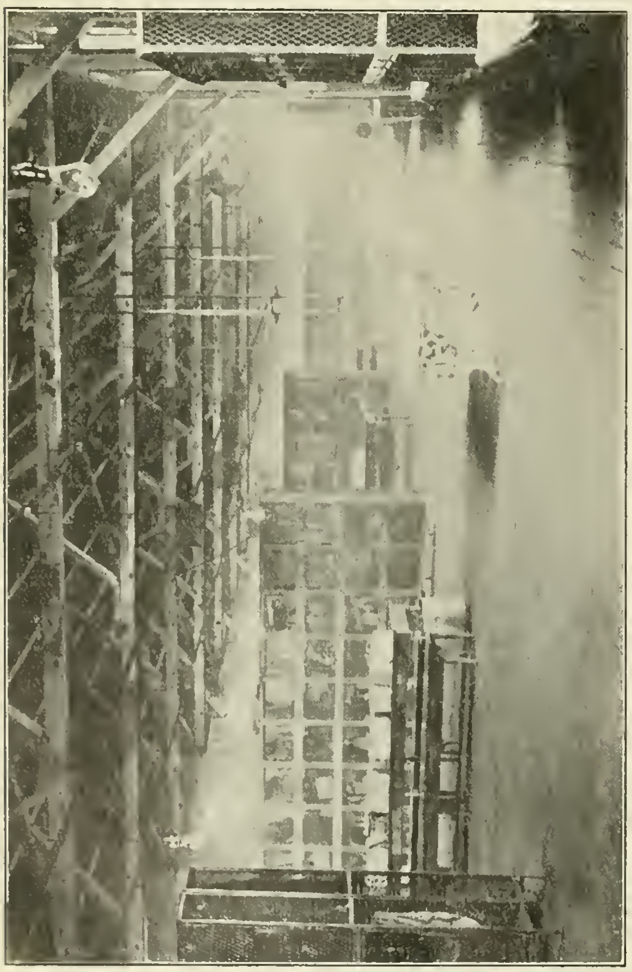


FIG. 37.—MEN'S ROOM, EAST-BOUND REPAIR YARD.

### FREIGHT SHOP.

The freight shop was built many years ago and is in the form of a round-house, the outer circle of which is 434 ft. in diameter, and having an open inner space 285 ft. in diameter, containing a 105 ft. turntable. The turntable is driven by a steam engine, and a small switch engine does the shifting. The width of the building inside is about 65 ft. It has 40 divisions or spaces. Thirty-four of these are used for repair purposes; three are in the form of tunnels and are used as running tracks; the remaining three divisions have two tracks only, and the space about them is devoted to the stores department for the storage of stock. Rivet heating forges are placed alongside two or three of the tracks upon which repairs to steel cars may be made. Cars are also repaired in the open space between the building and the turntable.

### STRAIGHTENING PARTS AT THE BLACKSMITH SHOP.[16]

The badly damaged steel parts are taken from the steel car shop, the freight shop and the west bound repair yard to the smith shop for straightening. This is done under a pneumatic press, which is shown in Figs. 40 and 41. A frame-work supports the 20 in. air cylinder. Underneath the cylinder is a foundation upon which a cast iron table, 6 in. thick, 4 ft. wide and 7 ft. long, is placed. The air in the cylinder is controlled by a pneumatic four-way valve at one side of the frame work.

There are two of these presses just outside one end of the blacksmith shop. With the aid of a few cast iron blocks and two or three men to handle and hammer the sheets it is possible to straighten any part of the car and bring it back to its original shape. This work is done by piece work, the men being paid a certain rate per 100 pounds of material straightened. It is remarkable how adept the men become in doing this work. At one

[16] At the Mt. Clair yards of the B. & O. this work is done in what is known as a flange fire shop, as described on page 162 of the May, 1907, issue.

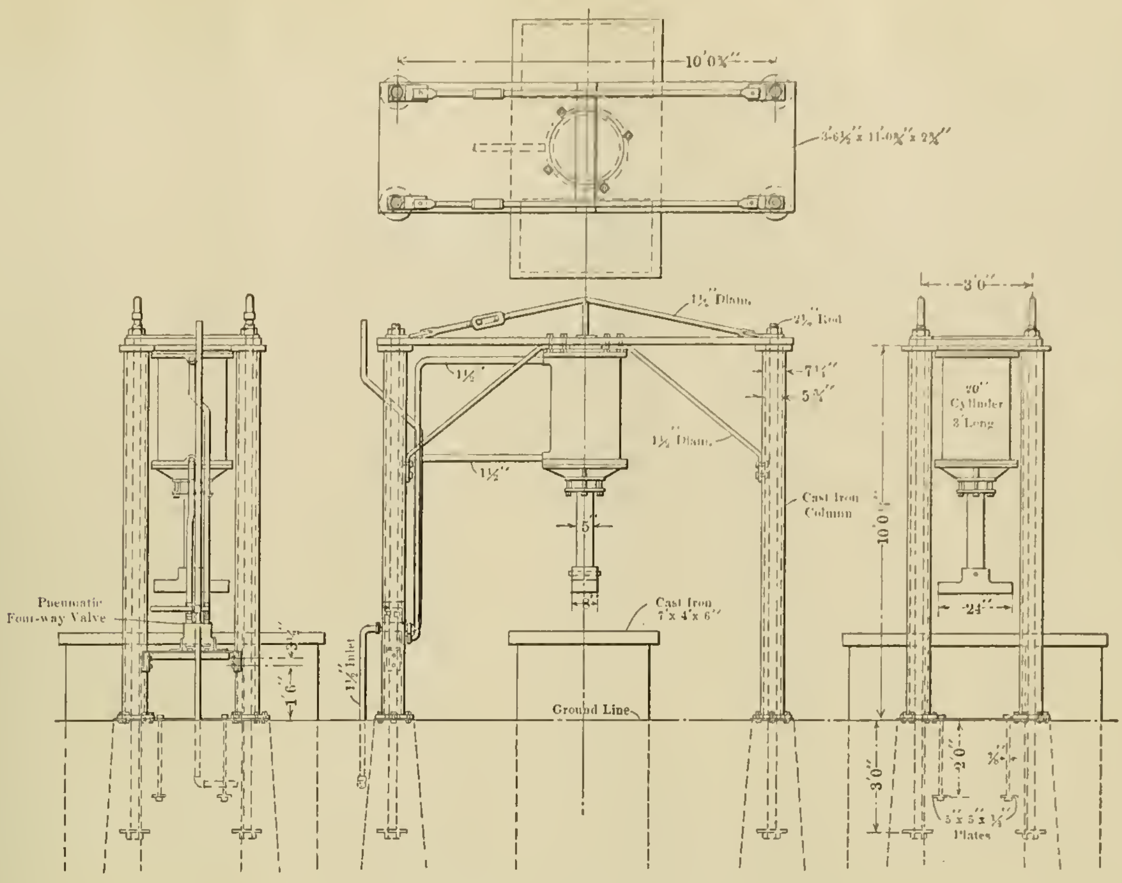


FIG. 41.—STRAIGHTENING PRESS, BLACKSMITH SHOP.

side of the press is a special oil furnace, with an opening 30 in. wide and 15 in. high, through which long material may be passed and any part of it heated locally. On the other side of the press is a large oil furnace for heating other parts. It has an opening 8 ft. wide and 21½ in. high at the center and is about 10 ft. deep.

## REPAINTING STEEL CARS.[17]

The question of repainting steel cars—how often they should be repainted and how it should be done—is a troublesome one. The inside of the car corrodes or deteriorates more rapidly than the exterior. The rapidity or extent to which this takes place depends upon the service to which the car is subjected. Where the car is in constant service and is not allowed to stand idle it is very slight. When allowed to stand with loads of coal, coke or cinders, especially during damp weather, it is more serious Experiments have been made to find some covering which would protect the interior of the car, but such materials as have been experimented with are quickly worn off by the friction of the lading.

The deterioration on the outside does not appear to be at all serious, the most notable instances of corrosion being opposite the hoppers at points where they have apparently been pounded with hammers or bars to loosen the lading. Frequent painting of the car would not do much good under such treatment. As the paint wears or flakes off the sheets become rusted, but it is a question as to whether the coat of rust does not to some extent protect the sheets. The underframes are protected from drippings from the inside of the car and where they were properly painted when they are built, are practically in as good condition as when they were first placed in service, although some of them are more than ten years old.

It would, therefore, appear that it is comparatively useless to repaint the interior of the car and that the necessity for repainting the exterior depends more on the appearance than on the effect which it would have on the life of the sheets. Surely it would not be policy to withdraw a car from service during busy times for repainting because of any increase in the life of the sheets which might result.

If the appearance of the cars is to govern the length of time before repainting them, the uncertain question as to just what will constitute a good appearance must be considered. If the appearance is to be first-class the car should be painted about once in three or four years, as against once in six or seven years for a wooden car. The expansion and contraction of the material, due to changes in temperature, the loading of the cars with hot cinders, and the fact that the paint does not adhere so readily to the steel as to the wood, makes repainting necessary more often than is the case with wooden equipment. As a matter of fact cars are running which have not been repainted since they were placed in service, six, seven, eight, nine, and even ten years ago.

At each of the car repair points in Altoona is a gang of painters, in charge of a gang leader, who look after the stenciling of the cars which are repaired and the painting of new or repaired parts. These men work by piecework, being paid a certain rate per square foot for painting and so much per letter for stenciling. The gang leaders report direct to the assistant paint foreman.

Where it is desired to repaint a car complete it is taken to the freight car paint shop, which is 109 x 512 ft. in size, and contains six tracks. Here the underframe and the body of the car are painted by a spraying machine. These machines consist of a tank, having a capacity of about 10 gallons, placed in a framework which may be wheeled about the shop. The arrangement of this apparatus and the details of the atomizer are shown in Fig. 42. The advantage of this type of spraying machine is that the atomizer is at the tank and only one hose extends from it to the car.

A visit to the paint shop showed that there was very little surplus paint on the ground about the car. The spraying machine has several advantages. Both labor and material are saved and better work is done. On a Gl hopper car only two-thirds as

[17] See also page 19 of the January, 1907, issue; page 173 of the May, 1907, issue; page 6 of the January, 1908, issue; and page 408 of the October, 1908, issue.

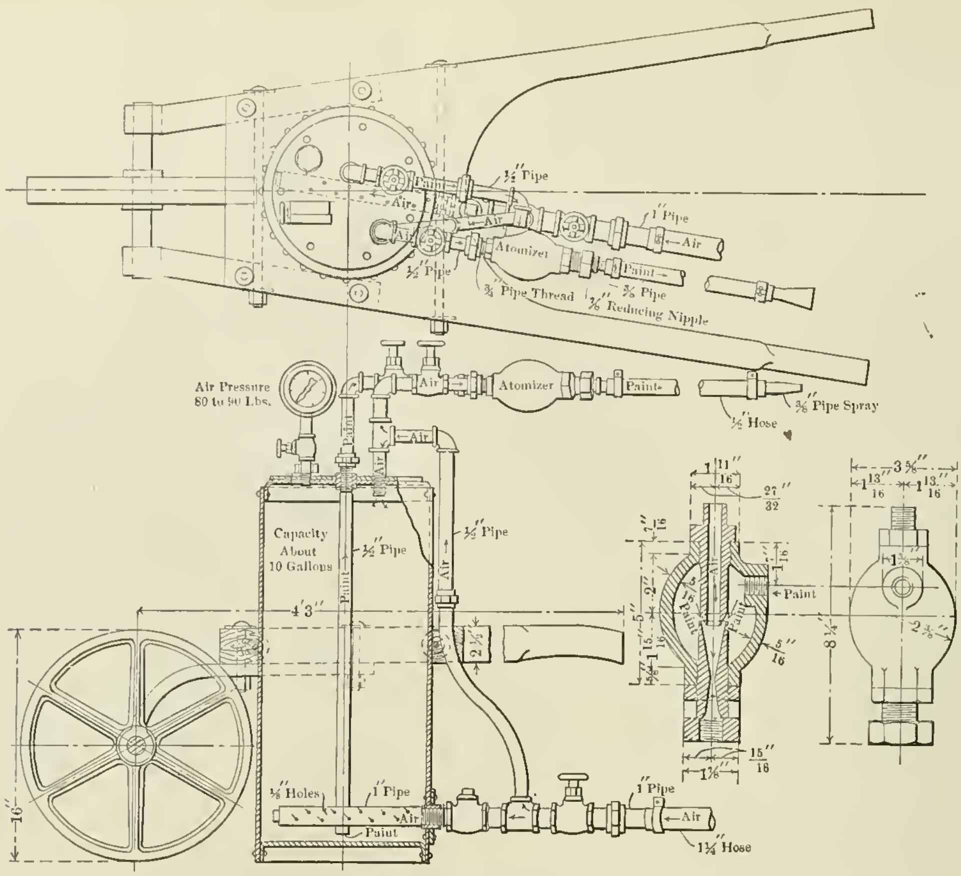



FIG. 42.—DETAILS OF PAINT SPRAYING MACHINE.

much paint is required with a spraying machine as by hand and the car can be painted in about one-half the time. The paint is also much more uniformly distributed. In painting with a brush, with the class of labor and the rate at which it is usually done, the rivets, bolt heads, etc. on the car pull the paint from the brush; any one who has watched the painting of freight cars will realize how much material is wasted in this way, at the same time detracting from the appearance of the car. Before repainting a car the rust is cleaned off with scrapers and wire brushes. Formerly two coats were used in repainting the steel cars, one of the standard black for use on steel or iron and the other of the standard Pennsylvania freight car color. During the past year or two, however, the cars have been given only one coat of paint, that being the standard freight car color.

The specifications for painting new cars require that all parts where metal is placed on metal, and either riveted or bolted, must be painted before assembling with a lute made by mixing one pound of lamp black with 9 pounds of linseed oil. All surfaces of the underframe and body, where metal is placed on metal, which are not accessible after assembling must be painted before assembling with one coat of black protective paint. After assembling all cracks must be thoroughly filled in with lute and all surfaces, which are accessible, must be painted with two coats of black protective paint after which the outside of the body, side sills and end sills, the bottom of the floor and all exposed parts under the slopes must be painted with a final coat of standard freight car color.

## A TEN MILLION POUND TESTING MACHINE.

The structural materials testing laboratory of the U. S. Geological Survey is having built, by Tinius Olsen & Co., of Philadelphia, a compression testing machine having a capacity of 10,000,000 pounds.

This machine will be capable of testing full size structures measuring 65 ft. high and having a section of 6 x 6 ft. This would easily take in a full sized structural steel part larger than was the chord which failed in the Quebec bridge.

The machine is a large verticle hydraulic press with one adjustable head and a weighing system which will record loads of 100 pounds on the regular beam, and smaller sub-divisions by means of an additional needle beam. It consists of a base containing the main hydraulic cylinder which has an effecive area of about 2,000 sq. in. upon which rests the lower head with a ball and socket bearing. The upper head is adjustable, through four vertical screws, 13½ in. in diameter and 72 ft. 2 in. long, by means of gearing operating four nuts provided with ball bearings. This head operating mechanism is controlled by the same motor which operates the compressor pump. The great length of the main screws necessitated splicing, which is accomplished as follows: In the center of the screw at the splice is a 3 in. threaded pin for the purpose of centering, the splice being made by means of long split sleeve nuts, which can be removed when it is necessary to lower the upper head below this point.

The hydraulic pressure is obtained from a triple plunger pump operated by means of a 15 h. p. variable speed motor. A needle valve is provided, which permits a constant load to be maintained on the compression cylinder.

The weighing device consists of a set of standard Olsen levers upon which is weighed 1-80 of the total load on the main cylinder, the reduction being effected through the medium of a small piston and diaphragm, the main cylinder having a diameter of 50 in. and the weighing cylinder of 5 9-16 in.

The main cylinder has a vertical movement of 24 in. and the upper head can be operated for adjustment at a speed of 10 in. per minute. The speed in applying loads varies from a minimum of 1-60 in. per minute to a maximum of ½ in. per minute. The contract provides that the machine shall have an accuracy of at least ⅓ of 1 per cent. for any load over 100,000 pounds up to its capacity.

The steam when skilfully made by the fireman must be skilfully and economically distributed in the cylinders if we wish to get power and speed from the steam for moving the train.

# DATA OF SPECIAL INTEREST TO THE DRAFTING ROOM.

## HELICAL SPRINGS.

| Outside Dia. of Coil | 3/8" Steel Load Solid | Hg't Free | 7/16" Steel Load Solid | Hg't Free | 1/2" Steel Load Solid | Hg't Free | 9/16" Steel Load Solid | Hg't Free | 5/8" Steel Load Solid | Hg't Free | 11/16" Steel Load Solid | Hg't Free | 3/4" Steel Load Solid | Hg't Free | 13/16" Steel Load Solid | Hg't Free | 7/8" Steel Load Solid | Hg't Free | 15/16" Steel Load Solid | Hg't Free |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1,020 | 1.38 | 1,680 | 1.26 | 2,600 | 1.18 | | | | | | | | | | | | | | |
| 2¼ | 883 | 1.50 | 1,450 | 1.35 | 2,250 | 1.25 | 3,300 | 1.18 | | | | | | | | | | | | |
| 2½ | 780 | 1.64 | 1,270 | 1.44 | 1,970 | 1.32 | 2,900 | 1.24 | 4,100 | 1.18 | | | | | | | | | | |
| 2¾ | 698 | 1.80 | 1,140 | 1.56 | 1,750 | 1.41 | 2,550 | 1.30 | 3,600 | 1.23 | 4,900 | 1.18 | | | | | | | | |
| 3 | 631 | 1.98 | 1,030 | 1.68 | 1,580 | 1.50 | 2,300 | 1.37 | 3,200 | 1.29 | 4,400 | 1.23 | 5,900 | 1.18 | | | | | | |
| 3¼ | | | 935 | 1.83 | 1,430 | 1.61 | 2,100 | 1.46 | 2,900 | 1.36 | 4,000 | 1.28 | 5,300 | 1.22 | 6,900 | 1.18 | | | | |
| 3½ | | | 858 | 1.98 | 1,310 | 1.72 | 1,910 | 1.54 | 2,650 | 1.42 | 3,600 | 1.33 | 4,800 | 1.27 | 6,300 | 1.22 | 8,000 | 1.18 | | |
| 3¾ | | | | | 1,210 | 1.85 | 1,760 | 1.64 | 2,450 | 1.50 | 3,300 | 1.40 | 4,400 | 1.32 | 5,800 | 1.26 | 7,300 | 1.22 | 9,200 | 1.18 |
| 4 | | | | | 1,130 | 1.98 | 1,630 | 1.75 | 2,300 | 1.58 | 3,100 | 1.46 | 4,100 | 1.38 | 5,300 | 1.31 | 6,700 | 1.25 | 8,500 | 1.21 |
| 4¼ | | | | | | | 1,520 | 1.86 | 2,100 | 1.67 | 2,850 | 1.54 | 3,800 | 1.44 | 4,900 | 1.36 | 6,200 | 1.30 | 7,800 | 1.25 |
| 4½ | | | | | | | 1,420 | 1.98 | 1,980 | 1.77 | 2,650 | 1.61 | 3,500 | 1.50 | 4,600 | 1.41 | 5,800 | 1.34 | 7,300 | 1.29 |
| 4¾ | | | | | | | | | 1,860 | 1.87 | 2,500 | 1.70 | 3,300 | 1.57 | 4,300 | 1.47 | 5,400 | 1.39 | 6,800 | 1.33 |
| 5 | | | | | | | | | 1,760 | 1.98 | 2,350 | 1.79 | 3,100 | 1.64 | 4,000 | 1.53 | 5,100 | 1.44 | 6,400 | 1.38 |
| 5¼ | | | | | | | | | | | 2,250 | 1.88 | 2,950 | 1.72 | 3,800 | 1.59 | 4,800 | 1.50 | 6,000 | 1.42 |
| 5½ | | | | | | | | | | | 2,100 | 1.98 | 2,800 | 1.80 | 3,600 | 1.67 | 4,600 | 1.55 | 5,700 | 1.47 |
| 5¾ | | | | | | | | | | | | | 2,700 | 1.89 | 3,400 | 1.74 | 4,300 | 1.62 | 5,400 | 1.53 |
| 6 | | | | | | | | | | | | | 2,550 | 1.98 | 3,300 | 1.81 | 4,100 | 1.69 | 5,100 | 1.58 |
| 6½ | | | | | | | | | | | | | | | 3,000 | 1.98 | 3,800 | 1.83 | 4,700 | 1.71 |
| 7 | | | | | | | | | | | | | | | | | 3,400 | 1.98 | 4,300 | 1.84 |
| 7½ | | | | | | | | | | | | | | | | | | | 3,900 | 1.98 |

FORMULA USED IN COMPUTING TABLE

$$P = \frac{S \pi d^3}{16 r}$$

P = load at solid height
S = fibre stress — 80,000#
d — diameter of steel
r — radius of center of coil

| Outside Dia. of Coil | 1" Steel Load Solid | Hg't Free | 1 1/16" Steel Load Solid | Hg't Free | 1⅛" Steel Load Solid | Hg't Free | 1 3/16" Steel Load Solid | Hg't Free | 1¼" Steel Load Solid | Hg't Free | 1 5/16" Steel Load Solid | Hg't Free | 1⅜" Steel Load Solid | Hg't Free | 1 7/16" Steel Load Solid | Hg't Free | 1½" Steel Load Solid | Hg't Free |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 10.500 | 1.18 | | | | | | | | | | | | | | | | |
| 4¼ | 9.700 | 1.21 | 11.800 | 1.18 | | | | | | | | | | | | | | |
| 4½ | 9 000 | 1.25 | 10.900 | 1.21 | 13.300 | 1.18 | | | | | | | | | | | | |
| 4¾ | 8.400 | 1.28 | 10.200 | 1.24 | 12.400 | 1.21 | 14.800 | 1.18 | | | | | | | | | | |
| 5 | 7.900 | 1.32 | 9.500 | 1.28 | 11.600 | 1.24 | 13.800 | 1.21 | 16.400 | 1.18 | | | | | | | | |
| 5¼ | 7.400 | 1.36 | 8.900 | 1.31 | 10.900 | 1.27 | 13.000 | 1.23 | 15.300 | 1.21 | 18.000 | 1.18 | | | | | | |
| 5½ | 7.000 | 1.41 | 8.400 | 1.35 | 10.300 | 1.30 | 12.200 | 1.26 | 14.500 | 1.23 | 16.900 | 1.20 | 19.800 | 1.18 | | | | |
| 5¾ | 6.600 | 1.45 | 8.000 | 1.39 | 9.700 | 1.34 | 11.500 | 1.30 | 13.700 | 1.26 | 16.000 | 1.23 | 18.700 | 1.20 | 21.700 | 1.18 | | |
| 6 | 6.300 | 1.50 | 7.600 | 1.43 | 9.200 | 1.37 | 10.900 | 1.33 | 12.900 | 1.29 | 15.100 | 1.26 | 17.600 | 1.23 | 20.400 | 1.20 | 23.600 | 1.18 |
| 6½ | 5.700 | 1.61 | 6.900 | 1.52 | 8.300 | 1.46 | 9.900 | 1.40 | 11.700 | 1.36 | 13.700 | 1.31 | 16.000 | 1.28 | 18.500 | 1.25 | 21.200 | 1.22 |
| 7 | 5.200 | 1.72 | 6.300 | 1.63 | 7.600 | 1.54 | 9.000 | 1.48 | 10.700 | 1.42 | 12.500 | 1.38 | 14.600 | 1.33 | 16.800 | 1.30 | 19.300 | 1.27 |
| 7½ | 4.800 | 1.85 | 5.800 | 1.73 | 7.000 | 1.64 | 8.300 | 1.56 | 9.800 | 1.50 | 11.500 | 1.45 | 13.400 | 1.40 | 15.400 | 1.36 | 17.700 | 1.32 |
| 8 | 4.500 | 1.98 | 5.400 | 1.85 | 6.500 | 1.75 | 7.700 | 1.66 | 9.100 | 1.58 | 10.600 | 1.52 | 12.400 | 1.46 | 14.200 | 1.42 | 16.300 | 1.38 |
| 8½ | | | 5.000 | 1.98 | 6.100 | 1.86 | 7.200 | 1.76 | 8.500 | 1.67 | 9.900 | 1.60 | 11.500 | 1.54 | 13.200 | 1.48 | 15.200 | 1.44 |
| 9 | | | | | 5.700 | 1.98 | 6.700 | 1.87 | 7.900 | 1.77 | 9.200 | 1.69 | 10.700 | 1.61 | 12.300 | 1.55 | 14.200 | 1.50 |
| 9½ | | | | | | | 6.300 | 1.98 | 7.400 | 1.87 | 8.600 | 1.78 | 10.100 | 1.70 | 11.600 | 1.63 | 13.300 | 1.57 |
| 10 | | | | | | | | | 7.000 | 1.98 | 8.200 | 1.88 | 9.500 | 1.79 | 10.900 | 1.71 | 12.500 | 1.64 |

(*From the American Locomotive Company's Standard Practice.*)

### CALCULATIONS.

In obtaining the net static load, the actual weights of the parts constituting dead load, such as wheels, axles, boxes, etc., should be deducted instead of taking a certain arbitrary percentage.

Maximum fibre stress allowable 80,000 pounds, when springs are solid. The figures given in the table in the "Load" column are the calculated loads which will bring springs solid at 80,000 pounds fibre stress.

It is advisable usually to make the capacity of springs slightly more than the net actual load, as given below.

The static load for helical springs must not exceed one-half the load required to bring the springs solid.

### REQUIRED CAPACITY.

DRIVING AND ENGINE TRUCK SPRINGS: Use calculated static load plus 500 to 1,000 pounds, or about 5 per cent.

TRAILING SPRINGS: Use calculated static load plus 15 per cent.

TENDER SPRINGS: Use calculated static load taken with three-quarters of maximum load of coal and water.

Spring Tables for helical springs give the capacity or load, for all heights, when spring is solid; the height free is per one inch of solid height.

## PISTON THRUST.

| CYLINDER. | | BOILER PRESSURE--Pounds | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DIAMETER | AREA | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 |
| 17" | 226.98 | 34050 | 36320 | 38590 | 40860 | 43130 | 45400 | 47670 | 49940 |
| 17½" | 240.53 | 36075 | 38475 | 40885 | 43285 | 45690 | 48095 | 50505 | 52905 |
| 18" | 254.47 | 38175 | 40720 | 43265 | 45810 | 48355 | 50900 | 53445 | 55995 |
| 18½" | 268.80 | 40320 | 43008 | 45695 | 48385 | 51075 | 53760 | 56450 | 59135 |
| 19" | 283.53 | 42525 | 45360 | 48195 | 51030 | 53865 | 56700 | 59535 | 62370 |
| 19½" | 298.65 | 44790 | 47775 | 50760 | 53745 | 56730 | 59720 | 62705 | 65690 |
| 20" | 314.16 | 47130 | 50270 | 53415 | 56555 | 59700 | 62840 | 65985 | 69120 |
| 20½" | 330.06 | 49500 | 52800 | 56100 | 59400 | 62700 | 66000 | 69300 | 72600 |
| 21" | 346.36 | 51960 | 55425 | 58890 | 62350 | 65815 | 69280 | 72740 | 76210 |
| 21½" | 363.05 | 54450 | 58080 | 61710 | 65340 | 68970 | 72600 | 76230 | 79860 |
| 22" | 380.13 | 57000 | 60800 | 64600 | 68400 | 72200 | 76000 | 79800 | 83600 |
| 22½" | 397.61 | 59635 | 63615 | 67590 | 71570 | 75540 | 79520 | 83490 | 87470 |
| 23" | 415.48 | 62320 | 66480 | 70630 | 74790 | 78950 | 83100 | 87250 | 91410 |
| 23½" | 433.74 | 65050 | 69390 | 73730 | 78070 | 82400 | 86740 | 91060 | 95420 |
| 24" | 452.39 | 67860 | 72380 | 76910 | 81430 | 85950 | 90480 | 95000 | 99530 |
| 24½" | 471.44 | 70710 | 75420 | 80130 | 84850 | 89570 | 84270 | 98990 | 103630 |
| 25" | 490.87 | 73630 | 78540 | 83450 | 88360 | 93270 | 98180 | 103080 | 108000 |
| 25½" | 510.71 | 76600 | 81710 | 86810 | 91920 | 97030 | 102130 | 107240 | 112350 |

(Established 1832).

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**Advertisements.**—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

**Contributions.**—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of offcial changes, and additions of new equipment for the road or the shop, by purchase or construction.*

## CONTENTS



## IMPROVEMENT IN LOCOMOTIVE FIRE BOXES.

On page 106 of this issue is illustrated what we believe to be the most radical change in the construction of locomotive fire-boxes that has ever been suggested, outside of a water tube equipment. Anything which will improve the steam-making capacity, decrease the cost of maintenance and increase the safety of a locomotive boiler is to be welcomed and it is with these three features in mind, accompanied by a desire for other less important improvements, that this design has been made. The matter of cost and rapidity of manufacture and renewal has been given careful attention and the different sections are all formed by dies and drilled from templets, so that they are exactly interchangeable in every way. This work is being done so accurately that when a complete fire-box is temporarily bolted in place a line of sight can be taken through any of the rivet holes throughout the length of the box, either inside or out, and the use of drift pins or forcing in any way is not required. This makes it possible to quickly and cheaply renew any section which may fail for any reason and greatly decreases the cost of manufacture. The opportunity for using very thin sheets, with their greater flexibilty and increased conductivity, for the inside fire-box sheets is also an important one, and should greatly assist in reducing maintenance troubles and cost, as well as improving the steaming capacity.

Taken altogether this design is worthy of the most careful study and we shall be glad to receive and publish the opinions our readers may form of it. That the Santa Fe officers have confidence in it, is evident from the fact that it has been specified for use on the two articulated type passenger locomotives now building at the Baldwin Locomotive Works which will be the largest locomotives in the world. In addition to this it is also being applied to some Santa Fe type locomotives at Topeka.

## OUR NEXT ISSUE.

Our April issue will be of a special nature and will be devoted largely to railroad shop practice and machine tools. During the past year or so, while business has been dull, the machine tool builders have given considerable attention to re-designing and improving their tools, and as the railroads will shortly be in the market for considerable equipment of this kind a special issue, of the above mentioned nature, will prove timely.

## CORRESPONDENCE.

In view of the vitally important part which letter-writing plays in the scheme of modern business it is somewhat surprising that more attention is not given to the instruction and training of men, often officials as well as clerks, in the proper principles and rules for obtaining the best results. If it were possible to compute the amount of time which is practically wasted by high salaried men in wading through a long and rambling letter, which more often than not, does not contain the desired information, the result would no doubt be so striking as to cause immediate attention to this subject. The story of the wrecking boss Harrigan illustrates a principle which is too often forgotten, even in railroad offices.

In addition to the principles of writing letters, the handling of the mail, particularly in connection with general offices, is in a majority of cases capable of considerable improvement, and can often be made to show direct savings of surprising amounts. In reporting on this feature recently a committee of the Association of Transportation and Car Accounting Officers stated that by having the mail for each address assembled and consolidated at regular intervals during the day in the different general offices or departments a saving of over 40 per cent. in the number of pieces handled could be made and a saving of from 75 to 100 dollars per month for postage on U. S. mail could be attained at one office investigated.

Mention of this feature was also made in connection with the instructions to chief clerks incorporated in the article on the organization of the motive power department of the L. S. & M. S. Ry., published in the December number of this journal; the section referred to being on page 468.

# THE RAILWAY BUSINESS ASSOCIATION—AN INSIDE VIEW

G. M. Basford.

For sixty days out of the one hundred and twenty days of the life of the Railway Business Association it has been the good fortune of the writer to be associated with this unique movement, and it is with regret that pressure of his own work makes it necessary for him to turn over to other hands the official duties of the position of secretary. A pleasant obligation will be fulfilled if some additional light may be thrown upon the accomplishments and possibilities of the work of the association from the inside.

It is doubtful if any association has ever before in such a brief period received such co-operation and recognition. Never before have the commercial interests dealing directly with the railroads been organized in such a way as this.

For very well understood reasons the railroads have not yet begun to share in the return of prosperity and while many commercial interests are busier than they were, those concerned in supplying railroads with material and equipment have been unable to secure orders sufficient to put their men back on full time. This serious situation brought together our members in an effort to effect a change in public opinion which would lead to an improvement of the general railroad situation and aid in restoring to prevent extremes in legislation constitutes a permanent

This movement was not only necessary but timely. The pendulum of popular sentiment had swung adversely to the railroads and swung too far, as indicated by a large amount of legislation, which affected the transportation interests by increasing the cost of railroad operation, while curtailing revenues.

At a recent dinner in New York the statement was made that during the years 1906 and 1907 the British Parliament enacted 114 laws for the government of Great Britain and Colonies, whereas during the same time Congress and the State Legislatures of the United States enacted 25,000 laws. It is reasonable to doubt that 12,000 wise laws, per year, can be enacted in any country. The thinking people who constitute the safeguard of the nation had begun to recognize that the railroad interests could not be adversely affected by restrictive legislation without affecting all other human interests. There has been no general sentiment in favor of weakening restriction of railroads, but there is a growing conviction that restriction must be intelligent.

The way in which the members of the association rallied to the call is scarcely more impressive than the ready support of the commercial public. By a combination of very important manufacturing concerns into a good-natured association, public opinion has crystallized to a gratifying extent and legislators, both State and National, have heard from the people in a voice devoid of quavering.

Some of the largest commercial associations have been ready and willing at the suggestion of the Association to make pacific utterances. Responses from the largest cities and from National Associations covering the entire country have been surprising. The voice asking for legislative quiet and for true statesmanship with respect to railroad enactments has come from many directions and from many interests, some of them being entirely separated from railroad affairs. Those, for instance, who make and sell shoes have co-operated through their national organizations to indicate appreciation of the fact that the welfare of those concerned in transportation is involved with their own welfare to such an extent as to justify a long step from their beaten paths to correct the unfortunate situation in which our members find themselves.

One reason for this co-operation lies in the recognition of the fact that the personnel of the association is remarkable in including men known for the most successful engineering, manufacturing, and commercial achievements. Some of our constituent concerns are as large commercially as a fairly large railroad. The number of men employed by such concerns as are represented in our membership is as great as the number employed by the railroads. Our association has conflicting competitive interests, all united in the bond of good fellowship to carry out the plan which makes for the common good. This plan is conducted absolutely independently of the railroads. It has been shown for the first time to be possible for influence outside of the railroads to band together to promote by organized action a realization of the inter-dependence between the public and the transportation interests.

Our activities are by this time very well known. In four months the fact has been demonstrated that the people are ready not only to acknowledge what the railroads have done for the country, but to give transportation questions the consideration which they deserve. To turn the light on obscure questions affecting the relation between the people and the railroads, tending to prevent extremes in legislation constitutes a permanent work for this organization.

Not all the work already accomplished has been easy. The railroads as well as the public have their part to do and the work of the association will include efforts to bring about a permanent friendly relationship. This cannot be done in a short time.

One of the most effective elements of the success of this association is the generous good fellowship of its members. The organization already extends into sixteen States and often competitive interests in the same city are united in local achievement. No discordant notes are heard in the conduct of its affairs and it is inconceivable that any will be heard under the leadership of such a personality as that of the president of the association, sustained by, and enjoying, the constant counsel of the able, energetic and potential men who compose its general executive committee. These two months in the executive office have been so crowded with important developments that they have seemed exceedingly short.

At the outset reasonable doubt of the possibilities of the movement may have been justified. Some may have felt that it was too intangible and experimental to win their instant support. Now there is no room for doubt. It is no longer experimental. The writer regrets that because of compelling business obligations he cannot continue in direct co-operation with a work so inspiring. This brief time has convinced him that the need for the organization was great, the field for its efforts wide, the plan of its work effective.

It is equally clear that so much remains to be done as to justify the question: How can any concern engaged in supplying the railroads with their requirements, delay enrollment in the Railway Business Association?

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Fulton Bill Reported Adversely.—Senator Elkins in reporting the Fulton amendment adversely said: "The country is now demanding repose in its industrial upbuilding. It is not a time to experiment and to change the basis upon which the former acts to regulate commerce have been predicated. The recent law passed by Congress so greatly enlarging the authority of the commission should, before changes are sought, have the opportunity of at least a fair trial as to the value of its provisions in the regulation of interstate commerce. When trial has been given and normal conditions have been restored, any defect in the regulating statute can then, in the light of experience, be promptly passed."

# JACOBS-SHUPERT LOCOMOTIVE FIRE BOX.

H. W. JACOBS.

Much effort and study have been expended upon the locomotive boiler to improve its efficiency in the generation of steam and to promote economy in its cost of maintenance. Many improvements have been made in its design and construction; yet no radical departure from early practice has been made since the locomotive reached its present general arrangement. Attempts at improvement have included a decided increase in size, a slight alteration of the general form, the occasional introduction of water tubes or the combustion chamber, and the widening of the water leg. The demand for greater tractive power has caused the enlargement of grate areas and the shape of firebox sheets and wrapper sheets has been modified. In the main, however, the principles long ago established have been adhered to until the present.

Long experience and careful study of the prevailing design, however, has led to the decision that improvements can be made in the arrangement and construction, and that the following results can be obtained:

1. The maximum of strength due to the form without artificial support, such as from stays.
2. A greater strength with a reduction in thickness and weight of material.
3. An increase of circulation of the water inside.
4. An increase in the circulation of the gases outside.
5. An increase of transference of heat from the gases to the water per unit of surface.
6. A reduction of weight in proportion to steaming power.
7. A greater heating surface in proportion to weight.
8. A reduction of fuel consumed per effective horse power.
9. A reduction of water delivered with the steam.
10. A reduction of heat delivered into the atmosphere.

The firebox meeting these requirements has been designed, and three are now under construction in Topeka shops of the Santa Fe Railroad. These boxes are being applied to what is known as the "Santa Fe type" engine, which is the largest engine in the world of rigid wheel-base design. This same type of firebox is also to be applied to the new passenger Mallet type engines, which will be the largest locomotives in the world of any type.

FIG. 1.—VIEW OF COMPLETED BOILER WITH JACOBS-SCHUPERT FIREBOX.

In this firebox the usual arrangement of flat sheets supported by staybolts has been abandoned except in the front sheets and door sheets. Side sheets and wrapper sheet have been replaced by sets of channel-shaped sections riveted together with their flanges away from the fire. Staybolts have been replaced by stay sheets, one at each joint of the channels, which are interposed between the sections and secured by the same rivets that

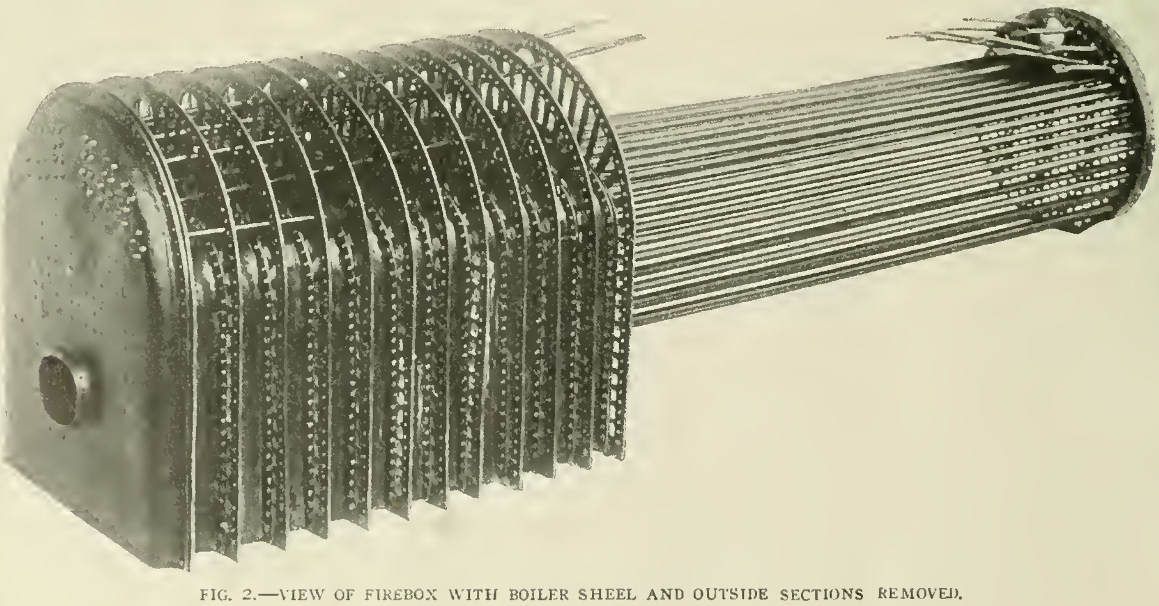


FIG. 2.—VIEW OF FIREBOX WITH BOILER SHEEL AND OUTSIDE SECTIONS REMOVED.

hold adjacent flanges. These sheets are partially cut away in the water leg, as shown in Fig. 2, to permit horizontal circulation of water around the firebox and the edges of the sheets form caulking strips for making tight joints between adjacent channel sections. All seams are submerged and no joints are exposed to the direct current of heat and gases. Due to the irregular outline thus formed for the firebox crown and sides, the available heating surface of the hottest section of the boiler is enlarged without increasing the size of the grate area. A mud-ring of either the ordinary type or a special design consisting of cast steel pockets, may be used.

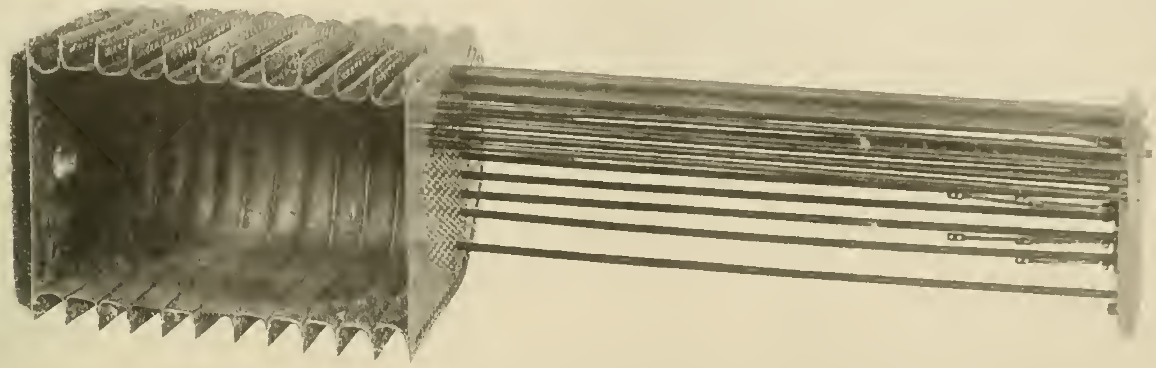


FIG. 3.—BOTTOM VIEW OF FIREBOX WITHOUT MUDRING OR OUTSIDE SHEETS.

In the fabrication of this firebox all the work is done by means of templets, jigs and formers, so that each one of the component parts is exactly like every other one, and all are interchangeable. This is achieved absolutely independent of the skill of the operators.

This construction presents many advantages over the usual design with very few counteracting disadvantages. The most striking features of advantage are:

SAFETY.

Due to its sectional construction this type of firebox is less liable to violent explosions than the ordinary type. Disastrous results of explosions with the ordinary firebox are shown in Figs. 4 and 5. With the ordinary construction when there is a weak place in the sheet, the pressure causes the sheet to be torn at that point. The larger the fracture, the larger is the leverage and the pressure acting with this increased leverage will rip out large portions of the sheet before it is relieved. It is the sudden opening up of these large holes that causes the violent explosions. There is practically nothing to check a break in the ordinary firebox sheet and, when it is once started, it is very liable to continue until much damage is done. In the sectional construction, however, it is impossible for a break to extend from one section to the other, and should a rupture occur in any section it will be simply a local break and cannot pass beyond the stay sheets to which the sections are riveted. The pressure will have no increased leverage to rupture the sheet in the original break, and consequently no violent explosion can occur which will give anything like the disastrous results shown in Figs. 4 and 5.

NO LOCALIZED STRESSES.

The arched, pressure-withstanding, concave construction (Fig. 6-c) of the sections insures that there will be no undue and enormous local stresses due either to the pressure or induced by large differences or sudden changes in temperature at different points. The shape of each section is such that it will expand or contract with variations of temperature, and produce only small stresses on the adjacent sections. This is not true of the usual firebox (Fig. 6-a). This sectional construction is specially adapted to relieve the excessive stresses that are set up in the ordinary construction by the local difference in temperature due to cold feed-water. When cold water is injected into the boiler, the temperature of the side sheet is very much reduced, and the effect is to contract the side sheet at its lower portion while it is expanded at its upper section. The forces induced by contraction and expansion, due to changes in temperature, are practically irresistible, and if no provision is made to take care of the contraction or expansion, there will be enormous local stresses set up in the metal.

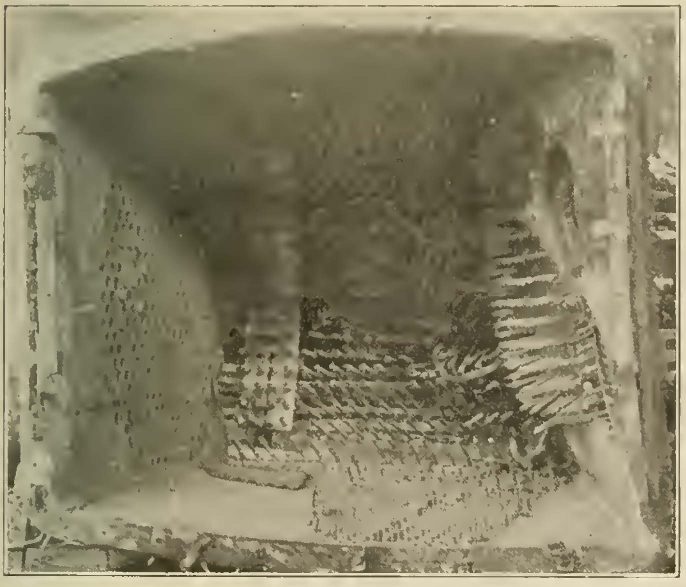


FIG. 4.—RUPTURED CROWN SHEET.

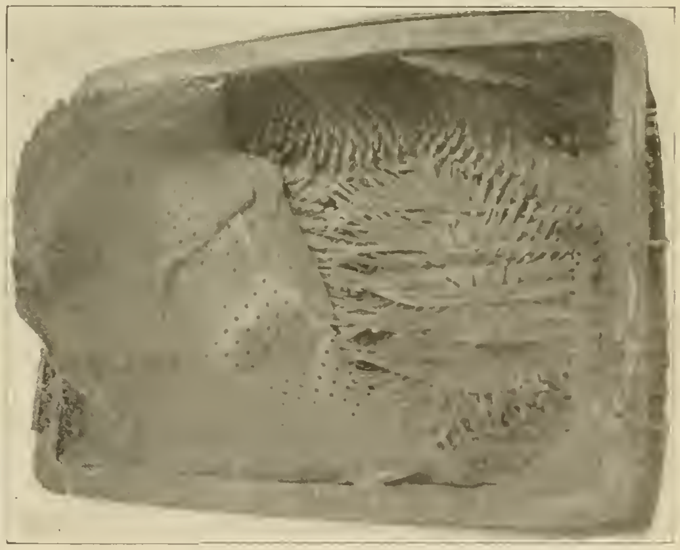


FIG. 5.—RUPTURED CROWN SHEET.

Take, for example, a sheet six feet in length, and assume that its temperature is suddenly lowered by 200 degrees; the metal will contract until its length is reduced from 72 inches to 71.91 inches, or about .1 inch. If no provision is made to take care of this change in length, local stresses will be set up in the metal as great as 36,000 lbs. per square inch. This is the value of the elastic limit of good steel and three times as great a pressure as should be used with safety under good conditions.

NO BURNED SEAMS.

All seams are submerged (Fig. 6-d), and thus are not subject to the danger of burning and leaking. The stay sheets between the channel and arch sections serve readily as caulking strips.

LOW MAINTENANCE COST.

Due to the design, and also to the absence of staybolts and crown-bar bolts, the maintenance cost of the boiler should be very much lower than with present usual construction. The maintenance cost would be approximately something over 40 per cent. less than is now the case. As the cost of maintenance and renewals of fireboxes, staybolts, and flues amount to an approximate expenditure of $2,000,000 per year on a road having 2,000 locomotives, this firebox should bring about a reduction of over $800,000 yearly in this expense.

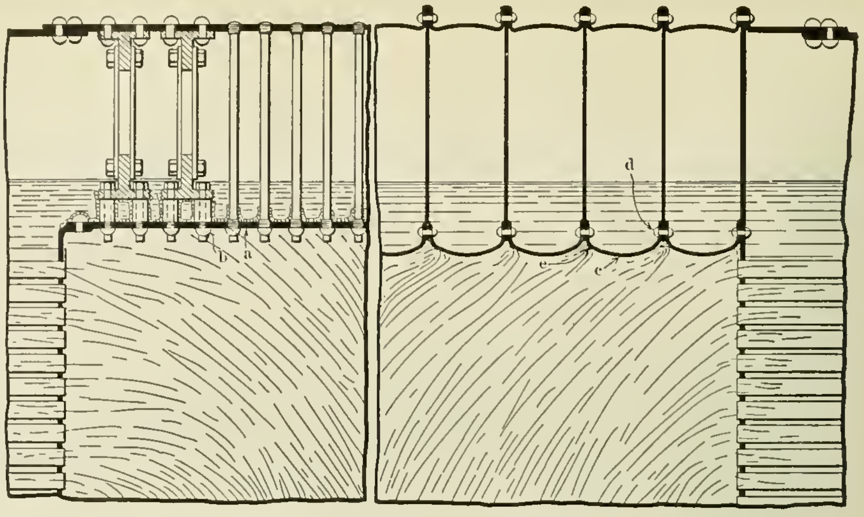
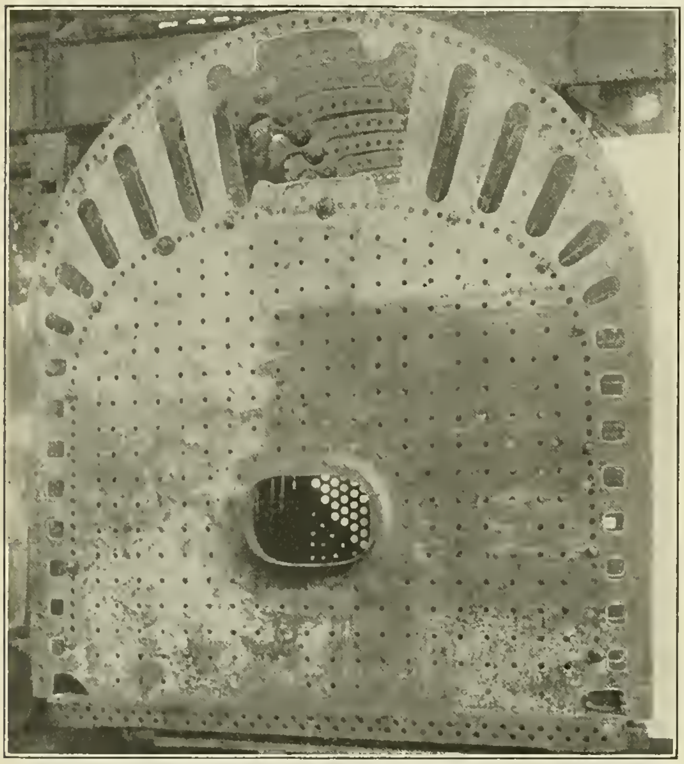



FIG. 6.



VIEW SHOWING WAY IN WHICH STAY SHEETS ARE CUT OUT.

USES THINNER SHEETS.

Owing to the absence of large local strains from unequal expansion and contraction (Fig. 6-c) the firebox sections can be thinner than in the design with flat sheets and stays (Fig. 6-a); also owing to the absence of any side staybolts and crown-bolt heads (Fig. 6-b), the heat will be transmitted to the water more rapidly, and it will cause a greater evaporation for a firebox of the same grate area and heating surface, and per pound of coal burned.

It is a fact requiring no demonstration that heat flows from hotter bodies to cooler bodies. This transfer of heat, however, is not instantaneous, but continuous through a period of time. In two bodies of the same temperature no heat transfer takes place, and it is obvious that beginning with this condition, the transfer must be very slight and slow when one body is only a little hotter than the other. The diagrams (Figs. 7, 8, 9) will illustrate this.

In Fig. 7 the two bodies are of the same temperature, and there is no heat transference owing to the temperatures being balanced.

In Fig. 8 there is a slight and slow flow of heat from the warmer body to the colder owing to the small difference in the temperature. It is well known that the pressure of water from a standpipe increases with the increase in height—that is, with the difference between the level of the source and discharge. The same principle holds true of temperature levels.

In Fig. 9 the heat differences are relatively greater, and the heat flow consequently more rapid. This flow of heat takes place as indicated irrespective of whether the warm and cold bodies touch each other (or are indeed portions of the same object at different temperatures) or whether the heat has to traverse some intermediary, such as air, a wall of metal or other substance, or a body of water or other fluid. In the case of a fluid intermediary, the circulation assists the heat flow.

The transfer of heat through metal is usually considered proportional to the difference in temperature of the two sides of the metal. The greater the difference in temperatures, the greater the quantity of heat that passes through the metal in a given time.

This fact is shown graphically in Fig. 10. The hot gases are on one side of the metal and the colder water is on the other side. If the temperatures are plotted vertically, and the thickness plotted horizontally, lines connecting the two temperatures will give the relative rates of heat transference.

The steeper the line, the greater quantity of heat that will be transferred in a given time. For instance, the slope of the line AB is less than that of AC in Fig. 10, showing that less heat passes through the metal per unit of time when the water has a

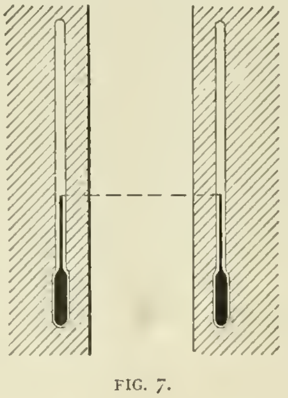


FIG. 7.

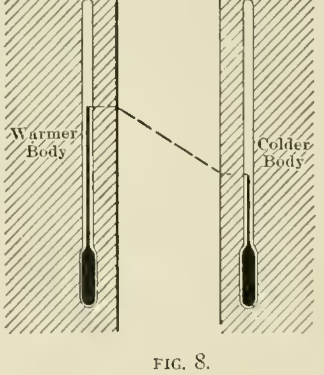



FIG. 8.

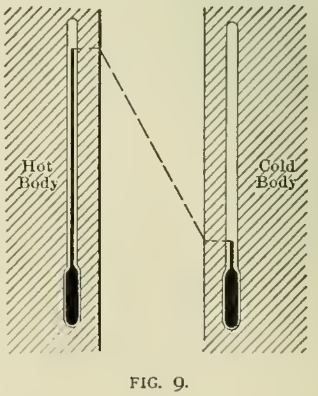



FIG. 9.

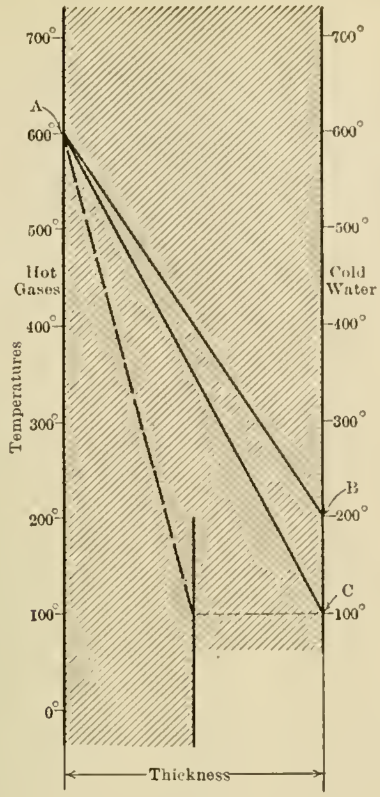



FIG. 10.

temperature of 200 degrees than when it has a temperature of 100 degrees.

If the metal were only half as thick and there was the same temperature difference, the slope of the heat flow line would be much greater, showing that more heat is transferred through thin than through thick metal in the same period of time.

Careful experiments, as well as mathematical demonstrations, show that heat is transferred through metal, not with a constant, but with a varying slope. The actual curve is similar to that shown in Fig. 11.

If horizontal lines are drawn through the temperatures to the slope curve, and vertical lines are then drawn, these vertical lines will divide the metal into portions of various width. The difference in temperature between the lines on the metal is always the same, for this case, 100 degrees. There is the same temperature head causing heat to flow, but because of the varying width of each section, the slope is less in each succeeding section. Heat flows less readily through H than through G, through G than through F, *et cetera.*

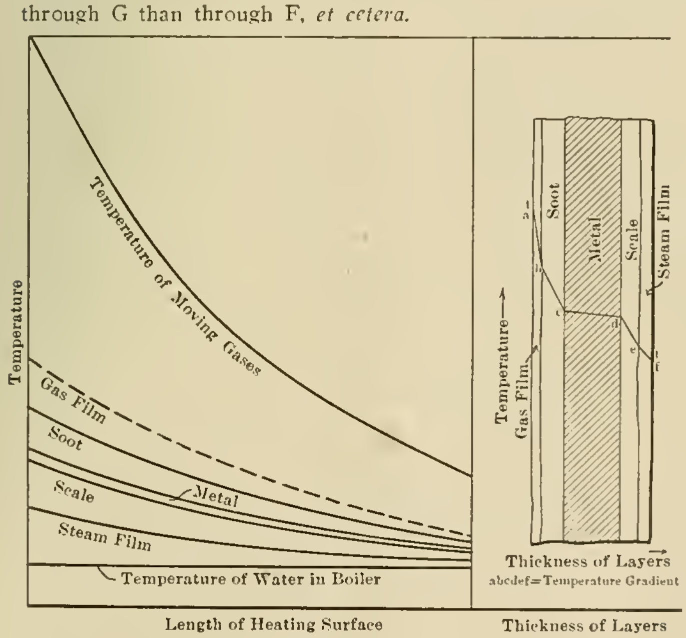



FIG. 12.

"In the theory of heat transmission the assumption is made that the gas comes directly into contact with the metal surface of the boiler flue, and also that the water in the boiler absorbs the heat as fast as the metal can transmit it. In a commercially operated boiler neither of these assumptions is true. The metal of the boiler flue is insulated from the gas with a layer of soot, and from the water with a layer of scale and, perhaps, a layer of steam (Fig. 12). As these layers of soot, scale and steam are very poor conductors, a resistance many times greater than that of the metal of the boiler tube itself is offered to the passage of heat. It is evident that under such conditions the difference of temperature between the first layer of gas and that of the first layer of water must be greater than it would have to be if the insulating layer of soot, scale, and steam were not present, in order that the heat should flow from the gas to the water at a certain desired rate. This temperature difference must be larger the greater the required rates of heat transmission and the thicker the insulating scales. Inasmuch as capacity is the rate of heat absorption, this explains why at higher capacities the gases leave the heating surface of a boiler at higher temperatures than they do at lower capacities. It is clear, then, that in order to have the heating surface efficient it must be kept free from soot and scale, and the bubbles of steam must be removed from the surface as fast as they form, so that the water can come directly into contact with the metal. This last requirement emphasizes the importance of water circulation in

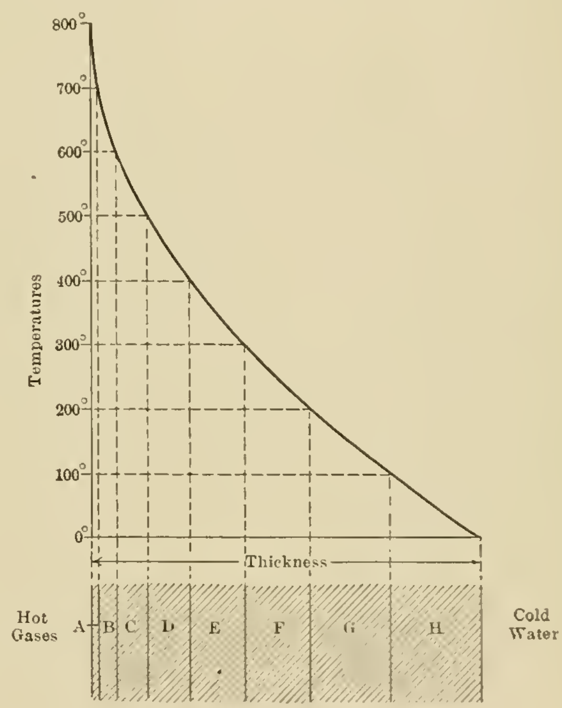



FIG. 11.

the boiler. The faster the circulation of water the faster are the bubbles of steam carried away and the better is the contact between the metal and the water." *

The comparative effect of heat on thick and thin plates can be illustrated by putting a postage stamp on the bottom of a tin drinking cup (Fig. 13-a), pasting it absolutely flat. Fill the cup with water and put a candle underneath the postage stamp. It will be found that the heat from the candle is absorbed so quickly in the water that it does not allow the stamp to be burned, the temperature of boiling water not being high enough to set fire to the stamp.

But should there be two thicknesses of tin, as in Fig. 13-b, and the same process tried, it would be found that the stamp would be charred or burned off.

If 1/16 of an inch of cement be deposited in the bottom of the cup (Fig. 13-c) it would be found that not alone would the

* Report of Prof. Breckenridge on St. Louis boiler tests. U. S. Geological Survey.

stamp be burned off, but the metal would be blue, due to the slow transmission of heat into the water.

The transfer of heat through irregular sections follows the same general law as just stated, but is more difficult to establish by experiment.

In Fig. 14 the lines of equal temperature are drawn for an irregular heating surface projecting into the water to be heated. A is the temperature of the metal next to the hot gases; for instance, it may be taken as 600 degrees. B is the line of temperature of 500 degrees throughout the metal, C is 400 degrees, D is 300 degrees, and E the temperature of the metal in contact with the cold water, is 200 degrees.

The transfer of heat through the crown sheet containing staybolts is rather more complicated, as shown in Fig. 15.

The surfaces A in contact with the hot gases will be at a high temperature and the heat wave will tend to travel across the metal perpendicular to the surface. The staybolt head is curved and the heat energy tends to concentrate. A portion of the energy in its travel will strike the inner portion of the head in an oblique direction. Because of the contact of two metals heat is reflected back from this surface and tends to travel outward toward the head of the staybolt. The effect is that the whole surface of the head of the staybolt gets very hot, while the surface of the sheet is much cooler because its heat has been transmitted freely through the unobstructed metal. In case, however, the surface E gets covered with a non-conductor and does not yield up heat freely, there is a tendency for the entire metal to get hot.

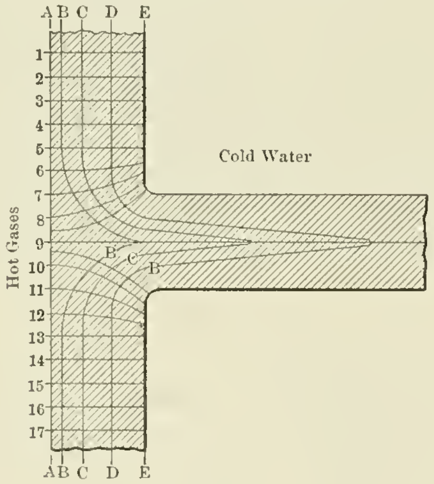


FIG. 14.

The transfer of heat through metal depends upon the action of the hot and cold bodies on either side of the metal. If there is a slow circulation, or no circulation, a small quantity of heat will be transferred. If the water circulates freely and rapidly, more water comes in contact with the surface in the same time and more heat is transferred.

If the heat is applied to the under side of a vessel containing water, the water will be rapidly heated. If the same heat is applied to the side of a vessel, the water will be heated very slowly. In the first case the heat is taken from the hot metal by convection of the bodily transference of the heat due to the motion of the heated water. In the second case, convection currents are not easily established and the heat is, for the most part, conducted through the water.

In a boiler the circulation is produced by convection, and it is of great importance to have a design that does not interfere with the water circulation in order to transmit heat.

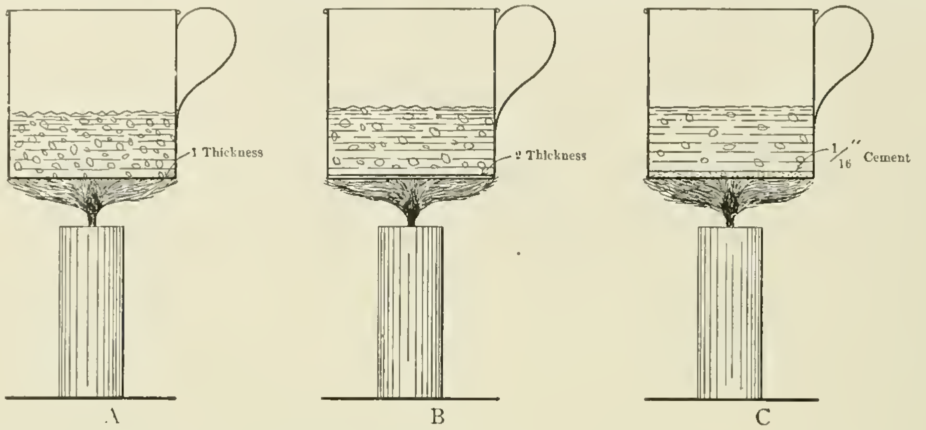


FIG. 13.

In the ordinary type the crown bars are a great obstacle to the free circulation of water in a boiler by convection. Referring to Fig. 6 the path of a particle of hot water leaving the sheet is seen to be obstructed by the crown bars which prevents free circulation, and makes the metal less efficient in transmitting heat.

In the other half of this figure it is seen that there is no obstruction to free circulation, and consequently there will be a high heat transference. In this type, the arched surfaces are more efficient in producing convection currents than the flat surfaces in the ordinary construction, due to the fact that less eddy-currents are set up.

LESS SCALE.

Since the water is generated into steam very much faster, we have very much better circulation. In consequence of better circulation, causing greater scrubbing action, and also, due to the expansion and contraction of each unit, scale will not adhere to firebox sheets.

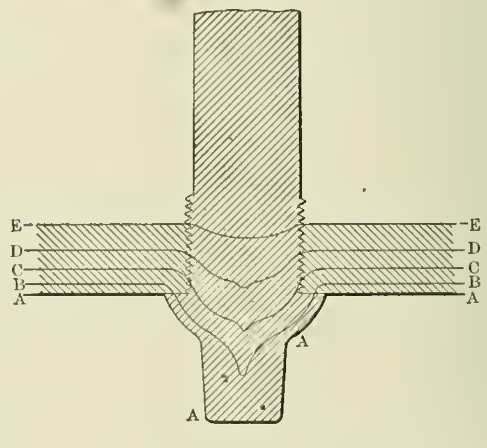


FIG. 15.

HEAT ABSORBED FASTER.

The corrugations of the interior walls of the firebox cause heat waves to be deflected into small eddies (Fig. 6-e) on the sheets, thus giving the heat units more time to pass through the sheet into the water and also scouring the soot off the sheet.

LONGER LIFE.

There will be much longer life in the flue sheet and flues, as they will be subjected to less strain on account of the expansion and contraction being taken up by the corrugated sections.

FUEL CONSUMPTION REDUCED.

There should be a reduction in the amount of fuel used per unit of power developed, equal to 12 per cent. This would appear either as a direct reduction in the total fuel cost, or as an increased gross ton mileage per ton of fuel consumed, and in either case the cost of fuel as a proportion of transportation expense would be reduced.

ROUNDHOUSE DELAYS REDUCED.

Detention of engines in roundhouses for boiler repairs should be so substantially lessened as to make engines available for service 8 to 16 per cent. more of their total time than at present, thus increasing the motive power available for traffic, and postponing the necessity for additions to this equipment.

[Editor's Note.—All the features of design and construction of this firebox are fully covered by patents.]

## OIL BURNING LOCOMOTIVES.

To the Editor:

Referring to the article in your January issue by Harrington Emerson on design of oil burning locomotives, the suggestions made by the author are, in my opinion, excellent as referring to design of a strictly oil burning locomotive boiler, but the items referred to as peculiar to burning oil fuel can be applied only, in practice, to construction of equipment for oil burning only. As the fuel supply of this country is somewhat indefinite as to quantity, it is impossible to predict, in the life of the locomotive, when it may not have to resume coal fuel. Hence, it does not appear, as a general proposition, that strictly oil burning equipment can be indefinitely maintained. With this in view there are some comments I would make on the items of Mr. Emerson's paper, as follows:

I agree that a larger combustion chamber for oil burning is required, not only in consequence of reduced friction referred to by Mr. Emerson, but because greater volume is required for combustion of volatile matter only. Ample space is required for proper mixing of air and hydrocarbons to complete combustion which properly should occur in the firebox and not in the flues for the following reasons:

If in an oil burning boiler sufficient firebox or combustion volume is not allowed, the hydrocarbon vapors must be consumed within the flues if burned at all. The purpose of flues in a steam boiler is to absorb heat from gases of combustion passing the furnace space. If these flues are fulfilling their office in absorbing heat, the temperature of the passing vapor falls rapidly. If small flues of sufficient length are used to deliver into the smokebox the least temperature, the vapors in process of combustion soon fall in temperature below that required for complete oxidation, hence there is a precipitation of soot. This, we know from experience, is very undesirable, as the soot is a non-conductor of heat and engines fall off in steaming capacity very rapidly as this deposit occurs. It is relieved by "sanding out," but this is not a prevention of the evil. It is my opinion that the smoking of oil burning locomotives is largely due to this, and it would be an error to place the smaller tubes unless we have a firebox amply large to insure complete combustion. It is my opinion that where oil burning is applied to ordinary locomotives, flues should be larger in diameter than they are now, instead of smaller.

The temperature of combustion maintained in our oil burning locomotives was recently determined by Dr. Arthur W. Gray, of the Department of Physics, University of California, who was conducting experiments for the University. The average temperature in hottest parts of the oil fire was found to be about 2,600 degrees F., observations ranging from 2,732 to 2,552 degrees F. While this is in excess of coal burning practice, under the same circumstances, by from 300 to 500 degrees F. the excess could hardly be termed "enormous," as referred to by Mr. Emerson. The temperature of smoke arch gases ranges from 870 to 820 degrees F. in our oil burning consolidated locomotives. In coal service this temperature ranges from 650 to 700 degrees F. The length of tube in these engines is fifteen feet. These boilers were designed for coal burning and evidently are forced in oil burning service. It is quite evident that if the combustion volume of the firebox were increased by diminishing length of flues, the engines would consume oil to better advantage. It appears, however, that the length of flues should remain; in other words, the whole boiler should be extended if it were designed for burning oil exclusively. In principle, any form of fuel used under a steam boiler should deliver its smoke arch gases at as low a temperature as possible, and the temperature should be the same for any fuel, but of course this can only be obtained by building boilers especially adapted for either fuel, which is the purpose of this reference.

As to severity of oil versus coal on firebox sheets and flues. We experienced considerable difficulty in the early history of our oil burning experience, from damage to firebox sheets, flue sheets, and tube ends. We did not consider this so much due to excessive temperatures as we did to the greater range of temperatures that must exist in a firebox supplied with either fuel. With coal fuel the solid mass in combustion on the grate serves as a reservoir of temperature, the control of which by dampers, etc., we are familiar with. In the use of oil fuel there is no fixed carbon or grates involved. The shutting off of oil fire leaves no bed of solid fuel to maintain even temperature. The difficulties are largely due to improper control of the extremes of temperature obtained in handling oil fires, from inexperience and carelessness of oil firemen.

From records we have kept as to cost of maintenance of coal versus oil burning locomotives, we know that if a furnace is properly equipped with draft adjustment as nearly perfect as it can be made by admitting the required amount of air and discharging the oil in the furnace at the proper temperature, preferably with superheated steam, and correctly regulated by the atomizer, the exhaust nozzle being as large as it will stand and getting sufficient draft on the fire to enable us to fill the whole interior of the furnace with a mellow flame, that an oil burning firebox will, under these conditions, outlast a firebox using coal. That is to say, on the same class of engine in the same class of service. However, as referred to above, it cost us a good many fireboxes to determine just what was the best arrangement.

In this connection it should be stated that the oil fireman is a large factor in successful oil burning practice on locomotives. Having the proper arrangement and draft appliances for oil burning it requires careful attention to business, and intelligence on the part of the fireman, with special training, to obtain best results. The personal equation enters largely into successful practice with oil burning. A careless fireman can do enormous damage on the locomotive.

San Francisco. Howard Stillman.

## EFFECT OF FLAT WHEELS ON RAILS.

To the Editor:

I have read with interest the various letters on the effect of the flat wheels on rails in the American Engineer and Railroad Journal and the *Railway Age Gazette*, and have noted the criticisms offered to the analysis given by the writer (American Engineer and Railroad Journal, May, 1908, page 188).

It should be clearly understood that when this analysis was written the author made no claim for completeness, but on the contrary, stated that many factors had been omitted. Two points in the analysis have been criticised, namely: (1) The equating of the kinetic energy of the wheel to the energy of a hammer falling through a given height. (2) The concentration of the mass of the car at the center of the wheel.

EQUATING KINETIC ENERGY.

Regarding the first point I would say that I attempted to measure the kinetic energy of the wheel in terms of some known kinetic energy, and the most natural comparison was with the energy required in accepted impact tests. In using this comparison it is not necessary to consider that the length of the flat spot is sufficient to break the rail. The idea was to equate the kinetic energy of the wheel to the maximum allowed for any given rail, and then taking a proper factor of safety, to get a safe length of flat spot. This method is entirely rational. It is the method used to get the safe tensile strength of materials, for example. In such cases the ultimate strength divided by a proper constant is always taken as the safe working strength.

It is true that in the impact test the rail rests upon supports three feet apart, while in the roadbed these supports are considerably closer, say 18 inches. This supposition, then, is on the side of safety. Everything considered, the writer is still of the opinion that no good reason has been advanced to show that the analysis is wrong in this particular.

CONCENTRATION OF MASS.

Regarding this point, the writer believes that it is more rational to consider only the mass of the rotating parts as concentrated at the center of the wheel. When this is done the "limiting velocity" is changed from five miles per hour to something like eighty miles per hour, as shown by George L. Fowler in the *Railway Age Gazette*, January 8, 1909. Under this assumption the effect of even small flat spots is very serious. The writer believes that with this change in his original assumption the analysis gives results much nearer the truth than those obtained by any analysis yet proposed.

In the analysis by H. H. Vaughan, in your journal, December, 1908, page 475, it is assumed that there is an upward force equal to $(Mv^2) \div r$, opposing the downward force, as soon as the wheel begins to turn about the forward edge of the flat spot. It is also assumed that the mass of all the parts below the springs may be included in M. This latter assumption is obviously wrong, since only rotating parts can have a lifting effect. Considering the assumptions made by Mr. Vaughan, the limiting speed is about fifteen miles per hour. While this analysis includes a factor neglected by any other, there seems some doubt as to whether or not the force $(Mv^2) \div r$ acts exactly as assumed.

It has been pointed out that many factors of importance in connection with the effect of impact of flat spots have been neglected; among those are the following:

(1) The swaying of the car from side to side, increasing at times the effect of the blow considerably.

(2) The elasticity of the track and roadbed, tending to decrease the effect of the blow.

(3) The bending of the rail, causing it to wrap around the wheel, lessening the blow.

(4) The decreased force of the spring as the wheel is forced downward.

It is obviously impossible to include all these factors in any mathematical analysis with any hope of obtaining results that will be of value. Indeed, it seems to the writer almost useless to extend mathematical work much beyond the present limits until some experimental confirmation of results are obtained. The matter now rests with the experimenter.

E. L. HANCOCK.

## 16-INCH BACK GEARED CRANK SHAPER.

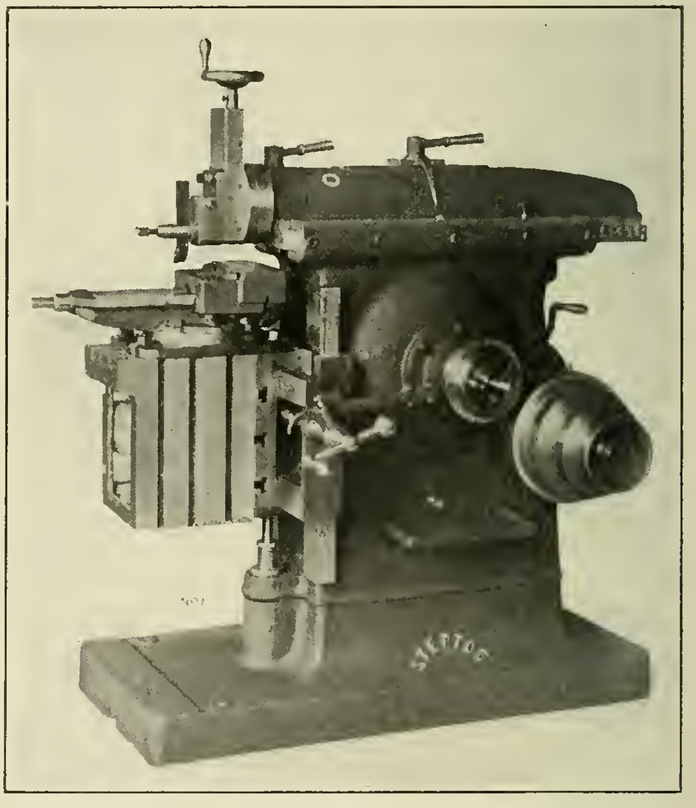
A number of new features have been incorporated in the newly designed 16-inch back geared crank shaper of The John Steptoe Shaper Company, Cincinnati, which is shown in the illustration. The head can be instantly loosened, so that it may be swiveled to any angle, by pushing the lever just back of it. It may be again instantly fastened securely in position, by pulling the lever toward the operator. This arrangement makes possible a considerable saving in time over the old method of fastening the head with bolts, and there is no wrench to be lost or misplaced.

The length of stroke is controlled by the shaft projecting through the feed plate and may be changed while the machine is in operation. There is no necessity of locking the shaft in position when the crank or lever with which it is operated is removed, since the device in the bull gear is self-locking. The ram is of substantial design, strongly ribbed and braced. The strength and stiffness of the operating side of the machine is increased by the basin-shaped projection or brace. The base of the machine is made heavier than the former designs.

The back gear ratio is 20 to 1 and the ratio in single gear 6¾ to 1. A single geared shaper of the same design is also made with a ratio of 6¾ to 1. The back gears are thrown in and out by the lever at the back of the column which is easily operated from the side of the machine. The driving gears are of phosphor bronze.

The shaft bearings are provided with cast iron bushings, which are pressed in, although they may be readily removed and replaced, if necessary. The shaft bearings are fitted with ring oilers, the ring carrying the oil from an oil well to the shaft, as it revolves, thereby affording constant lubrication. The rings are made of wide strips of brass, thereby having a liberal contact on the shaft, and distributing the oil more freely. It has been demonstrated that with a round ring the contact on the shaft is so small that comparatively little oil is distributed.

The feed plate is of an entirely new design. The feed eccentric is pivoted and may be swiveled in any direction. The holes in the plate are reamed tapered. The stud in the eccentric has a spring in it, and is also tapered. The tapered pin will thereby take up any wear which may occur in this hole. The holes are drilled in a circle to keep them as far apart as possible. They are drilled and numbered to agree with the teeth in the feed ratchet, thereby making it easy to secure any desired feed. The ring which encircles the feed eccentric is split, and fitted with a fibre washer, thereby permitting any wear, which may occur in the ring, to be easily taken up by filing the washer.



STEPTOE BACK GEARED CRANK SHAPER.

There is no opening through the base of the machine in the pocket in which the telescopic screw operates; dirt and moisture are thus prevented from getting in at the bottom. The graduations on the vise base are placed on an angle so that they may be more easily read by the operator. In fastening the work in the vise the upper jaw has a tendency to raise as the work is tightened. To overcome this the upper jaw may be firmly clamped to the lower one by two bolts as shown.

# RAILROAD CLUB ACTIVITIES

*Canadian Railway Club* (Montreal, Can.)—The meeting scheduled for April 6 is on "Snow Fighting," by A. W. Wheatley and T. McHattie.

At a January meeting the paper presented by Mr. Kinkead on "Locomotive Springs" was received with much interest and given an extended discussion. The experience in the making and use of springs from steel of both British and American manufacture, given by a number of the members, formed a very interesting part of the discussion. In reply to a question the author of the paper stated that he knew of no Vanadium steel springs in use in that country (Canada), although there were a number in service across the line, but he was unable to give any data showing results.

The seventh annual dinner of the club was held on Friday evening, January 29, with about 170 members and guests present. The President gave a brief address, drawing attention to the value of railroad clubs to all classes of employees and pointing out that no matter how minor a position a man occupies on a railway system his work is important and worthy of study. Toasts were responded to as follows: "The Railways," by G. E. Drummond, C. Murphy and G. T. Bell. "Our Guests," by Mr. Goodchild and Cy. Warman. "The Railway Supply Men," by S. King and J. S. N. Dougall. The members present were also entertained by a quartette and by humorous remarks from George Armstrong.

Secretary, James Powell, P. O. Box 7, St. Lambert, near Montreal, Can.

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*Central Railroad Club* (Buffalo, N. Y.)—The next meeting will be held at the Hotel Iroquois on the evening of Friday, March 12, at 8 o'clock. The paper will be by John M. E. Ames, mechanical engineer of the American Car & Foundry Co., on "The Use of Steel in Passenger Car Construction."

Secretary, H. D. Vought, 95 Liberty St., New York.

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*New England Railroad Club* (Boston, Mass.)—At the February meeting a paper by Henry C. Boynton, on "Steel Rails," which was illustrated by stereopticon views, brought out the largest attendance so far this year. The discussion of the paper was equally interesting. J. P. Snow, bridge engineer of the Boston & Maine Railroad, showed some slides on the same subject, as did also Professor Henry Fay, of the Massachusetts Institute of Technology.

The next regular meeting will be held at the Copley Square Hotel, Boston, March 19. Dinner will be served at 6.30 P. M. to be followed by the regular business session at 8 P. M. The paper will be by A. W. Martin, superintendent of the Boston Division of the N. Y., N. H. & H. R. R., on the subject of "The Railroad Club—Its Worth." The following subjects will also be discussed at this meeting: "The Abuse of the M. C. B. Repair Card" and "The Rules of Interchange of the M. C. B. Association." This will be the annual meeting of the club and election of officers will take place.

Secretary, George H. Frazier, 10 Oliver St., Boston, Mass.

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*New York Railroad Club.*—At the meeting of February 19 a paper entitled, "The American Railway Association's Bureau for Safe Transportation of Explosives and Other Dangerous Articles," was presented by Col. B. W. Dunn. In this paper Colonel Dunn explained the reasons for the formation of the bureau; the difficulties which it has met and overcome; its plans for the future and the large amount of good that it had already been able to accomplish. He made a plea for more general interest in the work which the bureau is doing, especially in connection with helpful suggestions.

The March meeting will be given up to the annual electrical discussion, which has always been a very popular feature of this club's activities. The best known authorities on steam railway electrification speak at this meeting, which will be held on March 19, at the Engineering Societies Building, 29 West 39th St., at 8 P. M.

Secretary, H. D. Vought, 95 Liberty St., New York.

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*Northern Railroad Club* (Duluth, Minn.)—The paper scheduled for the next meeting, Saturday evening, March 27, is on "The Soliciting of Freight; The Carrier and the Shipper," by W. H. Smith, assistant general agent, Northern Pacific Railroad.

At the January meeting the discussion was taken up on Mr. Clark's paper on "Concrete and Steel Ore Docks vs. Wooden Ore Docks." The general consensus of opinion seemed to be that the concrete offered a great many advantages for ore dock construction, and that it would undoubtedly be extensively used in this connection. Some trouble in the matter of freezing in cold weather had occurred, but it was not believed that this would be serious.

N. P. White, roundhouse foreman, Northern Pacific Railway, Duluth, presented a paper on "Engine Repairs in the Roundhouse, From the Standpoint of a Machinist." This briefly reviewed the changed conditions a roundhouse foreman has to meet at present compared with those of a number of years ago, which have added greatly to his burden and responsibility. The matter of making work reports was considered briefly and the custom of making strictly temporary repairs was depreciated.

A paper on "Boiler Repairs in the Roundhouse, From the Standpoint of a Boiler Maker," by Claude Richards, foreman boiler maker of the C., St. P., M. & O., was presented. This pointed out how much boiler trouble could be avoided by using proper care in washing out and also in making careful repairs.

Secretary, C. L. Kennedy, 401 W. Superior St., Duluth, Minn.

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*Railway Club of Pittsburgh.*—The next meeting, on March 26 will be given up to a discussion of the report of the standing committee on "The Revision of M. C. B. Rules of Interchange" and the subject of "The Abuse of the M. C. B. Repair Card."

Secretary, C W. Alleman, General Offices, Pittsburgh & Lake Erie Railroad, Pittsburgh, Pa.

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*St. Louis Railway Club.*—The February meeting was held on the evening of February 12, at the Southern Hotel, and was one of the most enthusiastic ever held by this club, there being over 400 members and visitors present. The paper presented was by W. E. Harkness on "Train Dispatching by Telephone." After the regular meeting a practical demonstration of the telephone in connection with the selector for train dispatching was given.

The paper for the meeting of March 12 will be by D. T. Taylor, foreman of the car department of the St. L. & S. F. Railroad, on "Piece Work in the Repair Shop."

Secretary, B. W. Frauenthal. Union Station, St. Louis, Mo.

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*Western Railway Club.*—The paper for the March 16 meeting will be by W. L. Park, general superintendent of the Union Pacific Railroad, on the subject of "Publicity for Railroad Accidents."

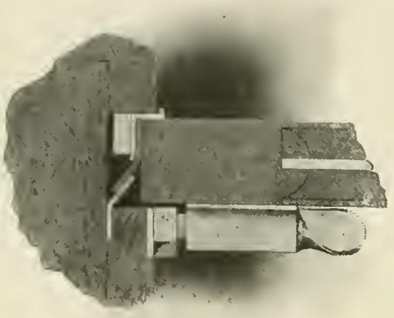
The paper by R. B. Dole, assistant chemist of the Water Resource Branch of the U. S. Geological Survey, on the "Quality of Surface Waters in the North Central States," presented at the February meeting, proved to be very interesting and was fully discussed, principally by the chemists of the various railroads entering Chicago.

Secretary, J. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

*Western Canada Railway Club* (Winnipeg, Man.)—A club has been organized with headquarters at Winnipeg, Man., which will hold regular meetings on the second Monday of each month, excepting June, July and August. At the intial meeting the following officers were elected: Hon. president, William Whyte; hon. vice-presidents, M. H. McLeod, G. J. Bury, G. W. Caye and Wilford Phillips; president, Grant Hall; vice-president, L. B. Merriman; secretary, W. H. Roseberry; treasurer, T. Humphries; executive committee, R. J. Hungerford, C. W. Cooper, J. McLenzie, W. Smith, R. McNeil and L. O. Moody.

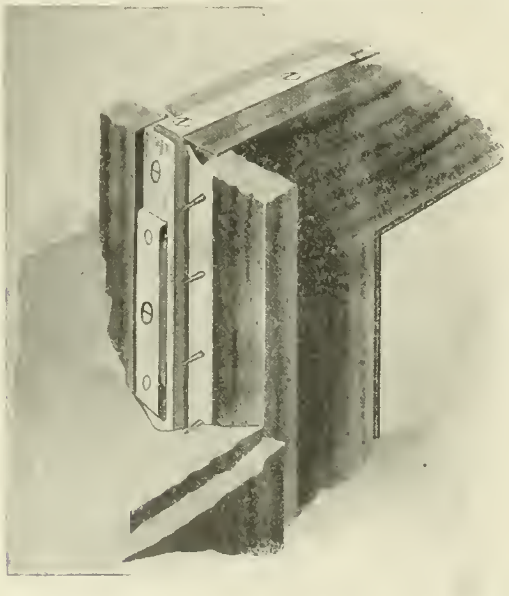
## SOME NEW CAR WINDOW FIXTURES.

The matter of having windows in passenger cars air and dust tight, non-rattling, and at the same time capable of being easily raised and secured at any desired height, is a very important one and is being given careful attention in modern passenger cars of all classes. Inventors are giving this subject thorough study and among the recent products of their energy are the system of weather stripping, dust deflectors and sash locking devices, shown in the accompanying illustrations, which would appear to fulfil the desired conditions perfectly.



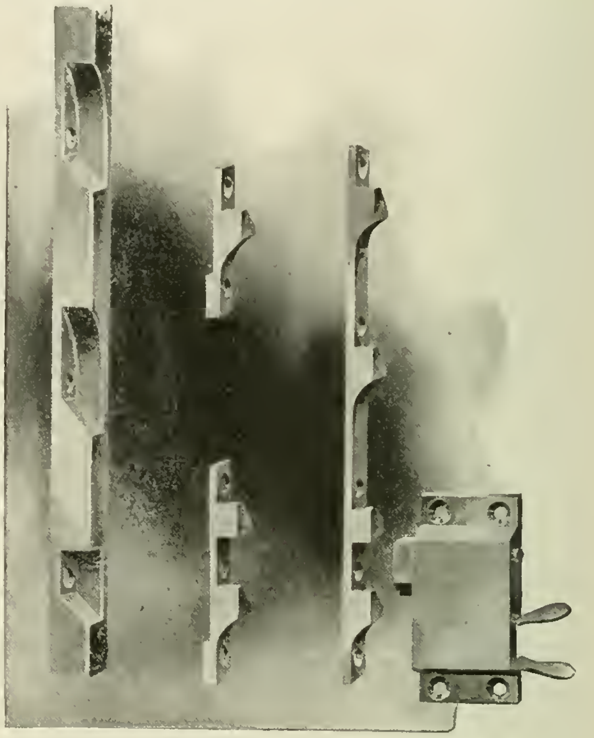
TOP VIEW OF WINDOW FIXTURES IN OPERATIVE POSITION.

With this arrangement the sash is fitted loosely between the stops, there being sufficient clearance to allow it to be easily raised and lowered at all times without binding. This opening around the loosely fitted sash is positively sealed air tight and dust proof by the weather strip forming a flexible joint. The illustrations show these strips in position on the window and make it evident that it will fulfil the purpose for which it is designed.



VIEW OF SIDE COMPRESSION WEATHER STRIP AND 3-INCH BEARING AT TOP CORNERS OF SASH.

For preventing the rattle and to prevent the sash from falling, a gravity wedge locking device is used. The lock bolt in this case is beveled at an angle of 45 degrees, and sets into a corresponding downwardly and outwardly beveled rack. This arrangement permits the weight of the sash to force it to a bearing against the outside stop and not only prevents it rattling, but also permits it to come to a gradual stop when lowered and eliminates any sudden jar, such as would loosen the fixtures or break the glass. A number of different designs of racks for these locks are shown in the illustration.



GRAVITY WEDGING SASH LOCK AND RACKS.

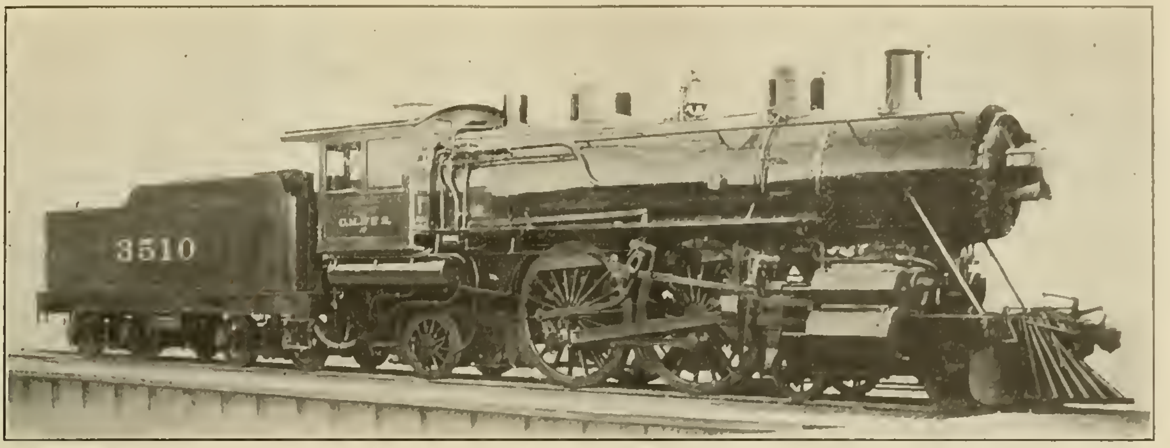
These devices are manufactured by the Grip Nut Company, 1590 Old Colony Building, Chicago, which also has a number of other improvements in car window fixtures, suitable for either wood or steel cars.

## CONDITION OF COUNTRY'S FOREST RESOURCES.

The forests of the United States now cover about 550,000,000 acres, or about one-fourth of the land of the whole country. The original forests covered not less than 850,000,000 acres, or nearly one-half. The forests owned by the government cover one-fourth of the total forest area, and contain one-fifth of all timber standing. Forests privately owned cover three-fourths of the area, and contain four-fifths of the standing timber.

Forestry, or conservative lumbering, is practiced on 70 per cent. of the forests publicly owned and on less than 1 per cent. of the forests privately owned. The chairman of the section of forests of the National Conservation Commission, in outlining the future recently said:

"By reasonable thrift, we can produce a constant timber supply beyond our present need, and with it conserve the usefulness of our streams for irrigation, water supply, navigation, and power. Under right management, our forests will yield over four times as much as now. We can reduce waste in the woods and in the mill at least one-third, with present as well as future profit. We shall suffer for timber to meet our needs, until our forests have had time to grow again. But if we act vigorously and at once, we shall escape permanent timber scarcity."



## VAUCLAIN COMPOUND ATLANTIC TYPE LOCOMOTIVE.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

The Baldwin Locomotive Works has recently completed an order of twelve Atlantic type locomotives, of the original Vauclain four-cylinder compound type, for the Chicago, Milwaukee & St. Paul Railway. This road has had an experience with this type of locomotive which dates back to the year 1896, when two engines were placed in high speed service between Chicago and Milwaukee. Subsequent orders of similar construction were made, and in 1901 a new design, employing the same type of cylinders but of much heavier construction, with a wide firebox, was prepared and a number built.

The service which these locomotives have been satisfactorily performing in handling heavy passenger trains is outlined as follows: Trains Nos. 5 and 6, running between Chicago and Minneapolis, normally made up of 10 cars weighing 508 tons, are scheduled to cover the distance of 420 miles between the two cities in 13 hours and 45 minutes, or an average speed of 30½ miles per hour, which, in view of the fact that the schedule calls for 45 stops and the trains are often composed of 13 or 14 cars, is a very creditable performance. On trains Nos. 1 and 4, between Chicago and Milwaukee, the distance is 85 miles, and the time is 2 hours and 10 minutes, or an average speed of 39.3 miles per hour. This includes three stops and a speed of 12 miles per hour within the city limits. These trains are frequently composed of 14 cars weighing 750 tons, and at times 16 cars are handled. On the run between Chicago and Omaha, a distance of 492 miles, trains of 7 cars, weighing 372 tons, are operated in 13 hours and 40 minutes, including 45 stops. A train of 11 cars, weighing 552 tons, covers the distance in 14 hours and 30 minutes and makes 25 stops.

This is a very creditable operation, especially for a four coupled locomotive and explains the last order of the same type of locomotive, which is different only in details from those now in service.

The cylinders are 15 and 25 x 28 in. and have the high pressure cylinder placed on top. The steam distribution on each side is controlled by one 15 in. piston valve driven by a Walschaert valve gear. The valve being necessarily set inside the cylinders, requires the introduction of a rocker, which will be seen secured in front of the guide yoke and connecting directly to the combination lever. The inner arm operates the valve through a short valve rod provided with a knuckle joint.

The frame bracing is most substantial and comprises a broad steel casting over the main driving pedestal, a cross steel casting at the front end of the mud ring and a steel casting at the guide yoke. The main frames are of cast steel and have single front rails. The rear extension or trailer frame is of the slab types 10 in. deep and 2½ in. wide, being adapted to accommodate the DeVoy type of trailer truck. In this truck the wheels have inside journals and both journal boxes are formed in the same casting which extends across the locomotive. It is guided by cast steel pedestals and the weight is transferred to it through steel rollers over each box. It has about 2½ in. lateral motion and requires no radius bar.

A conspicuous feature of the boiler design is the depth of the throat, the bottom of the mud ring being 28½ in. below the underside of the barrel. The grate is equipped with drop grates, front and rear, and a brick arch supported by four 3 in. tubes, is provided.

The smokebox is of the extension type and is fitted with a high double nozzle with a petticoat pipe. Provision for washing out the boiler has been given careful attention and includes a large number of wash-out plugs, there being six on the front tube sheet.

The general dimension, weights and ratios of this locomotive are as follows:

GENERAL DATA.

| | |
|---|---|
| Service | Passenger |
| Tractive effort, compound | 22,200 lbs |
| Weight in working order | 210,400 lbs. |
| Weight on drivers | 108,750 lbs. |
| Weight on leading truck | 55,950 lbs. |
| Weight on trailing truck | 45,700 lbs. |
| Weight of engine and tender in working order | 343,000 lbs. |
| Wheel base, driving | 7 ft. 4 in. |
| Wheel base, total | 29 ft. 2½ in. |
| Wheel base, engine and tender | 60 ft. 7 in. |

RATIOS.

| | |
|---|---|
| Weight on drivers ÷ tractive effort | 4.90 |
| Total weight ÷ tractive effort | 9.65 |
| Tractive effort × diam. drivers ÷ heating surface | 592.00 |
| Total heating surface ÷ grate area | 70.80 |
| Firebox heating surface ÷ total heating surface, per cent | 6.73 |
| Weight on drivers ÷ total heating surface | 34.30 |
| Total weight ÷ total heating surface | 66.00 |
| Volume equivalent simple cylinders, cu. ft | 9.20 |
| Total heating surface ÷ vol. cylinders | 346.00 |
| Grate area ÷ vol. cylinders | 4.90 |

CYLINDERS.

| | |
|---|---|
| Kind | Compound |
| Diameter and stroke | 15 & 25 x 28 in. |

VALVES.

| | |
|---|---|
| Kind | Piston |
| Diameter | 15 in. |
| Greatest travel | 5¼ in. |
| Lead H. P. | 3/16 in. |
| Lead, L. P. | 5/16 in. |

WHEELS.

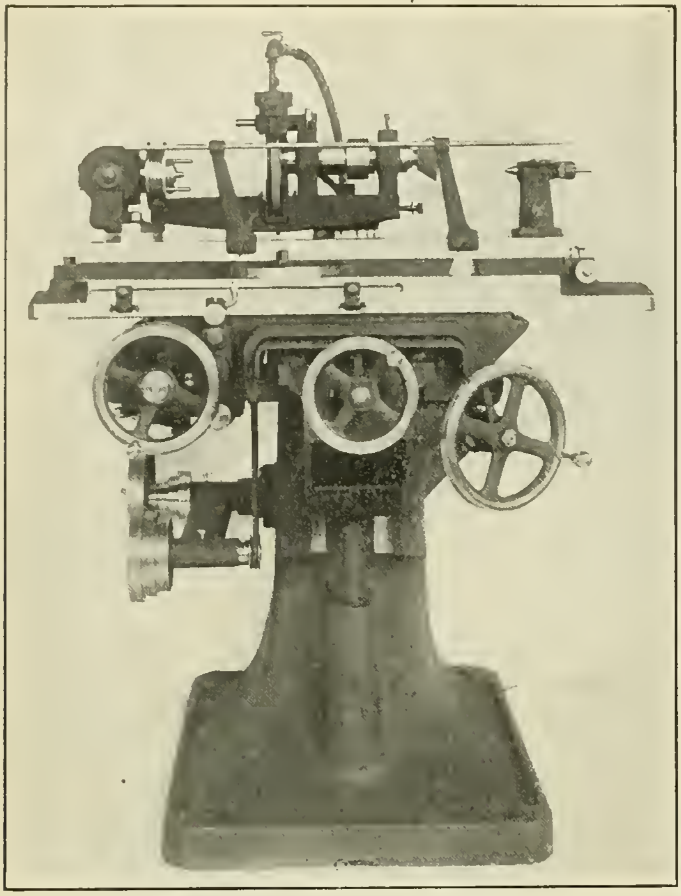
| | |
|---|---|
| Driving, diameter over tires | 85 in. |
| Driving journals, diameter and length | 10 x 12 in. |
| Engine truck wheels, diameter | 33 in. |
| Trailing truck wheels, diameter | 43 in. |

BOILER.

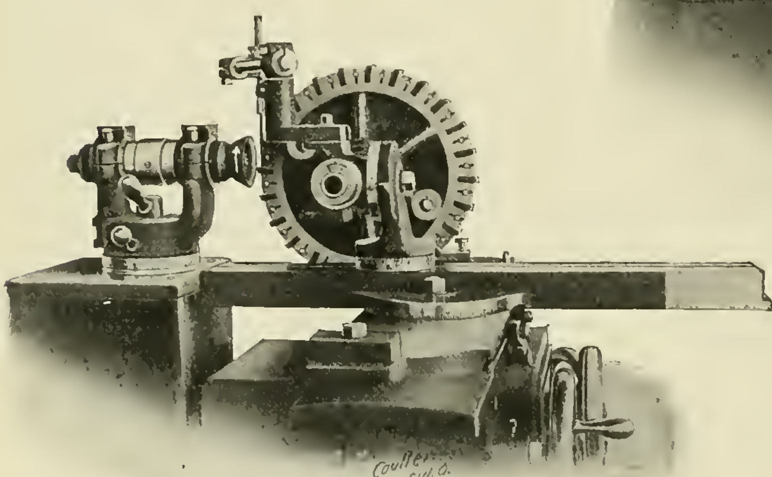
| | |
|---|---|
| Style | Wagon Top |
| Working pressure | 220 lbs. |
| Outside diameter of first ring | 66 in. |
| Firebox, length and width | 107⅛ — 59¼ in. |
| Firebox plates, thickness | S. & B.—⅜, C—7/16, T—½ in. |
| Firebox, water space | F-4½, S. & B. 4 in. |
| Tubes, number and outside diameter | 346-2 in. |
| Tubes, length | 16 ft. 6 in. |
| Heating surface, tubes | 2,974 sq. ft. |
| Heating surface, firebox | 214 sq. ft. |
| Heating surface, total | 3188 sq. ft. |
| Grate area | 45 sq. ft. |
| Smokestack, height above rail | 179 in. |
| Center of boiler above rail | 113½ in. |

TENDER.

| | |
|---|---|
| Wheels, diameter | 33 in. |
| Journals, diameter and length | 5½ x 10 in. |
| Water capacity | 7000 gals. |
| Coal capacity | 10 tons. |



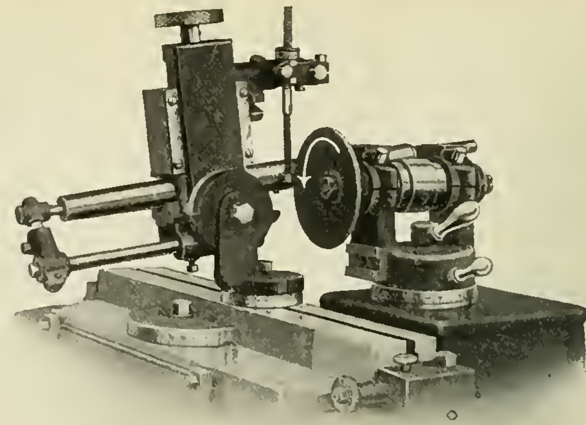
OESTERLEIN UNIVERSAL CUTTER GRINDER.



SHARPENING PERIPHERY OF INSERTED TOOTH MILLING CUTTER.

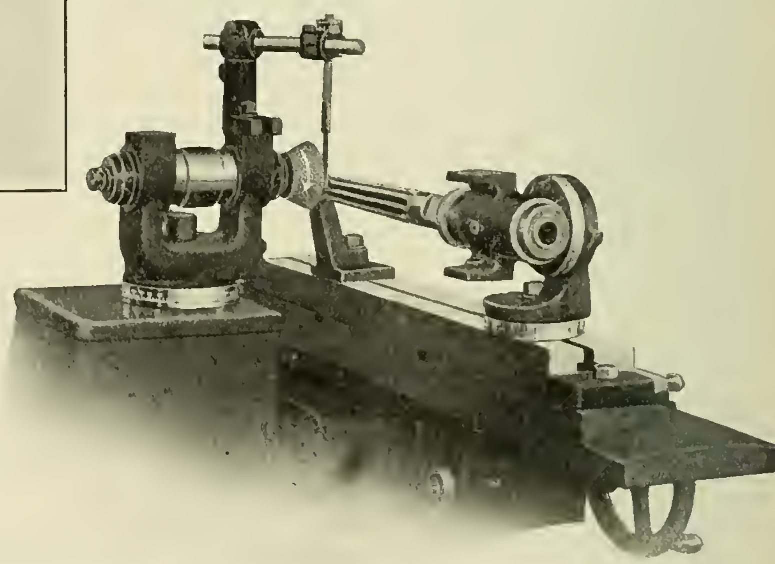
## UNIVERSAL CUTTER GRINDER.

This machine, known as the No. 3 universal and tool grinder, and manufactured by The Oesterlein Machine Company, Cincinnati, Ohio, is adapted for grinding all cutters and tools used in a machine shop and also for cylindrical work within its capacity. The chief difference between this new design and the No. 2 machine are the addition of an automatic feed, having six changes, and a pump and tank for providing a plentiful supply of water. The water guards and shields are adjustable and may be quickly removed, if necessary. The feed may be reversed within very close limits, allowing work to be ground close to a shoulder.

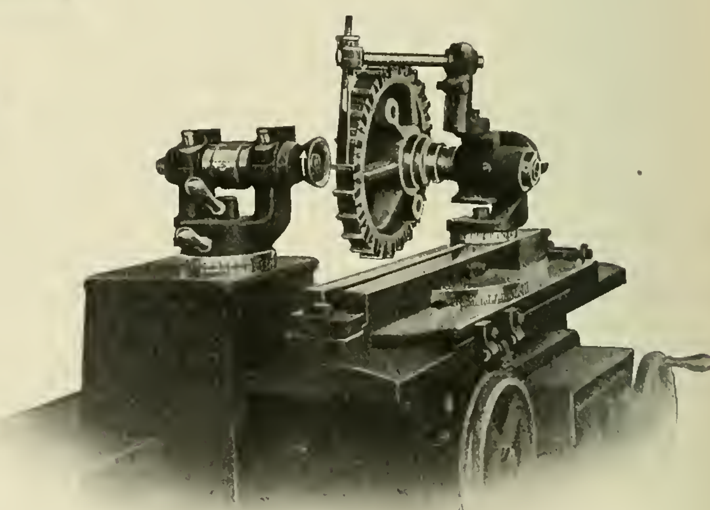


SHARPENING CUTTER IN STRAIGHT BAR.

The spindle head has a two-step cone pulley thus furnishing two speeds for the grinding wheel; it is graduated and may be swiveled to any angle. The table has a bearing its entire length on the slide and is graduated and may be turned clear



SHARPENING TAPER REAMER.



SHARPENING FACE OF AN INSERTED TOOTH MILLING CUTTER.

around and clamped in any position on the slide. There is also a scale on the slide which indicates the amount of taper per foot. The taper setting may be delicately adjusted by means of a worm and worm wheel at one end of the table. The slide has a V and a flat bearing on the saddle and the saddle has a V and flat bearing on the knee, thus insuring that the cross movement will at all times remain at right angles with the longitudinal movement.

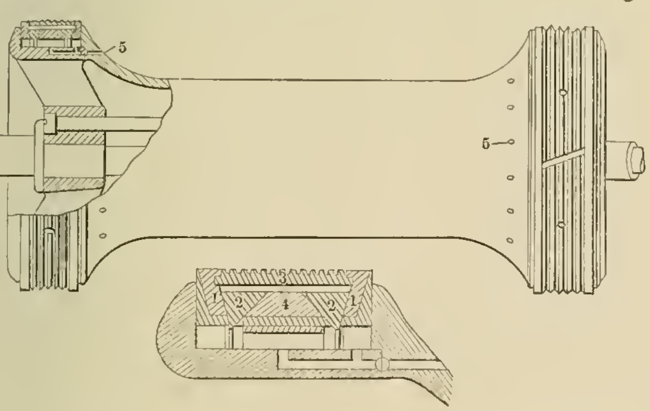
The headstock may be swiveled and clamped in any position in the vertical or horizontal plane. The tailstock has a compensating center and is actuated by a lever, making it very convenient to withdraw the centre from the work. The vise when mounted on the headstock swivels in any angle; it is provided with a V block to fit the lower jaw for holding circular work; the upper jaw swivels to accommodate any taper. A tooth rest is furnished which is universal in construction and has a micrometer adjusting nut for accurate setting in any position.

A simple device on the countershaft obviates the use of a tight and loose pulley. The table has an automatic feed of 16 inches, a transverse movement of 8 inches and a vertical movement of 7½ inches. It takes 24 inches between centres and swings 9 inches, or 12 inches, with raising blocks. The grinding wheel spindle operates at 2,942 and 4,080 r. p. m. and the table feed at the rate of 8, 11½, 16½, 24, 34 and 60 inches per minute. The machine weighs about 1,400 pounds. To give some slight idea of the range of work for which it is intended several illustrations are presented showing various operations on the No. 2 machine.

## AMERICAN SEMI-PLUG PISTON VALVE.

The valve which is shown in the accompanying illustration is called a "semi-plug" piston valve because when drifting, or at any time with the steam shut off, it acts like a snap ring valve, that is, the packing rings are expansible and adjust themselves to the valve chamber, but, when steam is turned on, it becomes a plug valve due to the pressure acting on the wedges, as will be explained below, and locking the snap rings at a fixed diameter.

It is, of course, of great importance for securing the best service from piston valves to have the cages perfectly true, and this condition would be best maintained by a plug valve. It is also of importance, for a satisfactory valve, to prevent lateral wear which will allow steam to blow around and underneath the rings.




It is for the purpose of fulfilling these requirements that this valve has been designed.

Referring to the sectional view, it will be seen that the packing consists of two snap rings (1) which have straight outside faces fitting against the straight wall of the follower and spool. The inner faces of the snap rings, however, are beveled. Inside of these are a pair of rings, (2) which are called wall rings. These are uncut, non-expansible, steel rings and are beveled at different angles on the two sides, as shown. Between these fits an expansible ring called a wedge ring (4). An expansible ring, (3) with grooves which forms the actual packing and bears on the cage, fits between and interlocks with the snap rings. This ring is wide enough to carry the snap rings across the port when drifting, and it also acts to keep them parallel with each other.

The operation of this packing is as follows: When steam is turned on, with an internal admission valve, it enters through the holes, (5) in the spool, of which there will be from 14 to 18 on each end, and thus gains admission beneath the packing. Its first action is to force out the first snap ring, which will also carry with it the second through the wide packing strip, and then acts to force out the expansible wedge ring, which wedges outward the non-expansible wall rings, which in turn force the snap rings against the walls of the follower and spool and hold them solidly in position. The angles on either side of the wall rings are carefully calculated so that the pressure is just sufficient to hold the snap rings in position, but not sufficient to reduce them in diameter. The importance of this is evident when it is considered that if it is too large it will force the snap rings inward, while if it is too small it will not prevent the steam underneath forcing the rings outward and thus defeat the desired plug effect.

The complete packing is entirely free to move up and down on the spool, which will permit it to fit the cage perfectly, regardless of any variation in the centering of the spool. It is, of course, disastrous to a valve cage to allow the weight of the spool to ride upon it and with this type of packing the spool must be carried by the valve rod.

The design of this packing is such, however, that in case the packing is locked at a point in the cage that is larger in diameter than at some other point the movement of the valve will force it down to the smaller diameter, where it will remain. From this it will be evident that this valve will not wear a cage out of true and it is also evident that it is important to have a true cage to begin with.

This design of piston valve is manufactured by the American Balanced Valve Co., Jersey Shore, Pa., and has proven in actual service to fulfil all the conditions for which it is designed.

## FILES OF PRECISION.

In the manufacture of files, the American makers have heretofore confined themselves very largely to the production of those which can be produced in large quantities and of a grade that can be sold at low prices, leaving it almost entirely to the Swiss file makers to supply the more limited, but important, demand for the better quality of file needed by tool makers, die sinkers, jewelers and manufacturers of fine tools and instruments generally. For work of this kind the ordinary American file is not sufficiently accurate in shape and gradation of cuts.

To produce these "Files of Precision," as they are called in Switzerland, the Swiss makers have a large body of highly skilled artisans whose wages in comparison with American labor are very low, only exceptionally good workmen receiving as much as one dollar a day. The Swiss file is the outgrowth of the Swiss watch industry, which is about 200 years old. These watches are made quite largely by hand, so that the production of files of the very highest grade early became a vital necessity in that country. The excellence of these files is largely due to the manual skill of the man who forms the teeth and the careful inspection which rejects all below a required high standard.

Even under the present protective duty, files of this grade could not be made in America by the same methods employed in Switzerland, and it is evident that new methods had to be devised in order to produce files of precision in the United States under American conditions, which would be of the same quality and able to compete with the imported product. These methods have been devised and are in use at the factory of the American Swiss File & Tool Company at Elizabethport, N. J., which is at present said to be the only manufacturer of these high quality files in the United States. Its methods of manufacture differ essentially from those of any other file factories either here or in Europe and the conditions which make it possible for these makers to compete with the imported product are briefly summed up as follows: An exact scientific method of annealing, which reproduces the same conditions day after day and year after year; the use of machinery in cutting the teeth, made possible by the uniformity of annealing, and thus greatly reducing the cost of cutting; the carefully devised scientific methods of hardening, reproducing exactly the same results continuously; and, finally, the greatest care and conscientiousness in the inspection of the finished product.

In making these files in America no improvement has been attempted in the shapes and sizes of the blanks and the fineness of the teeth used in Swiss files, which have been developed by the needs of the most skilful workmanship in the world, but in all other respects these files are not an imitation of either Swiss or American files and the machines used for making them have been altered and improved materially, so as to perform their work with greater precision. This company, therefore, claims to have established a new and rather difficult branch of industry, not by imitating any one, but devising new methods in forming and shaping the blanks, in cutting the teeth and notably, in the process of forging, annealing and hardening.

American mechanics are able to appreciate tools of this class and these makers are receiving large numbers of complimentary letters from such men. They are willing to let their product speak for itself by furnishing samples, to be used in competition with other makes, to any one desiring to make a competitive test. The address of the company is 24 John street, New York City.

## BORING JIGS IN THE MANUFACTURE OF SHAPERS.

It is of great importance in the manufacture of shapers to have the most accurate and uniform work in all parts if the finished tool is to be of the highest character and capable of the best grade of work. A shaper is subjected to many unusual stresses, because of its method of driving, the large overhang of the driving cone and the many holes and joints in which lost motion would be fatal to the best results. If the utmost care is not given to these features in the manufacture the machine is not only not capable of performing the service desired, but it soon wears itself into a comparatively useless condition.

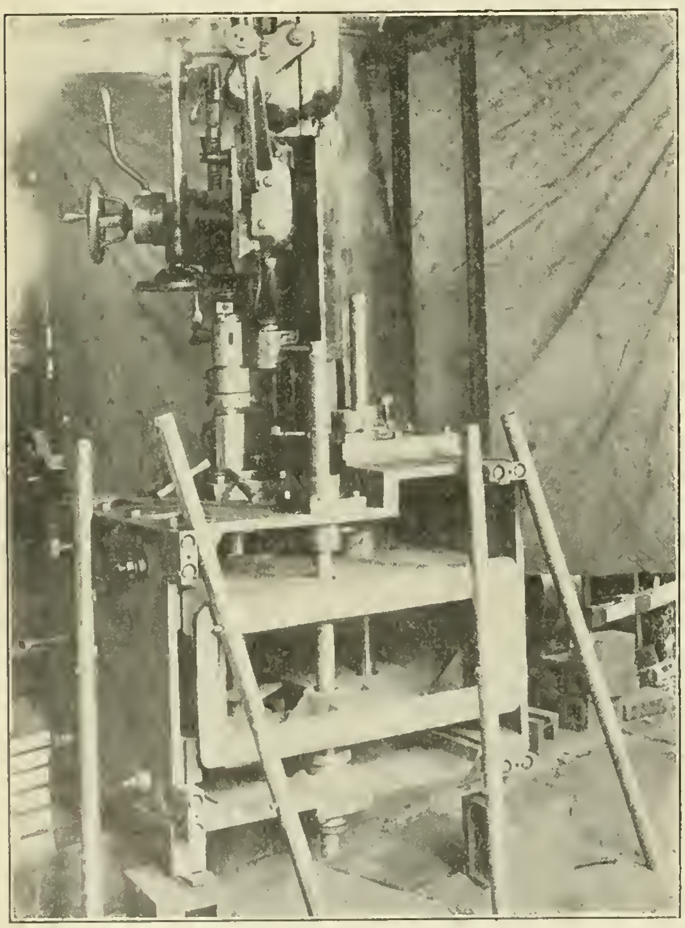


FIG. 1.—BORING JIG FOR SHAPER COLUMNS.

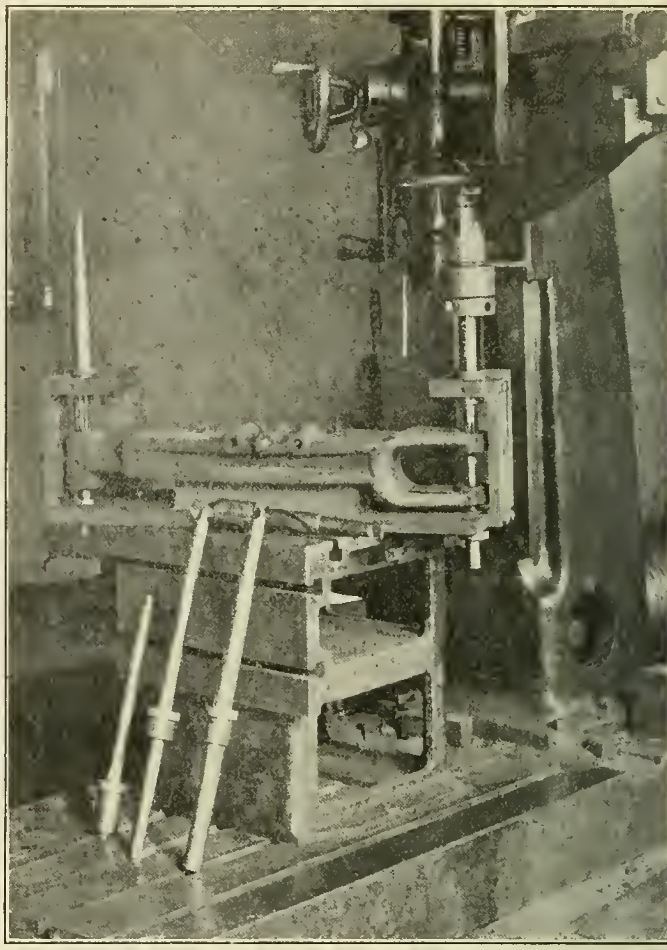


FIG. 2.—BORING JIG FOR ROCKER ARMS.

These points are thoroughly appreciated by most shaper manufacturers and the accompanying illustrations show some boring jigs which are used in the shops of the Queen City Machine Tool Company, Cincinnati, O., in order to obtain the very highest class of workmanship and perfect interchangeability in their crank shapers.

The illustration, Fig. 1, shows a boring jig for shaper columns, by means of which it is possible to get all the holes through the column in perfect alignment. The jig is of a full box pattern, both ends of the boring bar being supported. The bars have a universal joint connection to the driving spindle of the machine. Two cuts are taken in each case, the roughing cut leaving but a very thin film of metal to be removed by the finishing cut.

In Fig. 2 is shown a jig for boring and reaming the holes in the rocker arm, which must be at exact right angles to the sliding block bearing. The illustration shows the method of performing this work which turns out perfectly interchangeable rocker arms having all their bearings at exact right angles to the sliding surfaces.

These are but examples of the many jigs used in these shops, the value of which is proven by the high quality of the output.

## RAILWAY GENERAL FOREMEN'S CONVENTION.

The annual convention of the International Railway General Foremen's Association, will be held at Chicago, June 1 to 5. The Lexington Hotel has been chosen as the official headquarters. Arrangements have been made for exhibits by the supply firms, particulars of which can be secured from the secretary of the supply men's association, J. Will Johnson, 1427 Monnadnock block, Chicago. E. C. Cook, Royal Insurance Building, Chicago, is secretary of the foremen's association.

## RAILWAY APPLIANCES EXHIBITION.

An exhibition of all appliances used in the construction, maintenance and operation of railways will be held on a large scale at the Coliseum, Chicago, the week of March 15-20, inclusive. The appliances exhibited will be full size and many of them will be in operation.

For a number of years, The Road and Track Supply Association has had a small exhibit of models and drawings of these appliances in the parlors of the Auditorium Hotel during the annual meeting of the American Railway Engineering and Maintenance of Way Association. As railway officials naturally prefer to see the devices themselves, it was decided to give an exhibition that would comport in size and importance with the importance of the engineering and maintenance departments of American railways.

The Coliseum, which has been chosen for this purpose, has on the main floor 45,317 square feet, of which 32,517 square feet will be devoted to exhibits and 12,800 to aisles. In addition to this, there is an annex containing 9,582 square feet, 6,138 square feet of which will be devoted to exhibits. It will be the largest and most complete exhibit of materials for the engineering department that has ever been held in this country. It is expected that a very large number of railway officials will be in attendance, as it will be an opportunity of seeing the improvements made in the different devices, in which they are interested and that they could use to advantage.

That the manufacturers have shown great interest and taken advantage of this opportunity to show their product is evidenced by the large spaces that some of them have taken. Two firms have secured upwards of 1,500 square feet each, several 1,000 square feet each, and others sufficient space to show their devices.

Space at this exhibition can be secured from John N. Reynolds, Secretary-Treasurer, 160 Harrison street, Chicago.

## BOOKS.

The Internal Combustion Engine. By H. E. Wimperis. 5½ x 8½. Cloth. 320 pages. Illustrated. Published by D. Van Nostrand Co., 23 Murray St., New York. Price, $3.00.

This book was written as a text-book on gas, oil and petrol engines for the use of students and engineers. It is a very complete and thorough technical work on internal combustion engines and gas producers, very completely illustrated, and will prove to be a very valuable book for the gas engineer.

High Steam Pressure in Locomotive Service. By W. F. M. Goss. Bulletin No. 26 of the Engineering Experimental Station, University of Illinois. Published at Urbana, Ill.

This bulletin is a review of the report to the Carnegie Institution of Washington on the subject of high steam pressure in locomotive service and was given in practically its present form on page 13 of the January, 1907, issue of this journal.

General Lectures on Electrical Engineering. By Charles P. Steinmetz. 275 pages. 6 x 9. Cloth. 48 diagrams. Published by Robson & Adee, Schenectady, N. Y. Price, $2.00.

The lectures forming this book were delivered to a class of young engineers, consisting mainly of college graduates, during the winter of 1907-08, by Dr. Steinmetz. The book includes 17 lectures in which the use of mathematics has been avoided. They give a broad review of the entire field of electrical power generation, transmission, distribution, control and use, and comprise a thorough discussion of the different methods of application of electric energy; the means and apparatus available; the different methods of carrying out the purposes and the advantages and disadvantages of the different methods,, and apparatus. The matter, while of a very high character, is given in simple language and is thoroughly illustrated by line diagrams. Practically all of the important branches of electrical engineering are considered. An excellent colored photograph of Dr. Steinmetz forms the frontispiece of the work.

## PERSONALS.

J. A. Mellon, mechanical engineer of the Delaware, Lackawanna & Western Ry. at Scranton, Pa., has resigned.

W. S. Kenyon has been appointed master mechanic of the Missouri Pacific Ry., at Ferriday, La., succeeding Mr. Peasley.

George W. Kaiser, formerly assistant master mechanic of the Juniata shops of the Pennsylvania R. R., died at his home in New York recently.

E. G. Osgood has been appointed master mechanic of the Williamsville, Greenville & St. Louis Ry., succeeding O. D. Greenwalt, resigned.

J. C. Garden has been appointed master mechanic of the eastern division of the Grand Trunk Ry., with office at Montreal, succeeding T. McHattie.

W. H. Edgecombe has been appointed bonus supervisor of the western grand division of the Atchison, Topeka & Santa Fe Ry., with office at La Junta, Col.

T. McHattie, master mechanic of the Grand Trunk Ry. at Montreal, Que., has been appointed superintendent of motive power of the Central of Vermont.

B. J. Peasley, master mechanic of the Missouri Pacific Ry. at Ferriday, La., has been appointed master mechanic at De Soto, Mo., succeeding F. J. Conrath, resigned.

F. C. Pickard, master mechanic of the Mississippi Central Ry., has been appointed master mechanic of the Cincinnati, Hamilton & Dayton Ry. at Indianapolis, Ind., succeeding C. B. Cramer, resigned.

A. L. Kendall, general foreman of car shops of the New York Central & Hudson River R. R., at West Albany, has resigned to become general salesman for the W. P. Taylor Company, Buffalo, N. Y.

W. H. Dunlap, general foreman of the South Louisville shops of the Louisville and Nashville R. R., has been promoted to master mechanic at Covington, succeeding William Adair, who retires on a pension.

T. L. Burton has been appointed general inspector in charge of air brake, steam heat and car lighting equipment of the Philadelphia & Reading Ry., and will also perform such other duties as may be assigned to him.

R. G. Cullivan, general foreman, locomotive department, of the New York Central & Hudson River R. R., at West Albany, N. Y., has been appointed division superintendent of motive power at West Albany, succeeding E. A. Walton.

J. E. Irwin, master mechanic of the Marietta, Columbus & Cleveland Ry., has resigned to become superintendent of equipment of the Indian Refining Co., Georgetown, Ky., and Lawrenceville, Ind., and the position of master mechanic has been abolished.

Louis C. Fritch, assistant to the president of the Illinois Central R. R., has been appointed consulting engineer, in charge of electrification work, of the Illinois Central Ry., the Indianapolis

Southern and the Yazoo & Mississippi Valley, with office at Chicago.

G. I. Evans, chief draughtsman, is performing the duties of mechanical engineer of the Canadian Pacific Ry., with headquarters at Montreal.

S. S. Riegel has been appointed mechanical engineer of the Delaware, Lackawanna & Western R. R., with office as Scranton, Pa., vice J. A. Mellon, resigned. Mr. Riegel was formerly chief draughtsman of the Southern Railway and lately an engineer with the American Locomotive Company at Schenectady.

T. S. Reilly, who was appointed superintendent of motive power of the Canton Hankow Railway, at Canton, China, about a year ago, died suddenly from an abscess of the liver on January 30, 1909. He was 38 years of age at the time of his death. He graduated from the Pennsylvania Military College with the highest honors, and was well known among railway men in this country. His sudden death will be deeply regretted by his many friends.

Charles L. Gaspar, heretofore mechanical engineer on the Wisconsin Central Railway, has been appointed superintendent of motive power of the Canton Hankow Railway of China. Mr. Gaspar is a native of Wisconsin, and received his technical education at the Universites of Wisconsin and Purdue. He became special apprentice in the shops of the Wisconsin Central Railway in August, 1899, and in 1902 was employed as machinist on the same ground. From 1902 to 1903 he was chief draftsman, from which position he was promoted to that of mechanical engineer in 1904.

## CATALOGS

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Electric Pump Governors.—The Westinghouse Traction Brake Company is issuing instruction pamphlet No. T-1542 on the subject of electric pump governors, giving full instructions for the operation and maintenance of these instruments.

Calendars Received.—Among the many calendars received are a number deserving special mention, viz.: Dearborn Drug & Chemical Works, Chicago; Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio: Revere Rubber Co., Bostan, Mass., the Rodger Ballast Car Co., Chicago, and the American Tool Works Co., Cincinnati, Ohio.

Paints for Metal.—The National Paint Works, Williamsport, Pa., is issuing the seventh edition of a paper entitled, "The Review of Technical Paints for Metals," by Frank Cheeseman. This paper considers this important subject very carefully and contains many valuable pointers.

Oil vs. Coal.—Tate Jones & Co., Pittsburgh, Pa., is issuing a very attractive illustrated booklet largely given up to a synopsis of the fuel oil equipment in use at the Jacksonville shops of the Seaboard Air Line; the Fort Wayne Shops of the Pennsylvania Railroad and the Westinghouse Air Brake Company's plant.

Locomotive Valves.—The American Balanced Valve Co., Jersey Shore, Pa., is issuing booklet No. 28, designed for information and convenience in ordering repair parts for valves manufactured by it. Each separate part of the different valves is illustrated and a convenient system of numbering is employed for identifying the parts.

Emery and Corundum Wheels.—The American Emery Wheel Works, 176 Fulton street, New York, is issuing a standard size, 83-page catalog, illustrating a great variety of emery, corundum, adamite, vitrified and silicate grinding wheels. The catalog includes list prices in each case, and, in addition to wheels, abrasives in other forms are shown.

Shapers.—Gould & Eberhardt, Newark, N. J., is issuing the 1909 edition of its catalog on high duty shapers and attachments. This catalog shows several new features that have been introduced in these high class machines during the past two years and very attractively illustrates and describes the output of this company, which covers all types of shapers and attachments.

Westinghouse Apparatus.—Among the recent bulletins being issued by the Westinghouse Electric & Mfg. Co. is one on mercury rectifier battery charging outfits, explaining the principle of operation and the construction of this device very clearly. A very attractive catalog is also being issued on the subject of fan motors; and small leaflets on small direct current generator sets and electric vacuum cleaners.

Hard Water Made Soft.—The L. N. Booth Co., 136 Liberty street, New York, is issuing a booklet on the above subject, which points out the special advantages and many uses of the type F Booth water softener. The subject of the value of soft water is very fully covered.

General Electric Co.—Among the bulletins lately issued by this company are No. 4641, pointing out the advantages in the use of electricity in the lumber and woodworking industries, including a description of the plant of the Great Southern Lumber Co. No. 4643 covers the subject of direct current switchboard instruments, and No. 4640 is devoted to large transformers. A small catalog on fan motors is also being sent out.

Blue Printing Machine.—Keuffel & Esser Co., Hoboken, N. J., is issuing a catalog that very completely illustrates and describes the Champion continuous blue printing machine, which offers many advantages in connection with high speed and improved quality in making blue prints. The tracings are fed in either with separate sheets or on a continuous roll of blue print paper on top of the paper and right side up, which permits the operator to be much more accurate in his work than is usually possible in this type of machine.

## NOTES.

Ritter Folding Door Company.—Thornton N. Motley has been appointed eastern agent of the above company, with office at 1571, No. 50 Church street, New York City.

Railway Business Association.—Frank W. Noxon has been appointed secretary, succeeding G. M. Basford, who has completed his work with that organization and again taken up his duties as Assistant to the President of the American Locomotive Company.

Falls Hollow Staybolt Company.—William C. Ennis, formerly occupying official positions in the motive power department of various railways and of late connected with the American Locomotive Company, and now located at 543 Broadway, Paterson, N. J., has been appointed eastern traveling representative of the above company.

U. S. Metallic Packing Company.—Harry Vissering, for the last ten years general sales agent of the above company, with office at Chicago, has resigned, owing to his large interests in other fields. This resignation also covers his position as superintendent of the American Locomotive Sander Company.

Monarch Steel Castings Company.—Alexander B. Wetmore will accept the position of sales manager of the above company, Detroit, Mich., on March 1st. Mr. Wetmore leaves a long period of service with the Detroit Lubricator Co. to take up the sales of the "Monarch" coupler and "Monarch" graduated draft gear, made by the Monarch corporation.

Ajax Metal Company.—This company announces that the patent office has granted it a re-issue patent, which covers the process of making bearing metals by limiting the tin to 9 per cent. of the copper and thus permitting an almost indefinite increase of the lead above 20 per cent. This patent has been passed upon by the U. S. Circuit Court.

American Blower Company.—Announcement has been made of the consolidation of the American Blower Company, of Detroit, and the Sirocco Engineering Company, of New York. The plants of both companies will continue in full operation and the business will, hereafter be transacted under the name of the American Blower Company, with principal offices at Detroit, Mich.

J. Rogers Flannery & Co.—A selling company has been organized under the above name, with headquarters at Pittsburgh, Pa., to take over the sale of the Tate flexible staybolt, and also to exploit the Keystone nut lock. The representative of this company will be H. A. Pike, New York; W. M. Wilson, Chicago; Grundy & Leahey, Richmond, Va., and Tom R. Davis, mechanical expert, Pittsburgh, Pa.

American Specialty Company.—A contract has been closed between the American Specialty Company of Chicago and the High Speed Drill Company of Dubuque, Iowa, whereby the former takes the entire output of the latter and become exclusive sales agents for the complete line of Collis flat and flat twisted high speed drills. These drills have a standard taper shank, but can also be obtained with a straight shank.

Standard Roller Bearing Co.—This company announces that it has secured Henry Souther, a well-known engineer of Hartford, Conn., to devote a large part of his time to its interest as consulting engineer. Announcement is also made that the sales organization of the company has been extended by the appointment of F. M. Germane, formerly sales manager, as assistant general manager of the company; T. J. Heller has been appointed sales manager and F. W. Lawrence as western representative, the latter with headquarters at Chicago.

# A STUDY OF THE NUMBER AND KIND OF MACHINE TOOLS REQUIRED IN A RAILWAY LOCOMOTIVE MACHINE AND BOILER SHOP.

L. R. Pomeroy.

*Editor's Note.—Mr. Pomeroy presents a most valuable and unique scheme for logically determining the kind and number of machine tools which may be required in a railroad shop to furnish a desired output. The usual method of basing the selection of tools for a new shop on the number and kind of tools used in an older shop, or in some other shop on the same road, or on other roads, is faulty and is little less than a "hit and miss" method. Improvements in railroad shop organization and operation, the rapid development of modern machine tools, and the increase in the size and the changes in design of locomotive parts make it necessary to consider each new shop by itself, and in detail. The idea of carefully investigating and studying each individual machine tool operation and basing the tool requirements upon the average time required for each operation and the average number of such operations in a given time is certainly a far more logical method than that usually followed. In these days when piece work and bonus systems are so generally used, making it possible to readily find the average time required for each individual operation, it should not be a difficult task to make such an analysis.*

The Scranton shops of the Delaware, Lackawanna & Western Railroad are to have an ultimate capacity for building and repairing the following number of standard consolidation locomotives per month:

30 General Repairs.
8 Light Repairs.
4 New Locomotives.

The analysis, in tabular form on the following pages, considers each machine tool operation to be performed in the machine and boiler shops each month for the four new locomotives complete, and also the average number of operations to be performed for renewing or repairing the necessary parts for the engines receiving heavy and light repairs. Knowing the number of operations which must be performed each month and the average time required for each it is a simple matter to arrange the data as shown and to select the proper tools for doing the work.

Not only is it possible to determine the number and kind of tools required, but the study automatically indicates the proper grouping of the machines to promote a logical and proper sequence of operations, as will be apparent from a study of the tabulated data.

Knowing the tools which are necessary for the maximum output, a selection may readily be made of those necessary to meet a predetermined minimum condition, such as will prevail when the shop is first opened; at the same time the groups may be arranged to admit of tools being added from time to time, leading up to the maximum requirements. In this way the original scheme may be carried out without in any way interfering with the shop efficiency conducted on a minimum basis.

As the basis for the tabulation, the heaviest standard road engine was used. This is a 2-8-0 type with an anthracite burning, Wooten-type boiler and separate engineer's and firemen's cabs, the former being located ahead of the firebox. It has 21x32-inch cylinders, 55-inch driving wheels, and weighs 177,000 pounds on drivers, with a total weight of 200,000 pounds. It was thought that by using the largest standard locomotive as a basis, rather than the average, the figures would be more conservative.

On some details, where it might prove more difficult to predetermine the amount of work necessary to true up worn parts, etc. (*i. e.*, on a repair basis), a percentage has been used, based on manufacturing conditions for similar parts for new engines. In the column showing the number of repair parts to be machined each month the parts for both heavy and light repairs are included, although from the way in which they are derived it might appear that they referred to the heavy repairs only.

The use of the largest standard engine and the percentages used to determine the average work for repairs, have been considered as leaving enough margin to amply provide for contingencies, and also to provide for such manufacturing for other divisions of the road as is deemed wise: this is considered the main shop of the system and has a foundry and other facilities not possessed by the division shops.

A great deal has been done in the way of standardizing patterns, scaling them down very closely to finished sizes; such forgings as crank pins and piston rods are purchased rough-turned to within 1-16-inch of the finished size, and driving and truck axles are received within ⅛-inch of the finished size; the rough-turning is done with a flat nosed tool and therefore the amount of metal to be removed on such parts is reduced to a minimum.

The driving power for each machine and the method of driving, whether group or individual drive, is to be determined by the actual service requirements and the relation of the particular tool to the whole or local department, on the basis of an expected maximum amount of metal to be removed. Consequently it is safe to assume that a favorable load factor can be realized.

A STUDY OF THE MACHINE TOOL OPERATIONS REQUIRED IN A RAILROAD LOCOMOTIVE MACHINE SHOP, FOR MAKING REPAIRS TO AND BUILDING THE FOLLOWING NUMBER OF CONSOLIDATION LOCOMOTIVES PER MONTH, THE SHOP OPERATING EIGHT HOURS PER DAY:—30 GENERAL REPAIRS, 8 LIGHT REPAIRS, AND FOUR NEW LOCOMOTIVES.

| Class of Work | Machine Tool | Operation | Number of Pieces per Month: New Engs | Number of Pieces per Month: Repairs | Number of Pieces per Month: Total | Average Time per Piece | Total Days Work per Month | |
|---|---|---|---|---|---|---|---|---|
| Driving Wheels and Tires | 1 80″ Driving Wheel Lathe | Turning Tires | | 4x8[1] and 30x4[2] | 152[3] | 1½ hrs.[4] | 28⅝ | 1 mach. |
| | 1 Driving Wheel Lathe | Trueing Journals | | 152x50% | 76[3] | 2½ hrs.[4] | 24 | 1 mach. |
| | 1 7′ Vertical Boring Mill | Boring Tires | 4x8=32 | 30x8x15%=36 | 68 | 40 min. | 5⅔ | 1 mach.[6] |
| | | Smoke Arch Rings | 4x1=4 | 30x1x10%=3 | 7 | 2½ hrs. | 2¼ | |
| | 1 400 Ton Wheel Press | | | | | | | 1 mach. |
| | 1 Quartering Machine | Quartering Wheels | 4x4=16 | 30x4x10%=12 | 28 | 3 hrs. | 10½ | 1 mach. |
| | 2 Ver. Boring Mills, 6 and 7 ft. | Wheel Centers | 4x8=32 | 30x8x10%=24 | 56 | 8 hrs. | 56 | 2 mach. |
| Frames | 1 Planer, 36″x15′, 4 Heads. | Front Rails | 4x4=16 | 30x4x10%=12 | 28 | 4 hrs. | 14 | 1 mach. |
| | 1 Frame Planer, 72″x32′ | Main Frames (2 Per Setting) | 4x2=8 | 30x2x10%=6 | 14 | 8 hrs.[5] | 14 | 1 mach. |
| | 1 Three-Head Frame Slotter | Slot (4 Per Setting) | 4x2=8 | 30x2x10%=6 | 14 | 15 hrs.[5] | 26¼ | 1 mach. |
| | 1 Frame Drill, 4 Head. | Drill and Ream | 4x2=8 | 30x2x10%=6 | 14 | 15 hrs.[5] | 26¼ | 1 mach. |
| Axles | 1 Lathe, 32″x14′ | Driving Axles | 4x4=16 | 30x4x50%=60 | 76 | 3 hrs. | 29½ | 1 mach. |
| | 1 Double Keyway Cutter | Cutting Keyways | 4x4=16 | 30x4x50%=60 | 76 | 1 hr. | 9½ | 1 mach. |
| | 1 Lathe, 26″x14′ | Engine Truck Axles | 4x1=4 | 30x1x50%=15 | 19 | 2¼ hrs. | 5⅓ | 1 mach.[8] |
| | 1 D. H. Axle Lathe | Tender Truck Axles | 4x4=16 | 30x4x60%=72 | 88 | 45 min. | 8¼ | 1 mach. |
| Rods | 1 Slab Miller, 48″x16′ | Rods | 4x8=32 | 30x8x10%=24 | 56 | 6 hrs. | 42 | 1 mach. |
| | 1 Vertical Miller, 42″ | Mill Hubs | 4x6=24 | 30x6x10%=18 | 42 | 5 hrs. | 26¼ | 1 mach. |
| | 1 D. H. Rod Borer. | Rods | 4x6=24 | 30x6x10%=18 | 42 | 2 hrs. | 10½ | 1 mach. |
| | 1 Ver. Drill, 44″, Comp. Table. | Rods and Straps | | | | 4½ hrs. | 31½ | 1 mach. |
| | 1 Slotter, 10″. 1 Slotter, 12″ | Valve Yokes | 4x2=8 | 30x2x50%=30 | 38 | 2 hrs. | 9½ | 43½ days 2 mach. |
| | | Main Rod Straps, Back End. | | | 17 | 5¾ hrs. | 33¾ | |
| | | Main Rod Straps, Front End | | | 17 | | | |
| | | Main Connecting Rod Straps | | | 17 | | | |
| | | Main Connecting Rod Knuckle Fit | | | 6 | | | |
| | | Rods to Length | | | 24 | | | |
| | 1 Planer, 36″x8′, 4-Head. 1 Planer, 30″x12′ | Straps, New | | | 41 | 1½ hr. | 7¾ | 52½ days 2 mach. |
| | | Rods, New | | | 56 | 3¼ hrs. | 22¾ | |
| | | Rods, Old. | | | 15 | 1¼ hr. | 2¼ | |
| | | Back Cyl. Heads | 4x2=8 | 30x2x15%=9 | 17 | 9 hrs. | 19⅛ | |
| | 1 Lathe, 16″x8′ | Knuckle Pins | 4x4=16 | 30x4=120 | 136 | 30 min. | 8 | 24½ days 1 mach. |
| | | Knuckle Pin Bushings | 4x4=16 | 30x4=120 | 136 | 30 min. | 8 | |
| | | Wrist Pins | 4x2=8 | 30x2=60 | 68 | 1 hr. | 8½ | |
| | 1 Hyd. Press, 25 Ton | Bushings | | | | | | 1 mach. |
| Crank Pins | 1 Lathe, 26″x10′ | Crank Pins | 4x8=32 | 30x8x10%=24 | 56 | 3½ hrs.[9] | 24½ | 1 mach. |
| | 1 Vertical Drill, 36″ | Crank Pins | 4x6=24 | 30x6x10%=18 | 42 | 2½ hrs. | 13⅛ | 22 days 1 mach. |
| | | Guide Bars | 4x4=16 | 30x4x30%=36 | 52 | 49 min. | 5⅓ | |
| | | Guide Blocks | 4x4=16 | 30x4x30%=36 | 52 | 12 min. | 1⅓ | |
| | | Crossheads | 4x2=8 | 30x2x15%=9 | 17 | 15 min. | ½ | |
| | | New Crosshead Shoes[10] | | 30x2x25%=15 | 15 | 1 hr. | 1⅞ | |
| Driving Boxes | 1 Planer, 42″x20′. 1 Planer, 42″x12′ | Boxes | 4x8=32 | 30x8x10%=24 | 56 | 3¼ hr. | 22¾ | 2 mach. |
| | | Old Boxes | | 30x8x90%=216 | 216 | 54 min. | 24 | |
| | 1 Ver. Rapid Production Lathe, 37″ (Bullard). | Face New Boxes | 4x8=32 | 30x8x10%=24 | 56 | 1⅓ hr. | 9⅓ | 28 days 1 mach. |
| | | Turn Brass for Box Fit | 4x8=32 | 30x8x90%=216 | 248 | 20 min. | 10⅓ | |
| | | Bore Ecc. Crank (Walschaert) | 4x2=8 | 30x2x 5%=3 | 11 | 2 hrs. | 2¾ | |
| | | Piston Valve Cyl. Heads | 4x4=16 | 30x4x 5%=6 | 22 | 2 hrs. | 5½ | |
| | 1 Draw Shaper, Morton | Shape for Brass and Cellar Fit | 4x8=32 | 30x8x10%=24 | 56 | 3¼ hrs. | 22¾ | 1 mach. |
| | 1 Ver. Boring Mill, 37″ | Bore Brass and Face Box | 4x8=32 | 30x8=240 | 272 | 44 min. | 25 | 1 mach. |
| | 1 Crank Planer, 20″x20″x24″ | Cellars | 4x8=32 | 30x8x20%=48 | 80 | 30 min. | 5 | 34½ days[12] 1 mach. |
| | | Brasses | 4x8=32 | 30x8x90%=216 | 248 | 20 min. | 10⅓ | |
| | | Rod and Eccentric Keys | 4x8=32 | 30x8x40%=96 | 128 | 25 min. | 6⅔ | |
| | | Frame Keys | 4x16=64 | 30x16x50%=240 | 304 | 20 min. | 12⅔ | |
| | 1 Radial Drill, 3′ | Boxes | 4x8=32 | 30x8x10%=24 | 56 | 2¼ hrs. | 16 | 1 mach. |
| | | Old Boxes | | 30x8x90%=216 | 216 | 30 min. | 13½ | |
| Cylinders and Heads | 1 Cylinder Boring Mill. | Bore Cyls | 4x2=8 | 30x2x10%=6 | 14 | 8 hrs. | 14 | 1 mach. |
| | 1 Cylinder Planer, 72″x12′. | Plane Cyls | 4x2=8 | 30x2x10%=6 | 14 | 15 hrs. | 26¼ | 1 mach. |
| | 1 Port Miller | Mill Ports | | | | | | 1 mach. |
| | 1 Radial Drill, 5′ | Cylinders | 4x2=8 | 30x2x10%=6 | 14 | 6½ hrs. | 11⅜ | 1 mach. |
| | | Wheel Centers | 4x8=32 | 30x8x10%=24 | 56 | 40 min. | 4⅔ | |
| | | Front Frame Rails | 4x4=16 | 30x4x10%=12 | 28 | 4 hrs. | 14 | |
| | 1 Ver. Boring Mill, 42″ | Piston Packing Rings. | 4x6=24 | 38x6=228 | 252 | 20 min. | 10½ | 22¾ days 1 mach. |
| | | Front Cylinder Heads | 4x2=8 | 30x2x30%=18 | 26 | 68 min. | 3⅔ | |
| | | Back Cylinder Heads | 4x2=8 | 30x2x15%=9 | 17 | 4 hrs. | 8½ | |
| | 1 Ver. Rapid Production Lathe, 37″ Bullard | Piston Valve Bushing | | 30x4x25%=30 | 30 | 4 hrs. | 15 | 1 mach. |
| | | Piston Valve Packing Rings | | 30x8x50%=120 | 120 | 20 min. | 5 | |
| | 1 Radial Drill, 3′ | Front Cyl. Head | 4x2=8 | 30x2x30%=18 | 26 | 84 min. | 4½ | 23⅞ days 1 mach. |
| | | Back Cyl. Head | 4x2=8 | 30x2x15%=9 | 17 | 2 hrs. | 4¼ | |
| | | Piston Valve Bushing | | 30x4x20%=30 | 30 | 4 hrs. | 15 | |
| Piston Rods | 1 Lathe, 26″x12′ | Piston Rods | 4x2=8 | 30x2x60%=36 | 44 | 4 hrs. | 22 | 1 mach. |
| | 1 Gap Grinder, Norton. | Piston Rods | 4x2=8 | 30x2x60%=36, 30x2x40%=24 | 68 | 40 min. | 5⅔ | 1 mach.[11] |
| | 1 Cottering Machine | Keyways | | | | | | 1 mach. |
| Guides | 1 Plain Hor. Miller, 20″x8′. | Guides | 4x4=16 | 30x4x30%=36 | 52 | 4 hrs. | 26 | 36½[7] days 1 mach. |
| | | Old Guides | | 30x4x70%=84 | 84 | 1 hr. | 10½ | |
| | 1 Guide Bar Grinder, 80″ | Guides | 4x4=16 | 30x4=120 | 136 | 30 min. | 8½ | 1 mach. |
| | 1 Shaper, 16″ | Cut to Length, Cut Clearance | 4x4=16 | 30x4x30%=36 | 52 | 1 hr. | 6½ | 18⅛ days 1 mach. |
| | | Old Guides, Cut Clearance | | 30x4x70%=84 | 84 | 30 min. | 5¼ | |
| | | Guide Blocks | 4x4=16 | 30x4x20%=24 | 40 | 35 min. | 3 | |
| | | Frame Keys | 4x8=32 | 30x8x10%=24 | 56 | 30 min. | 3½ | |
| | 1 Lathe, 16″x8′ | Guide Blocks | 4x4=16 | 30x4x20%=24 | 40 | 1 hr. | 5 | 19⅛ days 1 mach. |
| | | Crank Pin Collars | 4x8=32 | 30x8x50%=120 | 152 | 40 min. | 12⅔ | |
| | | Wrist Pin Washers | 4x2=8 | 30x2x30%=18 | 26 | 30 min. | 1⅝ | |
| Crossheads | 1 Planer, 30″x10′ | Crossheads | 4x2=8 | 30x2x15%=9 | 17 | 4 hrs. | 8½ | 22 days 1 mach. |
| | | Crossheads, Old | | 30x2x85%=51 | 51 | 90 min. | 9⅝ | |
| | | Block and Gibs, Old Crossheads. | | 30x4x20%=24 | 24 | 72 min. | 3⅝ | |
| | 1 Horizontal Boring Mill 4″ Spindle, 6′ Table | Bore and Ream for Piston Rod Fit | 4x2=8 | 30x2x15%=9 | 17 | 2 hrs. | 4¼ | 18⅝ days 1 mach. |
| | | Ream Old Heads | | 30x2x15%=10 | 10 | 1 hr. | 1¼ | |
| | | Rebore Air Pump Cyl | | 30x2x50%=30 | 30 | 1 hr. | 3¾ | |
| | | Bore Steam Chests | 4x2=8 | 30x2x30%=18 | 26 | 1 hr. | 3¼ | |
| | | Bore and Make Joints, Throttle Box | 4x1=4 | 30x1x20%=6 | 10 | 3 hrs. | 3¾ | |
| | | Rebore Old Throttle Box | | 30x1x50%=15 | 15 | 1 hr. | 1⅞ | |

[1] Light Repairs. [2] Heavy Repairs. [3] Pairs. [4] Per Pair. [5] Per Frame. [6] Balance of Time Available for Wheel Centers. [7] See Previous Note. [8] Available for Driving Axles. [9] Time required when main pins are rough turned. [10] Drilled for old crossheads. [11] Balance of time available for valve yokes, wrist pins, etc. [12] See shoes and wedges.

| Class of Work | Machine Tool | Operation | Number of Pieces per Month: New Engs. | Repairs | Total | Average Time per Piece | Total Days Work per Month | |
|---|---|---|---|---|---|---|---|---|
| Steam Chests | 1 Planer, 36″x10′, D. H. | Steam Chests | 4x2= 8 | 30x2x30% = 18 | 26 | 3 hrs. | 9¾ | 20½ days 1 mach. |
| | | Steam Chest Covers and Pressure Plates | 4x2= 8 | 30x2x30% = 18 | 26 | 2½ hrs. | 8⅛ | |
| | | Steam Chests, Old | | 30x2x30% = 18 | 18 | 1 hr. | 2¼ | |
| | | Bore Stuffing Box [6] | | | | | | |
| | 1 Radial Drill, 3′ | Drill Steam Chests and Tap | 4x2= 8 | 30x2x30% = 18 | 26 | 1 hr. | 3¼ | 22⅞ days 1 mach. |
| | | Steam Chest Covers | 4x2= 8 | 30x2x30% = 18 | 26 | 2 hrs. | 6½ | |
| | | Pressure Plates | 4x2= 8 | 30x2x30% = 18 | 26 | 30 min. | 1⅝ | |
| | | Piston Valve Cyl. Head | 4x4=16 | 30x4x 7% = 8 | 24 | 1 hr. | 3 | |
| | | Drill and Tap Piston Heads | 4x2= 8 | 30x2=60 | 68 | 1 hr. | 8½ | |
| Valves | 1 Planer, 30″x10′, D. H. | Valves | 4x2= 8 | 30x2x50% = 30 | 38 | 4 hrs. | 19 | 26 days 1 mach. |
| | | Valve Yokes | 4x2= 8 | 30x2x50% = 30 | 38 | 30 min. | 2⅜ | |
| | | False Seats | | 30x2x25% = 15 | 15 | 2½ hrs. | 4 3/10 | |
| | 1 Plane Miller, 14″x6′ | Valves | 4x2= 8 | 30x2x50% = 30 | 38 | 2 hrs. | 9½ | 24 days 1 mach. |
| | | False Seats | | 30x2x25% = 15 | 15 | 2½ hrs. | 4¼ | |
| | | Valve Strips | 4x2= 8 | 30x2x75% = 44 | 52 | 1½ hrs. | 9¾ | |
| | 1 Lathe, 20″x10′; 1 Lathe, 24″x14′ | Valve Yoke | 4x2= 8 | 30x2x50% = 30 | 38 | 2 hrs. | 9½ | 51½ days 2 mach. |
| | | Piston Valves [8] | | 30x2x25% = 16 | 16 | 10 hrs. [8] | 20 | |
| | | Piston Valve Stems [9] | | 30x2x25% = 16 | 16 | 7 hrs. [9] | 14 | |
| | | Valve Rods | 4x2= 8 | 30x2x15% = 8 | 16 | 4 hrs. | 8 | |
| Valve Gear | 1 Lathe, 32″x12′ | Lifting Shaft | 4x1= 4 | 30x1x20% = 6 | 10 | 2½ hrs. | 3⅛ | 24½ days 1 mach. |
| | | Old Lifting Shaft | | 30x2x25% = 15 | 15 | 40 min. | 1¼ | |
| | | Rocker Arms | 4x2= 8 | 30x2x15% = 9 | 17 | 4 hrs | 8½ | |
| | | Old Rocker Arms | | 30x2x50% = 30 | 30 | 1 hr. | 3¾ | |
| | | Walschaert Link Saddles | 4x4=16 | 30x4x 5% = 6 | 22 | 2 hrs. | 5½ | |
| | | Drill, Ream, Turn Valve Rod (Wals.) | 4x2= 8 | 30x2x 5% = 3 | 11 | 1½ hrs. | 2 | |
| | 3 Lathes, 18″, 18″ and 16″ | Pins (34 Locos) | ..... | ..... | 800 | 45 min. | 75 | 3 mach. |
| | 1 Centering Machine, 14″ | For Center Pins | ..... | ..... | ..... | ..... | ..... | 1 mach. |
| | 1 W. S. Turret Lathe, 3″x36″ | Rocker Box Bolts [7] | ..... | ..... | ..... | ..... | ..... | 1 mach. |
| | 1 Rapid Production Ver. Lathe, 37″, Bullard | Bore and Turn Ecc. Cams | 4x4=16 | 30x4x50% = 60 | 76 | 1½ hr. | 14¼ | 25¾ days 1 mach. |
| | | Bore Ecc. Straps | 4x4=16 | 30x4x50% = 60 | 76 | 1 hr. | 9½ | |
| | | Rebore Old Ecc. Straps | | 30x4x20% = 24 | 24 | 40 min. | 2 | |
| | 1 Horizontal Boring Mill, 4″ Spindle, 6′ Table | Rocker Boxes | 4x2= 8 | 30x2x10% = 6 | 14 | 2 hrs. | 3½ | 19 days 1 mach. |
| | | Bore for Bushing | | 30x2x10% = 6 | 6 | 2 hrs. | 1½ | |
| | | Bushed Boxes | | 30x2x60% = 36 | 36 | 1½ hrs. | 5⅝ | |
| | | Valve Guide Crosshead | 4x2= 8 | 30x2x20% = 12 | 20 | 40 min. | 1⅝ | |
| | | Lift Shaft Boxes | 4x2= 8 | 30x2x30% = 18 | 26 | 45 min. | 2⅜ | |
| | | Trans. Bar Hangers | | 30x2x10% = 6 | 6 | 1 hr. | ¾ | |
| | | Link Brackets (Wals.) | 4x2= 8 | 30x2x 5% = 3 | 11 | 2½ hrs. | 3⅜ | |
| | 2 Planers, 30″x10′ | Eccentric Cams | 4x4=16 | 30x4x50% = 60 | 76 | 1 hr. | 9½ | 35¼ days 2 mach. |
| | | Link Bracket (Wals.) | 4x2= 8 | 30x2x 5% = 3 | 11 | 2 hrs. | 2¼ | |
| | | Rocker Boxes | 4x2= 8 | 30x2x20% = 12 | 20 | 3 hrs. | 7½ | |
| | | Link Saddle (Wals.) | 4x4=16 | 30x4x 5% = 6 | 22 | 3 hrs. | 8¼ | |
| | | Links | 4x2= 8 | 30x2x10% = 6 | 14 | 2½ hrs. | 4⅜ | |
| | | Union Lever Bracket | 4x2= 8 | 30x2x 5% = 3 | 11 | 1 hr. | 1⅜ | |
| | | Transmission Bar | | 30x2x10% = 6 | 6 | 2 hrs. | 1½ | |
| | 1 Horizontal Milling Mach. 30″x10′ (for Walschaert Valve Gear) | Comb. Levers | 4x2= 8 | 30x2x 5% = 3 | 11 | 3 hrs. | 4¼ | 25¼ days 1 mach. |
| | | Radius Bar | 4x2= 8 | 30x2x 5% = 3 | 11 | 5 hrs. | 6⅞ | |
| | | Eccentric Rod | 4x2= 8 | 30x2x 5% = 3 | 11 | 6 hrs. | 8¼ | |
| | | Guide Bar | 4x2= 8 | 30x2x 5% = 3 | 11 | 2 hrs. | 2¼ | |
| | | Reverse Lever | 4x1= 4 | 30x1x20% = 6 | 10 | 1½ hrs. | 1⅞ | |
| | | Reverse Lever Quadrant | 4x1= 4 | 30x1x20% = 6 | 10 | 1 hr. | 1¼ | |
| | 1 Vertical Miller, 42″; 1 Vertical Miller, 33″ | Links | 4x2= 8 | 30x2x10% = 6 | 14 | 6 hrs. | 10½ | 78¾ days 2 mach. |
| | | Combination Lever | 4x2= 8 | 30x2x 5% = 3 | 11 | 10 hrs. | 13¾ | |
| | | Radius Bar | 4x2= 8 | 30x2x 5% = 3 | 11 | 12 hrs. | 16½ | |
| | | Eccentric Rod | 4x2= 8 | 30x2x 5% = 3 | 11 | 1 hr. | 1⅜ | |
| | | Union Bar | 4x2= 8 | 30x2x 5% = 3 | 11 | 3 hrs. | 4⅛ | |
| | | Union Bar Bracket | 4x2= 8 | 30x2x 5% = 3 | 11 | 2 hrs. | 2¼ | |
| | | Eccentric Jaws | 4x4=16 | 30x4x25% = 30 | 46 | 2 hrs. | 11½ | |
| | | Rocker Arms | 4x2= 8 | 30x2x15% = 9 | 17 | 3½ hrs. | 7½ | |
| | | Link Blocks | 4x2= 8 | 30x2x10% = 6 | 14 | 1 hr. | 1¾ | |
| | | Link Hangers | 4x2= 8 | 30x2x10% = 6 | 14 | 3 hrs. | 5¼ | |
| | | Link Saddles | 4x2= 8 | 30x2x10% = 6 | 14 | 1½ hrs. | 2⅝ | |
| | | Rod Keys | 4x4=16 | 30x4x40% = 48 | 64 | 9 min. | 1⅕ | |
| | 1 Plain Miller 14″x6′ | Eccentric Straps | ..... | ..... | 76 | 20 min. | 3 1/12 | 23½ days 1 mach. |
| | | Union Bar | ..... | ..... | 14 | 35 min. | 1 | |
| | | Reverse Lever Latch | ..... | ..... | 34 | 2 hrs. | 8½ | |
| | | Valve Rod (Wals.) | ..... | ..... | 14 | 1½ hrs. | 2⅝ | |
| | | Cut Slot in Ecc. Crank | ..... | ..... | 14 | 1 hr. | 1¾ | |
| | | Throttle Latch | ..... | ..... | 34 | 15 min. | 1 | |
| | | Rev. Lever Latch Handle | ..... | ..... | 34 | 12 min. | 1 | |
| | | Throttle Lever Latch Handle | ..... | ..... | 34 | 12 min. | 1 | |
| | | Keyway in Lift Shaft | ..... | ..... | 10 | 30 min. | ⅝ | |
| | | Throttle Lever Quadrant | 4x1= 4 | 30x20%=6 | 10 | 2 hrs. | 2½ | |
| | 1 Slotter, 12″ | Keyways in Ecc. Cams | ..... | ..... | 76 | 20 min. | 3⅛ | 25¼ days 1 mach. |
| | | Keyway in Ecc. Crank | ..... | ..... | 12 | 15 min. | ⅜ | |
| | | Keyway in Lift Shaft Arm | ..... | ..... | 10 | 15 min. | 3/16 | |
| | | Ecc. Rod for Brass | ..... | ..... | 11 | 2 min. | 2¼ | |
| | | Clearance in Radius Bar | ..... | ..... | 14 | 1½ min. | 2⅝ | |
| | | Transmission Bars | ..... | ..... | 6 | 3 min. | 2¼ | |
| | | Clearance in Links | ..... | ..... | 20 | 2 min. | 5 | |
| | | Reverse Lever Quadrant | 4x1= 4 | 30x20%=6 | 10 | 3 min. | 3¾ | |
| | | Transmission Bars | ..... | ..... | 20 | 2 min. | 5 | |
| | 1 Crank Planer 20″x20″x24″ | Ecc. Straps for Blade Fit | ..... | ..... | 76 | 25 min. | 4 | 27 days 1 mach. |
| | | Lifting Shaft Boxes | ..... | ..... | 30 | 1 hr. | 3¾ | |
| | | Valve Rod Guide Box (Wals.) | ..... | ..... | 14 | 3 hrs. | 6½ | |
| | | Ecc. Blades for Strap Fit and Jaw Faces | ..... | ..... | 36 | 30 min. | 2½ | |
| | | Link Saddles | ..... | 30x2x20%=12 | 12 | 1 hr. | 1½ | |
| | | Radius Bar Guide Box | ..... | ..... | 14 | 2 hrs. | 3½ | |
| | | Link Block | 4x2= 8 | 30x2x10%=6 | 14 | 20 min. | ⅝ | |
| | | Link Block Plates | ..... | ..... | 88 | 20 min. | 3⅝ | |
| | | Top of Transmission Hanger | ..... | ..... | 20 | 30 min. | 1¼ | |

[6] See Crossheads. [7] Also rough turn all motion pins, eccentric set bolts, bushings, etc. [8] This incudes two cast steel follower plates, two skeleton rings and one center piece. [9] This includes straightening, centering and all work from the rough forging.

| Class of Work | Machine Tool | Operation | Number of Pieces per Month: New Engs. | Repairs | Total | Average Time per Piece | Total Days Work per Month | |
|---|---|---|---|---|---|---|---|---|
| Valve Gear (*Continued*) | 1 Vertical Drill, 21"; 1 Vertical Drill, 26"; 1 Radial Drill, 5' | Lift Shaft Arms | ........ | ........ | 10L.s. | 1 hr. | 1¼ | 87 days 3 mach. |
| | | Rocker Arms | ........ | ........ | 17 | 3 hrs. | 6⅜ | |
| | | Eccentric Crank | ........ | ........ | 11 | 2 hrs. | 2¾ | |
| | | Piston Valve Cyl. Heads | ........ | ........ | 30 | 1 hr. | 3¾ | |
| | | Valve Guide Crosshead and Cap | ........ | ........ | 14 | 1½ hr. | 2⅝ | |
| | | Lifting Shaft Boxes | ........ | ........ | 30 | 1¼ hrs. | 4⅝ | |
| | | Transmission Hangers | ........ | ........ | 20 | 30 min. | 1¼ | |
| | | Link Saddles | ........ | ........ | 40 | 15 min. | 1¼ | |
| | | Links | ........ | ........ | 20 | 1¼ hr. | 3⅛ | |
| | | Union Bar | ........ | ........ | 11 | 1 hr. | 1⅜ | |
| | | Crosshead Bracket | ........ | ........ | 14 | 30 min. | ⅞ | |
| | | Combination Lever | ........ | ........ | 11 | 1½ hr. | 2 | |
| | | Radius Bar | ........ | ........ | 11 | 2 hrs. | 2¾ | |
| | | Eccentric Rod | ........ | ........ | 11 | 1½ hr. | 2 | |
| | | Guide Bar (Wals.) | ........ | ........ | 11 | 45 min. | 1 | |
| | | Transmission Bar | ........ | ........ | 6 | 2½ hrs. | 1⅞ | |
| | | Reverse Lever | ........ | ........ | 10 | 35 min. | ¾ | |
| | | Reverse Lever Quadrant | ........ | ........ | 10 | 15 min. | 5/16 | |
| | | Eccentric Jaws | ........ | ........ | 30 | 35 min. | 2¼ | |
| | | Link Blocks | ........ | ........ | 14 | 1 hr. | 1¾ | |
| | | Throttle Latch | ........ | ........ | 34 | 3 min. | ¼ | |
| | | Throttle Latch Handle | ........ | ........ | 34 | 6 min. | 7/16 | |
| | | Rev. Lever Latch Handle | ........ | ........ | 34 | 6 min. | 7/16 | |
| | | Reverse Lever Latch | ........ | ........ | 34 | 15 min. | 1 | |
| | | Throttle Lever Quadrant | ........ | ........ | 10 | 10 min. | ¼ | |
| | | Radius Bar Guide Box | ........ | ........ | 11 | 45 min. | 1 | |
| | | Link Block Plates | ........ | ........ | 88 | 12 min. | 2⅕ | |
| | | Link Hangers | ........ | ........ | 20 | 1½ hrs. | 3⅛ | |
| | | Reach Rod | ........ | ........ | 20 | 40 min. | 1⅝ | |
| | | Eccentric Straps | ........ | ........ | 76 | 2 hrs. | 19 | |
| | | Eccentric Cams | ........ | ........ | 76 | 1 hr. | 9½ | |
| | | Link Brackets | ........ | ........ | 11 | 1 hr. | 1⅜ | |
| | | Rocker Box | ........ | ........ | 20 | 1 hr. | 2½ | |
| | | Valve Rods | ........ | 30x2x10%=6 | 6 | 20 min. | ¼ | |
| Pistons | 1 Rapid Prod. Ver. Lathe, 37" | Bore and Turn Piston Head | 4x2= 8 | 30x2=60 | 68 | 2 hrs. | 17 | 1 mach. |
| | 1 Rapid Production Vertical Lathe, 37" | Air Pump Packing Rings | ........ | ........ | 120 | 8 min. | 2 | 28⅔ days 1 mach. |
| | | Piston Rod Glands | 4x2= 8 | 30x2x35%=21 | 29 | 45 min. | 2¾ | |
| | | U. S. Packing Cases | ........ | ........ | 29 | 20 min. | 1¼ | |
| | | Dome Caps | 4x1= 4 | 30x10%=3 | 7 | 1½ hr. | 1⅓ | |
| | | Auxiliary Domes | 4x1= 4 | 30x10%=3 | 7 | 1½ hr. | 1⅓ | |
| | | Hub Plates | 4x8=32 | 30x8x30%=72 | 104 | 1¼ hr. | 16¼ | |
| | | Air Pump Piston Heads | ........ | 30x2x50%=30 | 30 | 1 hr. | 3¾ | |
| Engine and Tender Truck Work | 1 Wheel Borer, 48" | Truck Wheels, Eng. and Ten. | 4x10=40 | 11x30x60%=198 | 238 | 20 min. | 10 | 1 mach. |
| | 1 Wheel Lathe, Steel Tire 48" | Tires | ........ | ........ | 165[3] | 1 hr. | 20⅝ | 1 mach. |
| | 1 Planer, 48"x10' | Truck Center Casting | 4x1= 4 | 30x25%=8 | 12 | 2 hrs. | 1½ | 24 days 1 mach. |
| | | Truck Cradle Brace | 4x1= 4 | 30x50%=15 | 19 | 3 hrs. | 7⅛ | |
| | | Truck Frames | 4x1= 4 | 30x50%=15 | 19 | 2½ hrs. | 6 | |
| | | Pedestals | 4x4=16 | 30x6x50%=90 | 106 | 30 min. | 6⅝ | |
| | | Binder Cstg., Tender Truck | 4x1= 4 | 30x4x20%=24 | 28 | 45 min. | 2⅝ | |
| | 2 Drill Press, 20" and 26"; 2 Radial Drill, 3' and 4' | Eng. Trucks | 4x1= 4 | 30x50%=15 | 19 | 13 hrs. | 31 | 95 days 4 mach. |
| | | Tender Trucks | 4x2= 8 | 30x2x40%=24 | 32 | 16 hrs. | 64 | |
| | 1 Shaper, 20" | Col. Cstg., Ten. Truck | 4x8=32 | 30x8x25%=60 | 92 | 1½ hr. | 17⅓ | 30⅓ days 1 mach. |
| | | Eng. Truck Brasses | 4x2= 8 | 30x3x30%=27 | 35 | 20 min. | 1½ | |
| | | Hanger Brackets, Brake | 4x4=16 | 30x4x20%=24 | 40 | 1 hr. | 5 | |
| | | Filling Blocks | 4x2= 8 | 30x2x10%=6 | 14 | 1 hr. | 1¾ | |
| | | Spring Saddles | 4x6=24 | 30x6x50%=90 | 114 | 20 min. | 4¾ | |
| | 1 200-Ton Wheel Press | ........ | ........ | ........ | ........ | ........ | ........ | 1 mach. |
| Shoes and Wedges | 2 Planers, 36"x12', 30"x12'. | Shoes and Wedges | 4x16=64 | 30x16=480 | 544 | 35 min. | 39 | 2 mach. |
| | 1 Crank Planer, 20"x20"x24" | Shoes and Plane to Line | ........ | ........ | 544 | 15 min. | 17 | 1 mach. |
| | [6] | Drill for Set Bolts | ........ | ........ | ........ | ........ | ........ | ........ |
| Throttle Rigging | 1 Lathe, 32"x12'; 1 Lathe, 18"x8' | See Crossheads for Hor. Bor. Mill | | | | | | 40 days 2 mach. |
| | | Dry Pipes | 4x1= 4 | 30x20%=6 | 10 | 2 hrs. | 2½ | |
| | | Dry Pipe Sleeves | 4x2= 8 | 30x2x20%=12 | 20 | 2 hrs. | 5 | |
| | | Throttle Valves | 4x1= 4 | 30x50%=15 | 19 | 3 hrs. | 7⅛ | |
| | | Steam Pipe Joint Rings | 4x5=20 | 30x5x35%=50 | 70 | 1 hr. | 8¾ | |
| | | Stand Pipes | 4x1= 4 | 30x20%=6 | 10 | 1 hr. | 1¼ | |
| | | Old Stand Pipes, Trued | ........ | ........ | 24 | 30 min. | 1½ | |
| | | Throttle Valve Shafts | 4x1= 4 | 30x20%=6 | 10 | 1 hr. | 1¼ | |
| | | Throttle Valve Stems | 4x1= 4 | 30x50%=15 | 19 | 30 min. | 1¼ | |
| | | Dome Caps | 4x1= 4 | 30x20%=6 | 10 | 4 hrs. | 5 | |
| | | Exhaust Pipes | 4x1= 4 | 30x50%=15 | 19 | 1½ hr. | 3½ | |
| | | Exhaust Nozzle Tips | 4x2= 8 | 30x2x40%=24 | 32 | 40 min. | 2⅔ | |
| | 1 Radial Drill, 3' | Dry Pipe and Sleeves | 4x2= 8 | 30x2x20%=12 | 20 | 40 min. | 1⅔ | 26½ days 1 mach. |
| | | Standpipe U Bolt, Drill and Tap | 4x1= 4 | 30x1=30 | 34 | 20 min. | 1½ | |
| | | Front End Draw Casting | 4x1= 4 | 30x1x65%=20 | 24 | 1 hr. | 3 | |
| | | Standpipe Brace | 4x1= 4 | 30x50%=15 | 19 | 15 min. | ⅝ | |
| | | Throttle Stuffing Box and Gland | 4x1= 4 | 30x20%=6 | 10 | 20 min. | ⅜ | |
| | | Reversing Mechanism [7] | 4x1= 4 | 30x20%=6 | 10 | 2⅜ hrs. | 3 | |
| | | Dome Caps | 4x1= 4 | 30x20%=6 | 10 | 1 hr. | 1¼ | |
| | | Auxiliary Domes | 4x1= 4 | 30x20%=6 | 10 | 1 hr. | 1¼ | |
| | | Tee Heads | 4x1= 4 | 30x20%=6 | 10 | 1¼ hr. | 1½ | |
| | | Steam Pipes | 4x2= 8 | 30x2x40%=24 | 32 | 2 hrs. | 8 | |
| | | Exhaust Pipes | 4x1= 4 | 30x50%=15 | 19 | 1 hr. | 2⅜ | |
| | | Exhaust Pipe Shield | 4x1= 4 | 30x50%=15 | 19 | 10 min. | ½ | |
| | | Main Brace for Pilot | 4x1= 4 | 30x1x65%=20 | 24 | 30 min. | 1½ | |
| Pilot and Miscellaneous Work | 1 Vertical Drill, 22" | Bottom Frames | 4x1= 4 | 30x65%=20 | 24 | 1 hr. | 3 | 26⅞ days 1 mach. |
| | | Top Rails | 4x1= 4 | 30x65%=20 | 24 | 1 hr. | 3 | |
| | | Corner Uprights | 4x2= 8 | 30x2x65%=40 | 48 | 15 min. | 1½ | |
| | | Smoke Arch Braces | 4x2= 8 | 30x2x50%=30 | 38 | 30 min. | 2⅜ | |
| | | Bumper Beam Castings | 4x2= 8 | 30x2x50%=30 | 38 | 2 hrs. | 9½ | |
| | | Driving Box Cellars | ........ | 30x8x20%=48 | 48 | 15 min. | 1½ | |
| | | Shoes and Wedges | 4x16=64 | 30x16=480 | 544 | 3½ min. | 3⅞ | |
| | | Piston Rod Packing Glands | 4x2= 8 | 30x2x35%=21 | 29 | 20 min. | 1¼ | |
| | | Valve Stem Packing Glands | 4x2= 8 | 30x2x35%=21 | 29 | 15 min. | 1 | |
| Spring and Brake Rigging | 1 Radial Drill, 3'; 2 Ver. Drills, 25" and 40" | Spring Rigging | 4x1= 4 | 30x75%=22 | 26 | 9 hrs. | 29¼ | 87¾ days 3 mach. |
| | | Brake Rigging | 4x1= 4 | 30x75%=22 | 26 | 18 hrs. | 58 | |

[3] Pairs. [6] See Driving Boxes. [7] Levers, crank, shaft and arms, quadrant, quadrant brackets, latch, latch lifter and reach rod.

| Class of Work | Machine Tool | Operation | Number of Pieces per Month: New Engs. | Repairs | Total | Average Time per Piece | Total Days Work per Month | |
|---|---|---|---|---|---|---|---|---|
| | 1 Lathe, 16″x8′ | Piston and Valve Stem Packing | 4x4=16 | 30x4=120 | 136 | 1½ hr. | 25½ | 1 mach. |
| | | Tank Valves | 4x2= 8 | 30x2x60%=36 | 44 | 40 min. | 3⅔ | |
| | | Throttle Stuffing Box and Gland | 4x1= 4 | 30x20%=6 | 10 | 2 hrs. | 2½ | |
| | 1 Lathe, 18″x10′ | Turn Rocker Bushing | ........ | ........ | 96 | 20 min. | 4 | 21 days 1 mach. |
| | | Bells | 4x1= 4 | 30x10%=3 | 7 | 3½ hrs. | 3 | |
| | | Whistles | 4x1= 4 | 30x20%=6 | 10 | 4 hrs. | 5 | |
| | | Tank Hose Nuts and Connections | ........ | ........ | 68 | 20 min. | 2⅞ | |
| | | Hub Liner Bolts | ........ | 128x8=1,024 | 1024 | 4 min. | 8 | |
| | | Boiler Plugs | 4x10=40 | 30x10x50%=150 | 190 | 4 min. | 1 7/12 | |
| | 1 Lathe, 14″x6′ | Driving Box Plugs | 4x8=32 | 30x8=240 | 272 | 7 min. | 4 | 26½ days 1 mach. |
| | | Muffler Valves Overhauled | ........ | 30x2=60 | 60 | 1 hr. | 7½ | |
| | | Feed Pipe Sleeve | 4x2= 8 | 30x2x50%=30 | 38 | 17 min. | 1⅓ | |
| | | Valve Stems, etc. | ........ | ........ | ........ | ........ | 4 | |
| | | Relief Valves | 4x2= 8 | 30x2x50%=30 | 38 | 2 hrs. | 9½ | |
| | | Relief Valves Overhauled | ........ | 30x2x50%=30 | 30 | 20 min. | 1¼ | |
| | | Blow-off Cocks | 4x1= 4 | 30x50%=15 | 19 | 2½ hrs. | 7½ | |
| | | Blow-off Cocks Overhauled | ........ | 30x50%=15 | 15 | 30 min. | 15/16 | |
| | | Water Glass Cocks | 4x2= 8 | 30x2x50%=30 | 38 | 1⅔ hr. | 8 | |
| | | Water Glass Cocks Overhauled | ........ | 30x2x50%=30 | 30 | 20 min. | 1¼ | |
| | | Gauge Cocks | 4x6=24 | 30x6x50%=90 | 114 | 50 min. | 12 | |
| | | Gauge Cocks Overhauled | ........ | 30x6x50%=90 | 90 | 8 min. | 1½ | |
| | | Air Pump Valves, 1″ Angle | 4x1= 4 | 30x50%=15 | 19 | 95 min. | 3¾ | |
| | | Air Pump Valves Overhauled | ........ | 30x50%=15 | 15 | 25 min. | ¾ | |
| | | Blower Valves, 1¼″ | 4x2= 8 | 30x2x50%=30 | 38 | 95 min. | 7½ | |
| | | Blower Valves Overhauled | ........ | 30x2x50%=30 | 30 | 25 min. | 1½ | |
| | | Injector Steam Valves, 2″ Angle | 4x2= 8 | 30x2x50%=30 | 38 | 2¼ hrs. | 10¾ | |
| | | Injector Steam Valves Overhauled | ........ | 30x2x50%=30 | 30 | 30 min. | 1⅞ | |
| BRASS WORK | | Car Heater Valves | ........ | 30x25%=7 | 7 | 95 min. | 1⅜ | |
| | | Car Heater Valves Overhauled | ........ | 30x25%=7 | 7 | 25 min. | ⅜ | |
| | | Lubricator Valves, ¾″ Angle | 4x2= 8 | 30x2x50%=30 | 38 | 1½ hr. | 7⅛ | |
| | | Lubricator Valves Overhauled | ........ | 30x2x50%=30 | 30 | 20 min. | 1¼ | |
| | | Steam and Air Gauge Cocks | 4x2= 8 | 30x4x50%=60 | 68 | 25 min. | 3½ | |
| | | Steam and Air Gauge Cocks Overh'l'd | ........ | 30x4x50%=60 | 60 | 10 min. | 1¼ | |
| | | Tallow Plugs | 4x2= 8 | 30x2x50%=30 | 38 | 35 min. | 2¾ | |
| | 1 Turret Lathe, 20″x6′ | Tallow Plugs Overhauled | ........ | 30x2x50%=30 | 30 | 15 min. | 1 | 149 days 5 mach. |
| | 4 Turret Lathes, 18″x6′ | Check Valves | 4x2= 8 | 30x2x25%=15 | 23 | 2½ hrs. | 7¼ | |
| | | Check Valves Overhauled | ........ | 30x25%=15 | 15 | 25 min. | ¾ | |
| | | Air Cyl. Cocks | 4x4=16 | 30x4x50%=60 | 76 | 2 hrs. | 19 | |
| | | Air Cyl. Cocks Overhauled | ........ | 30x4x50%=60 | 60 | 8 min. | 1 | |
| | | Pet Cocks, ⅜″ | 4x8=32 | 30x8x50%=120 | 152 | 30 min. | 9½ | |
| | | Pet Cocks Overhauled | ........ | 30x8x50%=120 | 120 | 6 min. | 1½ | |
| | | Blower Connection | 4x2= 8 | 30x4x50%=60 | 68 | 18 min. | 2½ | |
| | | Tallow Pipe Conn. and Nuts | 4x2= 8 | 30x2x50%=30 | 38 | 17 min. | 1⅓ | |
| | | Tank Cocks | 4x1= 4 | 30x50%=15 | 19 | 70 min. | 2¾ | |
| | | Tank Cocks Overhauled | ........ | 30x50%=15 | 15 | 20 min. | ⅝ | |
| | | Whistle Elbow | 4x1= 4 | 30x25%=8 | 12 | 18 min. | 7/16 | |
| | | Cab Door Lock and Slides | 4x4=16 | 30x4x25%=30 | 46 | 30 min. | 3 | |
| | | Brazing Rings | ........ | ........ | 500 | ........ | 1 | |
| | | Ext., Gauge and Water Glass Cocks | 4x8=32 | 30x8x25%=60 | 92 | 12 min. | ¾ | |
| | | Pipe Sleeves and Nuts | ........ | 34x8x25%=68 | 68 | 17 min. | 2½ | |
| | | Filling Plugs and Nuts, Lubricator | ........ | ........ | 30 | 15 min. | 1 | |
| | | Drain Plugs for Lubricators | ........ | ........ | 30 | ........ | ¼ | |
| | | Sand Nozzles | ........ | ........ | 50 | ........ | ½ | |
| | | Safety Valve Extensions | 4x2= 8 | 30x2x25%=15 | 23 | 20 min. | 1 | |
| | | Nipples and Reducers | ........ | ........ | 200 | 10 min. | 4 | |
| | | Rocker Box Set Bolts | ........ | 30x8x25%=60 | 60 | 4 min. | ½ | |
| AIR BRAKE WORK | | Air Pump Piston Rods | ........ | 30x50%=15 | 15 | 2½ hrs. | 4¾ | |
| | | Old Piston Rods Rep'd[6] | ........ | 30x50%=15 | 15 | 40 min. | 1¼ | 15⅜ days 1 mach. |
| | 1 Lathe, 16″x6′ | Fulcrum Shaft | 4x2= 8 | 30x2x25%=15 | 23 | 1½ hr. | 4⅜ | |
| | | Refitting Brake Hanger Posts | 4x6=24 | 30x6x75%=135 | 159 | 15 min. | 5 | |
| ROD BRASSES | 1 B. B. Ver. Milling Mach. | Shape or Mill | 4x4=16 | 30x4=120 | 136 | 2 hrs. | 34 | 1 mach. |
| | 1 Ver. Rapid Prod. Lathe, 37″ Bullard, 4 Jaw Chuck | Bore and Face | 4x4=16 | 30x4=120 | 136 | 40 min. | 11⅓ | 25½ days 1 mach. |
| | | Bore Bushing and Turn | 4x8=32 | 30x8=240 | 272 | 25 min. | 14⅛ | |
| | | Sand Boxes, Top and Base | 4x1= 4 | 30x10%=3 | 7 | 3 hrs. | 2⅝ | |
| | | Eng. Truck Tires | ........ | 30x3x10%=10 | 10 | 3 hrs. | 3¾ | |
| | 1 Ver. Boring Mill, 51″ | Dome Rings | 4x1= 4 | 30x5%=2 | 6 | 2 hrs. | 1½ | 26¾ days 1 mach. |
| | | Crossheads, Face, Bore, Turn | 4x2= 8 | 30x2x15%=9 | 17 | 8 hrs. | 17 | |
| | | Crossheads, Rebore Old | ........ | 30x2x20%=12 | 12 | 1 hr. | 1½ | |
| | | Sand Box Shaft | 4x1= 4 | 30x10%=3 | 7 | 1 hr. | ⅞ | |
| | | Bell Yoke | 4x1= 4 | 30x25%=8 | 12 | 1½ hr. | 2¼ | |
| | 1 Lathe, 24″x10′ | Hand Holes and Covers | 4x1= 4 | 30x50%=15 | 19 | 30 min. | 1¼ | 19⅞ days 1 mach. |
| | | Male Center Casting | 4x1= 4 | 30x20%=6 | 10 | 2 hrs. | 2½ | |
| MISCELLANEOUS CASTINGS | | Mud Chambers | 4x2= 8 | 30x2x50%=30 | 38 | 2 hrs. | 9½ | |
| | | Tank Valve Racks | 4x2= 8 | 30x2x50%=30 | 38 | 45 min. | 3½ | |
| | | Expansion Braces | 4x1= 4 | 30x10%=3 | 7 | 12 hrs. | 10½ | |
| | | Guide Yokes | 4x1= 4 | 30x15%=4 | 8 | 7 hrs. | 7 | |
| | | Guide Yoke Brackets | 4x2= 8 | 30x2x25%=15 | 23 | 3 hrs. | 8⅝ | |
| | 1 Planer, 30″x8′ | Guide Yoke Extensions | 4x2= 8 | 30x2x10%=6 | 14 | 4 hrs. | 7 | |
| | 1 Planer, 36″x10′ | Castings[7] | 4x4=16 | 30x4x10%=12 | 28 | 2½ hrs | 9 | |
| | 1 Planer, 48″x12′ | Filling Blocks | 4x4=16 | 30x4x10%=12 | 28 | 2 hrs. | 7 | 81½ days 3 mach. |
| | | Driver Brake Fulcrums | 4x2= 8 | 30x2x10%=6 | 14 | 40 min. | 1⅛ | |
| | | Hopper Castings | 4x1= 4 | 30x1x20%=6 | 10 | 40 min. | ⅞ | |
| | | Drawhead Casting[8] | 4x3=12 | 30x3x10%=9 | 21 | 6⅔ hrs. | 17½ | |
| | | Chafing Blocks | 4x1= 4 | 30x1x20%=6 | 10 | 1¼ hrs. | 1½ | |
| | | Crosstie Link Bracket, etc.[9] | 4x1= 4 | 30x1x5%=2 | 6 | 15 hrs. | 11¼ | |
| | 2 Radial Drills, 4′ and 5′; 1 Ver. Drill, 32″ | Drilling Miscellaneous Holes for New and Repair Work[10] | ........ | ........ | 5500 | ........ | ........ | 3 mach. |
| | | Frame Braces | 4x3=12 | 30x3x25%=23 | 35 | 3 hrs. | 13⅛ | |
| | 1 Slotter, 12 | Equalizer, Main | 4x1= 4 | 30x10%=3 | 7 | 5 hrs. | 4⅜ | |
| MISCELLANEOUS FORGINGS | 1 Slotter, 18″ | Pedestal Binders | ........ | 30x8x25%=60 | 60 | 1 hr. | 7½ | 58¾ days 2 mach. |
| | | Grate Bearing Bars | 4x2= 8 | 30x2x25%=15 | 23 | 2 hrs. | 5¾ | |
| | | Frame Rails | 4x4=16 | 30x4x10%=12 | 28 | 8 hrs. | 28 | |
| | 1 Planer, 42″x10′ | Pedestal Binders | 4x8=32 | 30x8x10%=24 | 56 | 1½ hr. | 9⅓ | 16⅛ days 1 mach.[12] |
| | | Frame Braces | 4x4=16 | 30x4x10%=12 | 28 | 2 hrs. | 7 | |
| | 1 Radial Drill, 4′ | Miscellaneous[11] | ........ | ........ | ........ | ........ | ........ | ........ |
| STAY-BOLTS | 1 Lassiter 6-Spindle Mach. | Staybolts, Av. 7½″ Long | 4x1500=6000 | 30x1500x30%=13,500 | 19,500 | 1080[1] | 18 | 1 mach. |
| | 1 4-Spindle Drill | Telltale Holes in Bolts | ........ | ........ | 19,500 | 800[1] | 24⅜ | 1 mach. |
| PIN WORK | 1 Gisholt Lathe for 6″ Stock | Crank Pins | 4x6=24 | 30x6x50%=90 | 114 | ........ | ........ | |
| | 1 Gisholt Lathe for 4½″ Stock | Wrist Pins | 4x2= 8 | 30x2=60 | 68 | 45 min. | 6⅜ | 2 mach. |
| | | Knuckle Pins | 4x4=16 | 30x4=120 | 136 | 20 min. | 5⅔ | |

[1] Per day. [6] Old piston rods and heads filed and regrooved. [7] Center castings, female center, equalizer fulcrum, tender center castings. [8] Engine and tender, front and back. [9] Also lift shaft tie brace. [10] Drill center casting, engine and tender, fulcrum casting, expansion braces, filling blocks, driver brake fulcrum, hopper casting, drawhead castings, chaffing blocks, crosstie brace, mud chambers, tank valve racks, guide yokes, guide yoke brackets and extensions, sand boxes, dome rings, smoke box rings, fire door frames and doors, bell yokes and frames, hand hole plates and covers. [11] Drill frame braces, equalizers, binders, bearing bars and supports, crank pin collars, cab braces, foot board brackets, etc. Average 77 holes per day. [12] Available on miscellaneous castings.

| Class of Work | Machine Tool | Operation | Number of Pieces per Month: New Engs. | Repairs | Total | Average Time per Piece | Total Days Work per Month | |
|---|---|---|---|---|---|---|---|---|
| Miscellaneous Pins, Studs, Etc. | | Studs, average length 4½" | 4x600=2400 | 30x600x50%=9000 | 11,400 | 175[1] | 65 | 123⅛ days 5 mach. |
| | 1 Turret Lathe, 3"x36" | Pins, average length 7" | 4x80=320 | 30x80=2400 | 2,720 | 60[1] | 45 | |
| | 1 Turret Lathe, 2½"x24" | Core Plugs, Piston Heads | 4x8=32 | 30x8=240 | 272 | 125[1] | 2⅛ | |
| | 3 Turret Lathes, 2"x24" | Wedge Adjusting Screws | 4x8=32 | 30x8=240 | 272 | 40[1] | 6⅘ | |
| | | Driver Brake Adj. Screws | 4x2= 8 | 30x2=60 | 68 | 16[1] | 4¼ | |
| | 1 Lassiter Bolt Turner, 4-Head | Bolts, Av. 7" Long | 4x274=1896 | 30x474x50%=7110 | 9006 | 300[1] | 30 | 1 mach. |
| | 1 Centering Machine, 2" | | | | | | | 1 mach. |
| | 2 Lathes, 14"x5' | For Fitting Bolts | | | | | | 2 mach. |
| | 3 Lathes, Portable[12] | For Fitting Bolts | | | | | | 3 mach. |
| | 1 Bolt Pointer, 2" | | | | | | | 1 mach. |
| | 1 Threading Machine, D.H. | | | | | | | 1 mach. |
| | 1 Nut Tapper | | | | | | | 1 mach. |
| | 1 Nut Facing Machine | | | | | | | 1 mach. |
| | 1 Mach. for Pipe Nipples | | | | | | | 1 mach. |
| | 1 Pipe Cutting Mach., 6" | | | | | | | 1 mach. |
| | 2 Friction Drills, 13" | | | | | | | 2 mach. |

[1] Per day. [12] For erecting shop (14"x5').

The fact that the ability of roads generally in realizing the full advantage to be obtained from the use of cast steel frames, is dependent upon the facilities for machining and finishing them, leads to the selection of some tools not generally found outside of builders shops, and as such tools might be considered as of more or less intermittent character, special consideration has been made in their selection with a view of adapting them for general work, when not fully occupied on new work, in order to keep the surcharge down to the lowest possible point.

The forging department has received careful consideration and the general plan, and the selection and arrangement of tools, together with the further fact that water gas is to be used in the heating furnaces warrants the assumption that this department will bear its full share in preserving the integrity of the output.

The study has been based upon eight working hours per day. In some instances it will be noted that only one machine tool is provided where it is apparent that more work will be required of it than can be performed during the regular working hours. In such cases it has been deemed advisable to have the machine work over-

TOOL ROOM MACHINES.

1 Universal Miller.
2 Plain Millers, one 14" x 6' table, and one 39" x 10'.
4 Lathes: one 14" x 6'; one 16" x 8'; one 16" x 8'; one 12" x 6'.
2 Drill Presses: one 13" and one 25".
1 Shaper, 14".
1 Crank Planer, 20 x 20 x 24½ in. stroke.
1 2 x 24 in. Turret Lathe.
1 Gisholt Tool Grinder.
1 Sellers Tool Grinder.
1 Reamer Grinder.
1 Cutter Grinder.
1 Die Grinder.
2 Twist Drill Grinders.

*(Continuation of Table on Opposite Page.)*

| Class of Work | Machine Tool | Operation | Number of Pieces per Month: New Engs. | Repairs | Total | Average Time per Piece | Total Days Work per Month | |
|---|---|---|---|---|---|---|---|---|
| Roll | 1 Bending Roll, 15'; 1 Bending Roll, 8' | Crown Sheet of Firebox | 4x1= 4 | 30x1x25%=7 | 11 | 1 hr. | 1 3/8 | 2 mach. |
| | | Side Sheets, Firebox | 4x2= 8 | 30x2x27%=16 | 24 | 1½ hr. | 3 | |
| | | Crown Sheets, Boiler | 4x1= 4 | 30x1x4%=1 | 5 | 1 hr. | 5/8 | |
| | | Side Sheets, Boiler | 4x2= 8 | 30x2x4%=2 | 10 | 1½ hr. | 1¼ | |
| | | Cyl. Courses, Boiler[6] | 4x1= 4 | 30x1x4%=1 | 5 | 4½ hrs. | 2¾ | |
| | | Smoke Arches | 4x1= 4 | 30x1x25%=7 | 11 | 1½ hrs. | 2 | |
| | | Domes | 4x1= 4 | 30x1x4%=1 | 5 | 45 min. | 3¾ | |
| | | Smoke Arch Rings | 4x1= 4 | 30x1x25%=7 | 11 | 1 hr. | 1 3/8 | |
| | | Smoke Arch Liners | 4x1= 4 | 30x1x25%=7 | 11 | 30 min. | 11/16 | |
| | | Cistern Sheets | 4x1= 4 | 30x1x10%=3 | 7 | 4 hrs. | 3½ | |
| | | Hopper Chutes | 4x1= 4 | 30x1x10%=3 | 7 | 30 min. | 7/16 | |
| | | Draft Pipes | 4x1= 4 | 30x1x10%=3 | 7 | 30 min. | 7/16 | |
| | | Engineer's Cab Roofs | 4x1= 4 | 30x1x4%=1 | 5 | 30 min. | 6/16 | |
| | | Tank Cabs | 4x1= 4 | 30x1x10%=3 | 7 | 30 min. | 7/16 | |
| | | Fireman's Cabs | 4x1= 4 | 30x1x10%=3 | 7 | 30 min. | 7/16 | |
| | | Manholes for Cistern | 4x1= 4 | 30x1x20%=6 | 10 | 20 min. | 3/8 | |
| Plane | 1 Plate Planer, 30' | Crown Sheets, Firebox | 4x1= 4 | 30x1x25%=7 | 11 | 1½ hr. | 2 | 16 days 1 mach.[12] |
| | | Side Sheets, Firebox | 4x2= 8 | 30x2x27%=16 | 24 | 1½ hrs. | 4½ | |
| | | Crown Sheets, Boiler | 4x1= 4 | 30x1x4%=1 | 5 | 1½ hrs. | 1 | |
| | | Side Sheets, Boiler | 4x2= 8 | 30x2x4%=2 | 10 | 1½ hrs. | 2 | |
| | | Cyl. Courses for Shell[7] | 4x1= 4 | 30x1x4%=1 | 5 | 6 hrs. | 3¾ | |
| | | Smoke Arches | 4x1= 4 | 30x1x25%=7 | 11 | 1½ hr. | 2 | |
| | | Running Boards | 4x4=16 | 30x4x10%=12 | 28 | 10 min. | 5/8 | |
| Hyd. Riveting | Hyd. Gap Riveter, 17' Throat, 54" Gap | Riveting Boiler | 4x1= 4 | 30x1x4%=1 | 5 | 2 days | 10 | 1 mach. |
| Drilling | 1 Radial Drill, 6'; 1 Horizontal Drill; 1 4 Spindle Drill | Plate Frames | 4x1= 4 | 30x1x75%=22 | 26 | 3 hrs. | 9¾ | 89¾ days 3 mach. |
| | | Bearing Bar Support Brackets | 4x4=16 | 30x4x10%=12 | 28 | 10 min. | 5/8 | |
| | | Shaker Rods and Brackets | 4x1= 4 | 30x1x25%=7 | 11 | 3½ hrs. | 4¾ | |
| | | Tender Frames | 4x1= 4 | 30x1x10%=3 | 7 | 3 days | 21 | |
| | | Plug Holes in Back Head | 4x5=20 | 30x5x4%=5 | 25 | 8 min. | 3/8 | |
| | | Flue Holes | 4x2x350=2800 | 30x2x350x20%=4200 | 7000 | ........ | 24 | |
| | | Smoke Arch Front Ring | 4x1= 4 | 30x1x25%=7 | 11 | 6 hrs. | 8¼ | |
| | | Bead Iron for Cistern | 4x1= 4 | 30x1x10%=3 | 7 | 2 hrs. | 1¾ | |
| | | Dome Saddle | 4x1= 4 | 30x1x4%=1 | 5 | 6 hrs. | 3¾ | |
| | | Dry Pipe Hole in Flue Sheet | 4x1= 4 | 30x1x20%=6 | 19 | 1 hr. | 1¼ | |
| | | Reinforcing Ring | 4x1= 4 | 30x1x20%=6 | 10 | 1 hr. | 1¼ | |
| | | Bearing Bar Supports | 4x2= 8 | 30x2x25%=15 | 23 | 15 min. | ¾ | |
| | | Mud Ring | 4x1= 4 | 30x1x10%=3 | 7 | 14 hrs. | 12¼ | |
| Flue Work | Flue Rattler | Clean Flues | ........ | 30x350=10,500 | 10,500 | ........ | ........ | 1 mach. |
| | 1 Cutting-off Mach. | Making Safe Ends | ........ | 30x350=10,500 | 10,500 | ........ | 22 | 3 mach. |
| | 2 Cutting-off Mach. | Measure and Cut to Length | 4x350=1400 | 30x350=10,500 | 11,900 | ........ | 56 | |
| | | Cutting Off Rough Ends | ........ | 30x350=10,500 | 10,500 | ........ | 16¾ | |
| | 2 D. H. Welding Machines | Flues Scarfed | ........ | 30x350=10,500 | 10,500 | ........ | 16¾ | 2 mach. |
| | | Flues Welded and Swaged | ........ | 30x350=10,500 | 10,500 | ........ | 24 | |

[6] Three courses included. [7] Three courses included. [12] Available for planing throat sheets, flue sheets and door sheets on flange.

A STUDY OF THE MACHINE TOOL OPERATIONS REQUIRED IN A RAILROAD LOCOMOTIVE BOILER SHOP, FOR MAKING REPAIRS TO AND BUILDING THE FOLLOWING NUMBER OF CONSOLIDATION LOCOMOTIVES PER MONTH, THE SHOP OPERATING EIGHT HOURS PER DAY: 30 GENERAL REPAIRS, 8 LIGHT REPAIRS AND FOUR NEW LOCOMOTIVES.

| Class of Work | Machine Tool | Operation | Number of Pieces per Month: New Engs. | Repairs | Total | Average Time per Piece | Total Days Work per Month | |
|---|---|---|---|---|---|---|---|---|
| Shearing and Punching | 1 Throat Shear, 60"; 1 Throat Shear, 36" | Flue Sheet, P. and S. | 4x2= 8 | 30x2x20%=12 | 20 | 1 hr. | 2½ | 63 ⅝ days 2 mach. |
| | | Door Sheet, Firebox, P. and S. | 4x1= 4 | 30x1x25%=7 | 11 | 3 hrs. | 4⅛ | |
| | | Door Sheet, Back Head, P. and S. | 4x1= 4 | 30x1x10%=3 | 7 | 3½ hrs. | 3 | |
| | | Throat Sheet, Firebox, P. and S. | 4x1= 4 | 30x1x25%=7 | 11 | 3½ hrs. | 4¾ | |
| | | Throat Sheet, Boiler, P. and S. | 4x1= 4 | 30x1x4%=1 | 5 | 4 hrs. | 2½ | |
| | | Crown Sheet, Boiler, Shear | 4x1= 4 | 30x1x4%=1 | 5 | 45 min. | 3¾ | |
| | | Crown Sheet, Firebox, Shear | 4x1= 4 | 30x1x25%=7 | 11 | 45 min. | 1 | |
| | | Side Sheets, Firebox, Shear | 4x2= 8 | 30x2x27%=16 | 24 | 1 hr. | 3 | |
| | | Side Sheets, Boiler, Shear | 4x2= 8 | 30x2x4%=2 | 10 | 1 hr. | 1¼ | |
| | | Cyl. Courses, Shear * | 4x1= 4 | 30x1x4%=1 | 5 | 3 hrs. | 1⅞ | |
| | | Smoke Arch, Shear | 4x1= 4 | 30x1x25%=7 | 11 | 2½ hrs. | 3⅜ | |
| | | Smoke Arch Liner, Shear | 4x1= 4 | 30x1x25%=7 | 11 | 30 min. | 11/16 | |
| | | Expansion Sheets, Shear | 4x1= 4 | 30x1x10%=3 | 7 | 20 min. | ¼ | |
| | | Brace Sheets, Shear | 4x2= 8 | 30x2x10%=6 | 14 | 1 hr. | 1¾ | |
| | | Cistern Sheets, Shear | 4x1= 4 | 30x1x10%=3 | 7 | 4 hrs. | 3½ | |
| | | Ash Pan Hopper and Wheel Covers | 4x1= 4 | 30x1x30%=9 | 13 | 4 hrs. | 6½ | |
| | | Grease Box Cases | 4x10=40 | 30x10x25%=75 | 115 | 10 min. | 2⅜ | |
| | | Grease Box Plates | 4x10=40 | 30x10x25%=75 | 115 | 5 min. | 1¼ | |
| | | Fireman's Cab | 4x1= 4 | 30x1x15%=4.5 | 8.5 | 4 hrs. | 4¼ | |
| | | Engineer's Cab | 4x1= 4 | 30x1x10%=3 | 7 | 6 hrs. | 5¼ | |
| | | Foot Boards | 4x4=16 | 30x4x5%=6 | 22 | 20 min. | 1 | |
| | | Tank Cabs | 4x1= 4 | 30x1x15%=4.5 | 8.5 | 1 hr. | 1 | |
| | | Deck Plates | 4x4=16 | 30x4x10%=12 | 28 | 10 min. | ⅝ | |
| | | Diaphragm Plates | 4x1= 4 | 30x1x10%=3 | 7 | 15 min. | ¼ | |
| | | Draft Pipe and Netting | 4x1= 4 | 30x1x10%=3 | 7 | 20 min. | ¼ | |
| | | Hopper Chutes | 4x1= 4 | 30x1x10%=3 | 7 | 20 min. | ¼ | |
| | | Coal Box for Tenders | 4x1= 4 | 30x1x10%=3 | 7 | 20 min. | ¼ | |
| | | Shoe and Wedge Liners | ........ | 30x32x75%=720 | 720 | ........ | ⅝ | |
| | | Coal Aprons | 4x1= 4 | 30x1x10%=3 | 7 | 30 min. | 7/16 | |
| | | Pilot Steps | 4x2= 8 | 30x2x50%=30 | 38 | 5 min. | ⅜ | |
| | | Wedge Sheets | 4x1= 4 | 30x1x10%=3 | 7 | 20 min. | ¼ | |
| | | Wind Shields in Cab | 4x2= 8 | 30x2x10%=6 | 14 | 15 min. | 7/16 | |
| | | Cylinder Plates | 4x2= 8 | 30x2x10%=6 | 14 | 10 min. | ¼ | |
| | | Bumper Beam Sheets | 4x1= 4 | 30x1x10%=3 | 7 | 20 min. | ¼ | |
| | | Cab Sheets | 4x2= 8 | 30x2x10%=6 | 14 | 10 min. | ¼ | |
| | | Tool Boxes | 4x1= 6 | 30x1x10%=3 | 7 | 20 min. | ¼ | |
| | | Flag Boxes | 4x1= 4 | 30x1x10%=3 | 7 | 10 min. | ⅛ | |
| | | Cab Ventilators | 4x1= 4 | 30x1x10%=3 | 7 | 10 min. | ⅛ | |
| Punching | 1 Throat Punch, 60"; 1 Throat Punch, 36"; 1 Throat Punch, 16" | Flue Sheets, Front and Back | 4x2= 8 | 30x2x20%=12 | 20 | 1¾ hr. | 4⅜ | 67½ days 3 mach. |
| | | Door Sheet, Fire Box | 4x1= 4 | 30x1x25%=7 | 11 | 1¼ hr. | 1¾ | |
| | | Door Sheet, Back Head | 4x1= 4 | 30x1x10%=3 | 7 | 1⅔ hr. | 1½ | |
| | | Throat Sheet, Fire Box | 4x1= 4 | 30x1x25%=7 | 11 | 45 min. | 1 | |
| | | Throat Sheet, Boiler | 4x1= 4 | 30x1x4%=1 | 5 | 40 min. | ⅜ | |
| | | Crown Sheet, Boiler | 4x1= 4 | 30x1x4%=1 | 5 | 3¾ hrs. | 2½ | |
| | | Crown Sheet, Fire Box | 4x1= 4 | 30x1x25%=7 | 11 | 3⅘ hrs. | 5⅛ | |
| | | Side Sheets, Boiler | 4x2= 8 | 30x2x4%=2 | 10 | 2¾ hrs. | 3 7/16 | |
| | | Side Sheets, Fire Box | 4x2= 8 | 30x2x27%=16 | 24 | 3 3/10 hrs. | 10 | |
| | | Cyl. Courses of Boiler | 4x1= 4 | 30x1x4%=1 | 5 | 8⅕ hrs. | 5⅛ | |
| | | Smoke Arches | 4x1= 4 | 30x1x25%=7 | 11 | 1⅜ hr. | 1⅞ | |
| | | Smoke Arch Liners | 4x1= 4 | 30x1x25%=7 | 11 | 1 hr. | 1⅜ | |
| | | Expansion Sheets | 4x1= 4 | 30x1x10%=3 | 7 | 15 min. | ¼ | |
| | | Brace Sheets | 4x2= 8 | 30x2x10%=6 | 14 | 45 min. | 1 5/16 | |
| | | Ash Pan Hoppers and Wheel Covers | 4x1= 4 | 30x1x30%=9 | 13 | 5 hrs. | 8⅛ | |
| | | Grease Box Cases | 4x10=40 | 30x10x25%=75 | 115 | 1½ min. | ⅜ | |
| | | Fireman's Cabs | 4x1= 4 | 30x1x15%=4.5 | 8.5 | 4 hrs. | 4¼ | |
| | | Engineer's Cabs | 4x1= 4 | 30x1x10%=3 | 7 | 7 hrs. | 6⅛ | |
| | | Running Boards | 4x4=16 | 30x4x5%=6 | 22 | 20 min. | ⅞ | |
| | | Tank Cabs | 4x1= 4 | 30x1x15%=4.5 | 8.5 | 2 hrs. | 2⅛ | |
| | | Deck Plates | 4x4=16 | 30x4x10%=12 | 28 | 6 min. | ⅜ | |
| | | Diaphragm Plates | 4x1= 4 | 30x1x10%=3 | 7 | 8 min. | ⅛ | |
| | | Draft Pipes | 4x1= 4 | 30x1x10%=3 | 7 | 15 min. | ¼ | |
| | | Hopper Chutes | 4x1= 4 | 30x1x10%=3 | 7 | 8 min. | ⅛ | |
| | | Coal Box for Tender | 4x1= 4 | 30x1x10%=3 | 7 | 15 min. | ¼ | |
| | | Coal Aprons | 4x1= 4 | 30x1x10%=3 | 7 | 10 min. | ⅛ | |
| | | Pilot Steps | 4x2= 8 | 30x2x50%=30 | 38 | 10 min. | ¾ | |
| | | Wind Shields, Fireman's Cab | 4x1= 4 | 30x1x10%=3 | 7 | 20 min. | ¼ | |
| | | Wind Shields, Engr's Cab | 4x2= 8 | 30x2x10%=6 | 14 | 6 min. | 3/16 | |
| | | Cab Sheets | 4x2= 8 | 30x2x10%=6 | 14 | 3 min. | 1/12 | |
| | | Wind Shields in Cab | 4x2= 8 | 30x2x10%=6 | 14 | 15 min. | 7/16 | |
| | | Cylinder Plates | 4x2= 8 | 30x2x10%=6 | 14 | 5 min. | ⅛ | |
| | | Bumper Beam Plate | 4x1= 4 | 30x1x10%=3 | 7 | 10 min. | ⅛ | |
| | | Tool Box | 4x1= 4 | 30x1x10%=3 | 7 | 30 min. | 7/16 | |
| | | Flag Box | 4x1= 4 | 30x1x10%=3 | 7 | 10 min. | ⅛ | |
| | | Cab Ventilator | 4x1= 4 | 30x1x10%=3 | 7 | 5 min. | 1/16 | |
| | | Tender Frames | 4x1= 4 | 30x1x4%=1 | 5 | 3⅕ hrs. | 2 | |
| | 1 Punch and Shear and 25' Spacing Table; 1 Flange Punch | Cistern Sheets | 4x1= 4 | 30x1x10%=3 | 7 | 2¾ days | 19¼ | 2 mach. |
| | | Flue Sheets, Front and Back | 4x2= 8 | 30x2x20%=12 | 20 | 25 min. | 1 | |
| | | Throat Sheets, Fire Box | 4x1= 4 | 30x1x25%=7 | 11 | 45 min. | 1 | |
| | | Throat Sheets, Boiler | 4x1= 4 | 30x1x4%=1 | 5 | 95 min. | 1 | |
| | | Door Sheets, Back Head | 4x1= 4 | 30x1x4%=1 | 5 | 45 min. | ½ | |
| | | Door Sheets, Fire Box | 4x1= 4 | 30x1x25%=7 | 11 | 35 min. | 13/16 | |
| Flanging | 1 Hydraulic Flange Press | Back Flue Sheets | 4x1= 4 | 30x1x20%=6 | 10 | 45 min. | 15/16 | 15¾ days 1 mach. |
| | | Front Flue Sheets | 4x1= 4 | 30x1x20%=6 | 10 | 45 min. | 15/16 | |
| | | Throat Sheet, Firebox | 4x1= 4 | 30x1x20%=6 | 10 | 3 hrs. | 3¾ | |
| | | Throat Sheet, Boiler | 4x1= 4 | 30x1x4%=1 | 5 | 4 hrs. | 2½ | |
| | | Dome Saddles | 4x1= 4 | 30x1x4%=1 | 5 | 1 hr. | ⅝ | |
| | | Door Sheet, Firebox | 4x1= 4 | 30x1x25%=7 | 11 | 1 hr. | 1⅜ | |
| | | Door Sheet, Boiler Back Head | 4x1= 4 | 30x1x4%=1 | 5 | 2¼ hrs. | 1½ | |
| | | Door Holes | 4x2= 8 | 30x2x20%=12 | 20 | 30 min. | 1¼ | |
| | | Steam Chest Casing | 4x2= 8 | 30x2x10%=6 | 14 | 12 min. | ⅜ | |
| | | Cyl. Head Casings | 4x4=16 | 30x4x10%=12 | 28 | 10 min. | ⅝ | |
| | | Sand Box Casings | 4x1= 4 | 30x1x10%=3 | 7 | 45 min. | ⅝ | |
| | | Dome Casings | 4x2= 8 | 30x2x10%=6 | 14 | 45 min. | 1¼ | |

* Three courses included. NOTE.—Where not definitely specified, items under "Shearing and Punching" are sheared only.

*(The Continuation of this Table will be Found at the Bottom of page 126.)*

time, which may, of course, readily be done where the tools are driven by individual motors.

All of the new locomotives are to be equipped with Walschaert valve gear; the study is based upon the supposition that 80 per cent. of the engines in service have Stephenson gear, the remaining ones being equipped with the Walschaert gear.

On roads where each individual operation has been carefully studied, as, for instance, where piecework methods are used or schedules tabulated by time studies or other shop efficiency methods, there is no reason why a complete analysis of this kind could not be made for a new shop which is to turn out a similar class of work. The output is affected by so many conditions, such as the design and the type of the locomotives, the organization of the shop and its method of operation, the class of tools and the way in which they are driven, and the tool steel which is used, that it is, of course, necessary to make an individual study for each shop.

The writer was enabled to make these studies through the courtesy of T. S. Lloyd, superintendent of motive power and machinery of the Delaware, Lackawanna & Western Railroad and with the assistance of Thomas Jeffrey, general piecework inspector of that road.

## SETTING VALVES ON LOCOMOTIVES WITH WALSCHAERT GEAR.*

Oscar Antz.†

When the Walschaert valve gear was first introduced in this country, the impression was common that it was designed entirely on the drawing board and that no variations from the figures thus obtained must be allowed; later on it became evident that these exact dimensions cannot always be maintained, but outside of the locomotive works it does not, even now, seem to be generally known what is the best way of setting the valves and determining what to change to obtain certain results. The Stephenson link motion is usually set entirely by the lead, and as the Walschaert gear is designed to have constant lead at all points, it is believed by many that this is the first and only object to be obtained in setting the valves, the other events being correct as a natural consequence. While this is approximately so, it is not an easy matter and requires some calculations to determine just what is necessary to change, and how much to change it, to obtain this constant lead when more than one part is incorrect. What is therefore recommended as the best and at the same time the simplest method is to practically lay out the gear on each individual locomotive. This is not, by far, as complicated as it sounds, and may not be new to some, but as it is not generally known, it will be treated at some length.

It is assumed that the gear has been correctly designed and that the proportions of the combination lever are such that the travel of the valve in midgear is exactly twice the sum of the lead and lap. Such being the case, it is not necessary to measure the lead until the valves are practically set and ready to run over. It is further assumed that the parts have all been made to the drawings and have been checked as correct; that the valves and seats are of the correct dimensions to give the desired lap and exhaust clearance, and that the locomotive is on its wheels and ready to have the valves set. Then proceed as follows for each side of the locomotive.

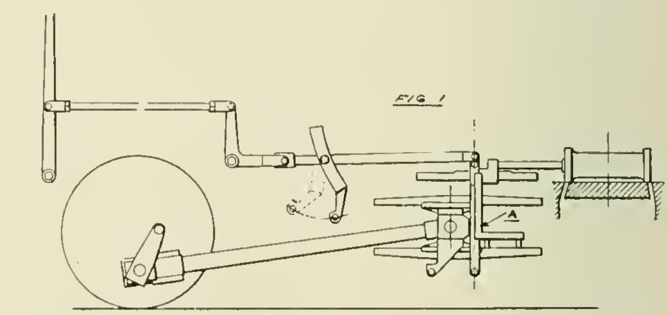
First:—Put the main wheels on rollers and have the main rod in place connected to the crosshead; have the valve in place and connected; have all parts of the valve gear in place and connected, except the union link and eccentric rod.

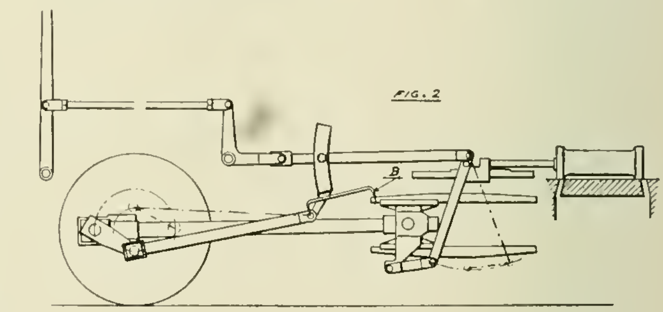
Find the exact front and back dead centers of the crank pin in the usual way and mark them on the wheel with a tram from the frames. Put marks on the guides and crosshead indicating the extreme front and back ends of the travel of the crosshead, also mark the point midway between these. Get "port marks" on the valve stem or other convenient part in the usual manner showing points of opening and closing of steam and exhaust sides of the valve.

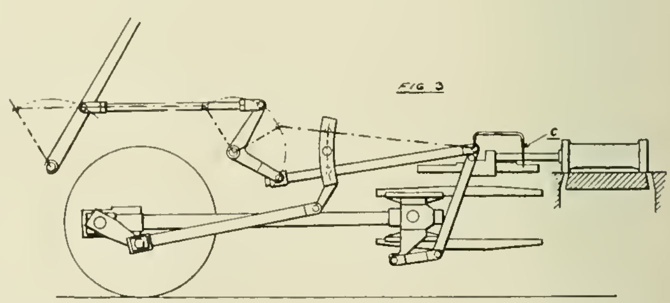
Second:—Put the link block in the exact center of the link. This can be ascertained by raising and lowering the block by means of the reverse lever and oscillating the link (see Fig. 1) by taking hold of the lower (now loose) end until there is no motion to the valve and combination lever. Should it not be possible to get both sides to remain stationary with one position of the reverse lever, adjustment must be made on either side in the lifting device until they do so.

Put the crosshead in the middle of its travel, and with straight edges on the lower guides and a tri-square (A, Fig. 1) move the combination lever, loose at the lower end, until a line through the centers of the upper two holes is square with the guides. Usually the three holes in this lever are in the same straight line, but in case they are not, the line through the upper two should be taken.

Tram the location of the valve and if it is not in central position with the valve seat, adjust the valve stem so that the valve is central and change the port marks to suit.




Connect the union link: it should not move the combination lever out of its vertical position; if it does so, adjust the length of the union link.

Third:—Connect the eccentric rod and put the engine on one center; with a convenient tram put a mark on the frame or an attached part, such as the guides, from the center of the front pin of the eccentric rod (B, Fig. 2). Move the engine to the other center and make a similar mark. These marks should coincide: if they do not, move the eccentric crank on the main pin

* See also American Engineer, November, 1908, p. 434.

† Supervisor of Valve Motion, L. S. & M. S. Ry.

until they do. The amount of the necessary change is one-half of the horizontal distance between the two marks made with the tram, measured on a horizontal line through the eccentric crank pin.

Fourth:—Put the engine on either center and move the reverse lever from extreme forward to extreme backward position; the combination lever and valve should not move. If they do, the length of the eccentric rod must be adjusted so that there will be no motion; the amount of the necessary change being one-half of the motion of the forward end of the radius arm, conveniently measured with a tram (C, Fig. 3), multiplied by the ratio of the link arm radius to that of the link block, that is, the distance of the center of this block in extreme upper or lower position from the center of the link.

The valves are now approximately set as close as it is possible on this particular locomotive and are ready to be run over to get the different valve events.

On account of the errors introduced when changing rectilinear to circular motion and vice versa, which occurs three times in this valve gear, there are always certain irregularities to be found in the valve events which can be minimized but never entirely overcome; two of these are important enough to be considered It is assumed that the work of adjusting the parts was carefully done and that they are correct.

The lead may be found to be more at one end than at the other, which will probably be due to the fact that the union link swings more to one side of a horizontal line than to the other; this can be corrected to a slight degree by adjusting the length of the union link.

The valve travel may be found to be more at one end than at the other; this can be corrected by slightly adjusting the length of the front end of the radius arm to make the travel nearer equal, and adjusting the length of the union link to keep the lead equal. This will throw the combination lever out of square with the guides in mid position and will also affect some of the other valve events.

None of these changes if considerable is advised until the motion is laid out on the drawing board and its effect ascertained and the best amount of the change determined. If after this, a still closer adjustment is desired, the entire gear must be redesigned.

## HOW ONE OF THE RAILROADS SELECTS ITS NEW MACHINE TOOLS.

It may be of interest to many of our readers to know just how a large railroad, such as the Pennsylvania, selects its new machine tools. In the fall of each year each grand division submits to the general superintendent of motive power its estimated

C I

THE PENNSYLVANIA RAILROAD COMPANY.

PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY
NORTHERN CENTRAL RAILWAY COMPANY
WEST JERSEY & SEASHORE RAILROAD COMPANY.

SHAPER. TRANSACTION No.

Number required, which should conform to the following requirements:

Type,

Stroke of tool,

Max. distance between tools, (double head)

Drive, Belt,

Drive, Motor, voltage, D. C.,

Drive, Motor, voltage, A. C. phase, Cycles,

Attachments,

The following information should be furnished by the manufacturer:

Maximum stroke, Length of bed,

Max. longitudinal travel of head,

Max. and min. distance from table to underside of head,

Speed of cutting stroke, Ratio cut to return,

Range of speeds, Range of feeds,

Horse power of motor,

Weight, (without motor)

F. O. B. at

Earliest delivery,

Price,

Name of manufacturer,

Date, Agent,

NOTE Any variation from the above requirements must be fully stated, and any alternate proposition must be made on a separate blank

FORM TO BE FILLED IN BY THE MACHINE TOOL BUILDER.

requirements for new tools for the coming year, covering replacements and additional equipment, to meet the conditions which it is estimated will obtain at the several shops of the respective divisions. These requirements are studied in the office of the general superintendent of motive power and eliminations and additions made as deemed advisable, after which a tool program is prepared therefrom, with the estimated costs, and is submitted to the executive officers for approval.

After the program has been approved, each division is informed as to the amount appropriated, and the superintendents of motive power request the purchasing agent to obtain bids from the various manufacturers for the kind and style of tool they desire. In requesting these bids the purchasing agent forwards to the machine tool builders a form covering the particular tool required. One of these forms, for a shaper, is shown in the illustration. In returning these blanks, filled in, to the purchasing agent, the bidders usually write to him, calling attention to any new attachments which may be on the machines, etc.

These letters are forwarded to the superintendent of motive power who requested the bids, and the information is transferred to a sheet, which condenses the information from all the bidders. After further investigation of the relative merits and adaptability of the tools the requisitions are made out by the superintendent of motive power and sent to the office of the general superintendent of motive power for approval, together with the individual bids and the condensed sheet before mentioned, as well as a letter explaining their preference for the machines specified on the requisitions. When the requisitions and bids are received in the office of the general superintendent of motive power they are carefully gone over. If the general superintendent of motive power can advise that there is some other machine in the market with features that make it more adaptable for the service than the one specified, or when it is known that the machine specified has not been a success at some other point, the requisition is changed accordingly. When approved by the general superintendent of motive power the requisition is returned to the superintendent of motive power, who forwards it through the regular channel to the purchasing agent.

It is understood that the various divisions, as well as the office of the general superintendent of motive power, shall keep in touch with the improvements that are made in machine tools from time to time, by carefully noting the catalogs and descriptive matter received from the machine tool builders, and by personal visits to other shops and manufacturing plants, making notes of machines for special work, and new attachments on machines with which the motive power department is familiar, for future reference.

THE MINERAL PRODUCTION IN THE UNITED STATES now exceeds two billion dollars per annum, and it contributes more than 65 per cent. to the total freight traffic of the country. We now produce nearly 500,000,000 tons of coal per annum, or 40 per cent. of the world's product. We also produce 58 per cent. of the world's iron; 22 per cent. of the world's gold; 60 per cent. of the world's copper.

TO FIND THE WEIGHT OF CASTINGS multiply the cubic inches by 0.27 for iron, 0.29 for steel and 0.30 for brass.

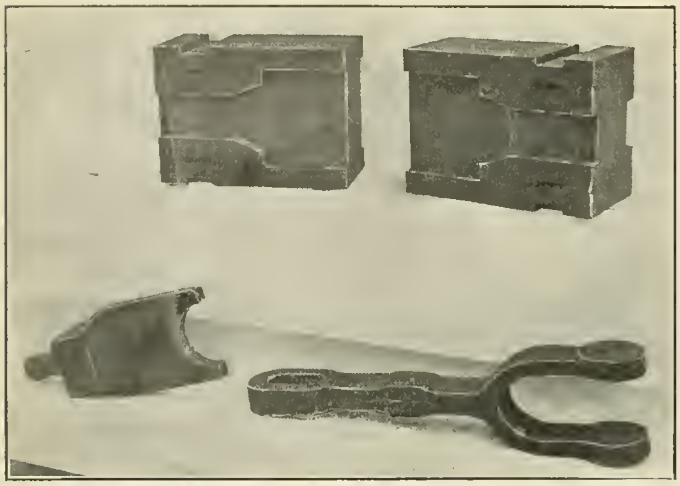


FIG. 1.—FIRST OPERATION, TRUCK HANGER.

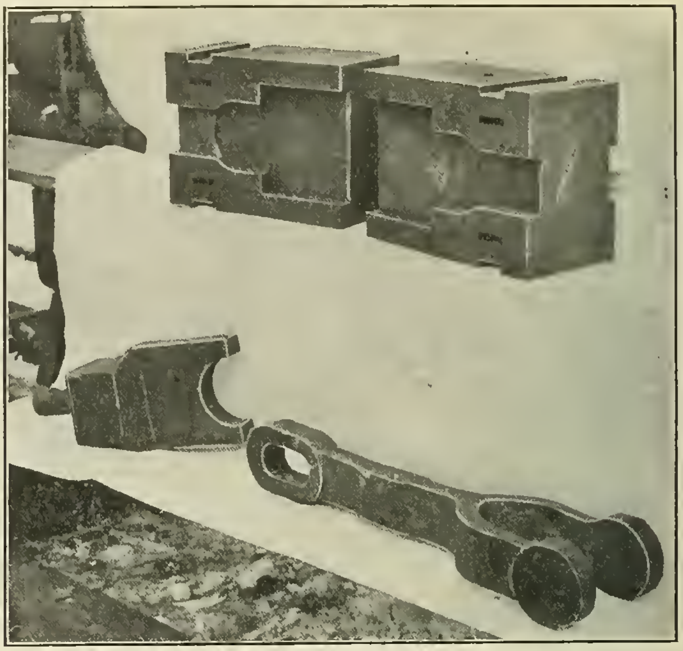


FIG. 2.—SECOND OPERATION, TRUCK HANGER.

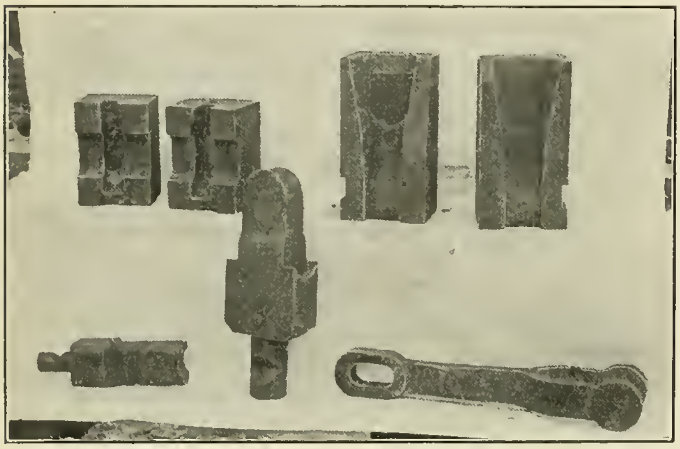


FIG. 3.—FINAL OPERATION, TRUCK HANGER.

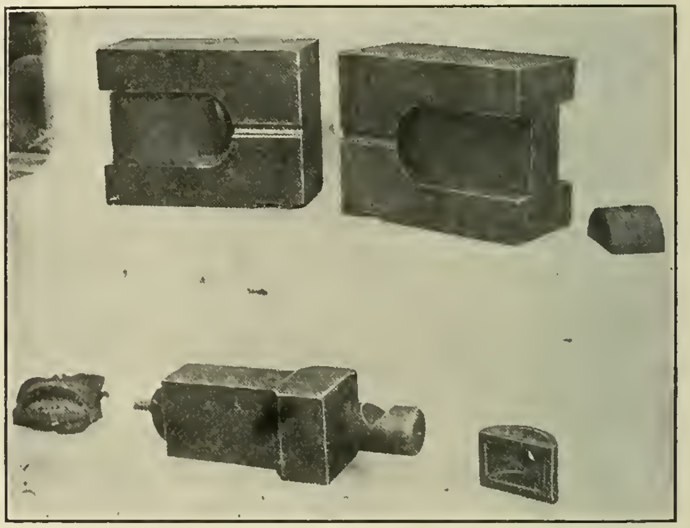


FIG. 5.—DIES AND FORMER FOR DRAWBAR YOKE FILLER.

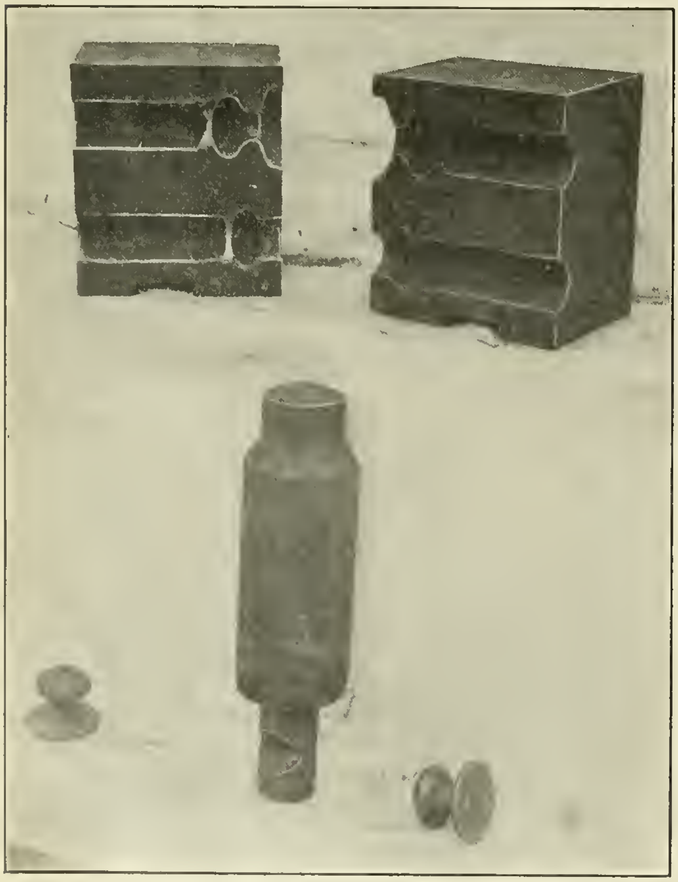


FIG. 7.—DIES AND FORMER FOR BAGGAGE CAR DOOR KNOB.

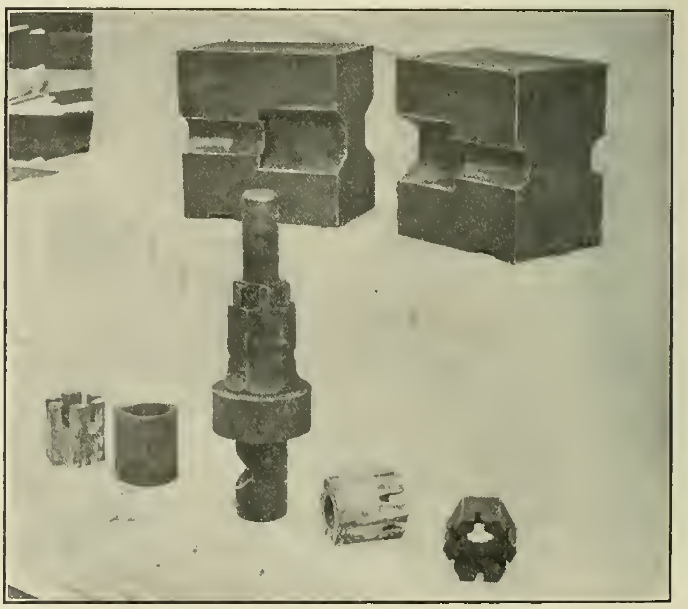


FIG. 6.—DIES AND FORMER FOR CASTLE NUT.

# FORGING AT THE COLLINWOOD SHOPS.*

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

*Truck Hanger.*—The dies and formers for forging a truck hanger for the standard Lake Shore & Michigan Southern Railway four-wheel passenger truck are shown in Figs. 1, 2 and 3. The hanger is made of two pieces of wrought iron 1⅛ by 3 in. in size. These pieces are heated and bosses are forged on the ends which form the fork, while they are separate, by the dies shown in Fig. 1. The two pieces are then clamped together, heated to a welding heat and the slotted end is formed by using the dies shown in Fig. 2; the two pieces are welded together at this end at the same time by squeezing them tight between the jaws with the side motion of the machine. The jaw, or forked end, is opened with a common wedge in a bulldozer.

The forked end of the hanger is then reheated and brought to a welding heat. It is placed in the forging machine and the jaw is finished and that end of the body of the hanger is completely welded together by the dies and former shown at the right in Fig. 3. The slotted end of the hanger is then heated and the slot is punched with the dies and punch shown at the left in the same photograph. The center of the hanger is drawn to length and finished under a steam hammer. This makes a very satisfactory hanger and costs less than a steel casting.

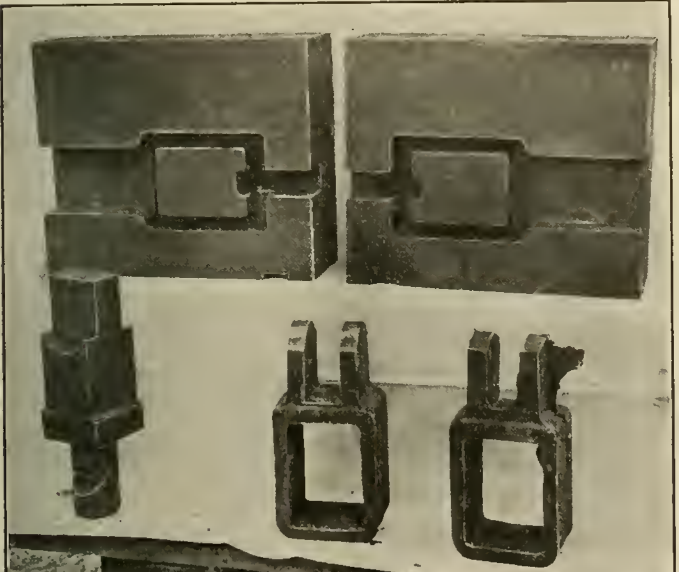


FIG. 4.—DIES AND FORMER FOR SPRING HANGER.

*Spring Band.*—A spring band for an under-hung type of spring and the dies and former for forging it are shown in Fig. 4. The band is formed from a 1 by 5 in. bar of commercial iron. The bar is bent to suitable shape to go into the die; a filler is placed between the two pieces and it is completed in one stroke of the machine. This makes a strong spring band at a very low cost.

*Drawbar Yoke Filler.*—The filling block for the back end of a curved drawbar yoke, and the dies and former for making it, are shown in Fig. 5. These blocks are usually made of malleable iron, but it has been found that they may be made more cheaply by forging them. The forged block is made from pieces of different size arch bars, varying from 1 by 3 in. to 1¼ by 4 in. The pieces are cut to the proper length to insure the same cubical contents; a hole is punched in the center and the piece is bent into a "U" shape, heated to a welding heat, placed between the dies of the forging machine, one blow of which causes the metal to flow to the shape shown in the photograph, welding it along the center line and maintaining the hole and completing the block.

It is important that these pieces be placed in the machine by inserting a bar in the hole, which is punched in the blank, thus insuring the blank fitting in a central position in the die. It sometimes happens that there is not sufficient metal to complete the block. In such cases a second heat is taken and pieces of iron, the required size to fill up, are placed in the recess of the block and both pieces are heated to a welding heat. Another operation of the machine will then turn out a complete block. The recesses are made in the side to bring the wrought iron block to the same weight as that of malleable iron.

*Castle Nut.*—A 2½ in. castle nut † and the dies, former and blank for making it are illustrated in Fig. 6. The guide pin or mandrel and punch for piercing the blank to form the castellations, are made in one piece with a threaded projection on the opposite end. This is screwed into the hexagon of the head, making a very simple form of header. The blank is made from a piece of commercial iron about ⅝ by 5 in. and is bent cold in the bulldozer to the shape shown in the photograph. It is then heated to a welding heat and placed between the dies; one blow of the machine welds it solid, forms the hexagon, pierces the castellations and finishes the nut complete, as shown.

*Door Knobs.*—Considerable trouble is found in getting a satisfactory porcelain door knob for baggage cars. Brass door knobs are stolen. The problem has been solved on the Lake Shore by using iron forgings, the dies and former for making them being shown in Fig. 7. The knob is formed with one blow of the machine from a round bar of iron in the lower part of the dies. It is then placed in the upper part of the dies where it is completed.

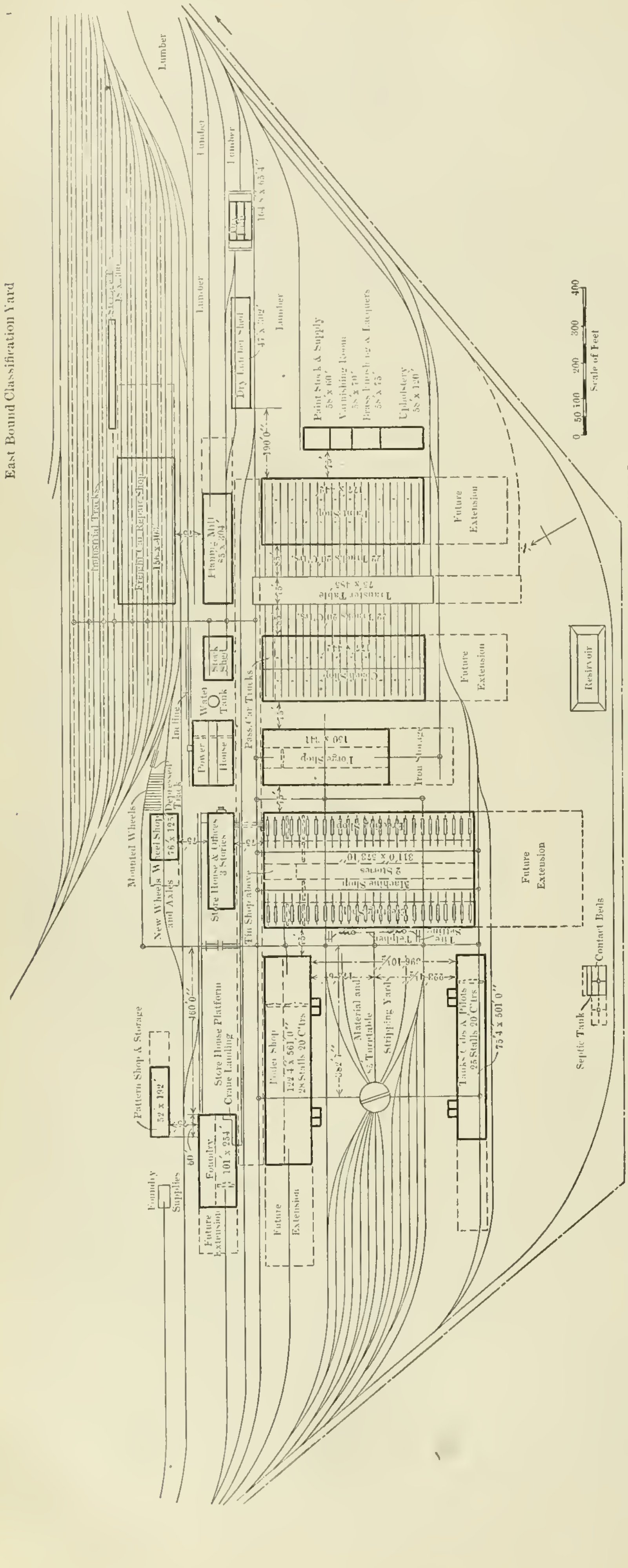
These forgings were all made on 3½ and 5 inch Ajax forging machines. For the past three or four years the Collinwood smith shop has been very successful in using compressed air for making difficult welds in these machines. An air pipe is connected to the forging machine dies and is so arranged that it may be directed on the parts to be welded. The high pressure air coming in contact with the heated parts, blows off the scale and dirt and raises the temperature of the heated iron to the point of fusion. With this method a poor weld is very rare.

* Other articles on forging at the Collinwood shops may be found on page 142 of the April, 1906, issue; page 234, June, 1906; page 192, May, 1907, and page 344, September, 1907. Machine forging at the South Louisville shops of the Louisville & Nashville Railroad was described on page 125, April, 1907; at the Topeka shops of the Santa Fe, page 463, December, 1906; at the St. Paul shops of the Gt. Northern Railway, page 222, June, 1908.

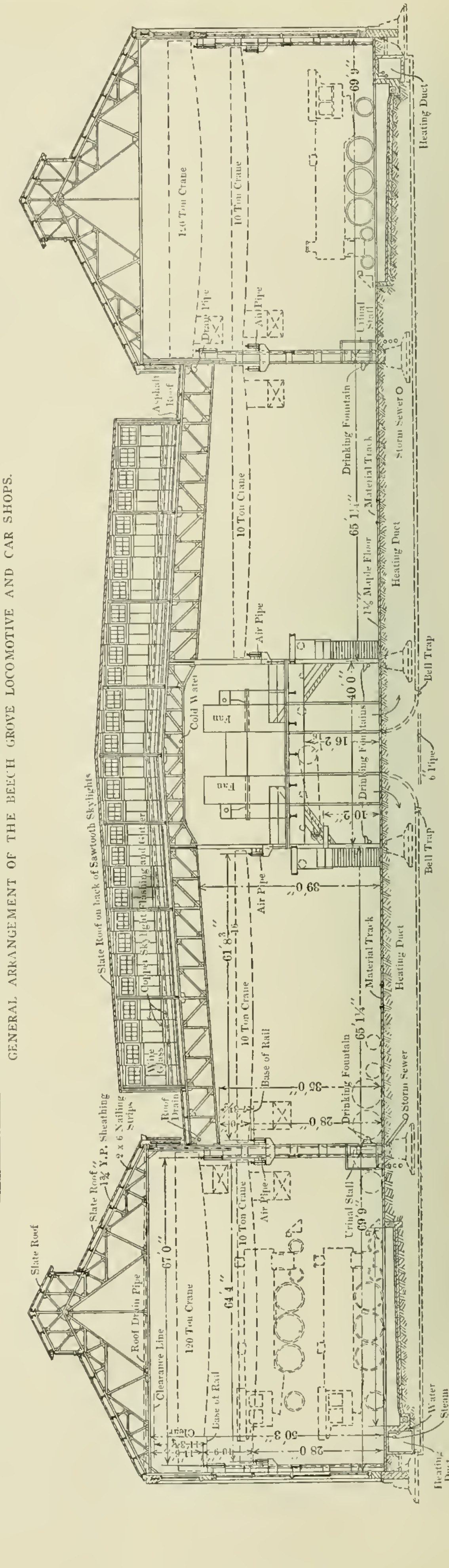
† The method of forging castle nuts from ¾ to 1¾ in. in size on the C. M. & St. P. Ry. is described in the November, 1908, issue, page 427 The dies and former for making the smaller size nuts at Collinwood were illustrated in the May, 1907, issue, page 192.

STEEL PASSENGER CARS.—The use of steel in passenger car construction is not an experiment, but a matter of daily use. It lends itself readily to the skill of the artisan and reduces risk of serious accident to the passengers. It is more available than wood, produces a plainer effect, is easy to clean and weighs no more than a wooden coach if economically designed. The initial cost per passenger carried is about the same as for wooden coaches, its maintenance considerably less. The life of a coach is greatly increased by the use of steel, and damage suits as well as suffering in case of accident greatly reduced. The use of steel in coach construction is increasing daily and is here to stay.—*John McE. Ames before the Central Railway Club.*

COST OF DROP TABLES.—In regard to the cost of the drop table, that varies from the smaller 24 ft. table, which is for trailer wheels, front or rear drivers or engine and tender trucks, costing about $8,000.00, to the large ones for a whole locomotive, which cost about $11,000.00.—*Wm. Elmer before the Railway Club of Pittsburgh.*




GENERAL ARRANGEMENT OF THE BEECH GROVE LOCOMOTIVE AND CAR SHOPS.




CROSS-SECTION THROUGH MACHINE AND ERECTING SHOP—BEECH GROVE, BIG FOUR SYSTEM.

# A STUDY OF THE GENERAL ARRANGEMENT OF THE BEECH GROVE SHOPS.

C. C. C. & St. L. Ry. (Big-Four).

The arrangement of the Beech Grove shops of the Big-Four is of special interest because, like the East Moline shops of the Rock Island System, there were no restrictions as to the shape and arrangement of the buildings. Every detail was carefully studied out and it may therefore be regarded as an ideal layout for the conditions for which it is intended. The buildings are all arranged so that they may be considerably enlarged in the future.

Indianapolis is the central and most important point of the Big-Four system; six divisions radiate from it. Beech Grove is about six miles from Indianapolis on the Chicago division. The new shops replace those at Brightwood, also near Indianapolis, but which were built a number of years ago and were not adapted for handling the new and larger power which has come into use since that time. The Big-Four has several other shops, most of which are not fitted for taking care of the heavier locomotives, and the Beech Grove shops, in addition to repairing the locomotives for the six divisions leading out of Indianapolis, will take care of the heavier power of the entire system and also do all of the manufacturing work for the system.

It is proposed to build a large concentration freight yard near Indianapolis and the new shop plant is located opposite the junction of the east and west bound classification yards of this yard. As may be seen from the general plan, provision has been made for repairing freight and passenger cars, as well as locomotives. When the new freight yards are installed it will be necessary to build a roundhouse which will probably be located north of the western part of the plant.

At present only the power house, store house and the machine and erecting, forge and boiler shops have been erected. These have been in operation for about six months. The car repair work is still done at Brightwood but will be transferred to Beech Grove as soon as conditions allow of the completion of the new plant.

Convenient handling of material and its steady progress from the raw to the finished state, and its application to the car or locomotive, have been carefully studied. The ten-ton yard crane extending from the end of the boiler shop to the end of the coach paint shop, about 2,000 ft., and the system of industrial tracks are important features in this connection. The lumber is stored at the eastern end of the plant, from which it goes direct to the planing mill or, if it is to be dried, to the dry kiln and from there to the planing mill or the dry lumber shed. The planing mill is near the power house and also convenient to the freight car repair shop and yards, where most of the lumber is used and to which it is transported over the industrial tracks. The coach shop is equally convenient to the planing mill. The small amount of lumber required for cabs and pilots may easily be delivered by the yard crane and over the industrial track extending from it to the cab and pilot shop. The cabinet shop willl be placed on the second floor of the planing mill.

The wheel shop is close to the freight car repair yard where the greater number of the wheels and axles will be used. The coach shop and the paint shop, each 177 ft. wide and 442 ft. long, are served by a transfer table. The truck work will be handled in the northern end of the coach shop. These shops are wide enough to accommodate two coaches on each track and there is also room for a coach between the transfer table and the building. If necessary, the coaches may be stripped in this open space and the seats and brass work may be sent to the upholstering shop and the brass finishing room before the coach is taken into the shop. The finishing work on the coaches may also be done here, if necessary. This arrangement also places the coach shop a sufficient distance from the paint shop to minimize the danger should the latter catch fire. The northern end of the forge shop and the eastern part of the southern end are to be used for car work and manufacturing; the southwestern quarter will be used for locomotive work. It is thus equally convenient to the three departments where its product is mostly used—the locomotive shop, the coach shop and the freight car repair yard.

The power house is centrally located and is equipped with Westinghouse-Parsons steam turbines, direct connected to the generators. It has a boiler room 45 ft. 6 in. wide, a pump room 23 ft. wide and a turbine room 45 ft. 6 in. wide. The building is 176 ft. long.

The locomotives, coming in for repairs, enter the plant at the western end. The 85 ft. turntable, west of the locomotive shop, is used for turning the locomotives so that they may be headed in the proper direction in the erecting shop; it is also used in transporting the boilers from the erecting shop to the boiler shop, and the tenders to the tank shop. As may be seen from the cross sectional view, the machine and erecting shop is of the double banked type and has two main erecting bays and a central portion consisting of two spans of about 65 ft. each and one span 40 ft. wide, with a balcony above it on which the heating fans, lavatories, locker rooms, tin shop, etc., are placed. The roof above these three central bays is of saw-tooth construction. The building is 572 ft. long, consisting of 26 panels of 22 ft. each. There are 52 engine pits, four being used for ingress and egress and 48 for repair purposes. The erecting shops are equipped with 120-ton traveling cranes, with 10-ton cranes operating on run-ways underneath those of the main cranes. The two bays in the machine shop, where the heavier tools are placed, are served by 10-ton traveling cranes.

The boiler shop is entirely separated from the locomotive shop and is 122 ft. 4 in. wide and 561 ft. long and has a 30-ton crane over the main bay and a 10-ton crane over the smaller bay in which the machine tools are placed. The foundry is located so that it has plenty of room about it for the storage of material; it faces the store house platform. The material may either be shipped from this platform or distributed throughout the plant by the midway crane and over the industrial tracks. The pattern shop is located convenient to the foundry. Like the power house, the store house and offices are centrally located, but directly opposite and nearest to the locomotive shop where the greater part of the supplies are used. The storehouse building is 70 ft. wide and 260 ft. long inside; the first and second stories are used for storehouse purposes and the third floor for offices, laboratory, assembly rooms, apprentice school room, hospital room, etc.

The buildings have concrete foundations to the water table and are of structural steel with walls of Colonial shale brick, which is very hard and does not absorb moisture. The foundation footings are in most cases reinforced, thus saving a considerable amount of concrete. The buildings are lighted with Cooper-Hewitt lamps.

There are three sewerage systems; one of them, known as the high level, drains the water from the roofs of the buildings into a reservoir, furnishing a supply of soft water for the toilet rooms, and other purposes. In case the reservoir should overflow the water from the high level system may be diverted into what is known as the low level system, which carries off all the surface drainage. The third system, the sanitary sewer, empties into the septic tank. The 100,000 gallon steel tank near the power house is 115 ft. high and is supplied from three wells.

The piping from the power house to the various buildings is carried in a tunnel; the wiring is carried in conduits laid alongside the tunnel.

The Beech Grove locomotive shop is in some respects modeled after the new erecting shop at Mt. Carmel, built a few years ago; the semi-cross-section is quite similar, the Beech Grove shop being of the double banked type. The Beech Grove shops, including the layout, design of the buildings and the selection and arrangement of the equipment, was worked out by a committee from the New York Central Lines' mechanical department, of which William Garstang, superintendent of motive power of the Big-Four, was chairman. The other members of the committee were E. D. Bronner, superintendent of motive power of the Michigan Central, L. H. Turner, superintendent of motive power of the Pittsburgh & Lake Erie Railroad, R. T. Shea, general inspector of tools and machinery of the New York Central Lines, F. M. Whyte, general mechanical engineer of the New York Central Lines and B. D. Lockwood, mechanical engineer of the Big-Four. The committee originally included H. F. Ball, who during his service on the committee was superintendent of motive power of the Lake Shore & Michigan Southern Railway, and who after his appointment as vice-president of the American Locomotive Company was succeeded by Mr. Turner. The committee was assisted in working out the general details by the Arnold Company, who worked in immediate touch with the chairman of the committee and his mechanical engineer, who were constantly in direct touch with all of the details of the installation.

## RAILROAD MACHINE SHOP PRACTICE.

### SHOES AND WEDGES.

George J. Burns.

Having an expensive machine tool and being confident that it represented in efficiency what it must command in price, the writer took up the study of machine shop practice in locomotive repair shops, with a view of getting at a basis on which to guarantee an increased output at a decreased cost. Appreciating that the output of a superior machine may be offset by clumsy methods, the investigations included a comparative study of shop practices in order that the best methods might be recommended. So far the principal shops of thirty of the largest railroads have been visited and the data obtained have been compiled and classified.

While the observations are of great value to the machine tool builder they are of even greater value to the railroads. The unnecessarily wide range in time and cost for doing the same work on similar machines in different shops is amazing. Nearly every shop has some superior methods, but some methods in every shop can be improved upon. Each shop should profit by the aggregate brains and combined experience of all. Co-operation through some common medium of analysis and comparison would bring about a revolution in the cost of repairs.

Aside from the skill of the operator in manipulating the machine after it is in actual operation, the output is limited by its speed and power capacity, and by the method and order of handling, setting and holding the work. The former can be increased only by superior mechanism, while in the latter there is usually great room for improvement. As the machine produces only while in operation, every gain in the time of handling the work is clear profit. Many shops are employing, or have employed shop economists, and nearly all have speed or efficiency men. No one man can possess the combined experience of all. Experimenting is expensive. What is required is direct specific knowledge of what are the best results and how they are being accomplished. Observation is the best teacher, and results are the most conclusive demonstration.

#### Shoes and Wedges.

*Material.*—Most roads use cast iron shoes and wedges; a few are using bronze, and one is using cast iron with a bronze facing. The use of bronze for locomotive parts is decidedly on the increase, but as the subject of material is not immediately pertinent to the purpose of these articles the comparative advantages of different materials will not be considered. It may be noted, however, that most tools on which bronze is machined are not running at speeds at which the metal can be cut most efficiently.

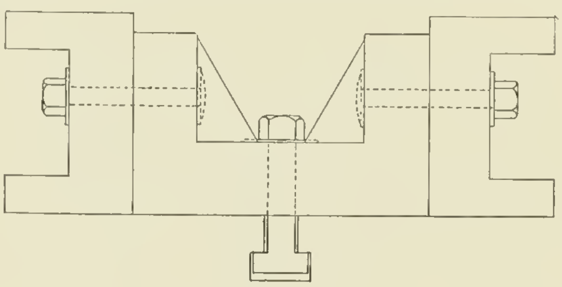


FIG. 2

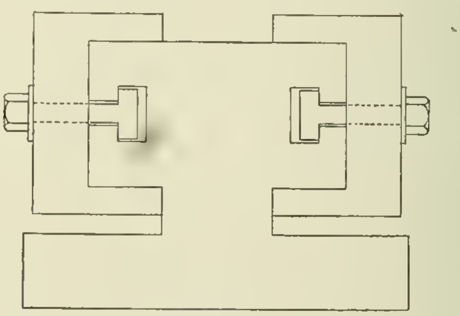


FIG. 4

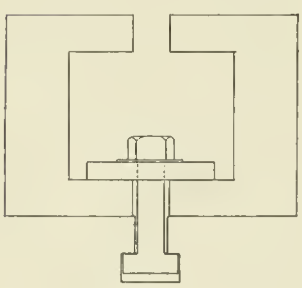


FIG. 1

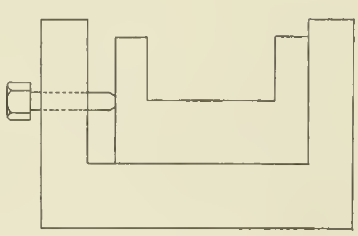


FIG. 3

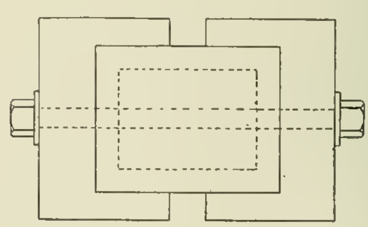


FIG. 5

MACHINING SHOES AND WEDGES.

*Preparing Shoes and Wedges.*—Most shops limit the preparing of shoes and wedges to the sides and the frame fit. The practice seems to indicate that anything more than that is an unnecessary expense. Shops that finish faces or edges argue that it assists in getting a square job. The value of that contention seems to be limited to practice where the frame fit is the last process in preparing.

The most common practice seems to be the least efficient. The pieces are usually set up on the sides in parallel rows, as shown in Fig. 1. One shop bolts the pieces to an angle, as shown in Fig. 2. Where machining the sides is the first process the pieces are chucked for frame fit as shown in Fig. 3. Another shop bolts the pieces down on the faces and planes the sides with the rail tool on the down feed. The last practice seems to be the least efficient, as there is a tendency for the tool to crowd out, often necessitating a second cut.

In preparing shoes and wedges the order of processes that seems to give the best results in output and cost is to finish the frame fit first. It is good planer and milling machine practice to start, when practical, by setting the piece on its broadest base, in which position it can be held most securely. The frame fit having been machined, the pieces are bolted to a jig for side planing or milling. This secures a quick setting, a secure hold and a square job. (See Figs. 4 and 5.)

The jig shown in Fig. 5 is removable; the operator fastens the pieces on one set of jigs while he is planing the other set.

The most common practice, and seemingly the best, in making the frame fit is to plane down the sides with a double point, or broad forming tool. Some shops have abandoned this method because of liability of breaking the tool. This can be overcome by blocking the tool to prevent it from rising on the return stroke. One shop that prepares shoes and wedges on milling machines runs two machines side by side with an operator and helper, each assisting the other in setting the work. Results, however, do not show as much efficiency as is secured by use of the jig (Fig. 4).

*Cost of Preparing Shoes and Wedges.*—Cost runs all the way from 15 cents to 64 cents, the most common cost being about 30 cents. The lowest cost observed was 15 cents on a planer, and included face and edges, but it was manufacturing work, and cannot be fairly compared to repair work, which in most shops is necessarily more or less intermittent. On a powerful milling machine the piece price was 20 cents and included faces and edges. The piece price of work done on the jig, shown in Fig. 5, was 20 cents, which includes planing the edges of the shoes; this is done on a slow planer, running much below the speed capacity of the steel. On a modern high speed planer the piece price on this process can be materially reduced.

*Replaning or Fitting Shoes and Wedges.*—This work is done on planers and shapers. The average time required is from 15 minutes in some shops to one hour in others, and the piece price varies from 8 to 35 cents, the usual cost being about 20 cents.

The average cost of the shoe and wedge work in a shop depends largely upon the proportion of new work. The shortest time and the lowest cost can be obtained only by a tool of superior efficiency. The amount of reduction is frequently more than one inch, and the material, as a rule, is very difficult to cut. Some shops line up old shoes and wedges when they become thin, but whether this pays depends upon the cost of preparing the new ones.

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PHOTOGRAPHING MACHINERY.—In photographing machinery the lens should be of long focus; never shorter than the diagonal of the sensitive plate. The machinery should be painted a "flat" drab color, parts in shadow being painted a lighter shade than more prominent parts. Light should come from one direction only, and at a downward angle of about 20 degrees from the horizontal. In focusing, the points of sharpest focus should be midway between the center and the edges of the ground glass. No matter how much the camera is pointed up or down, the ground glass should always be vertical. Exposure should be ample; an under-exposed plate can never show what the light has never recorded upon it.—*S. Ashton Hand, before the Amer. Soc. Mech. Engrs.*

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FEED OF A PLANING MACHINE.—The rate of feed is an important factor in determining the life of a knife edge on a planing cutter. It is, of course, dependent upon the lumber, the class of work desired, etc., but it should never be less than eight knife marks per inch and never finer than 16 knife cuts per inch.

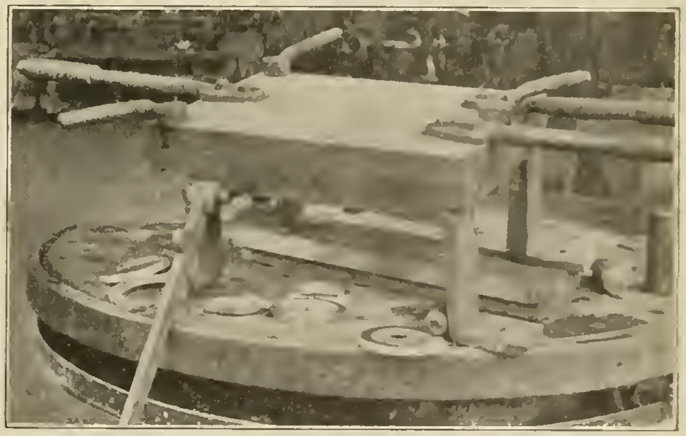
## MOULDING PACKING RINGS.

United States metallic packing rings for piston and valve stem packing are moulded at the McKees Rocks shops of the Pittsburgh & Lake Erie Railroad so as not to require machining; they are steam tight and satisfactory in every respect. The moulds are of cast iron and are shown in the accompanying illustrations. The contour of that part of the ring which fits the stuffing box is, of course, the same for all the engines; to provide for the variation in the diameter of the rod that part of the mould for

MOULD FOR PACKING RINGS.

the inner side of the ring is removable and a sufficient number of these removable parts are carried to provide the necessary variety of diameters.

When the plugs or inner parts have been adjusted the top of the mould is put in place, as shown in the second illustration. It is locked by the three clamps; the metal is poured in the larger holes, the air escaping through a set of smaller ones. The three clamps are then loosened, the two at the left-hand end dropping downward out of the way. The lever near the left is



PACKING RING MOULD, READY TO POUR.

lifted and the lug on it strikes the top plate of the mould, moving it backward and cutting off the sprues. The cover is then lifted off and the rings are removed and are ready for application to the locomotive. To use such a mould successfully the packing metal must be carefully selected. Most metals do not seem to flow freely enough to fill the entire space and the Lake Erie officials have only found one or two metals which are satisfactory for this purpose.

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PROTECTION OF RAILROAD MEN.—I am strongly convinced that the government should make itself as responsible to employees injured in its employ as an interstate railroad is made responsible by federal law to its employees, and I shall be glad, whenever any additional reasonable safety device can be invented to reduce the loss of life and limb among railway employees, to urge Congress to require its adoption by interstate railways.—*Inaugural Address of President Taft.*

# THE DESIGN OF MILLING CUTTERS.

C. J. Morrison.

The high initial cost of the alloy or high speed steels necessitates the use of extreme care in the design and manufacture of tools of these metals. A few spoiled or inefficiently designed tools will soon eliminate the saving in labor charges which should result from the use of tools made of alloy steel. This applies more directly to milling cutters than to any of the other tools. The average railroad machinist or toolmaker has had very little experience in designing and making milling cutters that will cut freely and not chatter. Yet the milling machine is so intimately associated with the economical operation of a railroad shop that the proper design of cutters is extremely important. The economy obtained by the use of milling machines for work on driving boxes, shoes and wedges, eccentrics, crossheads, rods, etc., is well understood, but, at the same time, many milling machines have been condemned for such work largely on account of the poor design of cutters.

General practice, under necessity of economy of manufacture and grinding, has placed milling cutters in two distinct classes, known as solid and inserted teeth. Under solid cutters are usually included all cutters under six inches in diameter. This type of cutter is used for milling flutes of reamers and taps and for general work where small sizes are best adapted. Under inserted teeth cutters, are included all cutters over six inches in diameter. This type is used for facing, side cutting and other special and general work. It is not considered practicable to make inserted teeth cutters under six inches in diameter. The blank for these cutters should, in all cases, be made of soft steel.

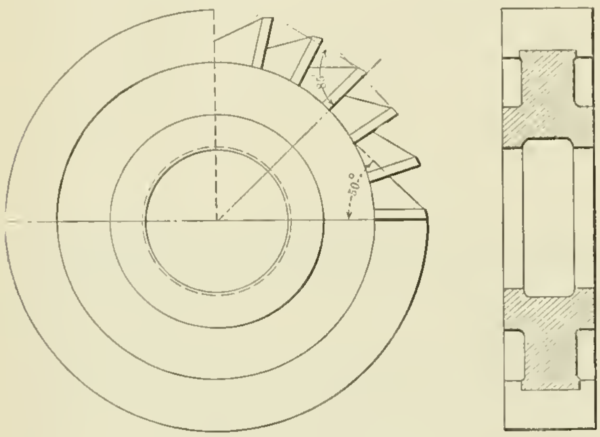


FIG. 1.—SOLID MILLING CUTTER.

*Solid Cutters.*—The number of cutting edges for solid milling cutters, intended for general work, has been taken in average practice as follows:

| Diameter of Cutter. | No. Cutting Edges. |
|---|---|
| ½″ | 6 |
| ¾″ | 8 |
| 1″ | 12 |
| 1¼″ | 14 |
| 1½″ | 16 |
| 2″ | 18 |
| 2½″ | 21 |
| 3″ | 24 |
| 3½″ | 26 |
| 4″ | 28 |
| 5″ | 30 |
| 6″ | 32 |

In most cases the cutting edge is made with a radial face, as indicated by dotted lines in Fig. 1. The spaces may be cut with a tool that will produce an angle of 50 degrees between the face and the back of the tooth. This angle gives ample depth to the clearance space, and at the same time furnishes well supported cutting edges. The milling machine cutter used for forming the teeth is run in deep enough to leave the lands .09 to .1 in. in width, according to the size of the cutter being made. The teeth are also cut on the sides of the cutter, as shown in Fig. 1. The spaces here may be cut with a milling cutter that will produce an angle of from 60 to 70 degrees between the face and the back of the tooth. When milling the teeth on the side the index head cannot be left at the 90 degree mark or on the zero mark, but must be inclined a little, in order that the cutter may make the lands of equal width. The amount the index head is to be inclined depends upon such varying conditions that computation of it is a very difficult problem, and in practice it is more easily found by trial.

After cutting the teeth, remove all burrs by filing, and then harden. In order to grind a high speed alloy cutter, it is first circularly ground, then backed off for clearance. It is essential that great care be taken not to draw the color on the cutting edge, as this tends to soften it. Alloy steel is air hardening, but nevertheless experience has shown that with any of these cutters that have been drawn, it is impossible to get as good results as with one that has been more carefully handled, and the color of which has not been drawn. Alloy cutters should preferably be ground dry, but not too viciously. If water is used, the supply should be plentiful, as sprinkling the cutters creates surface cracks. The reason for this is that the tungsten in the steel

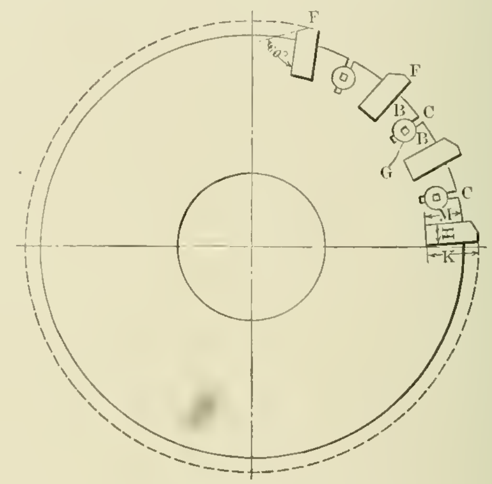



FIG. 3.—INSERTED TEETH CUTTER.

tends to adhere to the cutting edges and fill up the pores of the grinding wheel, thereby glazing the surface of the wheel, and causing the rapid heating of the piece being ground.

*Helical Milling Cutters.*—When making solid helical milling cutters, more commonly known as spiral milling cutters, choose the helix that will give the cutting edge an angle of about 20 degrees to a plane passing through the axis of the cutter. It does not make any particular difference whether the helix is left-handed or right-handed, when the cutter is intended for a machine on which the cutter arbor is supported at the end. However, when used for a machine on which the end of the arbor is free, the helix should be such that the tendency will be to force the arbor home; that is, if the cutter is left-handed, the helix should be right-handed. A right-handed helix is one that in advancing, turns in the direction of the hands of a clock; a left-handed helix turns in the opposite direction. A left-handed cutter is one that travels in the direction of the clock, when viewed from the front of the machine and looking towards the spindle, and a right-handed cutter is one that travels opposite to the hands of a clock.

For heavy milling a style of cutter with nicked teeth is recommended, as the nicks break up the chips, thereby enabling a heavier cut to be taken than is practicable with a cutter with a continuous cutting edge. These nicks, in the ordinary cutter, are ⅜ in. long by ⅛ in. deep and 1¼ in. from center to center on surface cutters under 6 in. in diameter; on surface cutters above 6 in. in diameter the nicks are ½ in. long by 3/16 in. deep and 1½ in. from center to center. These nicks are milled in rows around the circumference, a row consisting in alternate nicks and teeth, as shown on the cutter in Fig. 2, a row always extending around the edge of a cutter, as "AA," Fig. 2, thus eliminating breakage of teeth.

In the manufacture of inserted teeth cutters there are many ways of holding the blades in the body. The one outlined in Fig. 3 is adapted for medium sized cutters for all general work,

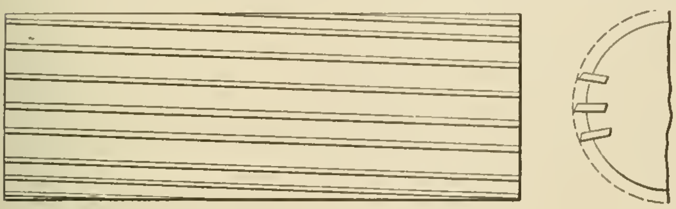


FIG. 5.—BLADES ARE TO BE MILLED TO THE LINES OF A HELIX.

and is a design furnished by many manufacturers. The metal between every pair of slots, as "BB," Fig. 3, is slotted with a narrow slot, "C." Before cutting these slots, a hole is drilled and reamed taper to receive the taper pin, "G," which is driven in after the cutter, "F," is in place, thus holding the blades frictionally. Driving the taper pin out loosens the cutter sufficiently to allow it to be easily withdrawn. In the case of very long

index head by trial to the angle that will give straight slots coinciding closely with the helix.

If a milling machine is not so arranged that the index head swivels on the platen, the slots will have to be cut with an end mill. Where the mill has a so-called raising block, to which the index head may be clamped and then swiveled across the platen, the slots can be cut with a regular axial cutter. After the cutters have been inserted into the slots, and locked, the milling machine is geared again for the proper helix, and the cutting face of each cutter is milled helical and radial. The number of cutting edges for milling cutters with inserted blades may be as given below, which is good average practice:

TABLE OF CUTTING EDGES FOR MILLS WITH INSERTED CUTTERS.

| Diameter. | Number. | Diameter. | Number. |
|---|---|---|---|
| 6 | 12 | 18 | 35 |
| 7 | 14 | 20 | 38 |
| 8 | 16 | 22 | 41 |
| 9 | 18 | 24 | 44 |
| 10 | 20 | 26 | 46 |
| 12 | 24 | 28 | 48 |
| 14 | 28 | 30 | 50 |
| 16 | 32 | 32 | 52 |

The proportions of the cutters may be about as follows: (See Fig. 3.) The thickness of the cutter may be about one-fourth the distance from one cutting edge to the next one. The depth "K" may be about .75 of the pitch of the cutting edges, and the depth "M" of the slots may be about .55 of the pitch. By pitch here is meant the distance from one cutting edge to the other measured along the arc of the circle circumscribed about the

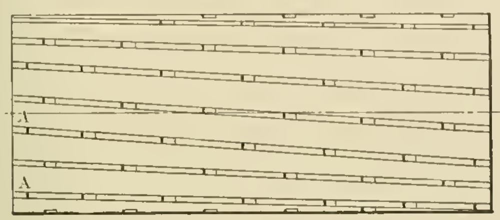



FIG. 2.—MILLING CUTTER WITH NICKED TEETH.

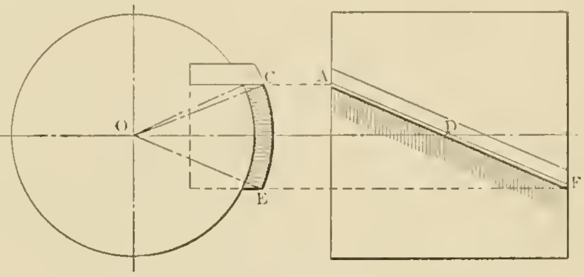



FIG. 4.—STRAIGHT BLADE SET AT AN ANGLE.

cutters, this method is not used, but the cutters are dovetailed in and the back of the cutting edge is then caulked.

Inserted milling cutters may be given a helical cutting edge for the same purpose that solid cutters are provided with it, but if a helical slot is cut in the body the cutting tool will have to be helical in order to fit. This is very hard to make, however, and cannot successfully be made with the machinery found in the average tool room. For this reason straight slots are cut at an angle which will vary with the length of the cutter. In no case should this angle be so small that when one blade leaves the work, the other is not engaged in cutting.

Straight cutters are universally used. Straight cutters set at an angle are open to one objection, which is that the front face of the cutter is not radial throughout its length, but changes from front rake at one end to radial face at about the center, and to negative rake at the other end. This is illustrated in Fig. 4, which shows one straight cutter inserted at an angle. In order to bring out the objectionable feature more clearly, the body has been made rather small. At the end, "A," the face of the cutting edge has front rake, as indicated by radial line "OC;" the cutting edge radial line changes to a negative rake at "F," as shown by "OE."

The best way to relieve this defect is to mill the cutting face helical with a suitable cutter set to produce a radial face. This is shown in Fig. 5. In order to allow this to be done the blades are made heavier in large cutters, being as much as one-half inch thick. Before cutting the slots at an angle, select a helix that will give an angle of about 5 degrees, with a plane passing through the axis. Gear the milling machine to cut this line and turn the blank body in the machine. With a scriber clamped to the milling machine arbor, scribe a helical line on the face of the body; this line will then serve as a guide for setting the

cutter, or in other words the pitch of the cutting edges is equal to the circumference of the cutter divided by the number of teeth. The cutters may be backed off with a milling cutter that will give an angle of about 60 degrees between the front and top of the cutter, as shown in the figure. The backing off may be carried forward far enough to leave a land of about .03 inches. After the cutters have been thus formed and shaped, they are

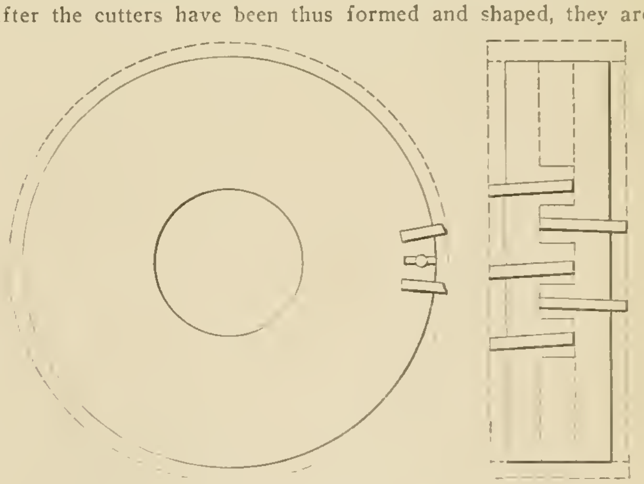


FIG. 6.—INSERTED TOOTH CUTTER WHICH MAY BE ADJUSTED FOR WIDTH.

driven out and hardened in the regular way of hardening alloy steel, and are then put in the slots and circularly ground and given a relief of about 5 degrees, in place of the old practice of 3 degrees which was generally used with the carbon steel.

A type of cutter known as the expanding inserted milling cutter is extremely useful in milling shoes and wedges, in that the body of the cutter is adjustable in width. Two distinct sets of blades are set in two separate bodies at an angle of 4 degrees from the axial line and with the cutting edges slanting inward. The two bodies interlock and by placing liners between them a variation of about 3/16 in. can be obtained in the width of the mill; this allows 3/32 in. to be ground off before resetting the blades, and at the same time lowers the labor cost in resetting the blades, and increases the life of a cutter. Such a cutter is shown in Fig. 6.

Adherence to the practices as here outlined will provide efficient milling cutters at low cost, which produce the large output of work required by modern shops.

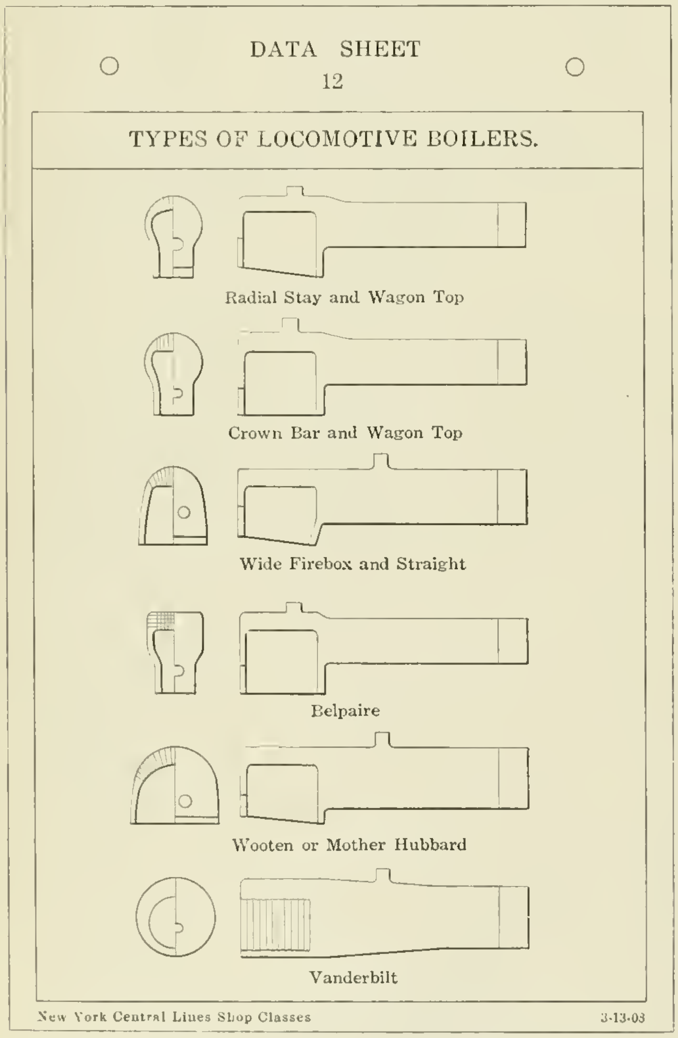
## THE RAILROAD SHOP APPRENTICE.

New York Central Lines.

A form of instruction which appeals to the boys and is giving very satisfactory results has recently been introduced in the school room. Large blueprints, showing sections and elevations of locomotive boilers, are spread out upon a table and one or two boys, working together, fill in on suitably prepared blanks all of the information called for. These forms include information such as ordinarily appears in a specification or bill of material, and are written in such language and terms as may be easily comprehended by the apprentices. Some of the questions require a long hunt before the answer is found. The boys know it is somewhere on the print and do not give up until it is found.

* * * * * * *

As a bonus for performing certain amounts of home study, as indicated by the number of problem sheets which are turned in,




TYPICAL DATA SHEET FOR APPRENTICES.

data sheets containing rules, formula, tables and sketches are issued to the boys in blueprint form. One of these sheets is reproduced herewith. The practice at one shop is to give a data sheet to the apprentice for every ten consecutive sheets of home arithmetic work which he turns in. To be useful the data sheets must be simple and applicable to features with which the apprentice comes in direct contact in connection with his work.

* * * * * * *

Sketching is being emphasized more and more strongly. Each apprentice on the system has recently been furnished with a sketch book, soft pencil and two-foot rule.

The successful mechanic must understand mechanical drawing, but even more important is the ability to quickly sketch an object or put practical ideas on paper intelligently, without the drawing-board and T square.

* * * * * * *

It has been found necessary to set an arbitrary educational standard for boys enrolling as apprentices. So many boys who are not fully qualified wish to enter the schools that an entrance examination has been adopted; failure to pass this requires the boy to wait and study until he can do so. One or two boys below the standard can very greatly lower the standing of a whole class.

* * * * * * *

*Harper's Weekly* has been running a series of articles entitled "This Land of Opportunity." One of these was given over to a consideration of the New York Central Lines apprenticeship system, from which the following extract has been taken:

"It is required from the boy, in order not to take too much from his shop time, that he shall do a considerable part of these problems at home. With only the rarest exceptions, this work is prosecuted faithfully and well. When it isn't, something drops. Your delinquent student in this college goes up before a faculty consisting of a division foreman in whose sight he is a very negligible unit.

"I am informed," said this Nemesis to a boy in the West Albany shop school a little while ago, "that you haven't been working out the problems given to you, and that you're away behind.'

"Yes, sir; I guess that's right."

"Well, you've got just one more chance. Work 'em or go get your time."

At shop time next morning the backslider walked up with a handful of problem papers, and all were solved.

"All these?" said the faculty, in surprise, "when did you do 'em?"

"Last night."

"H'm! It must have taken some time."

"It took all night. I haven't been to bed."

And having "worked off his condition," he went back to his job in the shops and put in a full day.

That is a fair sample of the school discipline and the way it works.

* * * * * * *

There are now ten apprentice schools on the New York Central Lines with a total of 547 apprentices. It is expected that two more schools will soon be opened.

Equipment of the C. P. R.—It is reported that Sir T. Shaughnessy has written a letter to Sir Wilfrid Laurier pointing out that during the years 1902 to 1908 the Canadian Pacific Railway has added to its rolling stock at the rate of fourteen freight cars every day, one passenger car every two days, and one locomotive every three days; and yet such is the volume of traffic that passes over this system that it has the utmost difficulty in keeping pace with the demand made upon it. It has been calculated that the combined freight cars on the Canadian Pacific Railway have a deadweight capacity equivalent to the weight of the entire population of England.

# ENGINEERING DATA—TUBES

*From a hand-book on "The Mechanical Properties of Shelby Seamless Steel Tubing"; prepared by Prof. Reid T. Stewart. Published and copyrighted in 1908 by the National Tube Company of Pittsburgh, Pa., through whose courtesy we are enabled to present this data.*

TABLE 3

## Inside Surface in Square Feet Per Lineal Foot For Shelby Standard Cold Drawn Mechanical Tubing

Reid T. Stewart and R. L. W., 1907. Chkd. by W. F. F.

| Outside Diam. Inches | THICKNESS IN GAGE AND FRACTIONS OF AN INCH | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 22 BWG | 20 BWG | 18 BWG | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 | 5/16 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 |
| ½ | .1162 | .1126 | .1052 | .0982 | .0818 | .0654 | | | | | | | | | | | |
| ⅝ | .1490 | .1453 | .1380 | .1309 | .1145 | .0982 | | | | | | | | | | | |
| ¾ | .1817 | .1780 | .1707 | .1636 | .1473 | .1309 | .1145 | .0982 | | | | | | | | | |
| ⅞ | .2144 | .2107 | .2034 | .1963 | .1800 | .1636 | 1473 | .1309 | .1145 | | | | | | | | |
| 1 | .2471 | .2435 | .2361 | .2291 | .2127 | .1963 | .1800 | 1636 | .1473 | 1309 | | | | | | | |
| 1⅛ | .2799 | .2762 | .2689 | .2618 | .2454 | .2291 | 2127 | 1963 | .1800 | .1636 | | | | | | | |
| 1¼ | .3126 | .3089 | .3016 | .2945 | .2782 | .2618 | 2454 | 2291 | .2127 | .1963 | .1636 | 1309 | | | | | |
| 1⅜ | ..... | .3416 | .3343 | .3272 | .3109 | .2945 | 2782 | .2618 | .2454 | .2291 | .1963 | .1636 | | | | | |
| 1½ | ..... | .3744 | .3670 | .3600 | .3436 | .3272 | .3109 | .2945 | .2782 | .2618 | .2291 | 1963 | .1309 | | | | |
| 1¾ | ..... | ..... | ..... | 4254 | .4091 | .3927 | .3763 | .3600 | .3436 | 3272 | .2945 | .2618 | .1963 | | | | |
| 2 | ..... | ..... | ..... | .4909 | 4745 | .4581 | .4418 | 4254 | .4091 | .3927 | .3600 | .3272 | .2618 | .1963 | | | |
| 2¼ | ..... | ..... | ..... | .5563 | 5400 | .5236 | .5072 | .4909 | 4745 | 4581 | .4254 | .3927 | .3272 | .2618 | | | |
| 2½ | ..... | ..... | ..... | 6218 | 6054 | .5890 | 5727 | 5563 | .5400 | .5236 | .4909 | 4581 | .3927 | 3272 | | | |
| 2¾ | ..... | ..... | ..... | 6872 | 6709 | 6545 | .6381 | 6218 | .6054 | .5890 | 5563 | 5236 | 4581 | .3927 | | | |
| 3 | ..... | ..... | ..... | ..... | .7363 | .7199 | .7036 | .6872 | .6709 | 6545 | 6218 | 5890 | .5236 | .4581 | .3927 | .3272 | .2618 |
| 3¼ | ..... | ..... | ..... | ..... | 8018 | .7854 | 7690 | .7527 | .7363 | 7199 | 6872 | .6545 | 5890 | .5236 | .4581 | .3927 | 3272 |
| 3½ | ..... | ..... | ..... | ..... | .8672 | .8508 | .8345 | 8181 | 8018 | 7854 | .7527 | .7199 | 6545 | .5890 | .5236 | .4581 | .3927 |
| 3¾ | ..... | ..... | ..... | ..... | ..... | .9163 | .8999 | .8836 | .8672 | .8508 | .8181 | .7854 | .7199 | .6545 | .5890 | .5236 | .4581 |
| 4 | ..... | ..... | ..... | ..... | ..... | .9817 | 9654 | .9490 | .9327 | .9163 | .8836 | 8508 | .7854 | .7199 | 6545 | .5890 | .5236 |
| 4¼ | ..... | ..... | ..... | ..... | ..... | ..... | 1 0308 | 1 0145 | .9981 | .9817 | 9490 | .9163 | .8508 | .7854 | .7199 | .6545 | .5890 |
| 4½ | ..... | ..... | ..... | ..... | ..... | ..... | 1 0963 | 1 0799 | 1.0636 | 1 0472 | 1 0145 | .9817 | .9163 | .8508 | .7854 | .7199 | 6545 |
| 4¾ | ..... | ..... | ..... | ..... | ..... | ..... | 1 1617 | 1 1454 | 1.1290 | 1.1126 | 1 0799 | 1 0472 | .9817 | .9163 | 8508 | .7854 | .7199 |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | 1 2272 | 1 2108 | 1 1945 | 1 1781 | 1 1454 | 1 1126 | 1 0472 | .9817 | .9163 | .8508 | .7854 |
| 5¼ | ..... | ..... | ..... | ..... | ..... | ..... | 1 3581 | 1 3417 | 1 3254 | 1.3090 | 1 2763 | 1.2435 | 1 1781 | 1 1126 | 1 0472 | .9817 | .9163 |

TABLE 6

## Capacity in Cubic Inches Per Lineal Foot For Shelby Standard Cold Drawn Mechanical Tubing

Reid T. Stewart and R. L. W., 1907. Chkd. by W. F. F.

| Outside Diam. Inches | THICKNESS IN GAGE AND FRACTIONS OF AN INCH | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 22 BWG | 20 BWG | 18 BWG | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 | 5/16 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 |
| ½ | 1 858 | 1 743 | 1 523 | 1.325 | 920 | .589 | | | | | | | | | | | |
| ⅝ | 3 051 | 2.903 | 2 618 | 2.356 | 1.804 | 1 325 | | | | | | | | | | | |
| ¾ | 4 539 | 4.358 | 4.007 | 3.682 | 2.982 | 2.356 | 1.804 | 1.325 | | | | | | | | | |
| ⅞ | 6.322 | 6.107 | 5.690 | 5.301 | 4.455 | 3.682 | 2.982 | 2.356 | 1.804 | | | | | | | | |
| 1 | 8 399 | 8.151 | 7.668 | 7.216 | 6.222 | 5 301 | 4.455 | 3.682 | 2.982 | 2.356 | | | | | | | |
| 1⅛ | 10 770 | 10.490 | 9 941 | 9.425 | 8.283 | 7.216 | 6.222 | 5.301 | 4 455 | 3.682 | | | | | | | |
| 1¼ | 13.436 | 13.123 | 12 508 | 11 93 | 10 64 | 9.425 | 8 283 | 7 216 | 6.222 | 5.301 | 3 682 | 2 356 | | | | | |
| 1⅜ | | 16.051 | 15.37 | 14.73 | 13 29 | 11.93 | 10.64 | 9.425 | 8.283 | 7.216 | 5 301 | 3.682 | | | | | |
| 1½ | ..... | 19 273 | 18 53 | 17.82 | 16.24 | 14 73 | 13.29 | 11.93 | 10.64 | 9.425 | 7.216 | 5.301 | 2.356 | | | | |
| 1¾ | ..... | ..... | ..... | 24.89 | 23.01 | 21.21 | 19.48 | 17 82 | 16.24 | 14.73 | 11.93 | 9.425 | 5.301 | | | | |
| 2 | ..... | ..... | ..... | 33.13 | 30.96 | 28.86 | 26.84 | 24.89 | 23.01 | 21.21 | 17.82 | 14.73 | 9.425 | 5.301 | | | |
| 2¼ | ..... | ..... | ..... | 42.56 | 40.09 | 37.70 | 35.38 | 33.13 | 30.96 | 28.86 | 24.89 | 21.21 | 14.73 | 9.425 | | | |
| 2½ | ..... | ..... | ..... | 53.16 | 50.40 | 47.71 | 45.10 | 42.56 | 40.09 | 37.70 | 33.13 | 28.86 | 21.21 | 14 73 | | | |
| 2¾ | ..... | ..... | ..... | 64.94 | 61.89 | 58.90 | 56.00 | 53.16 | 50.40 | 47.71 | 42.56 | 37 70 | 28 86 | 21.21 | | | |
| 3 | ..... | ..... | ..... | ..... | 74.55 | 71.27 | 68.07 | 64.94 | 61.89 | 58.90 | 53.16 | 47.71 | 37.70 | 28.86 | 21.21 | 14 73 | 9.425 |
| 3¼ | ..... | ..... | ..... | ..... | 88 39 | 84.82 | 81 33 | 77.90 | 74.55 | 71.27 | 64.94 | 58.90 | 47.71 | 37.70 | 28 86 | 21.21 | 14.73 |
| 3½ | ..... | ..... | ..... | ..... | 103.41 | 99.55 | 95.76 | 92.04 | 88.39 | 84.82 | 77 90 | 71.27 | 58 90 | 47.71 | 37.70 | 28.86 | 21.21 |
| 3¾ | ..... | ..... | ..... | ..... | ..... | 115.45 | 111.37 | 107.35 | 103.41 | 99.55 | 92.04 | 84 82 | 71.27 | 58.90 | 47.71 | 37.70 | 28 66 |
| 4 | ..... | ..... | ..... | ..... | ..... | 132.54 | 128.15 | 123.85 | 119.61 | 115.45 | 107.35 | 99.55 | 84.82 | 71.27 | 58 90 | 47.71 | 37 70 |
| 4¼ | ..... | ..... | ..... | ..... | ..... | ..... | 146.12 | 141.52 | 136.99 | 132.54 | 123.85 | 115.45 | 99 55 | 84.82 | 71.27 | 58.90 | 47.71 |
| 4½ | ..... | ..... | ..... | ..... | ..... | ..... | 165.26 | 160.37 | 155.55 | 150.80 | 141.52 | 132.54 | 115.45 | 99.55 | 84.82 | 71.27 | 58.90 |
| 4¾ | ..... | ..... | ..... | ..... | ..... | ..... | 185.59 | 180.40 | 175.28 | 170.24 | 160.37 | 150.80 | 132.54 | 115.45 | 99.55 | 84 82 | 71 27 |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | 207.09 | 201.60 | 196.19 | 190.85 | 180.40 | 170.24 | 150.80 | 132.54 | 115.45 | 99.55 | 84.82 |
| 5¼ | ..... | ..... | ..... | ..... | ..... | ..... | 253.62 | 247.55 | 241.55 | 235.62 | 223.99 | 212.65 | 190.85 | 170.24 | 150.80 | 132.54 | 115.45 |

TABLE 5

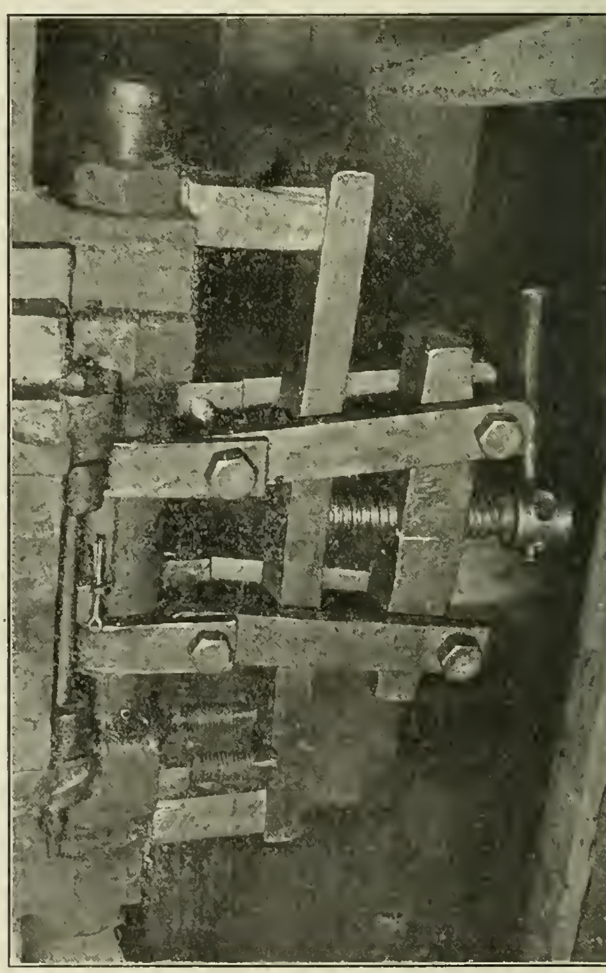
## Weight in Pounds Per Lineal Foot For Shelby Standard Cold Drawn Mechanical Tubing

Based on wt. 1 cu. in. Steel=0.2833 lb. Reid T. Stewart and R. L. W., 1907. Chkd. by W. F. F.

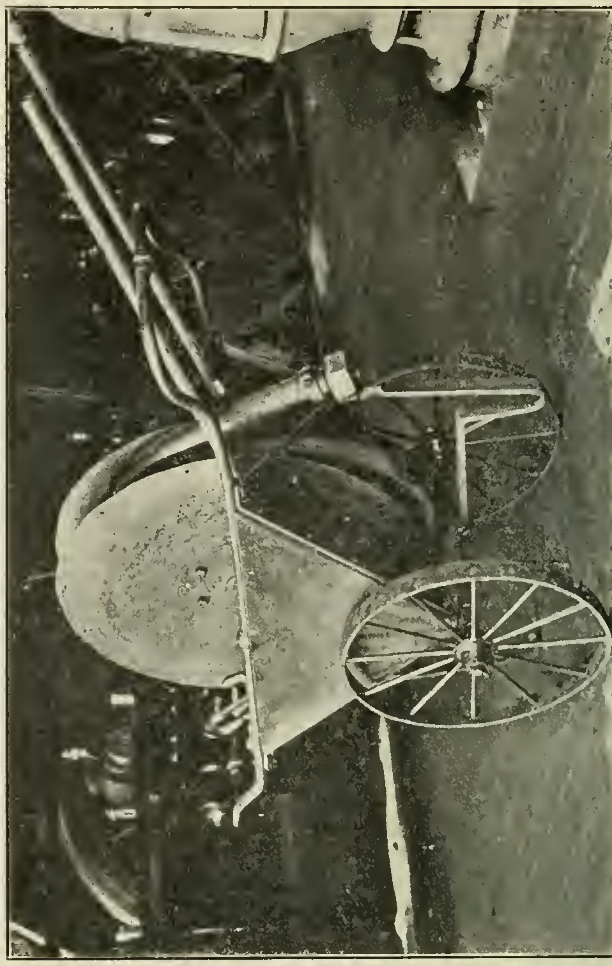
| Outside Diam. Inches | THICKNESS IN GAGE AND FRACTIONS OF AN INCH | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 22 BWG | 20 BWG | 18 BWG | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 | 5/16 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 |
| ½ | .141 | .174 | .236 | .292 | .407 | .501 | | | | | | | | | | | |
| ⅝ | .179 | .221 | .301 | .375 | .532 | .668 | | | | | | | | | | | |
| ¾ | .216 | .267 | .367 | .459 | .657 | .834 | .991 | 1.13 | | | | | | | | | |
| ⅞ | .253 | .314 | .432 | .542 | .782 | 1 00 | 1.20 | 1.38 | 1 53 | | | | | | | | |
| 1 | .291 | .361 | .498 | .626 | .907 | 1.17 | 1.41 | 1.63 | 1 83 | 2.00 | | | | | | | |
| 1⅛ | .328 | .407 | .563 | .709 | 1.03 | 1.34 | 1.62 | 1 88 | 2.12 | 2.34 | | | | | | | |
| 1¼ | .365 | .454 | .629 | .793 | 1.16 | 1.50 | 1 83 | 2.13 | 2.41 | 2.67 | 3.13 | 3.50 | | | | | |
| 1⅜ | ..... | .501 | .694 | .876 | 1.28 | 1.67 | 2.03 | 2 38 | 2.70 | 3.00 | 3 55 | 4.01 | | | | | |
| 1½ | ..... | .548 | .759 | .960 | 1.41 | 1.84 | 2.24 | 2.63 | 2.99 | 3.34 | 3 96 | 4.51 | 5.34 | | | | |
| 1¾ | ..... | ..... | ..... | 1.13 | 1 66 | 2.17 | 2 66 | 3.13 | 3 58 | 4.01 | 4 80 | 5 51 | 6 68 | | | | |
| 2 | ..... | ..... | ..... | 1.29 | 1.91 | 2.50 | 3.08 | 3.63 | 4.16 | 4.67 | 5.63 | 6.51 | 8 01 | 9 18 | | | |
| 2¼ | ..... | ..... | ..... | 1.46 | 2 16 | 2.84 | 3.49 | 4.13 | 4.75 | 5.34 | 6 47 | 7.51 | 9.35 | 10.85 | | | |
| 2½ | ..... | ..... | ..... | 1 63 | 2 41 | 3.17 | 3.91 | 4 63 | 5 33 | 6 01 | 7 30 | 8 51 | 10.68 | 12 52 | | | |
| 2¾ | ..... | ..... | ..... | 1.79 | 2 66 | 3 50 | 4 33 | 5 13 | 5 91 | 6.68 | 8 14 | 9 51 | 12 02 | 14 18 | | | |
| 3 | ..... | ..... | ..... | ..... | 2.91 | 3 84 | 4 75 | 5 63 | 6 50 | 7 34 | 8 97 | 10 51 | 13 35 | 15 85 | 18.02 | 19 86 | 21 36 |
| 3¼ | ..... | ..... | ..... | ..... | 3 16 | 4 17 | 5 16 | 6 13 | 7 08 | 8.01 | 9 80 | 11 51 | 14 69 | 17 52 | 20 03 | 22 19 | 24.03 |
| 3½ | ..... | ..... | ..... | ..... | 3.41 | 4 51 | 5.58 | 6 63 | 7 67 | 8 68 | 10.64 | 12.52 | 16 02 | 19 19 | 22.03 | 24 53 | 26 70 |
| 3¾ | ..... | ..... | ..... | ..... | ..... | 4 84 | 6 00 | 7.13 | 8.25 | 9 35 | 11.47 | 13 52 | 17 36 | 20 86 | 24 03 | 26 87 | 29 37 |
| 4 | ..... | ..... | ..... | ..... | ..... | 5.17 | 6.41 | 7.63 | 8 83 | 10 01 | 12.31 | 14 52 | 18.69 | 22 53 | 26.03 | 29.20 | 32.04 |
| 4¼ | ..... | ..... | ..... | ..... | ..... | ..... | 6.83 | 8.14 | 9 42 | 10.68 | 13.14 | 15 52 | 20.03 | 24 20 | 28.04 | 31.54 | 34.71 |
| 4½ | ..... | ..... | ..... | ..... | ..... | ..... | 7.25 | 8 64 | 10 00 | 11.35 | 13 98 | 16.52 | 21 36 | 25 87 | 30.04 | 33 83 | 37.38 |
| 4¾ | ..... | ..... | ..... | ..... | ..... | ..... | 7 67 | 9 14 | 10.59 | 12 02 | 14.81 | 17 52 | 22.70 | 27 53 | 32.04 | 36 21 | 40.05 |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | 8 08 | 9 64 | 11.17 | 12.68 | 15 64 | 18.52 | 24 03 | 29 20 | 34 04 | 38.55 | 42 72 |
| 5¼ | ..... | ..... | ..... | ..... | ..... | ..... | 8 92 | 10.64 | 12.34 | 14.02 | 17.31 | 20 53 | 26.70 | 32.54 | 38.05 | 43.22 | 48 06 |

PORTABLE STEEL TOOL BOX.

PORTABLE VISE BENCH.



DEVICE FOR PULLING DOWN PEDESTAL BINDERS.



TRUCK FOR BOILER WASHING HOSE AND TOOLS.

# LABOR AND TIME SAVING DEVICES IN THE ROUND-HOUSE.

Pittsburgh & Lake Erie Railroad, McKees Rocks, Pa.

There is no place on a railroad where labor and time saving devices are so important as in the roundhouse. The foreman's ingenuity is taxed to the utmost to make every move count and to perform each operation in the shortest possible time. D. J. Redding, master mechanic of the Pittsburgh & Lake Erie Railroad, and president of the Railway Club of Pittsburgh, has suggested that a description of the best labor and time saving devices and methods used in roundhouses, selected from a number of different railroads, would prove of great benefit to those interested in this work. Following this suggestion several such devices have been selected from the McKees Rocks roundhouse of the Pittsburgh & Lake Erie Railroad and are described herewith. Our readers are urged to send us descriptions of tools, devices or methods, which they have found valuable in roundhouse work.

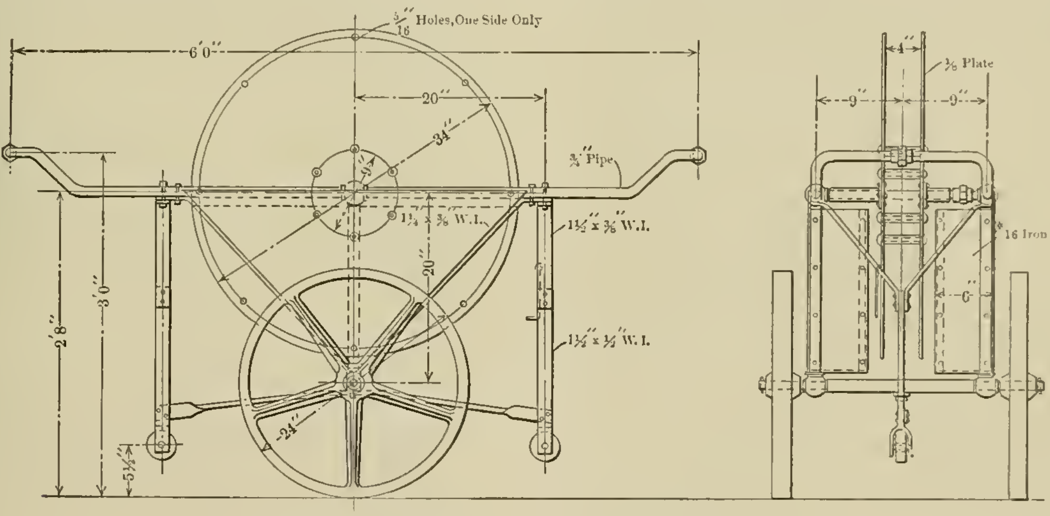
*Truck for Boiler Washing Hose and the Boiler Washer's Tools.*—This truck, or cart, is comparatively light and may easily be pushed about the house. There is no excuse for the boiler washer losing or misplacing his tools, or not keeping them in an orderly manner. The use of the hose reel has increased the life of the hose about 50 per cent. Where a hose reel is not used the hose is worn out by being dragged over rough floors and often it is left lying on the floor where it may be struck by falling objects or run over by trucks, wheelbarrows, etc. The side plates of the reel are of 1/8 in. steel and are spaced 4 in. apart, or just a trifle more than the diameter of the hose, thus preventing any possibility of its becoming tangled in winding it on or off the reel. The V shaped pockets on either side of the reel are for the boiler washer's tools and are 6 in. wide, about 19 in. deep, and 36 in. long at the top. They are made from No. 16 iron and are reinforced by iron bands or bars at the edges, as shown. The wheels are 24 in. in diameter and the push handles are of 3/4 in. gas pipe. The iron pipe nozzles used for washing out are shown projecting from the rear pocket in the photograph.

*Portable Steel Tool Boxes.*—Portable tool boxes for roundhouse machinists are not uncommon, but they are usually constructed of wood. While the steel boxes are more expensive than the wooden ones, as far as the first cost is concerned, they are practically indestructible and cannot be broken open.

These boxes are designed to hold all of the hand tools used by the workmen, except the larger wrenches, jacks, etc., which are kept in the tool room. This cuts out the necessity of a man making several trips for files, liners, chisels, etc., between the engine upon which he is working and his bench, which may be at opposite sides of the house.

The tool box shown in the photo is made of 1/16 in. steel with a wrought iron band 1¼ in. wide riveted along the top edges. The box is 39 in. long, 18 in. wide and 10½ in. deep. An end compartment, 12 in. wide, has a tray fitting in the top, which is about 7 in. long and may be moved back and forth, thus making it possible to get underneath it without lifting it out of the box. The cover of the box is flanged at the edges to fit over the sides and in addition is stiffened by the 1 x 1 in. angle, riveted to it. The truck is about 8 in. high.

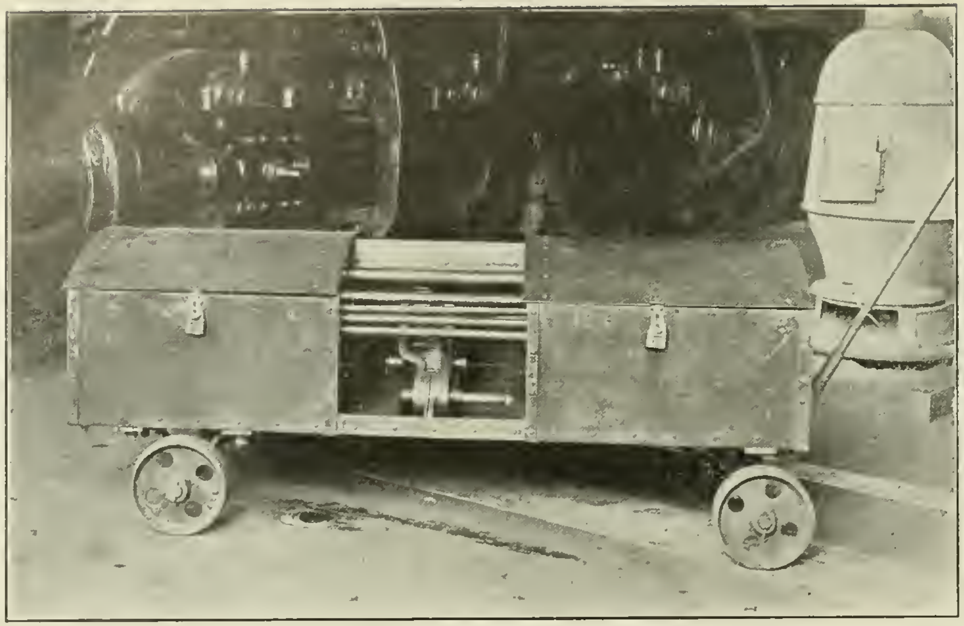
*Portable Vise Bench.*—This bench may be moved near the engine, thereby saving the time usually consumed in carrying material back and forth between the engine and the wall bench. When used in connection with the portable tool boxes there is no need for maintaining the old style benches, which are usually a "catch-all" for an accumulation of wrenches, sledges, liners, bars, old overalls and all sorts of material. The men will not accumulate this stuff when they have to carry it from one engine to another in the portable tool box. These benches are 48 x 24 in. in size and 32 in. high. They are fitted with 6 in. vises. The timbers in the frame work are 2½ x 2½ in. and are bolted together by the 3/8 in. rods. The wheels are 8 in. in diameter.



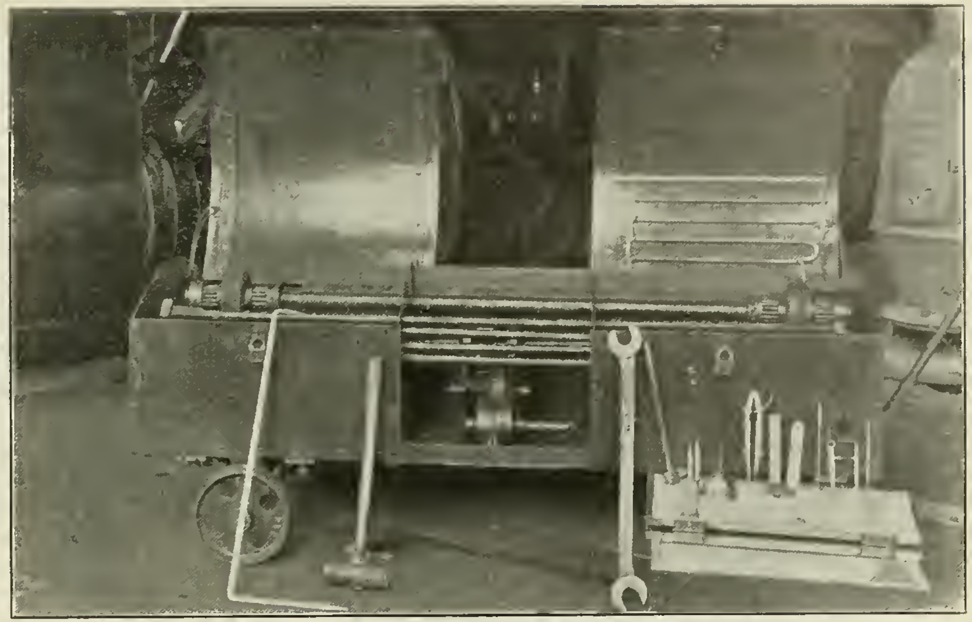

TRUCK FOR BOILER WASHING HOSE AND TOOLS.

*Device for Pulling Down Binders.*—This is used where the binders do not come down easily after the binder bolts are removed. The two yokes are slipped over the binder and connected to the rest of the apparatus, as shown, using wooden blocks between the ends of the long bar and the bottom of the pedestals. By operating the screw the binder is easily forced downward. The long bar is 26 x 3 x 1½ in.; the short one is 14 x 3 x 2½ in.; the screw is 2 in. in diameter and 10 in. long, with square threads.

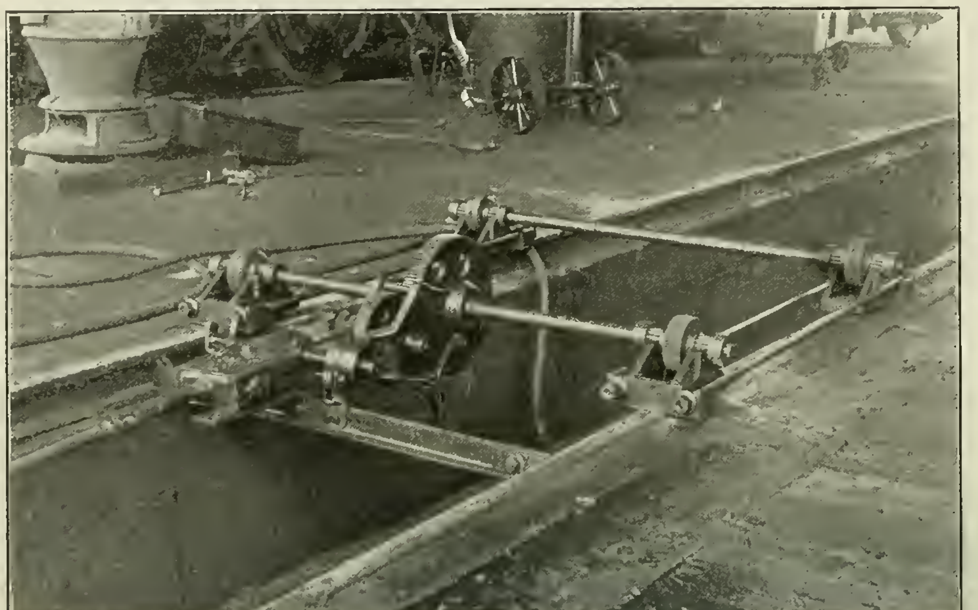
*Repairing Sand Boxes.*—It is quite often necessary to repair the sand boxes, or the sanding apparatus, in the roundhouse. Even if the hostler understands that this is to be done and does not take sand before bringing the engine into the house there is usually more or less left in the box from the previous trip. This must either be emptied and wheeled to the sand house or dumped with the refuse. When the engine is ready to go on the road it must be stopped at the sand house on the way out to take sand, which in most instances is not a convenient operation. To overcome this difficulty the tank and the apparatus shown in the



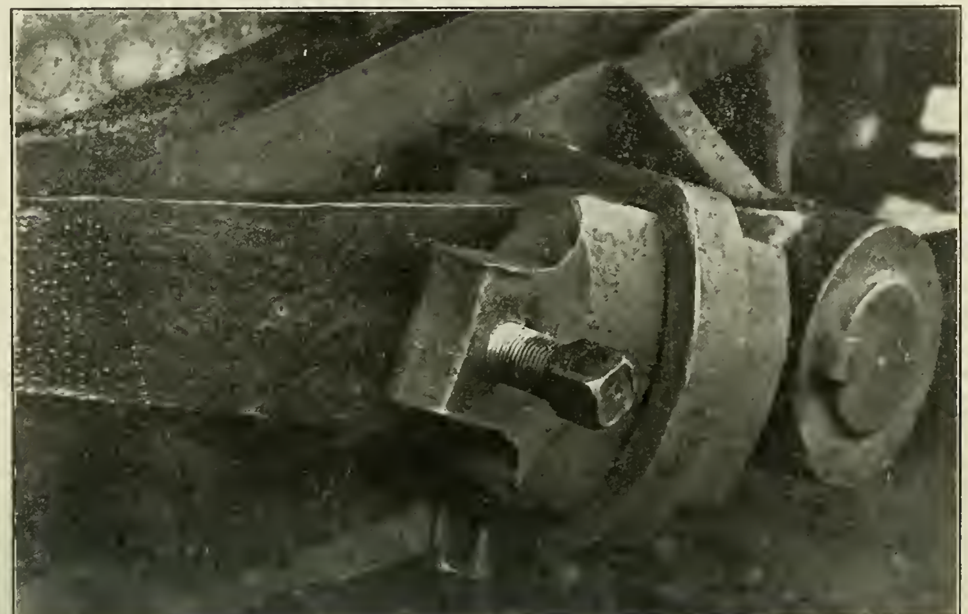
PORTABLE BOX FOR VALVE SETTING APPARATUS.



BOX FOR VALVE SETTING APPARATUS—OPEN.

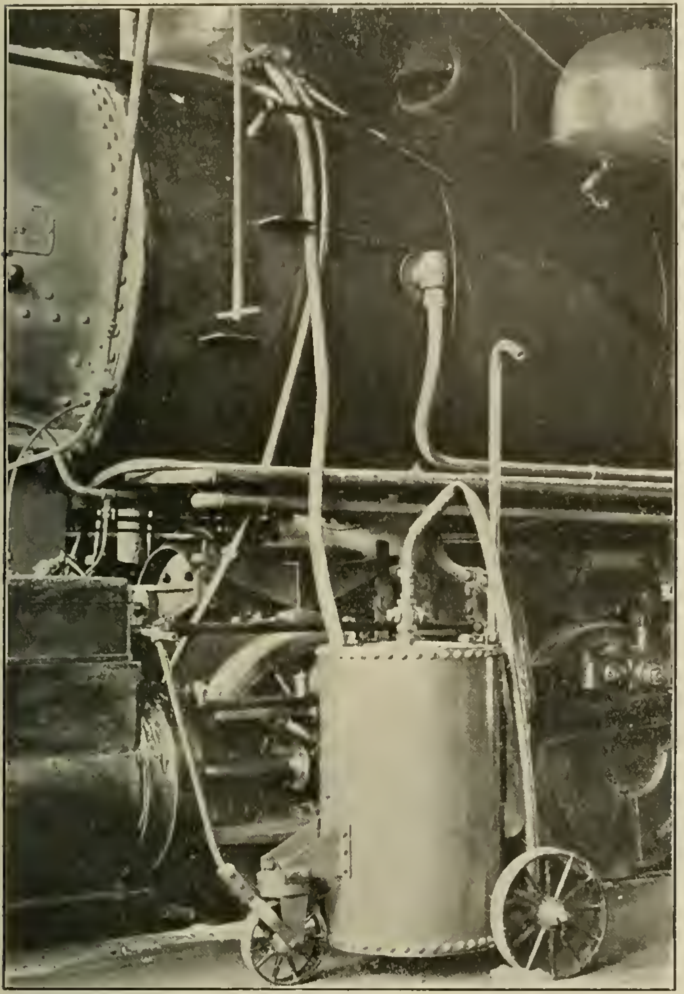


VALVE SETTING MACHINE.



DEVICE FOR STRAIGHTENING BRAKE LEVERS, ECCENTRIC BLADES, ETC.

photos have been constructed. If it is necessary to empty the sand box the tank is wheeled alongside the engine. The sand pipe is disconnected and the sand is run from the sand box on the locomotive into the tank through the rubber hose, as shown in the illustration below. The rubber hose is then disconnected and a nipple with a ¾ in. cut out cock is screwed into the hole in the tank through which the rubber hose emptied the sand.



EMPTYING SAND FROM SAND BOX INTO TANK.

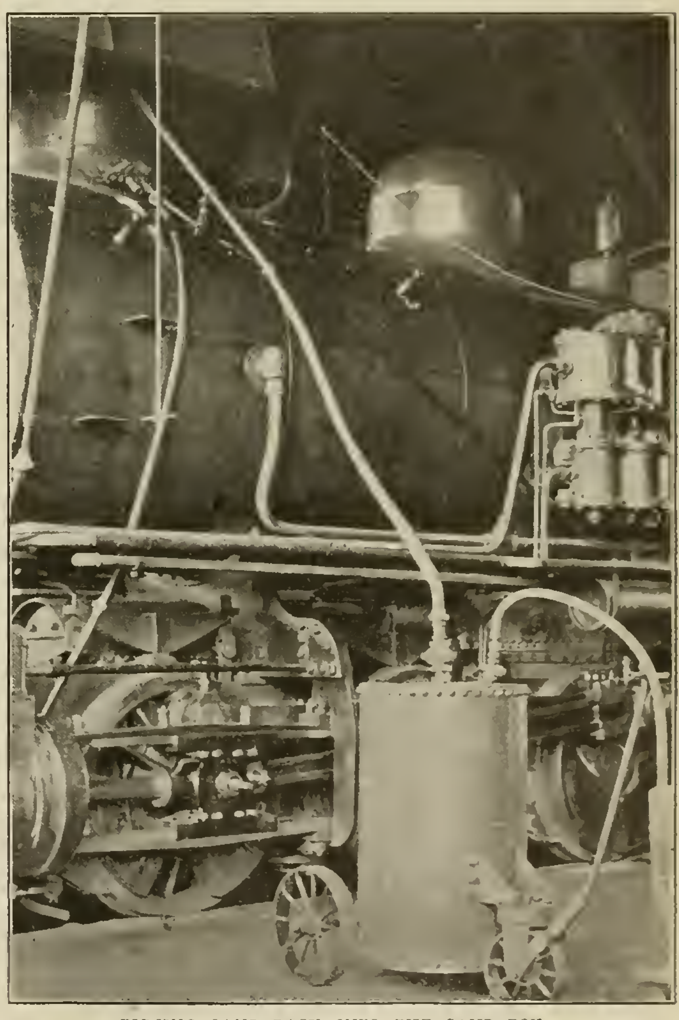
When the repairs have been completed the hose, which connects with a cast iron straight-way plug valve at the center of the head of the tank, is connected with the top of the sand box by means of a 1¼ in. pipe, which in the illustration above is shown standing alongside of the tank at the rear in an upright position. This pipe is securely held in place by a clamp, attached to the hand rail. A 1¼" pipe, connecting with the plug valve, extends to within about ¼ in. of the bottom of the tank. By connecting the ¾ in. cut-out cock with the compressed air line and allowing the air to enter the tank the sand may be quickly forced back up into the sand box.

The sand tank is 26 x 40 in. in size and of practically the same design as a main reservoir. A small amount of sand remains heaped around the side of the tank at the bottom, but this could be done away with by either shaping the bottom of the tank so that all the sand would run to the center, or by filling it with wooden blocking to give the inside the required shape. This apparatus permits the hostler to fill the sand boxes of all engines before they are taken into the house, whether repairs are to be made to the sand box or not, and it is thus never necessary to fill the sand boxes while the engine is leaving the roundhouse.

*Valve Setting Apparatus.*—Much time is lost, both in erecting shops and the roundhouses, in getting together the various parts of the device for turning the drivers and the necessary tools and trams used for adjusting and setting the valves. Parts of the apparatus are often lost or misplaced and oftentimes its condition generally is anything but what it should be. To overcome this a large portable double steel box has been constructed, specially arranged for holding all the apparatus and tools required for valve setting; it may easily be transported from place to place. It is kept in the tool room and when not in use is locked, as shown in one of the illustrations. Another view shows the box with the covers opened up and part of the tools removed. The box is constructed of ⅛ in. steel, reinforced at the corners by the iron bands, as shown. The wheels are 10 in. in diameter. The apparatus for turning the drivers is shown assembled in one of the illustrations and is driven by an air motor, the driving mechanism being modeled after that of an old cylinder boring machine.

*Portable Hoist for Handling the Large Compound Air Pumps.*—Many of our readers are familiar with the smaller size Franklin portable cranes and hoists. The one shown in the illustration is a special size and is used principally for handling the new Westinghouse 8½ in. compound air pumps. It is 12 ft. 9 in. high and the height of the hoist is 11 ft. 8 in. The bed is 4 ft. 10½ in. wide outside and 5 ft. 1 in. in length. The crane has an overhang of 4 ft. 1 in. and a capacity of 3 tons. It weighs about 1,940 lbs. and is manufactured by The Franklin Portable Crane & Hoist Co., Franklin, Pa. The two smaller castors at the side were added to increase its stability, thus giving it five points of support.

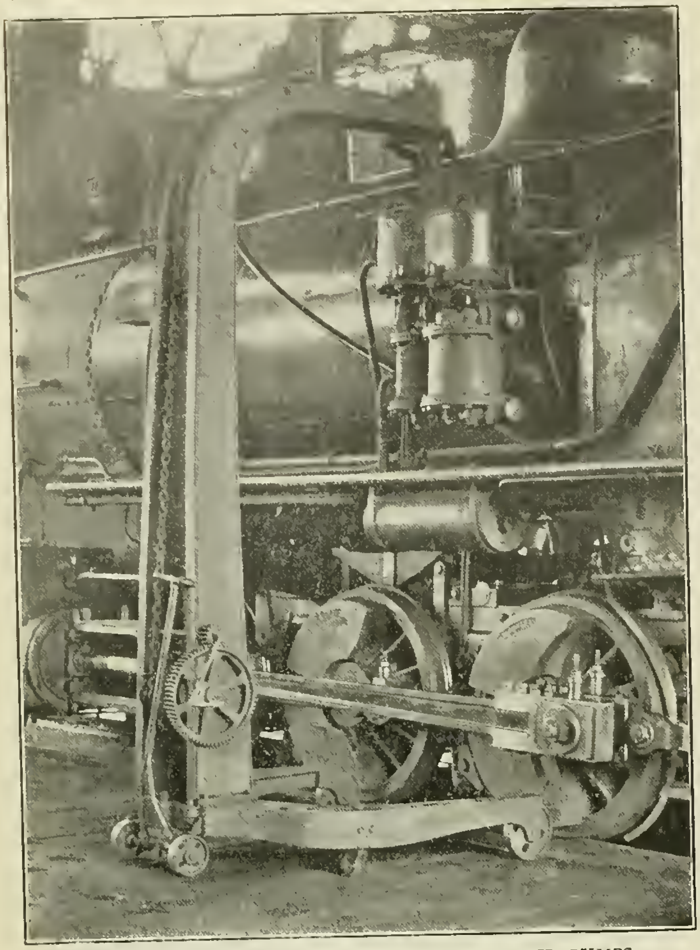
*Device for Straightening Levers, etc.*—This device is very simple and was designed for taking out kinks or bending brake levers or eccentric blades without taking them down. The strap



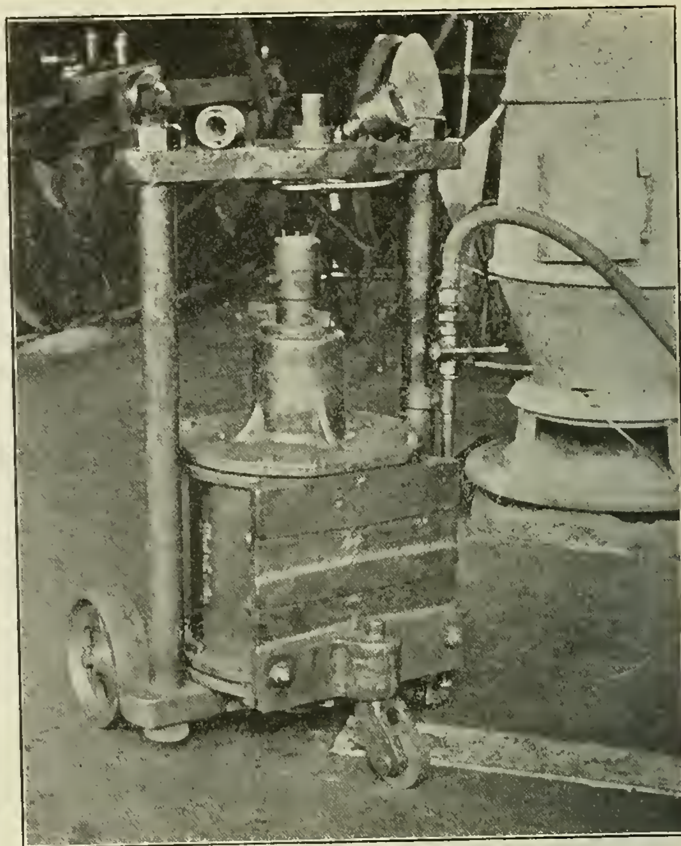
FORCING SAND BACK INTO THE SAND BOX.

is placed over the lever or bar, which is to be straightened, and the key is dropped in place, as shown at the rear. By turning the screw bolt the lever may be bent the desired amount. A smaller one of these is used for the eccentric blades.

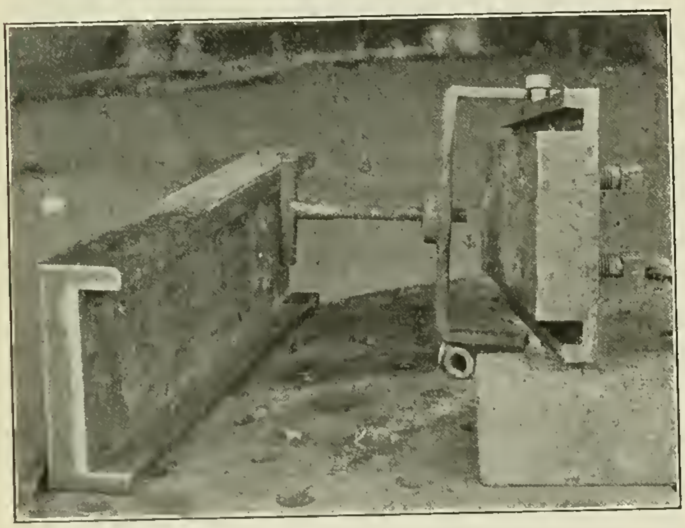
*Gasket Cutter.*—Considerable time is wasted in many roundhouses by cutting gaskets out with a knife; usually they do not give very good satisfaction when made in this way. A most



PORTABLE HOIST FOR HANDLING COMPOUND AIR PUMPS.



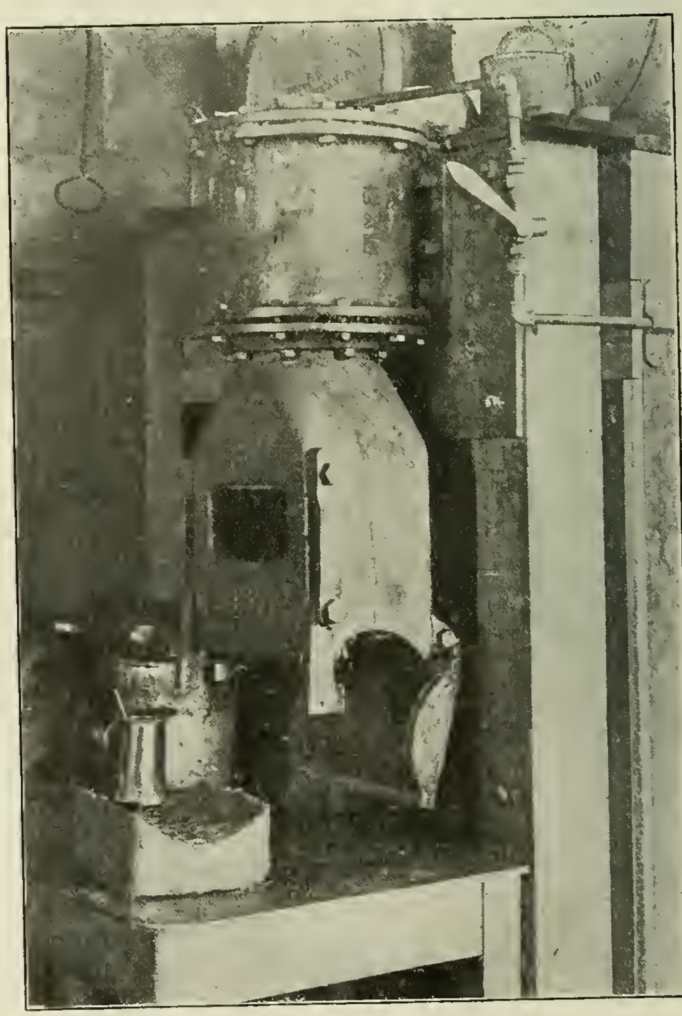
PNEUMATIC GASKET CUTTER.



DEVICE FOR BABBITTING CROSSHEAD SHOES.

efficient machine for cutting out gaskets from old hose has been constructed and is operated by the roundhouse tool man in his spare time. The air cylinder is 12 x 14 in. and is limited to a 3½ in. stroke, so that a comparatively small amount of air is consumed. The cutters are made of tool steel, as shown, and a copper plate is fastened to the top cross-bar back of the gasket, to reduce the liability of injuring them. The bar, which passes through a slot in the piston rod, limits its stroke and forces two pins upward, as the cutter drops back to the position shown in the illustration, pressing the gasket out. Where cutters of this type are struck with a hammer or sledge in cutting gaskets they are easily broken on account of the unequal pressure on the cutting edges. With this press there has thus far been no breakage and the life of the cutter seems to be indefinite.

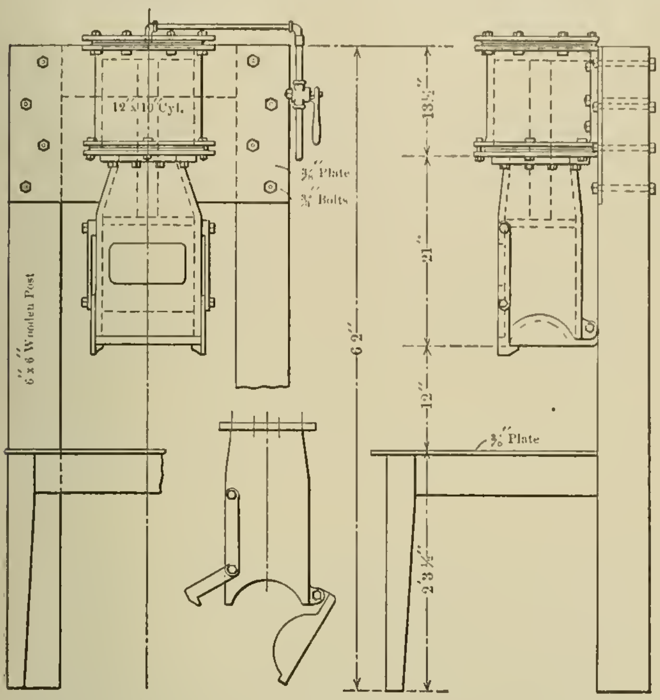
*Moulding Grease for Driving Boxes.*—The device used for



DEVICE FOR MOULDING GREASE FOR DRIVING BOX CELLARS.

moulding the grease for driving box cellars is illustrated both by a photo and a sketch. The bottom of the mould is held in place by the two latches and the grease is put in through the hole at the front. Air is then allowed to enter the 12 x 12 in. cylinder and the plate at the end of the piston rod presses the grease to the shape shown in the illustration. The former method of pounding the grease into shape by hand was slow and expensive.

*Babbitting Crosshead Shoes.*—The old practice was to fill the shoes with babbitt, over blocks slightly smaller than the guide, and plane them out to size. With the device illustrated the shoe,



DEVICE FOR MOULDING GREASE FOR DRIVING BOX CELLARS.

after being removed from the crosshead, is put in a frame; the frame is placed vertically on the floor and the babbitt is poured. The shoe is then ready to be replaced on the engine. No machine work is required and the entire operation may be performed in from fifteen to twenty minutes.

With the old method it was necessary, at roundhouses where there were no planers, to replace the shoe with one which had already been babbitted and was carried in stock. These shoes almost invariably required some fitting of the bolts, as the holes would not line up properly, so that in a short time a lot of shoes would accumulate in which the holes did not match properly with those in the crosshead.

## THE AMERICAN RAILROAD EMPLOYEES' AND INVESTORS' ASSOCIATION.

The following letter has been issued by P. H. Morrissey, president, explaining the plans of the above association for benefit to all railroad employees and investors. This movement is deserving of the support of all our readers:

*To Railway Men:*

The American Railroad Employees' and Investors' Association, organized at Chicago, Ill., September 14, 1908, invites the railway employees of the United States to a serious consideration of its plans and purposes.

Necessity for a medium through which the railroads and their employees might act jointly on questions of mutual interest prompted the formation of the association. It aims to bring together the railway employees and railway owners for the purpose of cultivating and maintaining between them such concern on the part of all for the welfare and prosperity of American railroads as will best promote their successful and profitable operation for the benefit alike of the employees, the investors and the public.

The association will at no time be used for partisan political purposes and will take no part in controversies, if any, which may arise between railroad employees and railroad officials. It will encourage by every proper method cordial and friendly feeling on the part of the public toward American railroads and their welfare, and will oppose the enactment of untimely, needless or arbitrary laws in regulation or restriction of railroad business.

This movement is but the development of a sentiment often expressed by both employer and employee—that there is a mutuality of interests between the two. Co-operation is, therefore, natural and practical, for in no other way can the things in which they are commonly interested be protected. The last year and a half, with its thousands of railway men either out of employment or working on short time, with their lean pay checks, is an object lesson.

How long can the railroads stand against increasing cost of service combined with decreasing rate of compensation?

Our plan will be to enroll as members the large army of railway employees of the United States. They are sufficiently numerous to influence public opinion materially, to the end that the hostile attitude of opposing interests may be changed, and that railways may be operated profitably, thus furnishing continuous employment at good wages to the many engaged in the service. In order that its work may be carried on systematically, subordinate branches will be organized at points where the required number of employees work. State organizations will also be formed.

It should be distinctly understood that the association will not interfere in any way with any of the established organizations of railway employees nor will it attempt to assume jurisdiction over matters which properly belong to them. It is organized for a specific purpose and will keep within its legitimate bounds. Its methods will bear scrutiny, for it is open and above board.

Its executive committee is composed of an equal number of representatives of investors and railway employees, and as all are tried and reputable men, it is assured that the influences of the association will at no time be used for any purpose that will be antagonistic to the employees. The employee's connection with it will be from the standpoint of promotion of his material welfare and not subserviency to the wish of the employer. A small admission fee will be charged.

The association has come to stay. The active co-operation of the railway employees of the country will make its influence a power for good.

Mr. C. D. Kellogg, of Cedar Rapids, Iowa, formerly editor of *The Railway Conductor*, has been elected secretary, and to him all communications should be addressed at 233 Railway Exchange, Chicago. The by-laws of the association have been adopted and, with other literature and information, may be had upon application.

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Depreciation of a Power Plant.—Charles T. Main, a well-known mill engineer of Boston, states that with good water and good care a stationary boiler should last about twenty years, thus having a depreciation of about 5 per cent. per year, assuming that it is operated 12 hours a day. Slow speed engines running 10 hours a day should have a life of about 25 years, or a depreciation of four per cent. High speed engines should have a depreciation of 7 per cent. or greater if operated more than 10 hours a day. Economizers have a depreciation varying from 10 to 2½ per cent., depending upon the initial temperature of the entering water.

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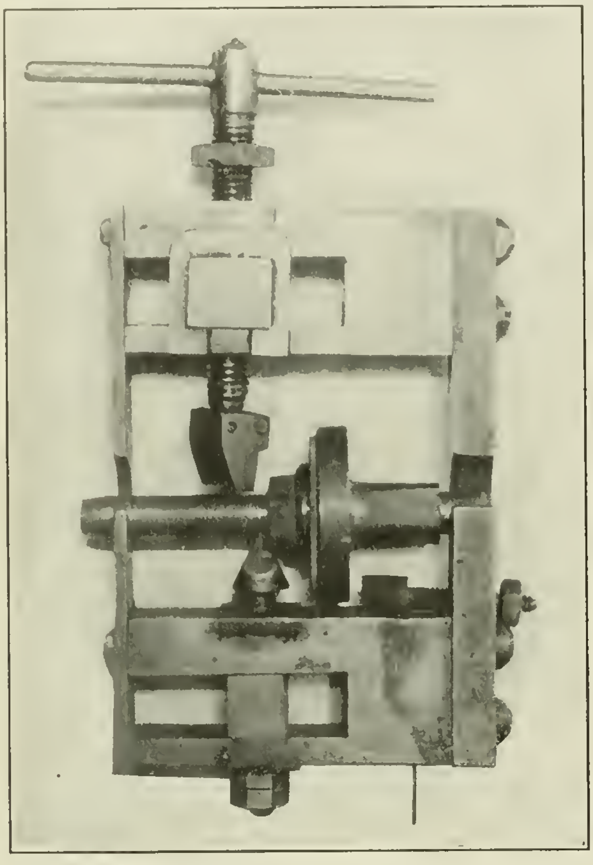
American Society of Hungarian Engineers & Architects.—A society having the the above title, has recently been organized for the purpose of bringing in closer touch the engineers and architects of Hungarian extraction living in this country and to give moral support and information to newcomers. It also desires to encourage the exchange of engineering, technical and industrial information between the technical men of Hungary and the U. S. and will hold monthly meetings. Information can be obtained by addressing the secretary at Box 103, General P. O., New York City.

## REPAIRING TRIPLE VALVES.

The illustration shows a simple but ingenious device for finding whether the emergency valve stem of the triple valve is bent, or if the valve has been distorted. It is used in the air brake room of the west-bound freight car repair yard of the Pennsylvania Railroad at Altoona. The valve is slipped into place, as



shown, and the partially cone-shaped piece just below the valve stem is screwed to within a very short distance of the stem. By revolving the valve it can readily be seen whether the stem is out of true. The cone-shaped part may be slipped sidewise to test the stem at various points. If the stem is out of true it may be pressed back into place by forcing the screw above the valve stem downward.

To the right, but indistinctly shown, is another screw with a block at its left end; this may be brought to within a very short distance of the side of the valve. By revolving the valve it may be seen whether it is distorted, if so it may be taken out and repaired in a vise. This device was made by W. L. Goodman of the air brake department.

## SHOULD RAILROADS MANUFACTURE?

In a *house organ*, published by The Crane Co., of Chicago, R. T. Crane writes an article on "Should Railroads Manufacture?" The article begins by saying:

"A nice question may be raised as to when a railroad legitimately and advantageously may enter into manufacturing for itself."

The writer relates how in his early business career as a manufacturer of car axle brasses he was asked to advise with the directors of the Galena (now the Chicago and Northwestern) railroad, as to whether they should go into the manufacture of their own brasses. Mr. Crane advised against it, and related how a few years ago Dr. Williams, of the Baldwin Locomotive Works, then a director on the Galena road, congratulated Mr. Crane on the wisdom of his counsel.

Mr. Crane continues: "After a long and varied business experience, I am more than ever of the opinion that the less manufacturing the railroads do the better. Railroad men, no matter how efficient, cannot be expected to know the inside and outside, the hindside and foreside of manufacturing, as well as those who devote their entire time to manufacturing."

It will occur to very many who read Mr. Crane's article to inquire where "a nice question may be raised as to when a manufacturer legitimately and advantageously may enter into publishing for himself, and whether a manufacturer, "no matter how efficient, can be expected to know the inside and outside, the hindside and foreside of publishing," as well as those who devote their entire time to publishing?—*Selling Magazine.*

## PREPARING PACKING LEATHERS FOR AIR BRAKE CYLINDERS.

The photograph shows a simple device, used by the Pennsylvania Railroad, at its different shops, for forming the packing leathers for air brake cylinders. An 8 and a 10 in. cylinder are mounted in a frame work, as shown. The top part of the cylinders are counter-bored for a distance of about 1 in., so that the flat piece of packing leather fits into them nicely. A wooden block with a projection on its under side, which fits into the inner circle of the leather ring, and is concentric with the outer edge of the block, is placed on top of the leather ring; this is forced down into the cylinder by means of the screw press. The wooden block is just enough smaller than the inside diameter of the cylinder to accommodate the edge of the leather ring, which is turned upward. The screw is then raised and another ring and block are forced down upon the top of the first one.

In this way the cylinder is filled with a number of packing rings and blocks. Each time a packing ring is required for use and is about to be forced out at the bottom of the cylinder a new ring and block are put in at the top. The rings are not removed until shortly before they are placed in the brake cylinders. It will be seen that two rings have been placed in position, preparatory to being forced into the cylinder at the right, and a ring and one of the blocks have been forced out at the bottom.

**Supply of Wood.**—The estimated amount of wood annually consumed in the United States at present is twenty-three billion cubic feet, while the growth of the forest is only seven billion feet. More than three times as much wood is thus being used than the forests are producing.

## CIRCULATION IN THE JACOBS-SHUPERT FIREBOX

To THE EDITOR:—

In your editorial in the March issue you invite opinions in regard to the Jacobs-Shupert locomotive firebox, and I venture to give you the following:

I think the principal defect in this boiler will be the lack of longitudinal water circulation and of the direct scrubbing action which is necessary to remove the steam film from the hot sheet and replace it with solid water, thus preventing the overheating of the sheet and at the same time insuring efficient transmission of heat through the sheet to the water. The illustration in the first column on page 108 shows the provision made for the horizontal circulation of water from the barrel of the boiler to the back of the firebox, and it will be seen that the plate area in the partitions is larger than the open space area for water circulation, and this plate area will act as a baffle constantly impeding the water current where it should be as free as possible. The small area of the open space is particularly noticeable along the side sheets. The ribs which extend out from the normal surface of the side sheet will each act as a dam to all currents running along the length of the firebox, and instead of flowing freely along the side sheet and constantly scouring it, the current will move in a corrugated or sinuous line and it will tend to leave steam pockets at each channel flange. The current will thus be very slow in getting to the back of the firebox, which may be overheated. On page 110 the description says that it is of great importance to have a design that does not interfere with water circulation in order to transmit heat, but the impression given by this design is that it must interfere with the circulation, and this will be found to be its greatest defect.

In the crown sheet the V-shaped pockets on the fire side will allow clinkers to accumulate because they are not in the direct line of the flame current tending to clean them, and to the extent that these pockets are filled up, the heating surface will be reduced. The scale will form along the rivets on the opposite side just as it is illustrated on the crown bars in the old construction shown on top of page 108. There will then be a greater tendency for these sheets to overheat and burn out than in a radial stay crown sheet which is perfectly clear on the fire side and has only staybolt obstructions on the water side.

Referring to Fig. 3, page 107, it is difficult to understand how the mud ring can be fitted to such a firebox and be so tight as to prevent constant leakage, as the spaces are all slightly different in their curvature, and it is not clear how any effective caulking can be done. Advantage is claimed for thinner sheets, but within the limits of thickness ordinarily used for firebox sheets, there is no perceptible change in the rate of heat transmission, and modern formulas do not take account of the thickness of the sheet. The first cost of the boiler will be greater, the cost of maintenance higher, the life shorter and the consumption of fuel per unit of work not very different from present construction.

From what I have said above and judging from the construction as shown by your illustrations I should not expect the firebox of this boiler to last a year. If it does and proves to be an important improvement in locomotive boiler construction, I shall be much pleased and quite willing to admit that I have been mistaken in the opinions as above expressed. CIRCULATION.

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To THE EDITOR:—

It is not surprising that the editorial in the March issue of your valuable journal, inviting comments on the Jacobs-Shupert firebox,* has called forth an adverse criticism from "Circulation." Human nature is naturally opposed to innovations, and the design of this firebox is a very decided innovation in locomotive boiler practice. Every innovation since time immemorial has met with opposition, and often with resentment. Everyone is familiar with the story of "Fulton's folly," yet steamboats are in operation to-day and there is no question as to their success.

Criticisms as to circulation and construction of this firebox are by no means original, for a number of competent mechanical men offered similar objections to the principles involved in the early design of this firebox when models were exhibited for the purpose of inducing comments. The work of developing this firebox has been progressing for several years, and many of its practical features are due to honest criticism, generously given. Several details have been contemplated and abandoned, and some of the original ideas have been greatly modified. In spite of the criticisms offered during the early stages of development, all practical men who have seen the actual boilers under construction at the Topeka shops have expressed unqualified belief in their ultimate success.

Your correspondent's principal objection to a boiler equipped with a Jacobs-Shupert firebox is what he refers to as the lack of longitudinal water circulation. While horizontal circulation is necessary to replace that water which has been generated into steam the greatest circulation around any firebox is vertical. When water in contact with the hot metal of the firebox becomes heated sufficiently to lessen its density, it rises and establishes convection currents. The circulation due to heat and convection currents causes the water in the boiler to rise vertically. Water replacing the heated water circulates in a direction depending upon the source of water supply. In the ordinary type of firebox, convection currents will be vertical at and near the inner side sheets. Water replacing the heated water will circulate horizontally as well as in an upward direction. In ordinary operation these currents will constantly intermingle. Much better results would be obtained if it were practicable to apply a circulating sheet separating the upward and downward vertical currents, thereby maintaining constant and uninterrupted convection currents. It would also be desirable, if possible, to separate the convection currents and the constant supply currents, thereby obviating any interruption in the vertical circulation. In no form of locomotive firebox, however, is the horizontal current of sufficient strength to give a scouring action along the side sheet, and this results only from the vertical currents formed by the rapid rise of the heated water.

The flanges of the channels forming the sides of the Jacobs-Shupert firebox, instead of impeding circulation, really assist it. These flanges tend to separate the vertical from the horizontal currents and thereby provide an unobstructed path for the upward movement of steam bubbles leaving the heated metal. The supply currents are prevented from distorting the convection currents and when the two become mingled, the general tendency in direction will be upward along the side of the firebox.

The experiments made by the Northern Railroad of France some years ago, demonstrating the relative value of heating surface in locomotive boilers, are well known. By dividing the boiler into separate sections and measuring the water evaporated in each section, the effectiveness of heating surface was found as follows:

Sections 1, 2, 3 and 4 are of the tubes, and section 5 is the firebox.

| Sections. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Area, square feet | 179.2 | 179.2 | 179.2 | 179.2 | 76.8 |
| Evaporation, lbs. per sq. ft | 2.0 | 2.9 | 4.3 | 9.7 | 34.7 |
| Evaporation, % of total | 5.5 | 8.6 | 12.7 | 28.7 | 44.5 |

Upon entering the boiler and moving toward the firebox the quantity of water passing through any section is less than that through a previous section by the amount evaporated during its passage. In the case cited, only 44.5 per cent. of the water passed to the firebox, the other 55.5 per cent. being evaporated before it reached the firebox. This is an important consideration in determining the sizes of the openings leading from the barrel of the boiler to the water legs.

Thirty thousand pounds of water are used per hour by a locomotive of the type to which the Jacobs-Shupert is applied, when working at the maximum capacity possible for it to maintain for any length of time. The area through the check valve is 2.36 sq. ins. and the velocity of water through the check valve is 81 feet per second, assuming that one injector delivers all the water and operates continuously.

In order to show the size of the water spaces leading from the barrel of the boiler to the water legs of the Jacobs-Shupert firebox, the accompanying illustration (Fig. 1) of the firebox

* For detailed description see page 106, March issue of this journal.

under construction is presented. The area of the space through the stay sheet immediately adjacent to the mud ring is 16.94 sq. ins. on each side. The area of both spaces then is 33.88 sq. ins. If half of the water is evaporated before reaching the firebox, and all water going to the water legs passes through the spaces immediately over the mud ring, the velocity of the water as it enters the water leg will be only 2.4 feet per second This velocity will never be exceeded and will really be much less, due to the fact that a considerable portion of the water will pass through the openings higher up in the stay sheets.

The criticism that the V-shaped pocket on the fire side of the crown sheet will allow "clinkers" to accumulate, is probably intended to mean the accumulation of so-called "honey-comb" sometimes noticeable in fireboxes. It is generally recognized that such an accumulation does not occur except where there is a leak. There is no reason, then, why this material should collect at any of the joints of the channel sections, or in the "V-shaped pockets" mentioned by "Circulation."

Experience with fireboxes having submerged seams at the juncture of all sheets illustrates quite clearly what may be expected as to any accumulation at the joints. The construction of the submerged seams produces a formation similar to that at the joint between the channel sections of the Jacobs-Shupert firebox. Fireboxes having these submerged seams have been in service for five years and during that time there has been no evidence of leaks or of any accumulation in the pockets at the joints.

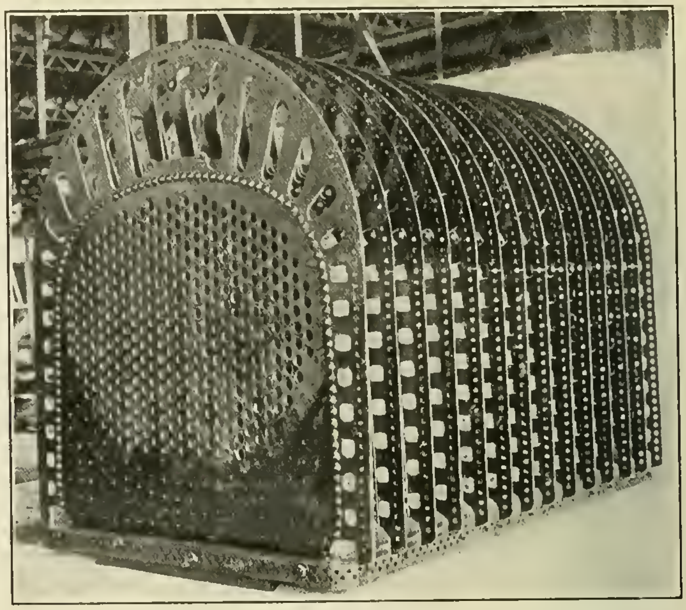

FIG. 1.—JACOBS-SHUPERT FIREBOX UNDER CONSTRUCTION.

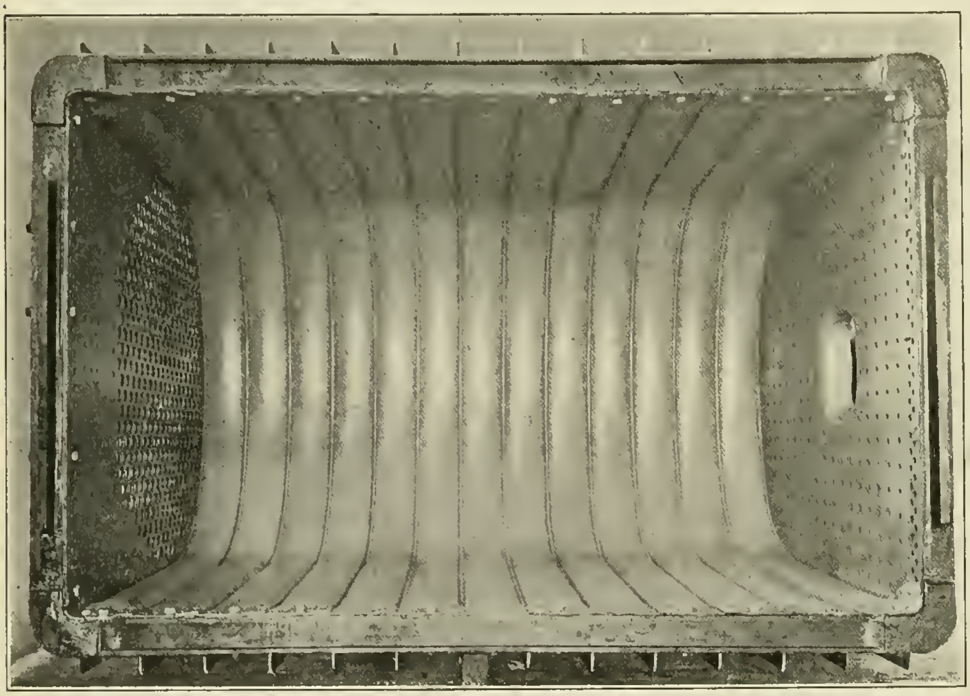

FIG. 2.—VIEW OF INTERIOR OF JACOBS-SHUPERT FIREBOX, SHOWING CONNECTION TO THE MUD RING.

Referring to Fig. 6, page 108, of the March issue, the criticism is made that scale will form along the rivets on the water side of the section corresponding to the crown sheet. There can be no comparison between the obstruction offered by a row of cone head rivets and the T irons of the sling stays. It is customary practice to introduce several rows of sling stays at the forward end of a crown sheet supported by radial stays. The usual form of T irons used in connection with sling stays impedes circulation to such an extent that it is not uncommon to find the space beneath the T irons solid with scale. This collection of mud and scale has caused crown sheets to burn even with water in the boiler at proper level.

The criticism as to the practical application of the mud ring is most readily answered by referring to the accompanying illustration (Fig. 2) of the interior of the firebox showing the mud ring in place, and to the sketch (Fig. 3) showing the method of reverse lapping the sections to fit the mud ring.

The criticism that the thickness of the sheet does not enter into consideration in the design and construction of boilers, is hardly in accord with the most eminent authorities. In all formulæ for the rate of conduction of heat, the thickness of the plate is taken as the denominator of the fraction, and the various authorities agree that conductivity is inversely proportional to the thickness of the plate. For example, the formula by Professor Clerk Maxwell (Theory of Heat, page 234), is as follows:

$H = a\,b\,t\,k\,(T - S) \div c$, in which
$c$ = thickness of plate.

In Rankine's formula:

$Q = (T^1 - T) \div r\,x$, in which
$x$ = thickness of plate
and $r$ = internal thermal resistance, constant for any one material.

In the "Modern Steam Boiler" by Rowan, the author quotes Mr. Blechynden as follows:

"The results of experiments certainly point to the conclusion that the thinner the plates forming part of the heating surface of a boiler, the higher should be the boiler's efficiency."

Topeka, Kan. H. W. JACOBS.

IDLE CARS.—The number of surplus cars on March 17 was 291,418, a decrease of 8,507 in two weeks.

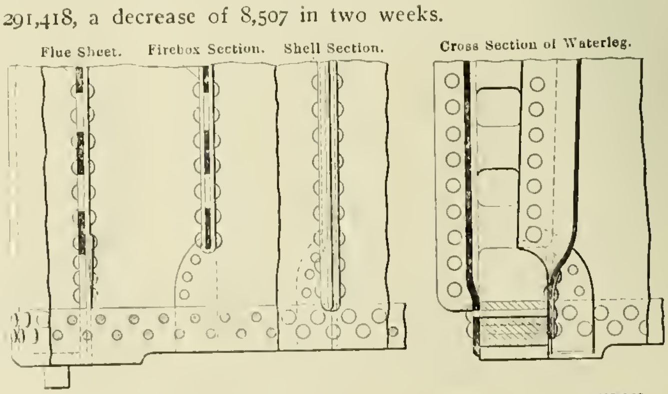


FIG. 3.—CONNECTION TO MUD RING—JACOBS-SHUPERT FIREBOX.

## EFFECT OF FLAT WHEELS ON RAILS.

To the Editor:

The discussions of my article on the effect of flat spots* by E. L. Hancock, given in your March number, and by George L. Fowler, in the *Railway Age Gazette*, January 8, 1909 (reprinted in the next column), are, I consider, more due to a misunderstanding of the article than a valid criticism of it.

Mr. Fowler calls attention to the fact that a flat spot delivers a substantial blow at speeds above five miles an hour as antagonistic to the results arrived at, and suggests that both writers based their computations on gravity, from which I can only infer that Mr. Fowler did not read carefully either the conditions assumed or the results stated in my article. The conditions assumed are very largely those outlined by Mr. Fowler, but on account of the weight below the springs supported by the wheel being considered as dropping with the wheel the acceleration taken is ten times that of gravity in place of 17.7 times as taken by Mr. Fowler. The speed at which the flat spot strikes its maximum blow would not, however, vary directly as the acceleration, but as its square root as shown in Section 1 of Mr. Spilsbury's analysis,† while it the decreasing action of the spring is taken into account it would be somewhat less. As a matter of fact for any ordinary flat spot the actual drop of the wheel is so small that the action of the spring may, without introducing any appreciable error, be taken as constant.

With regard to practical considerations of the irregularities in track, rolling of car, etc., it is true that these enter into the question and cannot easily be allowed for, but as I understand the importance of this question, the information desired is the order of magnitude of the blow delivered by flat spots with the existing limitations, and I consider that the results arrived at in Mr. Spilsbury's analysis have determined this to be of a reasonable and safe amount as opposed to the highly dangerous magnitudes arrived at in Mr. Hancock's original calculation. The blow will be substantially increased or decreased in the same way as the pressure between the rail and a wheel without a flat spot varies from the same causes, but this does not lead us to neglect the weight on the wheel as a measure of the pressure on the rail, and I consider that the kinetic effect of the wheel striking the rail is determined by Mr. Spilsbury with the same accuracy, with the proper figures for the various quantities, that the pressure between the wheel and the rail is, when the weight on the wheel is known, provided of course that no actual error is shown in the calculation, which so far has not been the case.

I do not quite understand Mr. Hancock's position, wherein he states that it is more rational to consider only the mass of the rotating parts as concentrated at the center of the wheel, as to whether he intends to supplement this with the action of the springs. If this be the case he has abandoned his original condition and there is simply a change in the assumptions I have made, and as an extreme condition let us take the weight of the wheel and one-half the axle as the rotating weight, say 1,100 pounds, take the same total weight per wheel as before, and assume that the springs, carrying the entire remaining weight per wheel, press directly on the journal. The resulting maximum striking velocity (see result D) is 4.6 ft. per second in place of 3.8. In other words, there is weight of 1,100 pounds striking at 4.6 ft. per second against one of 1,600 pounds at 3.8 feet per second, as originally assumed. The kinetic energy is 363 foot-pounds against 358 in the latter.

There is no assumption of an upward force in Mr. Spilsbury's analysis; when a body of mass M is rotating around a center, distance R from its center of gravity, the centrifugal force, as it is generally termed, is $Mv^2 \div R$, and this is the force referred to when the condition is postulated as in Section 1 of the wheel turning around the leading edge of the flat spot.

I trust you will pardon these demands on your space, but I consider Mr. Spilsbury has supplied a correct and reasonable analysis of this important question and one that agrees with practical experience, and I feel that the discussions that have taken place would not leave an entirely correct impression.

Montreal, Can. H. H. Vaughan.

* American Engineer and Railroad Journal, December, 1908, page 475.

† Page 477, December, 1908, issue.

*(Abstract of Communication from Geo. L. Fowler in the Railroad Age Gazette, January 8, 1909.)*

Every practical railway man knows that a flat spot does deliver a very substantial blow at speeds above five miles an hour if the evidence of the sense of hearing and an occasional bent rail is of any value. So it seems that there must be something wrong, not necessarily with the mathematics but with the premises on which the calculations are based.

A suggestion is offered to the effect that both writers (Vaughan & Hancock) based their computations on gravity, as if this were the only thing to be taken into consideration, but there are others.

For example, the weight of the car is resting on the axle box through the intervention of a spring, and this spring is, therefore, under considerable compression and ready to expand with all the strength of its elasticity the moment it gets a chance. The axle is being drawn by its housing and the truck pedestal, in which there is considerable lost motion, and so is crowding back against the fixed parts of the truck, and there is always a possibility of its being thrown forward to the limit of the lost motion by any force tending to drive it to the front. So when the wheel starts to roll over the flat spot there is the quick acting spring tending to push it down and forward. This spring has a compression due to the load above, which may be 18,000 or 19,000 lbs. Taking the lower figure and considering the wheel and half the axle to weigh 1,075 lbs., the rate of acceleration during the fall of the wheel will be about 17.7 times as fast as when gravity alone is at work. This would immediately raise the speed at which the train can be running, and the flat spot strike its full blow, from 4.55 to something more than 79.5 miles an hour, modified by the decreasing tension of the spring as the wheel drops away from it, by which the rate of acceleration is correspondingly decreased. The problem is further complicated by the size of the spring, as the fall in spring pressure will be the more rapid as the stiffness of the spring and its consequent compression is increased, and the severity of the blow will be increased according to the downward velocity of the wheel at the moment of the impact of the flat place. Further complications are added, in practice, by the motion of the load at the moment. If the car body is rising in its vibrations the blow will be less than if it is falling.

It appears, then, that this spring action accounts for the fact that the severity of the blow apparently increases with the speed, because the spring has a chance to produce a rapid downward acceleration, and may account for the destructive effects produced both on track and rolling stock, while the complexity of the forces involved renders a mathematical analysis and solution of the problem no easy task and one that would not be conclusive when it was finished, simply because there would be no certainty that all of the factors in the case had been taken into consideration and given due importance.

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The Mine Rescue Station at the University of Illinois.—The United States Geological Survey in coöperation with the State Geological Survey has established at the College of Engineering, University of Illinois, Urbana, Illinois, a Mine Explosion and Mine Rescue Station. The purpose of the station is to interest mine operators and inspectors in the economic value of such modern appliances as the oxygen helmets and resuscitation apparatus as adjuncts to the normal equipment of mines. The station also will concern itself with the training of mine bosses and others in the use of such apparatus. Its service is to be rendered gratuitously, and so far as possible to all in Illinois, Indiana, Michigan, West Kentucky, Iowa and Missouri, who may desire the benefits thereof.

The formal opening of the station constituted a part of the proceedings of a Fuel Conference which was held at the University of Illinois March 11 to 13, inclusive.

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**Advertisements.**—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

**Contributions.**—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

## CONTENTS



## RAILROAD MACHINE SHOP PRACTICE.

It is surprising to note the great difference both in the detail design of locomotive parts and the methods of handling and machining them in railroad repair shops. It is not unusual to find a difference of several hundred per cent. in the cost of performing the same operation in different shops. It is too bad that mechanical department officials generally do not realize the importance of having their shop officers visit other railroad shops and *study* their methods.

Mr. Burns' observations on the handling of shoes and wedges, in his article on "Railroad Machine Shop Practice," are based on the practices as noted in a large number of shops and forcibly emphasize the importance of having the shop official look about and compare his methods and costs with those of others doing the same work. This is the first of a series of articles which Mr. Burns has in preparation for this journal.

## CONCERNING MR. POMEROY'S ARTICLE.

Not only will the railroad official, interested in the selection of machine tool equipment for the locomotive repair shops, welcome Mr. Pomeroy's article in this number, but it will prove of great value to the machine tool builder who wishes to know just what class of work his tools are required to do in shops of this kind. While many of our readers have the pleasure of knowing Mr. Pomeroy personally, it may not be amiss to say something of the experience and qualifications that fit him so well for making a study of this kind—a study which is far more logical than that ordinarily followed by the railroad official in making a selection of machine tools to accomplish a certain output.

While Mr. Pomeroy has never been a railway mechanical department employee he has, for many years, as a representative of manufacturing interests, come into intimate contact with the officials of that department. As assistant to the general manager of a large locomotive building plant he has had special opportunities for studying the design and manufacture of locomotives. As the steam railroad representative of one of the most important electrical companies, he has not only exploited the possibilities of the application of electricity to steam road conditions, but also in the designing and equipping of railroad shops; during this time he was connected in a consulting capacity on the engineering details of some of the largest railway shop plants in this country. Having had experience with the designing and equipping of many railroad shops, and having watched their operation closely, he has gained a much broader view of the situation than could possibly be enjoyed by one having a less extensive experience or having an intimate acquaintance with one or two plants only.

A most pains taking investigator with systematic and well considered methods of classifying and investigating facts, he has developed the faculty to a marked degree, if indeed he was not born with it, of eliminating the inessential details or less important facts, and getting to the very root of things. Having access to the data of many plants and being an indefatigable worker he has developed principles and solved problems which others could not have done. By those who know him intimately, and this includes many of the leaders in railroad mechanical department affairs, he is regarded as an authority on questions referring to railroad repair shop requirements and the possibilities of the substitution of electric for steam locomotives.

With a rare unselfishness his knowledge has at all times been at the service of his friends. So quietly and unobtrusively has he worked that his name has not even been connected with many of the most important developments for which he has been largely responsible. His work in connection with the Master Mechanics' Association has been exceedingly important, but it has been done in such a characteristically quiet way that but very few realize its extent or importance.

In spite of the important work upon which he has been engaged he never misses an opportunity to encourage and help the young men with whom he comes in contact and many young men owe their advancement, at least to some extent, to a quiet word or suggestion made to a superior officer, although the young men themselves may not know or realize to whom they are really indebted.

## BELTING.

One of the most forceful arguments, showing the necessity of buying only high grade belting and of properly installing and looking after it, was the experience at the Topeka shops of the Atchison, Topeka & Santa Fe Railway, as described in the December, 1906, issue of this journal. In fourteen months the cost of maintaining the belting, including labor, supplies and new belting, was reduced from $1,000 to $310 per month. These figures have been still further reduced as the older belting has gradually been replaced by that bought under the new specifications, which call for belting of the best quality. The best practice indicates that the cost of maintaining belts should average yearly about 14 per cent. of its first cost.

What is the best qualiy of belting? The best belting is obtained from the native American steer when killed at about four years of age. Only a certain part of the hide is suitable for belting and the best quality is taken from a section about 30 in. wide, 15 in. each side of the backbone, and about 4 ft. long, measured from the tail. This should weigh about 16 ozs. to a square foot. A good second grade of belting may be secured from strips 6 in. wide taken at either side of the above section. The rest of the hide, consisting of the flanks and belly, is not suitable for belting but may be used to advantage for the making of halters, and other products.

As a matter of fact much of this inferior stock is made into belts, which, although sold at a lower price, proves very expensive to the user in the end. The hide or belting butt, as it is called, should not only be carefully selected but be tanned with oak bark and by slow process, and be properly curried, stretched and finished before it is cut into strips. That part of the butt directly over the backbone is of greater density and vitality and the fibres are more uniform than in the rest of the belting butt. Having greater strength and less elasticity this portion of the butt is especially valuable for the wider belts, but the center of the belt must correspond to the center of the butt, or that part directly over the backbone, in order to have the belt equally balanced so that it will run true.

How is it possible to check the grade of the belting? If the manufacturer has a regular system of cutting the strips it is possible, if the purchaser has a sample belting butt with the strips cut according to the same system, to check the belting with these strips. A movement is now on foot to have every large user furnished with the sides and centers of a butt showing the methods used in cutting the strips to get the various widths of belting. Such a system, while it checks the part of the butt from which the belt is taken, does not locate carelessness in the preparation of the leather. The only way in which the users of belts can protect themselves against this is to deal with reputable firms only and to insist that the maker's name and brand be marked on the belting at frequent intervals. The history should be kept of each belt installed in a shop, so that the user can know absolutely whether the belt is giving the service which he should have from it.

The railroads should buy belting on as definite and absolute specifications as other supplies. The great cost of replacements of belting in railroad shops is largely due to the fact that it is bought at the lowest price obtainable and too little atention is paid to the quality delivered.

## GRINDING CAR AXLE JOURNALS.

It has been suggested that the railroads could add considerably to the life of the car axles by grinding the journals after they have become worn instead of turning them on a lathe. It is believed that the saving which could be made would, within a short time, pay for the cost of installing the necessary grinding machine. Under present conditions, when an axle is re-turned it is necessary in order to get the best results to have the cutting tool pass underneath the low spot on the journal. With a grinding machine it would be possible to true the journal absolutely without removing an ounce more material than necessary.

This idea of regrinding the journals has appealed to several officials to whom it has been submitted. The only objection which was brought up was that the fine particles from the grinding wheel might become imbedded in the surface of the journal and cause hot boxes. The fallacy of this objection can readily be seen when it is recalled that a large number of railroads have been grinding their piston rods for several years. The links and link blocks of the valve motion are also ground. Parts of an automobile, including the various journals and the crank shafts, are ground and no difficulty of this kind has ever been experienced. The following is from an article written by Charles H. Norton, who probably knows more about grinding and grinding machines than any other man in this country or abroad.

"Another erroneous impression, not, however, so common, is that emery adheres to ground surfaces, causing cutting of bearings when used. It would seem clear to reason that should the emery adhere to the steel, there could be no grinding, but instead the wheel would be torn away. The fact is that neither the microscope nor chemical laboratory reveals an atom of emery in any form adhering to the steel. This has been thoroughly demonstrated and yet there are mechanics with large enterprises in charge who will not grind machine parts because they are so sure that emery adheres to them.

"A good illustration of this point is furnished by the well-known air-brake mechanism. Some fourteen years ago the writer designed special machines for grinding the cylinders of the so-called "triple." This cylinder is about 3½ in. in diameter by 1¼ in. deep, having a bottom, and is brass lined; the brass piston working very freely, yet air tight, in this brass lining.

"The general belief at that time was that emery would remain on the brass surface and cause scratching, and it was with no little effort that the writer overcame this objection. When tests were made it was found that a blast of air removed all dust from the interior of the cylinder and ports and that the life of the cylinders was very much increased over the lathe-finished ones.

"There still remain a few who suppose that copper, babbitt, lead and soft rubber cannot be ground with emery and corundum wheels, because the material adheres to the cutting wheel; when, the fact is, there is no substance of which the writer has any knowledge that cannot be ground successfully with a wheel suitably constructed for each case."

At present the fillets at either end of the journal vary considerably for the different size standard M. C. B. axles. It would, of course, be better to have the fillets at the outer end of the journals, and also those at the inner end, standardized so as not to have to change the grinding wheels for different size journals. If it is desired to repair the journals with the wheels removed, and to grind the wheel fit as well as the journal, it will be necessary to make the fillets at the inner end of the journal and at both ends of the wheel fit the same size.

## RAILROAD OUTLOOK IMPROVING.

Many signs point to a return of activity in the construction and extension of railroads, not only reasonably soon, but under such conditions that railroad projects will be undertaken with as much confidence and breadth of scope as other industrial and commercial enterprises.

So far as the tariff is concerned, it is not so much fear of what the schedules will be, as delay until it can be seen what they are, that causes hesitation. Never before in the history of the tariff has a bill enjoyed such a thorough going-over by the experts as the Payne Bill before its introduction into the House and it is understood that when the measure is sent to the Senate, the Committee on Finance of that branch will have considered it step by step and offer it for debate at the earliest possible moment. Pressure will be strong on all sides for short speeches and experienced observers are predicting that the bill will be signed very much earlier in the year than has been the case after previous revisions.

Other conditions, such as agricultural prosperity and activity in the manufacture and distribution of dry-goods, are sound and improving. The special reason for hesitation which has beset the railroad managers and officers, namely, the fear of hostile legislation which would make extensive construction hazardous, is now rapidly giving way to a feeling that the American people are being touched in one of the strongest features of their nature —the desire to see fair play—and many concerns making material and equipment for railroads are contemplating the future in a very hopeful way, while many of them are planning extensions to their plants to be carried out as soon as business is somewhat better.

Considering these conditions, the Railway Business Association issues the following: "The spirit of fair play towards railroads is unmistakably gaining ground. Signs of its approach can be seen here, there and everywhere throughout the country. A splendid nucleus of influential citizens who earnestly advocate moderation has been developed ready to help us disseminate, in widening circles, the doctrine of good nature in the discussion of railroad restrictions. We believe the present opportunity to place sound views as to railroads before the public is unique.

"Influential newspapers north, south, east and west are boldly advocating conservatism. Where a few editors urge moderation editorially, many now open their news columns to matter setting forth the needs of the transportation interests. We are confident that if the friends of the railroads will now speak under a concerted plan their words will be adequately spread before the people.

"Great interests, through their commercial organizations and their trade press, are declaring for conservatism. These men are the shippers of the country. They are becoming convinced that improved transportation is to be had by study and conference rather than by assault. We hope to impress this view upon others who still hesitate or who at present decline to express like sentiment, and we feel that the degree of our success in this direction will depend largely upon the support our efforts receive.

"Congress adjourned on March 4 without enacting any further restrictions of consequence on railroads, yet the members can return to their homes without fear of having forfeited their neighbors' good will. Some State Legislatures appear to be nearing adjournment with a similar record and a like confidence in the forbearance of their constituents. Even in the most radical Legislatures there has been decided resistance to purely hostile proposals. It looks as if there would not be a 'bumper crop' this year for the agitator.

"At a time when the overturn by judicial process of a two-cent passenger rate is widely received as a matter of course, we cannot avoid the conviction that the transportation interests will be able to command fair consideration at the bar of public opinion.

"The appeal we have been making to business men and working men to regard, in their own interest, railroad prosperity as vital, has still many ears to reach and many minds to convert, but it has gone far; a large field has been tilled. It is now for us to sow seed in the soil thus prepared or to be prepared.

"The public is developing a readiness to hear arguments without prejudice. We do not desire that regulation shall cease, or expect that our particular views as to specific measures will invariably and everywhere prevail. We shall feel that a useful service has been performed if we can seize upon the present receptive mood of the public and lay before them certain general fundamental principles of railroad economics, concerning which there has been much loose thinking. Once a large number of shippers, workingmen and citizens in general have been led to give careful consideration to our view of these problems, ideas will lodge permanently in their minds which may affect legislation for many years to come.

"The iron is hot. Now is the time to strike.

"The great industrial interest which the Railway Business Association is endeavoring to represent has before it a splendid opportunity for effective work. We need the influence and the financial support of more members in order that we may do this work thoroughly. If you have not joined, we earnestly urge you to do so at once and add the force of your co-operation and your contribution to a movement which many careful observers believe can, if adequately supported, do very much to promote a healthy stability in the conditions of railroad management, upon which the permanent and expanding prosperity of your business so largely depends."

# THE RAILROAD CLUBS.

*Central Railroad Club* (Buffalo, N. Y.)—The next meeting of the club will be held at the Hotel Iroquois on the evening of Friday, May 14.

Mr. John McE. Ames presented a paper on "The Use of Steel in Passenger Car Construction" at the March meeting, which considered briefly the primary reasons for the introduction of this material in passenger car construction and described the detailed features of a car, particularly as regards the use of other material than steel for interior finish and fittings. The best practice, in the author's estimation, was given for practically all of the different features. The matter of weight and cost was briefly considered; an important point in this connection was the greatly reduced liability for claims, when a wreck occurs, with steel equipment. This, in connection with the reduced cost of maintenance, more than offsets any increased price for equipment of this kind.

Secretary, H. D. Vought, 95 Liberty St., New York.

*Canadian Railway Club* (Montreal, Can.)—The meeting of April 6 will be given up to a paper on "Snow Fighting" by A. W. Wheatley, manager of the Montreal Locomotive Works. The discussion of the paper on "Shop Time Keeping," presented at the February meeting will be continued. The meeting of May 4 will be the annual meeting of the club; the subject of the paper has not yet been announced.

The paper on "Shop Time Keeping and Labor Distribution," by E. E. Lloyd, which was presented at the February meeting, drew attention to the importance of extreme accuracy and rapidity in shop time keeping. A number of the older systems were briefly mentioned and the weak points in each clearly pointed out. The modern methods of checking in and out men and distributing accounts were fully described and the important advantages of each mentioned. Samples of the blanks used by the foremen in distributing the accounts and the forms used in reporting the time, and other matters in connection with the shopmen, were illustrated.

This paper deals with a feature which in many cases is not given the attention that it really deserves.

Secretary, James Powell, P. O. Box 7, St. Lambert, Nr. Montreal, Can.

*New England Railroad Club* (Boston, Mass.)—At the regular meeting of the club to be held at the Copley Square Hotel, Boston, on April 13, Mr. George F. Baker will present a paper on "Smoke Prevention in Relation to Combustion." Dinner will be served at 6.30 P. M. and the business session of the club will start at 8 o'clock.

"The Single Phase Railway System" was the subject of a paper by N. W. Storer of the Westinghouse Electric & Mfg. Co., which was presented at the January meeting. The general subject of electric traction and the history of its application to steam railways up to the present time, as well as an elemenary discussion of the development of the electrical science, occupied the first part of the paper; following this was a comparison between direct current and single phase alternating current for use in heavy service, giving the advantages and disadvantages of each. Then followed quite an extensive description of the different designs of single phase equipment that have been installed in the last three or four years, showing the present state of the art. The discussion consisted largely of questions from the members.

Secretary, George H. Frazier, 10 Oliver St., Boston, Mass.

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*New York Railroad Club.*—At the meeting of March 19 the subject of "The Abuse of the M. C. B. Repair Card" was briefly discussed by Messrs. Chamberlain and Goodnough. Following this the electrical subjects were taken up. Mr. McClellan, in a very broad and conservative manner, considered the future of the electrification of steam railways and in that connection advised very strongly the adoption of standards for many features in electrification as soon as possible. Among these was the location of the third rail, of the over-head trolley, voltage, frequencies, etc. W. S. Murray gave some of the later experiences of the New Haven Railroad with electric traction and stated among other things, he was convinced that in a similar work of this kind it would be better to have the power house generate at a lower voltage, which could be stepped up by transformers at the power house. Mr. Murray stated that the mileage of the New Haven electric locomotives averaged 210 miles per day. Mr. Kattee, of the New York Central, gave some very interesting figures in connection with the train movement at the Grand Central Station and of the electric service on the N. Y. C. The N. Y. C. electric trains have during the past year averaged 3,000 miles per minute of delay. There are 450 electric train movements in and out of the Grand Central every 24 hours, which require 120,000 K. W. hours of current. C. L. de Muralt spoke to the effect that he believed standardization of details would be very foolish at the present time, stating that all important details were already practically standardized. He discussed the three phase current for use on railways, speaking very strongly in favor of it. The three phase system gives a great reduction in the weight of a locomotive, a constant speed irrespective of the resistance, a completely enclosed motor and the disadvantage of two overhead wires are offset by the absence of a commutator. Messrs. Storer and Stott also presented discussions. An extensive discussion by L. C. Fritch, of the Illinois Central, will be printed in the Proceedings.

The meeting of April 16 will be on the subject of "Air Brakes."

Secretary, H. D. Vought, 95 Liberty St., New York

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*Northern Railroad Club (Duluth).*—The paper scheduled for the next meeting, Saturday evening, April 24, is on "The Consumption of Fuel and Oil on Locomotives" by Frank Burk, traveling engineer, D. M. & N. Ry.

The February meeting was given up to a continuation of the discussion on the papers presented at the January meeting on Concrete and Steel Ore Docks and Boiler and Engine Repairs in Roundhouses. A large part of the discussion swung around the advantages and disadvantages of pooling locomotives.

Secretary, C. L. Kennedy, 401 West Superior St., Duluth, Minn.

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*Railway Club of Pittsburgh.*—The meeting on the evening of April 23 will be to consider a paper on "Titanium Alloy" by Charles V. Slocum.

The report of the standing committee on the M. C. B. Rules of Interchange was quite extensive, a large number of suggestions for the improvement of rules being offered and thoroughly discussed by the members. The results of the committee's and club's effort, will appear at the convention of the M. C. B. Association.

Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh.

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*Richmond Railroad Club.*—A stereopticon lecture by H. O. Williams, railroad secretary of the International Committee of the Y. M. C. A., entitled "Welfare Work of American Railways", will be given at the meeting of April 12.

The March meeting was entertained by W. Morris Tye, who demonstrated and fully explained the Burlingame telegraphic typewriter, which sends telegraphic messages by simply operating the keys of a typewriter.

Secretary, F. O. Robinson, Richmond, Va.

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*St. Louis Railway Club.*—The next regular meeting of the club will be held in the parlors of the Southern Hotel on Friday, April 7, at which time a paper will be presented by H. Wade Hibbard, Professor of Mechanical Engineering, University of Missouri, entitled "Organization." This will be the last meeting of the year and the officers will make their annual report. New officers will also be elected.

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

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*Western Canada Railway Club* (Winnipeg, Man.)—This last addition to the railway club circle has already over 150 members and bids fair to be a complete success. The first regular meeting was held on the evening of March 8, the paper being by G. J. Burry, general manager of the Western Lines of the Canadian Pacific Railway, on "A Review of Organization and Some Suggestions." The paper considered the history of labor organization down to the present time and very comprehensively discussed the labor problem on railways.

The active officers of this club are: President, Grant Hall, superintendent of motive power of the C. P. Ry.; vice-president, A E. Cox, general storekeeper of the C. N. Railway; second vice-president, L. B. Mirriam, division chief engineer of the G. T. P. Railway; treasurer, E. Humphreys.

Secretary, W. H. Rosevear, 199 Chestnut St., Winnipeg, Man.

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*Western Railway Club* (Chicago).—The meeting of April 20 will be given up to a discussion of the report of the Committee on Revision of Rules of Interchange and also a short paper on "The Influence of Ash on the Value of Coal in Locomotive Service" by A. Bement.

The meeting of March 17 was taken up by a discussion of the paper on "Publicity for Railroad Accidents." It was largely attended and the paper was very fully discussed by W. G. Bessler, general manager, C. R. R. of N. J.; W. B. Throop, general superintendent of the Iowa District of the C. B. & Q. R. R.; W. D. Cantillon, assistant general manager of the C. & N. W. Railway; C. E. Lee, gen. supt. of the B. & M. R. R., and others.

Secretary, J. W. Taylor, Old Colony Bldg., Chicago.

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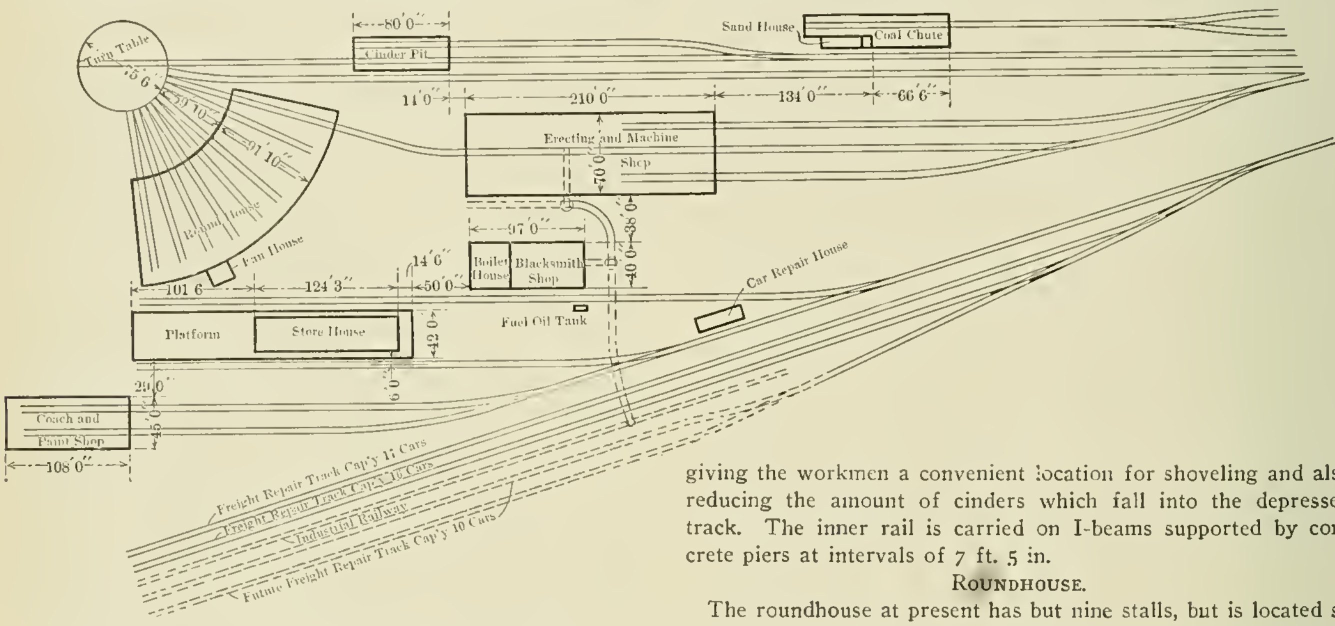
Meeting of the International Railway Fuel Association.—The first annual meeting of this association will be held in the Auditorium Hotel, Chicago, June 21, 22 and 23. At this meeting papers on the following subjects will be presented by the various committees for discussion: "Proper Method of Purchasing Fuel with Regard to Operating and Traffic Conditions, Considering also the Permanent Interests of the Producer When Located on the Consumers' Rails"; "Standard Type or Types of Coaling Stations, Best Design and Most Economical Coal Chute for Handling Coal from Cars to Locomotives"; "Best Method of Accounting for Railway Fuel, Including Movement from Mine Through Coaling Station to Engines, up to Monthly Balance Sheet"; "Difference in Mine and Destination Weights, Legitimate Shrinkage Allowable on Car Lots, Correct Weighing of Coal at Mines and on Railroad Track Scales, Importance of Tare Weights Being Correct"; "Difficulties Encountered in Producing Clean Coal for Locomotive Use." D. B. Sebastian, 327 La Salle Street Station, Chicago, is secretary.

# NEW LOCOMOTIVE AND CAR SHOPS.

IDAHO & WASHINGTON NORTHERN RAILWAY.

The new shops of the Idaho & Washington Northern Railway at Spirit Lake, Idaho, which were completed and put into operation last November, are designed to handle heavy repairs on about 40 locomotives annually. The railroad is equipped with the heaviest type of ten-wheel and consolidation locomotives and is being extended at present so that the shops are shortly expected to be worked at full capacity. They are also designed for easy extension and enlargement in case their present capacity is exceeded at any time. The same features apply to the repair of passenger equipment, for which a special building is provided.

In the general arrangement of the buildings, shown in one of the illustrations, the roundhouse and facilities for turning engines naturally takes precedence, and since, from the topography of the country, the shops had to be placed between the main line




ARRANGEMENT OF TRACKS AND BUILDINGS, SPIRIT LAKE SHOPS, I. & W. N. RY.

of the road and a hill side it was decided to locate the shop buildings between the main tracks and a straight lead to the roundhouse. As the buildings are comparatively few in number and of moderate size, this idea worked out very nicely.

Because of the comparatively high cost of steel in that region and the cheapness of timber, as small an amount as possible of the former material was used in the construction of the buildings. The structures throughout are of brick walls resting on concrete foundations with wooden roofs supported by wooden roof trusses. In the roundhouse the walls of the outer circle are carried up to a height of five feet above the floor, above which they are continued as pilasters for supporting the roof, I-beams being used as lintels. Concrete has been extensively used for pits, heating ducts, cinder pits and other places where its advantages apply.

Unusual care has been given to obtaining the maximum amount of natural lighting in all buildings. Pivoted sashes, fitted with operating mechanism for swinging, are used wherever desirable. This feature is especially noticeable in the roundhouse where nearly 60 per cent. of the outer circle is given up to windows in addition to 100 sq. ft. per pit of window area over the doors on the inner circle and three large windows in the end walls. There are 18 swinging sash between each two pilasters in the outer wall, 6 stationary sash over the doors and 9 swinging sash in each of the end wall windows. This gives, as can be seen in the illustration, a very light and pleasant roundhouse.

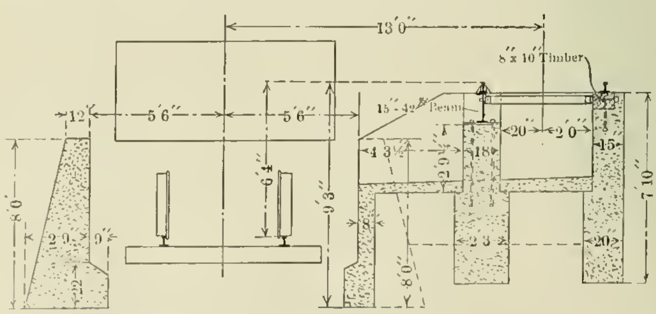
COAL CHUTE AND CINDER PIT.

On the approach tracks to the roundhouse is located a coal chute providing ten 5-ton pockets filled by gravity from a storage bunker of 175 tons capacity. The loaded coal cars are drawn up the 19 per cent. incline by a motor driven hoist and dumped directly into the storage pockets. This is a wooden structure and includes the sand house, which is provided with a compressed air elevating device, allowing the locomotive sand boxes to be filled by gravity.

Between the coal chute and the roundhouse on the same lead track is located the cinder pit, a section of which is shown in one of the illustrations. This is constructed of concrete throughout and is of the hand operated type. The bottom of the pit is extended outside the inner rail to make a ledge about 4 ft. wide, giving the workmen a convenient location for shoveling and also reducing the amount of cinders which fall into the depressed track. The inner rail is carried on I-beams supported by concrete piers at intervals of 7 ft. 5 in.

ROUNDHOUSE.

The roundhouse at present has but nine stalls, but is located so as to allow extension to the full circle of 44 stalls. A 75 ft. turntable in a concrete pit is provided, having two lead tracks for locomotives, one passing the coal chute and over the cinder pit and the other, for outgoing engines, located parallel to this and between it and the shops. The turntable is hand operated and is provided with a very complete set of interlocking derail devices for preventing runaway locomotives from dropping into the pit. These consist of a derail on each roundhouse track at a distance of 20 ft. from the turntable and on the lead tracks at a distance of 50 ft. from the pit. These derails are normally in operating position and can be thrown out only by the locking device on the table when it is set for that particular track.



SECTIONAL ELEVATION OF CINDER PIT.

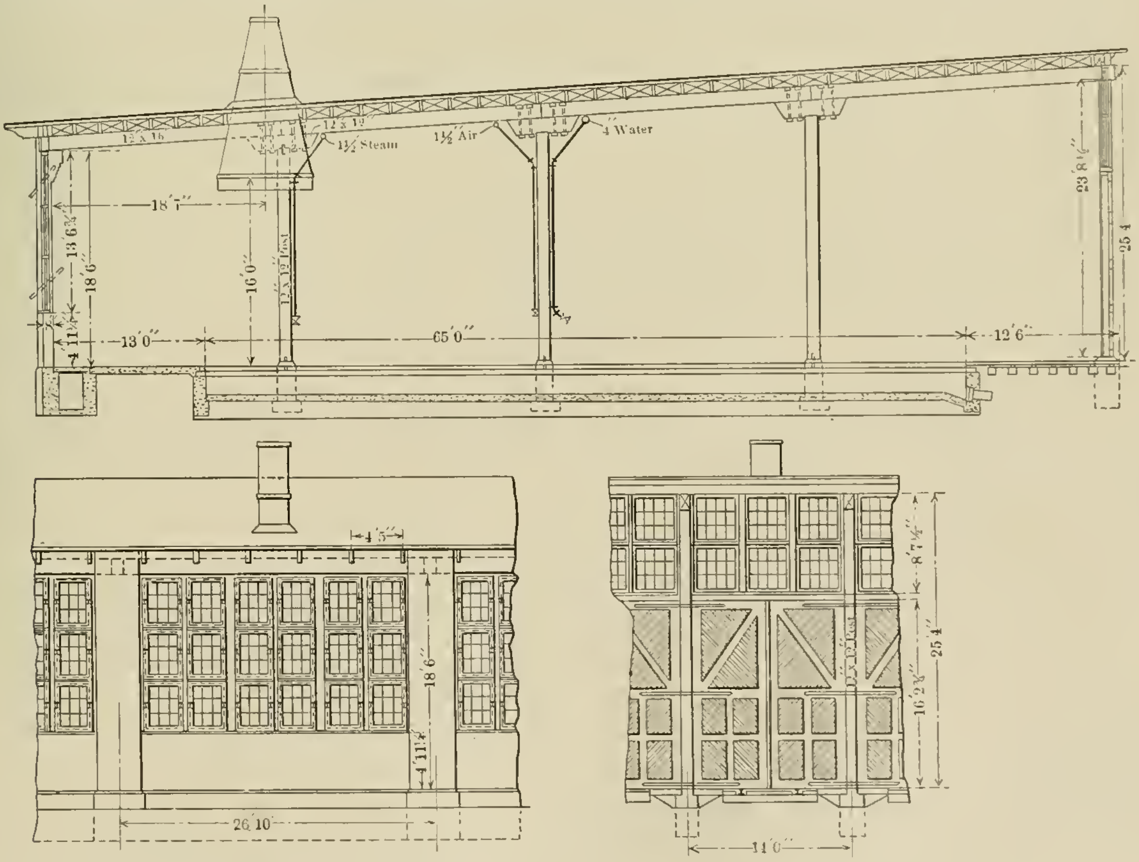
Provision for handling heavy pieces of machinery and driving wheels directly from the roundhouse to the machine shop is made by extending one of the roundhouse tracks through the

INTERIOR VIEW OF ROUNDHOUSE, IDAHO AND WASHINGTON NORTHERN RY.

outer wall, connecting it to the track which runs through the machine shop.

The cross section of this roundhouse, shown in one of the illustrations, gives its dimensions and general features very clearly. The roof has a continuous drop from the inner circle toward the outer wall and is supported by three rows of intermediate posts. The pits are of concrete, draining toward the inner end. The floor is of concrete and is slightly sloped to drain into the pits, permitting the house to be kept clean with minimum expense, in

doors are of a heavy framed wooden type and swing outward. The workmen's benches and lockers are placed between the stalls at the outer row of posts, giving a clear passage around the house along the outer wall. Drop pits for driving and truck wheels are provided, being fitted with hydraulic and pneumatic drop pit jacks respectively. The heating of the house is by the indirect system, a small building adjoining the outer wall containing the heating coils and fans, which deliver the hot air through underground ducts into the engine pits.



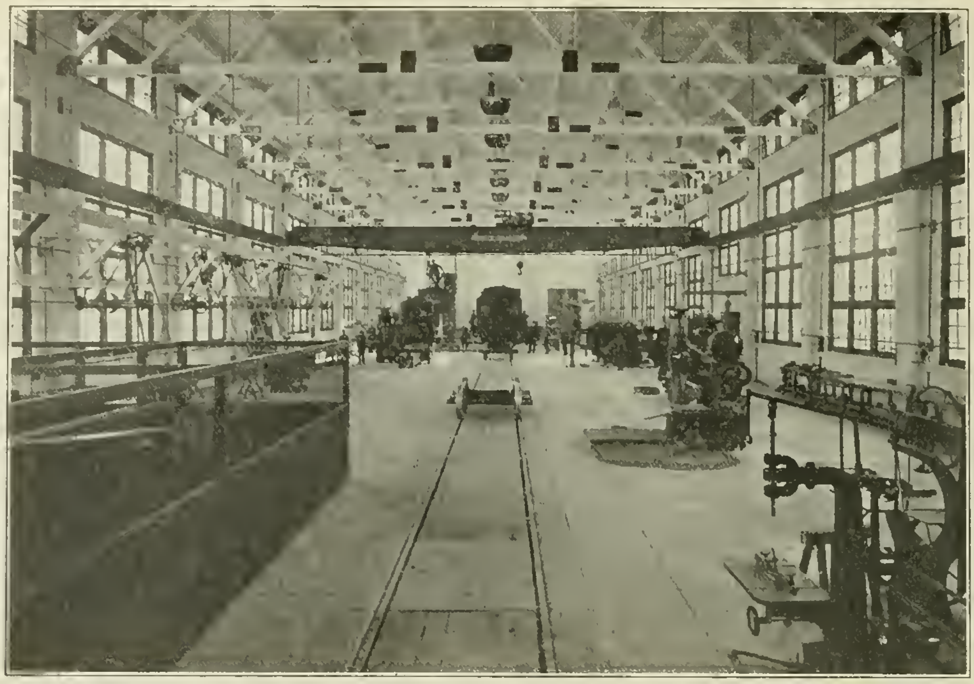

ELEVATIONS AND SECTION OF ROUNDHOUSE, IDAHO AND WASHINGTON NORTHERN RAILWAY.

addition to making the trucking of heavy parts comparatively easy.

A 4 in. water, 1½ in. air and a 1½ in. steam line are carried along the roof; the latter two having a connection at the posts between each two stalls and the water at every second stall. The

### Machine and Erecting Shop.

This shop occupies a building 210 x 70 ft., the entire area of which is served by a 10-ton, three-motor, electric crane, arranged to be operated either from a cage or by pendant cords extending to the floor. In it will be done all of the locomotive ma

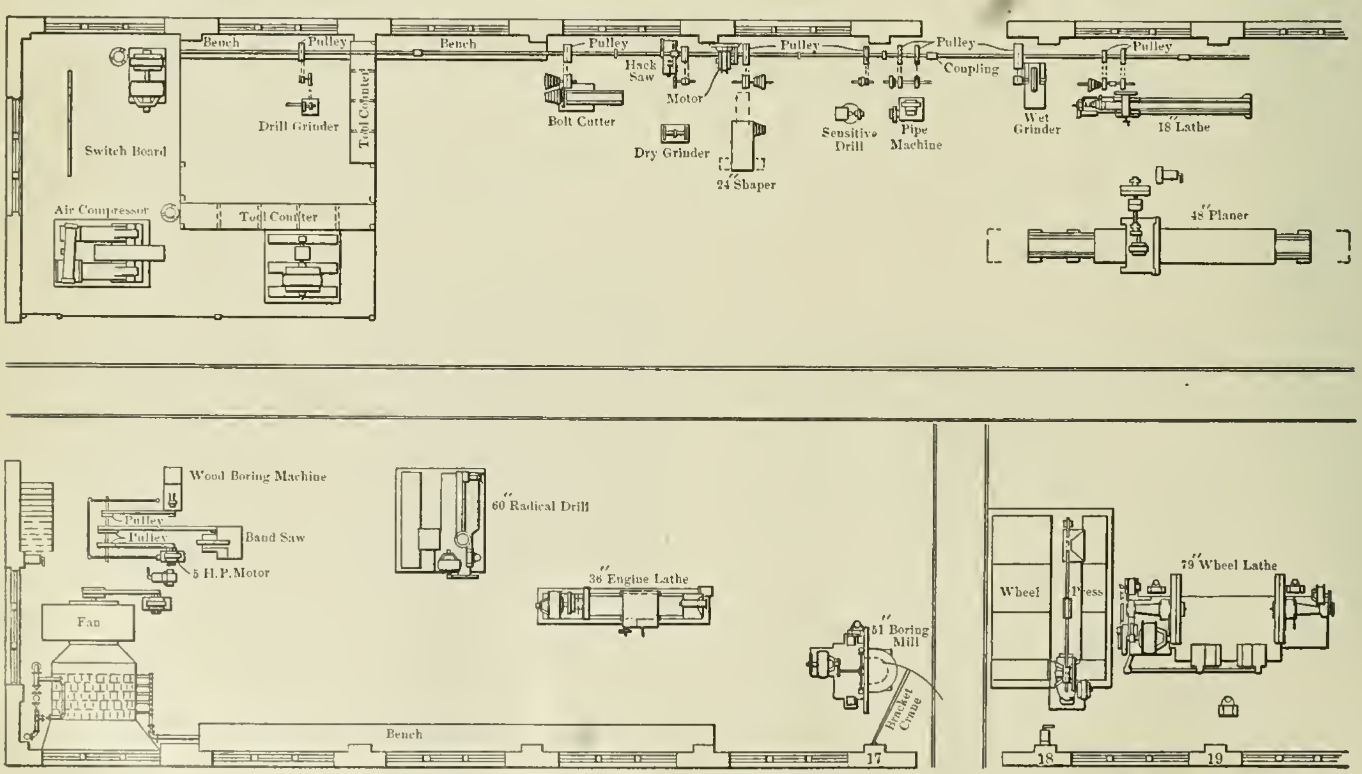


INTERIOR VIEW OF MACHINE AND ERECTING SHOP, IDAHO AND WASHINGTON NORTHERN RY.

chine and erecting work, as well as the boiler work, with the exception of the flues, which are handled in the blacksmith shop. Several wood-working tools are also included in the equipment of this shop.

The erecting shop occupies three pits at one end of the building, the track over the center pit extending throughout the length of the building and into the roundhouse as above mentioned. These three pits are served by a common drop pit containing a 30-ton hydro-pneumatic transfer jack. One of the illustrations shows the construction of this drop pit, the design of which was given close attention with the idea of making it thoroughly reliable and rapid in its action. The removable sections of the running rails over the drop pit are carried on 15 in. I-beams, the whole being hinged at one end and sliding on a guide, so that they can be quickly and easily removed, or replaced. This pit, if desired, can be used for removing and replacing the truck as well as the driving wheels. The locomotives are then either supported on blocks or special trucks, depending upon whether circumstances allow it to be stripped over the pit or not. Actual practice has shown that a locomotive can be wheeled with this arrangement as quickly as it could, under normal conditions, be transferred from another part of the shop and set down on its wheels by overhead cranes.

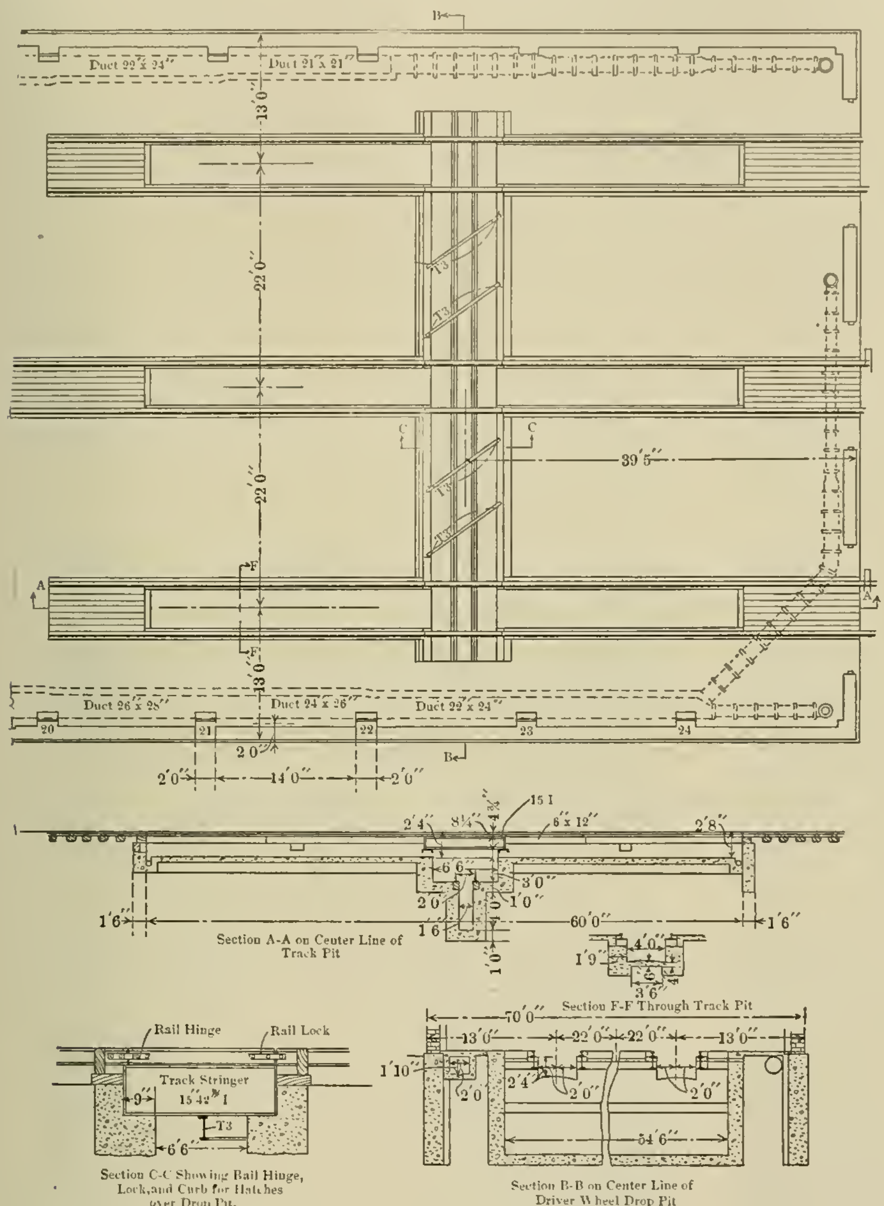
The location and arrangement of the machine tools in this shop are shown in one of the illustrations. The drive is by electric motor in all cases, the smaller tools being grouped along the east wall and driven from a line shaft supported by timbers carried on the wall and located so as to minimize the obstruction of light from the windows. The larger tools, consisting of a 48 in. planer, a 36 in. lathe, 51 in. boring mill, 60 in. half universal




PLAN OF MACHINE SHOP SHOWING LOCATION OF MACHINE TOOLS, SPIRIT LAKE SHOPS, I. & W. N. RY.

radial drill, 79 in. driving wheel lathe with double quartering attachments and a 400-ton wheel press, are driven by individual motors. The wheel press is set in a covered pit of such depth that the ram is at a height above the floor suitable for pressing on and off car and truck wheels. By removing the pit cover, driving wheels are handled in the same press. The boring mill has a chuck on the table and is used for boring car wheels as well as for general work. It is equipped with a jib crane and air hoist for handling work from the floor. The smaller tools consist of an 18 in. lathe, a 24 in. shaper with an attachment for slotting driving boxes and with index centers, a 2 in. bolt cutter with lead screws for cutting staybolts, a ¾ in. high speed drill press, a 4 in. pipe machine, twist drill grinder, power hack saw and wet and dry grinders. In addition to this there is a band saw and a single spindle wood borer, both of which are driven by a single motor set on the floor.

The tool room enclosure is located in one corner of the shop, at the end opposite the erecting shop. A 500 cu. ft. two-stage motor driven air compressor is located inside of the tool room, being operated automatically by means of an unloading device. In this same space is also located the motor generator which supplies direct current for the variable speed motors driving machine tools and for the crane motors. The power for the shops is supplied by a three-phase 440-volt current from an outside source. Since this electric equipment requires practically no attention, the same holding true for the air compressor, the services of an engineer are not required and this machinery is watched and cared for by the man in charge of the tool room.




PLAN OF ERECTING PITS AND DETAILS OF DROP PIT, SPIRIT LAKE SHOPS.

In the opposite corner of the building are located the radiators and fans for the heating system, and over these, on an enclosed platform, are the lockers and toilets for shop employees.

This shop has a concrete floor, the same as the roundhouse, and presents the same advantages. The heating is by hot air through underground concrete and tile pipe ducts, a motor driven 120-in. fan giving circulation. The lighting is by arc lights freely distributed along the roof trusses and the usual incandescent lights at the machines, plugs for portable lights also being frequent.

### Blacksmith Shop.

The blacksmith shop and boiler plant are located in a building 97 ft. long by 40 ft. wide, the former taking up 65 ft. of the south end. The equipment in this shop consists of one 1,100 lb. steam hammer, a single ended motor driven punch and shear, and three forges, one of them being extra large. A 3 ton jib crane serves the hammer, the punch and the large forge. One corner of this building is used as a flue shop and is equipped with a motor driven flue cutter and oil flue welding furnace and a pneumatic flue welder. Space outside of the building has been provided for a flue rattler.

Since the shops obtain power from an outside source there is no necessity for a power house, but steam is required for heating the various buildings and the coaches in the coach yard, for operating the steam hammer and for roundhouse uses. Therefore a boiler plant, consisting of two 125 h. p. horizontal return tubular boilers, which burn either coal or refuse wood, has been installed in one end of the blacksmith shop building, the two rooms being separated by a brick wall. This locates the boilers at about the center of the group of shop buildings.

### Storehouse and Office Building.

The storehouse is a brick building 124 x 30 ft. in the south end of which are the offices of the mechanical department, and, at the north end, a fireproof oil cellar. The metal oil tanks in this cellar are filled from the level of the storeroom floor, and the oil is distributed from a delivery counter, to the level of which the various kinds of oil are lifted by self-measuring pumps.

The storehouse platform extends all around the building at the same level as the storehouse floor; or at the height of the average car floor. At the north end of the building the platform is extended out 100 ft. from the building wall with the full width of 42 ft.

### Paint and Coach Shop.

This building is intended for general use in repairing, cleaning and painting passenger cars. It is 108 ft. long and 45 ft. wide with two longitudinal tracks extending nearly the whole length of the building. The roof has longitudinal skylights extending along the center line to give ample light between the tracks. The floor is of concrete and is sloped in accordance with an underground system of drains in order to permit washing of coach bodies and trucks. Along the walls at the north end are sinks for washing the removable parts and the drying racks for sashes, doors, ventilators and seat arms. Trussed planks resting on ladder horses are provided for painting or repairing coach sides.

COACH AND FREIGHT CAR YARD.

Owing to the ordinarily mild climate at Spirit Lake, the freight car repairs are made outside, on tracks west of the blacksmith shop. A car repairman's house 40 x 12 ft. is located alongside of the repair tracks, for housing tools and clothes. A line of piping for compressed air is run along the tracks with hose connections for compressed air drills and hammers. The coach yard has two tracks between which are service boxes at intervals of 50 ft., containing steam, water and air connections. Standard gauge industrial tracks are provided for handling mounted wheels and transporting heavy material between the machine shop and repair tracks and the blacksmith shop.

WATER SERVICE AND SEWERS.

The high cost of cast iron pipe in this locality made the use of iron water mains undesirable, and as the soil at the shop is a dry gravel, wooden water pipe was installed throughout the shop yards. Fire hydrants are arranged about the yard; and in addition two hose houses, each containing a hose reel on a truck and a supply of fire hose, have been provided. In the interior of each building hose valves and reels of fire hose have been provided so that fires originating inside of the building may be properly attacked.

Owing to the fact that seepage through the soil is very rapid, the roundhouse, turntable and cinder pit drain into a sump pit. The sanitary sewers from the machine shop and storehouse are connected through a manhole to a city sewer running near the shops.

CONSTRUCTION.

The preliminary work for the plans of the shops was taken up in May, 1908, and construction was begun the latter part of June.

All buildings and equipment were turned over to the railroad company for operation, early in November, 1908.

The shops were designed and built, and all the equipment was furnished and installed, including even all hand tools necessary to make the shops complete and ready for operation, by Westinghouse, Church, Kerr & Co., engineers, under the supervision of R. F. Blackwell, vice-president and general manager, and W. C. Smith, chief engineer of the Idaho & Washington Northern Railroad.

## CLEANING AND REPAIRING TRIPLE VALVES.

The cleaning and repairing of triple valves may be greatly facilitated by providing a special bench, such as shown in the illustrations. This bench is in use at the east-bound freight car repair yard of the Pennsylvania Railroad at Altoona. Two men may work at the bench at the same time, one at each end.

The triple valve is placed on the bench, as shown in Fig. 2; a pin fits into one of the bolt holes in the flange of the triple and the two clamps fit over the flange. These clamps are held firmly against the flange by a spring in the socket of the clamp and underneath the nut. The clamps may be quickly adjusted or released with the hands. The pin keeps the triple valve from turning and can be quickly removed and placed in other holes provided for receiving the different size triple valves. The old way of holding the triple valve on the bench with two pins, one on each side of the valve, was unsatisfactory, as it was not held firmly enough; with the new bench it is only necessary to have one pin, as there is a hole cut through the tilting table large enough to fit the projection on the bottom of the triple, which answers for the second pin.

While in the position shown in Fig. 2 the bolts are removed and the check valve case which projects forward and the cylinder cap which projects upward, are removed, as shown in Fig. 3.

The check valve case is dropped into and fits snugly in an opening which is cut in the edge of the bench to the left of the tilting portion upon which the triple valve is fastened. The check valve case is thus held firmly in position while the train line check valve is being ground in.

FIG. 2.—TRIPLE VALVE CLAMPED TO BENCH.

FIG. 4.—TRIPLE VALVE TILTED BACKWARD.

In order to carefully examine the space in the triple valve body between the emergency valve piston and the emergency valve and its seat, that portion of the table upon which the valve is carried is tilted backward, as shown in Fig. 4. This is accomplished by pressing the treadle alongside the bench with the foot, thus withdrawing the pin that locks the tilting portion, which when tilted locks itself in any one of a number of differ-

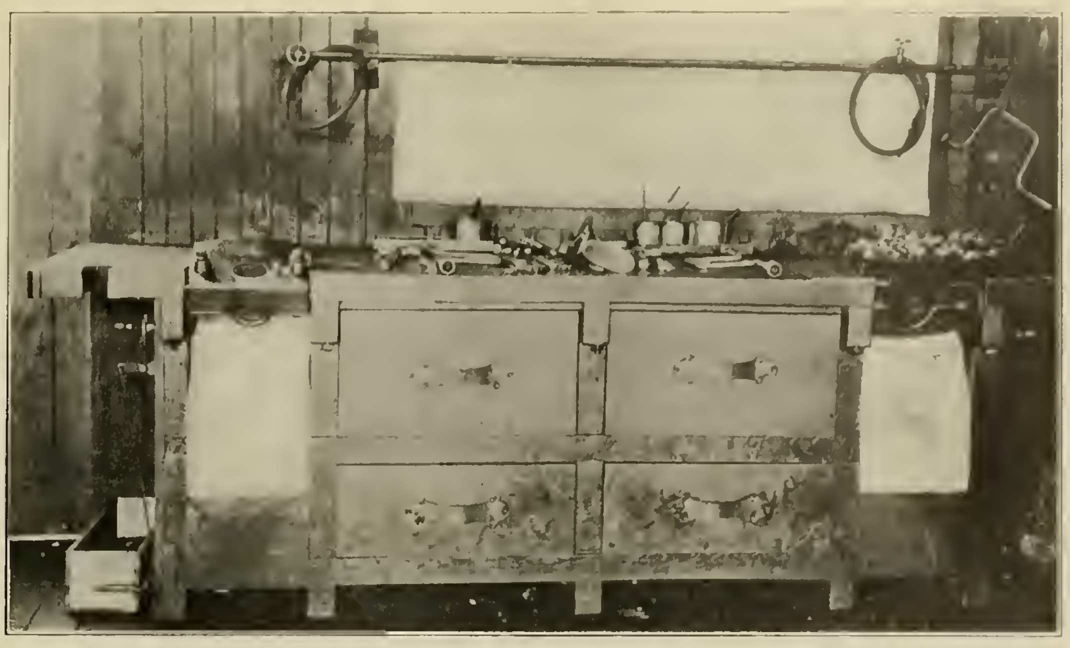


FIG. I.—BENCH FOR CLEANING AND REPAIRING TRIPLE VALVES.

FIG. 3.—CHECK VALVE CASE AND CYLINDER CAP REMOVED.

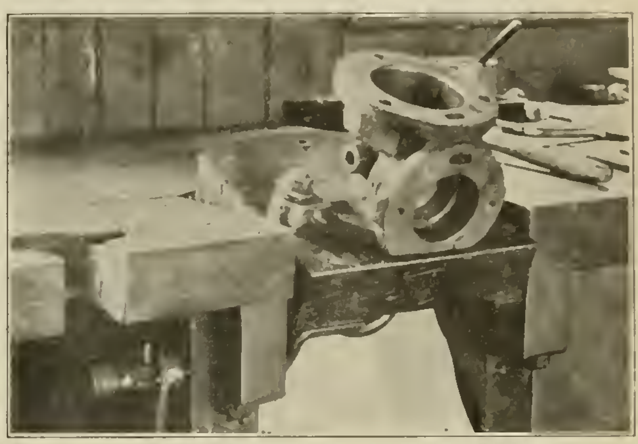


FIG. 5.—TRIPLE VALVE TILTED FORWARD.

ent positions, at the will of the operator. While in this position the feed groove in the upper wall of the triple piston cylinder is exposed to the light and can be thoroughly cleaned. In order to properly clean this feed groove on the old bench it was necessary to remove the valve from the pins and turn it over to the light. The feed groove is very small and must receive careful attention, as the air that charges the auxiliary reservoir passes through it.

To clean the cylinder and the slide valve bushing the table is placed as shown in Fig. 3. After this is completed the table is tilted forward, as shown in Fig. 5. The light reflected from the chute underneath makes it possible to examine the bushing properly. This being done the table is again placed as in Fig. 3 and all lint from the waste, which may have adhered to the valve, is blown out with compressed air. The parts of the valve are then reassembled.

## NOISELESS GEARS.

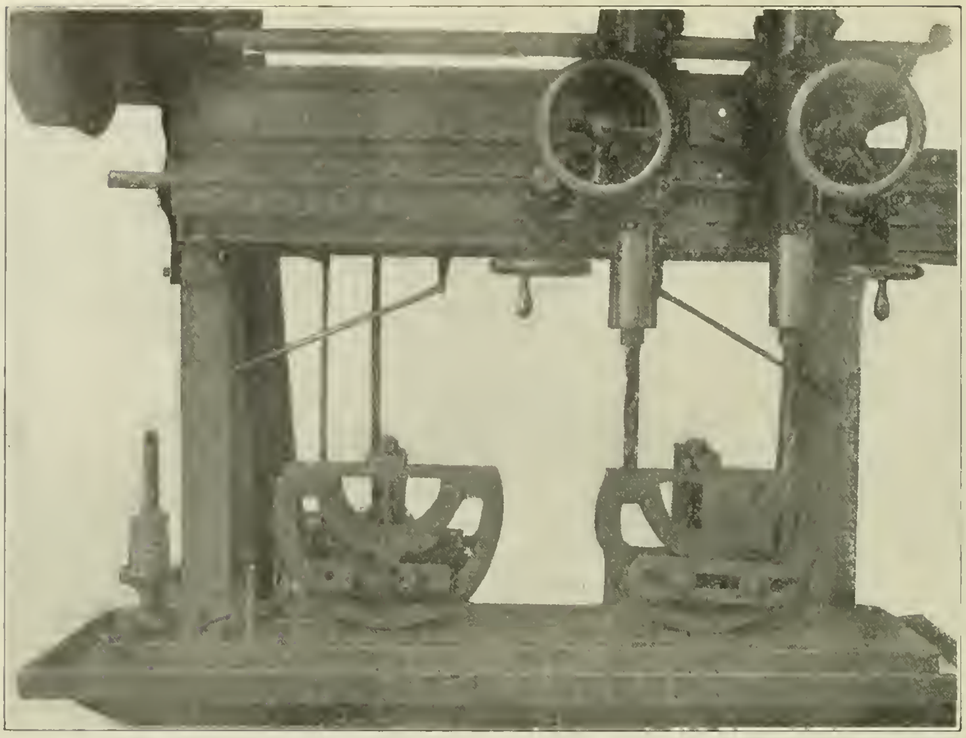
The introduction of motor driven machine tools has in many cases been accompanied by at least one disadvantage. This to be sure is minor when compared with the advantage derived in other ways, but nevertheless it is a decided and noticeable fault and one which is not at all necessary. Reference is made to the nerve racking noise which develops after metal gears running at high speeds have been in operation long enough to lose their perfect contour.

It is true that attention must be given to durability at these points and that the ordinary rawhide gears and some gears of special composition have not proven satisfactory, but that does not mean that the men studying this feature have given the problem up as insolvable. They have not by any means, and for many purposes they have actually solved it. Gears can be obtained which are noiseless in operation, and while they won't outwear the steel gears with which they mesh, they will last long enough to be entirely practical from a durability and cost standpoint.

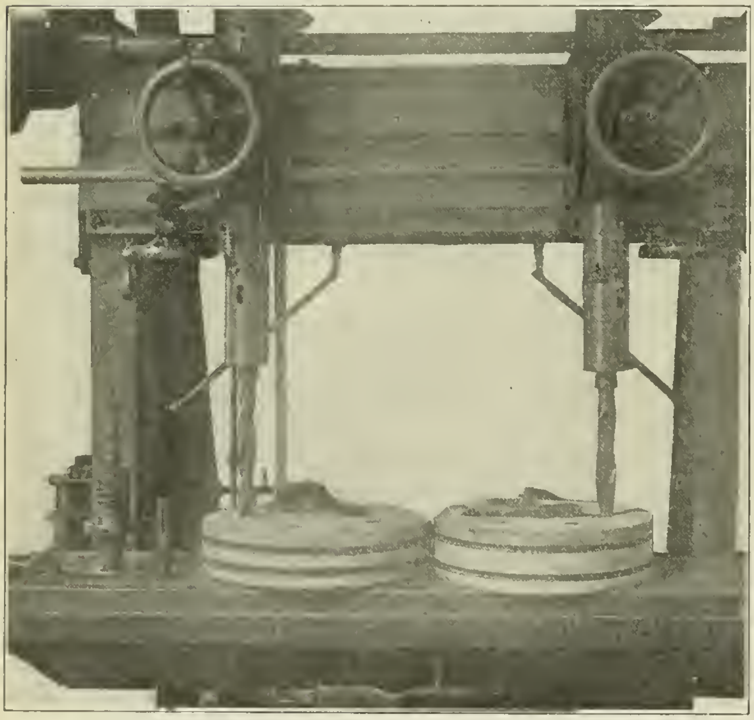
The great advantage of such gears will be readily appreciated by those who have to spend any time in the neighborhood of machine tools, electrically driven through steel gears, which have been in operation a few months, and while the value of less noise is hard to estimate in dollars and cents, no one denies that it has a very real value judged on that standard.

## A 1,200 VOLT DIRECT CURRENT ELECTRIC RAILWAY

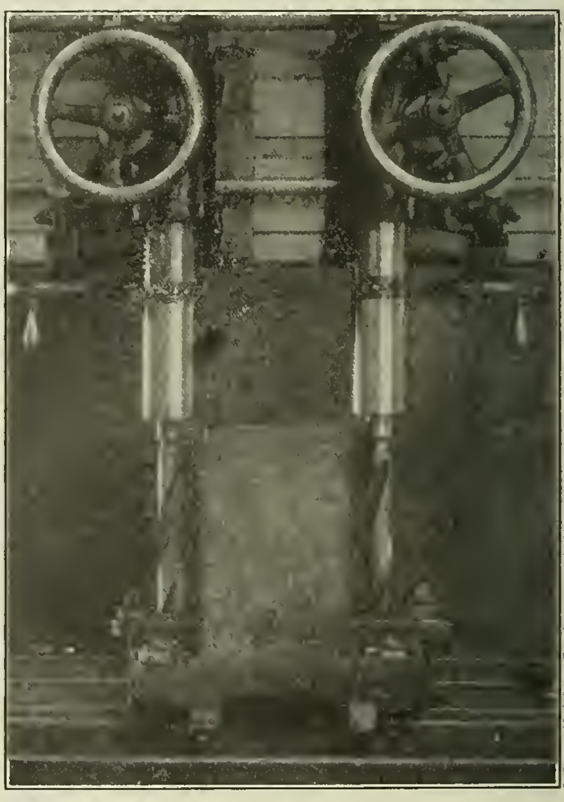
The Pittsburgh, Harmony, Butler & New Castle Railway, which was recently opened with 65 miles of single track and double track for 11½ miles, employs direct current of 1,200 volts pressure at the trolley wire. This is said to be the pioneer high tension direct current road of the country, although it is not the first to be actually put into operation. Grooved 0000 trolley wire is used, strung double over the entire line. The road is operating fourteen four-motor passenger cars of the usual interurban type and will shortly put into service several freight cars.



DRILLING ECCENTRICS.



DRILLING PISTON HEADS.



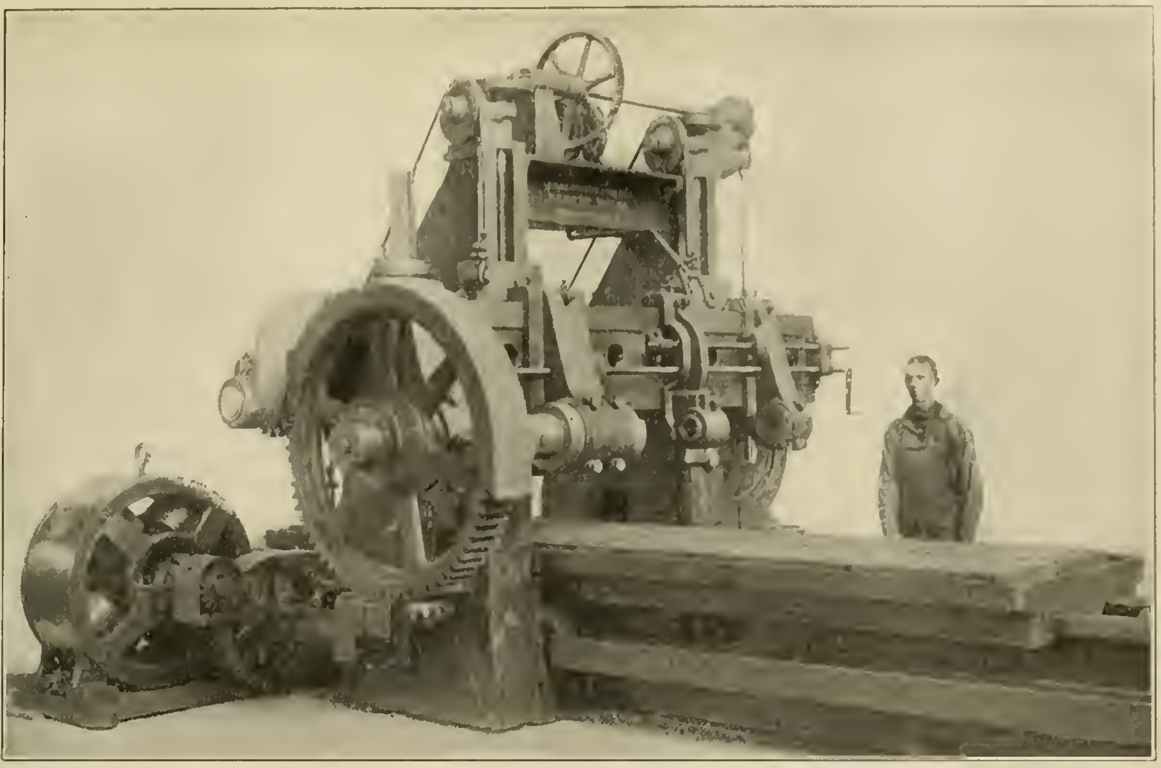
DRILLING SPRING SADDLE.

## MULTIPLE SPINDLE DRILLS IN RAILROAD SHOPS.

Several typical operations, which may be performed to advantage on a multiple spindle drill in a railroad locomotive repair shop, are shown in the accompanying illustrations. Two 1½ in. holes are being bored in the spring saddle at the rate of 1¼ in. per minute. The machine upon which the work is being done measures 49½ in. between uprights; the minimum distance between the center of the spindles is 8 in. and the maximum 48 in. The table has a vertical adjustment of 12 and the maximum distance from the nose of the spindle to the top of the table is 24 in. The heads are independent in drive and feed.

The two holes are drilled and tapped in one eccentric while the other one is being clamped to the table. The third illustration shows the method of drilling and tapping piston heads. The machine used is made by The Foote-Burt Company, as is indicated by the ball bearing thrust bearings on the spindle.

Jib Crane in Roundhouses.—In most modern engine houses there are one or more columns between the tracks, and the one at the front of the engine should be utilized for a jib crane of about 2,000 pounds capacity. This will be found of great assistance in handling stacks, fronts, bells, air pumps, steam chest lids, etc. A differential chain block hung on a trolley will be found to answer all requirements.—*Wm. Elmer, Ry. Club of Pittsburg.*



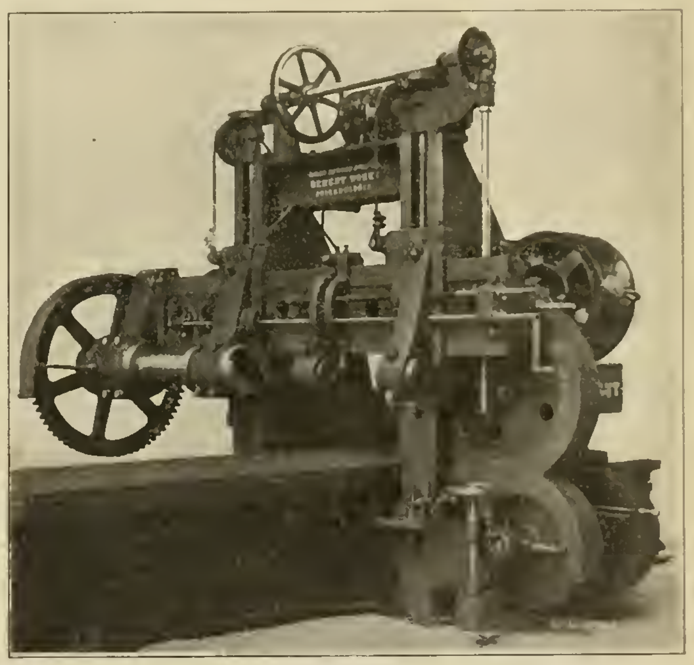
HEAVY MILLING MACHINE FOR CONNECTING AND SIDE RODS.

## EXTRA HEAVY ROD MILLING MACHINE.

The 48-inch milling machine, shown in the illustrations, is exceptionally powerful and was specially designed for milling locomotive connecting and side rods in pairs. It is driven by a 65 h.p. motor with a two to one speed range. This furnishes all the speeds necessary for milling rods, but motors of different speed ranges or greater power may be applied to suit other conditions. This machine has removed 82 cubic inches of steel per minute, but with a larger motor than noted above.

The machine measures 48 in. between the housings and the maximum distance from the center of the spindle to the table is 36 in. The spindle is 8 in. in diameter, except for that part to which the cutter mandrel is locked, which is enlarged to 12 in. in diameter. There is a horizontal adjustment for locating the cutters and a central bearing for supporting the mandrel between the cutters.

The table is 40 in. wide on its working surface and is usually made 14 ft. between the end pans, although this may be changed to suit requirements. A trough is cast around the table for collecting the cutting lubricant; this drains to a lower receptacle from which it is pumped to a tank by a power driven pump. The table is fed by a separate 7 h.p. variable speed motor, so wired with the driving motor that it stops when current to the driving motor is cut off. This motor also drives the table fast power traverse. By using this separate feed motor a great variety of table feeds are instantly obtainable without changing the cutting speed, and both may be adjusted to get the maximum output of both the cutters and the machine. This machine is made at the Bement Works of the Niles-Bement-Pond Company.



OPERATING SIDE OF ROD MILLING MACHINE.

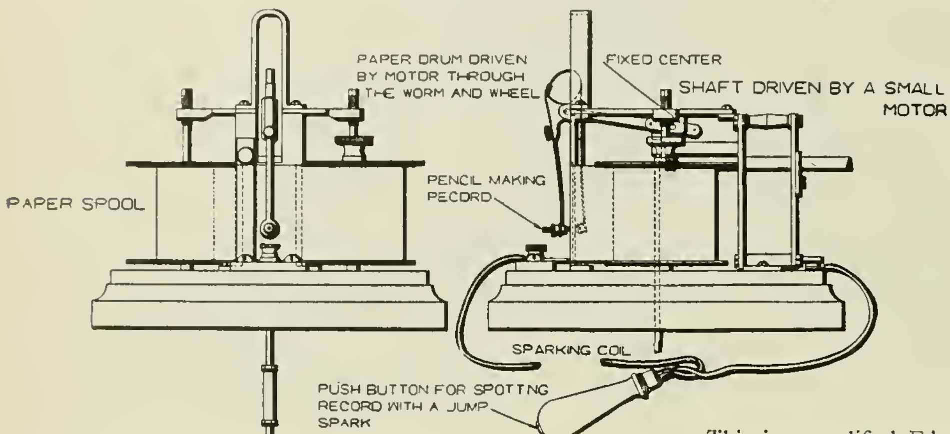
"Track Skate."—In regard to preventing engines from running into the pit, we have a very simple device which seems to have answered the purpose. It is a steel casting which we call a track skate. It has a thin edge which lies on top of the rail and the flange keeps it from shifting sideways, and the end is turned up 6″ or 8″ so that in case the engine starts to move into the pit the tender wheel rides on this track skate and pushes it along and it acts as a very effective brake.—*Wm. Elmer before the Railway Club of Pittsburgh.*

Forest Products Laboratory.—The government's new forest products laboratory will be located at the University of Wisconsin, at Madison. The establishment of this laboratory means the concentration of all lines of the experimental utilization of timber and the checking of wood waste. Forest Service laboratories for timber test work at Yale and Purdue Universities and the government's wood pulp and wood chemistry laboratory in Washington will be consolidated and transferred to Madison as soon as practicable. A force of fifteen to twenty timber test engineers, experts in wood preservation, wood pulp manufacture and wood distillation will have charge of the work carried on. The laboratory will have an equipment valued at not less than $15,000. The University will furnish the building, light, heat, and power, and in return advanced students will have the use of the laboratory for special work in related lines.

## SAFETY VALVE CAPACITY*

PHILIP G. DARLING,† Assoc. Amer. Soc. M. E.

The function of a safety valve is to prevent the pressure in the boiler to which it is applied from rising above a definite point, to do this automatically and under the most severe conditions which can arise in service. For this, the valve or valves must have a relieving capacity at least equal to the boiler evaporation under these conditions. If it has not this capacity, the boiler pressure will continue to rise, although the valve is blowing, with a strain to the boiler and danger of explosion consequent to over-pressure. Thus with the exception of a requisite mechanical reliability, the factor in a safety valve bearing the most vital relation to its real value is its capacity.



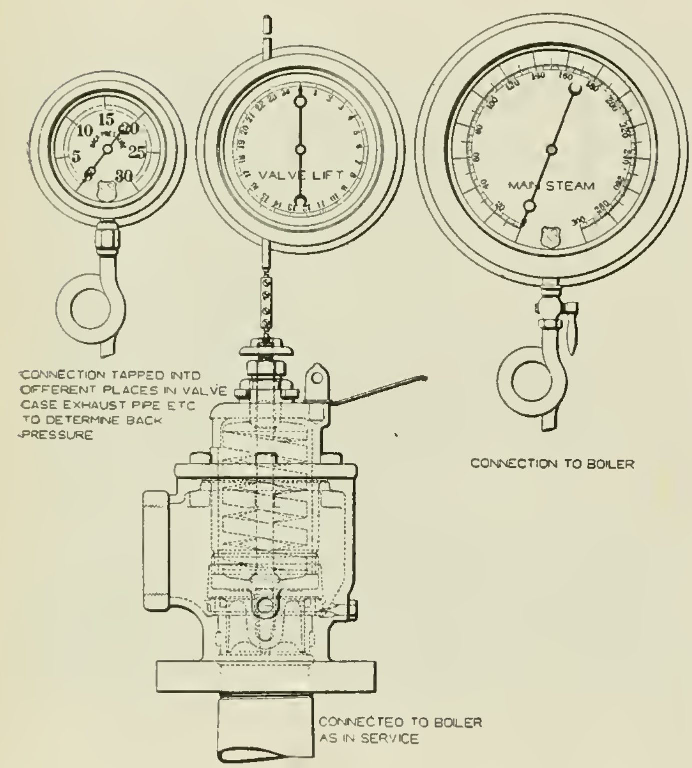




FIG. 2.—ARRANGEMENT OF APPARATUS TO GIVE VALVE LIFT DIAGRAM.

Two factors in a safety valve geometrically determine the area of discharge and hence the relieving capacity—the diameter of the inlet opening at the seat and the valve lift. The former is the nominal valve size, the latter is the amount the valve disc lifts vertically from the seat when in action. In calculating the size valves to be placed on boilers, rules, which do not include a term for this valve lift, or an equivalent, must necessarily be derived from the basis of a certain lift assumed for each size of valve. Nearly all existing rules and formulæ are of this kind and rate all valves of the same nominal size as of the same capacity.

To find what lifts standard make valves actually have in practice and thus test the truth or error of this assumption that they are approximately the same for the same size valve, an apparatus has been devised and tests upon different makes of valves conducted. With this apparatus not only can the valve lift be read at any moment to thousandths of an inch, but an exact permanent record of the lift during the blowing of the valve is obtained in a form somewhat similar to a steam engine indicator card (Fig. 1) and of a quite similar use and value in analyzing the action of the valve.

As appears in Figure 2 the valve under test is mounted upon the boiler in the regular manner, and a small rod is tapped into the top end of its spindle and connects the lifting parts of the valve directly with a circular micrometer gauge, the reading hand of which indicates the lift upon a large circular scale or dial. The rod through this gauge case is solid, maintaining a direct connection to the pencil movement of the recording gauge above. This is a modified Edson recording gauge with a multiplication in the pencil movement of about 8 to 1, and by means of a chart drum driven by a small electric motor (not shown), gives a horizontal time element to the record. The steam pressures are noted and read from a large test gauge and an electric spark device makes it possible to spot the chart at the different pound pressures during the blowing of the valve. The actual lift equivalents of the pencil heights upon the chart are carefully calibrated so the record may be accurately measured to thousandths of an inch.

With this apparatus, investigations and tests were started upon seven different makes of 4 inch stationary safety valves, and these were followed with similar ones upon nine makes of muffler locomotive valves, six of which were 3½ inches, all of the valves being designed for and tested at 200 lbs. The stationary valve tests were made upon a 94 h. p. water tube boiler from the Babcock & Wilcox Co. The locomotive valve tests were made upon locomotive No. 900 of the Illinois Central R. R., the valve being mounted directly upon the top of the main steam dome. This locomotive is a consolidation type, having 50 sq. ft. of grate area and 2,953 sq. ft. of heating surface. Although a large amount of additional experimenting has been done only the results of the above will be quoted in this paper. These lift records show (with the exception of a small preliminary simmer which a few of the valves have) an abrupt opening to full lift and an almost equally abrupt closing when a certain lower lift is reached. Both the opening and closing lifts are significant of the action of the valves.

The results of the 4 inch iron body stationary valve tests summarized are as follows: Of the seven valves the average lift at opening was .079 in. and at closing .044 in., or excluding the valve with the highest lifts, the averages were .07 in. at opening and .037 in. at closing. The valve with the lowest lifts had .031 in. at opening and .017 in. at closing, while that with the highest had .137 in. and .088 in. Of the six 3½ in. muffler locomotive valves the summarized lifts are as follows: Average of the six valves .074 in. at opening and .043 in. at closing. Average, excluding the highest, .061 in. at opening and .031 in. at closing. The lowest lift valve had .04 in. opening and .023 in. closing; the highest .140 in. opening and .102 in. closing.

The great variation—300 per cent.—in the lifts of these standard valves of the same size is startling and its real significance is apparent when it is realized that under existing official safety valve rules these valves, some of them with less than one-third

* Presented before a meeting of the American Society of Mechanical Engineers, Feb. 28, 1909.

† Mechanical Engineer, Consolidated Safety Valve Co.

the lift and capacity of others, receive the same rating and are listed as of equal relieving value. Three of these existing rules are given below as an illustration of their nature:

RULE OF THE UNITED STATES BOARD OF SUPERVISING INSPECTORS.

$$A = .2074 \times (W \div P)$$

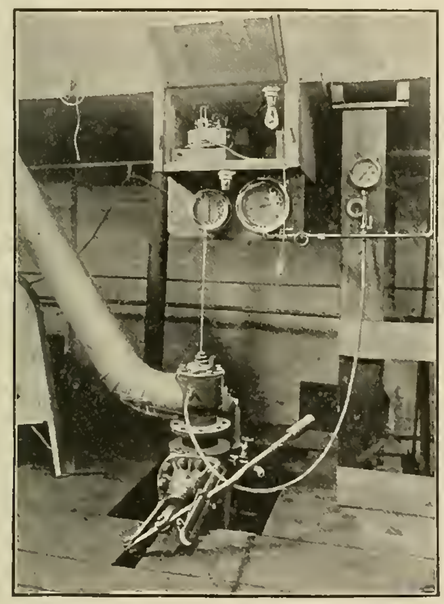
A = area of safety valve in sq. in. per sq. ft. of grate surface.
W = lbs. of water evaporated per sq. ft. of grate per hour.
P = boiler pressure (absolute.).

In 1875 a special committee was appointed by this Board to conduct experiments upon safety valves at the Washington Navy Yard. Although the pressures used in these experiments (30 to 70 lbs. per sq. in.) were too low to make the results of much value to-day, some of the conclusions reported are significant.

"First: That the diameter of a safety valve is *not* an infallible test of its efficiency.

"Second: That the lift which can be obtained in a safety valve, other conditions being equal, *is* a test of its efficiency."

The present rule of the Board as given above, formulated by L. D. Lovekin, Chief Engineer of the New York Shipbuilding Co., was adopted in 1904. Its derivation assumes practically a 45 degree seat and a valve lift of 1/32 of the nominal valve diameter. The discharge area in this rule is obtained by multiplying the valve lift (D ÷ 32) by the valve circumference ($\pi \times D$) and taking but 75 per cent. of the result to allow for the added restriction of a 45 degree over a flat seat. The 75 per cent. equals approximately the sine of 45 degrees or .707. This value for the discharge area, *i. e.* ($.75\ \pi\ D^2 \div 32$), is substituted directly into Napier's formula for the flow of steam.



LIFT TESTING APPARATUS ON STATIONARY BOILER.

Thus in the valves to which this rule is applied the following lifts are assumed to exist:

| | | |
|---|---|---|
| 1 in. valve... .03 in. | 3 in. valve... .09 in. | 5 in. valve... .16 in. |
| 2 in. valve... .06 in. | 4 in. valve... .13 in. | 6 in. valve... .19 in. |

Referring to the valve lifts obtained by the tests, it is seen that the highest lift agrees very closely with the lift assumed in the rule and if the valve lifts of the different designs were more uniformly of this value or if the rule expressly stipulated either that the lift of 1/32 of the valve diameter actually obtain in valves qualifying under it or that an equivalent discharge area be obtained by the use of larger valves, the rule would apply satisfactorily to that size of valve. However, the lowest lift valve actually has but ¼, the next larger less than ½ and the average lift of all but the highest lift valve, which average is .07 in., is but 56 per cent. of the lift assumed in the rule for these 4 in. valves.

MASSACHUSETTS RULE OF 1909.

$$A = (70\ W \div P) \times 11$$

A = area of safety valve in sq. in. per sq. ft. of grate.
W = lbs. of water evaporated per sq. ft. of grate surface per second.
P = boiler pressure (absolute).

This rule is merely the United States rule given above with a 3.2 per cent. larger constant and hence requiring a valve larger by that amount. The evaporation term is expressed in pounds per second instead of per hour and two constants are given in-

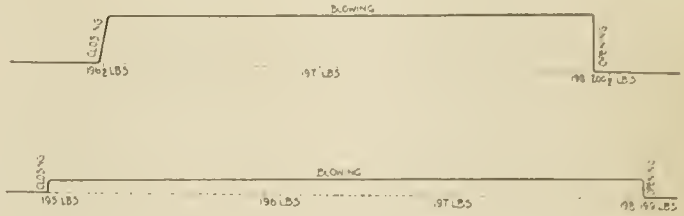


FIG. 1.—VALVE LIFT DIAGRAM.

stead of one, but when reduced to the form of the United States rule it gives $A = .214 \times (W \div P)$. Figuring this back as was done above with the United States rule, shows that this rule assumes a valve lift of 1/33 of the valve diameter instead of 1/32. This changing of the assumed lift from 1/32 to 1/33 of the valve diameter being the only difference between the two rules, the inadequacy of the U. S. rule just referred to applies to this more recent rule of the Massachusetts Board.

PHILADELPHIA RULE.

$$A = 22.5\ G \div (P + 8.62)$$

A = total area of safety valve or valves in sq. in.
G = grate area in sq. ft.
P = Boiler pressure (gauge).

The Philadelphia rule now in use came from France in 1868, being the official rule there at that time and having been adopted and recommended to the City of Philadelphia by a specially appointed committee of the Franklin Institute. The area (A) of this rule is the effective valve opening, hence if it is applied as its derivation by the French requires, the lift of the valve must be known and considered. However, the example of its application given in a city ordinance, as well as that given in the original report of the Franklin Institute Committee, which recommended it, show the area (A) applied to the nominal valve opening. In the light of its derivation, this method of using it takes as the effective discharge area, the valve opening itself, the error of which is very great. Such use, as specifically stated in the report of the committee above referred to, assumes a valve lift at least ¼ of the valve diameter, *i. e.*, the practically impossible lift of 1 in. in a 4 in. valve.

The principal defect of these rules in the light of the preceding tests is that they assume that valves of the same nominal size have the same capacity and they rate them the same without distinction, in spite of the fact that in actual practice some have but ⅓ of the capacity of the others. There are other defects as


LOCOMOTIVE ARRANGED FOR TESTING SAFETY VALVES.

have been shown, such as varying the assumed lift with the valve diameter, while in reality with a given design the lifts are more nearly the same in the different sizes, not varying nearly as rapidly as the diameters. And further than this the actual lifts assumed for the larger valves are nearly double the actual average obtained in practice.

The direct conclusion in this is that existing rules and statutes are not safe to follow. Some of these rules in use were formulated before, and have not been modified since spring safety valves were invented, and at a time when 120 lbs. was considered high pressure. None of these rules take account of the different lifts which exist in the different makes of valves of the same nominal size, and they thus rate exactly alike valves which actually vary in lift and relieving capacity over 300 per cent. It would, therefore, seem the duty of all who are responsible for steam installation and operation to no longer leave the determination of safety valve size and selection to such statutes as may happen to exist in their territory, but to investigate for themselves.

The elements of a better rule for determining safety valve size exist in Napier's formula for the flow of steam, combined with the actual discharge area of the valve as determined by its lift. In "Steam Boilers" by Peabody & Miller, this method of determining the discharge of a safety valve is used. The uncertainty of the coefficient flow, that is, of the constant to be used in Napier's formula when applied to the irregular steam discharge passages of safety valves has probably been largely responsible for the fact that this method of obtaining valve capacities has not been more generally used. To determine what this constant or coefficient of flow is and how it is affected by variations in valve design and adjustment, an extended series of tests were recently conducted by the writer at the Stirling Department of the Babcock & Wilcox Co., at Barberton, Ohio.

A 373 h. p. Class K, No. 20 Stirling boiler, fired with a Stirling chain grate, with a total grate area of 101 sq. ft. was used. This boiler contained a U type of superheater designed for a superheat of 50 degrees F. The water feed to this boiler was measured in calibrated tanks and pumped (steam for the pump being furnished from another boiler) through a pipe line all connections to which had been blanked by stop valves back of which there were open drips to insure that there was no leakage. The entire steam discharge from the boiler was through the valve being tested, all other steam connections from the boiler being either blanked or closed with stop valves beyond which were placed open drip connections to indicate any leakage. A constant watch was kept throughout the testing upon all points of the feed, and steam lines to insure that all water measured in the calibrated tanks was passing through the tested valves without intermediate loss.

The valves tested consisted of a 3 in., 3½ in. and a 4 in. iron stationary valve, and a 1½ in., 3 in. and 3½ in. locomotive valve, the latter with and without mufflers. These six valves were all previously tested and adjusted on steam. Without changing the position of the valve disc and ring the springs of these valves were then removed and solid spindles, threaded (with a 10 pitch thread) through the valve casing above, inserted. Upon the top end of these spindles, wheels graduated with 100 divisions were placed. Figure 3 shows the arrangement used with the locomotive valves, the spindle and graduated wheel being similar to that used with the stationary valves. By this means the valve lift to thousandths of an inch was definitely set for each test.

In conducting the tests three hours duration was selected as the minimum time for satisfactory results. Pressure and temperature readings were taken every three minutes, water readings every half hour. In all 29 tests were run, 15 were 3 hours long, 4 2½ hours, 3 2 hours and 7 of less duration.

Tests numbered 1 to 5 were preliminary runs of but one hour or less duration apiece, and the records of them are thus omitted in the table on the next page which gives lifts, discharge areas, average pressure and superheat, and the steam discharge in pounds per hour of each of the other tests. The discharge areas have been figured for 45 degree seats from the formula, $A = 2.22\ L\ D + 1.11\ L^2$, where A equals the effective area in sq. in., D equals the valve diameter in inches, and L equals the valve lift in inches. In tests 8 and 23 where the width of valve seat was .225 in. and .185 in., respectively, and the valve was thus slightly above the depth of the valve seat, the area was figured for this condition.

As previously stated the application of these results is in fixing a constant for the flow of Napier's formula as applied to safety valves. The formula is $W = AP \div 70$, in which W equals pounds of steam discharged per second, P equals the absolute steam pressure behind the orifice or under the valve and A equals the effective discharge opening in sq. in. This may be stated as $E = C \times A \times P$; in which E equals the pounds of steam discharged per hour and C equals a constant; the value of E, A and P being given for the tests, C is directly obtainable.

Figuring and plotting the values of this constant indicates the following conclusions:

(1) Increasing or altering the steam pressure from approximately 50 to 150 lbs. per sq. in. (tests 14 and 10) does not affect the constant, this merely checking the applicability of Napier's formula in that respect.

(2) Radically changing the shape of the valve disc outside of the seat at the huddling or throttling chamber, so-called, does not affect the constant or discharge. In test No. 15 the valve had a downward projecting lip, deflecting the steam flow through nearly 90 degrees, yet the discharge was practically the same as in tests Nos. 10 and 14, where the lip was cut entirely away, giving a comparatively unobstructed flow to the discharging steam.

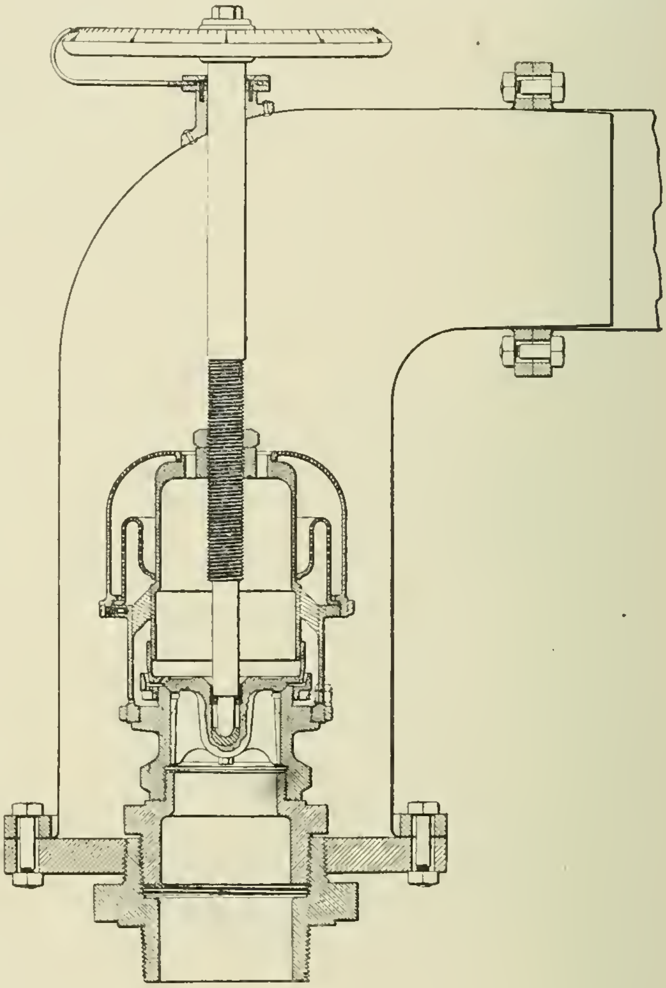


FIG. 3.—VALVE FITTED FOR CAPACITY TESTS.

(3) Moving the valve adjusting ring through much more than its complete adjustment range does not affect the constant or discharge (Tests Nos. 16 and 17).

(4) The addition of the muffler to a locomotive valve does not materially alter the constant or discharge. There is but 2 per cent. difference between tests Nos. 10 and 13.

(5) Disregarding the rather unsatisfactory 1½ in. and 3 in. locomotive valve tests, the different sizes of valves tested show a variation in the constant when plotted to given lifts of about 4 per cent.

(6) There is a slight uniform decrease of the constant when increasing the valve lifts.

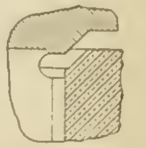
The variations indicated in the last two conditions are not large enough, however, to materially impair the value of a single constant obtained by averaging the constants of all the 24 tests

SAFETY VALVE CAPACITY TESTS.

Run at the Stirling Works of the Babcock & Wilcox Co., Barberton, Ohio. November 30 to December 23, 1908.

| Test No. | Duration of test, | Size and type of valve | Adjustment remarks | Valve lift, in. | Pressure, lbs. per sq.in. | Superheat, deg. F. | Discharge: Per hr., lbs. of steam. | Discharge: Area.* sq.in. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 3 hrs. | 4-in. R.F. iron stationary. | Reglr. adj., exhaust piped | 0.0695 | 151.7 | 43.6 | 5,120 | 0.0226 | No back pressure. |
| 7 | 3 " | 4-in. " " " | " " " " | .139 | 145.4 | 45.1 | 8,600 | 1.255 | Back pressure 2 lbs. |
| 8 | 3 " | 4-in. " " " | " " " " | .180 | 135.7 | 49.2 | 11,020 | 1.704 | Bk press. 3 lbs.; max. press.; lift greater than depth of seat. |
| 9 | 3 " | 4-in. " " " | " " " " | .1045 | 149.4 | 41.9 | 7,290 | .9400 | Back pressure, 1 lb. |
| 10 | 2½" | 3½ locomotive Form B. | " " without muffler. | .140 | 146.7 | 39.0 | 8,085 | 1.109 | Tests 10 to 12 inclusive, with an open locomotive valve. |
| 11 | 3 " | 3½ " " | " " " " | .070 | 152.5 | 38.0 | 4,670 | .5493 | |
| 12 | 3 " | 3½ " " | " " " " | .105 | 150.3 | 41.2 | 6,780 | .8280 | |
| 13 | 3 " | 3½ " " | " " with muffler. | .1395 | 146.3 | 38.1 | 8,400 | 1.106 | Muffler valve in this and following locomotive tests. |
| 14 | 2 " | 3½ " " | " " " " | .140 | 52.2 | 51.3 | 3,020 | 1.109 | Test at low steam pressure. |
| 15 | 2½" | Do.; with lipped feather. | " " " " | .140 | 146.4 | 39.0 | 8,600 | 1.109 | Different type of valve disc. |
| 16 | 3 " | 4-in. R.F. iron stationary. | " " exhaust piped. | .140 | 138.5 | 42,3 | 8,770 | 1.265 | No bk press.; rep. of test No. 7. |
| 17 | 3 " | 4-in. " " " | Adj. ring one turn 1-16 in. above regular position. | .140 | 142.0 | 50.1 | 8,900 | 1.265 | Back press., 3 lbs.; ring position changed. |
| 18 | 2 " | 1½ locomotive Form B. | Reglr. adj. with muffler. | .107 | 140.8 | 23.0 | 2,515 | .4272 | Tests 18-21, inc., unsatisfactory, valve too small for boiler used. |
| 19 | 1 " | 1½ " " | " " " " | .060 | 151.2 | None | 1,550 | .2038 | |
| 20 | 2½" | 1½ " " | " " " " | .075 | 146.3 | None | 2,025 | .2560 | |
| 21 | 2½" | 1½ " " | " " " " | .075 | 147.7 | None | 1,975 | .2560 | |
| 22 | 1½" | 3½ R.F. iron stationary. | " " exhaust piped. | .070 | 146.8 | 42.6 | 4,320 | .5493 | No back pressure. |
| 23 | 3 " | 3½ " " " | " " " " | .140 | 139.9 | 43.6 | 8,300 | 1.136 | No back press.; lift greater than depth of seat. |
| 24 | 3 " | 3½ " " " | " " " " | .105 | 141.6 | 48.7 | 6,300 | .8280 | Tests 24 to 27, inclusive, no back pressure. |
| 25 | 3 " | 3 " " " | " " " " | .130 | 140.1 | 48.4 | 6,370 | .8846 | |
| 26 | 3 " | 3 " " " | " " " " | .100 | 142.8 | 45.6 | 5,160 | .6770 | |
| 27 | 2 " | 3 " " " | " " " " | .070 | 142.4 | 29.5 | 3,705 | .4716 | |
| 28 | 3 " | 3 locomotive Form B. | " " with muffler. | .130 | 138.4 | 48.7 | 7,060 | .8346 | |
| 29 | 3 " | 3 " " | " " " " | .090 | 139.3 | 43.9 | 4,050 | .6031 | |

*The valves all having 45 deg. bevel seats these areas are obtained from formula: $a = 2.22 \times D \times l + 1.11 \times l^2$; except where, as in test Nos. 8 and 23, the valve lift is greater than the depth of the valve seat, where the following formula is used: $a = 2.22 \times D \times d + 1.11 \times d^2 + \pi \times D \times (l - d)$.
$a$ = discharge area (sq. in.). D = valve diameter (in.). l = valve lift (in.). d = depth of valve seat (in.).
NOTE.—The four wings of the valve feather or disc probably reduce the flow slightly, but as these are cut away at the seat (see sketch) a definite correction of the exit areas for them is impossible. Further, the formula constants are desired for the valves as made.



given. The selection of such a constant is obviously in accord with the other four conditions mentioned. This average constant is 47.5, giving the formula $E = 47.5 \times A \times P$. Its theoretical value for the standard orifice of Napier's formula is 51.4, of which the above is 92½ per cent.

To make this formula more generally serviceable, it should be expressed in terms of the valve diameter and lift, and can be still further simplified in its application by expressing the term E (steam discharged or boiler evaporation per hour) in terms of the boiler heating surface or grate area. For the almost universal 45 degrees seat the effective discharge area is, with a slight approximation ($L \times \sin 45^\circ \times \pi \times D$), in which L equals the valve lift vertically in inches and D the valve diameter in inches. Substituting this in the above formula gives

$$E = 105 \times L \times D \times P.$$

Note that the nominal valve area does not enter into the use of this formula and that if a value of 12, for instance, is obtained for D it would call for 2, 6 in. or 3, 4 in. valves. For flat seats this constant becomes 149.

The fact that these tests were run with some superheat (an average of 37.2 degrees F.), while the majority of valves in use are used with saturated steam, would, if any material difference exists, place the above constants on the safe side.

To make the use of the rule more direct where the evaporation of the boiler is only indirectly known it may be expressed in terms of the boiler heating surface or grate area. This modification consists merely in substituting for the term E (pounds of total evaporation) a term H (sq. ft. of total heating surface) multiplied by the pounds of water per sq. ft. of heating surface which the boiler will evaporate. Evidently the value of these modified forms of the formula depends upon the proper selection of average boiler evaporation figures for different types of boilers and also upon the possibility of so grouping these boiler types that average figures can be thus selected. This modified form of the formula is $D = CH \div LP$, in which H equals the total boiler heating surface in sq. ft. and C equals a constant.

Values of the constant for different types of boilers and service have been selected. These constants are susceptible of course to endless discussion among manufacturers, and it is undoubtedly more satisfactory where any question arises, to use the form containing the term E itself. Nevertheless, the form containing the term H is more direct in its application and it is believed that the values given below for the constant will prove serviceable. In applying the formula in this form rather than the original one, containing the evaporation term E, it should be remembered that these constants are based upon average proportions and hence should not be used for boilers in which any abnormal proportions or relations between grate area, heating surface, etc., exists.

For cylindrical multitubular, vertical and water tube stationary boilers a constant of .068 is suggested. This is based upon an average evaporation of 3½ lbs. of water per sq. ft. of heating surface per hour, with an overload capacity of 100 per cent., giving 7 lbs. per sq. ft. of heating surface, the figure used in obtaining the above constant.

For water tube marine and Scotch marine boilers, the suggested constant is .095. This is based upon an overload or maximum evaporation of 10 lbs. of water per sq. ft. of heating surface per hour.

For locomotives the suggested constant is .055. In locomotive practice there are special conditions to be considered which separate it from regular stationary and marine work. In the first place the maximum evaporation of a locomotive is only possible with the maximum draft obtained when the cylinders are exhausting up the stack, at which time the throttle is necessarily open. The throttle being open is drawing some of the steam and therefore the safety valves on a locomotive can never receive the full maximum evaporation of the boiler. Just what per cent. of this maximum evaporation the valve must be able to relieve under the most severe conditions can only be determined experimentally. Evidently the most severe conditions obtain when an engineman after a long, hard, up-hill haul with a full glass of water and full pressure, reaching the top of the hill, suddenly shuts off his throttle and injectors. The work on the hill has set the engine steaming to its maximum and the sudden closing of throttle and injectors forces all the steam through the safety valves. Of course, the minute the throttle is closed the steaming quickly falls off and it is at just that moment that the most severe test upon the valves comes.

A large number of service tests have been conducted to determine this constant. The size valves upon a locomotive has been increased or decreased until one valve would just handle the maximum steam generation, and the locomotive heating surface being known, the formula was figured back to obtain the constant. Other special conditions were considered, such as the liability in locomotive practice to a not infrequent occurrence of the most severe conditions; the exceptionally severe service which locomotive safety valves receive; and the advisability on locomotives to provide a substantial excess valve capacity.

As to the method of applying the proposed safety valve capacity rule in practice, manufacturers could be asked to specify the capacity of their valves, stamping it upon them as the opening and closing pressures are now done. This would necessitate no extra work further than the time required in the stamping, because for valves of the same size and design giving practically the same lift, this would have to be determined but once, which of itself is but a moment's work with a small portable lift gauge that is now manufactured. The specifying of safety valves by a designing engineer could then be as definite a problem as is that of other pieces of apparatus. Whatever views are held, as to the advantages of high or low lifts, there can be no question, it would seem, as to the advantage of knowing what this lift actually is, as would be shown in this specifying by manufacturers of the capacity of their valves. Further, as to the feasibility of adopting such a rule (which incorporates the valve lift) in statutes governing valve sizes:—this would involve the granting and obtaining by manufacturers of a legal rating for their valve designs based upon their demonstrated lifts.

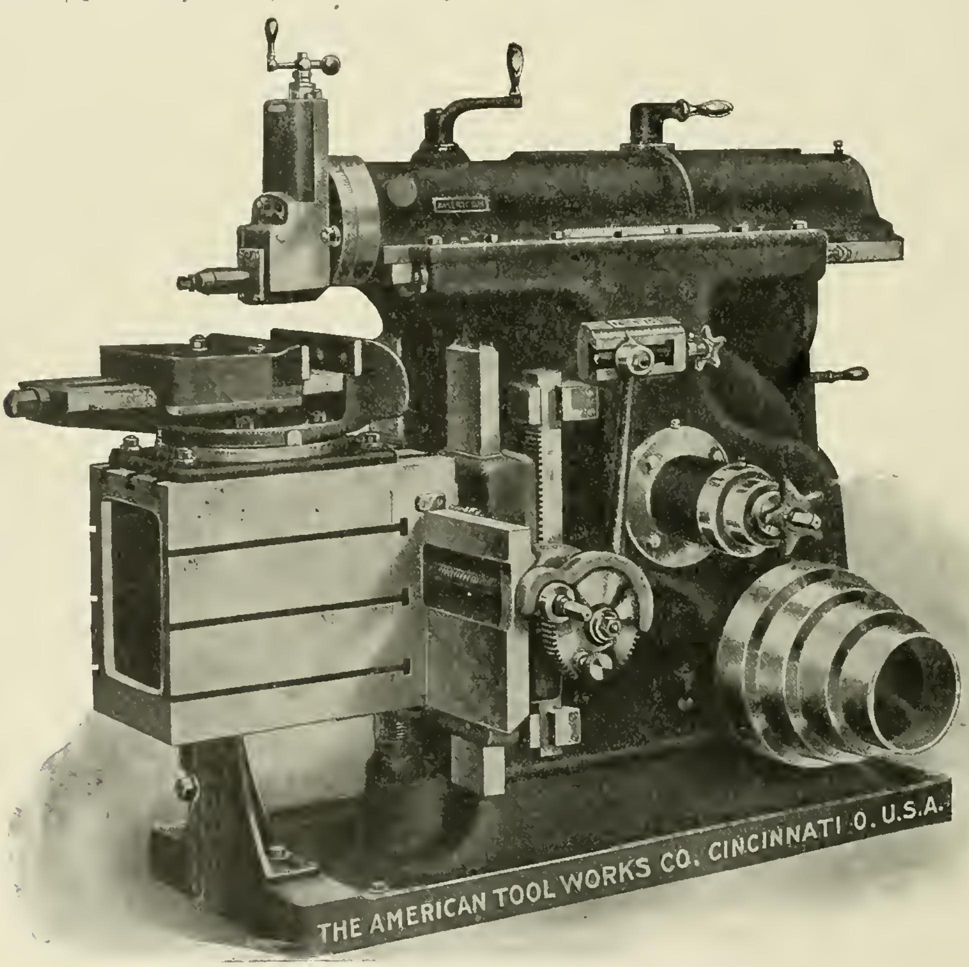
## BACK-GEARED CRANK SHAPERS.

A 21 in. back-geared crank shaper, one of a new line which is being placed on the market by The American Tool Works Company of Cincinnati, is illustrated herewith. To give some idea of the power and efficiency of these machines the results of several tests are shown in the tables. These are not intended to represent the maximum capacity of the machines, but leave a good factor of safety and are well within their limits. The 21 in. machine has a 21½ in. stroke, a down feed to the head of 9 in. and a table travel of 14½ vertically and 26½ in. horizontally. The column is usually deep and wide, tapering slightly towards the top. It is strongly braced internally, and is reinforced outside by a wide, deep rib. An exceptionally long bearing is provided for the ram. The base is deep and strongly ribbed, and is of pan construction to catch oil drippings. The ram is heavy and designed for uniform rigidity throughout the entire length of stroke. It is well braced by internal ribs, and has long wide bearings on the column with a continuous taper gib, having end screw adjustment for taking up the wear. The stroke of the ram is positive and has eight changes, ranging from 7.7 to 96 strokes per minute. The length of stroke may be easily changed without stopping the machine. The device for positioning the stroke is located on the ram near the head and may be operated while the machine is running. A pointer on the ram, traveling along an index, shows the length of stroke as set. The rocker arm is extra heavy and thoroughly braced and gives practically a uniform rate of speed to the ram for its entire stroke; it also provides an exceedingly quick return. The machine is readily changed from single to back-geared through a convenient, self-locking lever, and has a back-gear ratio of 24.3 to 1, which with the large cone pulley, gives it extraordinary power for taking heavy cuts.

TEST SHEET OF 21″ BACK GEARED SHAPER.

| Depth of cut. | Feed per Stroke. | Cutting Speed Ft. per Min. | Belt on Cone Step.* | Back Gear Position. | Revol's of Cone. | Length of Cut. | Amperes at Tool. | H. P. at Tool. | Voltage. |
|---|---|---|---|---|---|---|---|---|---|
| ½″ | .080″ | 11.4 | 2 | In | 157 | 13½″ | 9 | 2.65 | 220 |
| ⅝″ | .160″ | 16.3 | 3 | In | 225 | 13½″ | 24 | 7.07 | do. |
| ⅝″ | .200″ | 11.4 | 2 | In | 157 | 13½″ | 21 | 6.19 | do. |
| Above Test Made in Cast Iron—Close Grained—18″ Stroke. | | | | | | | | | |
| ½″ | .080″ | 11.4 | 2 | In | 157 | 14″ | 21 | 6.19 | 220 |
| ½″ | .096″ | 11.4 | 2 | In | 157 | 14″ | 24 | 7.07 | do. |
| ⅝″ | .080″ | 11.4 | 2 | In | 157 | 14″ | 32 | 9.43 | do. |
| Above Test Made in Machinery Steel—Very Tough—21″ Stroke. | | | | | | | | | |

*Cone steps are numbered from 1 to 4, 1 being the largest diameter.




TWENTY-ONE INCH BACK GEARED CRANK SHAPER.

The head is operative at any angle within an arc of 100 degrees and has a convenient and efficient locking device. The down slide is fitted with a continuous taper gib having end screw adjustment, for taking up the wear. The down feed is of unusual length and the feed screw has an adjustable graduated collar reading to .001 in. The table is of box form with three T-slots on both the top and the sides. It is thoroughly braced internally, insuring accuracy and stiffness and is readily detachable. The apron is provided with a continuous taper gib having end screw adjustment. It has three T-slots on the face for clamping work when the table is removed. A patented automatic stop releases the feed and prevents breakage to parts when the tool is fed into the cut or should the apron be accidentally fed to its limit in either direction on the rail.

The cross rail is of box form, heavy and strongly ribbed. It is of exceptional length, giving the table a long horizontal range of travel. It is bolted to the column by clamps and bolts of improved design, which prevent the cross rail from dropping away when the binder bolts are loosened. A telescopic elevating screw of large diameter is provided, having a ball-bearing thrust. The cross feed is a new patented design. It is variable and automatic with a range of .008 in. to .200 in., instantly obtainable while the machine is running. It is supplied with graduations either side of zero and a pointer reading from 1 to 25 notches, each notch representing .008 in. feed. The construction is such as to render unnecessary any adjustment of the feeding mechanism due to change of the position of the rail. The feed is uniform as set, regardless of the position of the rail. The feed is thrown in or out, and also reversed through the knob on the large feed gear. The feed gears are neatly covered to afford protection.

The rocker arm is made of double section at the top and this with the large opening through the column permits a shaft 3½ in. in diameter to be passed under the ram for keyseating. Larger shafts may be keyseated by setting over the table to allow the shaft to pass outside of the column, using the head set at an angle. Special attention has been paid to the thorough lubrication of all working parts. The ram slides are oiled from the center where oil pockets are provided, from which felt wipers take their supply of oil and distribute it through oil grooves to the extreme ends of the slides, thus doing away with a multiplicity of oil holes to be attended to. These slides are provided with felt wipers at both the front and center of the column. An oil pocket is cast integral with the column at the rear, storing any waste of oil, which may be drawn off through a pipe extending from the rear of column. A large quantity of oil is stored in a pocket cast integral with the arm, which, with suitable means of distribution, insures thorough lubrication on the crank pin and the sliding block in the rocker arm.

This new line of shapers consists of a 15 in. single-geared and 16, 18, 21, 25 and 30 in. back-geared machines. If desired they may be furnished with four-speed gear boxes and electric motor drives.

TEST SHEET OF 16″ BACK GEARED SHAPER.

| Depth of cut. | Feed per Stroke. | Cutting Speed Ft. per Min. | Belt on Cone Step.* | Back Gear Position. | Revol's of Cone. | Length of Cut. | Amperes at Tool. | H. P. at Tool. | Voltage. |
|---|---|---|---|---|---|---|---|---|---|
| ¼″ | .160″ | 17.3 | 2 | In | 210 | 12⅛″ | 21 | 6.3 | 224 |
| ⅜″ | .088″ | 17.3 | 2 | In | do. | do. | 24 | 7 2 | do. |
| ½″ | .080″ | 17.3 | 2 | In | do. | do. | 23 | 6.9 | do. |
| Above Tests Made in Cast Iron—Close Grained—16″ Stroke. | | | | | | | | | |
| ⅛ | .080 | 17.3 | 2 | In | 210 | 12″ | 11 | 3.3 | 224 |
| ¼ | .024 | 9.9 | 4 | In | 418 | do. | 15 | 4.5 | do. |
| ¼ | .040 | 14. | 3 | In | 294 | do. | 15 | 4.5 | do. |
| Above Tests Made in Machinery Steel—Very Tough—16″ Stroke. | | | | | | | | | |

*Cone steps are numbered from 1 to 4, 1 being the largest diameter.

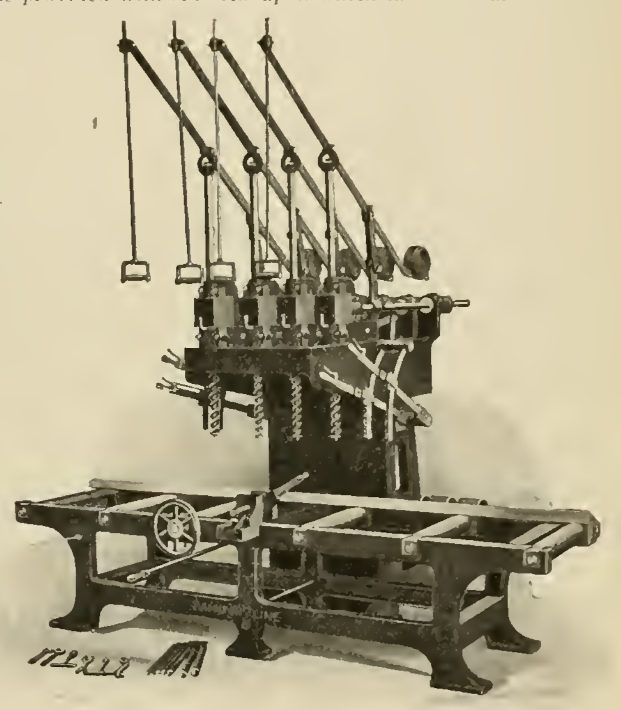
Safety Appliance Hearing.—The Interstate Commerce Commission will hold a hearing on May 5 in Washington, D. C., concerning an increase in the minimum percentage of power brakes on railroad trains.

## FIVE-SPINDLE VERTICAL CAR BORING MACHINE.

The Hamilton five-spindle, vertical car boring machine, shown in the illustration, is designed for heavy boring in railroad and car shops and is manufactured by The Bentel-Margedant Company, Hamilton, Ohio. The illustration shows three vertical and two radial spindles, but these are subject to variation in number.

The spindles, of heavy construction, are mounted in large housings which slide on the frame in improved dovetail slides. They have a 20 in. vertical stroke and a transverse adjustment of 22 in., the latter by means of a hand wheel and pinion with chain feed, quick and positive in action. Each spindle is separately driven by its own belt from the rear of the machine and any spindle may be thrown out of commission without disturbing the others. The spindles are provided with a miter gear drive which is covered by a dust-proof box; gears run in long slides preventing wear of the boxes by the action of the spindles. The spindles are brought down separately by hand to do the boring and are returned to their positions by counterbalanced levers in the three vertical spindles and by springs in the radials. Stop gauges are provided to gauge the depth of the hole.

The table is 10 ft. long, clamps 22 in. wide by 16 in. thick and has all the conveniences for handling heavy or light material. The top is provided with six rolls upon which the material rests. The center and two end rolls are geared together by a chain and may be driven either by power or hand feed. A large hand wheel is provided on the center roll for hand adjustment. A center clamp is also used to hold the material against the fence and to prevent the bits from raising it from the table. The power feed for the table consists of reversible friction pulleys controlled from the front by a convenient hand lever. The power feed is generally used for moving long distances, while the hand wheel feed is for accurate setting and short distances. A longer traveling table may be provided, if desired. The countershaft is placed on the floor at the rear of the machine and is provided with tight and loose pulleys. The machine weighs 7,000 lbs., occupies a floor space 6 by 10 ft. and requires from 10 to 15 h. p. for driving.



FIVE-SPINDLE VERTICAL CAR BORING MACHINE.

Address by F. W. Taylor.—Dr. Frederick W. Taylor, past-president of the American Society of Mechanical Engineers, gave an address before the College of Engineering of the University of Illinois on Thursday, February 18. His talk was along general engineering lines supplemented by anecdotes from the early part of the careers of successful engineers.

## HIGH POWER MILLING MACHINES.

A few years ago railroad officials, in buying machine tools, were inclined to lay considerable stress upon the weight of the tool as an indication of its capacity. To-day the purchaser insists on having accurate information as to the quality and quantity of work which a tool is capable of turning out, and the weight is a matter of secondary importance. This, and the demand for high power machines, has lead the Cincinnati Milling Machine Company to design its latest line of milling machines on the basis of certain standard cuts which may be taken continuously on each size of machine. Starting with this as a basis, and with the results of elaborate tests and experiments to guide them, it has been possible to design each individual part to produce a most efficient and harmonious design as a whole. The value of high cutting capacity may be largely offset by inconvenience in operating the machine and this point has also been given careful consideration.

An important feature, especially from the manufacturing standpoint, is that the vertical and horizontal machines are identical up to the frame head, the vertical machine differing only in the frame casting, the mechanism at its top and the pair of bevel gears for changing the motion to the vertical shaft. An even more important feature, from the standpoint of the purchaser, is that the method of driving and feeding may readily be changed at any time to suit changes in his power transmission system. For instance, the constant speed standard belt-driven machine, with the driving shaft parallel to the spindle, may be changed to a right angle drive by simply changing the brackets. By substituting a simpler driving gear box a cone pulley drive may be used. In the former case the feed box is driven from the constant speed driving shaft and in the latter from the spindle, but with no change in the feed box itself. By changing brackets the cone pulley drive may be changed to one at right angles. By substituting a sprocket wheel for the driving pulley and adding a bracket at the base a constant speed motor may be applied. In the same way the cone pulley drive may be changed to a variable speed motor drive. By changing an index plate the feed on the constant speed drive machines may be changed from inches per minute to thousandths per revolution.

To give some idea of the power and efficiency of these machines a view of the No. 4 plain horizontal machine is shown in Fig. 1, milling four drop-forged steel pieces at one time, taking a cut 13/16 in. wide and $1\frac{1}{4}$ in. deep, at a table travel of 2 in. per minute. This amounts to $8\frac{1}{8}$ cu. in. removed per minute. The machine is driven by a 10 h. p. motor.

The high power vertical machine, shown in Fig. 6, is engaged in milling forged steel bars, having 55,000 lbs. tensile strength and 50 per cent. elongation. The bars are 5 in. wide and the machine is taking a cut $\frac{1}{8}$ in. deep and feeding at the rate of 16 in. per minute. This amounts to 10 cu. in. per minute. The 10 h. p. driving motor is slightly overloaded, delivering 12 gross horse power.

The constant speed belt-driven machine has sixteen changes in spindle speed. A clutch, operated by the lever at the right of the driving gear box, Figs. 2 and 3, allows the driving pulley to run loose on the shaft when the machine is not in operation. Fig. 3 is a view of the exterior of the driving gear box; Fig. 4 shows the interior. The upper part of the column, with the cover plate removed, on the opposite side of the machine from the gear box, is shown in Fig. 5. The tumbling gears, shown near the center of the box, in Fig. 4,

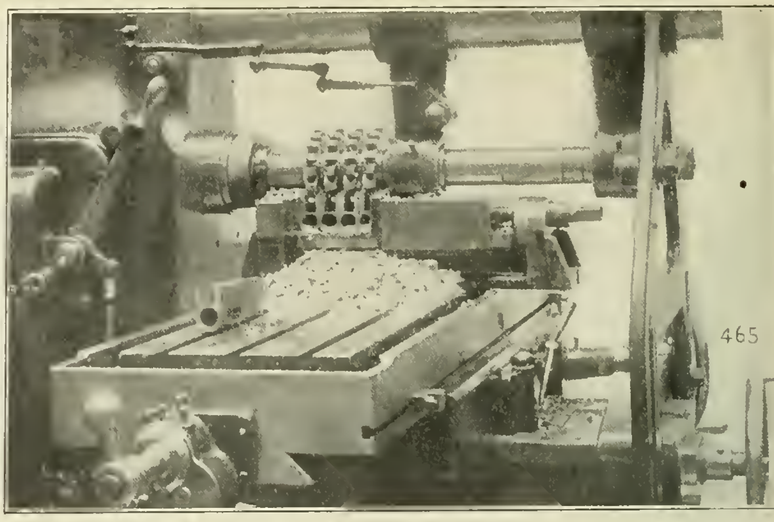



FIG. 1.—PLAIN HORIZONTAL MILLING MACHINE REMOVING $8\frac{1}{8}$ CUBIC INCHES OF DROP-FORGED STEEL PER MINUTE.

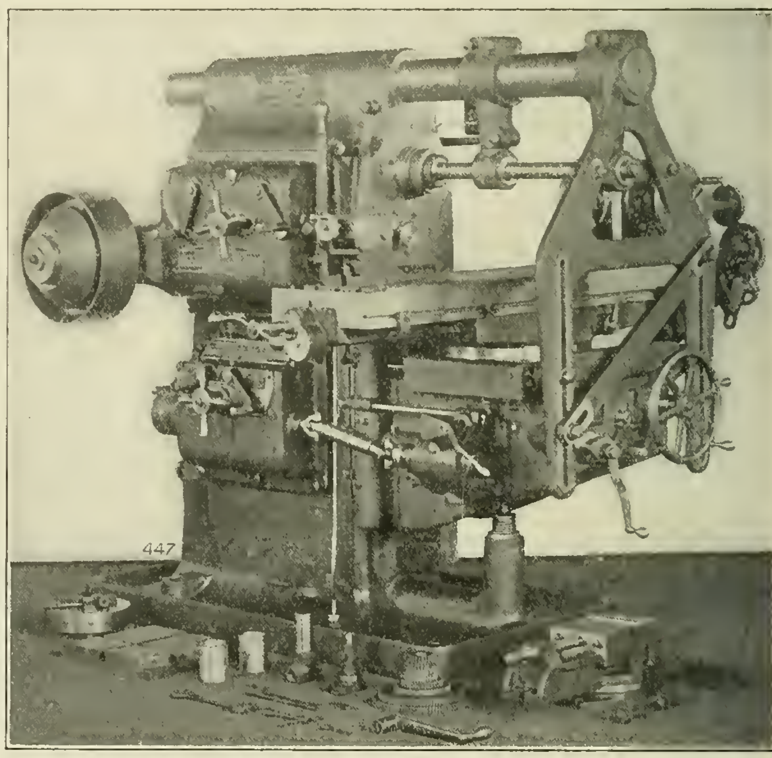



FIG. 2.—PLAIN HORIZONTAL MILLING MACHINE WITH RIGHT-ANGLE DRIVE.

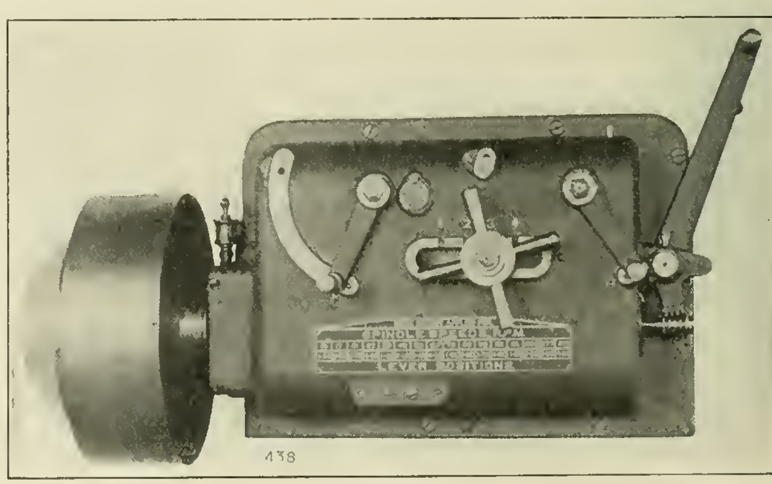



FIG. 3.—OUTSIDE OF DRIVING-GEAR BOX.

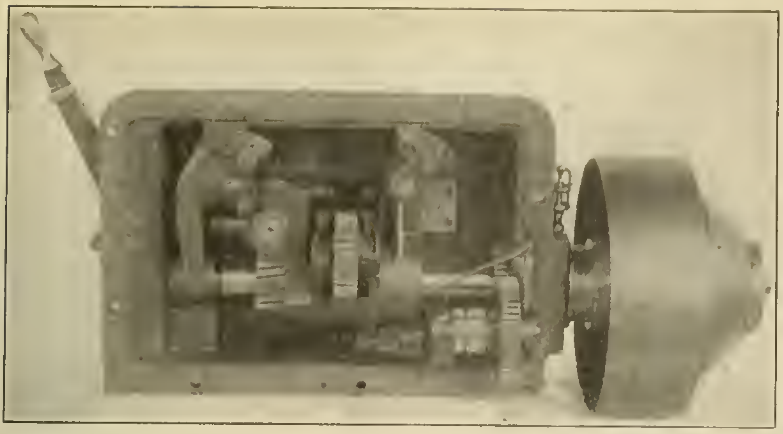


FIG. 4.—DRIVING-GEAR BOX, INSIDE.

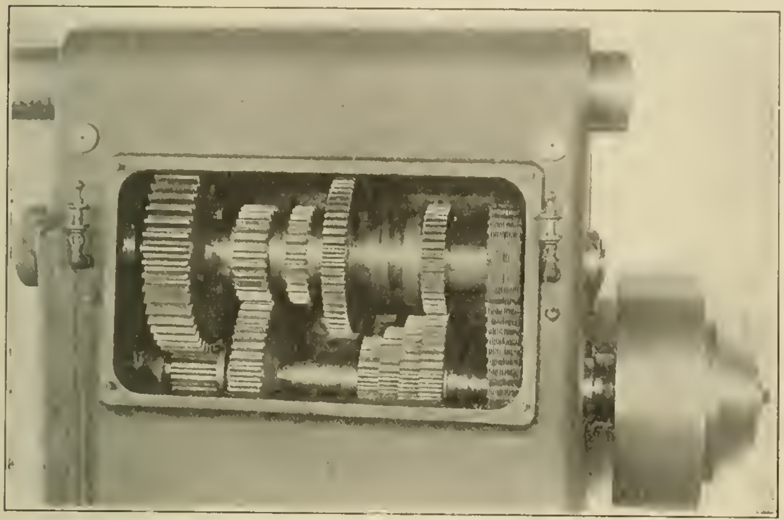


FIG. 5.—UPPER PART OF COLUMN WITH COVER-PLATE REMOVED SHOWING DRIVING-GEAR TRAIN.

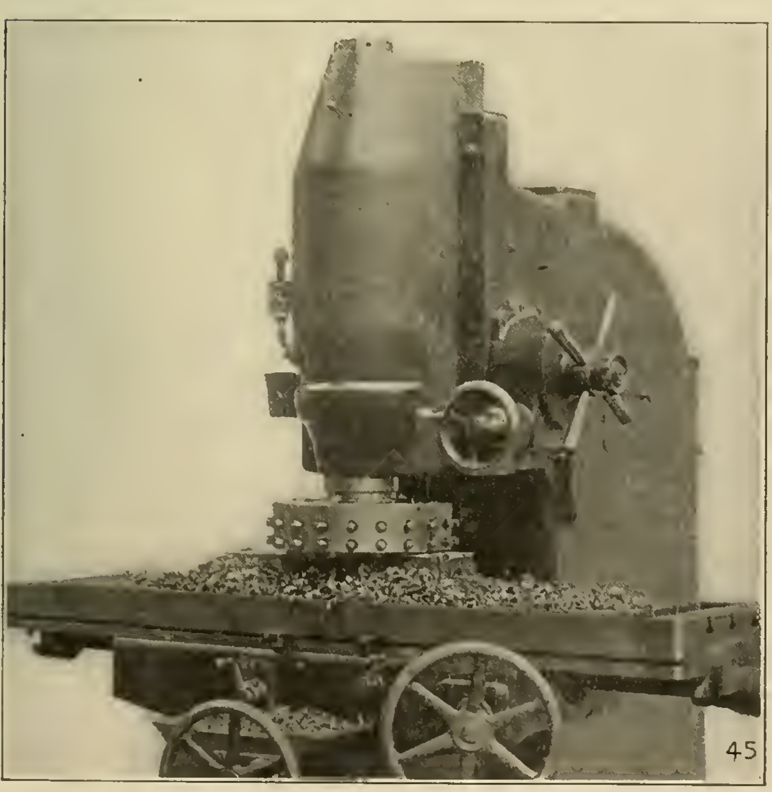


FIG. 6.—HIGH POWER VERTICAL MILLING MACHINE, REMOVING 10 CUBIC INCHES OF MATERIAL PER MINUTE FROM FORCED STEEL BARS. CUT ⅛ IN. DEEP AND 5 IN. WIDE. FEED 16 IN. PER MINUTE.

mesh with one of the four gears on the sleeve to the right on the lower shaft in Fig. 5. These four speeds are doubled by using the back gears at the left in Fig. 5. If the smaller one of the set of four gears is engaged with the large gear to the left on the sleeve on the spindle, eight additional spindle speeds may be obtained with the use of the back gears. The advantages of this scheme of transmission are that the spindle is relieved of torsional strains throughout its length and no gears are ever in mesh except those used for transmission. The eight fastest spindle speeds are obtained with only two pairs of gears in mesh.

The sliding gears are operated by the lever which takes the positions C and D in Fig. 3; the back gears and clutch pinion are moved by the lever which takes the positions A and B. The narrow gear to the right of the back gears in Fig. 5 facilitates the engagement of the teeth in the back gears. The tumbler is operated by the pilot wheel on the gear box and is automatically and positively locked in position after each change in speed. The tumbler gear mechanism is illustrated in Fig. 7. The arrangement of the index plate is clear from the illustrations. In case the gears should interfere while being shifted they may be revolved slightly by a gentle pressure on the treadle, which is connected to the main starting lever. When a cone pulley drive is used the tumbler mechanism and two of the cone gears are done away with.

By pulling out the pin, in the frame near the upper right hand corner of the driving gear box, the ribs in the face-gear web are engaged by a locking pin and the spindle is locked, a desirable feature when attaching or removing arbors, or face mills which screw on the spindle. The pin is automatically released when the starting lever is thrown to the left.

The feed box is just below the driving gear box, and provides 16 feeds; it is quite similar to the driving gear box in principle, except that the tumbling shaft is the last instead of the first shaft, thus making it possible to use gears of large diameter running at moderate circumferential speeds. The feed may be changed while the machine is in operation. The interior of the feed tripping and reversing box is shown in Fig. 8. This is located on the side of the knee and is connected to the feed box by the universal joint shaft. The feed trip mechanism, of the single plunger type, operates through a large clutch on a shaft in the reverse box, which runs ten times as fast as the feed screw. The strain on the teeth is therefore much lower and it is very sensitive. The feed screws are of large diameter with double threads and steep pitch and are provided with ball bearing thrust bearings. The table is provided with a quick return handwheel.

The column and knee are both of box construction, heavy and rigid. The table is of unusual depth with large bearings: wear is in all cases taken up by adjustable gibs. The outer arbor bearing is rigidly supported. Special attention has been given to the lubrication. A circular milling attachment has been made to fit both the horizontal and vertical machines.

The vertical type machines differ from the horizontal type only as concerns the distinctly vertical features. They are designed for heavy duty, and the parts are of the largest proportions practicable. The spindle is driven from the horizontal driving shaft by miter gears of large diameter and coarse pitch. The gear on the spindle is located so as to bring the drive as close to the lower bearing as possible, thus reducing the liability of torsional vibration to a minimum.

The head frame has long bearing surfaces and there is provision for taking up wear by means of a taper gib. There is also an adjustment provided for maintaining the vertical alignment of the spindle. When

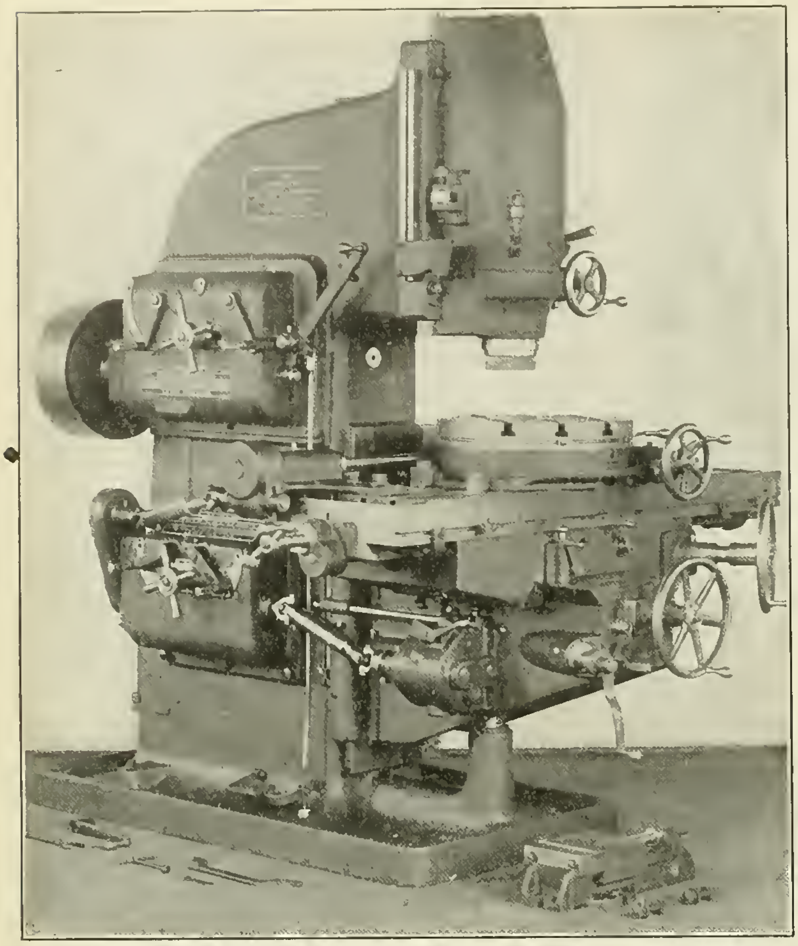


FIG. 9.—VERTICAL MILLING MACHINE, CONSTANT SPEED BELT DRIVE, CIRCULAR MILLING ATTACHMENT.

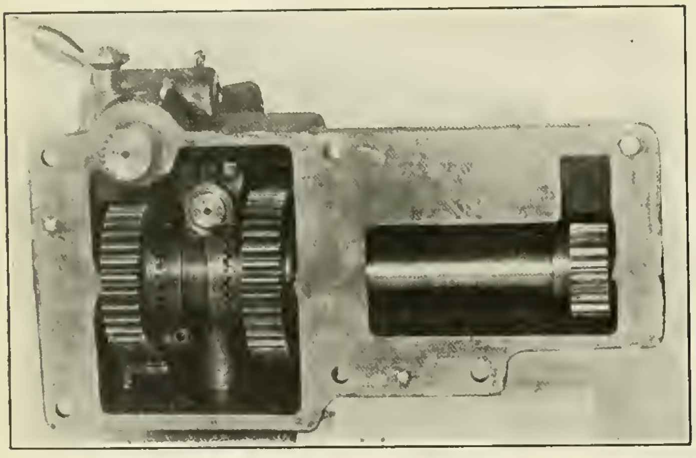


FIG. 8.—INSIDE OF FEED TRIPPING AND REVERSING BOX.

the machine is used on repetition work, requiring heavy cutting, the gib screws may be tightened so as to securely clamp the head to the body of the machine and thus hold it in a fixed position. The spindle may be adjusted vertically by means of the mechanism at the side of the head. The spindle has the same size bearings and is of the same length as that on the horizontal machines of equivalent size.

There is a pilot wheel for quick adjustment at the rate of 6 inches per turn. There is also a slow hand movement which is brought into engagement by means of a positive clutch operated by the knob on the end of the pilot wheel shaft. The slow movement is provided with a micrometer dial. The hand stop at the side of the head is fitted with a micrometer adjustment.

## A COMPRESSED AIR TRACTION SYSTEM.

The buildings of the Plymouth Cordage Co., Plymouth, Mass., on account of their extent—a length of 2,500 feet and breadth of 1,000 feet—can only be served to advantage with some sort of surface track scheme. This service is attained by compressed air locomotives, hauling small flat cars on a narrow gauge track. Five locomotives are in use. They have 5 x 10 inch cylinders, two coupled 24 inch drivers, a single storage tank 4 x 11 feet, with a capacity of 132 cubic feet, and weigh 8,500 pounds each. The track is run about the yard, into or through buildings, many of which are filled with inflammable material, with no danger from fire. A consideration of this single feature has convinced the owners that the steam locomotive is barred and the electric motor has a serious handicap in comparison.

The locomotives are charged at various points about the plant. The charging valves are located particularly with the idea of having the tanks filled at the same time that the cars are being loaded or unloaded. Some of the runs are quite long, the longest being 2,400 feet and the round trip under favorable weather conditions is made with one charge. On this run a net load of 8,500 pounds is carried and the cost of air figures .04 of a cent per ton per 100 feet. Other runs figure .08 of a cent per ton per 100 feet.

This cost is based on a cost of one-half cent per 100 cubic feet of free air and includes all charges up to delivering the air into the mains at 200 lbs. pressure; these figures are on the conservative side.

The system as a whole, taking lump figures, moves one ton, net load, one hundred feet for approximately one cent. This includes the air used for all other purposes, fixed charges on all the rolling equipment as well as compressing apparatus, and all attendance.

LARGE CANTILEVER BRIDGE OPENED.—The Queensboro bridge between Manhattan and Queens boroughs, passing over Blackwells Island, New York, was opened on March 30. This bridge cost $20,000,000 and has a total length of 7,636 ft.

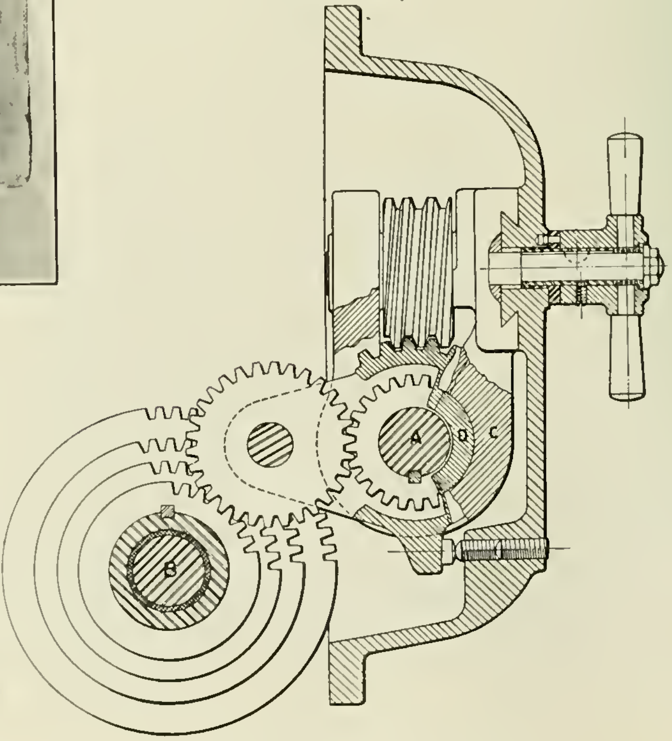
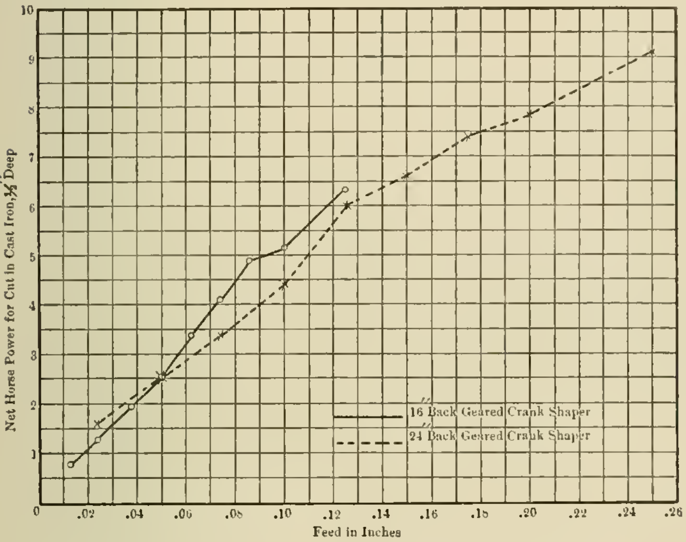



FIG. 7.—TUMBLER GEARS AND FRAME.

## SHAPER TESTS.

Several tests were recently made by the Queen City Machine Tool Company of Cincinnati to determine the horse power required by shapers under conditions met with in ordinary practice. These were made on a 16 in. shaper, driven by a 5 h. p. constant speed motor, and a 24 in. shaper, driven by a 20 h. p. motor. In both cases the shapers were belt-driven from a countershaft which was driven by an electric motor. The length of stroke in each case was 16 in., being the rated capacity of the smaller machine. All cuts were made with the back-gears engaged. The 16-in. machine was run at an average cutting speed of 24 ft. per minute, and the 24-in. at 22 ft. per minute.

The motor and countershaft were first run idle and the power noted. In the values noted on the diagram this is deducted from the other readings, the object of the test being to learn the horse power required to run the machine idle, and when cutting. The motor was arranged to take care of its own loss, and this would perhaps vary some in different types. When the machine belt was thrown in there was no appreciable increase in the current taken for the 16-in. shaper, and there was only about ½ ampere rise at the moment of reverse. The 24-in. shaper took just ½




TESTS OF 16 AND 24 IN. BACK GEARED CRANK SHAPERS.

ampere to run the ram on the stroke, and nearly 2 amperes at the moment of reverse. All readings were taken at the highest point reached by the needle of the ammeter on each stroke. The cuts were all ½ in. deep; the material was cast iron of a rather hard grade. The first cut on each machine was with a one notch feed, and each succeeding one with a one notch increase of feed, except the last one in each test.

It will be seen that the horse power on a given cut was about the same with both machines, and that it increased by about equal amounts for each increase in feed, showing little loss from bind and friction, even under the heavier cuts. This is accredited to accurate fitting of the machine parts, and is something of an achievement when the overhang and twist inherent in a shaper are considered.

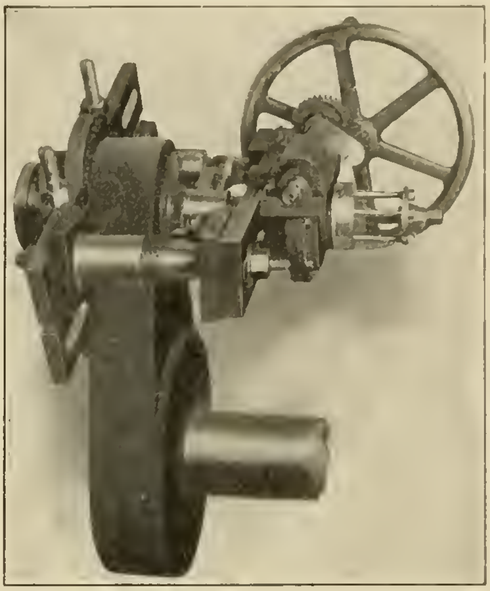
In selecting a motor for a shaper it is important to note that the return stroke of the ram is an idle one, consequently a motor, if of standard make, can be used with a rating somewhat less than the horse power called for, as such motors provide for a momentary overload of 100 per cent.

Electric Hammer.—An electric hammer, which has been used very successfully for chipping steel plates and iron castings, has been developed by The Cincinnati Electrical Tool Company, Cincinnati, Ohio, and will shortly be placed on the market. The hammer is light and its action under severe service conditions seems to indicate that it will not only prove successful but can be maintained at a very low cost, both as concerns power consumed and repairs required.

## UNIVERSAL BORING, TURNING AND FACING MACHINE.

The tool shown in the illustration was originally designed for turning off the rivet head on crank pins, in order to remove them; it is, however, adapted for a variety of other work. Two bars, with Vs cut in them, fit over the crank pin and are drawn together by the two one-inch bolts, clamping the pin firmly. The body of the machine is attached to this base by bolts which pass through the two adjustable spacing blocks that straddle the crank.

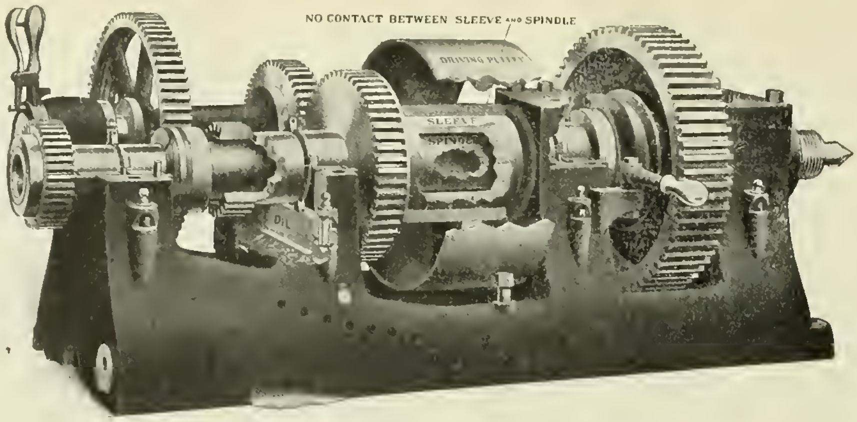
The spindle is driven by the handwheel through the two spur gears and a worm and worm wheel. The handwheel may be replaced by a pulley, electric motor or air drill. Three spindle speeds are available by interchanging the spur gears or by driving direct without these gears. The spindle has an endwise movement of 4 in. and will face up to about 12 in. in diameter. The cutting tool fits in a steel slide in the end of the spindle and is adjustable for different diameters by means of a hand feed screw at the end of the slide. The spindle is fed endwise by the screw with a square head at the extreme right.



BORING, TURNING AND FACING MACHINE.

The device when clamped in position is firm and rigid, yet each piece is light enough to be easily handled by one man in setting the machine up. It is claimed that at least 70 per cent. of the time required for chipping off the crank pin rivet head with a hammer and chisel may be saved by the use of this device. By using an extra facing attachment it is possible to face off pump or engine valve seats, it being immaterial whether the steam chest is solid or whether the valve seat is several inches below the face of the chest. When used on work of this kind the feed is operated by a star wheel knocker. For turning, an offset tool is used and it is possible, of course, to turn for comparatively small lengths only. This machine is made by H. B. Underwood & Co., of Philadelphia.

Painting Steel Passenger Cars.—After building a coach entirely of steel at great expense so as to safeguard the passenger against fire, the builder is often required to paint and varnish the exterior and grain the interior to resemble wood, using highly inflammable material. This is, of course, an inheritance from the wooden coach, a habit which is hard to change. Steel can be given an excellent dull paint finish which could be easily kept clean and we await some Lochinvar to lead us away from the highly polished and inflammable finish now in vogue. Incidentally the subject of noise due to the use of steel was a mooted question before any coaches were built, but anyone who has ridden in a steel coach will concede that, except for a slight drumming sound over the trucks, there is, if anything, less noise in a steel than in a wooden coach.—*John McE. Ames before the Central Railway Club.*

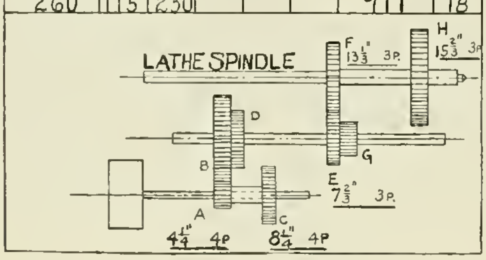



ARRANGEMENT OF PATENT LATHE HEADSTOCK.

## MODERN HEAVY DUTY LATHE HEADSTOCKS.

The following data, furnished by The Lodge & Shipley Machine Tool Company, Cincinnati, Ohio, presents a comparison of their patent head lathe with the all-geared lathe headstock. The all-geared head recognizes the necessity of accumulating belt travel, at the expense of spindle speed. Its power possibilities are very great, but power is obtained at the expense of the open belt speeds. The arrangement of an all-geared head is shown on one of the accompanying diagrams. The compact and powerful design is evident and the broad face and coarse pitch gearing will transmit much power. Both the all-geared head and the Lodge & Shipley patent head are capable of driving high speed steels beyond the limit of their efficiency. There are three serious defects in the all-geared head design: No open belt cuts; no adjustment for wear of headstock gearing; high gear speed of headstock gearing when lathe is run on small diameters.

| SPINDLE SPEEDS ALL OBTAINED THROUGH GEARS | SURFACE SPEED ON WORK IN FEET PER. MINUTE | | | | | PERIPHERY SPEED ON GEARING | H.P. OF DRIVING BELT |
|---|---|---|---|---|---|---|---|
| | 2" | 4" | 6" | 8" | 20" | | |
| 28 | 15 | 29 | 44 | 59 | 148 | 112 | 12 |
| 35 | 18 | 37 | 55 | 73 | 180 | 140 | 15 |
| 44 | 23 | 46 | 69 | 92 | 230 | 176 | 18 |
| 51 | 27 | 53 | 80 | 106 | 260 | 179 | 12 |
| 62 | 32 | 65 | 97 | 130 | | 217 | 15 |
| 77 | 40 | 81 | 121 | 161 | | 270 | 18 |
| 93 | 49 | 97 | 145 | 195 | | 376 | 12 |
| 114 | 60 | 119 | 179 | 239 | | 457 | 15 |
| 141 | 74 | 148 | 221 | 296 | | 494 | 18 |
| 172 | 90 | 180 | 270 | | | 680 | 12 |
| 210 | 110 | 120 | | | | 750 | 15 |
| 260 | 115 | 230 | | | | 911 | 18 |

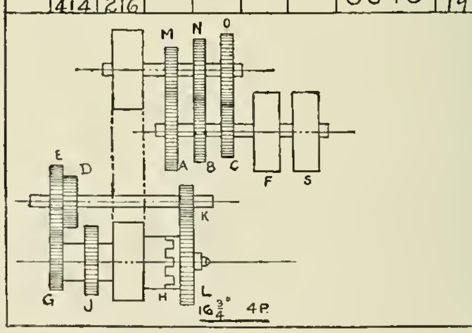



ALL-GEARED HEAD LATHE.

*No open belt cuts are possible* because a gear ratio must exist between the driving pulley and the spindle, the object being to make use of the high belt speed, and consequent great power obtained by revolving the headstock pulley at a speed far greater than would be practicable if carried upon the lathe spindle. The coarse pitch, wide face gearing is of such design as to transmit great power from the fast running driving belt to the spindle. This coarse pitch gearing is bound to mark the work being turned, particularly upon finishing cuts. This marking will be the same as that seen on work when the finishing cut is taken with worn back gears on a cone-head lathe. Finer pitch gears in the headstock will tend to remedy this fault, but with the sudden heavy loads that are thrown upon the gearing when picking up high speed cuts, the life of the gearing will be short.

*No adjustment for gear wear.* Since the shafts of the all-geared head are carried in bearings that are in alignment with each other, having no adjustment for wear, the wear of the gearing, that is inevitable from a constant service, will make the drive become noisy in operation. Just how long it will be before this becomes so great as to seriously endanger the quality of the machine output will depend upon the character of the service demanded from the lathe. The all-geared headstock illustrated, driven by a 15 h. p. motor, became so noisy after being less than four years in operation that it is was necessary to take out the machine and substitute a patent head. The work was limited to steel bars of 5½ in. diameter, one roughing and one finishing cut being taken; the bar was then finished to size on a grinder. The use of rawhide in place of the iron or steel pinions will remedy the noisy operation of the headstock, but will prove quite an expense to maintain, since the life of a rawhide pinion was found to be hardly two years, in the all-geared headstock under consideration.

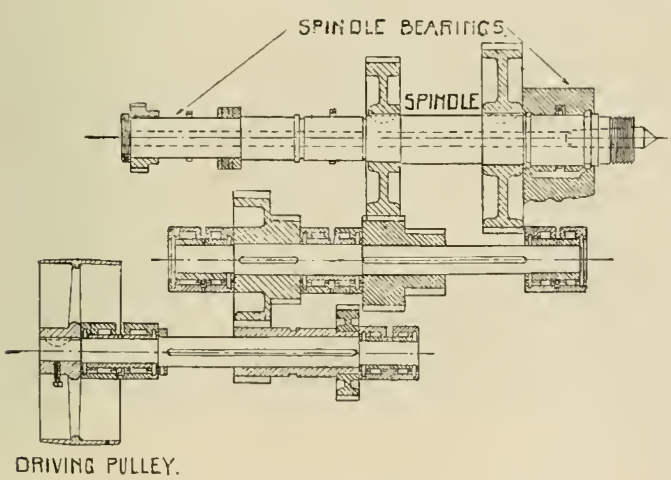
| SPINDLE SPEEDS | | SURFACE SPEED ON WORK IN FEET PER. MINUTE | | | | | PERIPHERY SPEED ON GEARING | H.P. OF DRIVING BELT |
|---|---|---|---|---|---|---|---|---|
| BACK GEAR | OPEN BELT | 2" | 4" | 6" | 8" | 20" | | |
| 11 | | 6 | 12 | 17 | 23 | 57 | 48 | 6½ |
| 13 | | 7 | 14 | 20 | 27 | 68 | 56 | 8½ |
| 17 | | 9 | 18 | 27 | 36 | 88 | 72 | 10½ |
| 21 | | 11 | 22 | 33 | 44 | 110 | 91 | 11½ |
| 26 | | 13 | 27 | 40 | 54 | 135 | 112 | 16 |
| 32 | | 16 | 33 | 50 | 66 | 167 | 138 | 19 |
| 39 | | 20 | 41 | 61 | 82 | 204 | 168 | 6½ |
| 47 | | 24 | 49 | 73 | 98 | 247 | 203 | 8½ |
| 61 | | 32 | 64 | 96 | 128 | | 264 | 10½ |
| 73 | | 38 | 76 | 114 | 153 | | 315 | 11½ |
| 93 | | 49 | 97 | 146 | 195 | | 401 | 16 |
| 112 | | 59 | 117 | 176 | 234 | | 484 | 19 |
| | 143 | 75 | 150 | 224 | 299 | | OPEN | 6½ |
| | 174 | 91 | 182 | 273 | | | | 8½ |
| | 220 | 115 | 230 | | | | BELT | 10½ |
| | 268 | 140 | 280 | | | | | 11½ |
| | 340 | 178 | | | | | CUTS | 16 |
| | 414 | 216 | | | | | | 19 |




PATENT HEAD LATHE.

*The high gear speed of the headstock gearing* in the all-geared head drive is due to the design that mounts a large diameter gear upon the lathe spindle, and the absence of open belt speeds for the fastest spindle speeds. In the headstock illustrated the two gears shown upon the spindle are 13 and 15 in. in diameter. Cuts taken on all diameters of work must be driven through one of these gears. Should these diameters be small, from 2 to 4 inches for example, the peripheral speed of the spindle gear in the headstock will be from four to eight times greater than the surface speed upon the work being turned. The result is that with proper cutting speeds, when high speed steel is used, the peripheral speed of the headstock gearing is very great and will thus introduce the element of rapid wear. The power of the drive on the all-geared head construction bears little relation to the actual cutting needs, since the belt travel is constant for all speeds that may be obtained through the gear changes in the headstock.

The diagrams show the spindle speeds, surface speeds on certain diameters, peripheral gear speeds, and horse power of the all-geared head, and a 24-inch patent headstock. It will be seen that the peripheral speeds of the patent head face gear are very much less for the high speeds than on the all-geared head spindle gears; also that the six high spindle speeds, when taken on the patent head, are delivered through the open belt.



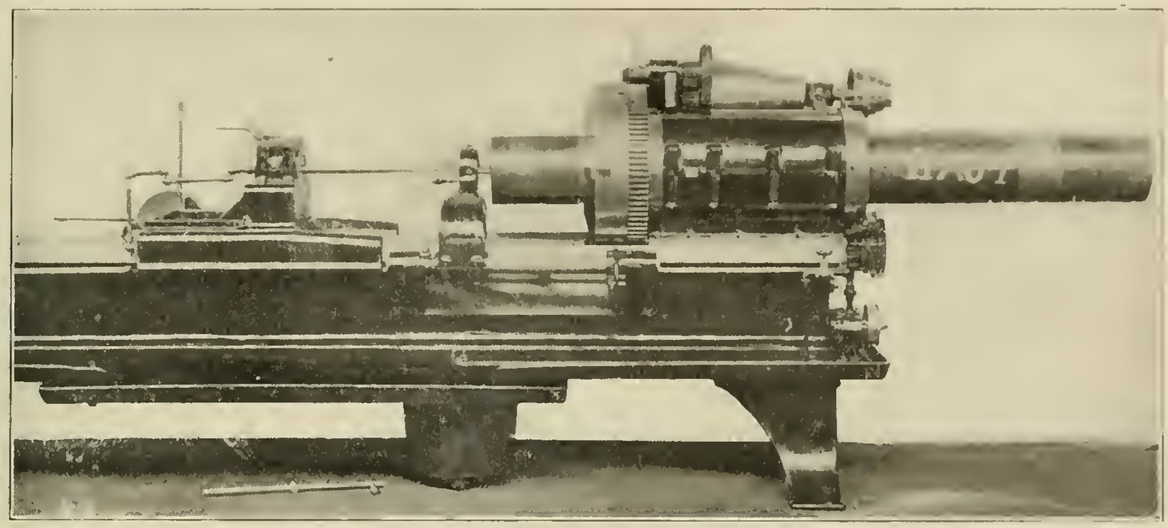

ARRANGEMENT OF GEARING ON ALL-GEARED HEAD LATHE.

The gearing in the patent headstock may be adjusted for wear by means of the eccentric bushes carrying the back gear sleeve. Independently of such wear or adjustment, work can be finished with open cuts, thus insuring a perfectly round surface and one free from gear marks. The belt speed may also be regulated to serve the needs of any particular cuts. Twenty horse power will not need to be delivered through the belt to the headstock when the nature of the cut calls for only 5 h.p.

## BORING LOCOMOTIVE AXLES.

It is the practice, in several railroad shops, to bore holes through the center of locomotive driving axles to guard against defective material or defects in forging. Such holes must be straight and smooth in order to discover these imperfections. The Springfield Machine Tool Company, Springfield, Ohio, recently made some tests on the smaller of two sizes of machines which have been developed for this purpose, and for boring spindles (February, 1905, page 62). It was found that a 1½ in. hole could be bored at the rate of 90 in. per hour.

Some idea of the heavy construction of the machine may be gained from the photograph. The head consists of a large annular bearing, the front of which carries a three jaw scroll chuck, with the face gear cut in the rear portion of the chuck. This chuck and spindle will receive an axle 11 in. in diameter. The head is provided with eight changes of speed. The carriage is exceptionally long and heavy and is driven by power feed and a double rack, thus insuring a long life, and a steady, powerful forward motion under the heaviest cuts. The carriage is provided with ten changes of speed.



MACHINE FOR BORING LOCOMOTIVE DRIVING AXLES

The machine is equipped with a special pump and telescopic brass oil piping. This system of conducting the oil to the tool is unique and convenient, and does away with all the inconveniences of flexible hose piping. The cutting compound, by a special construction of the boring bar, is delivered to the very point of the boring tool, under high pressure, thus forcing the chips from the cutting edge, and back out of the hole.

Wastes in Mining.—Attention is directed to the waste of material which is, to a considerable extent, preventable in the mining and extraction of ores in the mining industries, as in lead, zinc, copper, gold and silver mining; and especially to the enormous waste in coal mining, which is equivalent to about one-half of the total product mined, or for the year 1907 about 240,000,000 tons. The aggregate of all these products of mineral waste for the past year is estimated to approximate $1,000,000 per day in value. The mineral production of the United States during the past year was approximately $2,000,000,000, so that this estimated waste is equivalent to more than one-sixth the value of the total production.—*Report of Minerals Section of the National Conservation Commission.*

The Fulton Street Hudson River Tunnel between New York and Jersey City was holed through on March 11. This is the last of the river tunnels at New York City to be finished ready for lining.

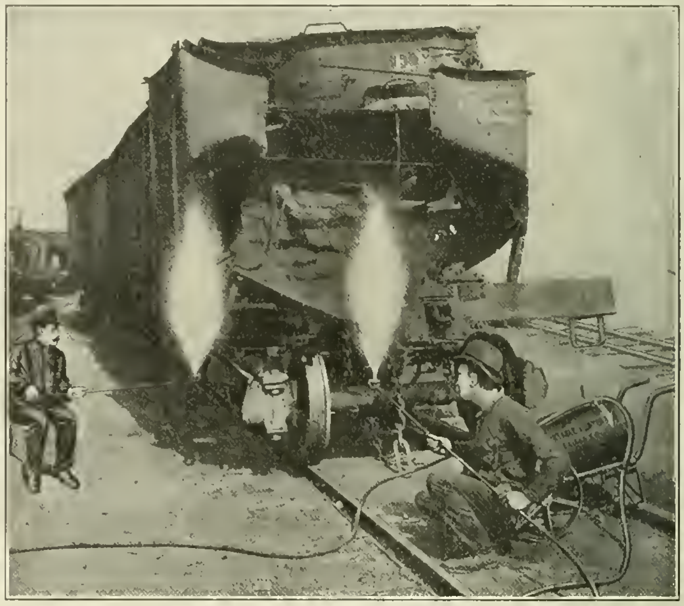
## STEEL CAR REPAIRS.

The repairing of steel cars is not a serious problem where proper facilities are provided. The greatest difficulty is with the bent or buckled parts, but they may be readily repaired after some form of heat treatment. In many cases these parts may be straightened in place; in others it is necessary to remove them and heat, straighten and re-rivet them to the car.

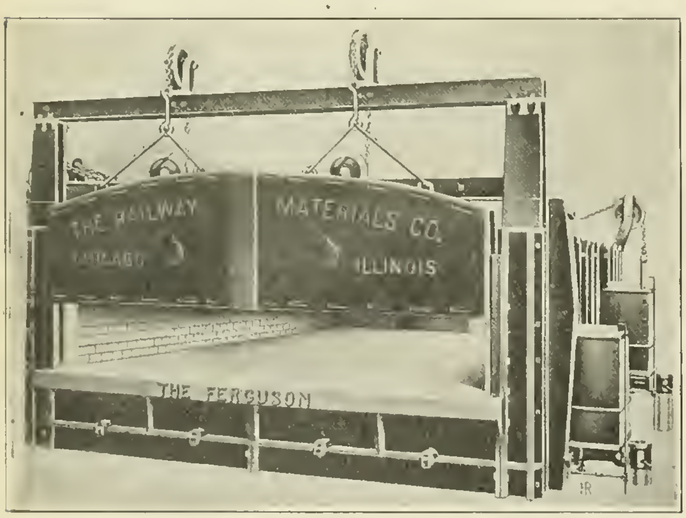
A steel car repair plant should have some means of heating bent parts in place; a proper equipment should comprise one or more portable heating outfits for this class of work. Also a furnace capable of taking plates at least 6 ft. in width and 10 ft. in length; this furnace to be used for straightening such parts as have to be removed from the car. The shop and yards should be provided with adequate facilities for riveting. The Railway Materials Company, of New York and Chicago, manufactures a line of heating equipment which is especially designed for use in repairing steel cars. It includes portable heaters for local repairs, several sizes of furnaces for heating plates, and a variety of rivet furnaces.

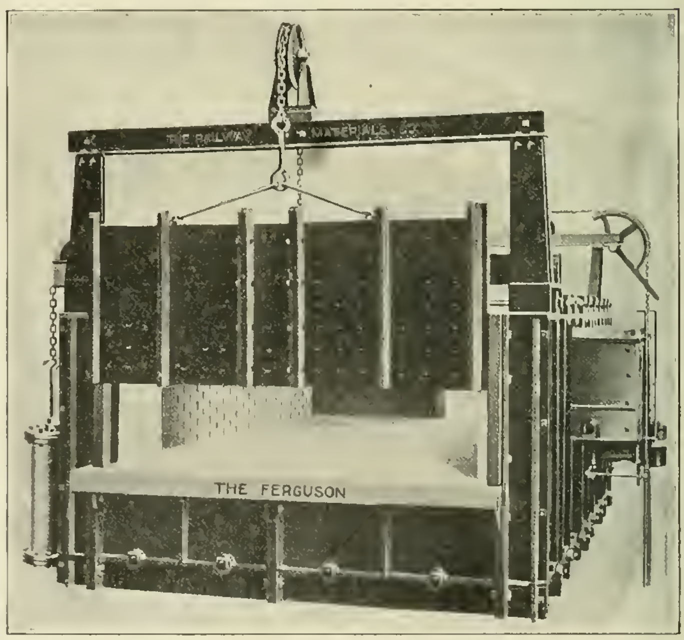
The Ferguson portable heater shown in the illustration affords a rapid and easy means of heating a damaged part locally. It operates with compressed air and consists of a tank mounted on wheels for holding a supply of oil. A mixing valve is provided at the tank for mixing the oil and air. Leading from the valve is a section of hose and a short piece of pipe at the end of which a burner is attached. Here the oil is ignited. The burner gives off an intense heat and rapidly brings the damaged part up to a suitable straightening heat. This heater can be readily handled over yard tracks and elsewhere by one person.

PORTABLE RIVET HEATING FURNACE.



PORTABLE HEATERS.




FURNACES FOR HEATING STEEL CAR PARTS.

For heating plates or other parts which have to be removed for straightening, this company manufactures a line of furnaces, two sizes of which are shown on the accompanying photos. One of these is 6 ft. 8 in. in width inside and 10 ft. in length. It has a door at one end the full width of the furnace; also a smaller door at the opposite end; on one side an additional burner is set at the floor line, thus providing admirable facilities for locally heating a sill or other part. The other furnace is larger, being 8 ft. 10 in. in width and 14 ft. in length inside. It also has a door the full width of the furnace at one end, and a smaller door at the other end. The larger door is constructed to lift in sections, which are independently operated by means of air hoist lifts. It is also equipped with an extra burner at the floor line for heating members locally. These furnaces are substantially constructed and are lined throughout with a heavy lining of high-grade fire brick; they are sold erected in position and ready to operate. They are intended to operate with crude or fuel oil supplied to the burners at a pressure of from 5 to 10 lbs. A fan blast pressure of 8 ozs. per sq. in. is used, compressed air not being required.

A portable outfit for heating rivets is also manufactured by this company and is shown in one of the illustrations. It carries its own fuel supply and operates with compressed air. Its weight is approximately 550 lbs. with a full supply of fuel and it may be easily transported about the yards. The tank holds about ten gallons of oil, or a sufficient quantity for a day's run.

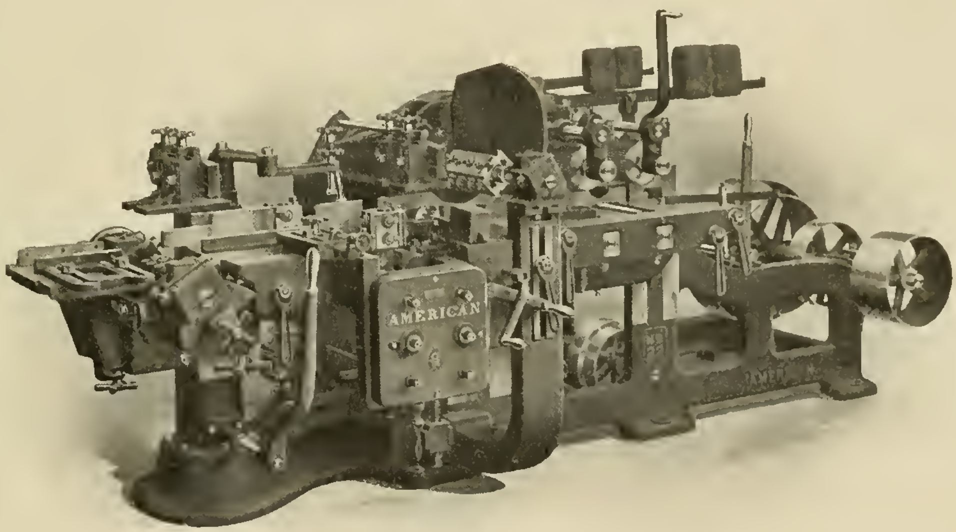
## NEW OUTSIDE MOULDER.

A number of important improvements have been made in the new American outside moulders. These will work 9, 10, 12 and 14 in. wide by 5 in. thick. The cylinder boxes are of a patent side clamping flange type which prevent the operator from screwing the top portion of the boxes down on the shaft so tightly as to cause the shaft to heat and often to spring. With the improved method the cap is held in position by drawing together the sides of the boxes with heavy bolts; as the cap is plain tapering, it is impossible to force itself up.

With the older type moulders it was necessary, in order to adjust the side spindles vertically, to loosen four bolts in each cap, or eight in all, and to re-tighten these after the spindle was adjusted. Now one movement of a lever locks and unlocks both caps and the spindle may be adjusted very quickly. This is true of the inside and outside side spindles, as well as of the top headstock. It has been necessary, up to the present time, in removing the lower feed rolls in moulders to almost entirely dismantle the machine, consuming at least half a day; on the new machine, the lower feed rolls can be removed and new feed rolls be put in and the machine be ready for work in not over ten minutes. This feature is appreciated when it is desired to change from plain to corrugated feed rolls for running wet stock. Another important feature, which is new on outside machines, is the provision for stopping and starting the feed from either end of the machine.

The frame is heavy and is cast in one piece. The heavy column at the rear end makes a substantial support for the end of the table, and also for the under cutter-head. The top arbor is provided with an adjustable outside bearing, bolted to the base of the frame, for lining up the arbor when necessary; at the top it is secured firmly by a bolt passing through the table and the frame. The bed is heavy and securely gibbed to the frame, with proper provision for taking up the wear; it is raised and lowered by a large screw on ball bearings, operated by a crank. There is a reversible bed plate directly under the top head—one side plain, the other side grooved ½ in. deep and 1½ in. wide, allowing knives to extend below the face of the bed, if necessary. The extension of the bed, beyond the lower head, drops down, giving free access to the cutter head, without disturbing the guides. The detachable plate or chip breaker in front of the bottom head can be adjusted from the top of the table. The adjustable guide back of the outside head has a screw adjustment of 4 in. without disturbing the base of the guide. The bed carries the inside and outside headstock; each headstock has an independent adjustment.

The feed works are exceptionally heavy, having four 6 in. driven rolls; a new direct gear drive makes it a most positive and powerful feeding device, without the use of heavy weights. There is a spring intervening between the weight lever and rolls to minimize any jar when dropping. The top rolls and the hoods for the top head can be raised and lowered by a lever placed conveniently. This will admit placing forms, setting knives, or slipping back stock when desired. The top rolls are provided with an outside bearing, which can be easily removed for changing the rolls. The feed is arranged with a new gear change, furnishing six rates of feed, 10, 15, 20, 30, 40 and 60 feet per minute, without extra pulleys or extra gears. The top head has a lateral adjustment; the bottom head has lateral and vertical adjustments controlled by hand wheels. The hood for the top head is fitted with an adjustable chip breaker, made in three interchangeable sections. It can be thrown up and back across the machine, giving free access to the top-head cutters. The cutting circle of all heads is 6⅛ in. All chip breakers are adjustable, permitting 3 in. extension of knives on top and bottom heads (giving 12 in. maximum swing), and 2½ in. on side heads. The side heads raise and lower with the table, and can be set to an angle and be moved vertically and laterally without changing the angle. The outside head is arranged with an adjustable weighted chip breaker, which travels with the head. The inside head can be adjusted from the front or rear side of the machine. Both side heads can be adjusted vertically from the top or bottom of the headstock. The step box for the side spindles has self-oiling, self-leveling steps. One movement of the lever locks the headstocks firmly. These machines are made by the American Wood Working Machinery Company of Rochester, N. Y.



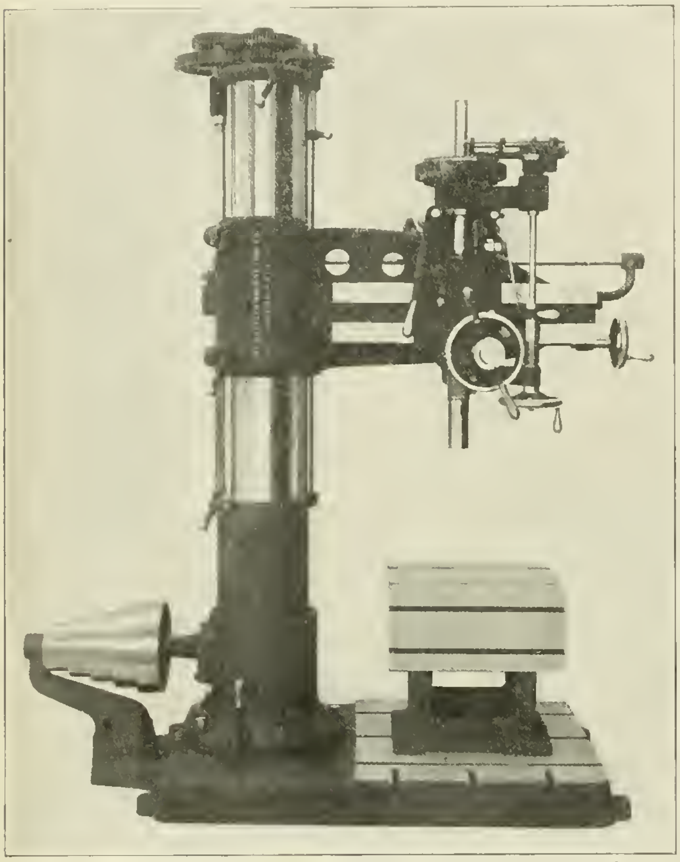

IMPROVED OUTSIDE MOULDER.

New York Train Service Record.—The record of the New York Public Service Commission shows that during the month of January, 53,560 passenger trains were run in the State of New York, and of these 86 per cent. were on time.

## TWO-AND-ONE-HALF FOOT RADIAL DRILL.

This drill is of simple and substantial construction, and while it embodies several of the good points of the standard line of radial drills made by the Mueller Machine Tool Company of Cincinnati, is not an expensive tool, but is intended for a class of work which does not require the higher grade machines of this type.

The stationary column is of heavy section throughout, making it strong and rigid. The arm is of tube section and cannot be twisted under severe service. It is clamped to the column by the two handles and may be raised and lowered rapidly; it is instantly controlled by a lever on the cap, within easy reach of the operator. The bronze plate attached to the arm enables the operator to select the proper speeds which may be changed while the machine is in operation. The head is traversed through a double pitch screw and is equipped with a locking device.

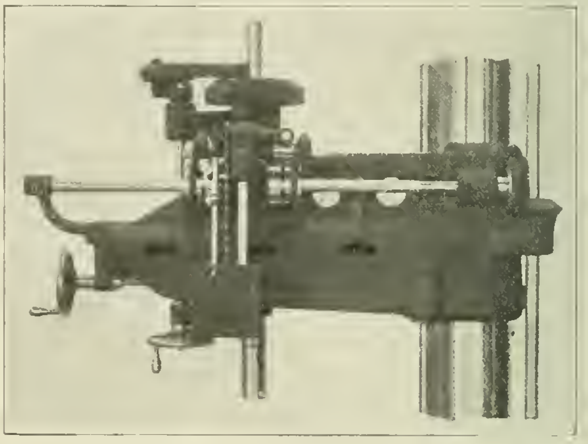


TWO-AND-ONE-HALF-FOOT RADIAL DRILL.

The spindle has ten changes of speed, all instantly available. It has quick advance and return and is counterbalanced. A tapping attachment is provided and is so arranged that an adjustable gauge screw causes the tap to slip when it reaches the bottom of a hole. The starting, stopping and reversing lever is located on the head directly in front of the operator, making it very convenient. The automatic feed has four changes and can be used as either a positive or friction feed. Changes may be made while the drill is at work. The feed is adapted for the use of high speed drills, etc. The gears, both spur and mitre, are planed theoretically correct and the shafts, as well as the column, are ground to size. This drill is also made in the 3 and 3½ ft. sizes.

## COLLEGE MEN IN RAILROAD SERVICE.

E. H. Harriman recently wrote to a Yale publication on college training for railway men, stating in part: "A high school boy is more likely to know arithmetic and to be able to prepare a clear and concise statement. However, in the long run, the college men should pull out ahead, as hard work and continued effort will alone lead to success, while pull can't last. A college education is, in the beginning, a real disadvantage, and I have found that in every case the high school boy does better work than the college man for the first few years. However, as soon as the college man has got back to first principles, he will go ahead much faster than his less educated rival. His mind is, naturally, better developed and more capable of grasping the fine points of the business. On the other hand, the high school boy, being younger, is more adaptable and has not, in most cases, the irregular habits of the college man. No matter how well educated a man may be, he must start in railroading at the very bottom. He has no fixed home; he is like a naval officer, always at sea, and moreover, he is always working to the limit of his endurance. It is the hardest life I know, and yet one of the most pleasant. It teaches a knowledge of men, and in this way is the best training for any profession. My advice to the college man expecting to enter railroading and hoping to have an easy life is 'Don't': but to the man who does not mind the hardest kind of work, who will not quit under early disappointments, and who wishes to have the most interesting sort of a career, 'By all means do.'"



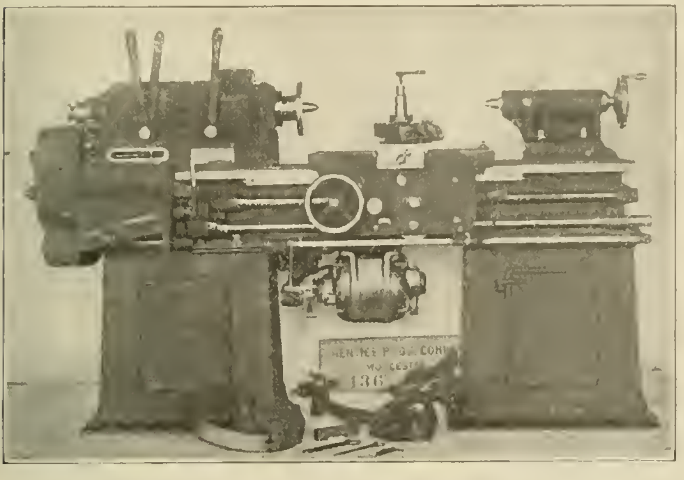
REAR VIEW OF ARM OF RADIAL DRILL.

Loss of Life in Coal Mines.—Even more serious than the question of the waste of materials is the excessive loss of life in our mining operations. During the past year in coal mines alone more than 3,000 men were killed and more than 7,000 injured. The number of men killed in the United States for each 1,000 men employed in the mines is from two to four times as great as it is in other coal-mining countries. Of course, it is not to be expected that the coal miners in the United States at 75 cents per ton for their coal at the mine can take the elaborate precautions in behalf of the safety of the men and the protection of waste of fuel which are taken in European countries where the value of the coal at the mine is more than twice this figure; but the American people cannot afford to demand cheap coal at the cost of human life and the waste of the heritage which belongs to the next generation. The miners and the operators are anxious to inaugurate these needed reforms, and certainly the American people are ready and willing to pay whatever increase in the cost of fuel may be found necessary in order to guarantee the safety of the miner and the saving of the fuel which belongs to the next generation.—*Report of Minerals Section of the National Conservation Commission.*

Pressures in the Metric System.—In the metric system, fluid pressure is expressed in kilograms per square centimeter. The constant for converting into pounds per square inch is 14.22, a kilogram per square centimeter being equal to 14.22 pounds per square inch. In scientific work, fluid pressures are commonly measured in atmospheres, this being a universal natural standard, and it happens that for rough approximations, a kilogram pressure per square centimeter is practically equal to one atmosphere.—*Machinery.*

## AN INTERESTING MOTOR APPLICATION TO A HIGH-SPEED GEARED-HEAD LATHE.

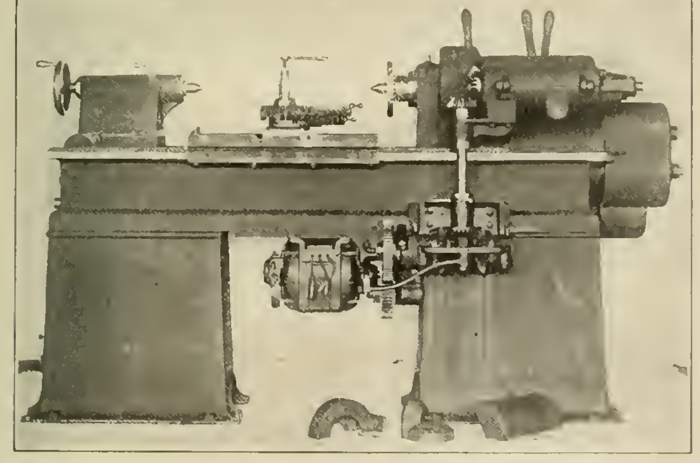
In applying a motor drive to their high-speed geared-head lathes, twenty-two inches in size and under, Prentice Bros. Company of Worcester, Mass., place the motor underneath the bed, as shown in the illustrations. On the larger lathes the size of the motor does not permit doing this, and it is placed at the rear of the headstock. The geared-head provides eight changes of spindle speed, without stopping the lathe, and the use of a constant speed motor having about 1200 r.p.m., and of either the direct or alternating current type, is therefore recommended. By using a variable speed motor a great number of speed changes may be furnished, but ordinarily these are not needed.



UNIQUE MOTOR APPLICATION TO HIGH-SPEED LATHE.

Where a constant speed motor is applied, as shown in the photos, the lathe spindle may be started, stopped or reversed, without stopping the motor, by the handle on the spline shaft at the lower right hand corner of the carriage. Time and power are thus saved over the method commonly used of reversing the motor.

Motion is transmitted from the motor to the headstock through the train of spur gearing and the bevel gears at the top and bottom of the vertical shaft at the rear. The direction of the vertical shaft is stopped, or changed, by shifting the two bevel gears on the horizontal shaft, which engage with the one at the lower end of the vertical shaft. These gears are controlled from the handle on the spline shaft at the front of the machine.



MOTOR APPLICATION TO HIGH-SPEED LATHE, REAR VIEW.

In cutting threads it is much easier to cut to a shoulder with this arrangement, as the controlling lever needs to be moved only two or three inches and works more easily than the reversible controller on a motor.

## FORGED STEEL HYDRAULIC JACKS.

The latest development in the hydraulic jack field is a design forged entirely out of open hearth, fluid compressed steel which is being put on the market by the Duff Manufacturing Company, Pittsburgh. The patents covering the special features and construction are held by the Bethlehem Steel Co. who designed and perfected it and do the special forging necessary. It is called the Duff-Bethlehem Hydraulic Jack and because of its steel construction weighs from 30 to 60 per cent. less than other hydraulic jacks of the same capacity and lift.

One of the greatest troubles with hydraulic jacks has been the packing, particularly that at the bottom of the cylinder. In this new design both the cylinder and ram have solid bottoms requiring no packing or joints at these points. The ram bottom is also forged integral with the pump socket and requires no packing at that point. In fact, there are practically only two small packings in the entire jack.

Careful attention has been given to obtaining the minimum number of parts in the operating mechanism and to make these as simple and strong as possible. These parts can be easily replaced if necessary without special tools. The jacks will extend to their full length when placed at any angle. The load may be tripped or may be lowered as slowly as desired, or stopped at any point when lowering.

Jacks of all types and capacities are made to this design. The illustrations show two types suited to railroad uses. The low or telescope type is fitted with an improved duplex pump which automatically regulates the change of speed proportional to the load being lifted. This type is regularly made with capacities from 30 to 300 tons and can be procured in higher capacities if desired.

FORGED STEEL HYDRAULIC JACKS FOR RAILROADS.

The Duff Manufacturing Co. by the addition of these hydraulic jacks is now prepared to furnish practically every kind of lifting jack for every possible condition or purpose. It will be remembered that it previously had a large line of Barrett jacks, Duff ball bearing screw jacks and other special designs.

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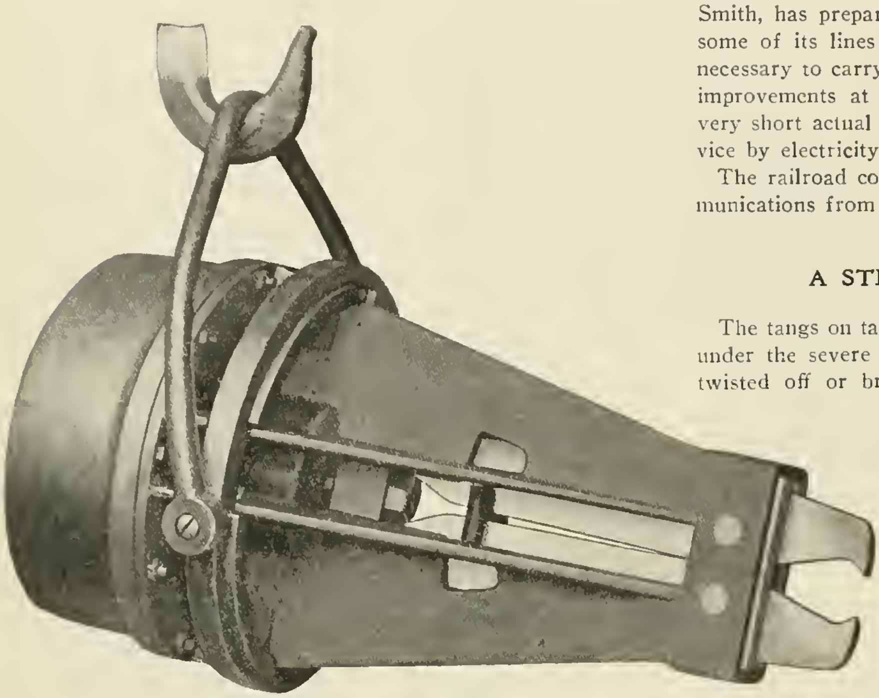
The Effect of Superheated Steam on cast-iron pipe fittings was strikingly shown in a 20-in. tee recently removed from a main steam line in the Pratt street power plant of the United Railways & Electric Co., Baltimore, Md. The main had been in service for three years, carrying steam at 160 lb. pressure with a superheat of about 500 deg. Fahr. above saturation. The fitting was found to have grown nearly ¾ in. in length and was fully 1 in. larger in diameter than when it was installed. The inner surfaces were covered with a hard reddish oxide in which no cracks were visible, but the outer surfaces were covered with fine hair cracks, some of which had in places opened up to about ⅛ in. Steam had begun to leak through these larger cracks, causing the removal of the tee.—*Engineering News.*

## PNEUMATIC STAYBOLT NIPPER.

A pneumatic staybolt nipper, developed by C. K. Lassiter, is shown in the accompanying illustration. The device is compact and convenient, being about 42 in. long and 20 in. in diameter at its largest part. It is made entirely of steel, weighing only 450 lbs. The action is simple, the piston forcing a wedge between the tapered bearings on the blades, a suitable spring drawing them back into position for the next stroke. The bail trunnions are on a ring, allowing the nipper to be operated in any position. A three way operating valve is placed in the center of the cylinder head for the air connection.



PNEUMATIC STAYBOLT NIPPER.

The nipper has a capacity for 1¼ in. staybolts when working with 80 lbs. pressure. It is sold by The Walter H. Foster Company, New York.

## STEAM RAILWAY ELECTRIFICATION IN BOSTON.

This subject received special attention in the report of the Massachusetts Railroad Commission recently submitted to the Legislature. In the commission's report for 1907 the statement was made that the railroads should investigate at the earliest possible date the whole question of electrification of their lines running into the city. The last report contains letters from the various companies stating what they have done up to the present time.

President Mellen, of the New York, New Haven & Hartford R. R., reported that the company considered the interruptions to its electric service between Stamford and New York no greater nor more frequent than was the case when steam was in use. It is not prepared to state, however, that there is any economy in the substitution of electric traction for steam, but on the contrary, it believes the expense is very much greater. In view of the short time the company has had an opportunity to gain definite knowledge by running its trains electrically into New York, it believes that the Boston public will make no mistake in waiting a while longer for the installation of electric traction in Massachusetts, for by such waiting the vexation, delay and embarrassment of experiment will be avoided, and the work will have advanced to a stage that will result in a better installation in some respects, and for a smaller outlay, than the pioneer work on the west end of the line.

President Tuttle of the Boston & Maine R. R. states that his company uses coke as a fuel on a very large portion of the local passenger service in the vicinity of Boston, and therefore feels that there is not the necessity of introducing electrification that exists where a fuel giving off more smoke and dirt is employed. The company is watching, however, the experiments and results obtained near New York, but feels that they do not indicate the desirability of electrifying the Boston service at the present time.

The Boston & Albany R. R., through Vice-President A. H. Smith, has prepared preliminary plans for the electrification of some of its lines into Boston, but it feels that the large sums necessary to carry out such work could be better used for other improvements at the present time, particularly in view of the very short actual experience in the operation of heavy train service by electricity.

The railroad commission publishes the full text of these communications from the various railroads without any comments.

## A STRONGER SHANK FOR DRILLS.

The tangs on taper shank drills have not proved strong enough under the severe service of modern practice and are frequently twisted off or broken. To overcome this the Standard Tool Company, of Cleveland, O., is putting drills on the market with a new standard of shank, known as the "Stantool" shank. This shank is shorter and the tang is much heavier than the old standard, thus practically eliminating the possibility of broken tangs. The contrast between the old and new shanks is clearly shown by the accompanying illustrations. This company is also prepared to furnish sockets and sleeves to fit all modern makes of drill presses on the market, and arranged to take the new "Stantool" shank.

"STANTOOL" SHANK.

MORSE STANDARD SHANK.

Daily Review.—The Daily Railway & Engineering Review issued during the convention of American Railway Engineering & Maintenance of Way Association in Chicago, March 15-19, was greatly appreciated by both the members attending and the exhibitors at the Coliseum. The convention, exhibition and the "daily" were all grand successes.

## BOOKS.

The Railway Locomotive. By Vaughan Pendred, M.I.M.E. Cloth. 5½ x 8¼ in. 310 pages. Illustrated. Published by D. Van Nostrand Co., 23 Murray St., New York. Price, $2.00, net.

It is stated by the author in his introduction, that in the many books written about the locomotive, it has always been treated anatomically, not physiologically, and he has attempted in this work to break new ground. There is practically nothing given on the history of the locomotive, the endeavor being to describe the modern machine and to explain why it is what it is. He has divided his subject into three parts—vehicle, steam generator and steam engine—and discusses each in a broad, general manner. Illustrations of present day practice are freely given, and while these are usually taken from British designs, the principles demonstrated are fundamental and apply equally well to American practice. Foot notes and other reference to more extensive and detailed treatises on the different phases of the subjects are numerous. This book will be found to be particularly suited to men who have specialized in some other branch of engineering and wish to get posted on the locomotive.

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Block Signal and Train Control Report to the Interstate Commerce Commission. 77 pages. 6 x 9. Illustrated. Obtained upon request to the Interstate Commerce Commission, Washington, D. C.

The first annual report of the committee appointed to investigate the subject of block signals and train control is now being issued by the Interstate Commerce Commission. It contains considerable information in connection with cab signaling and complete descriptions of foreign block signaling equipment of several kinds.

## PERSONALS.

Malcolm Baxter, master mechanic of the Western Ohio Railway, has resigned, effective April 1.

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L. H. Raymond, master mechanic of the New York Central R. R., at High Bridge, N. Y., has resigned.

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G. W. Robb has been appointed an assistant master mechanic of the Grand Trunk Pacific Ry., with office at Rivers, Man.

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George F. Hennessey has been appointed the roundhouse foreman of the Chicago, Milwaukee & St. Paul Ry., at Janesville, Wis.

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Roy S. Parker has been appointed the general storekeeper of the Kansas City, Mexico & Orient Ry., with temporary office at Fairview, Okla.

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W. C. Weigel has been appointed the general time and work inspector of the motive power department of the Union Pacific R. R., with office at Omaha, Neb.

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C. B. Smyth, assistant mechanical engineer of the Union Pacific R. R., has resigned and has been appointed the superintendent of the McKeen Motor Car Co., Omaha, Neb.

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E. H. Hohenstein has been appointed a general boiler inspector of the Chicago, Rock Island & Pacific Ry., with office at Horton, Kan., succeeding W. B. Embury, assigned to other duties.

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E. V. Williams has been appointed a general foreman, locomotive department of the New York Central & Hudson River R. R., with office at Avis, Pa., succeeding H. B. Whipple, promoted.

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A. J. Edmonds, a general car and locomotive foreman for Sioux City and Dakota divisions of the Chicago, Milwaukee & St. Paul Ry., has been transferred to Madison, Wis.

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G. E. Johnson has been appointed the master mechanic of the Wymore division of the Chicago, Burlington & Quincy R. R., with office at Wymore, Neb., succeeding A. B. Pirie, assigned to other duties.

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B. W. Benedict has been appointed bonus supervisor of the Atchison, Topeka & Santa Fe Ry. at Topeka, Kan., and will have territorial charge of bonus work on the Eastern Grand division and functional supervision over standardization of schedules.

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Euclid E. Grist, assistant general foreman of the Ft. Wayne, Ind., shops of the Pennsylvania Lines West, has been appointed an assistant master mechanic, with office at Ft. Wayne. Allen S. Courtney succeeds Mr. Grist.

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C. H. Seabrook, general master mechanic of the Trinity & Brazos Valley Ry., has been appointed the superintendent of motive power and equipment. The office of general master mechanic has been abolished.

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W. B. Embury has been appointed the master mechanic of the Oklahoma & Pan Handle divisions of the Chicago, Rock Island & Pacific Ry., with office at Chickasha, Okla., succeeding W. J. Monroe, resigned.

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E. V. Dexter, purchasing agent of the Mexican Central Ry., has resigned, and all purchasing and sales for account of the National Railways of Mexico will in future be done by J. H. Guess, purchasing and fuel agent, with office at Mexico City.

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W. A. Bennett has been appointed road foreman of engines of the Chicago, Burlington & Quincy Ry. at Edgemont, S. Dak., with jurisdiction over the line from Alliance, S. Dak., to Deadwood, and over all branches in the Black Hills.

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L. P. Breckenridge, professor of mechanical engineering at the University of Illinois, has resigned to take effect at the end of the college year and on September 1 will assume charge of the Sheffield Scientific School at Yale in place of Prof. Charles B. Richards, retired.

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Thomas A. Lawes, the mechanical engineer of the New York, Chicago & St. Louis R. R., and formerly the superintendent of motive power of the Chicago & Eastern Illinois R. R., has been appointed the superintendent of motive power of the Southern Indiana Ry., with headquarters at Bedford, Ind.

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L. B. Morehead has been appointed the mechanical engineer of the New York, Chicago and St. Louis R. R., vice T. A. Lawes, resigned. Mr. Morehead was formerly the chief draughtsman of the Louisville and Nashville Ry. and lately has been an elevation draughtsman for the American Locomotive Company at Schenectady. His office is at Cleveland.

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W. W. Atterbury, general manager of the Pennsylvania Lines east of Pittsburg has been elected fifth vice-president in charge of the transportation department of the Pennsylvania Railroad. Mr. Atterbury graduated from Yale University in 1886 and entered the service of the P. R. R. as an apprentice in the Altoona shops. From 1889 to 1903 he successively held positions as road foreman of engines; assistant engineer of motive power, northwest system; master mechanic, Fort Wayne; general superintendent of motive power of lines east and general manager of lines east.

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The mechanical department of the National Railways of Mexico has been divided into two districts, the Eastern and the Western. The Eastern district will be the main line from Mexico City to Laredo, with all branches, including the main line from Mexico City to San Juan del Rio, the narrow gauge system, the Cuernavaca district and the districts Gonzalez to Acambaro, Gonzalez to Jaral del Valle, Monterey to Hipolito and Paredon to Saltillo. The Western district will be the main line from San Juan del Rio to Ciudad Juarez, inclusive, and all branches west, and will take care of all engines running into western terminals, such as those running between San Luis and Aguascalientes, Torreon to Saltillo and Gomez Palacio to Hipolito. The Eastern district will be in charge of superintendent of mechanical department M. J. Schneider, with office at San Luis Potosi. The Western district will be in charge of superintendent of mechanical department J. J. Waters, with office at Aguascalientes.

## NOTES.

Crocker-Wheeler Co.—Among the recent orders booked by the above company are eight motors, aggregating 170 H. P. for the Alliance Machine Co., Alliance, Ohio; a 22 H. P. motor for the Newton Machine Tool Co.; and a number of small motors for Yawman & Erbe, of Rochester, N. Y.

Burton W. Mudge & Brother.—The above firm, 544 Commercial National Bank Building, Chicago, has been appointed western representative for the McInnes Steel Company of Corry, Pa., who handle a complete line of high grade tool steel of all kinds. A complete stock will be carried at Chicago, in the warehouse at No. 52 West Washington street.

The Union Switch & Signal Co.—The annual meeting of this company was held on March 9. The following were elected directors: George Westinghouse, Robert Pitcairn, William Conway, George C. Smith, Thomas Rodd, H. G. Prout, and James J. Donnell. It was announced that unfilled orders to the amount of $1,357,000 were on the books. Contracts were reported as coming in more freely than at any time for over a year.

The Rockwell Furnace Company.—This company has been awarded the contract covering the complete furnace equipment for the new Locomotive Shops of the Delaware, Lackawanna & Western R. R., at Scranton, Pa. It consists of thirty-five of the latest type furnaces operated with 300 B. T. U. water gas, made in Loomis Pettibone producers. These shops are to be in operation in three months, and embody throughout the latest and most improved machinery and equipment selected after a careful inspection of a large number of modern railway and industrial plants throughout the country.

Producer Gas Tests.—The long series of producer gas tests on various grades of bituminous coal, conducted by the U. S. Geological Survey at the St. Louis Exposition, have been productive of such fruitful results that the testing work has been perpetuated and the government has secured for this purpose a 140 H. P. Westinghouse 3-cylinder vertical single-acting gas engine. This engine is of the same type as that installed at St. Louis, upon which all of the producer gas tests were made. An important schedule of experimental work has been laid out by the government engineers and tests will be run on all classes of soft coals, lignites, peat, etc.

Joel S. Coffin received on February 27 a remarkably touching tribute from his friends and former associates in the Galena Oil Company, expressing their regard for him upon his recent retirement to become Vice-President of the American Brake Shoe & Foundry Company. Galena men from all parts of the country assembled in the office of Mr. Coffin, presenting him with a beautiful loving cup engraved with their fac simile signatures, also a magnificent mahogany office desk and handsome specially designed ink stand. Gifts from friends are not unusual upon the withdrawal of a highly esteemed officer and associate, but it is given to few men to inspire the staunch affection of strong, successful men such as was revealed on this occasion. The gifts themselves, handsome as they are, were only an incident in this demonstration of affectionate regard. While the affair was quiet and private, it is fitting that news of it should be extended outside the official family concerned to the hosts of others who admire and honor Mr. Coffin.

## CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Lubricating the Motor.—The Joseph Dixon Crucible Company, Jersey City, N. J., is issuing a booklet which deals with the subject of the lubrication of automobiles, motor boats and motor cycles. The subject is considered in chapters, each covering a separate part of the motor.

Quride.—A booklet being issued by the Picrome Hide Co., 1417 N. Salina St., Syracuse, N. Y., explains the qualities of "Quride," which is produced by treating hides by a patented chemical process, making a tough, homogeneous, insoluble product which will not become brittle. It is used in making noiseless gears, belt lacing, packing, etc.

Aids to Shippers.—Oelrichs & Co., 5 Greenwich street, New York, is sending out a 72-page book containing a large amount of information of great value to all engaged in the export and import trade. It includes a table of foreign monies, weights, and measures, with U. S. equivalent, as well as tariffs, custom requirements, etc. of foreign countries.

High-Duty Turbine Pumps.—Bulletin G of the Lea Equipment Company, 136 Liberty street, New York, very completely illustrates and describes a line of high efficiency turbine pumps for heads from 7 to 1000 ft., and capacities ranging from 75 to 30,000 gallons per minute. An account of some tests by Prof. Denton at Stevens' Institute are included.

Coal and Ash Handling.—Catalog 32-A of the Jeffery Manufacturing Co., Columbus, Ohio, contains 72 pages largely given up to photographs and elevation drawings of coal and ash handling equipments for power plants covering a wide range of capacities and arrangements. Some most interesting and suggestive arrangements are clearly shown in this manner.

Noiseless Gears.—The New Process Raw Hide Co., Syracuse, N. Y., is sending out a small catalog which fully explains how the "new process" differs from other raw hides, by fully describing the process and giving results of actual service. Gears made of this material can be obtained in almost any practical size or type. It also has other uses which are illustrated in this book.

Reinforced Concrete Chimneys.—The Weber Company, 929 Marquette Building, Chicago, is sending out a very interesting account of the origin and development of concrete chimneys. This company built the 300-ft. stack for the American Smelting and Refining Co., at Tacoma, Wash., which is said to be the highest and largest chimney in the world.

Machine Tool Motors.—Bulletin No. 4649 of the General Electric Co. discusses the advantages and disadvantages of the independent and group method of driving railroad shop tools. Illustrations of electrically driven tools are numerous. Tables of costs of tools for a shop arranged to drive by both of the methods are given and the suitability of alternating current in certain cases is discussed.

Users of C.-W. Generators.—A list of engine type D. C. generators sold by the Crocker-Wheeler Company, Ampere, N. J., is given in its Bulletin, No. 110. This list, covering fifteen pages, gives the names and addresses of companies and individuals using these generators. In several items no address is given, these being U. S. battleships, several of which are equipped with C.-W. generators.

Bettendorf Bears.—The virtues of the Bettendorf truck are very cleverly proclaimed in rhyme in the story of the visit of the S. M. P. of P. D. Q. to the shops of the Animal Line, by B. V. Crandall, which is being issued with the compliments of the Bettendorf Axle Co., Davenport, Ia. The colored illustrations are pleasing in every way and the fact that "every bear in that busy shop was through at noon and ready to stop," is conclusive evidence that the Animal Line was not troubled with truck repairs.

Under-Feed Stokers.—The Taylor stoker is said to be the only stoker in which green or uncoked fuel is fed under coked and burning fuel, while at the same time the entire fuel bed is moved by gravity down an incline in such a manner as to rid itself of ash and clinker. The construction, arrangement and principles of this stoker are fully given in a catalog being issued by the American Ship Windlass Co., Providence, R. I. This is fully illustrated and shows the stoker applied to practically all different types of boilers.

The Iron and Steel Department Store.—Joseph T. Ryerson & Son, Chicago, whose new warehouses at Sixteenth and Rockwell streets have an area of 750,000 sq. ft. and a capacity for 150,000 tons, are issuing a very attractive book descriptive of the excellent facilities at the new location which permit them to fill orders of any kind for iron or steel at very short notice. Excellent half-tones of views around the plant show the orderly and convenient arrangement of the very large stock. Illustrations of the extensive line of boiler shop machine tools handled by this company are also included.

Drills, Reamers, Cutters.—Catalog No. 16 of the Standard Tool Co., Cleveland, Ohio, is divided into four principal sections. The first section is given up to drills, sockets, etc., and covers 120 pages. It shows twist drills of all types in all sizes and with all kinds of shanks, drills with oil grooves, left handed drills, drills in metric sizes, and fluted drills, each being accompanied by a table giving complete dimensions and prices. The second section of 52 pages treats reamers in a like manner; the third, taps; and the fourth, milling cutters, chucks, etc. Taken all together this is a most complete reference for small tools and is accompanied by a full code for telegraphic orders.

Drafting Room Equipment.—The thirty-third edition of the catalog of Keuffel & Esser Co., 127 Fulton street, New York, contains 540 pages massed full of illustrations and prices of instruments, tools, furniture, appliances, etc., of interest to every engineer and draftsman. The product of this firm is too well known to require any mention of particular articles and it is sufficient to say that it is impossible to think of anything needed by the draughtsman or engineer in his work that is not shown in this book. Among the new products might be mentioned the Champion continuous blue printing machine, which offers many features of advantage over the earlier types of blue printing machines.

Grinding Wheels and Machinery.—Alundum is made by fusing the mineral Bauxite, chemically the purest form of aluminum oxide found in nature, in the intense heat of the electric furnace, and because of its peculiar combination of hardness, sharpness and temper, is the best abrasive material known. The way in which this material or mineral is made is fully described in a catalog being issued by the Norton Company, Worcester, Mass., who use it exclusively in manufacturing grinding wheels. The method of making and testing the wheels suitable for different purposes is also explained. The catalog includes illustrations of a great variety of shapes of wheels as well as a number of grinding machines, etc.

# MALLET ARTICULATED COMPOUND LOCOMOTIVE

SOUTHERN PACIFIC COMPANY.

The Baldwin Locomotive Works has recently completed two Mallet articulated compound locomotives for the Southern Pacific Company, which are the heaviest locomotives in the world. They will be used on the Sacramento Division of that railroad between Roseville and Truckee, where the maximum grade is 116 ft. per mile, and will have a rating of 1212 tons, exclusive of engine and tender, over that division. The locomotives have a total weight of 425,900 lbs, of which 394,150 lbs. is on drivers. The calculated tractive effort is 94,640 lbs. They are of the 2-8-8-2 type, the front truck carrying 14,500 lbs. and the back truck 17,250 lbs.

The most notable departure from previous locomotive practice in this case is found in the incorporation of the feed water heater forming a part of the boiler and in the introduction of the reheater between the high and low pressure cylinders. This, of course, is the largest number of wheels ever put under a single locomotive and the arrangement for removing the forward section of the boiler is entirely new.

The accompanying table has been prepared to permit a comparison between the four most notable examples of Mallet articulated compound locomotives that have been built in this country. From this it will be seen that while the Southern Pacific engine is by far the largest in total weight, it has not quite the tractive effort, working compound, that is given by the Erie locomotive, which carries all of its weight on drivers, and as a result has a higher factor of adhesion. The increased tractive effort of the Erie,

| Road | S. P. | Erie | G. N. | B. & O. |
|---|---|---|---|---|
| Type | 2-8-8-2 | 0-8-8-0 | 2 6 6-2 | 0-6-6-0 |
| Builder | Baldwin | Amer. | Baldwin | Amer. |
| Total Wgt., lbs. | 425900 | 410000 | 355000 | 334500 |
| Wgt. on Drivers, lbs. | 394150 | 410000 | 316000 | 334500 |
| Tractive effort (comp.), lbs. | 94640 | 94800* | 71600 | 70000* |
| Diam. Cylinders, in. | 26 & 40 | 25 & 39 | 21½ & 33 | 20 & 32 |
| Stroke, in. | 30 | 28 | 32 | 32 |
| Steam Pressure, lbs. | 200 | 215 | 200 | 235 |
| Diam. Drivers, in. | 57 | 51 | 55 | 56 |
| Diam. Boiler, in. | 84 | 84 | 84 | 84 |
| Total Heating Surface | 6393† | 5313.7 | 5703 | 5600 |
| Wgt. on Drivers ÷ Tractive Effort | 4.18 | 4 32 | 4.4 | 4.75 |
| Total Wgt. ÷ Tractive Effort | 4.51 | 4.32 | 4.95 | 4.75 |
| Tractive Effort × Diam. Driv. ÷ Heating Surf. | 843 | 910 | 690 | 700 |
| Heating Surface ÷ Grate Area | 93.4 | 53.14 | 73 | 77.3 |
| Wgt. Drivers ÷ Heating Surface | 61.0 | 76.9 | 59.2 | 59.5 |
| See American Engineer | —— | 1906 p429 | 1906 p371 | 1904 p237 |

*This is not the maximum tractive effort of these locomotives, since they are fitted with an intercepting valve and separate exhaust pipe, allowing them to be worked simple and thus increase the tractive effort given by 20%.

†Includes Feed Water Heater.

however, is largely due to the smaller diameter of drivers and increased steam pressure, it being designed altogether for pushing service and not for regular road work, which, we understand, the Southern Pacific is intended for.

The illustrations on the following pages show the general design and the boiler arrangement of the Southern Pacific locomotive, and in a later issue will be given some of the more interesting details of this design.

Oil is to be used for fuel, but it is evident from the construction of the firebox that coal can be burned, although probably not fast enough to develop the full power of the locomotive. The boiler is of the straight type, 84 in. in diameter at the front end. Ahead of the firebox is the barrel of the boiler proper, having 401 2¼-in. flues, 21 ft. long, and a heating surface of 4,941 sq. ft. These flues terminate in a combustion chamber 54 in. long, occupying the full section of the boiler in front of which is a feed water heater. The tubes in this feed water heater are of the same number and diameter as in the boiler and are set in alignment with the boiler tubes. They terminate in a front end of the usual form. The combustion chamber is provided with a man hole, so that the tube ends therein are readily accessible and a further provision for facilitating repairs is made by separating the boiler shell at the rear end of the combustion chamber. This joint is made by riveting a heavy ring to each boiler section, which rings are butted with a V-shaped fit and secured together by 42 1¼-in. bolts.

Two non-lifting injectors discharge on either side into the feed water heater, which is kept constantly filled with water. The boiler feed passes out from the top of this chamber and is delivered into the main barrel through two checks, one on either side, located just back of the front tube sheet.

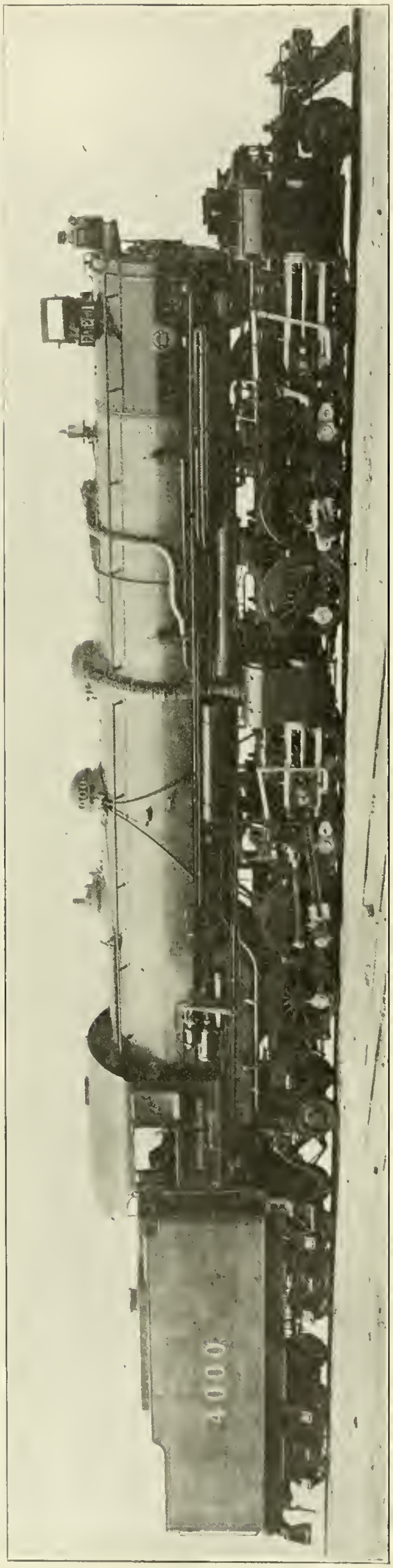
A Baldwin type of superheater is placed in the front end and connected in the piping system between the high and low pressure cylinders, thus forming, in this case, a reheater. It will no doubt be found that the addition of heat to the steam at this point will prove to be of great advantage from an operating standpoint as well as thermodynamically.

The waist-bearer under the combustion chamber is bolted in place, while the front waist-bearer and the high-pressure cylinder saddle, are riveted to the shell. The longitudinal seams in the barrel are placed on the top center line, and have diamond welt strips inside. Flexible staybolts are liberally used in the sides, back and throat of the firebox, while the crown sheet is stayed with tee irons hung on expansion links, in accordance with Associated Lines practice.

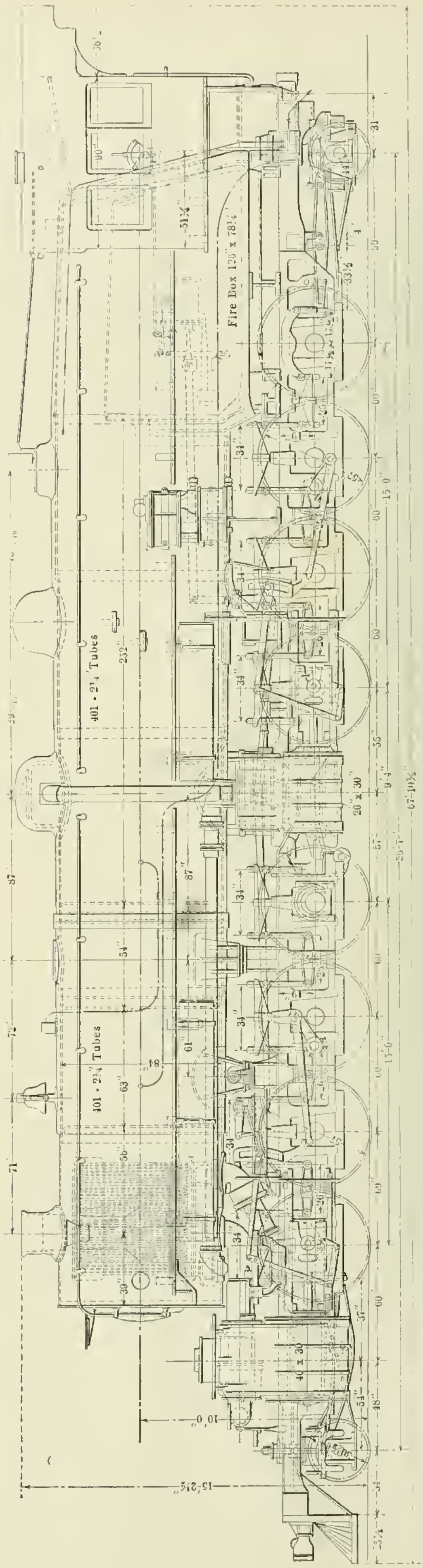
The dome, which is of cast steel, is placed immediately above the high-pressure cylinders, and the arrangement of the throttle and live steam pipes is similar to that used on heavy articulated locomotives previously built by this company. The exhaust from the high-pressure cylinders passes into two pipes which lead to the reheater in the front end. These pipes are of steel, and each is fitted, at the back end, with a slip joint made tight with a packed gland. The steam enters the reheater at the front end of the device, and passes successively through six groups of tubes. It then enters a T-connection, from which it is conveyed to the low-pressure cylinders through a single pipe having a ball joint at each end and a slip joint in the middle. Each low-pressure cylinder is cast separately, and is bolted to a large steel box casting, which is suitably cored out to convey the steam from the receiver pipe to a pair of short elbow pipes, making final connection with the low-pressure steam chests. The distribution is here controlled by 15-inch piston valves which are duplicates of those used on the high-pressure cylinders. The final exhaust passes out through the front of each casting, into a T-connection, which communicates with a flexible pipe leading to the smoke-box. The slip joint in this pipe is made tight by means of snap rings and leakage grooves. At the smoke-box end, the ball joint is fitted with a coiled spring which holds the pipe against its seat. The valves for both the high and low-pressure engines are set with a travel of 5½ inches and a lead of 5-16 inch. The steam lap is 1 inch, and the exhaust clearance 1-16 inch. Reversing is effected by the Raggonet power gear,* which is operated by compressed air and is self-locking. The gear is directly connected to the high-pressure reverse shaft. The reach rod connection to the low-pressure reverse shaft, is placed on the center line of the engine, and is fitted with a universal joint located immediately above the articulated frame connection. The joint is guided between the inner walls of the high-pressure cylinder saddle. In this way the reversing connections are simplified, and when the engine is on a curve the angular position of the reach rod has practically no effect on the forward valve motion. This arrangement has been made the subject of a patent.

One of the locomotives is equipped with vanadium steel frames, and the other with frames of carbon steel. The connection between the frames is single, and is effected by a cast steel radius-bar which also constitutes a most substantial tie for the rear end of the front frames. The fulcrum pin is 7 inches in diameter;

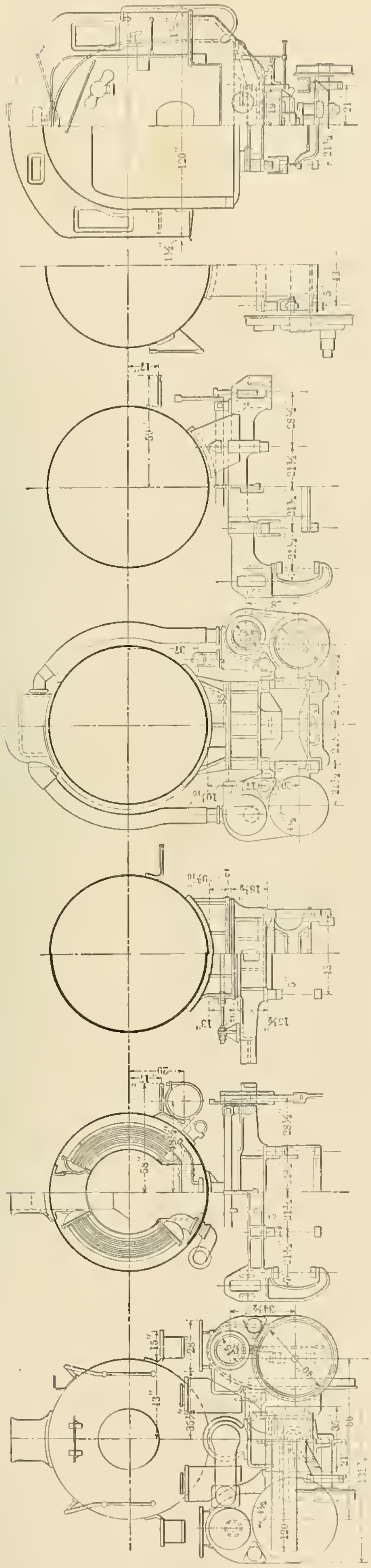
* See AMERICAN ENGINEER, July, 1908, page 260.



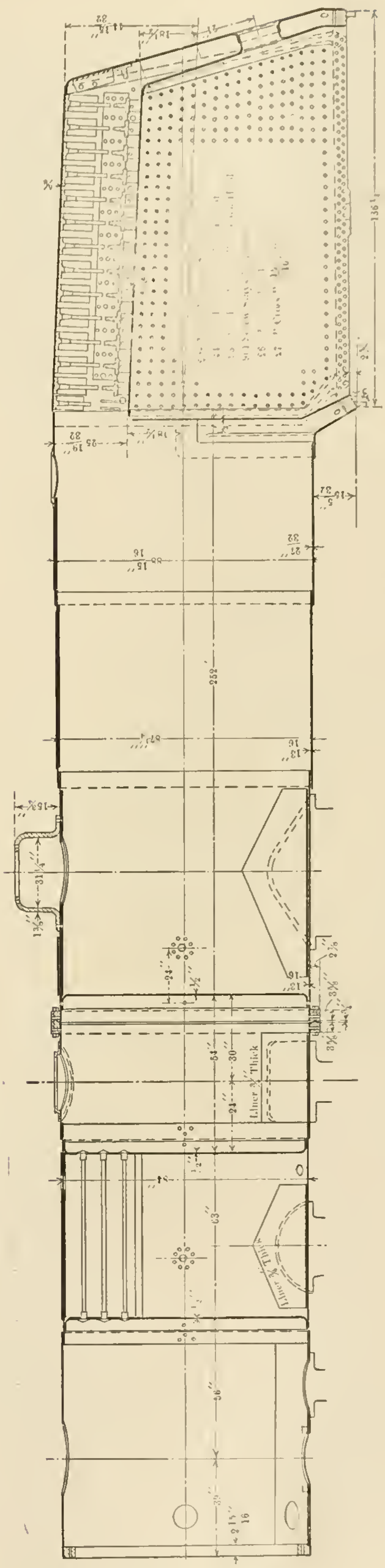
GENERAL VIEW OF THE LARGEST LOCOMOTIVE IN THE WORLD—SOUTHERN PACIFIC 2-8-8-2 TYPE.




ELEVATION OF MALLET ARTICULATED COMPOUND, 2-8-8-2 TYPE LOCOMOTIVE—SOUTHERN PACIFIC COMPANY.



END ELEVATION AND SECTIONS OF SOUTHERN PACIFIC 2-8-8-2 TYPE LOCOMOTIVE.



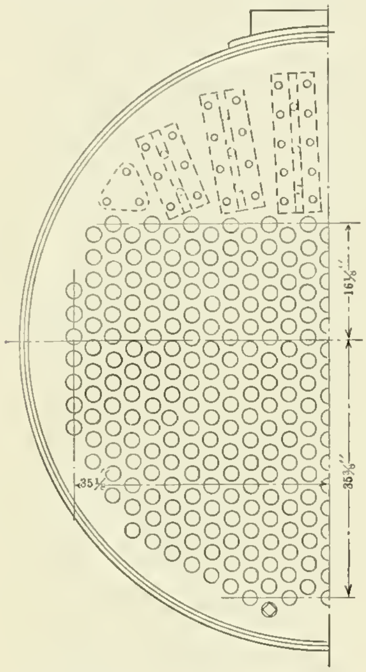
LONGITUDINAL SECTION OF BOILER AND FEED WATER HEATER—SOUTHERN PACIFIC 2-8-8-2 TYPE LOCOMOTIVE.

it is inserted from below, and held in place by a plate supported on a cast steel crosstie, which spans the bottom rails of the rear frames between the high-pressure cylinders. The weights on the two groups of wheels are equalized by contact between the front and rear frames, no equalizing bolts being used in this design.

The front frames are stopped immediately ahead of the leading driving pedestals, where they are securely bolted to a large steel box casting, previously mentioned, which supports the low-pressure cylinders. The cylinders are keyed at the front only. The bumper beam is of cast steel, 10 feet long, while the maximum width over the low-pressure cylinders is approximately 11 feet.

The boiler is supported, on the front frames by two bearings, both of which have their sliding surfaces normally in contact. The front bearing carries the centering springs, and the wear is taken, in each case, by a cast iron shoe 2 inches thick. Both bearings are fitted with clamps to keep the frames from falling away when the boiler is lifted.

This locomotive naturally embodies in its design many smaller details of interest which will be illustrated later. The cylinder



ELEVATION OF FRONT FLUE SHEET.

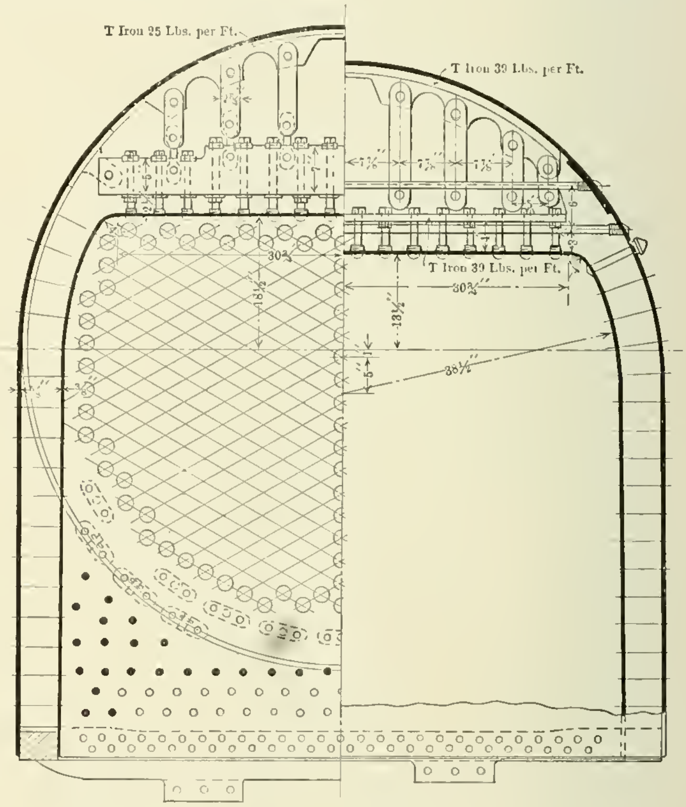
and steam chest heads are of cast steel, the low-pressure heads being dished and strongly ribbed. The low-pressure pistons are also dished; they have cast steel bodies, and the snap rings are carried by a cast iron ring which is bolted to the body, and widened at the bottom. The links for the low-pressure valve gear are placed outside the second pair of driving wheels, and are supported by cast steel bearers which span the distance between the guide yoke and the front waist bearer. The low-pressure valve stems are connected to long crossheads, which slide in brackets bolted to the top guide bars. The locomotive is readily separable, as the joint in the boiler is but a short distance ahead of the articulated frame connection, and all pipes which pass the joint are provided with unions. The separable feature has been tested and proved entirely feasible. Sand is delivered to the rear group of driving wheels from a box placed on top of the boiler, and to the front group from two boxes placed right and left ahead of the leading drivers. The high pressure cylinders are lubricated from the cab in the usual manner, while the low pressure are lubricated by means of a force feed pump driven from the forward valve motion. This arrangement avoids the use of flexible oil piping.

The tender is designed in accordance with Associated Lines standards, and is fitted with a 9,000 gallon water-bottom tank. The capacity for oil is 2,850 gallons.

The detail parts of this locomotive have, where possible, been designed in accordance with existing standards of the Associated Lines. The engine is practically equivalent, in weight and capacity, to two large consolidation type locomotives, and in spite of its great size, presents a pleasing and symmetrical appearance.

The general dimensions are given below:

| | |
|---|---|
| **GENERAL DATA.** | |
| Gauge | 4 ft. 8½ in. |
| Service | Freight |
| Fuel | Oil |
| Tractive effort | 94,640 lbs. |
| Weight in working order | 425,900 lbs. |
| Weight on drivers | 394,150 lbs. |
| Weight on leading truck | 14,500 lbs. |
| Weight on trailing truck | 17,250 lbs. |
| Weight of engine and tender in working order | 596,000 lbs. |
| Wheel base, driving | 39 ft. 4 in. |
| Wheel base, total | 56 ft. 7 in. |
| Wheel base, engine and tender | 83 ft. 6 in. |
| **RATIOS.** | |
| Weight on drivers ÷ tractive effort | 4.18 |
| Total weight ÷ tractive effort | 4.51 |
| Tractive effort x diam. drivers ÷ heating surface | 843.00 |
| Total heating surface ÷ grate area | 93.40 |
| Firebox heating surface ÷ total heating surface, % | 3.63 |
| Weight on drivers ÷ total heating surface | 61.00 |
| Total weight ÷ total heating surface | 67.00 |
| Volume equiv. simple cylinders | 28.8[illegible] |
| Total heating surface ÷ vol. cylinders | 220.00 |
| Grate area ÷ vol. cylinders | 2.38 |
| **CYLINDERS.** | |
| Kind | Compound |
| Diameter | 26 & 40 in. |
| Stroke | 30 in. |
| **VALVES.** | |
| Kind | Piston |
| Diameter | 15 in. |
| Greatest travel | 5½ in. |
| Outside lap | 1 in. |
| Inside clearance | 1/16 in. |
| Lead, constant | 5/16 in. |
| **WHEELS.** | |
| Driving, diameter over tires | 57 in. |
| Driving, thickness of tires | 3½ in. |
| Driving journals, main, diameter and length | 11 x 12 in. |
| Driving journals, others, diameter and length | 10 x 12 in. |
| Engine truck wheels, diameter | 30½ in. |
| Engine truck, journals | 6 x 10 in. |
| Trailing truck wheels, diameter | 30½ in. |
| Trailing truck, journals | 6 x 10 in. |
| **BOILER.** | |
| Style | Straight |
| Working pressure | 200 lbs. |
| Outside diameter of first ring | 84 in. |
| Firebox, length and width | 126 x 78¼ in. |
| Firebox plates, thickness | ⅜ & ½ in. |
| Firebox, water space | 5 in. |
| Tubes, number and outside diameter | 401—2¼ in. |
| Tubes, length | 21 ft. |
| Heating surface, tubes | 4,941 sq. ft. |
| Heating surface, firebox | 232 sq. ft. |
| Feed water heater tubes, number and diam. | 401—2¼ in. |
| Feed water heater tubes, length | 5 ft. 3 in. |
| Feed water heater, heating surface | 1,220 sq. ft. |




SECTION THROUGH FIREBOX—SOUTHERN PACIFIC MALLET.

| | |
|---|---|
| Heating surface, total | 6,393 sq. ft. |
| Reheater heating surface | 655 sq. ft. |
| Grate area | 68.4 sq. ft. |
| Smokestack, height above rail | 15 ft. 2½ in. |
| Center of boiler above rail | 120 in. |
| TENDER. | |
| Wheels, diameter | 33½ in. |
| Journals, diameter and length | 6 x 11 in. |
| Water capacity | 9,000 gals. |
| Oil capacity | 2,850 gals. |

## RAILROAD MACHINE SHOP PRACTICE.

### II.—DRIVING BOXES.

GEORGE J. BURNS.

If any one class of locomotive repair work more than another justifies a study of comparative costs and results it is locomotive driving boxes. With but few exceptions each shop is strenuous in claiming that its own particular practice is the best. If the cost happens to be high it is contended that the additional expense is more than offset by superior efficiency. If the job is somewhat roughly done it is claimed that it is all sufficient for its purpose, and that unnecessary exactness is extravagant. The object of this article will, therefore, be to lay before the reader comparative processes and costs and not to undertake to advise which practice should be adopted. The cost and time for doing the same work with the same class of tools in different shops varies so greatly as to justify any one in doubting the accuracy of some of the observations. To simplify comparisons, cast steel boxes only will be considered.

*Facing—Exclusive of Recess or Channel on Hub Side.*—This work is done on planers, milling machines, boring mills, shapers, and to a limited extent on lathes. The practice is determined by the character of work and by the equipment of the shop. If the recess on the hub side is machined, the facing, on that side at least, can be done most economically on a boring mill. The shortest facing time observed was 30 minutes per box on a powerful milling machine. That time is easily possible on a modern planer. The longest time observed was a three hour job on a planer.

*Recess on Hub Side.*—The practice is so varied that comparisons are almost out of the question. In some shops the recesses are machined and in others they are dovetailed in addition with more or less elaboration. This was particularly observed in a shop where a brass plate was used instead of casting babbitt on the box. The tendency seems to be in the direction of not machining the recess. The contention is that not only is the machining expensive, requiring the facing to be done on a boring mill, but that the rough surface holds the babbitt better than the machined surface. In most shops the babbit is held in place by tapping brass plugs into the box. In some shops the plugs are staggered with view of securing a continuous brass bearing. The best practice for holding the babbitt seems to be to have the sides of the recess slightly eccentric with each other.

*Crown or Shell Fit.*—This work is done on planers, shapers and slotters. The planer seems to give the poorest efficiency, and a special draw stroke shaper the best. The wide variation in time of doing this work on the same class of tools emphasizes the necessity of profiting by comparison. The shortest time was one hour per box, and the longest time was 7½ hours per box.

*Cellar Fit.*—In some shops the legs are machined at the time the crown fit is made and any variation resulting from pressing in the brass is allowed for by fitting the cellar to caliper measurement. In other shops the legs of the box are machined to standard after the brasses are pressed in; sometimes they are simply surfaced and squared, each cellar being fitted to its box.

The practice in coring the legs of the box also varies greatly. Some roads do not core at all, deeming the support the full width of the leg on the cellar to be of more importance than the shop time saved by coring. Some legs are cored in the center, leaving a band on four sides. The advantage of such coring is doubtful, as in machining the tool is required to make full stroke and where the coring is shallow there is a liability, as noted in one shop, that the tool will run in the scale. The most common practice in coring the leg is to core across, leaving a band at the top and the bottom. On some roads the coring is up and down, leaving a band at each side. That form is of doubtful advantage, especially as the coring is crosswise on most cellars. On some roads there is no uniformity as to coring, all forms being more or less in use. The time for machining the legs for the cellar fit varies all the way from 45 minutes to 3 hours per box.

*Shoe and Wedge Fit.*—The most universal practice is to back off or taper the side of the shoe and wedge fit. On one road, at least, the sides are not tapered and equally good results are claimed to be secured. The shoe and wedge fit is made on planers, milling machines, and shapers. The shortest time observed was one hour per box on a milling machine. That time ought to be possible on a modern planer. The longest time observed was four hours; the usual time was about two hours—all taper work.

*Replaning.*—Here again there is such a wide range in time and such a wide variation in practice that attempts at comparison are confusing. If the least expensive practices are sufficient, the most expensive are inexcusable.

Most roads in replaning follow the taper of the sides. Some few roads replane straight, relying upon the fillet to compensate for the taper. The practice seems to be tending toward one tool work, roughing and finishing in one cut.

Is there a necessity for a brass bearing between the box and the shoes and wedges? One important road, at least, does not deem such a bearing a necessity. The mechanical department, after carefully observing results and considering all arguments pro and con, contend that the advantage of the brass bearing is not commensurate with its cost. They claim that the brass bearing offers no advantage whatever, providing the surfaces are kept reasonably well lubricated. Other roads claim that the brass bearing is necessary and that lubrication will not offset it.

In shops where a brass bearing is deemed necessary, the following practices have been observed:

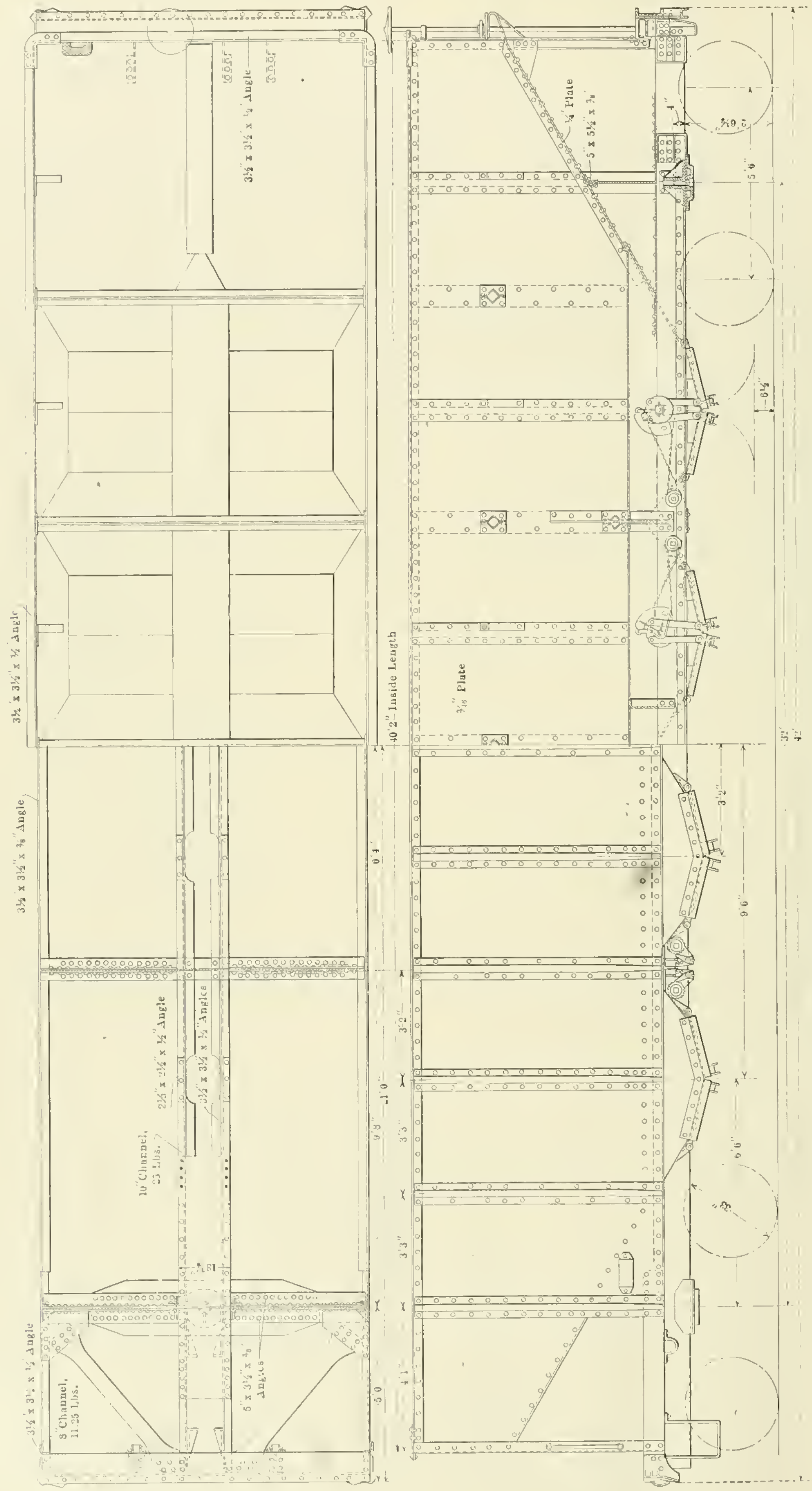
1. Brass shoes and wedges.
2. Shoes and wedges with brass facing.
3. Brass liners on first repairs.
4. Brass liners when boxes become so thin they cannot be safely further replaned.
5. Most brass liners are fitted and riveted to the box.
6. On some roads the brass liner is cast in position in the box.

The shortest time observed for replaning was 25 minutes per box, and the longest 1½ hours per box. The usual time was about one hour.

POWER PLANT EFFICIENCY.—H. G. Stott, Mem. of the Am. Soc. of Mech. Engrs., estimates the average heat distribution in the power house as shown in the following table:

| | Per cent. | Per cent. |
|---|---|---|
| Heat in the coal | | 100 |
| Loss in ashes | 2.4 | |
| Loss in stack | 22.7 | |
| Loss from boiler radiation and leakage | 8.0 | |
| Returned by feed water heater | | 3.1 |
| Returned by economizer | | 6.8 |
| Loss in pipe radiation | 0.2 | |
| Delivered to circulator | 1.6 | |
| Delivered to boiler feeder | 1.4 | |
| Leakage and high pressure drips | 1.1 | |
| Heating | 0.2 | |
| Loss in engine friction | 0.8 | |
| Delivered to small auxiliaries | 0.4 | |
| To house auxiliaries | 0.2 | |
| Radiation from engine | 0.2 | |
| Rejected to condenser | 60.1 | |
| Electrical losses | 0.3 | |
| Totals | 99.6 | 109.9 |
| Delivered to bus-bar | 10.3 | |

We may assume that with a good steam generating station we convert but ten per cent. of the heat stored in the coal into electricity, on the bus-bars. Further losses due to distribution and conversion, in various ways, to light and power occur so that we get but little of the potential energy provided for our use by a wise and beneficent nature. Surely, if our ecclesiastical brethren maintain that the storage of coal is a manifestation of Divine Providence, the present inventions for utilizing it must have emanated from his Satanic Majesty.—*From President M. L. Holman's address before the A. S. M. E.*




FOUR-HOPPER STEEL COKE CAR—100,000 POUNDS CAPACITY—PENNSYLVANIA RAILROAD.

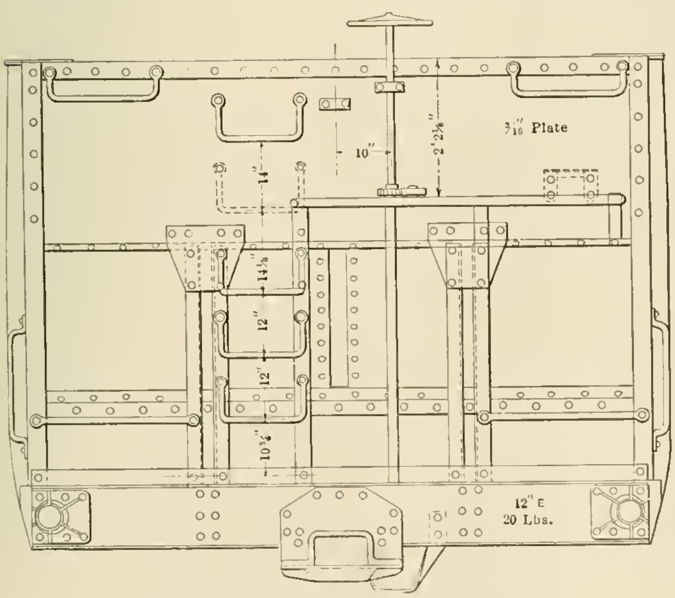
# FOUR-HOPPER STEEL COKE CAR

PENNSYLVANIA RAILROAD.

The standard equipment* of the Pennsylvania Railroad for transporting coke has been the classes Gpa, Gsa and Gsd cars, which were fully illustrated and described in this journal October, 1905, page 359, and January, 1906, page 11. Recently, however, in considering the ordering of more equipment of this type a new design, having four-hoppers, which is entirely self-clearing and has a capacity of 2,794 cu. ft., or 85,000 lbs. of coke, has been developed. This is known as class H-21.

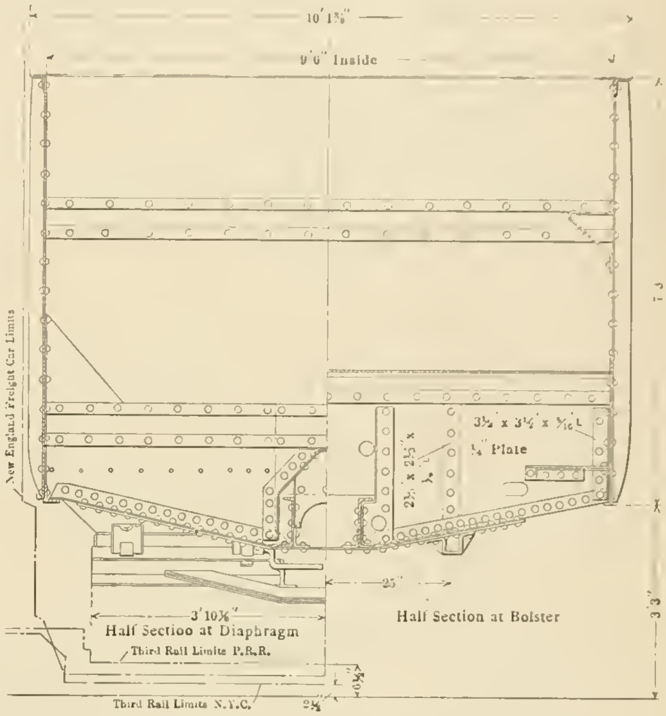
The features of this car are, in many particulars, very similar to the standard Gla steel hopper car, which was illustrated and described on page 148 of the May, 1905, issue of this journal. The same principles of design hold in both cars, the principal difference being in the arrangement and construction of the hoppers and their operating gear.

Structural steel members and plates are used almost exclusively, the side stakes, cross braces and diagonal braces at end sills being practically the only pressed forms. Two 10 in., 25 lb., channels extending continuously from end sill to end sill, reinforced by 3½ x 3½ x ½ in. angles on the lower edges between the bolsters, and a cover plate through and for a short distance on either side of the bolster, form the center sill construction. There are no side sills between the bolsters, the 8 in. channels reaching only from the end sills to the bolsters. The design utilizes the strength of the sides, which are built of 3/16 in. plates reinforced by pressed steel stakes, spaced about 3 ft. 2 in. apart, in a vertical direction and by the 3½ x 3½ x ½ in. angles at the top and 3½ x 3½ x ⅜ in. angles at the bottom, for load carrying. The body bolster, of the single plate type, is practically identical with that in the Gla car and consists of a ¼ in. plate set vertically and secured to the ¼ in. floor plate and the side plates by angles; also reinforced by angles at the bottom edge. The end sill is somewhat heavier than on the Gla car, being formed of a 12 in., 20 lb., channel. The diagonal braces are located between the ends of the bolster and the junction of the center sill and end sill, the same as in the former design. Because of the great length of this car another cross support or diaphragm, of construction quite similar to that of the bolster, is located at either end, 9 ft. 8 in. inside the bolster. It is also of ¼ in. plate, being secured at the top to a box type of cross brace, formed in two sections and secured to the side sheets. The sides are stiffened by a gusset plate at these points, as is shown in the illustration. The cross braces or side stiffeners, of which there are five in addition to the two forming part of the diaphragms just mentioned, all being of the same type, are placed about ⅓ of the distance down from the top of the sides and located at every second side stake.




END ELEVATION—FOUR-HOPPER COKE CAR.

The hopper doors are double and formed in pairs, one set on either side of the center sill. All four doors, on one hopper, however, are operated by one device. The doors are of ¼" pressed steel, hinged on the outer edges and provide an opening 3 ft. x 3 ft. 6 in. on each side of the center sills for each hopper or a total opening, with all doors released, of 84 sq. ft. in the bottom of the car. The doors when swung full open have a clearance of 6½ in. from the top of the rail.




SECTIONS OF FOUR-HOPPER COKE CAR.

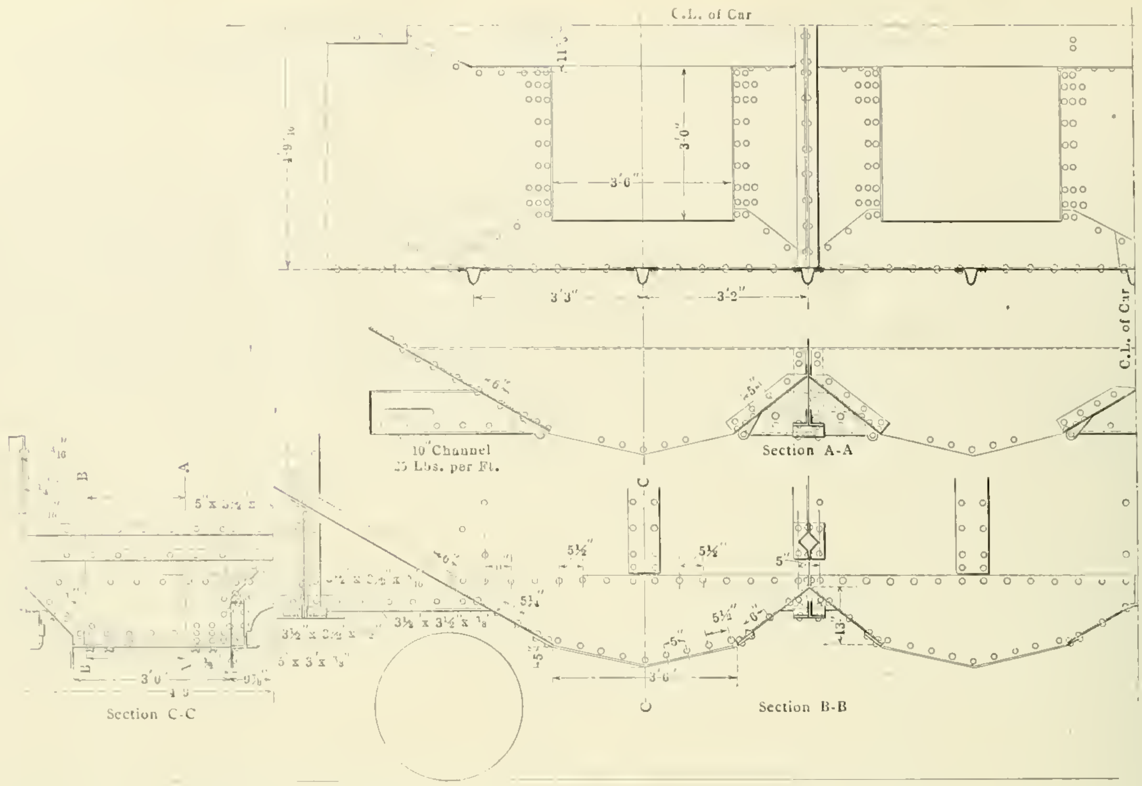
The illustrations show the construction of the hoppers and the door operating device very clearly. It was necessary to cut away the reinforcing channels on the bottom of the center sills at the points where the operating gear is located and a 5 x 3 x ⅜ in. angle is secured to the bottom of the center sill channels at these points. The ridge sheets which cover the center sills between the hopper openings are of ¼ in. plate and aid in giving stiffness to the sills. The door operating device is so constructed that when fully closed it is practically locked and requires a slight movement before it will open by gravity. As an additional safeguard a ratchet wheel and pawl are provided at each winding shaft, to prevent any possibility of the doors dropping by accident.

The trucks are of the Pennsylvania standard arch bar type for 100,000 lb. cars and have pressed steel bolsters, 33 in. wheels and 5½ x 10 in. journals.

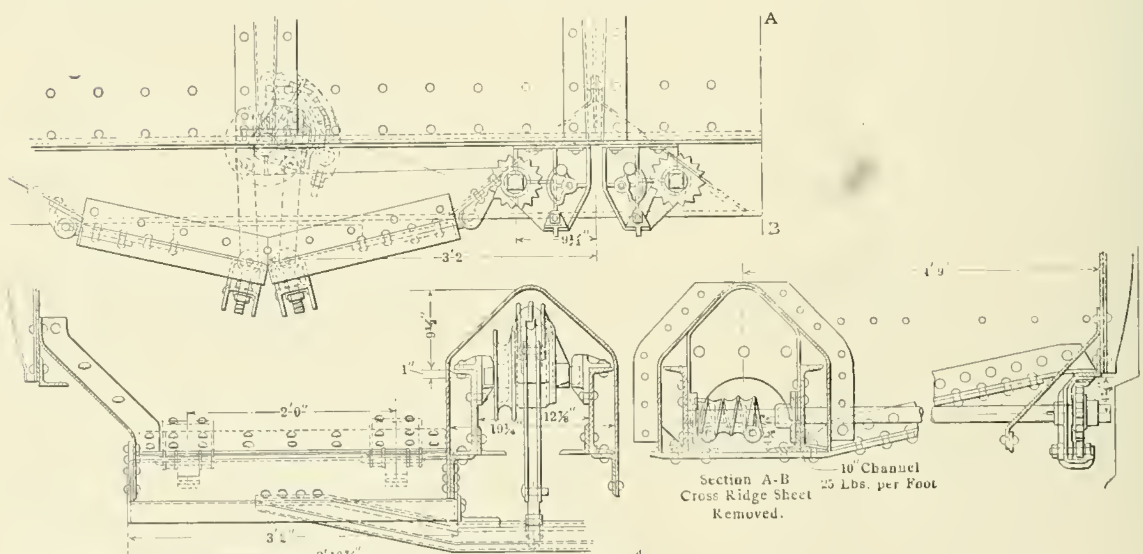
The draft gear arrangement provides for the use of Westinghouse friction draft gear, the lower flange of the end sill being cut away to accommodate the passage of the coupler shank; the sill is reinforced by a heavy steel casting at this point.

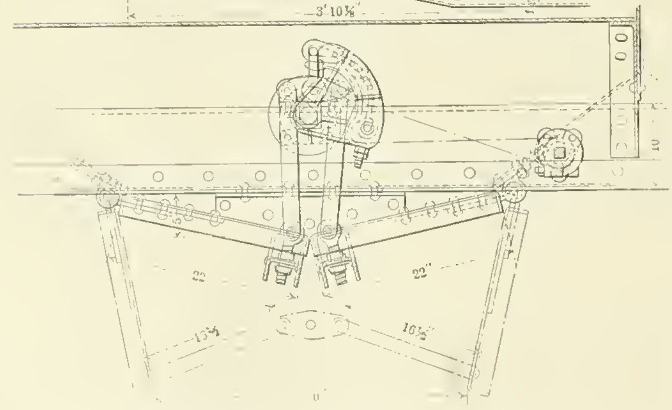
This is the first four-hopper coke car that has ever been built

* For the steel car equipment of the Pennsylvania Railroad reference can be made to the table on page 84 of the March, 1909, issue of this journal.




HOPPER DETAILS—FOUR-HOPPER STEEL COKE CAR, PENNSYLVANIA RAILROAD.



DETAILS SHOWING DOOR OPERATING DEVICE ON FOUR-HOPPER STEEL COKE CAR, PENNSYLVANIA RAILROAD.

and the present order provides for 1,000 cars. It does not incorporate the use of coke racks or netting of any kind. In this connection reference can be made to the three-hopper coke car for the Pittsburgh & Lake Erie Railroad of 80,000 lb. capacity, which was illustrated on page 307 of the August, 1907, issue of this journal.

The general dimensions of the car are as follows:

| | |
|---|---|
| Length over end sills | 42 ft. |
| Length inside | 40 ft. 2 in. |
| Inside width | 9 ft. 6 in. |
| Height from rail to top of sides | 10 ft. 6 in. |
| Truck centers | 32 ft. |
| Capacity in cu. ft. | 2,794 cu. ft. |
| Capacity in lbs. | 100,000 lbs. |
| Weight | 54,900 lbs. |

## BUYING COAL ON A HEAT VALUE BASIS.

The plan inaugurated by the Government two years ago for the purchase of coal on the basis of its heating value has resulted in the delivery of a better grade of fuel without a corresponding increase in cost. At the present time, forty departmental buildings in Washington, the Panama Railroad, more than 300 public buildings throughout the United States, navy yards, and arsenals are buying their fuel supplies on specifications the prime element in which fixes the amount of ash and moisture. Premiums are paid for any decrease of ash below 2 per cent. from the standard at a rate $.01 per ton for each per cent. Deductions are made at an increasing rate for each per cent. of ash when it exceeds the standard established by 2 per cent.

Since the Government has been purchasing coal on the basis of its heating value a growing interest has been manifest on the part of manufacturers and the general public in this important subject, and a demand has been created for authentic information concerning the results accomplished. In response to this demand the results of the Government's purchases of coal under the heat value specifications for the fiscal year 1907-8 have been assembled in a bulletin just issued by the Survey in the hope of promoting a better understanding of this method of buying fuel. John Shober Burrows, the engineer in charge of this part of the fuel problem, has included in the bulletin a list of the contracts with abstracts of the specifications for the current fiscal year.

In explaining the nature of the specifications, Mr. Burrows says: "Government specifications are drawn with a view to the consideration of price and quality. For manufactured articles and materials of constant and uniform quality they generally can be reduced to a clear statement of what is desired. For coal, however, the variation in character makes this impracticable.

"This lack of uniformity is the feature recognized and provided for in the coal specifications prepared by the Geological Survey. Under these specifications, bidders are requested to quote prices on the various sizes of anthracite, a definite standard of quality being specified for each size, and to furnish the standard of quality with price for bituminous coal offered. Awards are then made to the lowest responsible bidder for anthracite and to the bidder offering the best bituminous coal for the lowest price. The specifications become part of the contract, and the standards of quality form the basis of payment for coal delivered during the life of the contract. For coal delivered, which is of better quality than the standard, the contractor is paid a bonus proportional to the increased value of the coal. For deliveries of coal of poorer quality than the standard, deductions are made from the contract price proportional to the decreased value of the coal. The actual quality and value of coal delivered is determined by analysis and test of representative samples taken in a specified manner by agents of the Government and analyzed in the Government fuel-testing laboratory at Washington.

"The advantages of buying coal on specifications are explained as follows: Bidders are placed on a strictly competitive basis as regards quality as well as price. This simplifies the selection of the most desirable bid and minimizes controversy and criticism in making awards. The field for both the Government and dealers is broadened, as trade names are ignored and comparatively unknown coals offered by responsible bidders may be accepted without detriment to the Government. The Government is insured against the delivery of poor and dirty coal, and is saved from disputes arising from condemnation based on the usual visual inspection. Experience with the old form of Government contract shows that it is not always expedient to reject poor coal, because of the difficulty, delay, and cost of removal. Under the present system rejectable coal may be accepted at a greatly reduced price. A definite basis for the cancellation of contract is provided. The constant inspection and analysis of the coal delivered furnishes a check on the practical results obtained in burning the coal."

## COST OF STEEL PASSENGER CARS.

In commenting on the cost of all-steel passenger cars, at a recent meeting of the Central Railway Club, Charles Lindstrom, chief engineer of the Pressed Steel Car Company, spoke as follows: "The cost of cars depends, to a great extent, on the number of cars in a given order, but it is doubtful if many prospective buyers of steel cars have any real idea of what this cost amounts to. I will give a few figures to illustrate, in a general way, the work required for an all-steel passenger coach."

| | |
|---|---|
| Number of drawings and tracings | 510 |
| Cost of drawings and tracings | $3,000 to $5,000 |
| Number of blue prints issued to shops and manufacturers | 8,000 |
| Number of bills of material; 50 lines on each bill | 44 |
| Number of requisitions for material | 257 |
| Number of different items ordered from purchasing agent | 1,702 |
| Number of bolts of various diameters and lengths | 2,700 |
| Number of screws of various diameters and lengths | 4,200 |
| Number of rivets of various diameters and lengths | 31,200 |
| Number of pounds of castings for dies | 150,000 |
| Time required to prepare drawings, bills of material, shop instructions, etc. | 3 to 6 months |

"To further illustrate what the cost of a slight change in the construction of a car will amount to, I may say that the dies for making the end deck plates for a car weigh about 25,000 lbs. and cost about $1,000, and that the dies for making side posts weigh about 8,500 lbs. and cost about $450. The actual cost of pressing any one of these shapes does not exceed $1 each. This data, I believe, will give a fair idea of the very great expense involved in producing steel cars, and is referred to with the hope that prospective purchasers of such cars will look over the field and ascertain what cars have already been built, and are in service, and if it is desired to have sample cars built, select one of these types from which two or three cars may be built at moderate cost instead of submitting to manufacturers of cars drawings of their standard wooden cars with request for bids on one or two steel cars of each type for experimental purposes, for it can readily be seen that, if the so-called 'over-head' charges for getting up designs of steel cars is in approximate proportion as enumerated above (and while it is true that such expenses cannot be charged to a few sample cars as it makes such cars absolutely prohibitive to customers, still the cost is there and has to be paid), it means that the over-head charges on passenger cars will be greater than necessary.

"If sample cars of existing design are ordered and tried out, when the time comes that the purchaser is ready to go into the market for a larger number of steel cars a particular design, suitable to the requirements of the road, may be evolved without danger of prohibitive cost, even if entirely new plans, dies, templates and other requirements would have to be made, but it may not be out of place to mention here that changes should not be made in the design of cars merely in order to be different from some one else, or for the purpose of introducing some new ideas which may be just as good, but perhaps not better than what are already in use; changes should only be made when the service actually demands, in order to reduce the cost of the cars to the purchaser. When standard designs for steel cars are once adopted, the cost of such cars will not be much, if any, higher than wooden cars of the same seating capacity and including the same specialties."

PROPER CARE OF LEATHER BELTS.—In the average machine shop the writer is prepared to say that for more than half of the machines the belt drive can still be used with greater economy and with more satisfactory results than the electric drive; only on the assumption, however, that the belting is systematically cared for. The most serious objection to the belt drive as generally used is the loss of time due to interruption to manufacture when retightening and repairing and to the loss of driving power and consequent falling off in output, when the belt is allowed to run too slack. Belts can be tightened and repaired at regular intervals after working hours with the use of spring-balance belt-clamps to get the right tension, causing thus practically no interruption to manufacture.—*Fred W. Taylor before the A. S. M. E.*

## A NEW DEPARTURE IN FLEXIBLE STAY-BOLTS.*

H. V. WILLE.

There is practically no literature on the subject of stay-bolts, and this is particularly true of flexible stay-bolts. The increasing size and pressure of boilers make this subject of vital importance to railroads and to those responsible for the management of that type of boiler in which the firebox is stayed by a large number of bolts.

The boiler of the consolidation locomotive, now the prevailing type in freight service, contains about 1,000 bolts less than 8 in. long and about 300 of greater length. The large types of Mallet compound locomotives now meeting with much favor have a much larger number, there being 1,250 short and 300 long bolts in locomotives of this class recently constructel.

In recent years some form of flexible stay-bolt, that is, one having a movable joint, has been very extensively used in the breaking zone of locomotive boilers, but their high cost and the difficulty of applying them, their rigidity due to accumulation of rust and scale and the fact that their use throws an additional service on the adjacent bolts because of lost motion have militated against their more general use.

It is well known that stay-bolts fail, not because of the tensional loads upon them, but from flexural stresses induced by the vibration resulting from the greater expansion of the firebox sheets than of the outside sheets, but notwithstanding the general acceptance of this theory, engineers have designed stay-bolts solely with respect to the tensional loads. It is quite general practice, it is true, to recess the bolts below the base of the thread, and this has effected a slight reduction in the fiber stress, but practically no effort has been made to design a bolt to meet the flexural stresses or even to calculate their magnitude. This is surprising in view of the simplicity of the calculations to which the ordinary formulae for flexure apply.

Let

$F$ = fiber stress
$E$ = modulus of elasticity.
$I$ = moment of inertia.
$D$ = diameter.
$N$ = deflection.
$L$ = length.
$W$ = load.

We then have

$$W = \frac{2\,F\,I}{D\,L};\ N = \frac{W\,L^3}{3\,E\,I}.$$

Now substituting

$$N = \frac{2\,F\,L^2}{3\,E\,D};\ F = \frac{3\,E\,D\,N}{2\,L^2}.$$

This formula shows that the stress increases in direct proportion to the diameter and decreases as the square of the distance between the sheets.

The application of the formula to service conditions gives the following stresses:

Conditions: Bolt spacing, 4 ins. c. to c.
Assumed expansion, 4/100-in.
Length of bolt, 6 ins.

| Type. | Diameter of Bolt. | Flexural Stress. |
|---|---|---|
| Iron | 1⅛ in. | 51,500 |
| Iron | 1 in. | 45,000 |
| Iron | ⅞ in. | 39,400 |
| Spring steel | 1 in. ends, 7/16 in. stem | 19,700 |

Iron is universally employed in the manufacture of these bolts and it is not good practice to exceed a fiber stress of 12,000 lbs., per sq. in. It is apparent that stay-bolts in the zone which meets the expansion of the sheets are stressed above the elastic limit and must necessarily fail from fatigue. Fractures always originate at the outside sheet at the point where the bending moment due to the movement of the furnace sheets is greatest.

The fractures are in detail, usually starting from the base of a thread and gradually extending inward. Manufacturers of stay-bolt material have endeavored to minimize failures and to meet the unusual conditions of an iron stressed beyond its elastic limit by the supply of specially piled iron arranged with a view to breaking up the extension of the initial fracture. For this reason iron piled with a central section of small bars and an envelope of flat plates has met with much success for this class of service. In a further effort to secure an iron specially adapted to this class of work various forms of shock, vibratory and fatigue tests have been imposed. No design has yet been produced, however, which permits the employment of material of elastic limit sufficiently high to resist the flexural stresses, although a large class of material particularly adapted to the purpose is available.

It is obvious that the remedy does not lie in the use of a slow-breaking material but in the employment of material of sufficiently high elastic limit to meet the conditions of service. It is also possible to reduce the diameter of the bolt greatly by the use of such a material, thus proportionately reducing the fiber stress in flexure.

Stay-bolt material, however, must possess sufficient ductility to enable the ends to be readily hammered over to make a steam-tight joint and to afford additional security against pulling through the sheets. To meet these conditions the bolt illustrated in Fig. 1 has been designed. The stem is of the same grade of

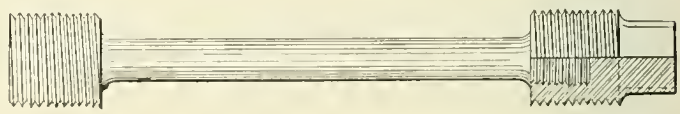


FIG. 1.

steel as that used in the manufacture of springs. It is oil-tempered and will safely stand a fiber stress of 100,000 lbs. per sq. in. Its high elastic limit makes it possible to reduce the diameter to ⅜ or 7/16 in. or even less. The ends are of soft steel, and it is thus possible to apply and head up the bolt in the usual manner. Fig. 2 shows this type of bolt in comparison with the regular design.

The employment of a stem of the diameter indicated reduces the fiber stress in flexure to less than one-half that in the ordinary type of bolt and it is of material capable of being stressed to a high degree. It has hitherto been impossible to employ in stay-bolts any of the steels containing chromium, nickel, vanadium or other metaloid possessing properties especially adapted to this class of work, but these steels can readily be used in the stem of the bolt described.

The stem of the bolt can be flexibly secured to the end in one of the customary ways, but the flexibility of the bolt does not depend upon a flexible connection. A type of bolt with a relatively inflexible connection, usually one in which the stem screwed into the ends with a running fit, met with the most favorable consideration. Such a bolt is flexible as a spring is flexible, in that it can be deflected to meet the requirements of service without exceeding the elastic limit. In fact the stem may be of a

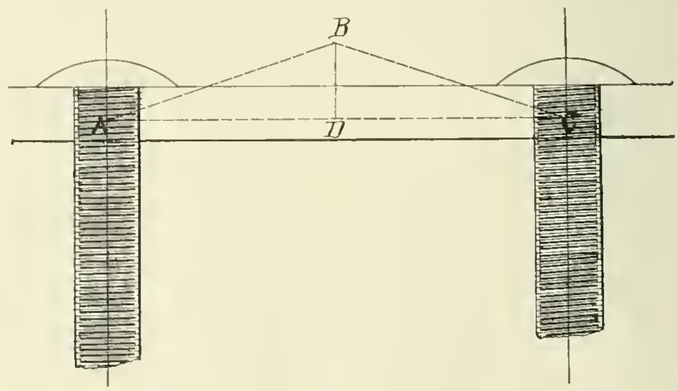



FIG. 3.

number of pieces, either of plates or small rods, thus increasing its flexibility.

The actual breaking strength of the bolt sizes ordinarily employed is shown in the accompanying table. These bolts were recessed to the base of the thread and tested in the same form as that in which they are employed in the service. For comparison, the approximate weights of bolts of the usual length are also given. These weights are for bolts over the entire length

* To be presented before the American Society of Mechanical Engineers.

including the squared ends for screwing the bolts into the sheets.

ACTUAL BREAKING STRENGTH OF STAY-BOLTS.

| Type. | Nominal Diameter. | Actual Breaking Strength in lbs. | Weight. | Vibrations. |
|---|---|---|---|---|
| Iron | 1-in. | 32,500 | 20 oz. | 6,000 |
| Iron | ⅞-in. | 24,500 | 15 oz. | 5,200 |
| Spring steel stem | 1-in. ends 7/16 in. stem | 32,000 | 10 oz. | 500,000 |

The vibrating test was made by clamping one end of the bolt in a machine and revolving the other end through a radius of 3/32-in., the specimen being 6 ins. long from the end of the right head to the center of the rotating head. A tensional load of 4,000 lbs. was also applied to the bolts. The best grades of iron bolts break on being subjected to from 5,000 to 6,000 rotations, whereas the spring steel bolts were vibrated 500,000 times without failure, and on some of them the test was continued without failure to 1,000,000 vibrations. These tests demonstrated that the bolt is not stressed beyond the elastic limit under these severe conditions and that the probability of its failure in less severe conditions is very remote.

The extent of the expansion work which can take place in the firebox of a boiler can readily be calculated.

Distance between stay-bolts, 4 ins.

Temperature of inside sheet, 400° F.

Temperature of outside sheet, 100° F.

Coefficient of expansion, 0.0000066.

Then the expansion between the two bolts will equal $0.0000066 \times (400 - 100) \times 4 = 0.0079$, and each bolt will deflect 0.00395 in. It has been shown that this amount of deflection will stress the usual type of bolt beyond the elastic limit. In practice, however, one bolt may hold rigidly, throwing the entire deflection on the adjacent bolt, or neither bolt may deflect and the sheet

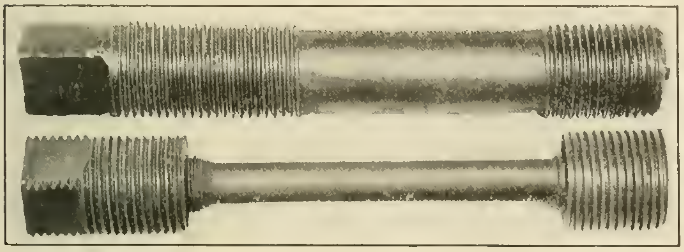


FIG. 2.

will then buckle. Under this condition the neutral axis will assume the form *ABC* (Fig. 3) and the length *AB* will equal 2.00395 in. and the sheet will buckle to an extent, $BD = \sqrt{2.00395^2 - 2^2} = 0.125$ in. It is obvious that the repetition of a force sufficient to buckle a sheet ⅛-in. must ultimately lead to a crack in the furnace sheets. If, however, the bolt deflects, allowing the sheet to normally expand, the latter will be relieved of these extranous loads.

A bolt of sufficient flexibility to deflect under the forces following expansion, and of material which will not be stressed beyond the elastic limit in resisting these forces, will greatly assist in reducing the cost of boiler maintenance by eliminating broken stay-bolts and reducing the stresses in the furnace plates. If in addition the bolt has a smaller diameter the life of the furnace plates should be further increased, as such a bolt will interpose less obstruction to the circulation of the water in the water legs.

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ALUMINUM A COMMERCIAL METAL.—The present price puts aluminum on a basis comparable with those of tin and copper. Weight for weight it is cheaper than tin, but bulk for bulk it is cheaper than either tin or copper. This level of price ought to stimulate greatly the consumption of aluminum, especially when the revival of general trade has gone a little farther. The producing capacity of Europe is increasing, while in the United States the Bradley patent will expire early in 1909, permitting free competition in the business here, just as there is now in Europe. Thus another year at least will put aluminum so that it can be classed, without the possibility of question, as an ordinary commercial metal.—*American Machinist.*

## SPRING MEETING OF THE A. S. M. E.

The American Society of Mechanical Engineers will hold its spring meeting in Washington, D. C., May 4-7. Professional sessions will be held at which papers on the conveying of materials, gas power engineering, steam turbines, the specific volume of saturated steam, oil well pumping and various other subjects will be discussed.

At the reception, which will be held in the New Willard Hotel, an address of welcome will be made by the Hon. B. F. Macfarland, president of the Board of District Commissioners, with a response by Jesse M. Smith, president of the Society.

During the convention, President Taft will hold a reception for the members at the White House. The War Department will give a special exhibition drill of the United States troops at Fort Myer, to which the members and guests will be invited. At the same time, if the conditions are favorable, an ascension of a dirigible balloon will be made and probably also that of an aeroplane.

An address will be given by Rear-Admiral Melville, retired, past-president of the Society, and former Engineer-in-Chief of the Navy, the subject being "The Engineer in the Navy." This evening will be made the occasion for the presentation to the National Gallery of a portrait of Rear-Admiral Melville, presented by friends and admirers. It will be received for the National Gallery by Dr. C. D. Walcott, secretary of the Smithsonian Institution.

F. H. Newell, director of the Reclamation service, will deliver an illustrated address on "Home Making in the Arid Regions." Trips will be made to various points of interest about the city and a number of pleasurable excursions have been planned.

The papers to be presented are as follows: A Unique Belt Conveyor, by Ellis C. Soper; Automatic Feeders for Handling Material in Bulk, by C. Kemble Baldwin; A New Transmission Dynamometer, by Prof. Wm. H. Kenerson; Polishing Metals for Examination with the Microscope, by A. Kingsbury; Marine Producer Gas Power, by C. L. Straub; Operating System for a Small Producer Gas Power Plant, by C. W. Obert; A Method of Improving the Efficiency of Gas Engines, by T. E. Butterfield; Offsetting Cylinders in Single-Acting Engines, by Prof. T. M. Phetteplace; Small Steam Turbines, by Geo. A. Orrok; Oil Well Tests, by Edmund M. Ivens; Safety Valve Discussion; Specific Volume of Saturated Steam, by Prof. C. H. Peabody; Some Properties of Steam, by Prof. R. C. H. Heck, and A New Departure in Flexible Staybolts, by H. V. Wille.

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THE OLDEST IRON SHIP IN THE WORLD.—The U. S. S. *Wolverine* (formerly U. S. S. *Michigan*) is the oldest iron ship in the world, according to Henry Penton in a paper before the Society of Naval Architects and Marine Engineers. This ship was built sixty-six years ago by the firm of Stackhouse & Tomlison, of Pittsburgh, and since that time has continued to be the whole United States navy on the Great Lakes, where treaty obligations restrict naval representation to one ship on each side. The firm who built the vessel has passed away, and probably few people are now living who even remember its launching; more probably none who took any part in its construction. Although it does not amount to much, judged by modern standards, it was a fine ship in its day and answers its purpose at the present time as well as then. It is stated that many naval officers who have risen to high rank and in their turn passed away have served on the old *Michigan.* On the navy list it is rated as an unarmored, unprotected cruiser, with a water line length of 165 ft.; beam, 27 ft.; displacement, 685 tons; indicated horsepower, 365; speed, 10.5 knots. The engines are of the simple inclined type, with two cylinders 36 in. in diameter and 8 ft. stroke. The original paddle wheels were 21 ft. 10 in. in diameter and each had 16 paddles or buckets. Much of our steam engineering knowledge is based upon the early experiments on expansion of steam, superheating, steam jacketing, condensation, etc., carried out on the *Michigan* by B. F. Isherwood, afterward engineer-in-chief, U. S. Navy.

# ENGINEERING DATA—TUBES

*From a hand-book on "The Mechanical Properties of Shelby Seamless Steel Tubing"; prepared by Prof. Reid T. Stewart. Published and copyrighted in 1908 by the National Tube Company of Pittsburgh, Pa., through whose courtesy we are enabled to present this data.*

*Table 9.*—The cylindrical wall, as shown by Fig. 1, is subjected to both the circumferential stress $f_t$, and the longitudinal stress $f_l$, due to the action of the internal fluid pressure. Clavarino's formula is theoretically correct for this case, for tubes having walls of any thickness, so long as the stress upon the most strained fiber does not exceed the elastic limit of the material.

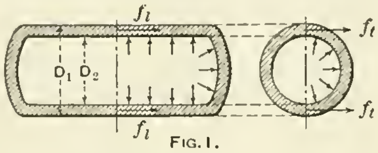



FIG. 1.

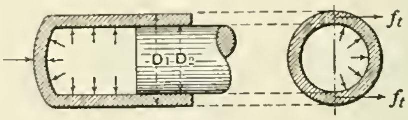



FIG. 2.

For steel tubes this formula is:

$$p=\frac{3(D_1^2-D_2^2)}{4D_1^2+D_2^2}f;\quad D_2=D_1\sqrt{\frac{3f-4p}{3f+p}};$$

$$D_1=D_2\sqrt{\frac{3f+p}{3f-4p}} \quad - - - - (1)$$

Where $D_1$ = outside diameter of tube in inches.
$D_2$ = inside diameter of tube in inches.
$f$ = working fiber stress of the material, pounds per square inch.
$p$ = internal fluid pressure, pounds per square inch.

The fiber stress of 10,000 lbs. per sq. in. used in the table, corresponds to a factor of safety of about 5 for regular stock material with "finish anneal" and to about 2½ for the same material with "soft anneal." The safe working pressure for any other working fiber stress may be had by multiplying the value in the table by the desired fiber stress in pounds per square inch and then cutting off the four figures from the right of the resulting product.

**Internal Fluid Pressures for Tubes with Closed Ends,* in Lbs. Per Sq. Inch Corresponding to a Fiber Stress of 10,000 Lbs. Per Sq. Inch in Wall**

TABLE 9 — Reid T. Stewart and F. P. K., 1907. — Chkd. by W. F. F

| Outside Diam. Inches | THICKNESS IN GAGE AND FRACTIONS OF AN INCH | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 22 BWG | 20 BWG | 18 BWG | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 | 5/16 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 |
| ½ | 1325 | 1648 | 2283 | 2877 | 4164 | 5294 | | | | | | | | | | | |
| ⅝ | 1063 | 1325 | 1840 | 2328 | 3408 | 4404 | | | | | | | | | | | |
| ¾ | 888 | 1107 | 1541 | 1953 | 2877 | 3750 | 4560 | 5294 | | | | | | | | | |
| ⅞ | 762 | 951 | 1325 | 1681 | 2486 | 3258 | 3988 | 4670 | 5294 | | | | | | | | |
| 1 | 668 | 833 | 1162 | 1475 | 2188 | 2877 | 3537 | 4164 | 4751 | 5294 | | | | | | | |
| 1⅛ | 594 | 741 | 1034 | 1314 | 1953 | 2574 | 3174 | 3750 | 4298 | 4814 | | | | | | | |
| 1¼ | 535 | 668 | 932 | 1185 | 1763 | 2328 | 2877 | 3408 | 3917 | 4404 | 5294 | 6058 | | | | | |
| 1⅜ | .... | 607 | 848 | 1079 | 1606 | 2124 | 2629 | 3120 | 3596 | 4053 | 4904 | 5658 | | | | | |
| 1½ | .... | 557 | 778 | 990 | 1475 | 1953 | 2420 | 2877 | 3320 | 3750 | 4560 | 5294 | 6486 | | | | |
| 1¾ | .... | .... | .... | 850 | 1268 | 1681 | 2087 | 2486 | 2877 | 3258 | 3988 | 4670 | 5854 | | | | |
| 2 | .... | .... | .... | 745 | 1112 | 1475 | 1834 | 2188 | 2535 | 2877 | 3537 | 4164 | 5294 | 6226 | | | |
| 2¼ | .... | .... | .... | 662 | 990 | 1314 | 1635 | 1953 | 2266 | 2574 | 3174 | 3750 | 4814 | 5735 | | | |
| 2½ | .... | .... | .... | 597 | 892 | 1185 | 1475 | 1763 | 2047 | 2328 | 2877 | 3408 | 4404 | 5294 | | | |
| 2¾ | .... | .... | .... | 543 | 812 | 1079 | 1344 | 1606 | 1867 | 2124 | 2629 | 3120 | 4053 | 4904 | | | |
| 3 | .... | .... | .... | .... | 745 | 990 | 1234 | 1475 | 1715 | 1953 | 2420 | 2877 | 3750 | 4560 | 5294 | 5940 | 6486 |
| 3¼ | .... | .... | .... | .... | 688 | 915 | 1140 | 1364 | 1586 | 1807 | 2242 | 2668 | 3487 | 4257 | 4966 | 5604 | 6163 |
| 3½ | .... | .... | .... | .... | 639 | 850 | 1060 | 1268 | 1475 | 1681 | 2087 | 2486 | 3258 | 3988 | 4670 | 5294 | 5854 |
| 3¾ | .... | .... | .... | .... | .... | 794 | 990 | 1185 | 1379 | 1572 | 1953 | 2328 | 3056 | 3750 | 4404 | 5010 | 5564 |
| 4 | .... | .... | .... | .... | .... | 745 | 929 | 1112 | 1294 | 1475 | 1834 | 2188 | 2877 | 3537 | 4164 | 4751 | 5294 |
| 4¼ | .... | .... | .... | .... | .... | .... | 875 | 1047 | 1219 | 1390 | 1729 | 2064 | 2717 | 3346 | 3947 | 4514 | 5044 |
| 4½ | .... | .... | .... | .... | .... | .... | 827 | 990 | 1153 | 1314 | 1635 | 1953 | 2574 | 3174 | 3750 | 4298 | 4814 |
| 4¾ | .... | .... | .... | .... | .... | | 783 | 938 | 1093 | 1246 | 1551 | 1853 | 2445 | 3018 | 3571 | 4099 | 4601 |
| 5 | .... | .... | .... | .... | .... | .... | 745 | 892 | 1039 | 1185 | 1475 | 1763 | 2328 | 2877 | 3408 | 3917 | 4404 |
| 5½ | .... | .... | .... | .... | .... | .... | 677 | 812 | 945 | 1079 | 1344 | 1606 | 2124 | 2629 | 3120 | 3596 | 4053 |

*Calculated by Clavarino's formula

*Table 10.*—The cylindrical wall in this case, Fig. 2, is subjected to circumferential stress only, as, for example, in the case of cylinders for hydraulic plungers, shrunk tubular hoops and rings, and rings and drums subjected to centrifugal action due to rotation about their axes.

Birnie's formula is theoretically correct for this case, for tubes of any thickness, so long as the material is not stressed beyond the elastic limit. For steel tubes this formula is

$$p=\frac{3(D_1^2-D_2^2)}{4D_1^2+2D_2^2}f;\quad D_2=D_1\sqrt{\frac{3f-4p}{3f+2p}};$$

$$D_1=D_2\sqrt{\frac{3f+2p}{3f-4p}} \quad - - - - - (3)$$

**Internal Fluid Pressures for Tubes with Circumferential Stress Only,* in Lbs. Per Sq. In. Corresponding to a Fiber Stress of 10,000 Lbs. Per Sq. Inch in Wall**

TABLE 10 — Reid T. Stewart and F. P. K., 1907. — Chkd. by W. F. F

| Outside Diam. Inches | THICKNESS IN GAGE AND FRACTIONS OF AN INCH | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 22 BWG | 20 BWG | 18 BWG | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 | 5/16 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 |
| ½ | 1137 | 1426 | 2004 | 2561 | 3824 | 5000 | | | | | | | | | | | |
| ⅝ | 908 | 1137 | 1599 | 2045 | 3072 | 4068 | | | | | | | | | | | |
| ¾ | 755 | 946 | 1330 | 1701 | 2561 | 3409 | 4228 | 5000 | | | | | | | | | |
| ⅞ | 646 | 809 | 1137 | 1455 | 2193 | 2927 | 3647 | 4342 | 5000 | | | | | | | | |
| 1 | 565 | 707 | 994 | 1271 | 1916 | 2561 | 3199 | 3824 | 4427 | 5000 | | | | | | | |
| 1⅛ | 502 | 628 | 882 | 1128 | 1701 | 2275 | 2846 | 3409 | 3960 | 4492 | | | | | | | |
| 1¼ | 451 | 565 | 793 | 1014 | 1529 | 2045 | 2561 | 3072 | 3576 | 4068 | 5000 | 5833 | | | | | |
| 1⅜ | .... | 513 | 720 | 921 | 1388 | 1858 | 2327 | 2794 | 3256 | 3711 | 4586 | 5393 | | | | | |
| 1½ | .... | 470 | 660 | 844 | 1271 | 1701 | 2132 | 2561 | 2988 | 3409 | 4228 | 5000 | 6316 | | | | |
| 1¾ | .... | .... | .... | 722 | 1088 | 1455 | 1824 | 2193 | 2561 | 2927 | 3647 | 4342 | 5607 | | | | |
| 2 | .... | .... | .... | 631 | 950 | 1271 | 1593 | 1916 | 2239 | 2561 | 3199 | 3824 | 5000 | 6022 | | | |
| 2¼ | .... | .... | .... | 560 | 844 | 1128 | 1414 | 1701 | 1988 | 2275 | 2846 | 3409 | 4492 | 5478 | | | |
| 2½ | .... | .... | .... | 504 | 758 | 1014 | 1271 | 1529 | 1787 | 2045 | 2561 | 3072 | 4068 | 5000 | | | |
| 2¾ | .... | .... | .... | 458 | 689 | 921 | 1154 | 1388 | 1623 | 1858 | 2327 | 2794 | 3711 | 4586 | | | |
| 3 | .... | .... | .... | .... | 631 | 844 | 1057 | 1271 | 1486 | 1701 | 2132 | 2561 | 3409 | 4228 | 5000 | 5703 | 6316 |
| 3¼ | .... | .... | .... | .... | 582 | 778 | 975 | 1172 | 1370 | 1569 | 1966 | 2363 | 3150 | 3918 | 4651 | 5334 | 5950 |
| 3½ | .... | .... | .... | .... | 540 | 722 | 904 | 1088 | 1271 | 1455 | 1824 | 2193 | 2927 | 3647 | 4342 | 5000 | 5607 |
| 3¾ | .... | .... | .... | .... | .... | 673 | 844 | 1014 | 1185 | 1357 | 1701 | 2045 | 2732 | 3409 | 4068 | 4698 | 5291 |
| 4 | .... | .... | .... | .... | .... | 631 | 790 | 950 | 1110 | 1271 | 1593 | 1916 | 2561 | 3199 | 3824 | 4427 | 5000 |
| 4¼ | .... | .... | .... | .... | .... | .... | 743 | 894 | 1044 | 1196 | 1499 | 1802 | 2410 | 3012 | 3605 | 4181 | 4734 |
| 4½ | .... | .... | .... | .... | .... | .... | 702 | 844 | 986 | 1128 | 1414 | 1701 | 2275 | 2846 | 3409 | 3960 | 4492 |
| 4¾ | .... | .... | .... | .... | .... | .... | 664 | 799 | 933 | 1068 | 1339 | 1610 | 2154 | 2696 | 3232 | 3759 | 4270 |
| 5 | .... | .... | .... | .... | .... | .... | 631 | 758 | 886 | 1014 | 1271 | 1529 | 2045 | 2561 | 3072 | 3576 | 4068 |
| 5½ | .... | .... | .... | .... | .... | .... | 573 | 689 | 805 | 921 | 1154 | 1388 | 1858 | 2327 | 2794 | 3256 | 3711 |

Calculated by Birnie's formula.

The notation is same as used above for Clavarino's formula.

*Tables 11 and 12.*—An exhaustive experimental research made by Prof. Reid T. Stewart on the collapsing pressure of lapwelded steel tubes (Trans. American Society Mechanical Engineers, Volume 27, page 730-822) resulted in the production of new formulas for the collapsing strength of tubes which give results for comparatively long lengths that differ greatly from those given in the older formulas. The principal conclusions to be drawn from Prof. Reid T. Stewart's researches may be briefly stated as follows:

1. The length of tube between transverse joints, stiffening rings, or end connections tending to hold it to a circular form has no practical effect upon the collapsing pressure of a commercial lapwelded tube so long as the length is not less than about six diameters of the tube.

2. The formulas as based upon researches for tubes 20 ft. in length between transverse joints or end connections tending to hold them to a circular form, which of course apply in practice without substantial error to any length greater than six diameters, for the collapsing pressures of National Tube Company's lapwelded Bessemer steel tubes, are as follows:

$$p = 86{,}670 \frac{t}{D} - 1{,}386 \qquad \text{(B)}$$

$$p = 50{,}210{,}000 \left(\frac{t}{D}\right) \qquad \text{(G)}$$

Where p = collapsing pressure in pounds per square inch.
D = outside diameter of tube in inches.
t = thickness of wall in inches.

Formula (B) is for pressures greater than 581 pounds per square inch, or for values of t/D greater than 0.023, while formula (G) is for values less than these.

These formulas apply to steel having the following average physical properties: Tensile strength, 58,000 pounds per square inch; yield point, 37,000 pounds per square inch; elongation in eight inches, 22 per cent.; and reduction of area, 57 per cent. They have been tested for commercial lapwelded steel tubing in sizes from 3 to 12 inches outside diameter, for all the usual commercial thicknesses, but are believed to be applicable to a much greater range in size. Formula (B) gives results that are in substantial agreement with Professor Carman's experiments * on 1½ in. and 3½ in. cold drawn seamless steel boiler tubes.

3. Both the modulus of elasticity, E, and the elastic limit of the material appear to have a joint influence in determining the strength of a tube to resist external fluid pressure, the former being paramount for tubes having very thin walls of say t/D less than 0.023, the latter being paramount for ratios of t/D greater than say 0.06, while they both exert an influence in varying degrees for intermediate ratios. That is to say, for tubes made of materials having physical properties other than those stated above, the collapsing pressures, other things being equal, will vary approximately for thin walls as the moduli of elasticity and for thick walls as the elastic limits of the materials. The apparent circumferential fiber stresses under which the different tubes failed, varied from about 7,000 pounds for the relatively thinnest to 35,000 pounds per square inch for the relatively thickest walls.

Table 11 was calculated by means of formulas (B) and (G), pages 793 and 795, Volume 27, Trans. American Society Mechanical Engineers, and is applicable to lengths greater than six diameters of tube between transverse joints or end connections tending to hold it to circular form. No experiments have yet been made to determine the collapsing strength of Shelby mechanical tubing. There appears, however, to be no reason why these formulas should not apply with sufficient accuracy for practical purposes to regular stock material. Accordingly Table 11 has been calculated by means of these formulas for Shelby standard cold drawn mechanical tubing in regular stock material and medium anneal. This table will probably give values for regular stock material that are somewhat too high for "Soft Anneal" and somewhat too low for "Finish Anneal," the difference being relatively greater for thick than for thin walls.

When applying this table of collapsing pressures to practice it must be remembered that a suitable safety factor should be applied. Ordinarily a safety factor of five is sufficient when the stresses due to actions other than a constant fluid pressure are more or less trivial. In case there is repeated fluctuations of the fluid pressure, vibration, shock, internal strain due to unequal heating, etc., then a larger safety factor of from six to twelve or more should be used depending upon the severity of these actions.

Table 12 is calculated directly from the preceding table by dividing each entry by five.

**Collapsing Pressure,* Lbs. Per Sq. Inch, For Lengths Greater than Six Diameters of Tube**
**For Shelby Standard Cold Drawn Mechanical Tubing**

TABLE 11 — Reid T. Stewart and R. L. W., 1907. — Chkd. by W. F. F.

| Outside Diam. Inches | THICKNESS IN GAGE AND FRACTIONS OF AN INCH | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 22 BWG | 20 BWG | 18 BWG | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 | 5/16 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 |
| ½ | 3468 | 4681 | 7108 | 9448 | 14865 | 20282 | | | | | | | | | | | |
| ⅝ | 2497 | 3468 | 5409 | 7281 | 11615 | 15948 | | | | | | | | | | | |
| ¾ | 1850 | 2659 | 4276 | 5837 | 9448 | 13059 | 16670 | 20282 | | | | | | | | | |
| ⅞ | 1387 | 2081 | 3468 | 4805 | 7900 | 10995 | 14091 | 17186 | 20282 | | | | | | | | |
| 1 | 1041 | 1647 | 2861 | 4031 | 6739 | 9448 | 12156 | 14865 | 17573 | 20282 | | | | | | | |
| 1⅛ | 771 | 1310 | 2389 | 3429 | 5837 | 8244 | 10652 | 13059 | 15467 | 17874 | | | | | | | |
| 1¼ | 564 | 1041 | 2011 | 2948 | 5114 | 7281 | 9448 | 11615 | 13781 | 15948 | 20282 | 24615 | | | | | |
| 1⅜ | ..... | 820 | 1703 | 2554 | 4523 | 6493 | 8463 | 10433 | 12402 | 14372 | 18312 | 22251 | | | | | |
| 1½ | ..... | 636 | 1445 | 2225 | 4031 | 5837 | 7642 | 9448 | 11253 | 13059 | 16670 | 20282 | 27504 | | | | |
| 1¾ | ..... | ..... | ..... | 1709 | 3257 | 4805 | 6352 | 7900 | 9448 | 10995 | 14091 | 17186 | 23377 | | | | |
| 2 | ..... | ..... | ..... | 1322 | 2677 | 4031 | 5385 | 6739 | 8094 | 9448 | 12156 | 14865 | 20282 | 25698 | | | |
| 2¼ | ..... | ..... | ..... | 1022 | 2225 | 3429 | 4633 | 5837 | 7040 | 8244 | 10652 | 13059 | 17874 | 22689 | | | |
| 2½ | ..... | ..... | ..... | 781 | 1864 | 2948 | 4031 | 5114 | 6198 | 7281 | 9448 | 11615 | 15948 | 20282 | | | |
| 2¾ | ..... | ..... | ..... | 584 | 1569 | 2554 | 3538 | 4523 | 5508 | 6493 | 8463 | 10433 | 14372 | 18312 | | | |
| 3 | ..... | ..... | ..... | ..... | 1322 | 2225 | 3128 | 4031 | 4934 | 5837 | 7642 | 9448 | 13059 | 16670 | 20282 | 23893 | 27504 |
| 3¼ | ..... | ..... | ..... | ..... | 1114 | 1947 | 2781 | 3614 | 4448 | 5281 | 6948 | 8614 | 11948 | 15281 | 18615 | 21948 | 25282 |
| 3½ | ..... | ..... | ..... | ..... | 936 | 1709 | 2483 | 3257 | 4031 | 4805 | 6352 | 7900 | 10995 | 14091 | 17186 | 20282 | 23377 |
| 3¾ | ..... | ..... | ..... | ..... | ..... | 1503 | 2225 | 2948 | 3670 | 4392 | 5837 | 7281 | 10170 | 13059 | 15948 | 18837 | 21726 |
| 4 | ..... | ..... | ..... | ..... | ..... | 1322 | 2000 | 2677 | 3354 | 4031 | 5385 | 6739 | 9448 | 12156 | 14865 | 17573 | 20282 |
| 4¼ | ..... | ..... | ..... | ..... | ..... | ..... | 1800 | 2438 | 3075 | 3712 | 4987 | 6261 | 8810 | 11359 | 13909 | 16458 | 19007 |
| 4½ | ..... | ..... | ..... | ..... | ..... | ..... | 1623 | 2225 | 2827 | 3429 | 4633 | 5837 | 8244 | 10652 | 13059 | 15467 | 17874 |
| 4¾ | ..... | ..... | ..... | ..... | ..... | ..... | 1465 | 2035 | 2605 | 3176 | 4316 | 5456 | 7737 | 10018 | 12299 | 14580 | 16860 |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | 1322 | 1864 | 2406 | 2948 | 4031 | 5114 | 7281 | 9448 | 11615 | 13781 | 15948 |
| 5½ | ..... | ..... | ..... | ..... | ..... | ..... | 1076 | 1569 | 2061 | 2554 | 3538 | 4523 | 6493 | 8463 | 10433 | 12402 | 14372 |

*Calculated by Stewart's formulas B and G.

**Safe External Fluid Pressure,* Lbs. Per Sq. In., for Safety Factor of Five**
**For Shelby Standard Cold Drawn Mechanical Tubing**

TABLE 12 — Reid T. Stewart and R. L. W., 1907. — Chkd. by W. F. F.

| Outside Diam. Inches | THICKNESS IN GAGE AND FRACTIONS OF AN INCH | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 22 BWG | 20 BWG | 18 BWG | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 | 5/16 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 |
| ½ | 694 | 936 | 1422 | 1890 | 2973 | 4056 | | | | | | | | | | | |
| ⅝ | 499 | 694 | 1082 | 1456 | 2323 | 3190 | | | | | | | | | | | |
| ¾ | 370 | 532 | 855 | 1167 | 1890 | 2612 | 3334 | 4056 | | | | | | | | | |
| ⅞ | 277 | 416 | 694 | 961 | 1580 | 2199 | 2818 | 3437 | 4056 | | | | | | | | |
| 1 | 208 | 329 | 572 | 806 | 1348 | 1890 | 2431 | 2973 | 3515 | 4056 | | | | | | | |
| 1⅛ | 154 | 262 | 478 | 686 | 1167 | 1649 | 2130 | 2612 | 3093 | 3575 | | | | | | | |
| 1¼ | 113 | 208 | 402 | 590 | 1023 | 1456 | 1890 | 2323 | 2756 | 3190 | 4056 | 4923 | | | | | |
| 1⅜ | ..... | 164 | 341 | 511 | 905 | 1299 | 1693 | 2087 | 2480 | 2874 | 3662 | 4450 | | | | | |
| 1½ | ..... | 127 | 289 | 445 | 806 | 1167 | 1528 | 1890 | 2251 | 2612 | 3334 | 4056 | 5501 | | | | |
| 1¾ | ..... | ..... | ..... | 342 | 651 | 961 | 1270 | 1580 | 1890 | 2199 | 2818 | 3437 | 4675 | | | | |
| 2 | ..... | ..... | ..... | 264 | 535 | 806 | 1077 | 1348 | 1619 | 1890 | 2431 | 2973 | 4056 | 5140 | | | |
| 2¼ | ..... | ..... | ..... | 204 | 445 | 686 | 927 | 1167 | 1408 | 1649 | 2130 | 2612 | 3576 | 4538 | | | |
| 2½ | ..... | ..... | ..... | 156 | 373 | 590 | 806 | 1023 | 1240 | 1456 | 1890 | 2323 | 3190 | 4056 | | | |
| 2¾ | ..... | ..... | ..... | 117 | 314 | 511 | 708 | 905 | 1102 | 1299 | 1693 | 2087 | 2874 | 3662 | | | |
| 3 | ..... | ..... | ..... | ..... | 264 | 445 | 626 | 806 | 987 | 1167 | 1528 | 1890 | 2612 | 3334 | 4056 | 4779 | 5501 |
| 3¼ | ..... | ..... | ..... | ..... | 223 | 389 | 556 | 723 | 890 | 1056 | 1390 | 1723 | 2390 | 3056 | 3723 | 4390 | 5056 |
| 3½ | ..... | ..... | ..... | ..... | 187 | 342 | 497 | 651 | 806 | 961 | 1270 | 1580 | 2199 | 2818 | 3437 | 4056 | 4675 |
| 3¾ | ..... | ..... | ..... | ..... | ..... | 301 | 445 | 590 | 734 | 878 | 1167 | 1456 | 2034 | 2612 | 3190 | 3767 | 4345 |
| 4 | ..... | ..... | ..... | ..... | ..... | 264 | 400 | 535 | 671 | 806 | 1077 | 1348 | 1890 | 2431 | 2973 | 3515 | 4056 |
| 4¼ | ..... | ..... | ..... | ..... | ..... | ..... | 360 | 488 | 615 | 742 | 997 | 1252 | 1762 | 2272 | 2782 | 3292 | 3801 |
| 4½ | ..... | ..... | ..... | ..... | ..... | ..... | 325 | 445 | 565 | 686 | 927 | 1167 | 1649 | 2130 | 2612 | 3093 | 3575 |
| 4¾ | ..... | ..... | ..... | ..... | ..... | ..... | 293 | 407 | 521 | 635 | 863 | 1091 | 1547 | 2004 | 2460 | 2916 | 3372 |
| 5 | ..... | ..... | ..... | ..... | ..... | ..... | 264 | 373 | 481 | 590 | 806 | 1023 | 1456 | 1890 | 2323 | 2756 | 3190 |
| 5½ | ..... | ..... | ..... | ..... | ..... | ..... | 215 | 314 | 412 | 511 | 708 | 905 | 1299 | 1693 | 2087 | 2460 | 2874 |

*Calculated by Stewart's formulas.

* Bulletin No. 5, page 6, of University of Illinois Engineering Experiment Station.

RAILROAD REGULATION.—No one conversant with the facts will deny that there have been mistakes and wrong-doing on the part of the railroads and other large corporations, and the corporations, as well as all good citizens, are glad that checks to stop them have been devised. I do not question the right, the wisdom, or the necessity for the supervision and regulation of railroads by the nation or state that creates them. Under our form of government the people rule, and the terms "rule" and "regulate" are synonymous.—*W. C. Brown.*

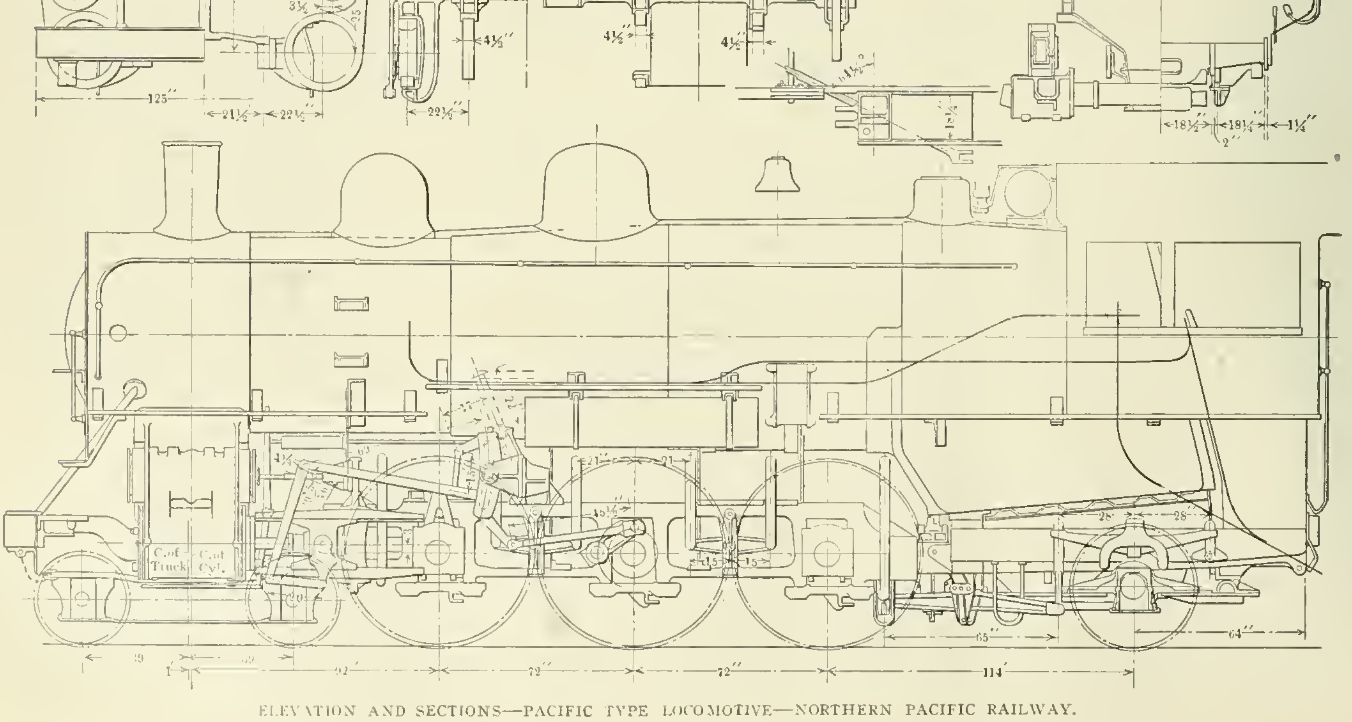
PACIFIC TYPE LOCOMOTIVE WITH COMBUSTION CHAMBER—NORTHERN PACIFIC RAILWAY.

## PACIFIC AND ATLANTIC TYPE LOCOMOTIVES.

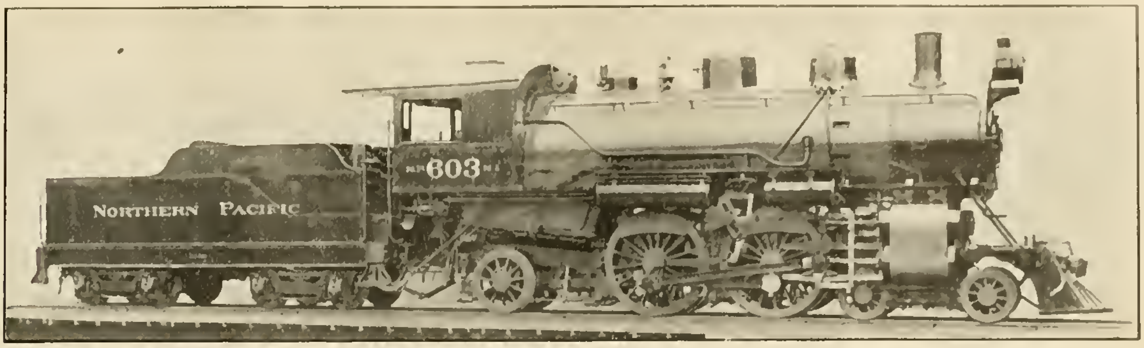
NORTHERN PACIFIC RAILWAY.

Pacific type locomotives were introduced on the Northern Pacific Railway in 1902, by A. E. Mitchell, superintendent of motive power. At that time the Schenectady works of the American Locomotive Company built 20 locomotives having 22 x 26 in. cylinders, 69 in. drivers and 200 lbs. boiler pressure for this company. Seven of these had piston valves and thirteen, slide valves. Five of them were equipped with the Davis counter balance. This design was illustrated in the AMERICAN ENGINEER, February, 1903, page 63. This class was followed in 1904 and 1905, at which time Mr. Van Alstyne was superintendent of motive power, by 18 locomotives having the same size cylinders, drivers and steam pressure, but a larger boiler, the weight being increased from 195,000 to 219,000 lbs. These locomotives were illustrated on page 8 of the January, 1905, issue of this journal. In the latter part of 1906, 20 more Pacific type locomotives were built by the American Locomotive Company, which were practically identical with the previous order, with the exception of the boiler, which in this case included a combustion chamber, 3 ft. in length, and a reduction in the number and length of flues. One of these locomotives was equipped with a Schenectady superheater. These locomotives were fully illustrated in this journal October, 1906, page 392. About two months later the same company turned out two balanced compound Pacific type locomotives for the Northern Pacific, which at that time were the heaviest locomotives ever built, weighing 240,000 lbs. These engines also had combustion chambers and included the Walschaert valve gear. They were illustrated on page 411 of the November, 1906, issue of this journal.

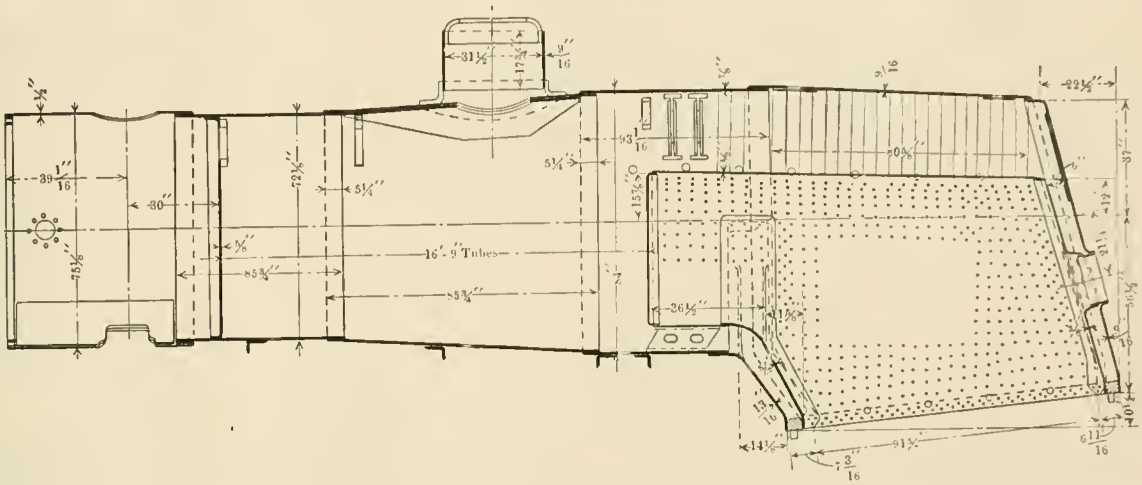
At this time this company then had in operation Pacific type locomotives of practically identical power as follows: Simple engines without combustion chamber or superheater; simple engines with combustion chamber and without superheater; simple



ELEVATION AND SECTIONS—PACIFIC TYPE LOCOMOTIVE—NORTHERN PACIFIC RAILWAY.




ATLANTIC TYPE LOCOMOTIVE WITH SUPERHEATER—NORTHERN PACIFIC RAILWAY.



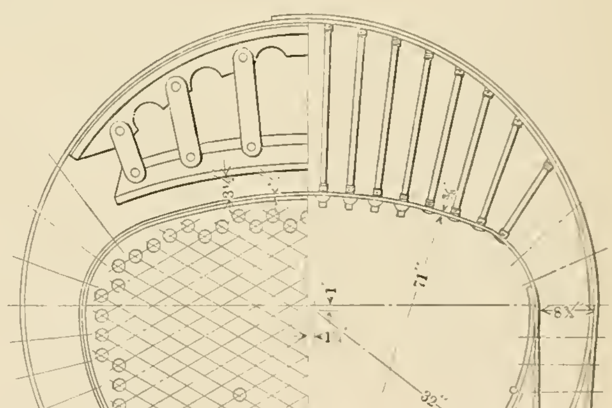

BOILER WITH COMBUSTION CHAMBER—PACIFIC TYPE LOCOMOTIVE.

engines with combustion chamber and superheater and balanced compound engines with combustion chamber and without superheater.

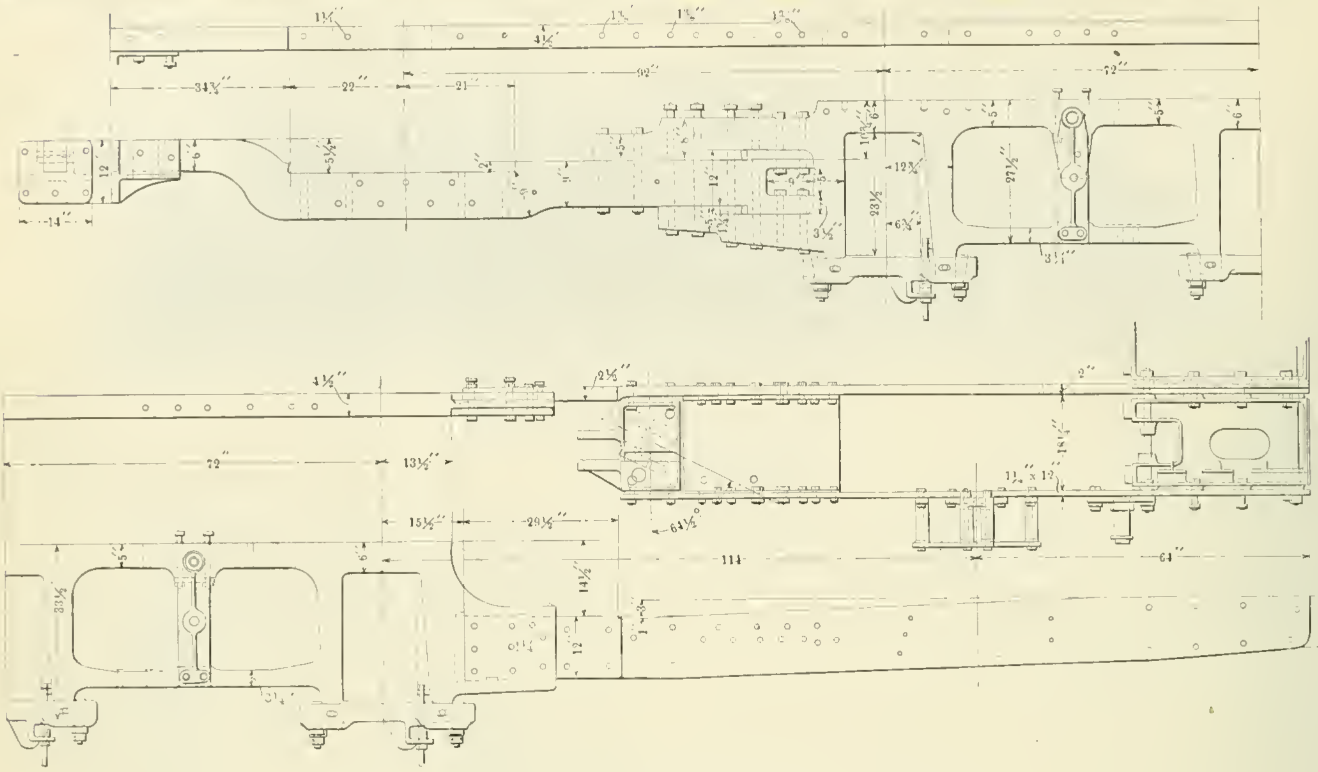
During this period of development of course changes in details were made as found desirable on each new order. Experience was obtained with both piston and slide valves, with Stephenson and Walschaert valve gear, in addition to the boiler and cylinder arrangements, and in August, 1907, 10 engines were ordered from the American Locomotive Company which had simple cylinders 22 x 26 in., 69 in. wheels and a boiler with combustion chamber, but no superheater, being practical duplicates of those previously built by the same company in 1906. They had Stephenson valve gear.

The latest step in this development is found in the design which is illustrated herewith, ten of which have recently been completed by the Baldwin Locomotive Works. These locomotives have combustion chambers, simple 22 x 26 in. cylinders, 12 in. piston valves and Walschaert valve gear. It has been found in practice that balanced compound cylinders, while fully successful, were not adapted to the service for which these locomotives are to be used, and for that reason simple cylinders have been specified. The combustion chamber has proved to be a complete success and the slight trouble which had been found with leaky seams has been eliminated in this last design by welding the connections between the combustion chamber ring, the crown sheet and the throat sheet. The experience with the superheater has evidently not been conclusive, as accompanying this order of Pacific type locomotives there are three of the Atlantic type, two of which are equipped with the Schmidt superheater. The design of the 4-6-2 engines is almost identical with the last order of simple locomotives of this type mentioned above, the principal difference being the use of the Walschaert valve gear in place of the Stephenson.

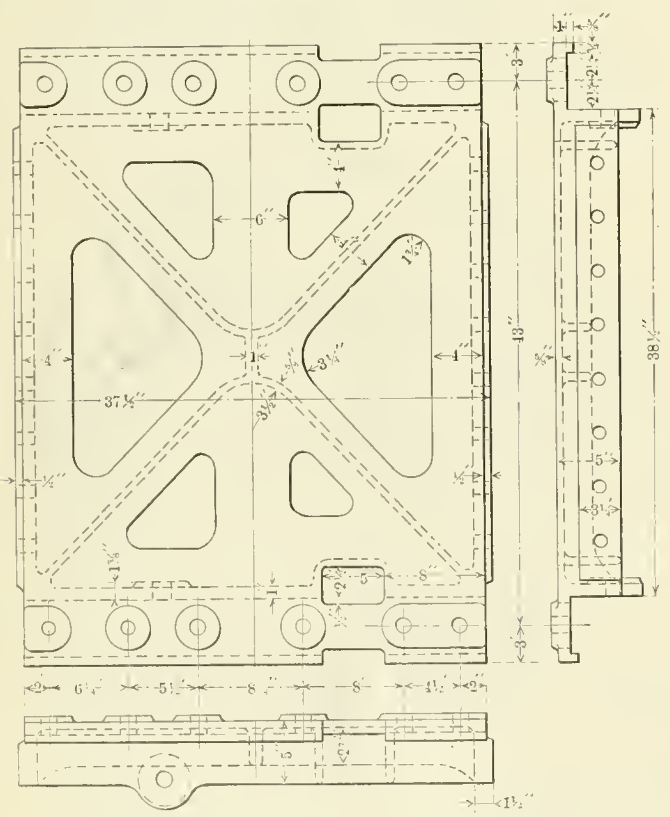
In view of the fact that this design can be considered as having been most thoroughly and carefully tried out in service covering several years, the details of the boiler and frames of the Pacific type are illustrated herewith. The 46 sq. ft. of heating surface in the combustion chamber, included with the firebox heating surface, gives a ratio with the total heating surface of nearly 8 per cent., which, of course, is a great advantage in itself in addition to the advantage of getting the tube ends removed from the



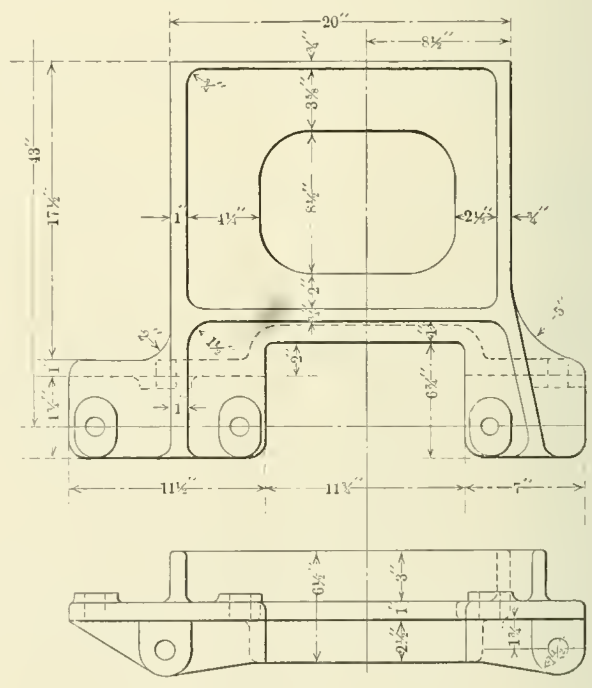
SECTION THROUGH THE COMBUSTION CHAMBER AND FIREBOX.



FRAMES—PACIFIC TYPE LOCOMOTIVE, NORTHERN PACIFIC RAILWAY.



FRAME BRACE BETWEEN SECOND AND THIRD PEDESTALS.



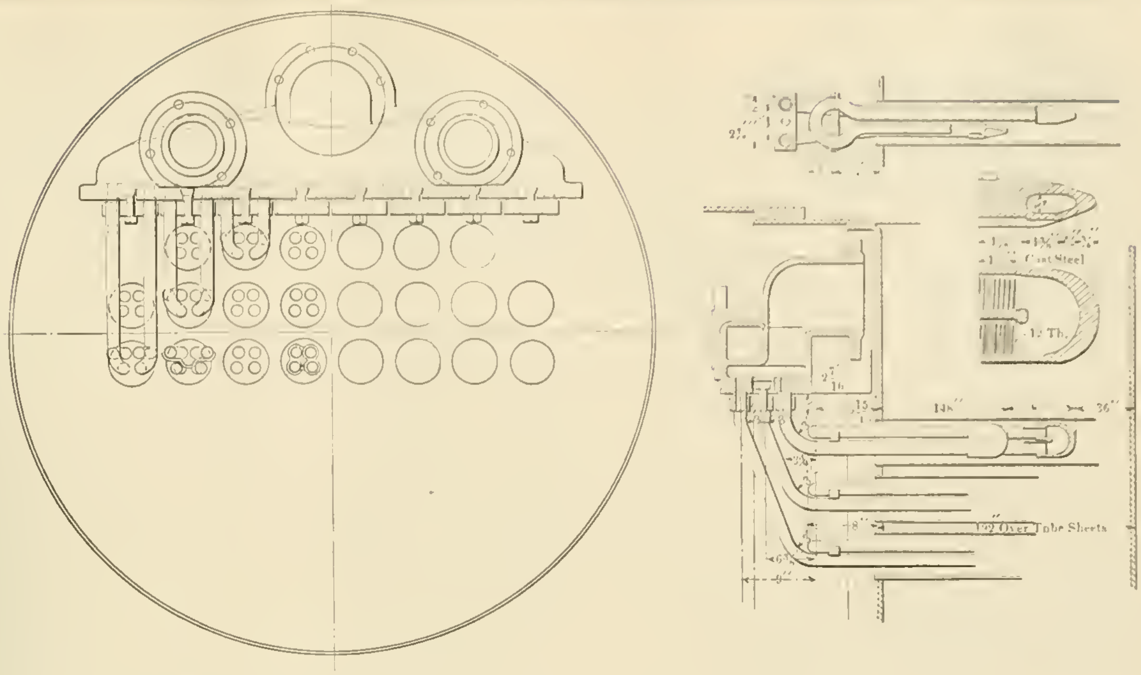
FRAME BRACE OVER FRONT PEDESTAL.

direct action of the flames. A brick arch supported on a single water tube is used. Careful attention has been given to providing ample space around the combustion chamber for circulation, particularly at the bottom. The grate area of 43.5 sq. ft. bears a ratio of 1 to 66 to the total heating surface.

The boiler of the Atlantic type locomotives is practically the same as that of the Pacific with the exception that the combustion chamber has not been used and the tubes are shorter. It carries but 185 lbs. pressure. The two boilers fitted with the superheater have 196 2-in. tubes in place of 306, and use 22-5⅜ in. tubes for the superheater elements. The heating surface of the superheater itself is 430 sq. ft. The ratios given for the Atlantic type engine are for the one without a superheater.

The frame construction is interesting and excellent and is identical with that used on the last 4-6-2 type order. The front frames are separate from the main frames and the connection between the two has been very carefully studied and is a proved success. The cast steel frame braces, which are shown in detail, are located over the front pedestal and between the second and third pedestals. They are broad and substantial and located where the greatest strains are known to occur. A cast steel bearer for the link and reverse shaft located between the first and second pedestals also acts as a frame brace.

The Atlantic type locomotives use the same cylinder and cylin-



SCHMIDT SUPERHEATER ON ATLANTIC TYPE LOCOMOTIVE, NORTHERN PACIFIC RAILWAY.

der heads as the Pacific, the difference in the diameter of piston being obtained by the introduction of a bushing. The valve motion details on the two designs are interchangeable wherever possible. The trailing truck on the Atlantic type has inside journals, while the Pacific type has outside journals. The method of frame bracing is also somewhat different in the two designs.

The general dimensions, weights and ratios are given in the following table:

| | | |
|---|---|---|
| **GENERAL DATA.** | | |
| Type | 4—6—2 | 4—4—2 |
| Gauge | 4 ft. 8½ in. | |
| Service | Passenger | |
| Fuel | Bit. Coal. | |
| Tractive effort | 31,000 lbs. | 24,760 lbs. |
| Weight in working order | 233,260 lbs. | 197.050 lbs. |
| Weight on drivers | 144,350 lbs. | 100,800 lbs. |
| Weight on leading truck | 47,000 lbs. | 51,950 lbs. |
| Weight on trailing truck | 41,900 lbs. | 44,300 lbs. |
| Weight of engine and tender in working order | 375,000 lbs. | 320,000 lbs. |
| Wheel base, driving | 12 ft. | 6 ft. 10 in. |
| Wheel base, total | 32 ft. 6 in. | 27 ft. 10 in. |
| Wheel base, engine and tender | 61 ft. 11 in. | 57 ft. 3 in. |
| **RATIOS.** | | |
| Weight on drivers ÷ tractive effort | 4.66 | 4.05 |
| Total weight ÷ tractive effort | 7.50 | 7.96 |
| Tractive effort × diam. drivers ÷ heating surface | 743.00 | 665.00 |
| Total heating surface ÷ grate area | 66.10 | 62.20 |
| Firebox heating surface ÷ total heating surface, % | 7.70 | 6.38 |
| Weight on drivers ÷ total heating surface | 50.00 | 37.00 |
| Total weight ÷ total heating surface | 81.00 | 72.40 |
| Volume both cylinders, cu. ft. | 11.40 | 10.40 |
| Total heating surface ÷ vol. cylinders | 252.00 | 261.00 |
| Grate area ÷ vol. cylinders | 3.82 | 4.19 |
| **CYLINDERS.** | | |
| Kind | Simple | |
| Diameter and stroke | 22 x 26 in. | 21 x 26 in. |
| **VALVES.** | | |
| Kind | Piston | Piston |
| Diameter | 12 in. | 12 in. |
| Valve gear | Walschaert | |
| **WHEELS.** | | |
| Driving, diameter over tires | 69 in. | 73 in. |
| Driving, thickness of tires | 3½ in. | 3½ in. |
| Driving journals, main, diameter and length | 9½ x 12 in. | 9½ x 12 in. |
| Driving journals, others, diameter and length | 9 x 12 in. | 9½ x 12 in. |
| Engine truck wheels, diameter | 33½ in. | 33½ in. |
| Engine truck journals | 6 x 11 in | 6½ x 12 in. |
| Trailing truck wheels, diameter | 45 in. | 45 in. |
| Trailing truck journals | 8 x 14 in. | 8 x 14 in. |
| **BOILER.** | | |
| Style | Conical | Straight |
| Working pressure | 200 lbs. | 185 lbs. |
| Outside diameter of first ring | 72⅛ in. | |
| Firebox, length and width | 96 x 65¼ in. | |
| Firebox plates, thickness | ⅜ & ⅝ in. | |
| Firebox, water space | F.—4½, S. & B.—4 in. | |
| Tubes, number and outside diameter | 306—2 | |
| Tubes, length | 16 ft. 9 in. | 16 ft. |
| Heating surface, tubes | 2,665 sq. ft. | 2,543 sq. ft. |
| Heating surface, firebox | 174 sq. ft. | 173 sq. ft. |
| Heating surface, combustion chamber | 46 sq. ft. | ........ |
| Heating surface, total | 2,885 sq. ft. | 2,718 sq. ft. |
| Grate area | 43.5 sq. ft. | |
| **TENDER.** | | |
| Frame | 13 in. chan. | |
| Wheels, diameter | 33½ in. | |
| Journals, diameter and length | 5½ x 10 in. | |
| Water capacity | 7,000 gals. | 6,000 gals. |
| Coal capacity | 12 tons | 9 tons. |

Superheater locomotives have:—

| | |
|---|---|
| Small tubes | 196—2 in. |
| Large tubes | 22—5⅜ in. |
| Heating surface, firebox | 173 sq. ft. |
| Heating surface, tubes | 2,112 sq. ft. |
| Heating surface, total | 2,287 sq. ft. |
| Superheater heating surface | 4[illegible]0 sq. ft. |

## PENNSYLVANIA RAILROAD SYSTEM.

The annual, "Record of Transportation Lines," recently issued by the Pennsylvania Railroad, shows that on December 31, 1908, this system had 11,236 miles of line and 23,977.4 miles of track. Of this 14,089.76 miles are east of Pittsburgh and Erie and 9,887.65 are west of these points. During the year the total trackage increased 405 miles. The system lines now have 3,326 miles of double track, 784 of triple track and 564 miles of four-track line.

During 1908 the Pennsylvania Railroad carried 142,676,779 passengers, an average of over three trips for every inhabitant of the States through which its lines run. Likewise during the year the company handled 334,429,541 tons of freight, an average of nearly eight tons to every person living in the States it serves. The estimated population of the States through which the lines of the Pennsylvania Railroad run was on January 1, 1909, 44,936,522, or almost exactly half of the estimated population of the whole United States.

During the year the system carried on an average of 316,098 passengers over every mile of its line and an average of 2,621,631 tons of freight over every mile of the line.

SHORT BELT CENTERS.—In driving the new and extra powerful tools for using high-speed steel, much attention has been paid to trains of gearing and endless chains for getting sufficient torque, the poor old-fashioned belt being neglected as being too weak and of no account. The trouble with the old-time belt drive was that the belts were run much too slow, hence did not have the capacity to transmit much power. I have found, however, that the cheapest and most practical method to drive a shaft from a motor is with a short belt running at high speed and endless. A small belt running at 3,000 to 4,000 feet a minute will transmit an enormous amount of power and can be kept so loose as not to be strained up to its working limit, thus being very durable. Because it runs loosely the shafts are not pulled together, so that there is very little journal friction and wear. There need not be any fear of its being too short between pulley centers if it is strong, thin, endless and runs at high speed.—*Oberlin Smith before the A. S. M. E.*

(Established 1832).

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**Contributions.**—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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## CONTENTS



## M. M. AND M. C. B. ASSOCIATIONS.

The American Railway Master Mechanics' Association will meet at Atlantic City, June 16, 17 and 18. The Master Car Builders' Association will meet at the same place June 21, 22 and 23. Jos. W. Taylor, 390 Old Colony Building, Chicago, is secretary of both these associations. Exhibit space may be secured by communicating with Earl G. F. Smith, secretary of The Railway Supply Manufacturers' Assn., 345 Old Colony Building, Chicago.

## STEEL PASSENGER CAR DESIGN.

The designers of steel passenger cars are confronted with many serious problems not the least of which is to know just how strong and stiff to make the cars. We know how a wooden car acts in a collision, but we have not yet had sufficient experience with steel cars to understand how they will act and what feature will prove of greatest danger to the passengers. In this connection it is interesting to note the careful provision which steel passenger car designers, at least in some cases, have made for fastening the seats securely to the floor.

Another problem is the fact that it is much harder to heat the steel cars, the heat radiating from the car much more quickly than was possible with the wooden car. It has been necessary to greatly increase the heating facilities on some of the new steel cars.

## THE INGENIOUS WORKMAN.

One cannot but be impressed by the many devices and contrivances which are developed by the workmen and often add greatly to the efficiency of the plant or department. It is to be regretted that the officials do not always realize the importance of what some of these men are trying to do by giving them better facilities for developing their ideas, thus adding to their efficiency.

At a certain freight car repair yard the man in charge of the tools did not have facilities for regrinding them and it was either necessary to use them dull or send them a considerable distance to one of the main shops for grinding. He did have a supply of compressed air and set to work to contrive some device with which he could grind the tools. He had a badly worn washing machine at home from which he took the "bucket" wheel of the water motor. This he placed on an old piece of shafting and somewhere else he found a casting with a couple of bearings upon which it could be mounted. An old emery wheel was dug up out of the scrap heap at the main shop and was attached to the opposite end of the shaft. A vise in which to hold this grinder and an air hose, with a small nozzle at its end, connected to an air pipe, completed the equipment. The air driving against the wings of the "bucket" wheel did the work and the device really proved quite satisfactory, except that the grinding wheel was revolved at a pretty high velocity. How much air was required and just how much it cost to operate it will never be known, but the increased efficiency of the steel car repairmen undoubtedly offset this many times.

## EDUCATION OF FIREMEN.

It is the practice on many roads to give the fireman an examination at the end of each year for the first three years of service. At the beginning of the year he is given a pamphlet or small book containing questions the answers to which he will be expected to be familiar with at the end of the year.

The booklet usually contains a preface stating that the fireman is invited to ask the master mechanic, roundhouse foreman, and other officials for such information as he may need in preparing himself for the examination. No doubt these gentlemen will be glad to help him if he can catch them when they have the time to spare. No attempt is usually made to encourage or follow the progress of the fireman in his studies during the year, except as concerns such instructions as he may receive in the use of air brakes or on the engine. The result is that in many cases the men put the matter off until the last moment and just previous to the time of examination lay off and start to "dig" or "cram," as it is called at college.

In some cases they have been known to hire halls and secure a young engineer or some one familiar with the subject to lecture to or quizz them. This practice is all wrong and cannot produce the best results. Some arrangement should be made so that the work and study of each individual fireman can be followed through the year. It has been suggested that correspondence school methods could be adopted. The firemen could be required to send in papers covering the answers to certain of the subjects at more or less regular intervals; these could be corrected and returned to him with suggestions and criticisms; in case the fireman desired information on any topic in connection with his work he could write in for it, if he could not conveniently get it in other ways. The yearly examination would be held as at present, but the men would be much better prepared.

## INCREASING THE FIREMAN'S OUTPUT.

Again the limits for size and weight of locomotives have been exceeded and we have a new, "largest locomotive in the world" in the Southern Pacific 2-8-8-2 type, two of which have recently been finished by the Baldwin Locomotive Works. A study of the design of this locomotive, which is illustrated on page 181 of this issue, shows, however, that it is deserving of attention for reasons more important than those of mere size and weight.

It has truthfully been contended that the capacity of a locomotive is limited by the physical capacity of the fireman and it was felt, when Mallet compounds were first introduced, that they would be impracticable because of the impossibility of a fireman being capable of developing so large an amount of power. Such, however, did not prove to be the case as it was found that the economy of the compound cylinders, combined with the other advantageous features of the design, permitted one man to furnish steam enough for the full capacity of the locomotive. It did seem though that, in the B. & O. engine, the limit had been reached and probably as a matter of fact it had been reached for continuous service, but later the Erie locomotive, with over 30 per cent. more tractive effort, after a long trial has been found to require the services of but one fireman; this, however, in pushing service with short periods of maximum power requirement.

By burning oil, the Southern Pacific locomotive has escaped this limiting feature, but nevertheless there has been incorporated in its design features which probably with a coal burning locomotive would allow one fireman to develop the full capacity of the engine in regular service. This, of course, refers to the feed water heater and re-heater, both being originally intended for money savers in smaller locomotives, but in this case being far more valuable as permitting the decided extension of the limits of one fireman's capacity.

It looks as if American locomotive development had reached a stage where refinements for increasing the steam and water economy are absolutely essential, not to save money as they were originally designed to do, but to permit continual progress along the line of increased size and power.

In studying the design from this standpoint, however, it is hard to harmonize the application of front and rear truck wheels. In this case we have a locomotive which has a total weight about 16,000 lbs. greater than the Erie and is evidently more powerful in every respect, but still has not as large a tractive effort. In other words, instead of increasing the fireman's capacity it would seem as if, in this feature, it has been directly decreased. Of course, locomotive building companies will build whatever a railroad company wants and there are probably operating reasons in this case which make truck wheels desirable, but it is known that locomotives of this type without trucks will operate under severe conditions of curvature with entire safety and with a surprisingly small amount of flange wear, the latter being less than on consolidation locomotives in the same service. With these facts in mind and viewing the design from the standpoint of capacity it is to be regretted that unusual conditions exist which make it desirable to apply truck wheels to this type of locomotive.

## AN IMPORTANT DEVELOPMENT IN ENGINEERING AND INDUSTRIAL EDUCATION.

The introduction of co-operative engineering courses at the University of Cincinnati marks a most distinct and important advance in engineering education. It is greatly to the credit of the Cincinnati machine tool builders and manufacturers that they were foresighted enough to grasp the significance of Prof. Schneider's scheme and to lend their aid and support in order that it might be given a fair trial. Briefly the idea is to combine practical and theoretical instruction by having the students spend alternate weeks in the engineering college of the University and in the manufacturing shops of the city. Each class is divided into two sections so that one part is in the University while the other is in the shops.

The course is six years long; the entrance requirements are the same as for the regular four-year engineering course at the University. The latter statement possibly requires some modification—the co-operative course has become so popular that many times more applications are received than the number of students that can be accommodated; it is therefore possible to carefully select those who seem best adapted for following engineering pursuits. Except for two or three weeks' vacation the students must work in the shop during the summer months, although this work need not necessarily be in Cincinnati.

As far as possible the student in his shop work follows the progress of the material from the raw state to the finished product, including, for instance, work in the shops, test department, drafting room and sales department. This work is just as carefully planned as that at the University and is intended to give the student a good shop and business training. The manufacturers take a great interest in the co-operative students and since they unite with the University authorities in planning and developing the shop courses the best possible results are obtained. Ask most of the Cincinnati machine tool builders if they have co-operative students in their shops, or if they know Prof. Schneider, and you will be surprised at the hearty and enthusiastic response.

It will be found that the students who enroll in the average college engineering department do not in most cases have a clear idea of what their work after leaving college is really to be. It is comical to hear some of the reasons why students select the course in which they are entered. The work at college, at least during the early part of the course, does not tend to enlighten them very much in this respect. The college shop work is a kind of a farce—it is true one gets some idea of the way things are done, a kind of smattering, but from a practical standpoint it is not of much value compared to gaining the experience under actual shop conditions.

It costs money to give young men an education. Is the money spent to the best advantage when young men entirely unsuited to follow or make a success of a profession, and having mistaken ideas as to what it really is, enter a course and drop out one by one during the four years or discover after graduation that it does not suit their tastes? It is surprising to note the small number of men who graduate and take up engineering work as compared to the number that entered in the freshman year for the same class. Are those in charge spending the money of the State economically and efficiently when this condition exists, and is it fair to the misguided young man to have him use his time in this way.

Is it logical to have a young man spend four years at an important period of his life, digging away at theory, and under conditions far removed from practical work, and at the end of that time, at the age of 22 or more, don overalls and start in at the bottom in the shop as an apprentice? Unfortunately college life at many institutions unfits a man to go into the shop and get on the same plane as the workman, whose work, habits, ideals and manner of living he must understand if he is to become a successful manager of men. Is it not much better to study theory and practice together, as in the co-operative courses, so that he will realize at the beginning something of what his life work is to be? (He will have a pretty good idea before he is allowed to enter, for Prof. Schneider and his assistants go through the list of applicants with a fine-toothed comb. There is little chance of a candidate getting by them who does not realize just what he is up against.)

By combining theory and practice from the start, and while he is still in his teens or early twenties, the student is enabled to make better use of his time, to gain a bigger and broader view of his life work and will develop more symmetrically, mentally and physically.

With the co-operative courses expensive shops and laboratories and the cost of maintaining them are done away with. This money may be used for other things. Not only is the cost per capita thus reduced, but because of the alternation of classes more students can be reached with the same facilities as concerns buildings, equipment and faculty than by the other method.

An interesting fact in connection with the development of this work at the University of Cincinnati is that the co-operative students are doing better work and a relative larger amount than the students in the regular engineering courses. Their physical condition, because of the shop work, is also much better.

When the co-operative courses were first started the work of the four-year engineering courses was simply spread over six years. Important changes have been made since that time—mathematics is now taught as one subject, useless matter is eliminated, repetition is avoided (it is remarkable how much of this there is if members of the engineering faculty would compare notes), and education is being administered on strictly business principles. The professors have simply got to be practical, or they can't hold their jobs. Subjects are being added to the curriculum which will broaden the men and make them better citizens.

Incidentally it may be noted that the student is paid a sufficient wage for his shop work to go a long way toward paying his expenses during the six years at college.

The co-operative plan originated with and was developed by Prof. Herman Schneider, dean of the college of engineering of the University of Cincinnati. When first started it was severely criticised by professional educators, but gradually this has changed until it is quite probable that it will be extensively adopted by other colleges and universities; in fact it is being seriously considered by several at the present time.

Prof. Schneider's co-operative idea as applied to industrial education, and it is being applied thus in several instances, is of even greater importance as may be seen from an extract of a paper on "Partial Time Trade Schools," prepared by Prof. Schneider for *The Annals of the American Academy of Political and Social Science:*

"Education, generally speaking, should aim to do the greatest good to the greatest number. The first object of all education is to make better citizens, and the first duty of a good citizen is to be self-supporting. The second duty is to be a good citizen in the civic sense. Consequently, for this large number, educational plans should tend to increase the industrial efficiency of the youth who has already secured a position and is working at it. It should give him such training as will insure upon his part the proper performance of his duties as a citizen of a republic.

"To show more clearly the situation confronting the educator, the following figures may be cited: In the city of Cincinnati, of 8,567 pupils entering the schools in the first grade, 447 are left at the tenth grade, when the children reach the age at which the law permits them to withdraw from the school. The majority of these children enter the industrial life of the city, and thereafter they obtain no further instruction of any sort whatever, except what may be given in the night schools. They receive no instruction in industrial efficiency, and very little in good citizenship.

"It is unquestionably impossible to organize under private direction a school which would deal with the education of this number of industrial workers. Investigation, however, discloses the fact that if a partial time school was arranged, a great many children could attend for part of the time if they were earning something the other part; and further, that parents would make sacrifices if the children were taught in the partial time school such subjects as would make them more highly efficient in their work, and thereby increase their earning capacities at their trades. It is evident that there is but one organized institution which can meet this situation, and that is the public school system.

"The logical solution, therefore, is a broad plan of co-operation between the public schools and the industries. How such a scheme may be planned, may perhaps be best exemplified by the working of the co-operative courses in engineering now in operation at the University of Cincinnati."

Just a word about the man who has developed the co-operative idea. Many men with a hobby cannot see over or around it. Prof. Schneider is not in this class. Keen and thorough in analyzing conditions, capable of looking at a problem from a broad and liberal viewpoint, apparently possessed of a goodly supply of patience and absolutely unselfish in his efforts to help others, he is an ideal man to stand at the head of such a movement.

## CONCERNING THE JACOBS-SHUPERT FIRE-BOX.

To the Editor:

The criticism in your April issue discussing the Jacobs-Shupert fire-box leads me to believe that this communication signed "Circulation" was from one who had not seen the fire-box and one who is not a practical boiler man. The arguments presented were, I believe, based upon a casual observation of the illustrations published. I offer this explanation for the reason that the opinion which I held before seeing the actual fire-box was far different from the opinion which I now hold after examining it carefully.

Before seeing the fire-box, my early impression as to the design, given by looking at drawings and pictures, was that such a fire-box must be a monstrosity. Upon looking at the actual boiler under construction, however, these impressions were entirely reversed and I now feel satisfied that the fire-box will be one of the most practical innovations introduced into recent locomotive construction.

This fire-box is so different from anything that has heretofore been attempted, and is so radical in its departure from former general practice, that one would naturally be skeptical concerning it. Few men have the imagination to realize how a fire-box of such construction could be developed successfully, but since my personal examination I am convinced that it is no mistake to build fire-boxes of this type for locomotives.

When an unusual form of locomotive boiler construction is introduced or suggested, the first consideration which excites the interest of the average railway mechanical man is the possible effect on circulation and boiler washing. As regards circulation, I feel that Mr. Jacobs has ably explained the principle in his communication (page 147, April issue), and I heartily concur in the opinions which he has expressed. In regard to boiler washing, I would like to direct especial attention to the clear channel through the stay sheets for the entire length of the mud ring. My personal opinion is that boiler washing is often carried to excess, for I consider it much better practice to prevent solid forming substances from entering boilers than to spend a great deal of time washing out sludge and scale that have been precipitated by untreated water. Nevertheless, I believe that the designers are to be commended for providing a clear channel along the mud ring.

The stay sheets are cut away sufficiently to provide this channel and the ingenious method of reverse lapping the flanges of the corrugated sections to conform to the mud ring, removes the obstruction which the flanges would present. This peculiar construction provides a smooth surface several inches in height throughout the entire length of the mud ring and prevents any pockets or corners in which scale and mud might collect. The movement of a hoe or other tool used by the boiler washer is entirely unimpeded and the boiler washer is allowed a full sweep through the full length of the mud ring. At the height of the crown sheet, there is a washout hole in each corrugated section forming the outer shell. Through these holes a stream of water may be directed either for cleaning out the spaces above the crown or the space between the vertical sections.

With the present Santa Fe improved method of softening boiler feed water and using boiler compounds to advantage, fire-boxes of the Jacobs-Shupert type should be unusually durable, should run for long periods between washouts and should be easily and economically maintained.

The ingenious methods of manufacture which have been developed for the construction of the fire-box impressed me particularly. I was surprised to find jigs and formers used in laying out and forming the first fire-box of this unusual type, thoroughly developed and being used in a very systematic manner. It is particularly worthy of note that by the use of these jigs and formers, the parts formed are perfectly interchangeable and it is, therefore, unnecessary to mark or designate the individual parts in any way. Naturally, such a system must minimize the first cost of manufacture, and the greater the number of fire-boxes built the less the cost of each.

The method of construction according to standards has the further advantage of facilitating repair work. Should renewal of parts be necessary at any time, it would be a simple matter to supply standard parts ready for application. In fact, an entire fire-box could be built and held in the shop ready for application, so that changing fire-boxes would be a simple matter, involving very little time.

Among the ingenious methods of manufacture, which have been brought to bear in building this boiler, is the autogenous process of welding. The reverse lap joints of the corrugated sections near the mud ring have been welded by this process and should any cracks develop in the fire-box, they could be readily welded in the same way.

My thorough examination of the actual fire-box, as well as a careful study of each individual part and unit, leads me to the conclusion that this design is unusually safe and strong. The built-up construction is somewhat parallel to the introduction of bridge building principles in boiler construction and the fire-box should be unusually stable because of such construction. Not only is it provided with great stability to withstand the stresses imposed, but it is also peculiarly well adapted to resist possible tendency toward explosions. This is a feature of unusual merit which I think should be marked with due significance and it is one that I have not heard mentioned among those who have voiced sentiments on the design. Examination of any fire-box in which a crown sheet has blown down will show the destructive effect resulting from the spread of eruption, usually evident by the sheet having been torn asunder like so much paper. The sectional form of this fire-box protects all seams and no bolt heads are exposed to the direct heat of the fire and gases. Furthermore, a rupture in one section cannot be conveyed to the next section, and, as the escape of steam and water is restricted, an explosion would not be so violent nor the destruction of life and property so great.

I feel assured of the entire success of this construction and that it will be but a very short time before the Jacobs-Shupert fire-box demonstrates its value in actual service.

New York City. George Wagstaff.

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To the Editor:

In reading over the March issue of your journal I note you invite opinions in regard to the Jacobs-Shupert locomotive fire-boxes.

As far as my experience goes I should say from the construction of this fire-box that the circulation would be considerably interfered with by the plate staying, and in my opinion the riveted seams in the flanged sections will interfere with the heating surface; inasmuch as the conduction of heat will not be as rapid through riveted joints as by flat or corrugated plates. There is a decided disadvantage in having deep sections and the riveted seams. The riveted seams, from experience, will attract incrustation, and any sediment in the water will naturally precipitate into each one of these sections and cause trouble.

The diagram given in the April issue of your journal shows the mud ring very ingeniously arranged, but I should think it would be very difficult to keep it free from leaks.

I note also a letter criticising the fire-box signed "Circulation," which appeals to me to be very practical. I note he states it will be an expensive fire-box to build, which I endorse.

I have studied a great deal, from a practical standpoint, to design a locomotive fire-box and tube plates, and in doing so, those acquainted with what I have produced* will note that I eliminated many of the parts which are incorporated in the Jacobs Shupert fire-box. It is my opinion that all riveted seams that can be, either vertical or horizontal, should be eliminated from locomotive fire-boxes. No deep recesses should be formed over the crowns and sides of a fire-box. The fire-box should be left as free as possible for the plates, of which it is made up, to expand and contract, consistent with it taking care of the pressure at which the boiler is worked.

I believe, as Mr. Jacobs does, in dispensing with as many stays as possible, but in doing so every point in the fire-box should be made flexible in order that the stay may become, in a sense, permanent, allowing the plates to take care of the expansion and contraction and relieve the stays from excessive vibration. In some boilers which I recently finished the number of staybolts in the fire-box was reduced by 350 from the number in the regular fire-boxes which were displaced.

I have spent a large amount of money, on my own account, in trying to better the locomotive fire-box and tube plates, and believe that I have fully attained my object. In fact, I feel so confident, that I am willing to furnish one-half of a prize of $1,000 to be given to the winner of a competition between my fire-box and tube plates and those of any other design, both boilers to be applied to identical engines in identical service; both fire-boxes to be fitted with firebrick arches, having the same distance from the grates to the water bars, and if possible the same engineers to run the engines all the time. The reports to be made by experts and the decision to be made by a selected committee of three. Wm. H. Wood. Media, Pa.

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To the Editor:

I have been much interested in the new design of fire-box shown in your March issue. It seems to me to have a number of features of merit, but in some ways I don't believe it will be a success and since you have asked for expressions of opinion about it I take the opportunity to give you my ideas.

In the first place, it looks to me as if it would be a very expensive construction if the work is properly done. The rivet holes will all have to be exactly in line and, even with a jig, the drilling and cleaning of all those holes (over 6,000 I should say) will cost considerable. Then the riveting, which must of course be carefully done, will, I should imagine, take as long as to screw in, cut off and rivet over all the staybolts in the ordinary fire-box. Although the construction at the mud ring is not clear, if it is to remain tight, it will require a more or less expensive arrangement. Taking it all together I should think that a fire-box of this type, in place, would cost two or three times as much as the ordinary radial stay type.

I don't think I should care to be responsible for any number of boilers of this type in a district having bad feed water. I believe it will be found that the flanges and connecting plates in the water leg will become thickly coated with scale which it will be practically impossible to get off and which will cause the inner sheets to overheat at the joints. I don't imagine that there will be much trouble on the flat parts of the sheets, as the circulation ought to be rapid enough there to keep them clean, but around the rivet head and bars in the connecting sheets, scale is bound to become troublesome.

Another feature in connection with the circulation is the many obstructions offered to the water which is to reach the back water leg and the consequent sluggish movement and heavy deposit at this point. It seems to me that this space is very narrow and is practically cut off from the side water leg as far as getting cold water to it is concerned.

* See American Engineer, May, 1908, page 100.

In this connection I would like to ask if any trial has ever been made in locomotive practice with a forced circulation such as is sometimes used in marine practice by means of a "hydrokineter." M. M.

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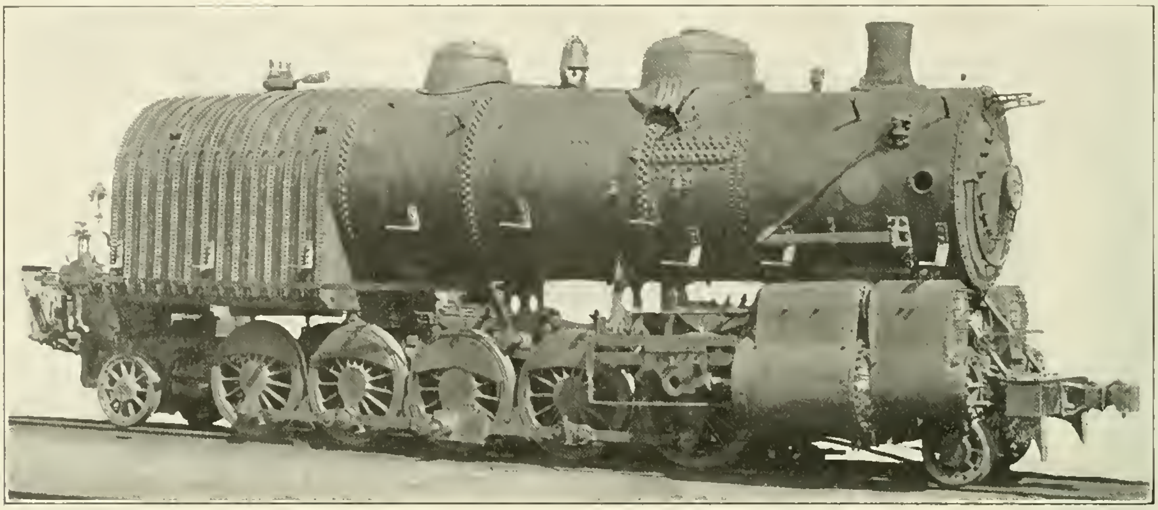
To the Editor:

Those who have examined the Jacobs-Shupert firebox and those who have formed conclusions regarding it by looking at illustrations, differ materially in their opinions. The former are unanimous in endorsing it, while the latter offer numerous criticisms as to circulation, transmission of heat to the water, formation of scale on rivet heads, accumulation of "clinkers," application of mud ring, cost of construction, length of service, etc. Some of your correspondents are among the latter. It is evident that these criticisms are voiced by men who look upon this design of firebox as a freak without appreciating its practical construction and the clever manner in which it has been designed to meet service conditions.



2-10-2 TYPE LOCOMOTIVE WITH JACOBS-SHUPERT FIREBOX.

Since I have been in close touch with this boiler since its inception and have had opportunities to study its design and construction carefully I would like to attempt to answer some of the criticisms offered by your correspondents.

Considering the criticisms in detail, it is evident that those who have not seen the actual firebox wonder how the curved surfaces of the corrugated sections have been made to fit the flat surface of the mud ring. This arrangement is one of the clever pieces of boiler making which characterizes the construction of this unusual firebox, and was, I believe, made clear by Mr. Jacobs on page 148 of your April issue. He does not mention, however, that the lapped portions are welded by the autogenous process. This joint has successfully withstood a water test of 300 pounds pressure as well as a steam test of 270 pounds pressure.

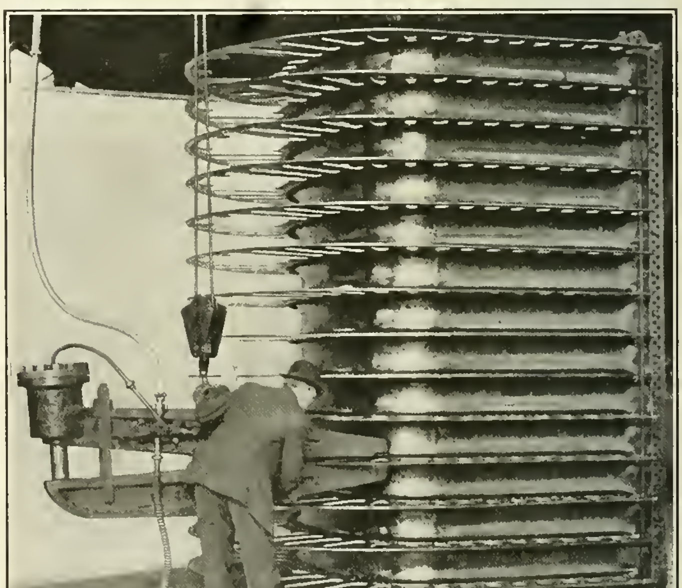
As to the precipitation of incrusting solids contained in the boiler feed water, it is but natural to anticipate the deposit of more or less incrusting material where solids are contained in the water supplied to the boiler. However, there is no logical reason why such solids should adhere to any parts of the Jacobs-Shupert firebox as much as to the staybolts of the ordinary firebox. And certainly there is no obstruction at any point in this firebox which aggravates the accumulation of mud and scale to such an extent as the common form of crown bars and sling stay T irons.

An unusual advantage peculiar to this firebox is a provision for gaining access to the space above the crown sheet. A portion of each stay sheet is cut away above the crown sheet, providing a continuous opening large enough to admit a man. The staying of the crown sheet is not impaired, as two removable stays are substituted for the metal cut away. The openings through the stay sheets, as well as the bosses provided for the application of the removable stays are clearly illustrated by the half-tone engraving, Fig. 1, on page 148 of your April issue.

Boiler washing is peculiarly well provided for in this type of firebox. In addition to the usual location of a washout hole at each corner of the mud ring there is a washout hole in each channel section at the height of the crown sheet. Therefore, by properly directing the nozzle of the washout hose any possible accumulation of mud and sludge can be washed from the crown sheet or a stream of water forced down each space formed by the staysheets and the channel sections.

The formation of the channel sections into a continuous smooth surface where attached to the mud ring prevents any pockets or corners where mud and scale might collect along the mud ring. Due to this construction and to the large opening through each stay sheet there is ample room for the manipulation of the boiler washers' tools and for directing a stream of water along the mud ring.

Each individual unit or section entering into the construction of the Jacobs-Shupert firebox is made according to a standard jig or former. Each channel section is formed by standard dies under the hydraulic press and the channel is bent to conform to the shape of the firebox, or of the wrapper sheet, by standard forms. All holes are drilled according to standard templets so that no time is consumed in laying out. Holes in the templets are bushed with hard steel bushings and when a templet is clamped to a sheet or channel very rapid time is made in drilling holes at the drill press. The use of a standard templet is carried even



BULL RIVETER WORKING ON JACOBS-SHUPERT FIREBOX.

to the extent of laying out holes in the throat sheet where this sheet is joined to the barrel of the boiler.

By the use of such standards the manufacture of the firebox is not only much simplified, but the cost is considerably lessened. The greater the number of parts manufactured the less the cost of each operation.

The assemblage of the parts follows quite simply after their manufacture. As a result of their formation by standards they fit together readily and easily. Riveting the sections together is much simpler than the form of the firebox would lead one to believe. The riveting is done by a small bull riveter especially designed for this work and the method of operation is evident from the accompanying illustration. The riveter is hung from a point immediately above the center of gravity and is readily manipulated by the operator. Both the feed and discharge hose are flexible, permitting easy adjustment of the riveter and ready movement from one rivet to the next.

While considering these criticisms it is interesting to note the confidence in this firebox displayed by the operating officials of the Santa Fe Railway System. The accompanying photograph illustrates the firebox applied to a large freight engine of the Santa Fe type. In addition to several other fireboxes of this design being built at the Topeka shops for application to large freight engines, one of the locomotive building companies is constructing four Mallet compound locomotives to which fireboxes of the Jacobs-Shupert type are to be applied.

Topeka, Kans. M. H. Haig.

## THE CAUSES OF DERAILMENTS.

In speaking before the New England Railroad Club, Prof. C. W. Doten, of the Mass. Inst. of Technology, recently presented the following data concerning the causes of derailments:

Classification of Derailments by General Classes of Causes.

| Period | Defects or Failure of Permanent Way | | Defects or Failure of Rolling Stock | | Negligence or Malice | | Unforeseen Obstruction | |
|---|---|---|---|---|---|---|---|---|
| | Number | Per cent. | Number | Per cent. | Number | Per cent. | Number | Per cent. |
| 1873-77* | 909 | 38 | 380 | 16 | 533 | 22 | 573 | 24 |
| 1878-82* | 580 | 28 | 358 | 18 | 486 | 24 | 611 | 30 |
| 1883-87* | 958 | 35 | 541 | 20 | 420 | 16 | 782 | 29 |
| 1888-92* | 881 | 27 | 847 | 26 | 625 | 19 | 889 | 28 |
| 1893-97* | 602 | 21 | 1002 | 35 | 488 | 17 | 789 | 27 |
| 1898-1902† | .. | . | .. | . | | | . | .. |
| 1903-07‡ | 5,509 | 25 | 12,732 | 58 | 2,238 | 10 | 1,632 | 7 |

* Figures obtained from the Railroad Gazette.
† No data obtainable for this period.
‡ Statistics in Quarterly Bulletin, Interstate Commerce Commission.

An inspection of this table discloses marked tendencies under three heads. Accidents due to negligence or malice have decreased to a large extent during the thirty-five years covered by the table. This is extremely significant in view of the contention, so frequently heard, that employees are growing less reliable with the increase in the strength of the labor-union movement. It is to be noted also that there has been a decrease in the proportion of derailments due to failure of permanent way, which is particularly significant in view of the discussion that we have just listened to. It shows that the blame for derailments does not rest entirely upon the manufacture of steel rails.

*Finally, there has been a great increase in accidents due to defects and failure of rolling stock.* This increase has been pretty uniform during good times and bad, and seems to indicate that there is something radically wrong with either the construction or the method of handling equipment. Of course the great increase in this sort of breakdowns, in very recent years, has been in part due to the use of old cars because of a general shortage of equipment, but this cannot explain a steady tendency covering a period of thirty-five years. Here is a weak place in the railroad machine which the railroads are themselves responsible for. Many roads make their own cars, and in some cases their own locomotives. When they do not, they usually furnish plans and specifications for their construction. Moreover, they are in all cases responsible for the inspection and repairs of equipment in use. It is probable that part of the difficulty lies in a lack of co-operation between the mechanical and operating departments. This state of affairs has resulted from a feverish struggle for results in the way of large train-loads, which necessitates larger trains and more freight per car, both of which are very destructive to equipment, particularly to old cars. The average train-load on the railroads of the United States rose from 198.81 tons in 1896 to 344.39 tons in 1906, or an increase of 73 per cent. in ten years.

## THE INSIDE LINING OF STEEL PASSENGER CARS

The first steel coach was built for the Pennsylvania Railroad with all-steel framing and outside sheathing. The lining throughout, including doors and partitions, also the outside roof, was made of artificial board. It was found that this board did not stand the wear and tear of service as well as desired, for which reason the next coaches were equipped with steel lining and a steel roof; in fact, all the coaches built since that time were literally all-steel cars, with the exception of window sash and seat arms. We still retain artificial board for headlining, for which it is apparently more satisfactory than any other material. The steel lining has proven more durable and less costly in repairs. On the other hand, as steel is a good conductor of heat, it is cold to the touch, even in a warm room, because it rapidly carries away the heat of the hand or body. This seems to indicate the necessity of making the window sills of wood, or other non-conducting material, and possibly covering the steel lining below the window sills with a thin coating of non-conducting material.

One of the principal objections that is found in the use of wood, or artificial board, for inside lining, is that the metal frame will expand considerably in very warm weather, or at times when the sun's rays exert a maximum effect on the steel. For an increase in temperature of 100 degrees soft steel will expand 1-inch in 125 feet, while wood varies very little under change of temperature. This would indicate that decidedly more trouble would be experienced with wood lining than with steel lining, as the latter would be used in very thin sheets, and, naturally, would be sufficiently flexible to adjust itself to conditions of temperature differing between inside and outside of car. From the experience which we have had, we can, therefore, safely say that steel is the best material for outside sheathing and inside lining, except at such places where its coldness to the touch will be uncomfortable for passengers.—*A. W. Gibbs, Central Railway Club.*

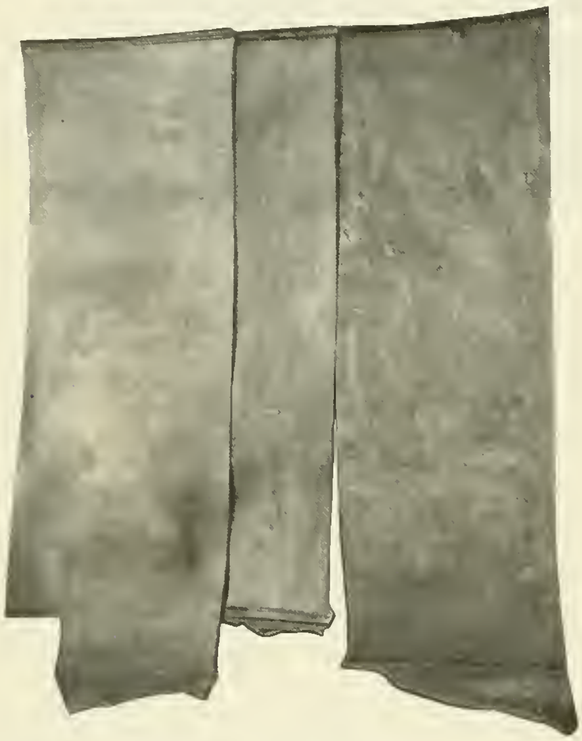
The Formal Opening of the Virginian Railway was held on April 2, with a celebration at Norfolk, Va. The new railway, originally separated into two companies known as the Tidewater Ry. and the Deepwater Ry., extends from Deepwater, Fayette County, W. Va., on the Kanawha River, to Sewall's Point, at Norfolk. Its length is 446 miles. The line has low gradients, for excess of eastbound traffic, and is planned chiefly for carrying coal, etc., to the seaboard. H. H. Rogers is president; R. Du Puy is general manager; H. Fernstrom is chief engineer, and R. P. C. Sanderson is superintendent of motive power of the new line.

Museum of Safety and Sanitation.—Announcement has just been made of the acceptance of the treasurership of the Museum of Safety and Sanitation by Frank A. Vanderlip. An executive office for the administrative and promotive work of the Museum has been opened at the United Engineering Societies' Building, 29 West 39th street. Plans are being pushed forward along practicable lines to prevent the enormous loss of life and limb to American life and labor, through the Museum of Safety and Sanitation, where safety devices for dangerous machines and preventable methods of combatting dread diseases, may be demonstrated.

## LEATHER BELTING.

The editorial on the importance of using a high quality of leather belting in order to improve its efficiency and reduce the cost of maintenance, on page 151 of the April issue, has brought forth several inquiries as to just what constitutes a high grade of belting and how it is possible to detect the difference between it and a lower grade.

Very few hides are suitable for first-class belting. The cow hide is thin, is not uniform in thickness and lacks in firmness of texture. The sharp angles of the hip bones tend to form pockets which injure it for belting purposes. The excessive and prolonged stretching of the hide, and its subsequent complete relaxation, due to calf bearing, also make it unsuitable for belting purposes. The hide of the bull is coarse and hard, with the neck full of wrinkles, causing a variation in the thickness and run of grain of the leather. The best hides for belting are taken from the American steer, raised on the open range and killed in the month of October, when about four years of age. During

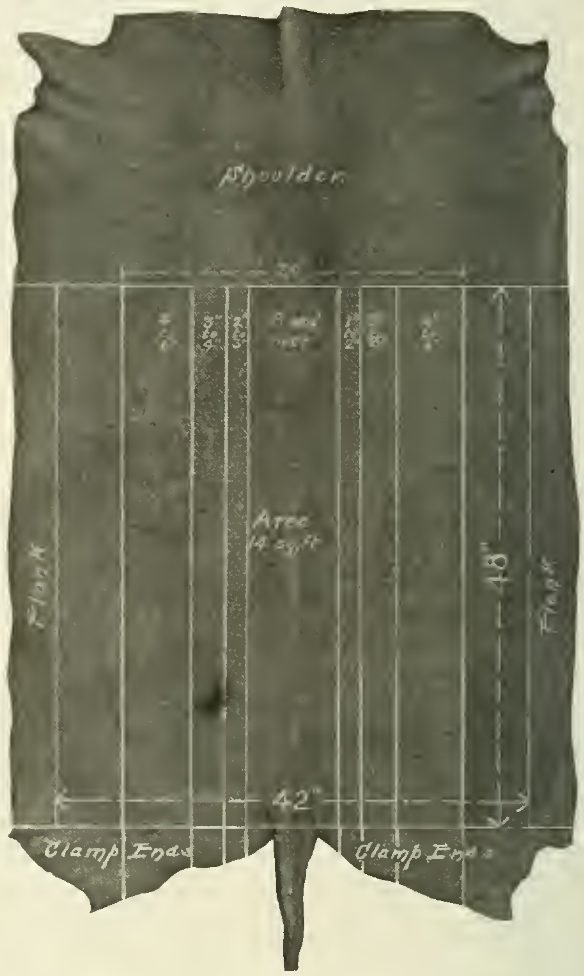


ILLUSTRATING DIFFERENCE IN STRETCH BETWEEN CENTRAL AND SIDE PORTIONS OF BELTING BUTT.

the fall of the year the animal is in its best physical condition and the hide is almost entirely free from grubs.

*Tanning.*—The neck, legs and belly of the hide are unsuitable for belting and are trimmed off before tanning. The remaining part, known as the belting butt, is about four feet wide by six and a half feet long, with that part directly over the backbone as the center. The belting butt is first soaked in spring water to wash out the dirt and is then treated with lime water, which loosens the hair and skin, making it easy to remove them. The hide should be tanned with oak bark and by a slow process, which requires nine or ten months before the hide is ready for the market. Tanning solidifies and preserves the gelatin of the skin, converting it into leather. The fibrous portion of the hide is protected from the joint action of air and moisture and at the same time the tenacity and suppleness are not injured. It has been found possible to chemically tan hides in a very much shorter time and therefore cheaper than by the oak bark process, but such hides are lighter in weight and stretch so that they are unfit for belting purposes. The chemically tanned belt may be increased in weight and made to look like an oak tanned belt by filling in the pores with glucose, sugar of lead or other material, but this, of course, merely improves the appearance of the belt and does not increase its strength. A green hide, weighing 70 to 75 lbs., after being trimmed and tanned by the oak bark process weighs only about one-half as much.

*Physical Characteristics of the Belting Butt.*—The fibers along the center line of the butt (over the backbone) are stronger and more dense than those farther from it; if a butt was cut along this line and a belt was made with one edge corresponding to this center line it would be more elastic on one side than on the other and would not run true on the pulley. As the central portion of the butt is less elastic and stronger than the remaining portion and as by making the center of the belt correspond with the center of the butt it can be very evenly balanced, it is the practice to cut the larger belts from the center of the butt. The shoulder part of the hide is coarse and wrinkled and should be removed from the belting butt, leaving only about four feet in length available for belting. It is possible to work or iron out




SHOWING PART OF HIDE SUITABLE FOR BELTING.

the wrinkles in the shoulder piece, but the texture is not uniform and it does not make first-class belting.

After the shoulder has been removed the butt should be cut into three pieces—a center and two side portions. The width of the center portion is cut the exact width of the wide belt into which it is to be made. This width is determined by grasping the outer edge of the butt near the shoulder and doubling it backward; the point where it kinks or forms a fold shows where the closely knit portion adjacent to the backbone disappears. If this point shows well in toward the backbone an 8 in. center is taken out; if further removed a wider center is cut. The part of the hide between the flanks and the central zone of dense and strong fibers which has been removed is quite uniform in strength and density.

*Currying.*—The parts are then curried, making the hard and flexible leather soft and pliable, without affecting its strength and vitality. The first operation is to shave off the membrane and fleshy particles, after which the leather is washed and scoured by machinery. A pure animal grease should then be worked into the leather evenly and thoroughly, while both the leather and the grease are cold and the pores in their normal condition. While still damp the leather should be placed on the table of a machine and under slight pressure the fibers should be rubbed from the butt toward the shoulder. Any thick spots in the hide must be planed off.

*Stretching.*—The hide, still damp, should then be placed in clamps and stretched. These clamps must be such that the leather will be stretched evenly. To show the greater flexibility of the sides over the central portion of the butt and the necessity for stretching them separately an illustration is reproduced showing the difference in the length of these portions after proper stretching, although they were exactly the same length before this operation.

The stretching of the butt is one of the most important features in the manufacture of the belting. It must be stretched evenly and to a sufficient extent or it will not run true and will stretch excessively when the belt is placed in service. The

STRETCHER TO SAVE HIP "CHEEK."

clamps indent and discolor the leather and various methods are used to eliminate these marks in order to use the greatest possible percentage of the belting butt. This often results in insufficient stretching, distortion of the grain of the leather, and the inclusion of the flabby cheek leather to the right and left of the tail, which is spongy and unfit for good belting. The better practice would seem to be to use a substantial clamp that would grasp the leather firmly all the way across the piece, pulling it evenly and holding it rigidly while it dries. Pieces stretched in this way are shown in one of the illustrations; it will, of course, be necessary to cut off the pieces at the clamp marks. A stretcher designed to save the hip "cheek" is also shown. Stretching a belt to its limit takes out all of the elasticity; therefore after the hide is removed from the stretchers it is dampened slightly to draw it up a bit and furnish it with the elasticity that a belt must have to accommodate itself to various conditions of strain.

*Finishing the Leather.*—The next process is to "jack" or roll the piece on a special machine, rolling out all unevenness, condensing the fibers of the leather and making it flat and pliable. The pieces are hung up to dry, after which they are moistened and piled when the jacking process is again repeated on a polishing machine with a different type of roller from that used first.

*Cutting the Belt Strips.*—An approved method of cutting the belt strips from the finished pieces, used by one of the largest manufacturers, is as follows: The centers, as previously described, are taken out before the hide is curried. All main driving belts are made from the centers; the width of the center piece is governed by the texture of the hide. The thickness of the hide increases as it gets farther away from the backbone and the problem in cutting the two side pieces into strips is to have each width of belt taken from a fixed location on the hide so that the pieces can be matched and will be of uniform thickness. It must be understood that strictly first-class belting is taken from the section about 4 ft. long, measured from the tail, and within 15 in. either side of the backbone. A second quality of belting may be taken from the strip 6 in. wide either side of this section. The remaining part of the hide is useless for good belting.

Of the 26 or more square feet in the hide, as it is received from the tannery, only 14 sq. ft. are thus suitable for good belting—the remaining part must be sold at a small cost to be used for other purposes. By using part of it for belting, making the strips longer than four feet, the manufacturer can afford to sell his belt at a lower price, but it will not prove as satisfactory to the buyer and will be more expensive in the end.

The narrower strips are taken from either side of the center, as shown on the diagram, the width of the piece depending on the width of the center which was removed and whether the increase in the thickness of the hide is gradual or precipitate. The pieces are sorted, matched, lapped and cemented into continuous strips and then finished.

*How to Distinguish Between Good and Poor Belting.*—The most important problem which confronts the purchaser is to know just how to distinguish between high and low grade belting. In the first place he should buy belting on a rigid specification, and, what is more important, he must then see that the specification is lived up to.

Fortunately nature has provided a means by which it is possible to check closely the quality of the leather and the approximate location from which it is taken from the butt. By bending a piece of belt the nature of the pit or kink will indicate the approximate location from which it is taken. Therefore if the large user of belting has a belting butt with strips cut, as shown in the diagram, he can check the belting purchased with it.

Belting which is "loaded" or not properly prepared can be detected by making a physical test of its strength and elongation. For obvious reasons test pieces should be taken from parts of the coil other than the ends.

Finally, every large user of belting should keep a service record of every belt in his shop. This may very readily be done, when proper provisions are made for belt maintenance, at little or no expense.

Smokeless Combustion.—A bulletin on the "Smokeless Combustion of Coal in Boiler Plants," with a chapter on central heating plants, will soon be issued by the Technology Branch of the United States Geological Survey. This will give in detail a study of the conditions found in industrial establishments in thirteen of the largest cities in the eastern and middle western States, between 400 and 500 plants having been inspected. The bulletin not only shows that bituminous coal, high in volatile matter, can be burned without smoke, but also that large plants carrying loads that fluctuate widely, where boilers must be put into service quickly and fires forced to the capacity of their units, can be operated without producing smoke that is objectionable. Proper equipment, efficient labor and intelligent supervision are the necessary factors.

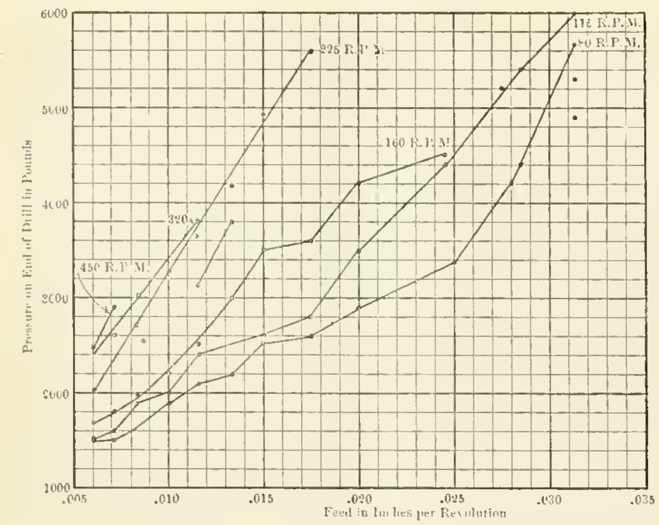



FIG. 1.—VARIATION IN PRESSURE ON END OF DRILL DUE TO CHANGE OF FEED. 1¼ INCH DRILL IN BESSEMER MACHINE STEEL.

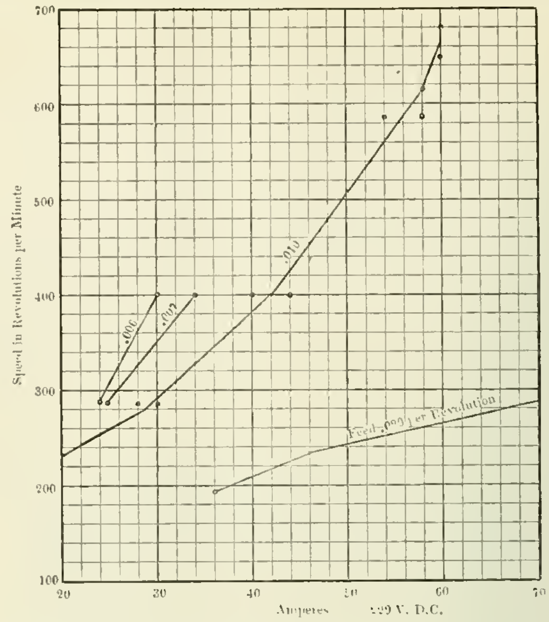



FIG. 3.—HORSE-POWER CONSUMED WITH CONSTANT FEED AND VARYING SPEEDS. 1¼ INCH DRILL IN 0.40 CARBON HAMMERED OPEN HEARTH STEEL.

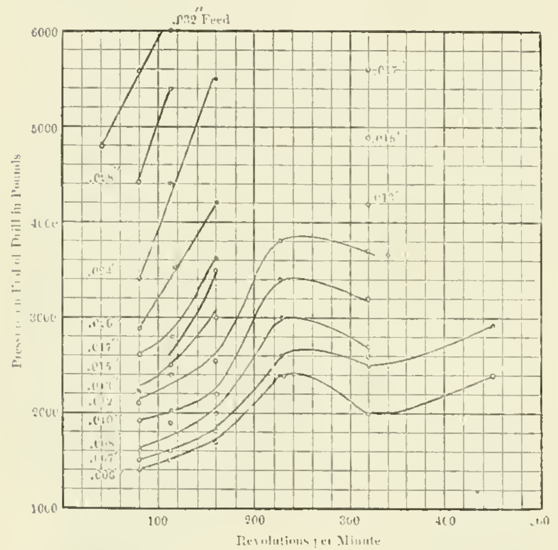



FIG. 2.—PRESSURE ON END OF DRILL DUE TO CHANGE IN SPEED FOR DIFFERENT FEEDS. 1¼ INCH DRILL IN BESSEMER MACHINE STEEL.

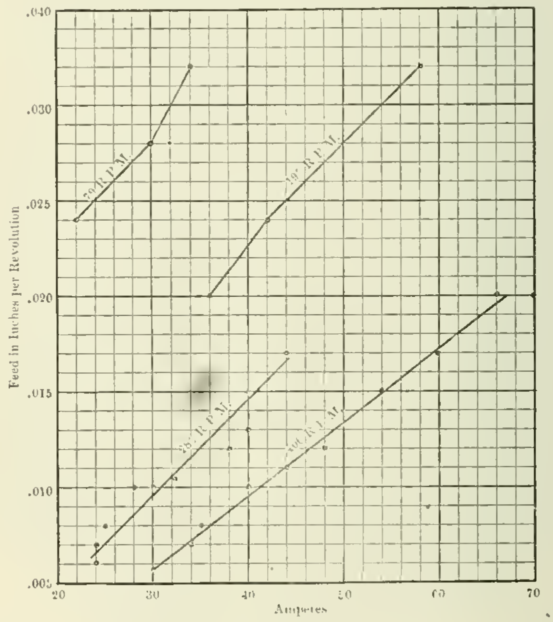



FIG. 4.—EFFECT OF VARYING THE FEED. 1¼ INCH DRILL ON 0.40 CARBON HAMMERED OPEN HEARTH STEEL.

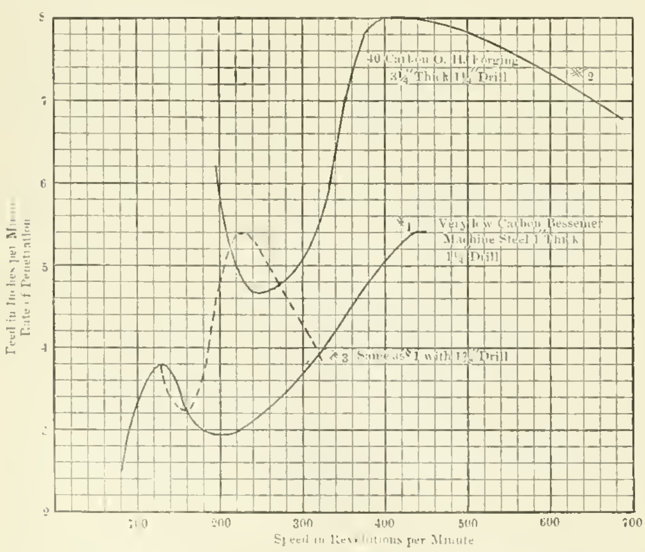



FIG. 5.—ILLUSTRATING RELATION OF FEED AND SPINDLE SPEED TO EACH OTHER. THE FEED IN ALL CASES IS THE MAXIMUM AT WHICH THE DRILLS COULD BE USED AT THE DIFFERENT SPEEDS.

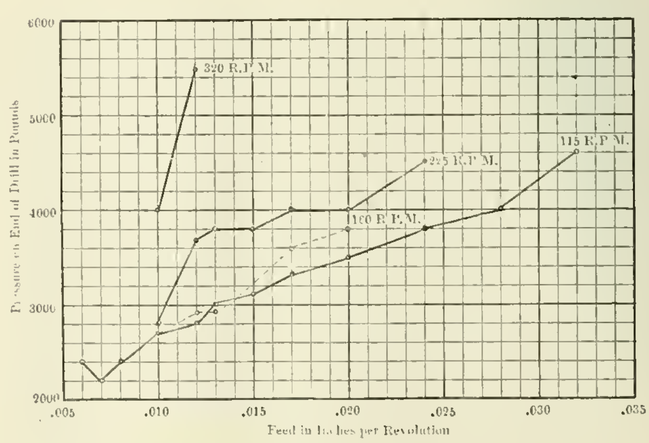



FIG. 6.—PRESSURE ON DRILL POINT DUE TO VARYING FEED.

## SOME DATA ON HIGH SPEED DRILLING.

GEO. E. HALLENBECK.*

The accompanying diagrams show the results of tests made with high speed drills on a Baker Brothers high speed drilling machine. They represent part of the experiments which have been made with a view to securing the most efficient design of machine for driving medium size drills, *i. e.*, drills from ¾ to 2 in.

Some of the drilling which has been done is little short of marvelous; 1⅛ in. holes have been drilled through 4¼ in. blocks of cast iron at the rate of 8⅔ seconds per hole, or a vertical feed of 29 in. per minute. Several holes were drilled at this speed without necessitating the regrinding of the drill. Holes 15/16 in. in diameter were drilled through ¾ in. machine steel plate at the rate of 3½ seconds each. When we stop to consider that the average punch press when punching a 15/16 in. hole in ¾ in. material will make about 20 to 30 strokes a minute, or in other words, will take two to three seconds to punch the 15/16 in. hole, which was drilled in 3½ seconds, the really remarkable performance stands out more clearly, especially when it is understood that a number of holes were drilled at this rate without resharpening the drill. The holes were drilled without lubricant of any kind.

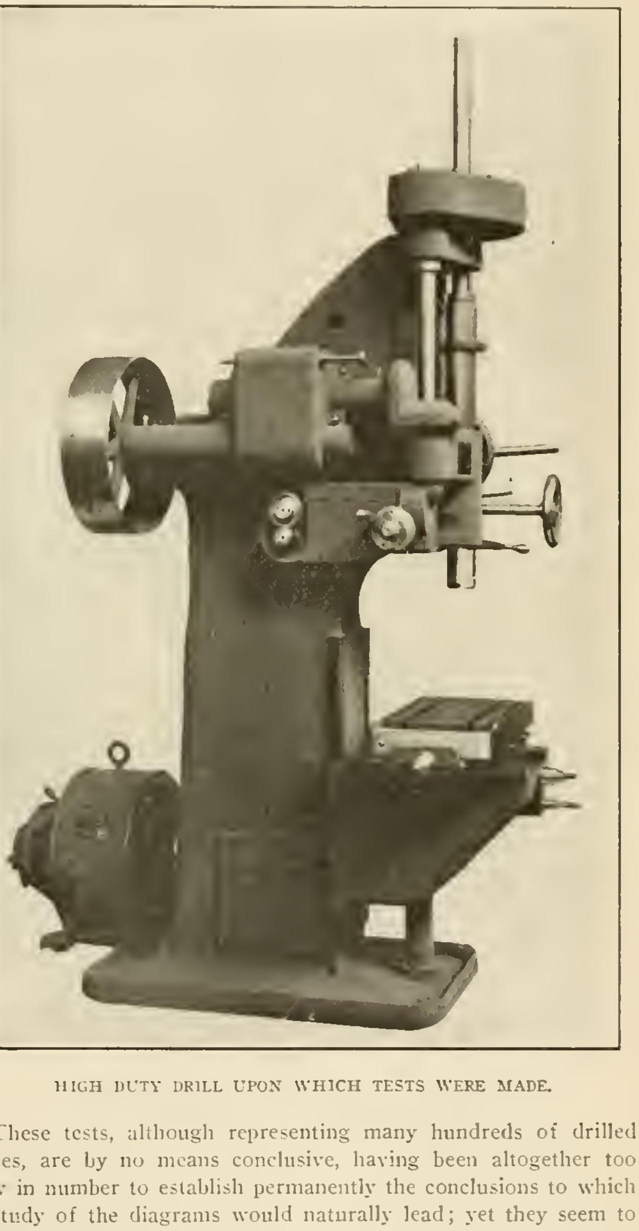
Among other things, it was desirable to know just what the vertical thrust on the spindle was in order to properly design the thrust bearing and feeding mechanism, experience having demonstrated that the load on the feeding mechanism was far greater than it was ordinarily thought to be. The result of some of these tests, made with a 1¼ in. drill, are shown in Fig. 1. The variation of the pressure on the end of the drill is shown in relation to a gradually increasing rate of feed. Several tests are shown at speeds varying from 80 to 450 r. p. m. It will be appreciated that the conditions under which these tests were made were such that nothing more than general conclusions can be drawn from them. The effect of increasing the feed is to increase the pressure on the drill point in a straight line ratio, although the tests made at 80 r. p. m. would indicate that there was a tendency toward a more rapid increase of pressure as the feed was increased beyond a certain point. So far as it was possible to observe, there was no great variation in the vertical thrust with the increasing depth of hole after the first ¼ in. had been drilled.

A series of tests is shown in Fig. 2, with constant feeds and varying speeds. These curves, together with those in Fig. 5, are perhaps the most interesting of the series from the fact that they show a peculiar decrease in pressure by increasing the speed beyond a certain critical point with the feed constant. All the tests show practically the same results in regard to this decrease. It will be noted that while it was impossible to drill with a feed of .013 in. at 225 r. p. m. it was easily drilled at that and even at .015 and .017 in. feed per revolution, at 320 r. p. m. It was attempted to show the relation of pressure to the feed in inches per revolution in Fig. 6, but the data was not sufficient to render the diagram satisfactory.

The horse-power consumed and its variation with the variation in speed is shown in Fig. 3. It will be seen that with the fine feeds, *i. e.*, feeds of under .010 in. per revolution, the amount of power required increases at a much less rapid rate, as the speed is increased, than with a feed of .020 in. per revolution. The ampere readings shown on the diagram represent the total electrical imput into the motor, no deduction having been made for either the losses in the motor or in the machine itself. Tests were made of both the motor and machine showing them to be very efficient.

The variation in power required with constant speeds and varying feeds is shown in Fig. 4. The increase in power consumption is apparently directly proportional to the increase in feed.

The remarkable increase in production which may be secured by increasing the speed is clearly shown by Fig. 5. The curves are plotted showing the maximum feed at which the stock was successfully drilled without destroying the drill. With the next higher feed the drill would be destroyed. In order to secure as nearly uniform conditions as possible all of one series of tests were run with the same drill, it being resharpened when necessary. The curve shows quite conclusively that the drill, with the .40 carbon steel, gave a greater production without failing at 200 r. p. m. than it did at 250 r. p. m., also that it gave a much greater production with the speed still further increased to 440 r. p. m. This may be an index to the solution of the much mooted question of whether a slow speed and heavy feed, or a high speed and fine feed are preferable. It would seem that the adherents of each of the above sides of the question would get into trouble as they began to gradually increase or decrease their speed.



HIGH DUTY DRILL UPON WHICH TESTS WERE MADE.

These tests, although representing many hundreds of drilled holes, are by no means conclusive, having been altogether too few in number to establish permanently the conclusions to which a study of the diagrams would naturally lead; yet they seem to point quite strongly to the conclusion that the best results will be obtained at comparatively high speeds and moderate feeds. It was this fact, oft recurring, that led to making the series of tests, the results of which are shown in Fig. 5, for the purpose of demonstrating whether such was actually the case or whether the apparent increase was due to other causes.

Most of the drilling on these tests was done with a 1¼-in. drill and it required resharpening only a few times. The machine on which these tests were made was driven by a 4 to 1 variable speed motor and has a range of spindle speed from 70 to 700 r. p. m. By providing suitable gearing a wide range of feeds between .006 and .032 per revolution may be secured. The

* Superintendent, Baker Bros., Toledo, Ohio.

machine was provided with roller bearings; outside of this feature it was the regular high speed drill as now built by Baker Brothers.

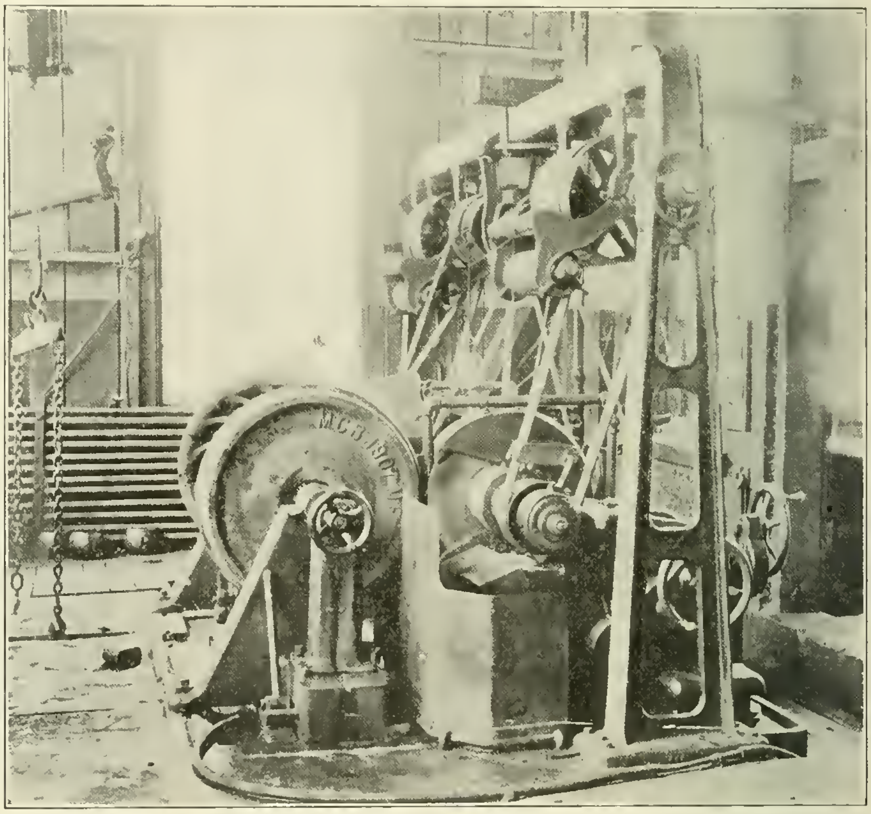
## GRINDING CAR WHEELS.

The Pennsylvania Railroad has two machines at Altoona for grinding the treads of mounted cast iron car wheels true. All of the new cast iron wheels that are placed under passenger equipment are thus ground and also all freight car wheels which are removed and have slid flat spots not greater than 2½ in. in length. If a wheel is even slightly out of round, or is not bored exactly central, the effect upon the easy riding of a passenger car is very noticeable. The machine upon which the grinding is done is of very substantial construction and so designed that the wheels may be ground practically perfectly true, removing the irregularities mentioned above, and also the slight ridges or projections on the tread caused by the contracting chill.

On both passenger and freight equipment the engineer usually handles his air so as to put as much braking pressure upon the wheels as is possible without having them catch and slide. Any irregularity in the roundness of the wheel is liable under these conditions to stop the wheel revolving and cause it to slip, wearing a flat spot. Thousands of cast iron wheels with flat spots are scrapped every month on the railroads in this country, which at small expense for grinding could be saved to the railroads. The difference between the first cost of a new wheel and the scrap value of an old one, including the cost of removing the wheel from the axle and mounting another one in its place, as compared with the cost of grinding out the flat spot amounts to several dollars per wheel. Steel wheels, having slid flat spots are also ground on this machine, when they do not exceed 1½ in. in length.

The car wheel grinder in the truck shop of the Altoona car shops grinds out flat spots on old wheels and trues up new cast iron wheels for use in passenger service. The grinding machine at the eastbound repair tracks is in continual use for grinding out flat spots on freight car wheels. Three more of these machines are in use at other points on the Pennsylvania Railroad.

These machines are made by the Norton Grinding Company, Worcester, Mass., and were described in detail in the October, 1906, issue, page 403. They will grind car wheels up to 44 in. in diameter and are arranged with water pumps and tanks to supply 80 gallons of water per minute, 40 gallons on each wheel. The wheels are ground perfectly true while revolving on their own journals, the error from accuracy not exceeding .002 in. or .003 in.



MACHINE FOR GRINDING CAR WHEELS, PENNSYLVANIA RAILROAD AT ALTOONA.

The operation of that part of the grinding wheel slide that travels parallel with the face of the car wheel is automatic. There is an arrangement to prevent the operator from stopping the slide in the wrong position as related to the flange on the car wheel. By means of a small handle the traverse of the grinding wheel across the tread of the wheel may be stopped. There is one of these handles either side of the center for either slide. There is also an arrangement by which the revolution of the car wheel can be stopped accurately in the correct position for removing it from the worm wheel or drive bearing. The uprights for carrying the car axles while grinding are adjustable for either car wheels or engine truck wheels. The machine may be built to grind wheels that have been bored but have not been mounted on the axles. For this purpose, it is supplied with an expanding arbor; two wheels are mounted, one on either end of the arbor, and both are ground simultaneously. The machine weighs about 31,000 lbs.

## DRAFT IN STEAM BOILER PRACTICE.

A preliminary bulletin on "The Significance of Drafts in Steam-Boiler Practice" is soon to be issued by the Technologic Branch of the United States Geological Survey. The authors of the bulletin, Walter T. Ray and Henry Kreisinger, in carrying out the particular work assigned to them in the general plan for the conservation of the fuel resources of the country have this to say in their bulletin:

"The experiments so far made seem to indicate that it is possible to double or treble the capacity of a plant without making any radical changes in the furnaces and boilers. These increases require about double and treble the quantities of air to be put through the fuel beds and boilers. It also seems probable that rebaffling the boilers will often permit the capacity to be doubled or trebled, while still getting more steam than formerly per pound of coal for uses outside the boiler room.

"These experiments were undertaken with the object of clarifying ideas concerning the passage of air through fuel beds and boilers. Measured weights of air were passed through two beds of lead shot, in series, one of which remained always the same and represented a boiler; the other being varied as to size of shot and depth of bed, and representing a fuel bed. Careful observations were made of the weight of air passing through the beds per minute. All data were plotted in many charts, so as to permit the study of them from several points of view. A number of laws were deduced bearing on the relative amounts of power required to force air through fuel beds of various thicknesses, composed of various sizes of coal, and through boilers of various lengths and areas of gas passages.

"An important part of the discussion relates to an increase in the capacity of boilers by increasing the amounts of power which must be applied to pressure and exhausting fans in order to force several times as much air through the fuel beds and boilers.

"It may be possible, as a result of these investigations, to raise the rate of working the boiler heating surface to three or even four times its present value. Such an increase would undoubtedly mean new designs of grates, stokers, furnaces and boilers, especially fitted for high rates of working. Fan equipments designed to supply three or four times as much air under several times the pressure would be provided with more efficient engines, which is an additonal factor favoring high-capacity working.

## THE RAILWAY CLUBS.

*Canadian Railway Club (Montreal)*.—The annual meeting and the election of officers will take place at the Windsor Hotel on Tuesday evening, May fourth.

The paper on "Snow Fighting," presented by A. W. Wheatley at the April meeting, was largely given over to a consideration of the equipment required in sections of the country where the conditions are the most severe. The rotary snow plow was fully described and also the way in which it should be operated to give the best results. Other types of equipment, including the Russell, or wedge plow, and flangers, were discussed for less severe conditions.

Secretary, James Powell, P. O. Box 7, St. Lambert, near Montreal.

*Central Railway Club (Buffalo)*.—Frank Tuma, master mechanic of the Erie Railroad at Buffalo, will present a paper on "Practical Instructions on Bituminous Fuel Economy" at the May meeting, Friday the fourteenth.

Secretary, Harry D. Vought, 95 Liberty street, New York City.

*Iowa Railway Club (Des Moines)*.—Next meeting Friday, May fourteenth.

Secretary, W. B. Harrison, Union Station, Des Moines, Iowa.

*New England Railroad Club (Boston)*.—Next meeting, Tuesday, May eleventh, at Hotel Somerset. Charles J. Glidden will give an illustrated talk on "The World and Its People as Seen from a Motor Car." This is "Ladies' Night"—reception at 6:30 and dinner at 7 P. M.

Secretary, George H. Frazier, 10 Oliver street, Boston, Mass.

*New York Railroad Club*.—Julius Kruttschnitt, director of maintenance and operation of the Harriman Lines will present a paper on "The Organization and Operation of the Union and Southern Pacific Systems" at the next meeting, Friday, May twenty-first.

Secretary, Harry D. Vought, 95 Liberty street, New York City.

*Northern Railway Club (Duluth, Minn.)*—"The Consumption of Fuel and Oil by the Locomotive" is the subject of the paper to be presented by Frank Burke, traveling engineer of the D. M. & N. Ry., Proctor, Minn., at the next meeting, Saturday, May twenty-ninth.

Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

*Railway Club of Pittsburgh*.—L. H. Turner, superintendent motive power of the P. & L. E. R. R., will read a paper on "Practical Education for Railroad Service" at the next meeting, Friday, May twenty-eighth.

Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

*Richmond Railroad Club*.—Next meeting Monday, May tenth. Secretary, F. O. Robinson, 8th and Main streets, Richmond, Va.

*St. Louis Railway Club*.—Next meeting Friday, May fourteenth.

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

*Southern and Southwestern Railway Club*.—Next meeting in August. Secretary, A. J. Merrill, Prudential Bldg., Atlanta, Ga.

*Western Canada Railway Club (Winnipeg)*.—Next meeting Monday, May tenth. A paper on "Reciprocal Demurrage" was read by H. R. Patriarche at the April meeting. The discussion of this will be continued at the May meeting.

Secretary, W. H. Rosevear, P. O. Box 1707, Winnipeg, Man.

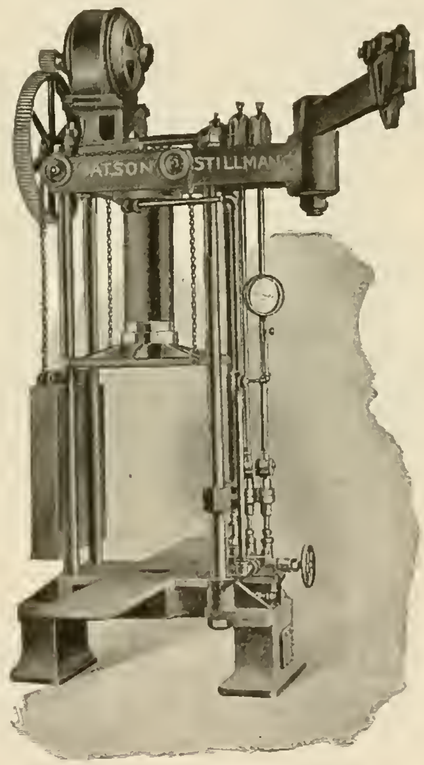
*Western Railway Club (Chicago)*.—The annual meeting and the election of officers will be held Tuesday, May eighteenth. It will be followed by a vaudeville entertainment and smoker.

Secretary, Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

## FORCING PRESS.

A new hydraulic forcing press has just been placed on the market by the Watson-Stillman Company, of New York City. A crane bracket and beam extend from one end and enable the operator to swing a heavy piece of work onto the bracket shelves extending out from each side of the bottom platen. These shelves, 30 in. long by 12 in. wide, are detachable and can be lifted off for jobs where they will be in the way. They are sufficiently strong to support any work that will go into the machine and will be appreciated by those who have had to push castings or parts into place on the ordinary small platen.

The motor, mounted on top of the press, drives the pump shaft



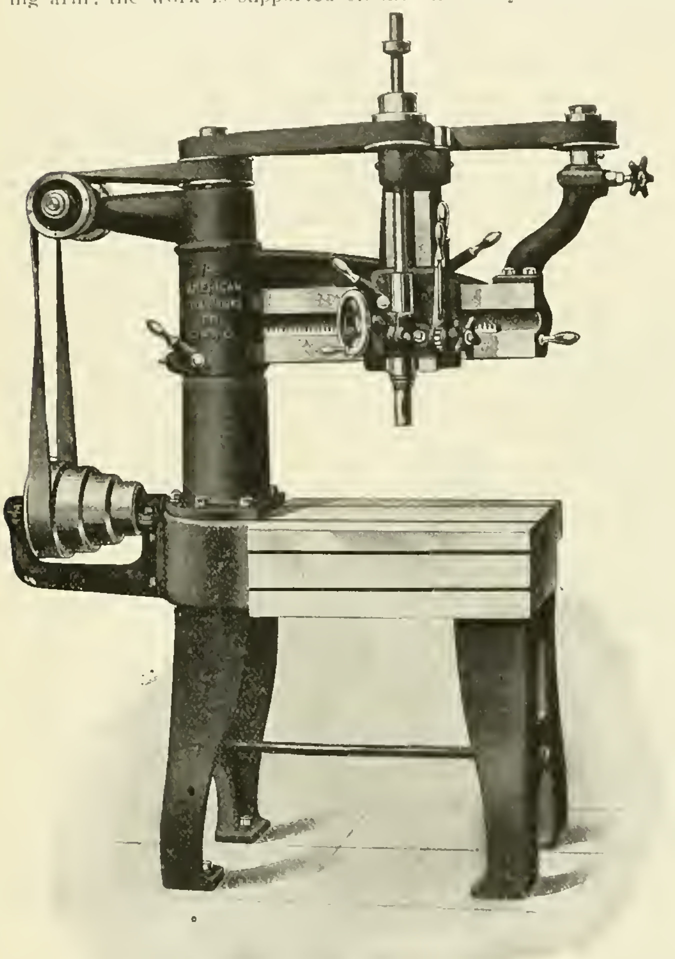

A NEW FORCING PRESS.

through single reduction gearing. A hand or belt drive may be furnished, if desired, instead of the motor. On the other end of the pump shaft are two eccentrics each driving one of the pistons of a ¾ by 2 in. twin pump, for which the pedestal legs act as reservoirs.

The operating valve is of the single screw stem type, and connected to release the pressure from the work when opened, and start the ram down when closed. It will not retain the pressure unless the motor is stopped or the liquid driven through the safety valve. Other types of valves may be substituted to meet special conditions. A gauge is furnished to read in tons or pounds per square inch, as desired. The press is built in two sizes for 50 or 100 tons pressure.

## SENSITIVE RADIAL DRILL.

What is believed to be the first sensitive radial drill made in this country is shown in the accompanying illustration. A considerable amount of small drilling can be handled more economically on a tool of this type, where the high speeds are obtained without the use of gearing than on the heavier and more expensive radial drills. This drill is especially adapted for drills up to ¾ in. in diameter. To give some idea of its capacity it may be said that a machine of this type, with a 2 ft. arm, drilled a ¾ in. hole in cast iron, with a feed of .028 in. per revolution or at the rate of 10½ in. a minute, using 3¼ h. p. The head that carries the spindle is adjustable, in and out, on the swinging arm; the work is supported on the stationary table. All the levers controlling the operation are located conveniently for the operator.



SENSITIVE RADIAL DRILL.

The arm is of a parabolic beam and tube section, to give it the proper resistance to the bending and torsional strains. The lower edge of the arm is parallel with the surface of the table. It swings easily on the column and may be securely clamped in any position by the binder lever. The arm does not move vertically, as provision is made on the head for variable heights of work. The head is moved along the arm by a hand wheel through an angular rack and spiral pinion and may be clamped at any point on the arm by the lever shown at the right of the head. The head consists of the main saddle which slides upon the arm and carries an auxiliary sliding head upon a vertical dovetail, thus allowing a vertical movement to the head and doing away with the necessity of elevating or lowering the arm. The vertical slide may be locked by the lever shown at the left of the head.

The double loose pulley at the top of the column is driven from the cone and in turn drives the spindle by a flying belt arrangement, giving a constant tension at all positions of the arm. This tension is adjustable by shifting the position of the idler at the extreme right of the arm. All of the driving and idler pulleys are equipped with specially designed ball bearings. They are dust proof and form a retainer for the lubricant, which needs to be renewed only at long intervals. The spindle has six changes of speed, ranging from 300 to 900 revolutions per minute, and is provided with a ball thrust bearing. It is fed by a long hand lever on a ratchet wheel, the latch handle being self releasing when in the uppermost position. A convenient star wheel supplies a quick return movement to the spindle.

The table is 35 in. above the floor, a convenient height for the average operator. The top and front sides are fitted with T slides, planed from the solid. The column is of tubular section, internally ribbed, and extends through the arm into the cap at the top of the drill. This machine with the 2-ft. arm drills to the center of a circle 49 in. outside of the column; the minimum distance from the spindle center to the column is 6¼ in., and the maximum distance from the spindle to the table is 19 in. These machines are also made with 3-ft. arms and can be equipped with a tapping attachment if desired. They are manufactured by The American Tool Works Company, of Cincinnati.

## FORGING AT THE ALTOONA CAR SHOPS.

PENNSYLVANIA RAILROAD.

G. M. Steward, foreman of the Altoona car shops smith shop of the Pennsylvania Railroad, in making a report on tools and formers before the last convention of the Railroad Master Blacksmiths' Association, described several dies and formers used at that shop. Unfortunately the association, in publishing its proceedings, was not in a position to reproduce all of the illustrations, thus detracting somewhat from the value of the paper. The following extracts from the report are accompanied by the necessary illustrations.

A former for bending running-board brackets for box and refrigerator cars is shown in Fig. 1. These brackets are made from ½ x 1½-inch material, cut 22½ inches long. With wings *A* and *B* of the former standing open, a piece of material is placed in position and each motion of the machine forms a complete bracket.

Fig. 2 shows a former for bending brake-shaft brackets for box cars; these brackets are made from ⅜ x 1½-inch material, cut 14¼ inches long; the piece is placed in position, wings *A* and *B* of the former standing open; the process is the same as described in connection with Fig. 1. These formers may be used on either a bulldozer, air press, forging machine, bolt machine or steam hammer.

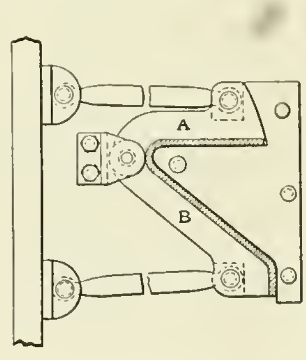



FIG. 1.—FORMER FOR RUNNING-BOARD BRACKET.

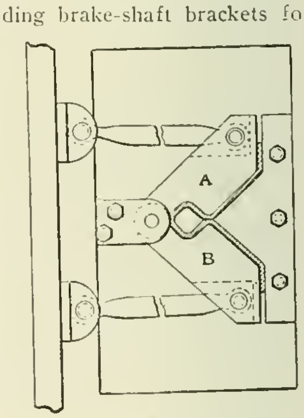



FIG. 2.—FORMER FOR BENDING BRAKE-SHAFT BRACKETS.

Fig. 3 shows dies designed for the forming of the upper tank supports for the new steel dining cars. The application of one of these supports to the car is shown in Fig. 4. These supports are made from sheet steel 3/16 x 14¾ x 57 inches. This die can be adjusted to either bulldozer, hydraulic press or steam hammer.

Fig. 5 is a die for bending brake-beam safety hangers for 6-wheel passenger car trucks.

A wing die for bending Westinghouse friction draft gear yokes is shown in Fig. 6. These yokes are made from 1¼ x 5-inch

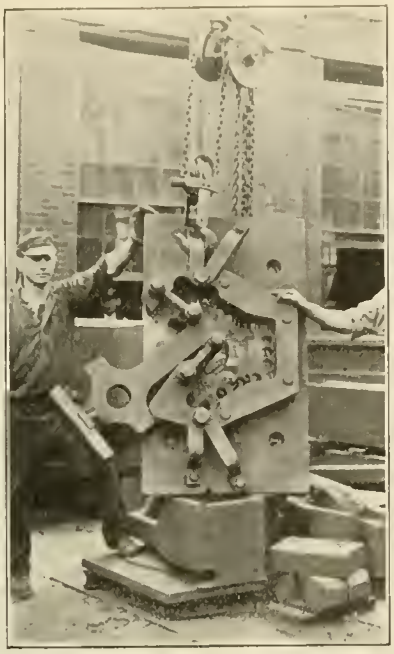


FIG. 7.—WING DIES FOR COMPLETING BRAKE HANGER GUIDES.

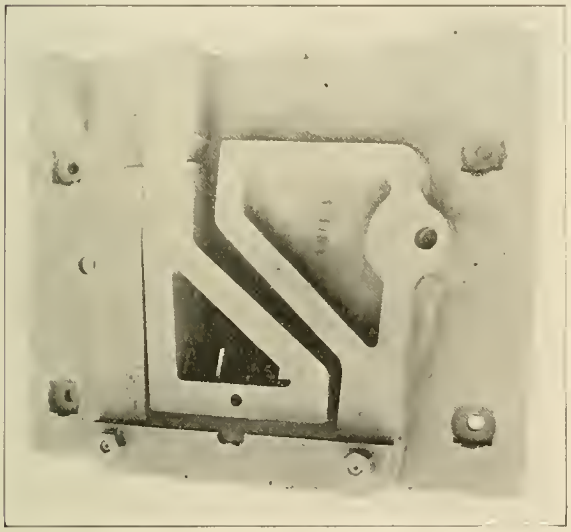


FIG. 5.—DIES FOR BENDING BRAKE-BEAM SAFETY HANGERS.

material, cut 78 inches long. Both ends are upset in a forging machine, after which it is heated in center, placed in the die and one revolution of the machine forms the yoke and punches the center hole in the end.

Fig. 7 is a wing die for completing brake-hanger bearings for freight-car trucks, as shown in Fig. 8. These are made from 1⅛ x 3¾-inch material, cut 42½ inches long; they are first bent to shape except for the turning of the eyes. They are then taken to a punching machine where all holes are punched, then reheated and placed in this die, which straightens them and turns the eyes complete in one operation.

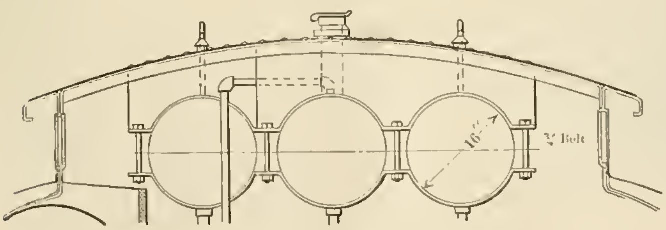


FIG. 4.—APPLICATION OF UPPER TANK SUPPORT IN DINING CAR.

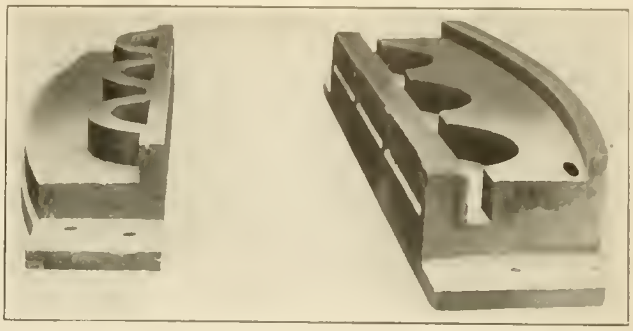


FIG. 3.—DIES FOR UPPER TANK SUPPORT—DINING CAR.

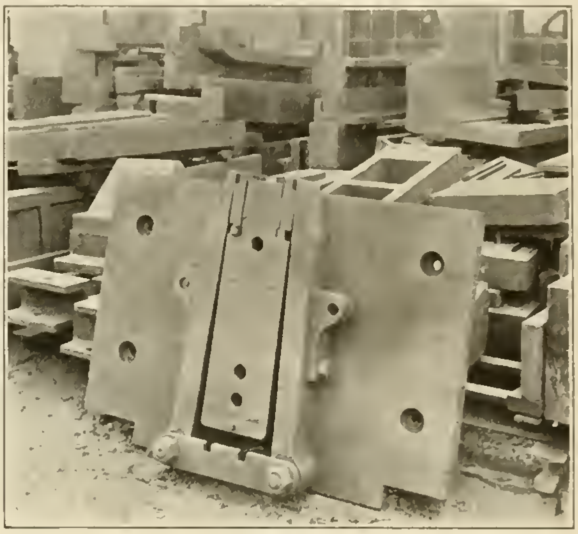


FIG. 6.—DIES FOR FORMING DRAWBAR YOKES.

The dies are stored on a platform, just outside the shop, which is served by an overhead trolley system. There are over 2,000 of these dies, some of them weighing as much as three tons each.

Extension of the Hudson Tunnel System in New York City has been approved by the Public Service Commission. The northern terminus of the system as hitherto planned was at Sixth avenue and 33d street, but now it is to be extended from this point north under Sixth avenue to 40th street and diagonally to 42d street and Fifth avenue and then east to a station near Lexington avenue, alongside the Grand Central Station.

Commercial Rating of Gas Engine.—The Internal Combustion Engineers' Association, H. R. Linn, president, 61 Ward street, Chicago, is endeavoring to settle the question of a uniform commercial rating for internal combustion engines, which will permit a fair comparison being made between gas engines of various sizes.

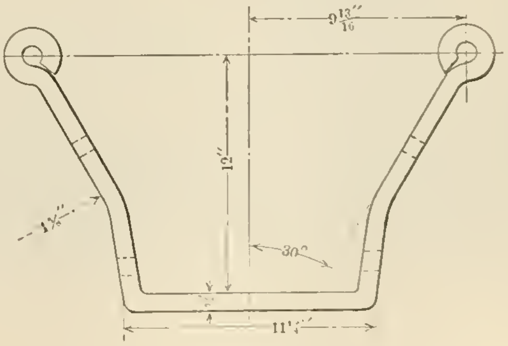
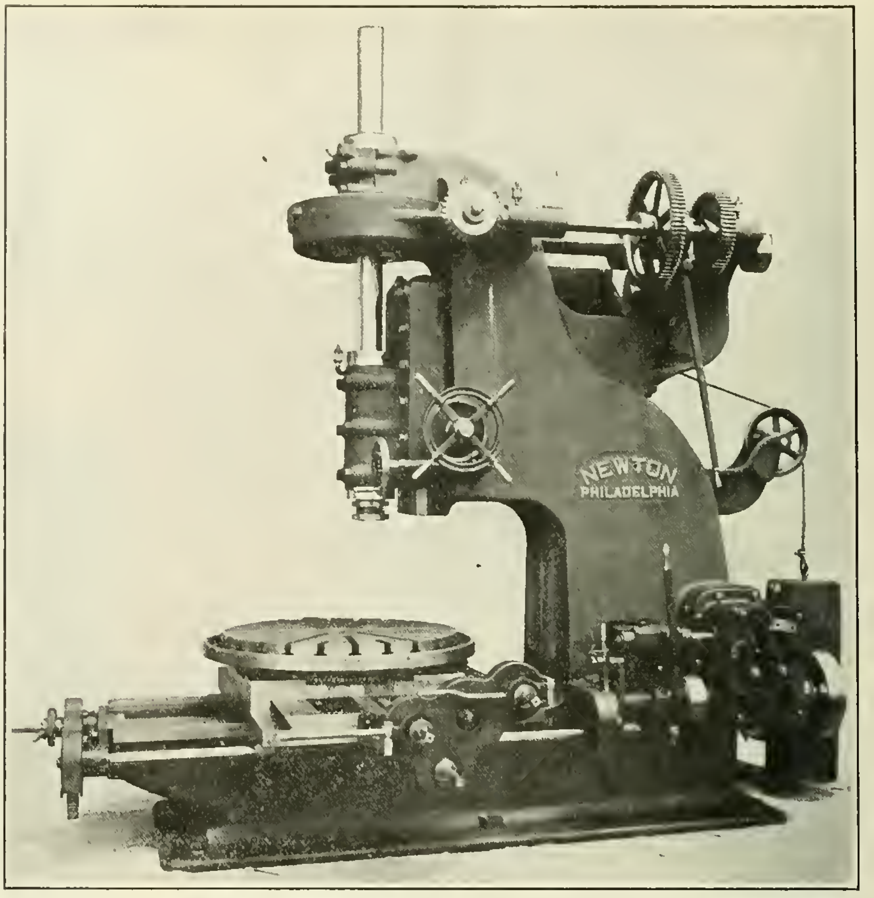



FIG. 8.—BRAKE HANGER BEARING.

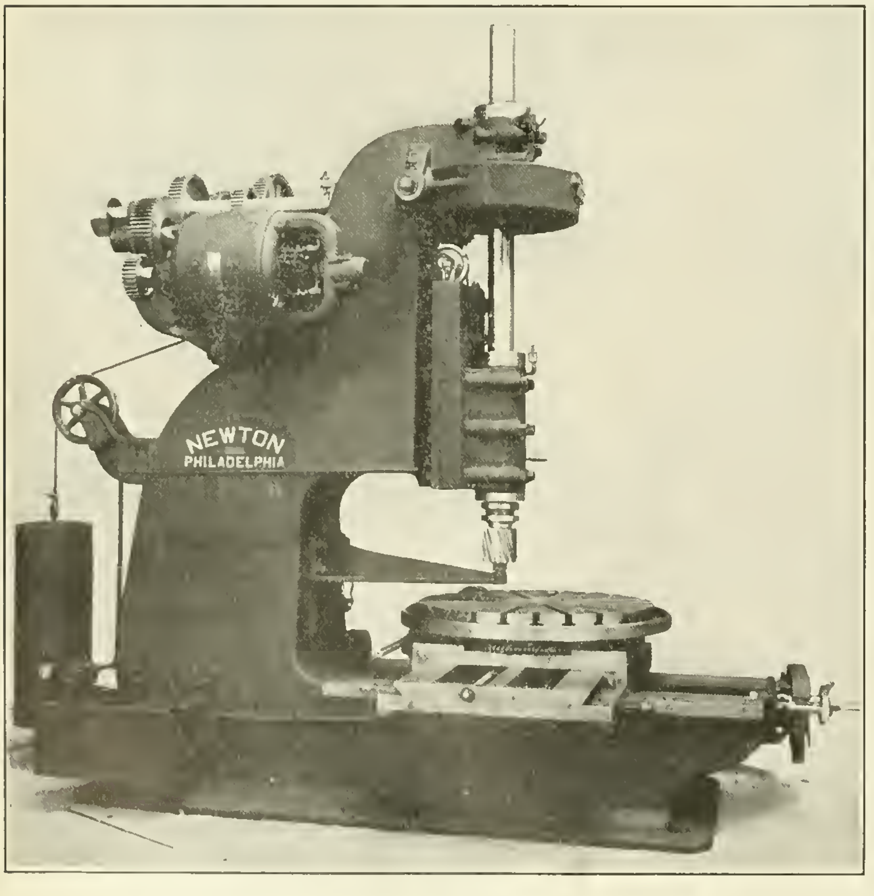
## WORM-DRIVEN VERTICAL MILLING MACHINE.

The vertical milling machine illustrated herewith is of heavy construction with a powerful drive, the spindle being driven by a steep lead bronze worm-wheel and a hardened steel worm, both of which are enclosed and arranged for continual lubrication. The levers controlling the operation are placed near together and convenient to the operator. Power is transmited from a 15 h.p., 2 to 1 General Electric motor through the rawhide pinion and the intermediate shaft, on which are mounted two spur gears which engage with the clutch gears on the shaft at the operating side of the machine. The milling spindle has a range of speed of from 17.22 to 34.44 r. p. m. in the low gear and 48.18 to 80.37 in the high gear.

The spindle is 5 in. in diameter and revolves in a straight brass-bushed capped bearing 22 in. in length. It is mounted in a saddle having square lock bearings on the upright, side adjustment being made by means of brass taper shoes. The saddle is counter-weighted and has fast and slow vertical adjustment by hand through a distance of 21½ in., the minimum distance between the bottom of the spindle and the top of the circular work table being ½ in. Work 20 in. high may be placed under the end of the vertical spindle. The distance from the center of the spindle to the front of the frame is 33 in.; the length of both the in and out feed and the cross feed is 33 in. The front of the frame has a finished surface for convenience in setting the work and also to support a bearing for the lower end of the spindle, as shown in one of the photographs.




OPERATING SIDE OF VERTICAL MILLING MACHINE.




REAR SIDE OF WORM-DRIVEN VERTICAL MILLING MACHINE SHOWING APPLICATION OF MOTOR DRIVE.

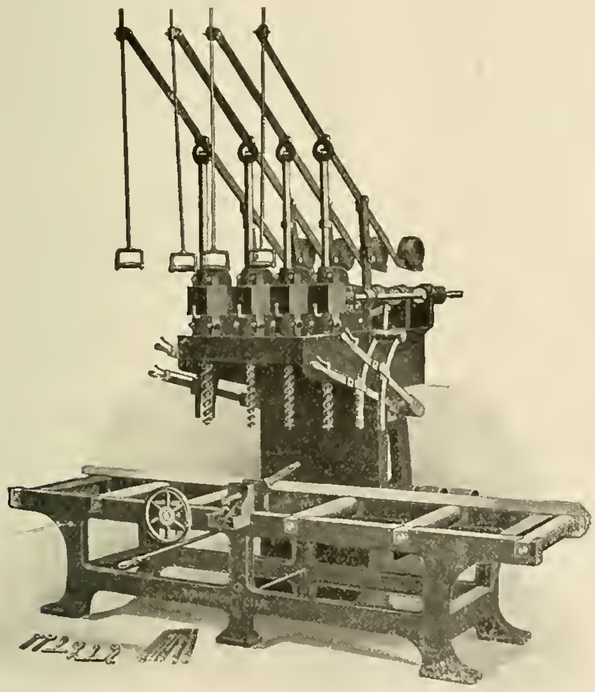
There are nine changes of feed; a fast traverse is provided for all movements. The power which drives the feed and the fast traverse is transmitted from the pulley at the end of the intermediate driving shaft to the pulley at the right of the feed box. The direction of the feed is reversed by tumbler gears. The motion for the fast traverse is obtained by engaging a friction clutch. With the high speed gears in mesh across and in and out feeds are obtained from .0052 to .0526 in. per revolution of the spindle. With the low speed gears in mesh feeds from .0121 to .1274 in. per revolution of the spindle are obtained; the corresponding circular feeds on a 10 in. circle are from .0063 to .0706 and from .0148 to .1649.

The circular table is 42 in. in diameter over the T slots and is surrounded by a reservoir for lubricant, having an over-all diameter of 48½ in. The table has a central bush bearing in the saddle 8 in. in diameter and has an over-all surface bearing 37 in. in diameter; it is held securely against the bottom bearing by corner clamps. The worm wheel by which the table is rotated is of bronze. The cross-slide adjustments are obtained with taper brass shoes. The cross saddle has square lock bearings on the frame, adjustment being made by brass taper shoes. The surplus lubricant is conveyed from the top of the table through the saddle and cross-slides to the frame and is returned to the storage tank, shown at the rear of the machine. It is circulated by a No. 3 Brown & Sharpe pump. The cutters are screwed on the spindle or fitted to a No. 5 Morse taper; it is intended that these cutters should be driven by a broad face key. The work table has a No. 4 Newton taper to accommodate mandrels for the location of the work. The machine occupies a floor space of about 4 x 10 ft. and is made by the Newton Machine Tool Works of Philadelphia.

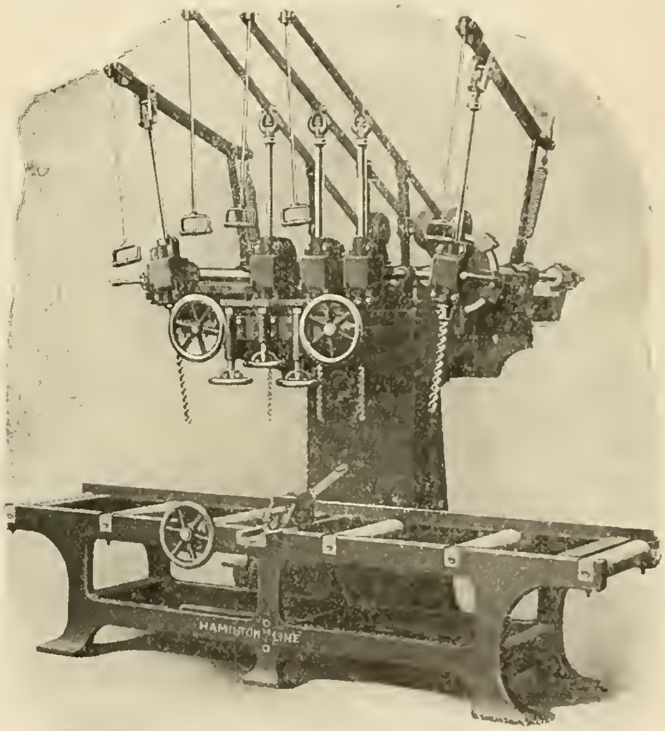
## VERTICAL CAR BORING MACHINES.

In describing the Hamilton five-spindle vertical car boring machine, with three vertical and two radial spindles, on page 167 of the April issue, an error was made in using as an illustration a machine having four vertical spindles. The five-spindle machine is illustrated herewith; the spindles have 20 in. stroke and a transverse adjustment of 22 in.

The four-spindle machine, the illustration of which is reproduced, was also designed for use in railroad and car shops. It carries four spindles in heavy housings mounted in dovetail slides on top of the heavy column frame. The housings have a transverse adjustment of 22 in. by means of self-clamping and quick-moving hand levers. Each housing is provided with its own driving pulley, driven from a countershaft mounted on the floor at the rear of the machine. This allows for the stopping of the spindles not in use by simply throwing the belt from the pulley. The spindles have 20 in. stroke. They are brought down separately to do the boring by hand and are returned to their position above the work by counterbalanced levers. Stop collars are furnished to gauge the depth of hole.



HAMILTON FOUR-SPINDLE VERTICAL CAR BORING MACHINE.




HAMILTON VERTICAL AND RADIAL CAR BORING MACHINE.

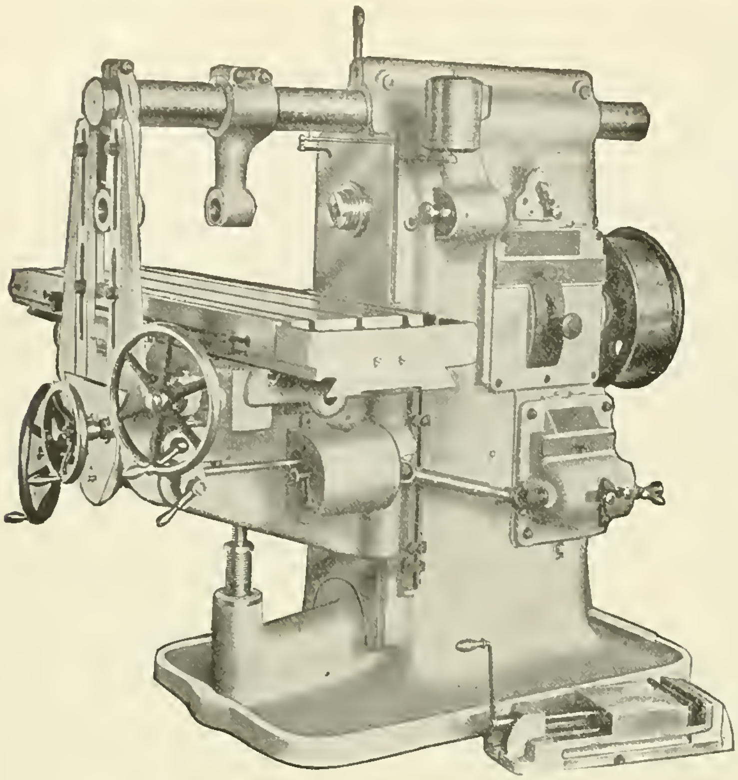
The driving power is transmitted to the spindles by means of miter gearing placed between two bearings on the housings and covered by caps, preventing the dust and dirt from lodging in them. The miter gears are provided with long sleeves running through the lower box allowing the spindles to slide freely and without wear in the boxes. The table is 10 ft. long, clamps 22 in. wide by 16 in. thick, and is provided with all conveniences for handling heavy or light material easily. The top is provided with rolls upon which the timbers rest. The center and two end rolls are geared together by chain and can be driven by either power or hand feed. A large hand wheel is placed on the center roll for hand adjustment. A center clamp is also provided to hold material against the fence and to prevent the bits from raising it from the table.

The feed mechanism for the table consists of reversible friction pulleys controlled from the front by a convenient hand lever. The power feed is generally used for moving long distances while the hand wheel feed is for accurate setting and short distances. This machine weighs 6,500 lbs., requires 10 horse-power for driving and occupies a floor space of 6 by 10 ft. It is manufactured by The Bentel & Margedant Company, Hamilton, Ohio.

THE RAILROADS AND THE PUBLIC.—The railroads want to give the people the best possible service, for it is only by doing this that they can obtain an increase of traffic. Do not understand me as saying that the blame for this ill-feeling towards railroads should be placed entirely upon the people. The railroads themselves are responsible for a share of it, but I believe that the public and railroads are getting closer together. The problems which brought about the distrustful feeling are being solved, and the railroads are trying to do their full part by the public, upon whom they must depend for business and even existence itself. The laws upon the statute books in Texas which have worked undue hardships upon railroads should be wiped off and a new start made. I do not mean by this that I am opposed to the regulation of railroads by laws. I favor their regulation.—*E. H. Harriman.*

ILLUSTRATED LECTURE ON SAFETY AND SANITATION.—The executive committee of the Museum of Safety and Sanitation, 29 West 39th street, New York, has detailed Dr. William H. Tollman for field work and he will start May 1 on a lecture tour. Railway and other clubs, engineering societies, etc., can avail themselves of this illustrated exposition of devices and methods for reducing damage suits and preserving efficiency, for the cost of the lantern operator ($10.00) if not too far removed from the itinerary.

THE PASSING OF THE V-THREAD.—The tap and die makers have adopted the United States standard thread as the only standard and relegated the V-thread to the list of "specials," to be had only on order and at an advance in price.



## HEAVY PLAIN MILLING MACHINE.

The plain milling machine illustrated herewith is manufactured by the Brown & Sharpe Manufacturing Company, Providence, R. I., and is designed for a heavy class of work. It has a longitudinal feed of 50 in., a transverse feed of 12 in. and a vertical feed of 21 in.

It is driven by a constant speed belt drive, thus eliminating the usual cone pulley; a constant speed motor drive may readily be applied at any time. The arrangement of the driving mechanism is shown on one of the drawings. The constant speed pulley A is driven by a 7-in. belt. The long pinion C is keyed to the shaft B. Either one of the four gears F may be driven by C through an intermediate gear, not shown, which is shifted longitudinally by two knobs on the front side of the column. The handle above these knobs rotates the pinion J which meshes with the circular rack teeth cut in the hub of the double gear H. Either the 31 or the 47-tooth end of H may thus be engaged with the corresponding gear FF. The eight spindle speeds which it is thus possible to obtain are further increased by the back gears. The lever that controls the back gears, automatically operates the locking pins that engage the spindle sleeve.

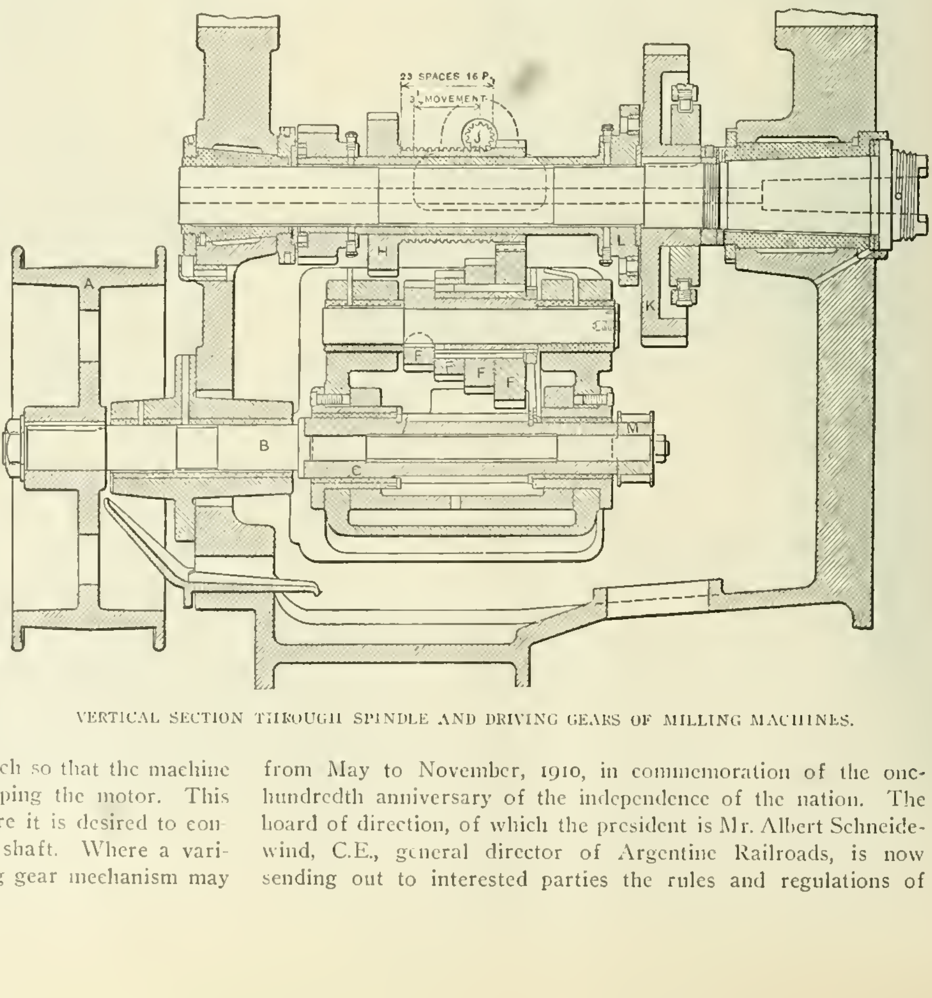
Finished bosses are provided on the frame of the machine so that a motor may be applied at any time. The chain sprocket which usually replaces the pulley A when a motor drive is used is connected to the shaft B by a friction clutch so that the machine may be started and stopped without stopping the motor. This may also be done with the belt drive where it is desired to connect the driving pulley direct to the line shaft. Where a variable speed motor drive is used the driving gear mechanism may be made much simpler. The spindle is rigidly supported both by the upper part of the frame which is entirely enclosed and by the knee slide. This extended knee slide makes it possible to clamp any of the regular attachments directly to the face of the column in such a way that they become practically a part of the machine.

The spindle is of large proportions and the boxes are provided with means of compensation for wear. The front box extends beyond the face of the column, acting as a centering guide for the attachments.

The table has a working surface of 68 by 21 in. It is deep and heavy and has a quick return and a slow speed longitudinal feed. The handwheels for the three adjustments can be operated together without interference. They are provided with throw-out clutches to disengage them after the adjustment is made and have dials graduated to read to thousandths of an inch.

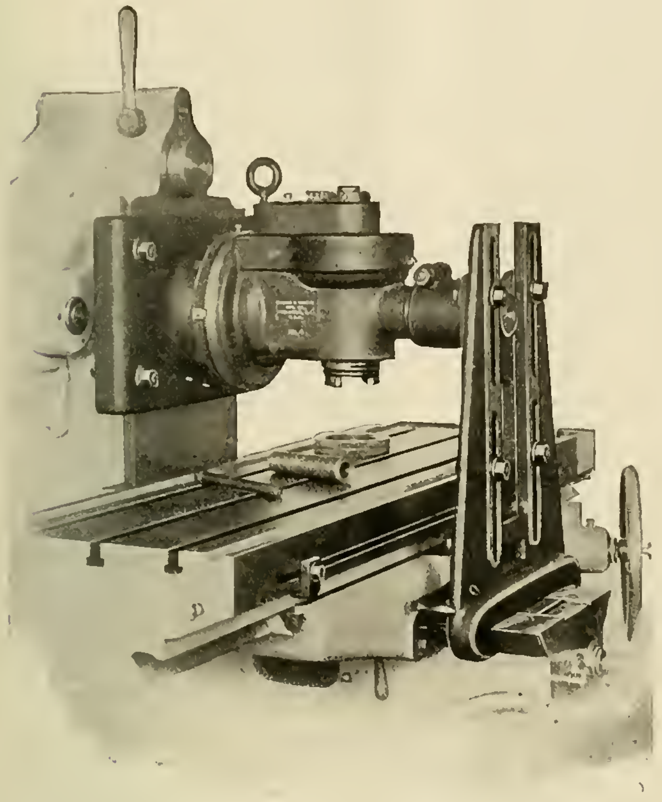
Sixteen changes of feed are obtained by a quick change-gear mechanism. The drive is by spur gears entirely, connected with the constant speed shaft of the driving pulley. An automatic tripping mechanism is supplied for all three feeds. When desired, the machine may be simplified by having only the longitudinal feed automatic. Suitable oil pans and channels are provided. When an oil pump is furnished, provision is made to carry the oil into the saddle and then to the tank, thus doing away with the long piping necessary to follow the movement of the table.

The machine weighs about 11,340 pounds. It may be furnished with a vertical attachment, as shown in one of the illustrations, which will carry any cut within the capacity of the main driving belt.




VERTICAL SECTION THROUGH SPINDLE AND DRIVING GEARS OF MILLING MACHINES.

An International Exhibition of Railways and Land Transport is to be held by the Argentine Republic, at Buenos Aires, from May to November, 1910, in commemoration of the one-hundredth anniversary of the independence of the nation. The board of direction, of which the president is Mr. Albert Schneidewind, C.E., general director of Argentine Railroads, is now sending out to interested parties the rules and regulations of the exposition and a schedule of the various industries and appliances which are to be exhibited. These include all manner of railways and tramways, automobiles, cycles, post-office and telegraph appliances, telephones, beasts of burden and vehicles, roads and highway military transportation, municipal street cleaning



VERTICAL ATTACHMENT FOR MILLING MACHINE.

and fire fighting wagons, hygiene and safety devices. In view of the wonderful progress that the southern republics have recently made and are still making, this would seem to be a field for exhibits for some of the railway equipment houses of the United States.

## BOOKS.

Engineering Index Annual for 1908. Cloth. 437 pages. 6½ x 9½. Published by the *Engineering Magazine*, 140 Nassau street, New York. Price, $2.00.

This forms the third volume of the "Annual," which has been greatly appreciated by all engineers. It contains complete indexes of all technical and scientific articles of importance that have appeared during the year in the technical papers of all countries. It is based on the indexes published monthly in the *Engineering Magazine* and follows the same scheme of classification. Cross references are very freely used and with the experience of former years to guide them the editors of this annual have about reached perfection in this respect. The classifications have all been most carefully studied and are now practically standard.

## PERSONALS.

L. L. Dawson has been appointed the superintendent of motive power of the Ft. Worth & Denver City Ry.

W. A. Deems has been appointed a master mechanic of the New York Central, with office at Tupper Lake, N. Y.

C. B. Keiser has been appointed the master mechanic of the Pennsylvania Tunnel & Terminal, with office at New York.

C. J. Morrison has been appointed bonus supervisor of the Topeka shops of the Santa Fe. This is in addition to his duties as standardizing engineer.

T. J. Raycroft has been appointed master mechanic of the Sterling division of the Chicago, Burlington & Quincy R. R., with headquarters at Sterling, Colo., vice E. D. Andrews.

H. B. Whipple has been appointed master mechanic of the Harlem division of the New York Central, with office at North White Plains, succeeding W. H. Foster, transferred.

W. P. Chrysler, superintendent of motive power of the Chicago Great Western Ry., has been appointed assistant superintendent of motive power and machinery, with office at Oelwein, Iowa.

W. J. Hill, general foreman of the Atchison, Topeka & Santa Fe. Ry., has been appointed the master mechanic of the Oklahoma division, with office at Arkansas City, Kan., succeeding J. T. Lendrum, transferred.

W. F. Ackerman has been appointed the shop superintendent of the Havelock shops of the Chicago, Burlington & Quincy R. R., with office at Lincoln, Neb., succeeding F. Kroehler, assigned to other duties.

S. E. Kildoyle, master mechanic of the Vera Cruz & Isthmus Ry., has resigned, and his position has been abolished. J. A. Baker, general foreman, has been appointed the foreman of shops and locomotive repairs, with office at Tierra Blanca, V. C., Mex., and reports to the acting superintendent.

E. D. Andrews has been appointed master mechanic of the newly formed Omaha division of the Chicago, Burlington & Quincy Ry., with headquarters at Omaha. This division is formed of that section east of, but not including, Lincoln, Neb., which was formerly part of the Lincoln division.

W. H. Foster, master mechanic of the New York Central & Hudson River R. R., in charge of the Harlem division, with office at North White Plains, N. Y., has been transferred to High Bridge as master mechanic and put in charge of the Hudson and the New York & Putnam divisions, succeeding L. H. Raymond, resigned.

Levi B. Paxson, consulting mechanical engineer of the Philadelphia & Reading Ry., died April 10 at Reading, Pa. He was born in 1827 in Chester County, Pa., and began railway work on the Philadelphia & Reading as a brakeman. He later became master mechanic and then engineer of machinery. By 1888 he had become superintendent of motive power. In August, 1899, he was made consulting mechanical engineer.

Wilson E. Symons has been appointed the superintendent of motive power and machinery of the Chicago Great Western Ry. Mr. Symons began railroad work in 1880 as a machinist and, after ten years' experience in merchant marine service, as a locomotive fireman and engineer and special engineering work, was appointed general foreman of the Santa Fe at Chanute, Kans., and two years later, master mechanic at Raton. In 1896 he was made master mechanic of the Mexican Central Ry. at San Luis Potosi, Mex., and in the same year was appointed mechanical expert and salesman of the Galena Oil Co., in the United States, England and France. In July, 1898, he was appointed superintendent of motive power and equipment of the Plant System Railways at Savannah, Ga. In May, 1902, he was made mechanical superintendent of the Gulf, Colorado & Santa Fe Ry., and in August, 1904, superintendent of machinery of the Kansas City Southern Ry. From 1905 to 1909 he has been engaged in special expert and consulting railway work in Chicago. His office will be in St. Paul, Minn.

## CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Storage Batteries in Isolated Lighting Plants.—A booklet being issued by the Gould Storage Battery Co., 341 Fifth avenue, New York, fully considers the successful isolated electric plant, giving diagrams, photographs, tables, prices, etc.

Scaling Boiler Tubes.—The proper method of removing scale from boiler tubes and the effect of the operation on the tubes and headers is fully discussed in several pamphlets being issued by the Wm. B. Pierce Co., 327 Washington street, Buffalo.

Forged Steel Hydraulic Jacks.—The Duff Manufacturing Co., Pittsburg, has prepared a catalog fully illustrating and describing the new Duff-Bethlehem forged steel hydraulic jacks. The details of construction and operation are clearly shown. Price lists are included.

Type K Triple Valve.—Instruction pamphlet No. 5030 from the Westinghouse Air Brake Co., Pittsburg, Pa., gives full description of all the improvements incorporated in the new Type K freight triple valve. The action of the valve under all circumstances is fully illustrated.

Smoke Box Superheaters.—Record No. 66 of the Baldwin Locomotive Works, recently issued, contains a reprint of an article by John W. Converse describing the Baldwin superheater, a description of the Baldwin feed water heater as applied to the Central of Georgia Railway and an article by Lawford H. Fry on the advantages of low superheat for locomotives.

Train Lighting.—A very attractive booklet is being published by the General Electric Co., which points out the many advantages to be derived from the use of Tantalum incandescent lamps for the illumination of railroad cars. The generator outfit designed by this company for use in connection with the illuminating system on trains is also briefly considered.

Engine and Axle Lathes.—A series of sheets in a loose leaf binder has been received from the Bridgeford Machine Tool Works, Rochester, N. Y. Various sizes of their patent geared head lathes are illustrated and described, arranged for both belt and motor drive. Specifications are presented for a 26 in. cone driven lathe. Axle lathes, or the single and double head and gap type are also shown.

Lock Jaw Wrenches.—The Jeffrey Mfg. Co., Columbus, O., has recently organized a forge and foundry department in which are manufactured a number of specialties. Among these is a new lock jaw wrench intended primarily for track work, which is shown in catalog numbered 101. Illustrations, tables of sizes and dimensions, as well as attractive cuts showing the wrench in practical operation, form the subject matter of this booklet.

Rolled Steel Wheels.—A catalog being issued by the Midvale Steel Company, Philadelphia, Pa., describes the methods used in forming solid rolled steel wheels, as well as locomotive tires, car axles, etc. This catalog also contains a number of valuable tables in connection with the proper shrinkage for tires, weight of tires of all sizes, specifications for steel forgings, and other information in connection with steel forgings and castings.

Fitting Up Air Hose.—A machine for forcing air or steam hose upon their metal fixtures, in a rapid and safe manner, and securing the clamps, which can also be used for cutting the bolts and stripping the hose, is fully illustrated and briefly described in a catalog being issued by Baker & Carr Mfg. Co., 19 Fairview Heights, Rochester, N. Y. This is called "The 20th Century Outfit," and by actual tests is capable, when operated by one man, of mounting 443 air hose in ten hours.

B. & S. Machinery and Tools.—The 1909 edition of the Brown & Sharpe Mfg. Company's catalog is now being issued. It is of the usual pocket size and contains over 550 pages into which space is condensed the desired information on what is probably the most complete line of small tools in existence, in addition to milling machines, grinding machines, automatic gear cutting machines, screw machines, milling cutters, etc. The office and plant of this company are at Providence, R. I.

Steam Hammers.—A large size catalog is being issued by the Niles, Bement, Pond Co., New York, on the subject of Bement single and double frame hammers. The general design of these hammers is briefly considered in the first five or six pages, following which there are over 40 pages, giving excellent illustrations of the different types or sizes of Bement hammers. These are shown very clearly and attractively in each case. Tilting hammers, steam drop hammers and board drop hammers are included.

Curtis Steam Turbine Generator.—A very attractive catalog bearing No. 4653, being issued by the General Electric Company, Schenectady, N. Y., is devoted to the Curtis steam turbine generator. This bulletin is quite elaborate and contains illustrations of many of the details of construction, showing interior views and cross sections of various parts of the turbine and generator. It describes large and small turbines of both vertical and horizontal types and contains illustrations of numerous representative installations.

Drills and Sockets That Are Different.—Twisted flat high speed drills having either straight, standard taper or square shanks, in connection with a new type of drill socket which eliminates all the tang troubles with tapered shank drills, forms the subject matter of a very attractive catalog being issued by the American Specialty Company, Chicago. Different drills are illustrated in a number of different sizes and designs, each of which is briefly described. Tables giving dimensions and prices of both the drills and drill sockets are included.

Hydro-Electric Equipment.—Bulletin No. 1613, being issued by Allis-Chalmers Co., Milwaukee, Wis., gives a very complete well illustrated description of the development of the Great Northern Power Company's plant at the head of Lake Superior. This is the largest hydro-electric development of its kind in the world and at present is fitted with three turbine water wheels of 13,500 h. p. capacity each, under a head of 365 ft. These are direct connected to 6,600 volt, 25 cycle, three-phase generators. Copies of this bulletin can be obtained upon request.

Safety Valve Capacity.—The paper by Philip G. Darling, presented before the American Society of Mechanical Engineers, in February, and given on page 162 of the April issue of this journal, is being issued in bound pamphlet form by the Consolidated Safety Valve Co., 85 Liberty street, New York. In addition to the paper, there are also included a number of tables and other data compiled by the author from his extensive tests along these lines. This forms a most complete and valuable discussion of this important subject and should be carefully studied by any one responsible for the safety of steam boilers.

The Products of Kennicott.—Most railroad men when they "Think Kennicott, think soft water" and do not remember that at the plant of this company, Chicago Heights, Ill., there are also manufactured such things as water tube boilers, car tanks, smoke stacks and breechings, tanks and towers for water storage, track troughs and all manner of steel plate and structural work. This, however, is a fact, as a most artistic loose leaf catalog issued from the office of this company, 602 Corn Exchange Building, Chicago, Ill., shows, largely by means of illustrations. The catalog is in loose leaf form, so that only the section describing equipment in which the applicant is interested need be sent him bound between the covers.

## NOTES

Standard Bridge Tool Co.—The offices of this company were moved on April 1 from 709 Curry Bldg., to 706 Ferguson Bldg., 4th avenue, Pittsburgh, Pa.

United States Metallic Packing Co.—Morris B. Brewster will represent the above company and the Locomotive Sander Company, in Chicago. His offices will be at 509 Great Northern Building.

Baldwin Locomotive Works.—William P. Henszey, a partner of the firm of Burnham, Williams & Co., died on March 23, 1909. Mr. Henszey had been connected with these works since March 7, 1859.

Sligo Iron and Steel Co.—Henry F. Gilg has been appointed manager of sales of the above company, whose works are at Connellsville, Pa. Mr. Gilg was formerly with the Refined Iron & Steel Company of Pittsburgh.

Homestead Valve Manufacturing Co.—A number of applications of Homestead valves to 5,000 lbs. hydraulic pressure have proven so satisfactory that several repeat orders have been received from these customers.

H. G. Hammett.—Edward C. Sawyer, who was formerly the representative of the H. W. Johns-Manville Co., is now associated with H. G. Hammett, Troy, N. Y., manufacturer of Trojan metallic packing, locomotive specialties and machinery.

Northern Metallic Packing Co.—A. Munch, for the past eight years sales manager of the Northern Metallic Packing Co., of St. Paul, Minn., has resigned. It is understood that Mr. Munch will, after taking a vacation, become identified with a prominent supply concern.

Grip Nut Company.—An addition, 20 x 277 ft. and two stories high, is being made to the works of the above company at South Whitley, Ind. This has been made necessary by the rapidly growing business in its design of grip nut and Universal window fixtures.

Chicago Pneumatic Tool Co.—W. P. Pressinger, who recently resigned as general manager of the compressor department of the above company, has organized the W. P. Pressinger Co. to handle vacuum cleaning machines, both portable and stationary. Offices and salesrooms have been opened at 1 W. 34th street, New York.

Morton Mfg. Co.—Matthew Morton, founder and president of the above company, died at his home at Muskegon Heights, Mich., March 10, from an attack of pneumonia. Mr. Morton was a native of Scotland and was born May 5, 1836. He came to this country in 1844 and from his earliest boyhood had been identified with machinery firms.

# THE SUCCESSFUL MECHANICAL DEPARTMENT OFFICIAL

*The training and duties of the average railroad official seem to be such that he finds it difficult, and in some cases almost impossible, to stand back and take a broad and general view of his work. There are certain fundamental principles which, if followed, will not only insure success but will bring a department to the very highest point of efficiency. It has been said by one who is well qualified to make the statement, that the net earnings of the railroads could be very materially increased if the roads were directed on the broad principles which underlie an ideal organization. An attempt has been made, in the following, to sum up certain of the more important principles which should underlie an efficient organization. These are not the product of the imagination, but one or more of them have been tried out and proved successful by each of several motive power officials whose work has met with more than ordinary success.*

I. *Establish an organization which is automatic and will not suffer by the loss of an official, even the highest.*

The effectiveness of an organization depends largely upon how strong a spirit of team work and co-operation permeates it. The true organization forces co-operation automatically. Without this spirit the above condition cannot exist. Certain of the more important principles which underlie a good organization and will bring about the desired *esprit de corps* may be briefly stated as follows:

A strong leader who is able to enthuse and bring out the best in each of his subordinates, so that they in their turn will have a similar influence on those under them. The policy of the leader must be thoroughly understood by his line and staff officers and have their hearty support.

Team work is best brought about by clearly defining what is required of each man and having him feel that having accomplished his task he has done all that is expected of him and that he will be adequately recognized in a pecuniary as well as other ways. The organization must be so far reaching that it recognizes definitely the personality of each individual and makes him feel that he is recognized as an important member of it, and not simply one of a large mass.

An official is only eligible for promotion when he has a man under him who can step up and take his place and produce as good or better results. Don't discourage the men by taking others in from outside the organization to fill positions to which they are eligible and which they are capable of filling. Men selected to receive promotion from the ranks should be carefully studied to determine whether they have the qualities which, if properly developed, will fit them for the higher positions in the organization. The eligibility of any member of the organization for promotion should be determined from individual efficiency records (See V).

Officials who are not capable of being developed should be eliminated from the organization, so as not to block the way of those under them.

Criticism of subordinates should be constructive, not destructive. It may be confined largely to failure to reach standards of efficiency of service or cost (See II).

The officials should invite frank criticism and suggestions from those under them.

Young men should be developed and promoted to positions of responsibility.

II. *Establish a standard cost or allowance for each of the various items of expenditure and see that it is not exceeded.*

Three things are necessary in order to do this:

(a) Determine an efficiency of service and quality of output below which you will not go.

(b) Find out what each detail of the cost of such service and output should be.

(c) Bring down the cost of each detail to what it should be.

The first is accomplished by inspectors having instructions as to the minimum of efficiency and quality permissible and who are not interested in the cost.

The second is accomplished by specialists who scientifically determine the required efficiency of service and quality of output. Explicit instructions are issued as to what is required and how it can be reached.

The third is accomplished by having hourly, daily, weekly, monthly or yearly reports and records of each detail, determining why the excessive ones are high and eliminating the cause so that they may be brought down.

III. *Keep minute records of the pay rolls and other cost statistics.*

It is useless to prepare statistics unless they are to be used. They are also useless if not based on the proper units of output so as to permit of intelligent comparison. They must be intelligently compiled and arranged or they will not only be useless but misleading. Their value will depend largely upon how soon they are placed in the hands of those interested, after the expiration of the period of time which they cover. In order that the allowance system mentioned above may be a success it is necessary that the officers be fully informed at all times as to whether they are above or below the allowance.

The statistics that must be digested by the average motive power department officer are so numerous that he cannot properly grasp them unless they are arranged in a simple or a graphical form. The motive power officer should have his records in such shape that he will positively know at all times what is doing; what everything costs and what it ought to cost.

*IV. Explicit instructions to each employee.*

The form of organization should be such that each man will understand his place in it and will have his duties clearly defined. It is also necessary that current practice should be covered with circulars giving explicit instructions in detail for all employees. These should be clear and definite and should be kept strictly up to date. Steps must be taken to make sure that the men to whom they are issued understand them and that they refer to them and read them over often enough to keep them clearly in mind.

No detail is too petty to receive the highest official's attention but he must have such a system that a detail when once passed upon will be automatically followed up. Too often an official, after carefully studying a problem, will issue certain instructions. They are closely followed for a short time with good results, but their importance is gradually lost sight of and they fall into disuse until the problem is again brought to his attention, when the same process is repeated.

*V. Keep efficiency records of each man in the organization.*

At first glance this seems almost impossible, but with a proper and well established organization it is a comparatively simple matter to, in a short time, have a record of the efficiency of every man, covering his attainments, character, disposition and workmanship.

When piece work or bonus systems are used the individual earning capacity of those working under them is known exactly. The efficiency record referred to above means more than this, however. Records should be available for every man in the department, showing his weak and strong points and these should be revised from time to time so that the development of each individual may be followed.

## WHAT OTHERS THINK OF THESE PRINCIPLES.

The above article, before final revision, was submitted to sixteen gentlemen for comments and criticism. These included officers in the executive, operating and mechanical departments of the railroads; executive officials and plant managers of industrial concerns, all of whom had previously been connected with the motive power department; also one or two others who have had special facilities for studying the work of the mechanical department. These gentlemen are all generally recognized as more than ordinarily successful officers and organizers. Their comments and criticisms were used to advantage in revising the article.

One suggestion was that the principles should be amplified and in the following notes, which were prepared with this in mind, the paragraphs printed in italics are quoted from the letters of the above-mentioned gentlemen. For convenience the notes are arranged in the same divisions and order as the article itself.

### Introductory.

*"Speaking on the subject of earnings, I think it is entirely true that the average railroad official does not, or, in many cases, is not allowed to stand back and take a broad and general view of his work. By this, I mean a business man's view. Very often a railroad official finds many limitations surrounding his work and activity, in directions that he gets from his board of directors and from financial influences that have temporary and speculative advantages in view. Sound business and ultimate economy are frequently overlooked, and I think this is a just and reasonable ground for criticism. For instance, in very many cases it has gotten to be the practice to purchase the very cheapest material at first cost, and the idea of spending a dollar at an opportune time to save two or more is far from being generally observed. The old saying, "A stitch in time saves nine," I have seen thoroughly carried out in some cases and have observed the results; in other cases I have observed that this principle has not been carried out and the difference in results is very marked."*

### I.—Establish an Organization Which Is Automatic and Will Not Suffer by the Loss of an Official, Even the Highest.

The study of the principles which will bring about this condition clearly indicates it is not the policy of an "opportunist"—one who takes advantages of opportunities and circumstances, or seeks for immediate advantage with little regard for ultimate consequences. It is rather the policy of one who builds substantially and carefully from the foundation up and having regard for the future.

* * * *

*"I feel that one of the essentials among all officials, particularly the highest, is the item of character. High character—one that has a fine sense of duty—is a necessity. One cannot exact from others that which they do not themselves live up to, and do it successfully."*

* * * *

Referring to the second paragraph beginning "A strong leader, etc.," the following criticism has been made: *"The business of the top is not to inspire but to help. Inspiration should come from the bottom. Napoleon fell because he attempted the too great task of dragging up."* It is necessary to differentiate between the starting and building up of an organization and carrying it on after it is well established. A strong leader is a necessity in either case, but more especially in the first. It is not intended that he should supply all the enthusiam but that he should so plan and arrange the work that his subordinates and men will of necessity be enthused and inspired. *"Voluntary effort can only be inspired in men. It is latent in nearly all men, but must be fostered."*

* * * *

*"You state: 'Team work is best brought about by clearly defining what is required of each man and having him feel that having accomplished his task he has done all that is expected of him, etc.' I believe that by putting it in this shape a man may feel that he only has to do a certain amount of work and that that is all there is necessary to do. I think you will find that the most successful men are those who are continually looking for something to do after they have finished what they have of their own particular work."*

Many railroad officers, and among them some of the very best, are often discouraged because they do not know whether the results they are obtaining are satisfactory to their superiors or not—in fact, their superiors do not seem to have any definite standard by which to measure the results of their work. Where standards of efficiency are clearly established, as indicated in II, there is no question as to a man's work if he reaches the standard or can show good cause for not reaching it. If he can give better results than 100 per cent. the records will show it and it will be so much more to his credit. There is just as much or more incentive, for he realizes that his superiors have an accurate gauge by which to measure his efficiency—guesswork is eliminated.

* * * *

*"I feel like laying particular stress upon the point that you make on individualism. The importance of recognizing the personality and capacity of each individual cannot be over-estimated."*

* * * *

*"You state: 'Young men should be developed and promoted to positions of responsibility.' I think that it would be well to call attention a little more in detail to the need of proper coaching of men in connection with their work not only for the purpose of enabling them to overcome what is presently before them, but for the future. A great many railroad officers make the mistake of not giving sufficient instructions to their employees. I do not think that they use enough pains to do so. There is some labor involved, but this is amply repaid by the results obtained in the more intelligent handling by the employees of the situations which present themselves, and in their adaptability for higher positions."*

II.—Establish a Standard Cost or Allowance for Each of the Various Items of Expenditure, and see that It Is Not Exceeded.

*"Each item should have a base line of measurement, not hazy and indefinite. Each mechanical or technical action should be based on the business end of the question and above all authority commensurate with the responsibility should be imposed."*

III.—Explicit Instructions to Each Employee.

The following rules govern the use of "permanent instructions" and "circulars" in the mechanical department of one system. "Permanent instructions" are issued only by the mechanical superintendent and cover the duties of employees, standard methods of doing work, standard reports, standard dimensions not covered by drawings, and other rules to be permanently adhered to. Each one is numbered and designates the employees who are required to be familiar with it. They are posted in books furnished for the purpose, the following officers having such books: General master mechanics, master mechanics, master car builders, mechanical engineer, chief draftsman, shop superintendents, inspector lighting and heating, chief chemist, coal inspector, general air brake inspector, assistant general air brake inspector, general boiler inspector, roundhouse foremen, car foremen, road foremen and all shop foremen. When instructions are issued each officer must personally acknowledge receipt and advise that he understands them.

Every three months the following blank, referring to all the permanent instructions in the officers' possession, must be personally signed and sent to the office of the mechanical superintendent:

Date..................190....
I have within the last thirty days read, understood and am carrying out "Permanent Instructions" Nos..........................................
..........................................................................
Signed..........................................
Station........................................

"Circulars are numbered and designate the employees who are to receive copies. They are kept on a clip board and in a prominent place until the work has been completed, when they are filed.

IV.—Individual Efficiency Records.

A complete description of a method of keeping individual efficiency records in the broad sense of taking into consideration a man's character and personality will be found on pages 459 and 468 of the December, 1908, issue of this journal.

General Comments.

*"The opportunity, rather the obligation, of training and making better men to the company and to society at large is given and is as great a duty, as from the efficiency viewpoint it is to get the greatest amount of service, i. e., work for the least expenditure."*

*"Be a master of opportunity, not mastered by it."*

* * * *

*"There is one other thing that you do not mention, and it is probable that you do not do so for the reason that it may seem personal, or somewhat in the nature of an advertising of your business, but I really think that one of the most important things for a man to do who desires to equip himself for any responsible position in railroad work is to read the literature of the profession. Unless a man does this he becomes encased in a shell and is bound to lose many of the good ideas that other men have which it is true may come to him after considerable study in his own line of work, yet, if he receives suggestions through reading it enables him to devote more of his thought to additional ideas and suggestions, thus increasing his capacity."*

## RAILROAD MACHINE SHOP PRACTICE.

George J. Burns.

### III.—OBSERVATIONS ON BABBITTING AND BRASSES.

Although these observations are based on the practices as noted on a large number of railroads the writer does not undertake to say that there are not still better methods. At each shop visited new facts and further data are obtained. At the best it is but taking notes by the way. Rapid progress is being made in improving the efficiency of the railroad shops and the last word to-day is very apt not to be the last word to-morrow.

*Babbitting Shells of Driving-Boxes.*—It is debatable as to what extent, if any, babbitting any part of the shell is necessary. If it is not necessary, its elimination would be an important saving in time and cost. Some roads babbitt the entire surface of the shell. Other roads do not babbitt the shell at all, while most roads use babbitt as an insert in larger or smaller proportions.

It is probable that the use of the patent grease cellar improves lubricating conditions more than enough to offset any advantage of babbitting. It is contended that the use of the babbitt insert is not good bearing practice, for the reason that the softer metal does not carry its part of the load, which is thereby proportionately increased per square inch upon the denser metal. One man compared the two metals in one bearing to a piece of felt in a feather pillow.

*Babbitting the Hub Side of Driving Boxes.*—In the previous article (May issue, page 185) attention was directed to the growing practice of holding the babbitt in position by making the two sides of the babbitt channel slightly eccentric with each other, instead of holding the babbitt with brass plugs. The advantage of this method is too obvious to warrant argument.

*Casting the Brass Plate on the Hub Side and Casting the Shell, in Position.*—This practice is on the increase on roads where brass foundries are available and convenient. Granting proper facilities, it is undoubtedly good practice to cast the plate and shell in position. It is both economical and efficient. The chief objection seems to be one of repairs. No construction is good that cannot be replaced in any shop to which the engine may be sent for repairs.

*Shimming Brasses on Repairs.*—This practice seems to be on the wane, especially on heavy engines, where shimmed brasses seem to work loose. Its advisability depends considerably upon exigencies. It is a practice that can always be fallen back upon in an emergency. Whether it is profitable in any particular case depends somewhat upon the difference in cost between brass castings and scrap brass. In some localities the difference is but a fraction of a cent per pound; in others, it is several cents.

*Babbitting Cross-Head Gibs—Babbitt Not Planed.*—On one of the most important roads of the country—a road known for the high excellence of its rolling stock—the cross-head babbitting is not planed. In that shop two men are babbitting sixteen gibs in eight hours with one mould. The output would be increased by the use of additional moulds, as considerable time is lost waiting for the babbitt to set after the mould becomes heated through repeated pouring. Investigation seems to indicate that the unplaned babbitt gives as great efficiency as the planed babbitt. It should be borne in mind that the bearing conditions of cross-heads, as to surface and radiation, are more favorable than is frequently had in journal bearings running at high speeds and under heavy loads. It seems to be the general consensus of opinion among master mechanics that the planing of cross-head babbittings is unnecessary. However, on some roads there exists among locomotive engineers a prejudice against unplaned babbitt cross-heads, and, as is often the case, a disposition to shift the responsibility for all breakdowns on the repair shop. In consequence, mechanical departments often lack confidence in introducing reforms that may be condemned on *ex parte* evidence.

# LOW, MODERATELY AND HIGHLY SUPERHEATED STEAM.

F. J. COLE.

*Introductory.*—While the value of superheated steam for locomotive practice has been more or less recognized by railroad men in this country for several years, it is only very recently that its fullest advantages in combination with reduced boiler pressures and enlarged cylinders have been fully appreciated.

Steam pressures on locomotive boilers have been gradually increased from 140 to 225 pounds in the last twenty-five years. A considerable amount of this increase, say from 180 to 225 lbs., has been brought about since 1890 by the use of compound engines in order to improve their efficiency and to more fully realize the benefit of the greater ratio of expansion possible in the compound engine. This has naturally led to increases in pressure on simple engines, with the result that three or four years ago practically all locomotives were built with steam pressures of 200 pounds, or over. The result has been that the cost of boiler repairs has been very much increased and losses through leakage, decreased life of firebox, staybolts, flues, etc., has followed in its train. These high pressures have not only increased the actual labor charges for locomotive maintenance, but have decreased the percentage of time that the locomotive is available for useful service. The latter, of course, is none the less costly because of its being harder to estimate.

In this paper the following terms will be used:

| | | |
|---|---|---|
| Low Superheat.................... | 25° to 50° F., | Smoke Box Type |
| Moderate Superheat.............. | 100° to 125° F., | Single Loop Fire Tube |
| High Superheat.................... | 175° to 250° F., | Double " " " |

*High Boiler Pressure.*—The following two considerations are probably largely responsible, especially in compound engines, for the increase in boiler pressures. First, the increased heat in the steam and therefore a slight increase in efficiency; second, a decrease of the cylinder condensation due to the smaller diameters and reduced surfaces of the cylinder walls. On the other hand, the bad features attendant, which are inseparable from the increased pressures, are the great increase in boiler repairs and the large losses due to leaks in boilers, valves, cylinder packing, etc.

*Theoretical Efficiency of an Engine.*—The theoretical efficiency of a heat engine is given by the expression:

$$\frac{T_1 - T_2}{T_1}$$

in which $T_1$ equals the absolute heat received and $T_2$ the absolute heat rejected. The above conditions cannot be realized in practice as they presuppose a perfect engine with no transfer or loss of heat.

Considering three engines, all using steam at 160 pounds pressure, the theoretical efficiency would be as follows:

$$\text{Saturated Steam, } \frac{831 - 691}{831} = \frac{140}{831} = 16.8 \text{ per cent.}$$

$$40^\circ \text{ Superheat, } \frac{871 - 691}{871} = \frac{180}{871} = 20.6 \text{ per cent.}$$

$$230^\circ \text{ Superheat, } \frac{1061 - 691}{1061} = \frac{370}{1061} = 34.8 \text{ per cent.}$$

*Superheated Steam vs. High Boiler Pressures.*—Superheating affords a convenient means of adding heat to the steam without increasing its pressure. No useful purpose is served by high boiler pressures when superheat is used. The necessary heat for increasing the efficiency of the engine can be added to any extent without increase of pressure. Cylinder condensation due to the enlarged cylinders required with the lower boiler pressures is eliminated with the higher degrees of superheat, permitting the abstraction of the full amount of superheat without condensation. Its low thermal conductivity also prevents so much heat being absorbed from the cylinder walls.

Saturated steam at 160 lbs. has a temperature of 370 degrees; at 200 lbs., 388 degrees, and at 225 lbs., 397 degrees, or an increase in heat of about 27 degrees for practically the entire range of pressures in locomotive practice. The low degree of superheat as afforded by the smokebox superheater adds 35 to 40 degrees, which is more than can be obtained by means of high pressures. Moderate and high superheat, on the other hand, afford a convenient and practical means of adding from 100 to 250 degrees of heat. Its great thermal value therefore can be at once appreciated.

*What Is Superheated Steam?*—Steam is said to be superheated when it is at a temperature higher than the boiling point corresponding to the pressure. Steam cannot be superheated in contact with the water from which it is generated. In order to receive additional heat it must be separated from its liquid and subjected to a still higher temperature.

*Saturated Steam.*—The expression "dry saturated steam" is often used, but in practice it is seldom realized, and in locomotive boilers it is probably within the limits of current practice to assume that the saturated steam contains from 1½ to 2 per cent. of moisture.

In the St. Louis tests the quality of steam was:

| Road | Number | Class | Quality of Steam in Dome | |
|---|---|---|---|---|
| | | | Maximum | Minimum |
| P. R. R. | 1499 | 2-8-0 | .9907 | .9850 |
| L. S. & M. S. | 734 | " | .9880 | .9837 |
| Mich. Cent. | 585 | " | .9877 | .9828 |
| A. T. & S. F. | 929 | 2-10-2 | .9846 | .9445 |
| " " " | 535 | 4-4-2 | .9823 | .9626 |
| Hanover | 628 | " | .9986 | .9936 |
| N. Y. C. & H. R. | 3000 | " | .9835 | .9499 |
| P. R. R. | 2512 | " | .9859 | .9812 |

The average quality of the steam varied between 98.3 and 99.0 per cent., the average moisture therefore being 1 to 1.7 per cent.; the minimum amount of moisture was .14 per cent and the maximum 5.55 per cent.

Saturated steam is in a certain sense an unstable fluid or vapor. When in contact with its liquid at any given pressure it is evident that a narrow margin of heat divides the vapor from the liquid. Any abstraction therefore of heat causes one of two things; either a portion will become liquefied or the pressure will be decreased.

*Action of Steam in a Locomotive.*—What occurs in a locomotive is about as follows: When the throttle is opened the steam enters the dry pipe, containing probably 2 per cent. of moisture. If the throttle is only open to such an extent that "wire drawing" takes place, the pressure will evidently be reduced from that of the boiler and some re-evaporation of the moisture will take place, but if the throttle is opened so that full boiler pressure will be admitted to the dry pipe, the steam containing the original amount of moisture is carried to the cylinders. Assuming that the cylinders have been heated to the temperature of the steam at termination of expansion, steam will flow in and some of the heat will be absorbed by the cylinder walls when the valves cut off the supply; it expands with a consequent decrease of temperature. With the completion of the stroke the exhaust opens and the pressure is still further reduced during the period of exhaust, so that the cylinder walls are alternately subjected to the heat of the steam at full and at reduced pressures. This results in the transfer of heat from the steam to the cylinder walls. In the case of saturated steam, which is an extremely good conductor of heat, great losses are incurred in what is generally known as cylinder condensation. It is found that a large amount of saturated steam which is just at the dew point must be converted into moisture, a part of which is re-evaporated by abstracting heat from the cylinder walls.

With superheated steam that has received, say 175 degrees of additional heat after removal from contact with the water, it is found that 175 degrees of heat can be extracted at a constant pressure before it reaches the dew point. Therefore its expansion will partake of the properties of a gas and the loss due to the condensation and re-evaporation of the cylinder walls will be largely obviated.

The advantages of superheated steam are: At high temperatures it behaves like a gas and is therefore in a far more stable condition than in the saturated form. Considerable heat may be extracted without producing any liquefaction, whereas the slightest absorption of heat from saturated steam results in condensation. If superheat is high enough to supply not only the heat absorbed by the cylinder walls, but also the heat equivalent of the work done during expansion, then the steam will be dry and saturated at release. This is the condition of maximum efficiency in a single cylinder. (Ripper, "Steam Engine Theory," page 155.)

To obtain dry steam at release the steam at cut-off must be superheated 100 to 200 degrees F. above saturation temperature. A superheat of 125 to 175 degrees F. at admission is necessary to insure dry steam at release in the average single cylinder engine, cutting off at one-fourth stroke and boiler pressure of 100 lbs. There will be a reduction of approximately 1 per cent. in cylinder condensation for every 7.5 to 10 degrees of superheat. (Gebhardt, "Steam Power Plant Engineering," page 130.)

### Fire Tube vs. Smokebox Superheater.

*Smokebox Temperature.*—In Lawford Fry's article on the advantages of the use of moderately (low) superheated steam in locomotive practice in the *Railroad Age Gazette*, March 19, 1909, he bases his argument upon smokebox temperatures of at least 800 degrees F. for locomotives equipped with the fire tube superheater.

In looking over a number of tests I do not find that the available figures sustain this assumption, nor does it appear that the smokebox temperatures are any higher than when using saturated steam. The following test shows that under the same conditions they were actually less:

SUPERHEATED STEAM ENGINE 1126

| | Run | | | | Summary | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Max | Min | Mean |
| Number of cars | 8 | 6 | 9 | 9 | | | |
| Smokebox Tem.-Ave | 584° | 595° | 576° | 588° | 595° | 576° | 586° |
| Superheat average while working | 80° | 114° | 99° | 101° | 114° | 80° | 98.6° |

SATURATED STEAM ENGINE 1123.

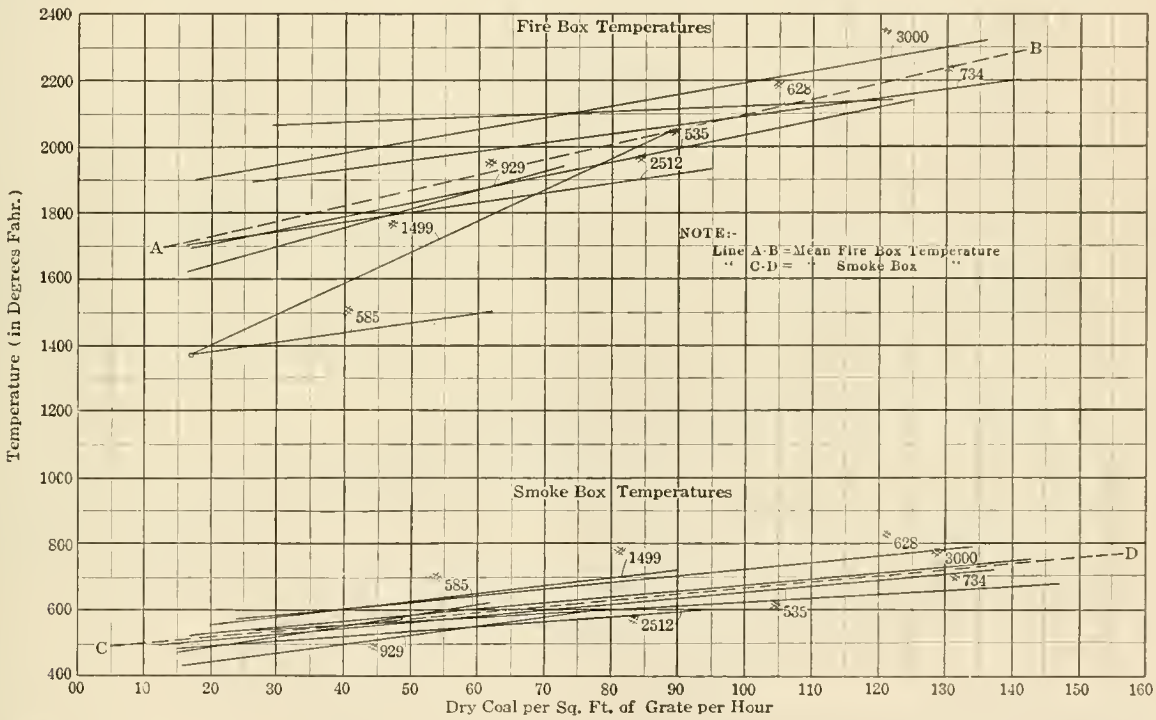
| | Run | | | | Summary | | |
|---|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | Max | Min. | Mean |
| Number of cars | 9 | 8 | 7 | 9 | | | |
| Smokebox tem. average | 594° | 589° | 600° | 597° | 600° | 589° | 595° |

The summary of all the tests actually shows that there were 9 degrees lower temperature with the superheater locomotive than with the saturated steam locomotive, while an average superheat of 98.6 is obtained at the steam chest.

In the St. Louis tests, with engines carrying 200 lbs. pressure and approximately the same rate of coal burned per square foot of grate per hour, the following smokebox temperatures were noted:

Engine No. 3000 .......... 600 degrees
" " 535 .......... 570 "
" " 734 .......... 573 "

These compare favorably with the figures given for the smokebox superheater. Fig. 1 shows the firebox and smokebox tempera-




| Engine Number | 1499 | 734 | 585 | 929 | 2512 | 535 | 628 | 3000 |
|---|---|---|---|---|---|---|---|---|
| Class | 2-8-0 | 2-8-0 | 2-8-0 | 2-10-2 | 4-4-2 | 4-4-2 | 4-4-2 | 4-4-2 |
| Cylinder: Size | 22"x28" | 21"x30" | 23"&35"x32" | 19" & 32"x32" | 14$\frac{7}{16}$" & 23$\frac{11}{16}$"x25$\frac{1}{4}$" | 15" & 25"x26" | 14$\frac{5}{32}$"& 22"x23$\frac{5}{8}$" | 15$\frac{1}{2}$" & 26"x26" |
| Cylinder: Number of | 2 | 2 | 2 | 4 | 4 | 4 | 4 | 4 |
| Cylinder: Style | Simple | Simple | Cross Comp. | Tandem Comp. | Balanced Comp. | Balanced Comp. | Balanced Comp. | Balanced Comp. |
| Length of Tubes | 164.5" | 178.9" | 190.4" | 238.5" | 176.14" | 225.14" | 173.7" | 191.0" |

FIG. 1.—FIREBOX AND SMOKEBOX TEMPERATURES AS RELATED TO COAL BURNED PER SQUARE FOOT OF GRATE PER HOUR—ST. LOUIS TESTS.

tures with the amount of coal burned per square foot of grate per hour in pounds. From this chart the following averages are derived:

TEMPERATURES OF FIREBOX AND SMOKEBOX (Fahr.) AND POUNDS OF COAL PER SQUARE FOOT OF GRATE PER HOUR.

| Lbs. of coal per sq. ft. grate per hour......... | 40 | 55 | 120 | 140 |
|---|---|---|---|---|
| Smokebox | 550° | 580° | 700° | 735° |
| Firebox... | 1820° | 1890° | 2190° | 2280° |

Other tests show that the smokebox temperatures of superheater locomotives are not necessarily higher than those using saturated steam, and consideration of the flue arrangements and areas does not show any reason why increased smokebox temperatures should be the result, or why high degrees of superheat may not be obtained without increasing the smokebox temperature.

When it is remembered that the superheater tubes extend backward to within from 35 to 40 inches of the firebox, in which location the gas temperatures must be at least fifteen or sixteen hundred degrees, it will readily be seen that high superheater temperatures can be obtained without raising the smokebox temperature abnormally. The superheater arrangement occupies relatively only from a quarter to a third of the flue area, so that the remainder remains unchanged. Even if the gas in the large tubes is discharged into the smokebox at a somewhat higher temperature, it would be a small proportion of the whole and would only result in raising the smokebox temperature proportionately. For instance, if the enlarged tubes comprise 25 per cent of the total flue area and the gas in them was discharged at 40 degrees higher temperature, it would only result in increasing the total temperature of all the gas passing through the smokebox 10 degrees. As a matter of fact, the smokebox temperatures follow very closely the amount of coal burned per square foot of grate per hour. It consequently bears a direct relation to the firebox temperatures, so that if the data for any test, as for instance those made at St. Louis, is plotted out, it will be found that the smokebox temperatures increase or decrease as the rate of combustion. This is shown in Fig. 1.

Referring to the smokebox superheater test made on the Rock Island System, mentioned by Mr. Fry, the data shows that about 55 pounds of coal per square foot of grate per hour were consumed with the following smokebox temperatures:

| | | |
|---|---|---|
| Front of flue sheet.................. | 652 | 618 |
| " " superheater .............. | 541 | 527 |
| Difference ...................... | 111 | 91 |

The steam pressure was 160 lbs., consequently the required boiler temperatures were lower.

*Coal Consumption with Fire Tube Superheaters.*—As a matter of fact, it has been shown conclusively by accurate tests that locomotives equipped with fire tube superheaters actually consume from 15 to 25 per cent. less fuel, which means for a given size of firebox that where 100 lbs. of coal per square foot of grate per hour are consumed in a locomotive using saturated steam, that the same locomotive equipped with an efficient fire tube superheater would burn only from 75 to 85 lbs. of coal per square foot of grate per hour.

*Desirable Degree of Superheat.*—R. Garbe, in his book entitled "The Application of Highly Superheated Steam to Locomotives," gives as his opinion that at least 100 degrees of superheat are required to give perceptible saving under all conditions of working, and also that "the smokebox superheaters of the usual type in which the smokebox temperatures are not raised above the normal, are scarcely more than steam dryers and do not in any sense realize the peculiar gas-like properties of highly superheated steam."

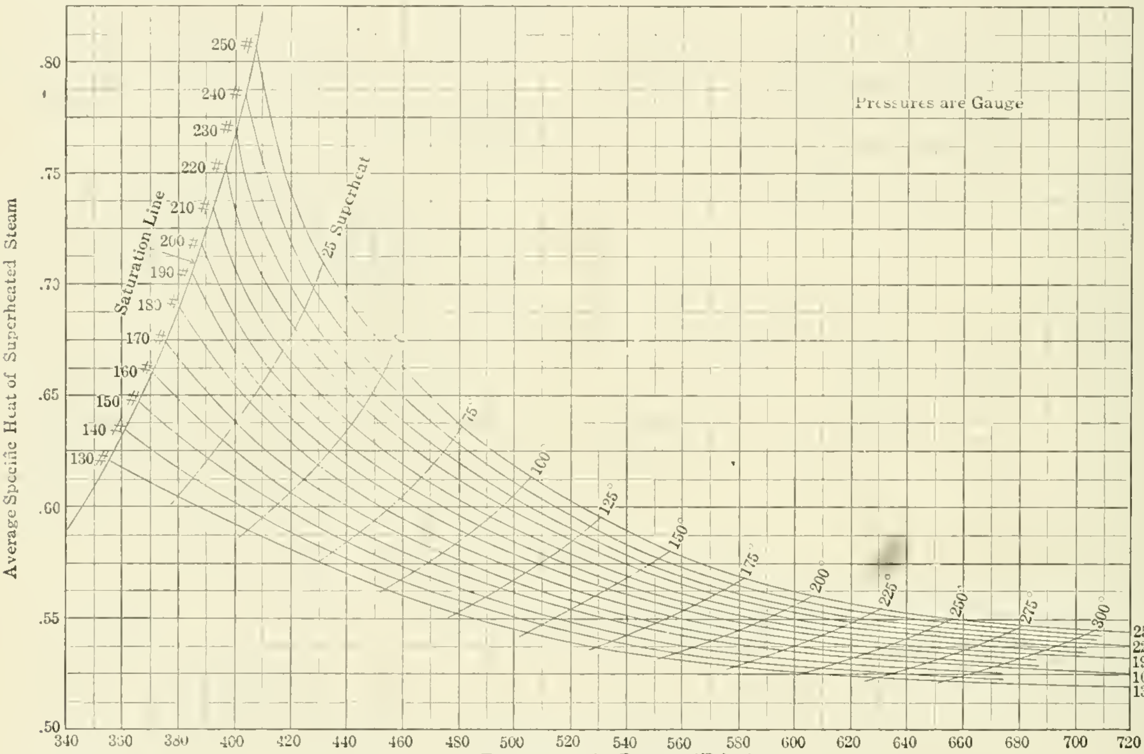



FIG. 2.—AVERAGE SPECIFIC HEAT OF SUPERHEATED STEAM AT DIFFERENT PRESSURES. DATA IS REPRODUCED FROM PUBLISHED EXPERIMENTS OF KNOBLAUCH AND JAKOB.

*Cost.*—It is probable that the same cost is involved in building new locomotives with either smokebox or fire tube superheaters. This being the case, it would appear most economical to use the apparatus capable of producing the greatest efficiency.

*Life of Superheater Tubes.*—The cutting action of the flue gases and cinders is probably at its maximum when the tubes are at right angles to the flue gases, and at its minimum when parallel with the flues. This being the case, it would seem that the *longest* life of the superheater tubes would be obtained in the fire tube type and the *shortest* with the smokebox type.

## The Value of a High Degree of Superheat.

*More Work Performed Per Pound of Steam.*—The amount of work that can be performed by one pound of steam, whether used expansively or not, is very closely proportional to its PV, or the absolute pressure multiplied by the volume of one pound of steam at that pressure. Since the amount of heat required to produce one pound of steam varies with its pressure and temperature, the PV divided by the heat of production is a measure of the economy with which work is obtained. (H. H. Vaughan. "The Use of Superheated Steam on Locomotives." Proc. Am. Ry. Master Mechanics' Assn., 1905, page 92.) On the above assumption for a constant pressure of 160 lbs., the following table gives the saving in the amount of work that can be performed with different degrees of superheat over saturated steam.

| | Volume Cub. Ft. | Total Heat | $\frac{PV}{H}$ | Per Cent. of Saving |
|---|---|---|---|---|
| 160 lbs. saturated | 2.608 | 1193 | .348 | 0.00 |
| 160 lbs. superheated, 40° | 2.76 | 1222 | .361 | 3.74 |
| 160 lbs. superheated, 125° | 3.07 | 1265 | .388 | 11.50 |
| 160 lbs. superheated, 230° | 3.46 | 1318 | .419 | 20.40 |

This considers only the saving due to the increased temperature and volume, to which must be added the saving from elimination of cylinder condensation, either wholly or in part.

but of constant volume for the different curves, is given in Fig. 2. The data is reproduced from the experiments of Knoblauch and Jakoh. The following table gives the same information tabulated for the range of ordinary locomotive practice:

| Gauge pressure | Saturated Tem. | Saturated Spec Heat | Superheat Degrees F. 25° | 40° | 50° | 75° | 100° | 125° | 150° | 175° | 200° | 225° | 230° | 250° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 160 | 370 | .660 | .629 | .615 | .606 | .589 | .575 | .563 | .553 | .546 | .540 | .536 | .535 | .533 |
| 180 | 379 | .689 | .646 | .629 | .618 | .598 | .583 | .569 | .557 | .549 | .545 | .540 | .539 | .537 |
| 200 | 388 | .717 | .659 | .641 | .631 | [illegible] | .591 | .578 | .566 | .556 | .549 | .544 | [illegible] | .541 |

*Greater Hauling Power.*—In addition to the advantages resulting from the decreased pressure without the loss of efficiency, the increased diameter of the cylinders over and above that required for producing the same tractive power with the higher pressure, is a distinct advantage in the use of moderate and high degrees of superheat, say of 100°-125° to 175°-250° at the steam chest, as compared to low superheat of say 40° F. A large increase in the hauling power of locomotives can be utilized as

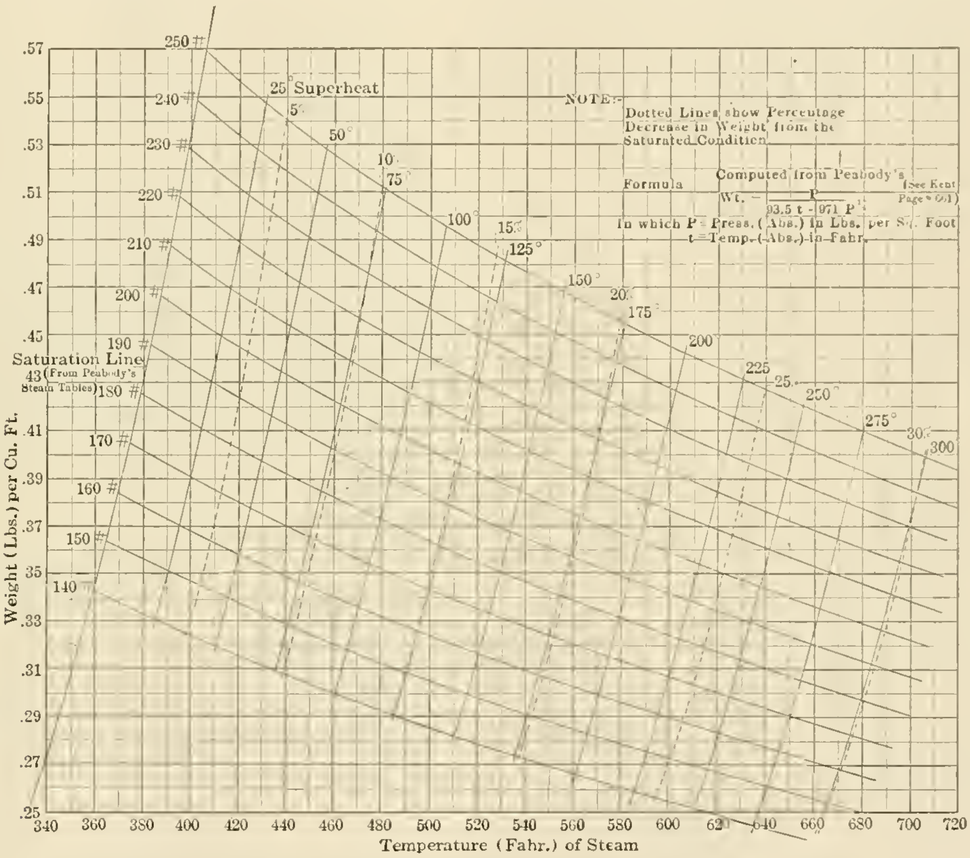



FIG. 3.—WEIGHTS OF SUPERHEATED STEAM PER CUBIC FOOT FOR DIFFERENT PRESSURES AND TEMPERATURES.

*Cylinder Condensation.*—The amount of cylinder condensation is estimated by tests made at the Purdue University by Prof. Goss on a simple locomotive as:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 35 | per | cent. | at | 20½ | per | cent. | cut | off |
| 25 | " | " | " | 25 | " | " | " | " |
| 20.5 | " | " | " | 30 | " | " | " | " |
| 16.5 | " | " | " | 35 | " | " | " | " |
| 16 | " | " | " | 40 | " | " | " | " |
| 14 | " | " | " | 50 | " | " | " | " |
| 13 | " | " | " | 60 | " | " | " | " |
| 12 | " | " | " | 70 | " | " | " | " |

Assuming that each 1 per cent. of moisture will require about 7.5 degrees of superheat to entirely prevent condensation, therefore for 25 per cent. of moisture a superheat of 187½ degrees would be required.

*Specific Heat.*—From the above the decrease in specific heat makes a very favorable condition for the use of highly superheated steam. In other words, the B. T. U's required to raise one pound of steam one degree decrease as the temperature of the superheated steam increases. The average specific heat of superheated steam of different pressures at various temperatures, shorter cut-offs can only be economically maintained with temperatures not less than just noted.

*The Most Efficient Degree of Superheat for Locomotive Service.*—It seems, therefore, well established that the smokebox temperatures do not increase with the increase of superheat. That being the case, it necessarily follows that the increased economy and efficiency in the engine increases according to the amount of superheat, and is only limited by the temperature which can be successfully used and operated under ordinary conditions of service. This appears to be reached in the neighborhood of about 600-650 degrees F., which means with a pressure of 160 lbs., superheat of 230 to 280° F. The weights of superheated steam per cubic foot for different pressures and temperatures are given in Fig. 3.

*Cost of Maintenance.*—The maintenance of fire tube superheaters applied in the last three or four years has been very low, one locomotive having run for 14 months without any repairs at all to the superheating apparatus. The wear on the bushings and valve of a steam motor car with superheat of 200 to 250° and 250 lbs. boiler pressure, was not perceptible after several months' service.

**High vs. Low Degree of Superheat on Basis of Heat Units and Volume.**

B. T. U's necessary to raise one pound of steam from water at 60° to 160 lbs. (370° F.) boiler pressure and to superheat it 230°, or to 600° total.

| | | | B.T.U. | |
|---|---|---|---|---|
| .98 pound dry saturated steam | | × 1167 = | 1143 | |
| .02 pound moisture | | × 310 = | 6 | |
| | | | | 1149 |
| .02 pound at 370 | .02 | × 857 = | 17 | |
| 1.00 pound dry steam superheated 230° | .535 | × 230 = | 123 | |
| | | | | 140 |
| | | | | 1289 |

10.85 per cent. of the total heat is absorbed by the superheater.
Saturated steam at 160 lbs. weighs .3840, therefore

$$1 \text{ lb.} = \frac{1.000}{.3840} = 2.60 \text{ cubic feet.}$$

Superheated steam, 160 lbs. at 600°, weighs .2890, therefore

$$1 \text{ lb.} = \frac{1.000}{.2890} = 3.46 \text{ cubic feet.}$$

$$\text{Then } \frac{3.46 - 2.60}{2.60} = 33.1 \text{ per cent. less steam for the same work.}$$

But 10.85 per cent. more heat is required to superheat the steam.
The saving then is: 33.1 — 10.85 = 22.25.
To this figure must be added the saving due to the evaporation of 2 per cent. of moisture and the elimination of *all* cylinder condensation.

B. T. U's necessary to raise one pound of steam from water at 60° to 160 lbs. (370° F.) boiler pressure and to superheat it 40°, or to 410° total, moisture assumed 2 per cent.

| | | | | |
|---|---|---|---|---|
| .98 pounds dry saturated steam | | × 1167 = | 1143 | |
| .02 pounds moisture | | × 310 = | 6 | |
| | | | | 1149 |
| .02 pounds at 370 | .02 | × 857 = | 17 | |
| 1.00 pounds dry steam | .615 | × 40 = | 25 | |
| | | | | 42 |
| | | | | 1191 |

3.52 per cent. of the total absorbed heat is taken by the superheater.
Superheated steam, 160 lbs. at 410, weighs .3630 lbs.

$$1 \text{ pound} = \frac{1.000}{.3630} = 2.76 \text{ cubic feet.}$$

$$\text{Then } \frac{2.76 - 2.60}{2.60} = 6.14 \text{ per cent. less steam for the same work.}$$

But 3.52 per cent. more heat is required to superheat. The saving is 6.14 — 3.52 = 2.62. To this figure must be added the saving due to the evaporation of 2 per cent. moisture and the decrease in loss from cylinder condensation.

The number of heat units required to convert one pound of water at 60° F. into steam at 160 and 200 lbs. boiler pressure respectively and then to superheat it to 600° F., is shown graphically in Fig. 4. The full line shows the total heat in B. T. U's

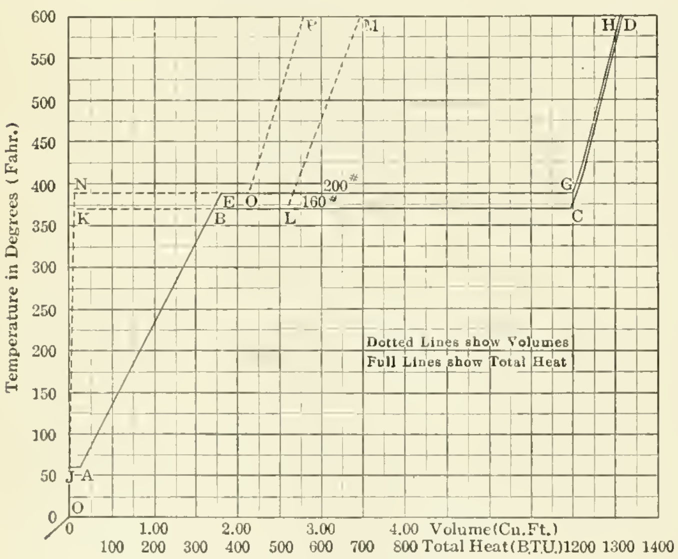



FIG. 4.—TOTAL HEAT AND VOLUME OF ONE POUND OF $H_2O$ AT PRESSURE OF 160 AND 200 POUNDS GAUGE FROM TEMPERATURES OF 60 TO 600 DEGREES.

starting at A at 60° for the feed water, and the diagonal line continuing to B, where the temperature reached is 370° F., corresponding to a gauge pressure of 160 lbs. From thence no increase of temperature takes place, the water is gradually vaporized, the process terminating at C, requiring 1195 B. T. U's. If it is then separated from the liquid from which it is generated and subjected to further heat, 230° of superheat will be found at D corresponding to an addition of 123 B. T. U's, making a total of 1318, so that for an expenditure of about 10 per cent. additional heat the temperature has been increased from 370° to 600°, about 62 per cent. The line A, E, G, H, gives the same data for one pound of steam at 200 pounds boiler pressure.

The volume of one pound of water converted into steam at 160 and 200 pounds boiler pressure is also shown on Fig. 4. For 160 pounds the dotted line J to K shows the increase of volume of the liquid until the maximum temperature of 370° is reached at K. The water is gradually converted into steam and the volume increased on the horizontal line K to L, corresponding to a volume of 2.608. If the steam is then separated from the water and subjected to 230° of heat, the volume is correspondingly increased, as shown in the diagonal line L to M. At the latter point the temperature of 600° is obtained and the volume is increased to 3.46, an increase in volume of about 33 per cent., with an increase of 10 per cent. additonal heat. Corresponding volumes for 200 lbs. pressure are given on the dotted line, J. N, O, P.

**Summary**

From the foregoing the following may be deduced:

(a) The smokebox temperatures are not increased when high degrees of superheat are obtained; on the contrary the tendency is towards a decrease on account of the decreased amount of coal burned.

(b) Smokebox temperatures vary according to the firebox temperatures, length of tubes, and to the amount of coal consumed, irrespective of the superheating apparatus.

(c) Economy in fuel and water and increase of efficiency are obtained with increasing degrees of superheat.

(d) The enlarged cylinders necessary to produce the best results can only be used without condensation and at short cut-offs with superheat of 100-125 degrees and above.

(e) Smokebox superheaters operating under normal smokebox temperatures produce only about 35-40 degrees of superheat.

(f) Unless means are resorted to for increasing the smokebox temperatures, such as Schmidt's earlier designs of one large flue, smokebox superheaters cannot give much more than a drying effect to the steam.

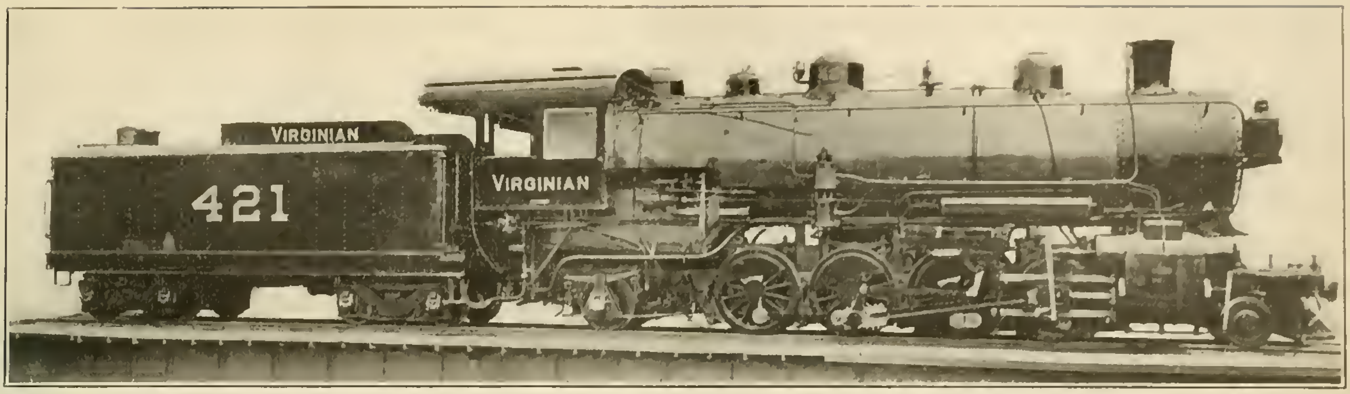
(g) No difficulty is experienced in the lubrication of valves and cylinders using fire tube forms of superheaters.

(h) Assuming equal cost, the fire tube superheater is the most efficient apparatus.

(i) The smokebox superheater weighs, if anything, more than the fire tube, and this weight is concentrated in the front at the center of the smokebox. On the other hand the weight of the fire tube type is added more nearly on the center of gravity of the locomotive.

---

Efficiency of an Organization.—No wisdom expressed in the advanced manufacturing systems of the day is greater than the wisdom of recognizing that the efficiency of the whole organization is the efficiency of the individual workman, and that the efficiency of the workman is secured and stimulated by providing an adequate reward proportioned to his production. In devising and applying methods which make it manifestly to the men's interest to produce with high efficiency, the Santa Fe is abreast with the foremost industrial ideals of the time, and far in advance of most business concerns. And this is peculiarly noteworthy because the course is not taken under spur of the direct competition that drives manufacturers willingly or unwillingly to progress. It is inspired and guided by a vivid realization and an energizing acceptance of the great economic commandment, "Thou shalt not waste." The results are significant in the figures of net earnings, but they have a far wider meaning yet in national and universal economy. They point to possibilities in the conservation of finances which would lead directly to enormous expansion of financial support for railway enterprises.—*Charles Buxton Going in the Engineering Magazine.*



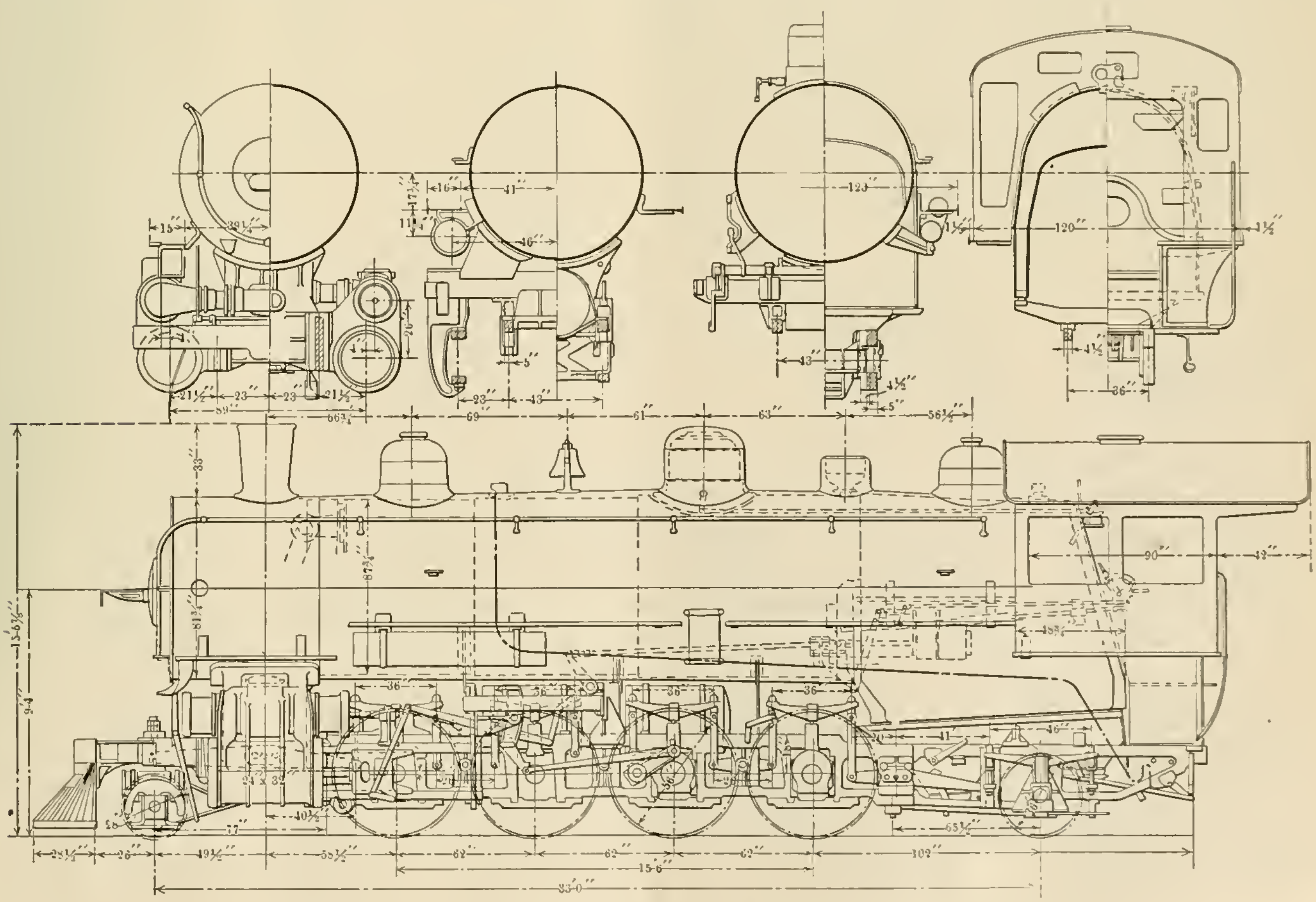

POWERFUL FREIGHT LOCOMOTIVE OF THE 2-8-2 TYPE—VIRGINIAN RAILWAY.

## MIKADO TYPE FREIGHT LOCOMOTIVE.

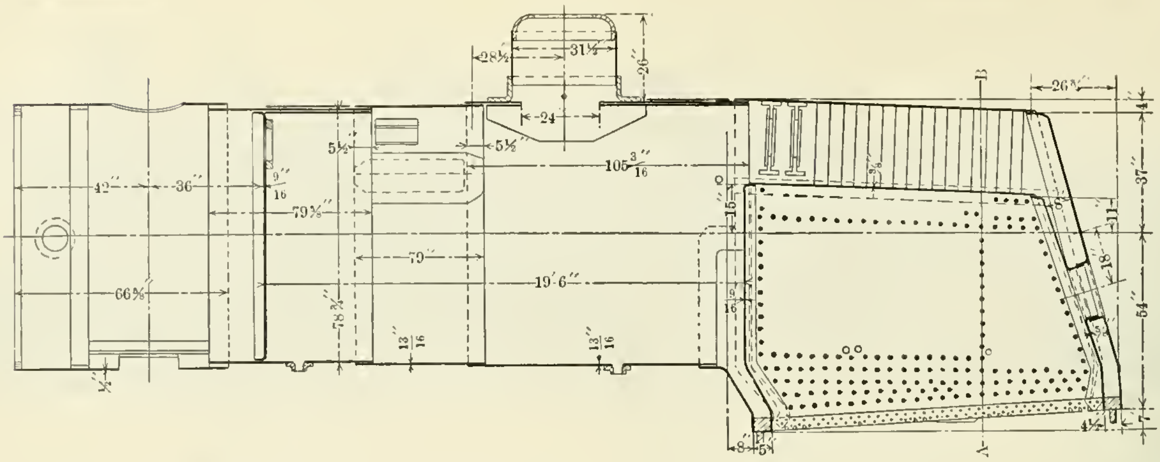
### Virginian Railway.

On that section of the Virginian Railway connecting Princeton, W. Va., with Sewell's Point, near Norfolk, Va., a distance of 347 miles, there are, opposed by east bound traffic, 10 miles of .6 per cent. grade and 33 miles of .2 per cent. grade. Otherwise the line is practically level, or descending. Opposed to west bound traffic, which will be largely empty, there is altogether 18 miles of 1½ per cent. grade. The traffic on this line will be largely coal from the West Virginia fields to tidewater. For handling these trains over the three divisions between Princeton and Sewell's Point the Baldwin Locomotive Works has recently completed twelve locomotives of the Mikado type shown in the accompanying illustrations. Although the tonnage rating has not yet been determined, these locomotives are designed to give a tractive effort of 50,350 lbs. and to traverse 20 deg. curves. The general drawings and specifications of the locomotives were prepared by the railway under the direction of R. P. C. Sanderson, superintendent of motive power.

Ample boiler power has evidently been the key-note of the designer, although the matter of large, unrestricted steam passages and substantial bracing and ample strength in the frames has been given close attention. A heating surface of 4,466 sq. ft. on a locomotive weighing 207,450 lbs. on drivers, gives a ratio of one sq. ft. to 45.5 lbs. on drivers, a very large ratio for a locomotive of this size and one that is exceeded by but one locomotive on our records. The same feature is noticed in the B. D. factor of 631, which is remarkably low for a freight engine and is practically within the limits usually assigned to high speed passenger locomotives. There is one square foot of heating surface to 11¼ lbs. of tractive effort, which gives these locomotives the largest amount of heating surface per lb. of tractive effort of any freight engine on our records. The grate area, however, is not larger than is customary for this size engine and is small for the amount of heating surface. This feature depends so much on the quality of fuel to be used that ratios



ELEVATIONS AND SECTIONS OF 2-8-2 TYPE LOCOMOTIVE—VIRGINIAN RAILWAY.

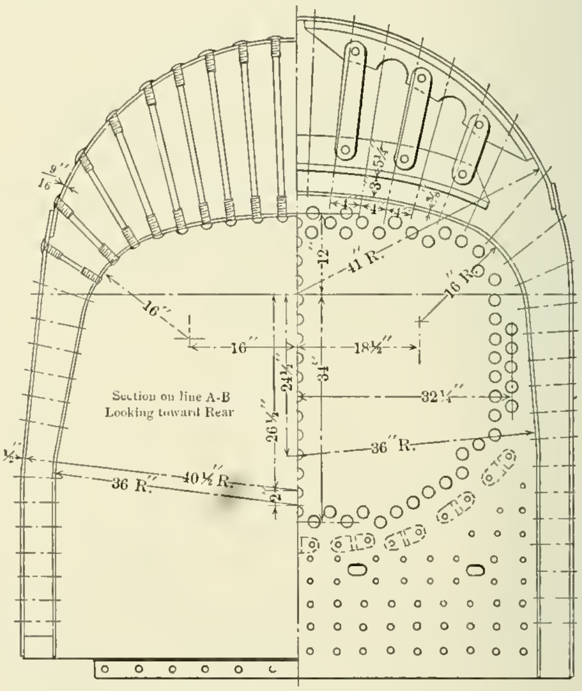


SECTIONAL ELEVATION OF BOILER—2-8-2 TYPE LOCOMOTIVE—VIRGINIAN RAILWAY.

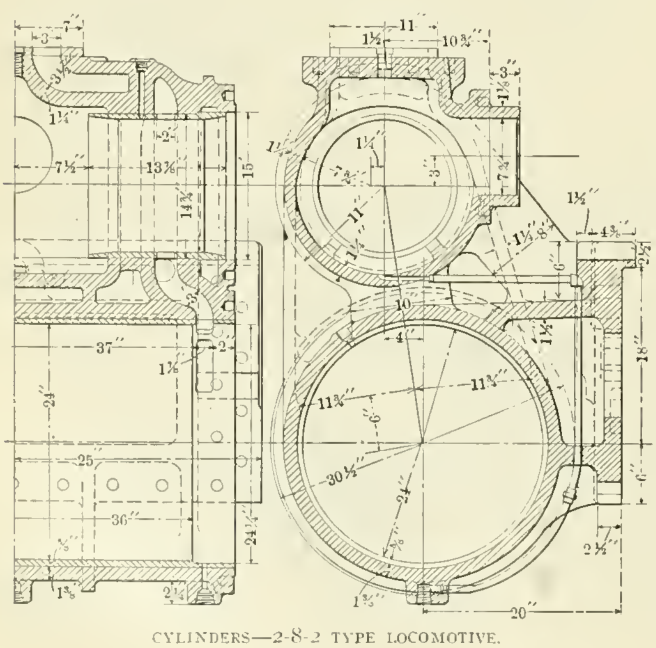
concerned with it are not reliable for direct comparison. Fifty-one sq. ft. of grate area with a free burning non-clinkering coal is better and worth more than 70 sq. ft. with some of the so-called coal that is used on locomotives at times.

*The boiler* is of the straight top type with sloping back head and throat sheet. It is radially stayed, with the exception of the two front rows of crown bolts, which are supported by T-irons hung on expansion links. The shape of the firebox side sheets and water leg is shown in the cross section. The mud ring is 4½ in. wide on the sides and back and 5 in. in front; the side water leg maintains this distance with vertical sheets for about 18 in. and then both sheets slope inward, the inner one being given a greater angle, so as to materially increase the width of the water leg at the turn of the crown sheet. The barrel is made up of three rings with the dome on the third ring from the front, its center being about 74 in. ahead of the back tube sheet. The check valve is placed on the top center line of the boiler just back of the junction of the first and second barrel sheets and the water is discharged from the valve direct without any internal pipes. A baffle plate prevents the cold water striking the dry pipe. The boiler is connected to the frames by three waste bearers and a buckle plate at the front and rear mud ring. A sliding bearing is also provided by a crossbrace at the center of the firebox. The smokebox is of the self-clearing type without a spark hopper. A brick arch supported on four 3 in. steel tubes is used.

*The cylinders* are cast separate from the saddle and there are no steam passages, except those leading to the relief valve and the ports from the valve chamber to the cylinder, in the cylinder casting. The saddle casting, which is shown in detail in one of the illustrations, has cored in it short direct steam passages 6 in. in diameter, which convey the steam from the steam pipes to the side faces of the saddle above the frames, where a connection is made by a short pipe, also illustrated, directly into the center of the valve chamber, the valves being of the center admission type. The exhaust steam is discharged out of the ends of the valve chamber into large exhaust pipes which pass over the frames and connect to a passage cored from the front and back faces of the saddle casting to the connection with the exhaust pipe in the front end. The outside exhaust pipes have a sliding joint and a ground ball joint, permitting them to have freedom of movement under temperature stresses and also to be easily applied and kept tight. The valve chamber heads, arranged with a deflecting wing, as shown in the illustration, form part of these exhaust pipes. The relief, or by-pass valves on the cylinders, consist of flat plates over relief ports in the top of the valve chamber, which will be lifted by any unbalanced pressure.

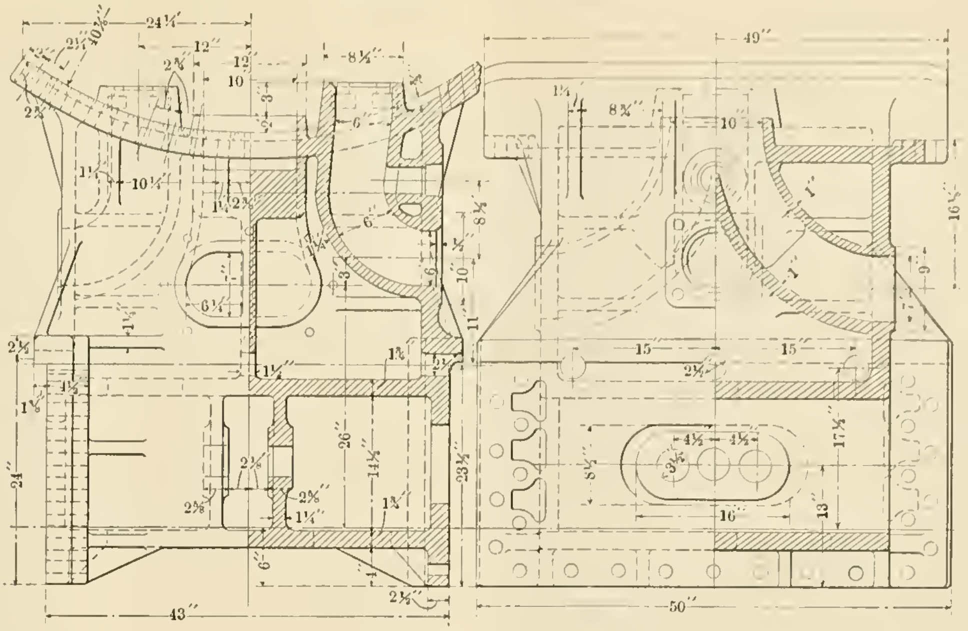



SECTIONS THROUGH FIREBOX—2-8-2 TYPE LOCOMOTIVE.

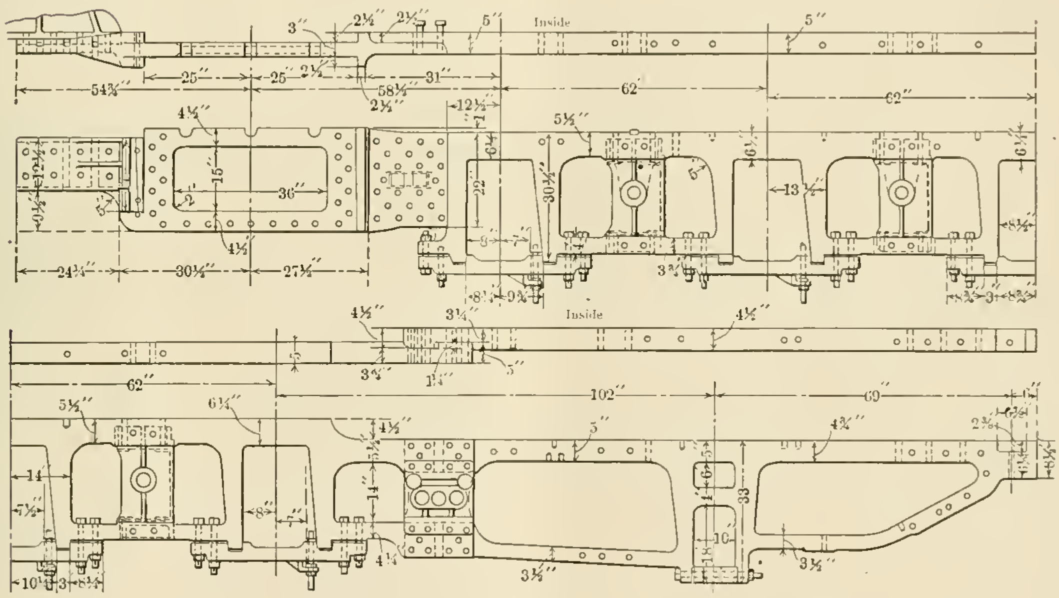


CYLINDERS—2-8-2 TYPE LOCOMOTIVE.

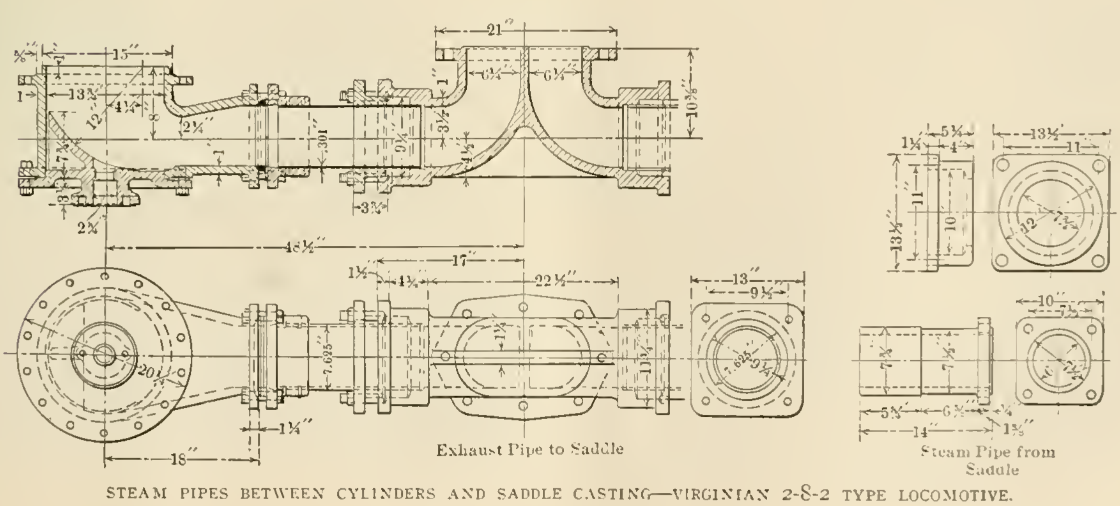
The front frames are of the slab section, 3 in. thick, and are provided with shoulders both inside and outside, front and rear. Both the cylinder and saddle castings bear against these shoulders at the back, have a lip over the top frame and are secured by horizontal bolts through the flanges and by vertical keys in



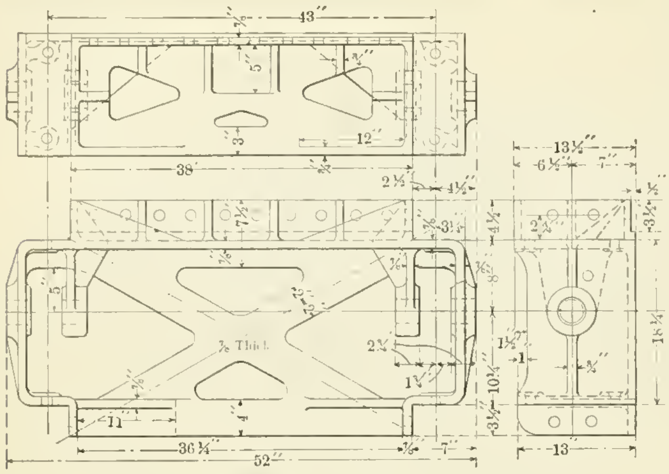
SADDLE CASTING—2-8-2 TYPE LOCOMOTIVE—VIRGINIAN RAILWAY.



HEAVY CAST STEEL FRAMES—VIRGINIAN 2-8-2 TYPE LOCOMOTIVE.




STEAM PIPES BETWEEN CYLINDERS AND SADDLE CASTING—VIRGINIAN 2-8-2 TYPE LOCOMOTIVE.



FRAME BRACE—VIRGINIAN 2-8-2 TYPE LOCOMOTIVE.

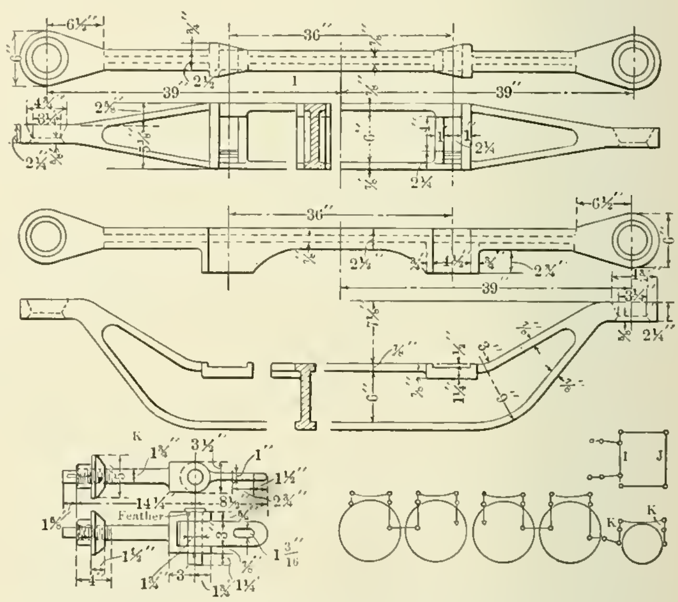
front which are driven home in pairs with their taper faces in contact and then bolted in place. A further fastening is made by three 2½ in. bolts which pass continuously from one cylinder to the other, having nuts on both ends. These bolts do not bear in the frames, which are cut away to give the proper clearance, nor do they have a fit in the saddle casting. The saddle casting also acts as a fulcrum for the truck equalizer bar, which is inserted through a cored passage in the center, the pin bearings being arranged as shown in the illustration.

*The frames* are in three sections; the front section of the slab type including the shoulder for the cylinders is secured to the main frames by a long splice, having 24 1¼-in. horizontal bolts and a horizontal wedge key in the center, which is riveted over on the inside. The main frames are 5 in. in width and 6¼ in. deep over the top of the pedestals. The trailer frames, 4½ in. in width, are spliced to the upper and lower rails of the main frames and have vertical keys in each. There are ten horizontal bolts in each splice. The frames, as well as the pedestal caps and all frame braces, are of cast steel. Between the pedestals the frames are braced in a most substantial manner by specially designed castings secured to both the top and bottom rail on both sides and carrying the brake hanger or equalizing beam fulcrum pins. The details of one of these castings are shown in the illustration above. The waste bearer plates are also secured to these castings. In addition to these, there are substantial cast steel frame braces over the front pedestal and at the guide yoke, in addition to the foot plate and the bumper beam casting.

The first and second pairs of driving wheels are equalized with the leading truck and the third and fourth pairs are equalized with the trailing truck, which is of the radial swing type with outside journals of a design incorporating a number of novel features. The cast steel boxes of the trailing truck are secured to the truck frame which is pivoted in a frame cross tie located at the splice of the main and trailer frames. Semi-elliptic springs rest on top of the boxes and the side motion of the truck is taken by the spring hangers, which are hinged and also have a ball joint where they rest in the equalizing beams. The front spring hangers connect to the cross equalizer, carried by the equalizers from the rear driving wheels and the back spring hangers connect to an extension casting secured across their frames. What appears to be a pedestal in the trailing frame is simply an opening for the passage of the trailer axle. This truck is arranged with a pedestal binder which can be removed and allow the wheels and axles to be dropped without difficulty. The illustrations show the detailed construction of the truck and spring hangers, equalizers, etc.

All driving tires are flanged and held by shrinkage only, no lips being used. Flange lubricators, consisting of short pieces of iron pipe cut to fit the flanges and filled with oily waste are applied to the first and fourth pair of drivers. These lubricators are held in place by suitable clips and are constantly in contact with the wheels.

The arrangement of the valve gear requires no special comment. The link bearings are bolted to the guide yoke and the reverse shaft bearings are carried on a cross tie which spans the frames. The brackets supporting the valve rod are bolted to the top guide yoke and the combination lever connects directly to the valve rod. The bearing of the valve rod in its bracket is circular and of large diameter. The longitudinal braces between the frame cross tie and the guide yoke, outside of the valve gear, are for stiffness only and do not carry any of the bearings.

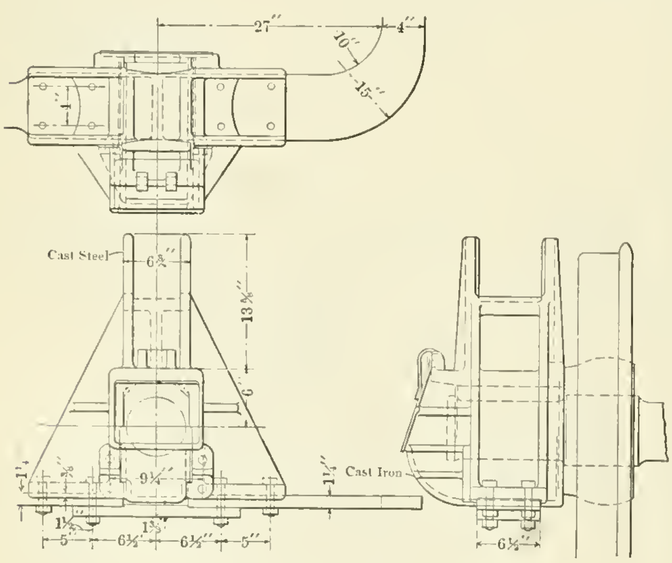



CROSS EQUALIZER, SPRING HANGERS AND CONNECTIONS AT TRAILER TRUCK—VIRGINIAN 2-8-2 TYPE LOCOMOTIVE.

The throttle valve is operated from a shaft which projects through a stuffing box in the side of the dome. The throttle lever in the cab occupies a vertical position, being mounted in a bracket bolted to the back head of the boiler and is connected by an outside rod to an arm at the side of the dome. Reversing is effected by the Raggonet power gear, which is so arranged in this case that it can be operated by hand if necessary, a type of screw reversing gear being employed for this purpose.

A 9,500 gallon tank is applied to the tender and space is provided for 16 tons of coal. The frame is built up of 15 in. channels, for center sills and 10 in. channel side sills. The tender trucks are of the equalized pedestal type, with cast steel bolsters and semi-elliptic springs.

The general dimensions, weights and ratios of these locomotives are as follows:




TRAILER TRUCK WITH OUTSIDE BOXES—VIRGINIAN 2-8-2 TYPE LOCOMOTIVE.

GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Service | Freight |
| Fuel | Bit Coal |
| Tractive effort | 50,350 lbs. |
| Weight in working order | 254,000 lbs. |
| Weight on drivers | 207,450 lbs. |
| Weight on leading truck | 20,850 lbs. |
| Weight on trailing truck | 25,700 lbs. |
| Weight of engine and tender in working order | 427,000 lbs. |
| Wheel base, driving | 15 ft. 6 in. |
| Wheel base, total | 33 ft. |
| Wheel base, engine and tender | 65 ft. 10¼ in |

RATIOS

| | |
|---|---|
| Weight on drivers ÷ tractive effort | 4.10 |
| Total weight ÷ tractive effort | 5.05 |
| Tractive effort x diam. drivers ÷ heating surface | 631.00 |
| Total heating surface ÷ grate area | 87.50 |
| Firebox heating surface ÷ total heating surface, per cent | 4.23 |
| Weight on drivers ÷ total heating surface | 46.50 |
| Total weight ÷ total heating surface | 56.90 |
| Volume both cylinders, cu. ft. | 16.75 |
| Total heating surface ÷ vol. cylinders | 266.00 |
| Grate area ÷ vol. cylinders | 3.05 |

CYLINDERS.

| | |
|---|---|
| Kind | Simple |
| Diameter and stroke | 24 x 32 in. |

VALVES.

| | |
|---|---|
| Kind | Piston |
| Diameter | 13½ in. |
| Greatest travel | 6 in. |
| Outside lap | 1 in. |
| Inside lap | 1/16 in. |
| Lead | ¼ in. |

WHEELS.

| | |
|---|---|
| Driving, diameter over tires | 56 in. |
| Driving, thickness of tires | 3½ in. |
| Driving journals, main, diameter and length | 10½ x 12 in. |
| Driving journals, others, diameter and length | 9½ x 12 in. |
| Engine truck wheels, diameter | 28 in. |
| Engine truck, journals | 5½ x 10 in. |
| Trailing truck wheels, diameter | 36 in. |
| Trailing truck, journals | 6 x 11 in. |

BOILER.

| | |
|---|---|
| Style | Straight |
| Working pressure | 180 lbs. |
| Outside diameter of first ring | 78¾ in. |
| Firebox, length and width | 102 x 72 in. |
| Firebox plates, thickness | ⅜ & 9/16 in. |
| Firebox, water space | F—5 in. S. & B. 4½ in. |
| Tubes, number and outside diameter | 374—2¼ in. |
| Tubes, length | 19 ft 6 in. |
| Heating surface, tubes | 4,277 sq. ft. |
| Heating surface, firebox | 189 sq. ft. |
| Heating surface, total | 4,466 sq. ft. |
| Grate area | 51 sq. ft. |
| Smokestack, height above rail | 185⅞ in. |
| Centre of boiler above rail | 112 in. |

TENDER.

| | |
|---|---|
| Frame | 15 & 10 in. Chan. |
| Wheels, diameter | 33 in. |
| Journals, diameter and length | 5½ x 10 in. |
| Water capacity | 9,500 gals. |
| Coal capacity | 16 tons |

## THE ABUSE OF THE M. C. B. REPAIR CARD.

TO THE EDITOR:

A considerable amount of attention has recently been given by the railway clubs and technical journals to the use and abuse of the M. C. B. repair card. The free discussion has no doubt resulted in much good on many roads, but I believe we are now receiving the maximum benefit that we will receive from such discussion.

Reading between the lines in the remarks of various persons it is easy to infer that they are not all satisfied that they are getting the protection the repair card is intended to give. It is possible that the abuse of the repair card in the majority of cases is due to failure to apply or properly fill out rather than deliberate misuse of the card.

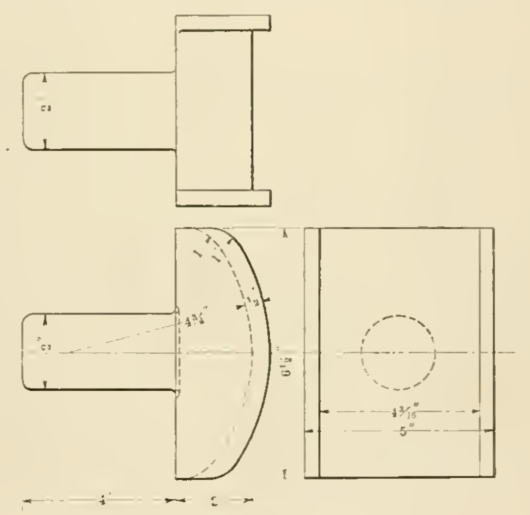
If there is reason to believe that the repair card is not now being properly used there is a cheap and certain remedy, *i. e.*, to have a corps of inspectors representing all roads, the expense to be prorated on the basis of the total number of cars owned by each road, these inspectors to have access to repair tracks, shops and records and report to the proper authority any misuse of the repair card which they find. I believe that great good would be accomplished by a surprisingly small number of inspectors. The mere fact of their being liable to visit any repair track at any time would keep all concerned on the alert at all times to know that the repair card was being properly used.

M. C. B.

DIES AND FORMERS FOR FORGING COUPLER YOKE FILLERS.

## FORGING COUPLER YOKE FILLERS.

The filling pieces used in connection with draw bar yokes having the rear end curved instead of being forged with square corners, are usually made of cast steel. Machine forging has, however, been developed to a point where it is cheaper to use

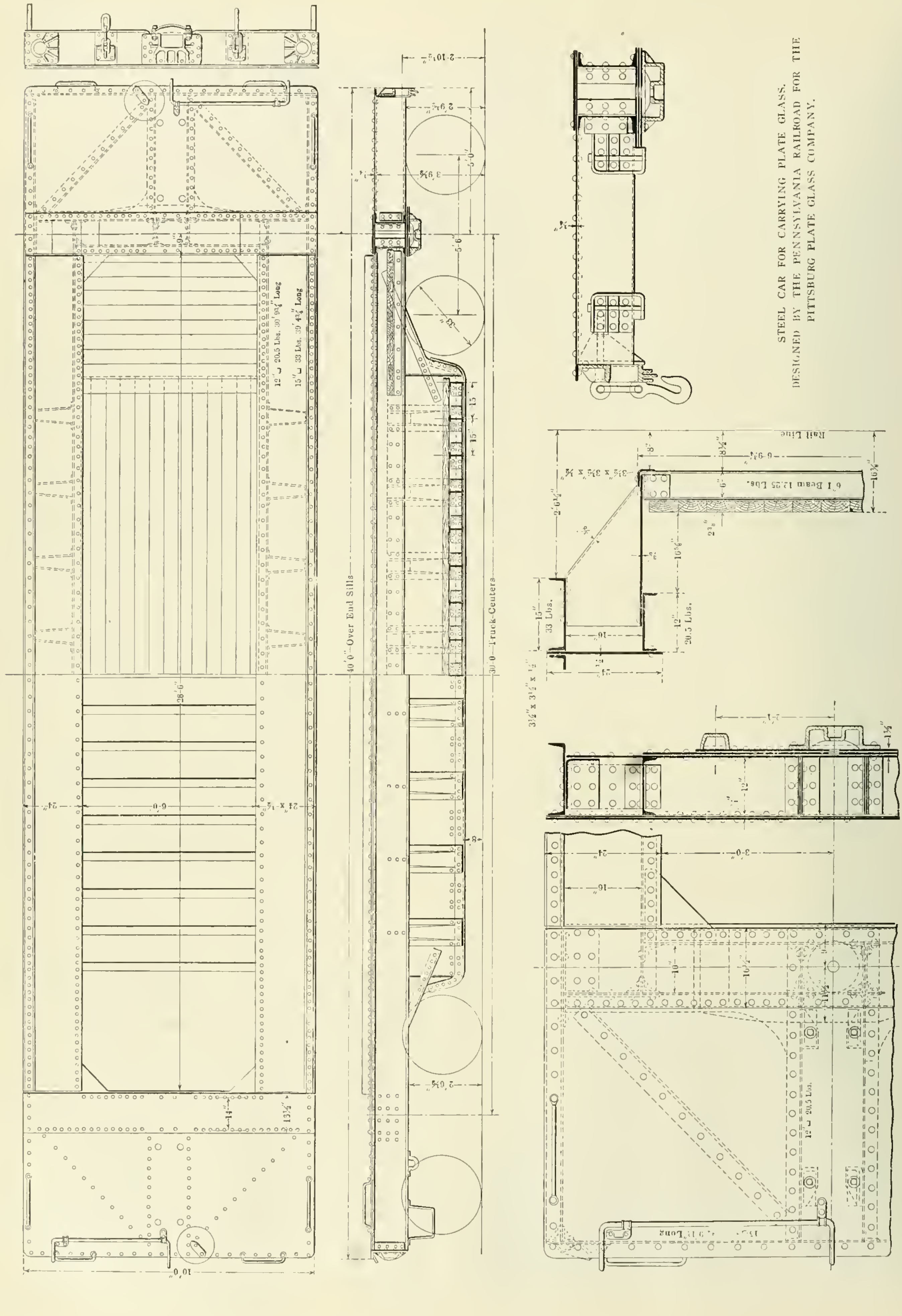


COUPLER YOKE FILLER.

scrap wrought iron or steel for this purpose. The forgings are more satisfactory because the parts may be formed truer, they are finished with a smoother surface and are stronger than the average cast steel usually furnished.

The coupler yoke filler, shown on the drawing, is used on several classes of Pennsylvania Railroad freight equipment and is being very successfully forged on a 6-inch universal forging machine,* with the dies and formers shown in the photo. Scrap material is assembled, as shown in the foreground of the photo and is heated. The flat pieces are usually made from old arch bars. The amount of the parts thus assembled is governed by weight. Only one movement of the machine is necessary to complete the forging. The fin is at the edges of the rectangular section and is easily removed by forcing the forging, while hot, through a die in the vertical press of the machine. These forgings are made in the smith shop of the Altoona car shops.

* See page 382 of the October, 1905, issue for description of this type of machine.




STEEL CAR FOR CARRYING PLATE GLASS.
DESIGNED BY THE PENNSYLVANIA RAILROAD FOR THE PITTSBURG PLATE GLASS COMPANY.

## STEEL CAR FOR CARRYING PLATE GLASS.

A steel car for carrying plate glass, designed by the Pennsylvania Railroad for the Pittsburg Plate Glass Company, is shown on the accompanying drawings. As the glass must be carried standing in an upright position it is necessary, in order to have sufficient room within the clearance limits, to provide a well-hole. This arrangement also makes it easier to securely brace the lading. Following are the general dimensions of the car:

| | |
|---|---|
| Length over end sills | 40 ft. |
| Width over sides | 10 ft. |
| Distance between truck centers | 30 ft. |
| Length of well-hole opening (about) | 19 ft. 2 in. |
| Width of well-hole opening | 6 ft. |
| Depth of well-hole | 2 ft. 5⅛ in. |
| Height from rail to top of floor | 3 ft. 10 in. |
| Height from rail to top of well-hole floor | 1 ft. 4⅞ in. |

The well-hole makes it impossible to use the ordinary center sill construction and the arrangement of the bolster and the end must be such as to transmit the buffing stresses to the sills at the side of the car. The outside sills consist of 15 in., 33 lb. channels and extend the full length of the car. The inner sills are 12 in., 20½ lb. channels. The end sill is a 15 in., 33 lb. channel and is reinforced at the center, at the coupler opening, by a steel casting. The coupler carrier iron is also of cast steel. The draft sills are arranged for the use of Westinghouse friction draft gear and consist of 12 in., 20½ lb. channels. The top of the car between the bolster and the end sill is covered with a ¼ in. plate, which also forms part of the bolster, being included between the channel members and the top cover plate. This floor plate is stiffened by angles extending from near the junction of the end and center sills to the end of the bolster.

The bolster is built up of structural steel members and plates. At the top is a ½ in. cover plate in addition to the ¼ in. floor plate. The underside of the bolster consists of three ½ in. plates of different lengths, as shown on the drawing. The front and back channels of the bolsters are 12 in. deep, weighing 20½ lb. per foot. The front channel is continuous and fastened to the inside and outside channels of the side sills with angles and pressed steel shapes. The rear channel is shorter, and is fastened only to the inside channel of the side sills, with angles. The short angles, plates and channels riveted between the bolster channels over the center plates, reinforce the draft sills and assist in distributing the buffing strains.

The two sills on each side are covered with a ½ in. plate, 24 in. wide, and are tied together by the ⅜ in. pressed steel diaphragms spaced 30 in. apart. The 3½ x 3½ x ½ in. angle riveted to the outer edge of this floor plate is used in connection with the bracing of the lading. The floor at the bottom of the well-hole is supported by the ⅜ in. plate extending downward from the inner sill and by the above mentioned diaphragms. The 6 in. I-beams, 12¼ lb., which carry the 2⅜ in. floor timbers, are supported by the angle plates and by the 3½ x 3½ x ½ in. angles which extend longitudinally and are fastened between the bottom of the vertical plates and the diaphragms. The part of the car between the end of the well-hole and the bolster is slightly depressed and is covered with planking, as shown. The car is equipped with the standard Pennsylvania 40-ton trucks.

## COMBUSTION AND EVAPORATION.

LAWFORD H. FRY.

Our knowledge of these two processes, which are so important in the economy of the locomotive, is by no means exhaustive, and every contribution to it is to be welcomed. In his recent book on the locomotive,* Mr. Nadal throws light on some of the least well recognized points. His conclusions are based largely on an analysis of the experiments made by the Pennsylvania Railroad on their locomotive testing plant at St. Louis. Briefly stated, his opinion, based on the heat balances calculated for a number of the tests, is that the efficiency of a locomotive is mainly determined by the efficiency of the combustion, and that the decrease in the efficiency of the boiler when the rate of evaporation is increased is principally due to the increase in the force of the draft which carries away very considerable quantities of unburned coal, in the form both of solid sparks and of unconsumed gas. In other words, he concludes that the most important factor in determining the power of a locomotive is the extent of the grate area and that the amount of the heating surface is of only secondary importance.

In his chapter on combustion Mr. Nadal examines the results obtained at St. Louis on three of the locomotives working under varying loads. The locomotives considered are the Hanover compound superheater, the French de Glehn compound, and the Cole compound. From the report of the tests on these engines heat balances are calculated by the method described below. In the first place the amount of carbon actually burned is determined by deducting the amount of carbon in the sparks from the amount of carbon in the coal fired; although, as will be shown later, this does not give an entirely accurate result in the St. Louis tests. The amount of air supplied per pound of carbon burned is determined from the analysis of the smokebox gases, and the development of the heat balance then proceeds by the following steps:

(I)—The loss of heat in the sparks is determined from their weight and their calorific value.

(II)—The loss of heat due to the formation of carbonic oxide is determined from the amount of this gas present in the smokebox gases, it being known that that volume of carbonic oxide which contains one pound of carbon might have been burned to carbonic dioxide with the production of 5,680 calories.

(III)—The amount of heat carried away by the smokebox gases is determined from their weight, assuming their specific heat to be constant at 0.24.

(IV)—If the hydrogen in the coal is completely burned, about 0.35 pounds of water will be produced for each pound of carbon burned, and the amount of heat carried into the smokebox in this water must be taken into account.

(V)—The difference between the actual total loss of heat, as determined by the measurement of the boiler efficiency, and the sum of the above losses (I, II, III, IV), represents the heat lost by external radiation, together with any losses through the escape of unburned combustible gas. Now, for any one locomotive the loss by external radiation must be constant for all tests, and independent of the rate of combustion, since it is determined only by the extent of the exterior surface of the boiler, and by the difference between the temperature of the boiler, which remains constant, and the temperature of the surrounding air. At the lowest rates of combustion the loss by unburned gas, if existent, is a minimum, and the difference (V) will be a close approximation to the loss by external radiation alone. In effect the difference (V) calculated for the different locomotives from the tests at the lowest rates of evaporation gives losses which are closely proportional to the dimensions of the locomotives, that is to say, to their exterior surfaces. It is also found that in the tests at a high rate of evaporation, there is a further very considerable loss, which is partly due to the fact that not all of the sparks were caught and taken into account, but which is mainly to be accounted for by the escape of hydrocarbons in an unburned state.

It is the escape of these unburned hydrocarbons which is responsible for the decrease in the boiler efficiency, which takes place when the amount of fuel burned per square foot of grate per hour is increased. The hydrocarbons are not burned in the layer of incandescent coal on the grate, but are distilled off from the coal on the grate and being carried through the firebox by the flow of air, are more or less completely burned according to the speed of the flow.

In applying the above method of analysis to the St. Louis tests, it should have been slightly modified as to the method of determining the amount of solid carbon escaping unburned, for as the Pennsylvania report of the tests points out, it was found to be

* *Locomotives à Vapeur*, by Joseph Nadal, Assistant Chief Engineer of Motive Power, French State Railways. Octave Doin, Paris.

impossible to catch all of the sparks. Mr. Nadal in taking the difference between the carbon fired and the sparks as the amount of carbon burned obtains too high a figure for the amount of carbon actually burned, particularly in the tests at high rates of combustion. This is shown by Mr. Nadal's figures though he does not call attention to it. In the tests of the Cole engine the sparks amount to just 3 per cent. of the coal fired, with the de Glehn engine 9 per cent. of the coal re-appears as sparks, while with the Hanover engine the sparks collected are 5.5 per cent. of the coal fired at the lowest rate of combustion and 17.4 per cent. at the highest rate of combustion. An examination of the tests as a whole shows that this difference is not due to a greater efficiency of combustion on the part of the Cole engine, but merely to the escape of the sparks. As a matter of fact, the Cole engine was fitted with an American self-cleaning front-end, while the other two machines had nettings which tended to retain a larger proportion of sparks in the smokebox.

The discussion of the escape of the unburned hydrocarbons might also have been extended with advantage. It is pointed out that the gases distilled from the coal on the grate are carried away by the flow of the air through the grate and that the completeness of combustion is dependent on the rate of the flow of the air. The completeness of the combustion and consequently the boiler efficiency, is also very largely dependent on the style of firebox in which the combustion takes place. An increase in the volume of the firebox increases the length of time the gas and air are in contact and has the same effect as a reduction of the rate of flow of the air, and at the same time the efficiency of the combustion is promoted by any arrangement which tends to maintain the interior of the firebox at a high temperature, or which tends to produce a more intimate mixture between the air and the gas to be burned, the fire-brick arch is of value in both these directions. It is also to be noted that it is not uncommon for the efficiency to be cut down for lack of a sufficient excess of air beyond that actually needed for the complete combustion. It may be further pointed out that the experimental investigations of the escape of unburned hydrocarbons are by no means complete. In the St. Louis tests no examination was made of the smokebox gases to determine whether there were any combustible gases present. Experiments made by Mr. Dubost on locomotives on the Eastern Railway of France are quoted by Mr. Nadal. These showed that when no solid combustible was carried over into the smokebox, the smokebox gases contained no hydrocarbons or free hydrogen; but that when the boiler was forced so that solid combustible was carried over, the smokebox gases contained an amount of hydrocarbon which was considerably in excess of that corresponding to the amount of solid combustible.

Coming now to the utilization of the heat in the production of steam, Mr. Nadal points out the heat produced in a locomotive firebox is transmitted to the heating surface in two ways. Part of the heat is communicated to the products of combustion and serves to raise their temperature, while another part heats the firebox walls by direct radiation. If there were no radiation the temperature of the products of combustion in the firebox would be very much higher than is actually the case. The difference between the actual temperature and that obtainable if all of the heat produced were communicated to the firebox gases, gives a measure of the heat transmitted by direct radiation. Taking the tests for the three locomotives considered above and those for the Baldwin compound tested at St. Louis, the heat radiated directly is about one-half of the total heat produced at low rates of combustion and about one-third of the heat produced at the high rates of combustion, or in other words the evaporation due to the firebox heating surface is from one-half to one-third of the total evaporation of the boiler. Contrary, however, to a generally accepted idea the area of the firebox heating surface, or rather the ratio of this surface to the area of the grate has little effect on the evaporative power of the boiler, for the firebox heating surface absorbs the radiated heat very readily. For example, Mr. Nadal finds that when the rate of combustion is 103 pounds of coal per square foot of grate per hour the rates of evaporation of the various fireboxes are as follows:

For the de Glehn engine, 21.7 pounds of water per square foot of firebox heating surface per hour.

For the Baldwin engine, 25.7 pounds of water per hour.

For the Hanover engine, 28.8 pounds of water per hour.

And for the Cole engine, 40.6 pounds of water per hour.

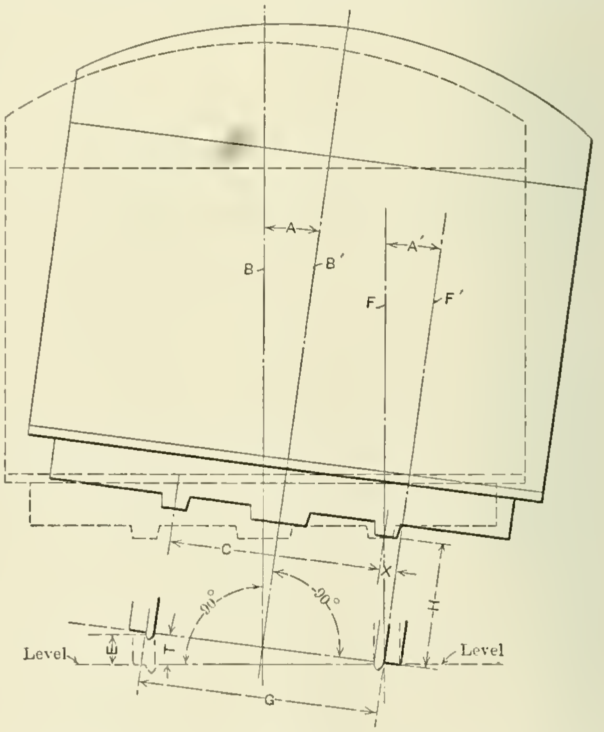
This considerable variation in the rate of evaporation at the firebox heating surface is chiefly due to the fact that the amount of heat radiated is determined by the area of the grate, and not by the extent of the firebox surface; consequently, as the firebox absorbs all of the heat radiated, a large grate area combined with a restricted firebox surface, as in the case of the Cole engine, will give a high rate of evaporation per unit of firebox surface, without directly affecting the general boiler efficiency.

## LOCATION OF SIDE BEARINGS ON TENDER TRUCKS.

Theodore H. Curtis.*

The distance from center to center of side bearings on a tender truck bears a certain relation to the gauge of the flanges of the truck wheels, to the height of the top of the side bearing on the truck from the top of the rail, and to the maximum elevation of the outer rail on a curve. The height of the bearing of the center bearing above the top of the rail does not affect the position of the side bearing, nor does the height of the center of gravity of the tender above the rail. The lower the center of gravity of the tender, the better for stability in running.

The centers of the side bearings should not be outside of a perpendicular line from the point of support on the rail. This point of support varies a little, due to the position of the rail in relation to the throat of the wheel flange, but in the calculations herein it will be assumed as coming in the throat of the flange of the wheel. The greater the distance from the top of the rail to the top of the side bearing, the closer the side bearings should be, center to center, for the same gauge of the wheel




TENDER ON LEVEL TRACK AND ON TRACK WITH OUTER RAIL RAISED SEVEN INCHES.

flanges and the same maximum elevation of one rail above the other.

When the center of the side bearing is located over the point of support on the rail, or inside of the supporting points, a vertically applied load that may come on either side bearing cannot

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produce a stress that will tend to lift either side of the truck off the rail; but when the side bearing is outside of the point of support on the rail, a vertically applied load may come on one side bearing and produce a stress through a leverage (with the point of support on the rail below the loaded side bearing as a fulcrum), and if the leverage is long enough and the load heavy enough, it will lift the wheels on one side of the truck off the rail. One arm of the lever is the distance from the supporting point on the wheel and rail to a perpendicular line through the center of the side bearing that is overhanging the rail, and the other arm of the lever is the distance from the supporting point on the wheel and rail to a perpendicular line through the first point of contact within the center bearing or the opposite side bearing, as the case may be. Therefore, for safety, under any general condition (with one rail higher than the other) a side bearing should not be outside of a perpendicular line above the point of support on the rail.

On the accompanying diagram the tender is shown in a level position by the dotted line; the full lines show it as it would appear on a track having the outer rail raised about seven inches. The center line B is perpendicular; likewise the line F of support over the rail is perpendicular; therefore, lines B and F are parallel. The center line B′ is at an angle to line B, and the line F′ is at the same angle to line F; therefore, lines B′ and F′ are parallel. The angle A and the angle A′ are therefore the same. The angle T is the same as A or A′, as the perpendicular line B is square with the level surface line of the track, and B′ is square with the surface line of the tread of the wheel.

As the angles A, A′ and T are the same, the dimension X bears a direct relation to the distance E, X representing the distance from the line F to F′ at the top of the side bearing. The distance from center to center of side bearing (C) is the distance of the gauge of wheels (G) less twice the distance X, and distance C is determined by the following formula:

$$C = G - \left( \frac{2\,H\,E}{} \right)$$

Example: Assume the gauge of wheels to be 56 inches, the elevation of the outer rail 7 inches, and the height from the top of the rail to the top of the truck side bearing 28 inches.

$$C = 56 - \left( \frac{2 \times 28 \times 7}{56} \right) = 49 \text{ Inches}$$

The gauge between the throat of the flange of the wheels, or wheel gauge, is the distance that affects the position of the side bearing and not the distance that the rails are apart.

The above formula does not take into account the weight of the truck in comparison to the weight on the truck, as the weight on the truck in its relation to the truck weight varies, because of the varying amounts of water and fuel carried, and the unevenness of the track and the listing to one side or the other, which varies the load on one side bearing or the other. The formula gives the location of side bearings that is reasonable for any load on the truck when vertically applied.

In review: When a tender lists to one side when running or standing on a straight track, due to one rail being lower than the other, the tendency is for the tender as a whole to rotate sidewise over the lower rail (this rail being the fulcrum); likewise, the portion of the tender above the trucks has a tendency to rotate sidewise over the side bearing on the low side (this side bearing being the fulcrum), and when the centers of the side bearings are far enough apart to permit of the side bearing on the side over the lower rail to overhang the rail, the weight will produce a lifting tendency on the wheels on the higher rail, but when this side bearing does not overhang the rail, the weight does not produce the lifting tendency referred to.

When the tender is listing, the body and trucks of the tender will tend to move sidewise over the fulcrum rail as a whole, and, when the side bearing overhangs the lower rail and the listing is intense enough, the weight will raise the wheels from the higher rail. This is equally true on a curved track, unless the speed is great enough to produce a centrifugal force sufficient to keep the wheels on the high outside rail to the track.

When the listing, or sidewise force, is intense enough and the centers of the side bearings are sufficiently close together, the body of the tender above the trucks will rotate on one side bearing (the lower side bearing being the fulcrum) instead of the body and truck as a whole rotating sidewise over the fulcrum rail, thereby leaving the truck to stay on the track with the wheel flanges between the rails.

It is better, when the sidewise stresses are approaching the critical point, to have the side bearings close enough together to cause the portion of the tender above the trucks to rotate independently on the side bearing as a fulcrum and cause the center bearing to raise up momentarily and cushion the thrust, as this center bearing has a center pin to guide it back to position, than to have the wheel flanges raise up momentarily and have nothing to guide them back between the rails, as the case would be if the side bearings were far enough apart to cause the body and trucks to rotate as a whole over the rail as a fulcrum.

## THE INTERNATIONAL RAILWAY FUEL ASSOCIATION

This association will hold its first annual meeting at the Auditorium Hotel, Chicago, June 21, 22 and 23. Although it was only organized last fall it has a membership representing practically fifty per cent. of the railway mileage of North America; also a number of members in foreign countries.

Committee reports will be presented on the following subjects: The proper method of purchasing fuel with regard to operating and traffic conditions, considering also the permanent interests of the producer when located on the consumers' rails; chairman, Thomas Britt, general fuel agent, Can. Pacific, Montreal, Can. Standard type or types of coaling stations, best design and most economical coal chute for handling coal from cars to locomotives; chairman, J. H. Hibben, fuel agent, M. K. & T., Parsons, Kan. Best method of accounting for railway fuel, including movement from mine through coaling station to engines. up to monthly balance sheet; chairman, J. P. Murphy, storekeeper, L. S. & M. S. R. R., Collinwood, Ohio. Difference in mine and destination weights; legitimate shrinkage allowable on car-lots; correct weighing of coal at mines and on railroad track scales; importance of tare weights being correct; chairman, F. C. Meagly, A. G. F. A., Santa Fe, Chicago, Ill. Difficulties encountered in producing clean coal for locomotive use; chairman, Carl Scholz, mining engineer, Rock Island-Frisco Lines, Chicago, Ill. An individual paper on "Briquetted Coal as a Railway Fuel" will be presented by C. T. Malcolmson, briquetting engineer, Roberts & Schaefer Company.

On the second day of the meeting the association will be guests of the United States Steel Co., at Gary, Ind., making the round trip from Chicago by water on the specially chartered 1909 steel steamship, *United States.* Opportunity for a business meeting will be afforded en route and refreshments and music will be provided.

Eugene McAuliffe, general fuel agent of the Rock Island-Frisco Lines, is president of the association, and D. B. Sebastian, fuel supervisor, C. & E. I., and E. & T. H. R. R., 327 La Salle Street Station, Chicago, is secretary.

Summer School at the Wisconsin University.—A new feature of this summer school, which will continue for six weeks, beginning June 28th, will be the courses in public utilities testing and accounting, for those desiring to become familiar with the requirements of the Railroad Commission of Wisconsin which has the administration of the Wisconsin public utilities law. Certain engineering courses are also offered for those having the requisite preparation; also courses in steam and gas engines, electricity, machine design, mechanical drawing and allied subjects. There are no entrance requirements, the purpose of this school being to offer practical instruction by lectures and laboratory practice. Information may be obtained from F. E. Turneaure, Dean, College of Engineering, Univ. of Wisconsin, Madison.

# EFFICIENT FOREMEN.

J. F. Whiteford.

*Introductory.*—The maintenance of equipment of railroads absorbs approximately 16 per cent. of the gross earnings and with the reduction of rates and higher labor and material costs, the tendencies are toward an increase in this percentage rather than otherwise. The attention of many railroad managers has for several years been directed toward economy in this department and considerable effort has been devoted to the improvement of the efficiency of the wage earner. The introduction of mechanical methods in shop management, the development of specialized workmen and the improvement in machine and hand tools have all contributed to the increase in operative efficiency of shop organizations, but the training of the individual workman has perhaps received the most attention.

Well organized and thoroughly appointed systems of instruction have been established for apprentices; night schools, reading rooms and circulating libraries have been provided for the older employees in an effort to educate in knowledge and skill. As these are of little value without a willingness on the part of the individual to work, differential wage systems have been designed and applied with the intent of inducing industry, and well directed and persistent effort has accomplished splendid results.

*The Necessity for Training the Foreman.*—As a shop organization is merely an arrangement whereby the efforts of its members, both individually and collectively, are directed toward the accomplishment of certain results, inefficiency on the part of any member will diminish the effectiveness of the entire organization. Educational efforts, therefore, cannot be confined to any one portion of the organization and since the training of the workmen has proven advantageous it is not improbable that the training of foremen will be equally profitable. Efficient workmen are highly desirable, but efficient foremen are even more so, as the influence they exert upon the remainder of the organization is of greater importance and varies according to the relative positions they may occupy.

Under the old régime the main requisite for a foreman was proficiency in his particular trade, but in modern practice, while practical knowledge is an important feature, administrative ability is largely the controlling factor. To be a good foreman does not consist merely in being able to keep in touch with the work of subordinates, to issue instructions covering a routine of operations or to pass judgment on the quality of the work done; neither does it consist in possessing personal qualifications necessary to drive men to the limit of endurance for a brief period in case of urgent need. A foreman to be real efficient must be able, through intelligent and careful study of conditions, to keep all of his men up to their highest efficiency throughout their entire working hours; and not for an occasional day, but for a continuous period.

*The Difficulty in Determining the Efficiency of the Foreman.*—To properly determine his efficiency is often a complex problem, as his efforts are directed under variable conditions. In many locomotive repair shops to-day the efficiency of the shop force is measured by the total number of engines turned out; in others the output is classified, *i. e.*, light, heavy and general; neither considering fully the size of, nor the extent of repairs to the engines with any degree of accuracy. With this method, the apparent efficiency of the shop increases with an increased cost, even though the repairs remain the same; less efficient organization producing a higher cost for the same quantity of work.

Any standard where the number of engines repaired, as well as one where cost alone constitutes a basis, is wholly inadequate and entirely unreliable, as there is no measure of the amount of work which may have been necessary. Supposing, however, that an equitable standard could be arranged for the efficiency of a shop on an output basis; the determining of the efficiency of the individual foreman would be as far from solution as ever. Measuring the efficiency of an erecting shop by the number of engines repaired per pit, or the average number of days detention per engine, is as unsatisfactory as measuring the efficiency of a machine shop by the number of engines turned out plus the number of shop orders or similar work during a given period.

Efficiencies determined in this manner are so misleading as to create erroneous impressions, more especially where records are not kept of the operations performed by each individual workman.

*How to Gauge the Efficiency of the Foreman.*—With differential wage systems these records are available and the most satisfactory method is to consider the efficiency of each foreman equal to the average efficiency of all the men under his supervision for any given period. With a "standard," scientifically determined for a certain operation, whether it be time or money, the efficiency attained is the relation the actual performance bears to the "standard"; the relative advantage of the employment of time standards is very evident. The efficiency of a workman for any period is the relation the total hours worked bear to the total hours allowed, and the efficiency of any gang or department is the relation the total hours worked by all of the men bears to the total "standard" hours allowed for all of the operations performed.

Having, therefore, determined a satisfactory standard and made provision for accurate and constant measurement, it is essential that each foreman be furnished with all information possible concerning the men whose work they are directing. Under the "efficiency" wage system this is arranged in a very simple manner, as each foreman is furnished a monthly statement showing the following data relative to his department:

Number of men employed.
Number of men on schedule work.
Number of hours actually worked.
Number of hours actually worked on schedules.
Number of hours standard.
Average efficiency of department.
Per cent. of hours covered by schedules.

He is also furnished with a detailed statement showing the name of each man under his supervision, the number of hours worked on schedule and the efficiency of each individual for the month. Having such information each foreman knows without further inquiry the relative abilities of his various men; a matter which otherwise would be exceedingly difficult to accurately determine. As the average foreman has from forty to sixty men under his supervision, he can only know in a general way where his assistance is most needed, but with such definite information there need be no question.

*How to Stimulate and Reward the Foreman.*—Putting aside sentiment, adequate compensation should be provided for acquiring skill and efficiency and no exception should be made in the case of the foreman. To stimulate the foreman in this respect the "efficiency" plan provides for the payment of a bonus to the foreman according to the average efficiency of his men. If the average efficiency of all of the men in his department is 100 per cent. the foreman receives a bonus equal to 20 per cent. of his wages, with further provision that 10 per cent. additional bonus will be paid if all of the hours worked are covered by schedule. Both the percentage on efficiency and on hours worked on schedule decreases until 66.6 per cent. is reached, at which point no bonus is paid.

The results obtained from the application of this system are very gratifying, as foremen who felt they were making every effort found they were able to increase their average efficiency by close study of the men whose efficiencies were below normal. To keep the men steadily employed and to assign work to them in which they are most proficient, together with the avoidance of shifting them from one class of work to another, calls forth many of the qualities that go to make a good foreman.

One foreman in an erecting shop was able to increase his efficiency from 87 to 99 per cent. by working his men individually and in pairs rather than in gangs of three to six men. Another foreman in the car department was able to increase his efficiency from 97 per cent., a very satisfactory figure itself, to 101 per cent. through re-arranging his force so that men, whose personality or physical ability enabled them to work to better advantage, were placed together. Another foreman finding that considerable rivalry existed between two of his men placed one of them on a class of work with which he was very familiar, with a high efficiency resulting, and the other, not to be outdone, raised his efficiency to equal that of the first one.

This illustrates the far-reaching effect produced through a stimulus to the foreman and something which would not make itself evident without an accurate method of determining foremen's efficiency. While these are matters of minor importance individually, when taken collectively they assume enormous proportions, as they reflect daily occurrences in all industrial establishments.

This feature of including the foreman has perhaps been overlooked in discussions as to the relative advantages of the different wage systems. Numerous occurrences can be cited by the writer from personal experience where shop foremen opposed the introduction of piece work, not because of antagonism to its economic principles, but due to the system affording opportunity for the men to earn more money than the foreman. Various hindrances were placed before the exceptionally fast men—minor delays in being furnished with material or additional help when required, and in some instances insufficient work provided—in an effort to hold his earnings at a lower figure than the foreman's wages.

This need not occasion surprise when it is considered that the wages of foremen have not increased in proportion to the wages of the workmen. In many positions to-day, *foremen are receiving the same salaries as fifteen years ago, while the average rate of pay of their men has advanced 20 per cent., and the duties of the foremen are far more exacting than under former conditions.*

A precautionary measure against any inclination on the part of the shop foreman to encourage quantity of work in preference to quality, is incorporated in the schedule covering the work of shop inspectors, who pass final judgment on the finished products. This feature consists in providing substantial increase in efficiency of the inspector for each defect located. The efficiency of the general foreman of a shop is the average efficiency of all of his subordinates, which directs his efforts to maintaining an even balance among the several departments.

*The Road Foreman of Engines.*—To provide the necessary stimulus to a road foreman of engines by permitting him to adjust his wages according to his ability, a schedule covering various items upon which a standard has been placed, is provided whereby his efficiency is determined. Originally the road foreman's duties were to instruct new engineers in how to get over the road and new firemen in the art of keeping up a full head of steam, but in addition he is now held accountable for the consumption of fuel, lubricants and supplies. He is also asked to explain the cause and suggest the remedy for engine failures, utilize his ingenuity to increase the average mileage between shoppings and at the same time keep a watchful eye on the repair bill of all engines in his territory.

With no well defined duties the work of the road foreman is largely discretionary and the results he obtains are entirely due to his personality and his ability to properly divide his time and attention.

FOREMAN SCHEDULE................ MONTHLY

For supervising and directing all work in..............................
a Bonus will be paid on the per cent. of hours worked Bonus and the Efficiency of the.......................................as a whole, to the ............................................as per attached schedule.

Bonus will not be paid unless all work is satisfactory to the............. ............ Bonus will not be paid on per cent. of hours unless over 67% of the total number of hours worked in the department are worked on Bonus Schedules. Bonus on efficiency will be subject to deduction, as per column headed "% of Deduction," when the per cent. of hours worked falls below 67%, and no bonus will be paid when 33% or less is worked. When the per cent. of efficiency is over 100%, no increase will be made in the 20% bonus on efficiency, unless 100% of all the hours are worked Bonus. If 100% of all the hours are worked, bonus will be allowed as per schedule.

| % Hours and Efficiency | Bonus on % Hours Worked | Bonus and % Efficiency | % Deduction | % Hours and Efficiency | Bonus on % Hours Worked | Bonus and % Efficiency | % Deduction | % Hours and Efficiency | Bonus on % Hours Worked | Bonus and % Efficiency | % Deduction |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 % | | | 100.00 | 58 % | | | 6.00 | 82.5% | 2.31 | 4.69 | |
| 33.5 | | | 96.95 | 58.5 | | | 5.60 | 83 | 2.46 | 4.92 | |
| 34 | | | 92.55 | 59 | | | 5.10 | 83.5 | 2.62 | 5.23 | |
| 34.5 | | | 91.22 | 59.5 | | | 4.40 | 84 | 2.77 | 5.53 | |
| 35 | | | 88.50 | 60 | | | 3.60 | 84.5 | 2.93 | 5.85 | |
| 35.5 | | | 85.80 | 60.5 | | | 3.25 | 85 | 3.09 | 6.17 | |
| 36 | | | 83.10 | 61 | | | 2.75 | 85.5 | 3.25 | 6.50 | |
| 36.5 | | | 80.45 | 61.5 | | | 2.30 | 86 | 3.42 | 6.84 | |
| 37 | | | 77.80 | 62 | | | 1.83 | 86.5 | 3.60 | 7.20 | |
| 37.5 | | | 73.20 | 62.5 | | | 1.43 | 87 | 3.79 | 7.56 | |
| 38 | | | 72.63 | 63 | | | 1.10 | 87.5 | 3.92 | 7.94 | |
| 38.5 | | | 70.10 | 63.5 | | | .80 | 88 | 4.19 | 8.33 | |
| 39 | | | 67.65 | 64 | | | .55 | 88.5 | 4.36 | 8.71 | |
| 39.5 | | | 65.20 | 64.5 | | | .35 | 89 | 4.56 | 9.11 | |
| 40 | | | 62.00 | 65 | | | .30 | 89.5 | 4.76 | 9.51 | |
| 40.5 | | | 60.40 | 65.5 | | | .10 | 90 | 4.96 | 9.91 | |
| 41 | | | 58.10 | 66 | | | .05 | 90.5 | 5.16 | 10.32 | |
| 41.5 | | | 55.90 | 66.5 | | | | 91 | 5.37 | 10.74 | |
| 42 | | | 53.70 | 67 | .01 | .01 | | 91.5 | 5.59 | 11.18 | |
| 42.5 | | | 51.60 | 67.5 | .02 | .02 | | 92 | 5.81 | 11.62 | |
| 43 | | | 49.55 | 68 | .03 | .06 | | 92.5 | 6.04 | 12.08 | |
| 43.5 | | | 47.55 | 68.5 | .05 | .07 | | 93 | 6.28 | 12.56 | |
| 44 | | | 45.65 | 69 | .06 | .11 | | 93.5 | 6.52 | 13.04 | |
| 44.5 | | | 43.55 | 69.5 | .08 | .16 | | 94 | 6.76 | 13.52 | |
| 45 | | | 41.00 | 70 | .11 | .22 | | 94.5 | 7.01 | 14.02 | |
| 45.5 | | | 39.70 | 70.5 | .13 | .29 | | 95 | 7.26 | 14.52 | |
| 46 | | | 37.80 | 71 | .19 | .37 | | 95.5 | 7.52 | 15.04 | |
| 46.5 | | | 36.00 | 71.5 | .23 | .46 | | 96 | 7.78 | 15.56 | |
| 47 | | | 34.20 | 72 | .28 | .55 | | 96.5 | 8.05 | 16.09 | |
| 47.5 | | | 32.50 | 72.5 | .33 | .65 | | 97 | 8.31 | 16.62 | |
| 48 | | | 30.85 | 73 | .38 | .76 | | 97.5 | 8.58 | 17.16 | |
| 48.5 | | | 29.25 | 73.5 | .44 | .88 | | 98 | 8.85 | 17.70 | |
| 49 | | | 27.65 | 74 | .51 | 1.02 | | 98.5 | 9.13 | 18.25 | |
| 49.5 | | | 26.15 | 74.5 | .59 | 1.16 | | 99 | 9.26 | 18.81 | |
| 50 | | | 24.60 | 75 | .66 | 1.31 | | 99.5 | 9.99 | 19.39 | |
| 50.5 | | | 23.10 | 75.5 | .74 | 1.47 | | 100 | 10.00 | 20.00 | |
| 51 | | | 21.65 | 76 | .82 | 1.64 | | 100.5 | | 20.50 | |
| 51.5 | | | 20.25 | 76.5 | .91 | 1.81 | | 101 | | 21.00 | |
| 52 | | | 18.90 | 77 | 1.00 | 1.99 | | 101.5 | | 21.50 | |
| 52.5 | | | 17.60 | 77.5 | 1.09 | 2.18 | | 102 | | 22.00 | |
| 53 | | | 16.35 | 78 | 1.19 | 2.39 | | 102.5 | | 22.50 | |
| 53.5 | | | 15.15 | 78.5 | 1.30 | 2.59 | | 103 | | 23.00 | |
| 54 | | | 14.00 | 79 | 1.40 | 2.80 | | 103.5 | | 23.50 | |
| 54.5 | | | 12.90 | 79.5 | 1.52 | 3.03 | | 104 | | 24.00 | |
| 55 | | | 11.85 | 80 | 1.64 | 3.27 | | 104.5 | | 24.50 | |
| 55.5 | | | 10.85 | 80.5 | 1.76 | 3.52 | | 105 | | 25.00 | |
| 56 | | | 9.90 | 81 | 1.88 | 3.78 | | 105.5 | | 25.50 | |
| 56.5 | | | 9.00 | 81.5 | 2.00 | 4.05 | | 106 | | 26.00 | |
| 57 | | | 8.20 | 82 | 2.17 | 4.33 | | 106.5 | | 26.50 | |
| 57.5 | | | 7.30 | 82 | 2.17 | 4.33 | | | | | |

Checked by ............ Approved ............ Approved ............ Approved ............

ROAD FOREMAN OF ENGINES

*Standard Schedule*

...................Division.

This schedule provides for the monthly payment of bonus to road foremen of engines for economical and efficient performance of locomotives on the division indicated above. The performance of locomotives on the division will be determined by the following items: (a) the cost of repairs to freight engines per engine mile; (b) pounds of fuel per freight engines per 1000 ton miles; (c) miles run per engine failure (freight and passenger); (d) cost of lubricants charged to freight engines; (e) cost of other supplies charged to freight engines; (f) average mileage between shoppings of freight engines; (g) average mileage of passenger engines between shoppings.

In determining the efficiency of road foremen for the current month, consider the following allotments for each item as constituting 100 per cent. efficiency on this division. The relative value or proportion which each bears in the determination of the operating efficiency is shown in the column headed "Relative Values." In calculating the efficiency of road foremen, multiply the efficiency of each item by the corresponding figure in the "Relative Value" column, add together the figures thus obtained and divide the total by 20.

| | Allotment. | Relative Values. |
|---|---|---|
| (a) Cost of frt. eng. reprs. per eng. mi., 12 mo. avg., in cents ........................ | .......... | .......5 |
| (b) Pounds of fuel, frt. engs. per 1000 T. M., 12 mo. avg., in miles ........................ | .......... | .......5 |
| (c) Miles per failure, frt. and pass. engs., 12 mo. avg., in miles ........................ | .......... | .......3 |
| (d) Cost of lubricants per 100 eng. miles, 12 mo. avg., in cents ........................ | .......... | .......1 |
| (e) Cost of other supplies per 100 eng. mi., 12 mo. avg., in cents ........................ | .......... | .......1 |
| (f) Mileage of frt. engs. between shoppings, 12 mo. avg., in miles ........................ | .......... | .......3 |
| (g) Mileage of pass. engs. between shoppings, 12 mo. avg., in miles ........................ | .......... | .......2 |

...................Division.

All possible information is furnished the road foreman at regular intervals and all items contributing to low performance of locomotives are constantly and systematically followed, the average efficiency of the road foremen from month to month reflecting directly the result of their efforts.

*The schedule acts as a further check on the efficiency of the shop foreman, should he be induced through desire of extra compensation to increase his efficiency by accepting poor work. In this event it would become evident in the fuel consumption, the number of failures and the extent of repairs necessary to correct the matter and the road foreman losing on all of these items would take prompt action to have the difficulty corrected.*

*The Master Mechanic.*—Nor should the application of the efficiency plan end with the general foreman or the road foreman of engines, as the master mechanic upon whom rests the responsibility of the entire performance of the division is entitled to full consideration. Successful railroad operation is dependent upon the ability to furnish efficiently and economically its only commodity—transportation. The efficiency of a master mechanic must, therefore, be measured by the extent to which he is responsible and the standards provided must consider the cost and quality of service rendered within his jurisdiction.

To Master Mechanics:

In recognition of efficiency and economy in operation of divisions, it is proposed to share with master mechanics a proportion of the savings effected by their efforts.

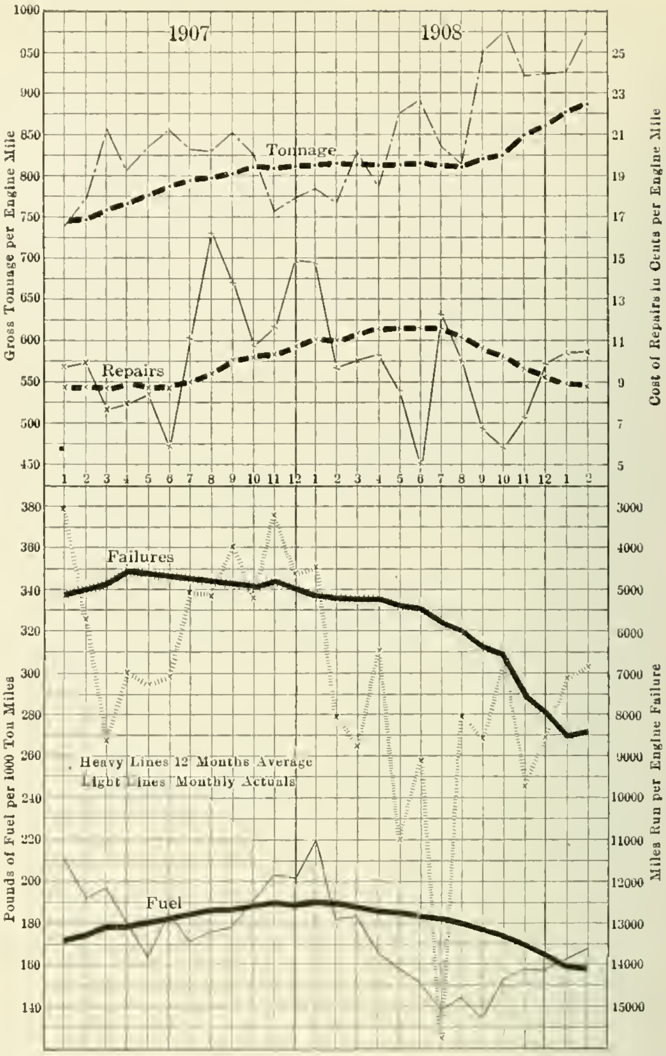
In ascertaining the operating efficiency for the current month, consider the following allotments for each item as constituting 100 per cent. efficiency on this division. The relative value or proportion which each item bears in the determination of the operating efficiency, is shown in the column headed "Relative Values." In calculating the operating efficiency of the division multiply the efficiency for each item by the corresponding figure in the "relative values" column; add together the figures thus obtained and divide the total by 40.

| | Allotment. | Relative Values. |
|---|---|---|
| 1—Locomotive repairs, per locomotive mile, 12 mo. avg., in cents | .......... | ........5 |
| 2—Freight car repairs, per 100 car miles, 12 mo. avg., in cents | .......... | ........5 |
| 3—Passenger car repairs, per 100 car miles, 12 mo. avg., in cents | .......... | ........2 |
| 4—Shop tools and machinery, per 100 locomotive miles, 12 mo. avg., in cents | .......... | ........1 |
| 5—Miles between shoppings, frt. and pass locos., 12 mo. avg., in miles | .......... | ........3 |
| 6—Miles per locomotive failure, 12 mo. avg., in miles | .......... | ........1 |
| 7—Hours detention, per engine, 12 mo. avg., in hours | .......... | ........3 |
| 8—Total mach. dept. expense (frt.), per 1000 gr. ton mi., 12 mo. avg., in cents | .......... | .......20 |

No well defined plan can be outlined to enable a master mechanic to furnish better service at reduced cost, the results obtained reflecting directly upon his ability and ingenuity together with his personality in securing the entire co-operation of every employee under his jurisdiction. His power must be kept in good condition to give efficient service on the road and repairs must be made promptly and efficiently in order to reduce the time engines are held out of service. To secure a lower cost of repairs he must not only see that all employees in the various departments are working at the highest efficiency, but that every foreman follows the material issues with due care and that close supervision is exercised over the scrap pile.

If the efficiency of any one department in the shop is low, personal attention must be directed toward assisting the foremen concerned in raising it to a satisfactory figure and oftentimes he finds opportunity to enthuse through personal contact an individual workman to attain higher efficiency; all of these details have considerable bearing on the cost of operation.

Again, some particular engine may not be giving satisfactory service, or have insufficient mileage to warrant being sent to the shop for repairs, in which event the road foreman must be conferred with personally and the necessary steps taken to correct the matter.



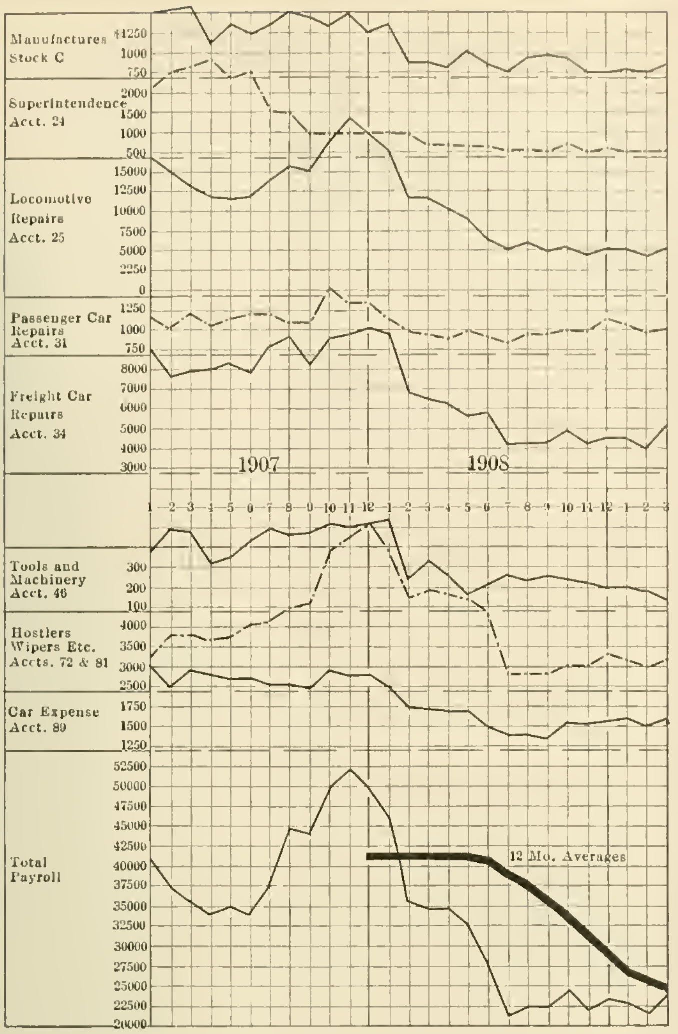

FREIGHT LOCOMOTIVE PERFORMANCE, —— DIVISION.

It is, however, essential that he should be furnished with all information relative to the performance in his territory and that this should be presented in such a manner as to enable him to locate any irregularity or extravagance without delay.

*Keep Foreman and Officials Posted as to Costs and Performances.*—Important as is the education of foremen, and especially that they should be kept thoroughly familiar with the result of their work, many of our railroads do not keep the individual foremen fully advised as to the costs or furnish them with sufficient information to enable satisfactory comparisons to be made with previous periods. Reports are often furnished of performance data but too voluminous to enable the foreman to make correct deductions and generally sixty to ninety days after the performance occurs, with no other data available to assist in determining the cause of any fluctuations. It is necessary that all available information be furnished promptly and be sufficiently clear and concise to enable a master mechanic or his individual foremen to determine at a glance where attention is most required.

The accompanying chart illustrates the method of furnishing the necessary data to foremen under the "efficiency" plan and has proven extremely valuable in assisting them to effect economies. Charts are furnished illustrating the labor charges by accounts month by month for an extended period for each station, the material charges being shown in a similar manner. As these are furnished as early after the close of the month as the data can be compiled, all charts being prepared and distributed by a central office, the necessity of each individual foreman keeping records is removed.

The same data is also compiled by divisions, grand divisions and system territory and furnished to such officials as are interested, as are also performance data on locomotive, freight and

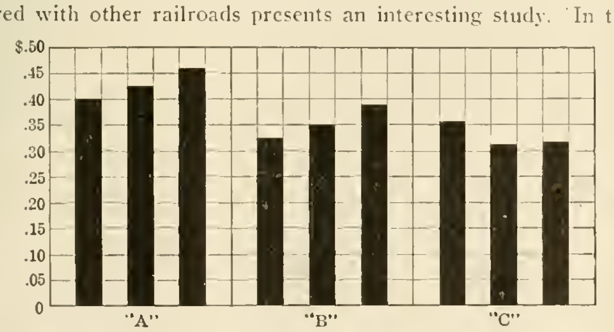



PAYROLL BY ACCOUNTS.

passenger car repairs, lubricants, supplies, engine failures, freight tonnage, fuel consumption, etc.

For comparative purposes, the latter charts are arranged to show the performance data by individual months and also the average of a twelve month period, ending each month, all information upon which efficiencies are determined being graphically outlined. No foreman need be ignorant of his present costs nor of past performence either of himself or others; the charts serve doubly the purpose of keeping each foreman informed of his work and of keeping his superiors in touch with the ability of the individual.

*The Results.*—The results obtained from the application of these methods cannot be accurately measured, though the cost of maintaining equipment where such practices are in vogue as compared with other railroads presents an interesting study. In the




COST OF MAINTAINING EQUIPMENT PER TRAIN MILE ON THREE ROADS FOR THREE YEARS.

accompanying illustration the cost of maintenance of equipment per train mile for three successive years is graphically portrayed for three railroads each with a different wage system. Exhibit A is that of a railroad where the day rate system is used; Exhibit B, where piece work is established in all departments, and Exhibit C, where the efficiency plan is in effect, not alone upon the workmen, but on the foremen as well.

While comparison of maintenance costs among railroads cannot be made without considering operating conditions, this does not interfere with comparisons on the same road for different periods. On "A," with no incentive for efficient performance on the part of either the workmen or the foremen the cost per train mile shows a steady increase. On "B," where compensation is provided for efficient workmen without regard to the foremen the same tendency is in evidence. On "C," offering every incentive to both workmen and foremen to enlist their co-operation, the costs for the three successive years present an entirely different appearance; a conclusive argument that efficient supervision is not only advisable but absolutely necessary for economical operation.

The education of a foreman is never complete, no service is so satisfactory that field for further improvement is not available and the provision of suitable remuneration for increased efficiency is so potent a factor in securing results that it should not be overlooked or underestimated.

## WITH THE RAILWAY CLUBS.

*The Canadian, Central, New York, Pittsburgh, Richmond, St. Louis, Western and Western Canada Clubs will not meet again until September. The New England Club will not meet until October.*

*Canadian Railway Club (Montreal).*—The club expects to have an excursion during the summer. At the annual meeting in May the following officers were elected: President, H. H. Vaughan, assistant to vice-president, C. P. Ry.; first vice-president, A. A. Maver, master mechanic, Grand Trunk; second vice-president, A. A. Goodchild, auditor of stores and mechanical accounts, C. P. Ry.; secretary, James Powell, chief draftsman, motive power department, Grand Trunk; treasurer, S. S. Underwood, chief draftsman, car department, Grand Trunk.

*Central Railway Club* (Buffalo).—This club has just closed a most successful season. As the result of a letter ballot the meetings will hereafter be held in the evening rather than in the afternoon. The vote stood 203 to 89. The annual outing of the club will be held the second Friday in September. At the business meeting to be held the evening of that day, Col. B. W. Dunn, chief inspector of the American Railway Association, will give an illustrated lecture on "The Safe Transportation of Explosives and Other Dangerous Articles."

*New England Railroad Club* (Boston).—At the May meeting a "Ladies' Night," three hundred and thirty-five sat down to the banquet. It was a great success.

*Northern Railway Club* (Duluth).—F. L. Klock, chairman, Missabe Range Car Service Association, will speak on "Demurrage, Its Benefits, Necessity, Etc." at the next meeting, June 26.

*St. Louis Railway Club.*—At the May meeting the three new vice-presidents presented papers. J. E. Taussig spoke on "Active Membership—Its Obligations"; H. J. Pfeifer on "Grade Crossings"; C. Burlingame on "Club Uplift Suggestions."

*Western Canada Railway Club* (Winnipeg).—At the May meeting W. B. Lanigan, assistant general freight traffic manager of the Can. Pac. Ry., read a paper on the "Transportation Salesman." The club now has a membership of about 230 and is planning big things for the fall.

## HIGH SPEED TWIST DRILLS.

The grade of the materials that are drilled in a railroad shop varies so much, and the machines upon which the work is done differ so greatly in construction, capacity and condition, that it is impossible to tabulate the maximum speeds and feeds at which different size drills may be used safely on various materials. Under these conditions the manufacturers of high speed twist drills are naturally inclined to be conservative in recommending the speeds and feeds at which their drills may be used for general work.

The table below has been compiled from data submitted by manufacturers of high speed twist drills and shows the

| SIZE OF DRILL | WROUGHT IRON MACHINERY STEEL AND SOFT TOOL STEEL | | WROUGHT IRON AND STEEL | | | | MILD STEEL | | GEN. WORK | | E | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R. P. M. * | | B | | CARBON | | C | | D | | CAST RON | | MED. HARD STEEL | |
| | A | Carbon | R. P. M. | Feed | R. P. M. | Feed | R. P. M. | Feed | R. P. M | Feed | R. P. M. | Feed | R. P. M. | Feed |
| 1-16 | 3057 | 1834 | | | | | 4584 | .003 | | | | | | |
| 1-8 | 1528 | 917 | | | | | 2292 | .005 | | | | | | |
| 3-16 | 1020 | 611 | | | | | 1528 | .006 | | | | | | |
| 1-4 | 765 | 458 | 700 | .008 | 223 | .005 | 1146 | .008 | 1068 | .008 | 735 | .0075 | 920 | .0063 |
| 5-16 | 612 | 367 | 567 | .008 | 178 | .005 | 916 | .010 | 856 | .008 | | | | |
| 3-8 | 510 | 306 | 467 | .011 | 148 | .005 | 764 | .011 | 716 | .011 | 490 | .0086 | 614 | .0072 |
| 7-16 | 437 | 262 | 400 | .011 | 122 | .005 | 657 | .013 | 608 | .011 | | | | |
| 1-2 | 382 | 229 | 350 | .016 | 111 | .007 | 573 | .014 | 534 | .016 | 368 | .0094 | 460 | .0079 |
| 9-16 | 340 | 204 | | | | | 507 | .016 | | | | | | |
| 5-8 | 306 | 184 | 254 | .016 | 89 | .007 | 458 | .017 | 428 | .016 | | | | |
| 11-16 | 277 | 167 | | | | | 417 | .018 | | | | | | |
| 3-4 | 255 | 153 | 233 | .016 | 74 | .010 | 382 | .020 | 356 | .016 | 245 | .0109 | 306 | .0091 |
| 13-16 | 235 | 141 | | | | | 353 | .020 | | | | | | |
| 7-8 | 218 | 131 | 200 | .016 | 69 | .010 | 327 | .020 | 304 | .016 | | | | |
| 15-16 | 204 | 122 | | | | | 305 | .020 | | | | | | |
| 1 | 191 | 115 | 174 | .020 | 58 | .010 | 287 | .020 | 266 | .016 | 184 | .0119 | 230 | .01 |
| 1 1-16 | 180 | 108 | | | | | 270 | .020 | | | | | | |
| 1 1-8 | 170 | 102 | 154 | .020 | 49 | .010 | 255 | .020 | 236 | .016 | | | | |
| 1 3-16 | 160 | 96.5 | | | | | 241 | .020 | | | | | | |
| 1 1-4 | 153 | 91.8 | 143 | .020 | 44 | .010 | 229 | .020 | 214 | .016 | 147 | .0129 | 184 | .0108 |
| 1 5-16 | 145 | 87.3 | | | | | 218 | .020 | | | | | | |
| 1 3-8 | 139 | 83.3 | 134 | .020 | 40 | .010 | 208 | .020 | 202 | .016 | | | | |
| 1 7-16 | 133 | 79.8 | | | | | 199 | .020 | | | | | | |
| 1 1-2 | 127 | 76.3 | 120 | .020 | 37 | .010 | 191 | .020 | 178 | .016 | 122 | .0136 | 153 | .0114 |
| 1 9-16 | 122 | 73.4 | | | | | 183 | .020 | | | | | | |
| 1 5-8 | 117 | 70.5 | | | | | 176 | .020 | | | | | | |
| 1 11-16 | 113 | 67.9 | | | | | 170 | .020 | | | | | | |
| 1 3-4 | 109 | 65.5 | 100 | .020 | 32 | .010 | 164 | .020 | 152 | .016 | 105 | .0144 | 131 | .0121 |
| 1 13-16 | 105.3 | 63.2 | | | | | 158 | .020 | | | | | | |
| 1 7-8 | 102 | 61.1 | | | | | 153 | .020 | | | | | | |
| 1 15-16 | 98.7 | 59.2 | | | | | 148 | .020 | | | | | | |
| 2 | 95.6 | 57.3 | 87 | .020 | 28 | .010 | 143 | .020 | 132 | .016 | 92 | .015 | 115 | .0126 |
| 2 1-16 | 92.7 | 55.6 | | | | | 139 | .020 | | | | | | |
| 2 1-8 | 90.0 | 54.0 | | | | | 135 | .020 | | | | | | |
| 2 3-16 | 87.4 | 52.4 | | | | | 131 | 020 | | | | | | |
| 2 1-4 | 85.0 | 51.0 | 80 | .020 | 26 | .010 | 127 | .020 | | | 81.7 | .0156 | 102 | .0131 |
| 2 5-16 | 82.7 | 49.5 | | | | | | | | | | | | |
| 2 3-8 | 80.5 | 48.2 | | | | | 121 | .020 | | | | | | |
| 2 7-16 | 78.5 | 47.0 | | | | | | | | | | | | |
| 2 1-2 | 76.5 | 45.8 | 70 | .020 | 23 | .010 | 115 | .020 | | | 73.5 | .0162 | 92 | .0136 |
| 2 9-16 | 74.6 | 44.7 | | | | | | | | | | | | |
| 2 5-8 | 72.8 | 43.7 | | | | | 109 | .020 | | | | | | |
| 2 11-16 | 71.1 | 42.6 | | | | | | | | | | | | |
| 2 3-4 | 69.5 | 41.7 | 67 | .020 | 21 | .010 | 104 | .020 | | | 66.7 | .0167 | 83.5 | .014 |
| 2 13-16 | 68.0 | 40.7 | | | | | | | | | | | | |
| 2 7-8 | 66.5 | 39.8 | | | | | 100 | .020 | | | | | | |
| 2 15-16 | 65.1 | 39.0 | | | | | | | | | | | | |
| 3 | 63.6 | 38.2 | 60 | .020 | 19 | .010 | 96 | .020 | | | 61.3 | .0172 | 76.5 | .0144 |
| 3 1-4 | | | | | | | | | | | 56.5 | .0176 | 70.5 | .0148 |
| 3 1-2 | | | | | | | | | | | 52.5 | .0181 | 65.6 | .0151 |
| 3 3-4 | | | | | | | | | | | 49 | .0185 | 61.2 | .0155 |
| 4 | | | | | | | | | | | 46 | .019 | 57.5 | .0158 |

* Feeds of from .004 to .007 in. are recommended for drills smaller than 1-2 in. and from .005 to .010 in. for larger sizes

feeds and speeds which they recommend for different size drills. The maker of drills A also furnished similar data for carbon steel drills. A feed of from .004 in. to .007 in. per revolution is recommended for drills smaller than ½ in. and a feed of from .005 in. to .010 in. for larger sizes. The maximum results may be gained by watching closely the condition of the drill—a chipped edge indicates too heavy a feed and the wearing of the corners too high a speed. The maker also writes as follows: "It isn't safe for a twist drill manufacturer to recommend too high a speed for high speed twist drills; if this is done, and the advice is followed, and the drills are smashed, the blame comes on the drill and never on the material or the drill press. What advice we have given and the tables used in our publicity work have been conservative and are what we call a *"starting point,"* to be increased as the consumer finds it can be done with safety. We have had many letters approving the speeds recommended and we also have had a number stating they were too low. We don't recall a single complaint of their being too high."

The speeds recommended for twist drills B are lower than those for A, but the feeds are heavier and are more clearly defined; this is also true in the case of the data for carbon drills furnished by the two manufacturers. The speeds given for B are intended for wrought iron and steel and also for cast iron, although it is stated that in nine cases out of ten it will be possible to run at a 25 per cent. increase in speed on the latter material.

The speeds recommended for drills C are considerably higher than for either A or B, although it is quite possible that they are based on drilling a softer material. The feeds for the larger size drills are practically the same as those recommended for B.

The manufacturer of drills D states that in order to obtain the best results from high speed drills it is necessary to operate them at high speeds and light feeds. A lubricant is recommended, except for cast iron. The data given for this drill is for general work. For ordinary shop practice on mild steel the following may be taken as a guide: 1 in. drill, 300 r. p. m., .016 feed—reduce speeds approximately 15 to 20 per cent. where a lubricant is not used. For cast iron a 1 in. drill should be operated at 200 r. p. m. with a feed of .025 in. Generally speaking, the feeds can be increased for thin work and decreased for deeper holes. Care must be exercised when breaking through the material at high speeds.

The data under E is taken from a paper on "Experiments

| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. |
|---|---|---|---|---|---|---|---|
| Diameter of Drill in Inches. | Revolutions per Minute, $N = \frac{12 \times 60}{\pi d}$ | Feed in Inches per Revolution, $t = \frac{d^{\frac{1}{3}}}{100}$ | Cubic Inches Removed per Minute, $1.8 d^{\frac{4}{3}}$ | Cutting Horse-Power, $2.85 d$. | Feeding Horse-Power $\frac{d^{\frac{1}{3}}}{77}$. | Total Horse-Power. | Horse-Power per Cubic Inch of Metal Removed per Minute. |
| 0.25 | 920 | $0.0063 = \frac{1}{160}$ | 0.284 | 0.712 | 0.0092 | 0.721 | 2.54 |
| 0.375 | 614 | $0.0072 = \frac{1}{139}$ | 0.485 | 1.068 | 0.0102 | 1.078 | 2.22 |
| 0.5 | 460 | $0.00795 = \frac{1}{126}$ | 0.716 | 1.425 | 0.0109 | 1.426 | 1.99 |
| 0.75 | 306 | $0.0091 = \frac{1}{110}$ | 1.23 | 2.14 | 0.0121 | 2.152 | 1.75 |
| 1 | 230 | $0.01 = \frac{1}{100}$ | 1.8 | 2.85 | 0.013 | 2.863 | 1.59 |
| 1.25 | 184 | $0.0108 = \frac{1}{92.5}$ | 2.44 | 3.56 | 0.0138 | 3.574 | 1.47 |
| 1.5 | 153 | $0.0114 = \frac{1}{88}$ | 3.08 | 4.27 | 0.0145 | 4.285 | 1.39 |
| 1.75 | 131 | $0.0121 = \frac{1}{83}$ | 3.81 | 4.99 | 0.015 | 5.005 | 1.31 |
| 2 | 115 | $0.0126 = \frac{1}{79.5}$ | 4.54 | 5.7 | 0.0155 | 5.715 | 1.26 |
| 2.25 | 102 | $0.0131 = \frac{1}{76.5}$ | 5.3 | 6.42 | 0.0159 | 6.436 | 1.21 |
| 2.5 | 92 | $0.0136 = \frac{1}{73.5}$ | 6.12 | 7.12 | 0.0163 | 7.136 | 1.165 |
| 2.75 | 83.5 | $0.014 = \frac{1}{71.5}$ | 6.92 | 7.84 | 0.0167 | 7.857 | 1.135 |
| 3 | 76.5 | $0.0144 = \frac{1}{69.5}$ | 7.76 | 8.55 | 0.0171 | 8.567 | 1.105 |
| 3.25 | 70.5 | $0.0148 = \frac{1}{67.5}$ | 8.06 | 9.25 | 0.175 | 9.267 | 1.07 |
| 3.5 | 65.6 | $0.0151 = \frac{1}{66}$ | 9.5 | 9.98 | 0.178 | 9.998 | 1.05 |
| 3.75 | 61.25 | $0.0155 = \frac{1}{64.5}$ | 10.48 | 10.7 | 0.0181 | 10.718 | 1.024 |
| 4 | 57.5 | $0.0158 = \frac{1}{63}$ | 11.4 | 11.4 | 0.0184 | 11.42 | 1 |

TABLE II.—REVOLUTIONS PER MINUTE, FEED PER REVOLUTION, CUBIC INCHES REMOVED PER MINUTE AND HORSE-POWER WHEN DRILLING MEDIUM HARD STEEL.

| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. |
|---|---|---|---|---|---|---|---|
| Diameter of Drill in Inches. | Revolutions per Minute, $N = \frac{12 \times 48}{\pi d}$ | Feed in Inches per Revolution of Drill, $t = \frac{d^{\frac{1}{3}}}{84}$. | Cubic Inches Removed per Minute, $1.715 d^{\frac{4}{3}}$ | Cutting Horse-Power, $1.16 d$. | Feeding Horse-Power, $\frac{d^{\frac{1}{3}}}{142}$ | Total Horse-Power. | Horse-Power per Cubic Inch of Metal Removed per Minute. |
| 0.25 | 735 | $0.0075 = \frac{1}{133}$ | 0.27 | 0.29 | 0.005 | 0.295 | 1.092 |
| 0.375 | 490 | $0.0086 = \frac{1}{116}$ | 0.462 | 0.435 | 0.0055 | 0.4405 | 0.954 |
| 0.5 | 368 | $0.0094 = \frac{1}{106}$ | 0.682 | 0.58 | 0.0059 | 0.586 | 0.862 |
| 0.75 | 245 | $0.0109 = \frac{1}{92}$ | 1.17 | 0.87 | 0.0066 | 0.8766 | 0.748 |
| 1 | 184 | $0.0119 = \frac{1}{81}$ | 1.715 | 1.16 | 0.007 | 1.167 | 0.681 |
| 1.25 | 147 | $0.0129 = \frac{1}{77.5}$ | 2.32 | 1.45 | 0.0073 | 1.457 | 0.628 |
| 1.5 | 122 | $0.0136 = \frac{1}{74}$ | 2.92 | 1.74 | 0.0078 | 1.748 | 0.598 |
| 1.75 | 105 | $0.0144 = \frac{1}{69.5}$ | 3.63 | 2.03 | 0.0081 | 2.038 | 0.563 |
| 2 | 92 | $0.015 = \frac{1}{67}$ | 4.32 | 2.32 | 0.0084 | 2.328 | 0.539 |
| 2.25 | 81.7 | $0.0156 = \frac{1}{64}$ | 5.05 | 2.61 | 0.0086 | 2.619 | 0.519 |
| 2.5 | 73.5 | $0.0162 = \frac{1}{62}$ | 5.82 | 2.9 | 0.0089 | 2.909 | 0.500 |
| 2.75 | 66.75 | $0.0167 = \frac{1}{60}$ | 6.6 | 3.19 | 0.0091 | 3.199 | 0.486 |
| 3 | 61.3 | $0.0172 = \frac{1}{58.4}$ | 7.4 | 3.48 | 0.0093 | 3.489 | 0.472 |
| 3.25 | 56.5 | $0.0176 = \frac{1}{57}$ | 8.22 | 3.77 | 0.0095 | 3.78 | 0.46 |
| 3.5 | 52.5 | $0.0181 = \frac{1}{55.4}$ | 9.05 | 4.06 | 0.0096 | 4.07 | 0.45 |
| 3.75 | 49 | $0.0185 = \frac{1}{54}$ | 10.0 | 4.35 | 0.0098 | 4.36 | 0.436 |
| 4 | 46 | $0.019 = \frac{1}{52.8}$ | 10.8 | 4.64 | 0.00995 | 4.65 | 0.431 |

TABLE III.—REVOLUTIONS PER MINUTE, FEED PER REVOLUTION, CUBIC INCHES REMOVED PER MINUTE AND HORSE-POWER WHEN DRILLING CAST IRON.

Upon the Forces Acting on Twist Drills When Operating on Cast Iron and Steel," presented before The Institution of Mechanical Engineers by Dempster Smith, of the Municipal School of Technology, Manchester, and R. Poliakoff, of the Imperial Technical Institute, Moscow. The authors state that "there is no general agreement amongst the makers of high speed twist drills as to what the cutting speed should be for ordinary workshop practice. Some decrease the speed with the increase of the diameter of the drill, some recommend the reverse, but the most makers advise a constant periphery speed throughout. The mean of these values is about 60 feet per minute with a feed per revolution of $d^{\frac{1}{3}} \div 100$ for mild steel. For cast iron it is usual to decrease the above speed 20 per cent. and increase the feed by a similar amount. Using these figures and the experimental force values given herein an estimate of the net horsepower required for drilling can be made. With the object of presenting these results in concise form and to show at a glance the influences of speed, feed and diameter, the values deduced have been tabulated" (Tables II and III).

One manufacturer writes: "It is practically impossible to give any definite rules for speeds and feeds for the reason that the class of material and the characteristics of each class vary so greatly; also the kind of lubricant, or the absence of it. We have found that one of the necessities for obtaining satisfactory results with our drill is to keep the point of the drill continually buried, *i.e.*, the feed must be such that the cutting lip of the drill will be down in the metal continually. When the speed is high and the feed light the tendency is for the drill to rub, resulting in excessive heating."

A builder of drilling machines arranges the feed and speed plates with the following in view.

Cutting speed for wrought iron and steel............40 to 70 ft. per min.
Cutting speed for cast iron............................60 to 90 ft. per min.
Feeds.......................... .005 to .006 in. for drills from 1/8 to 1/2 in.
Feeds.......................... .007 to .008 in. for drills from 1/2 to 1 in.
Feeds.......................... .014 to .015 in. for drills above 1 in.

In the article on "Some Data on High Speed Drilling" by Geo. E. Hallenbeck in the May issue, page 207, one of the diagrams shows a series of tests which were made to determine the relation between the feed and speed. Curves were plotted showing the maximum feeds at which the drills could be used at different speeds. They indicate that the feed in inches per minute which can successfully be used at low speeds is unsuitable for slightly higher speeds, but that after a certain critical point is reached the rate of penetration may be increased as the speeds are increased. For instance, in one case a 1¼ in. drill was used successfully feeding at the rate of 3.8 in. per minute at 130 r.p.m. At 200 r.p.m. it could only be used at the rate of 2.95 in. per minute; at 300 r.p.m. at the rate of 3.7 in. per minute; at 420 r.p.m. at the rate of 5.4 in. per minute. While these tests were roughly made they indicate the importance of a more careful investigation into this subject from the standpoint of production.

RAILROAD REGULATION.—No one conversant with the facts will deny that there have been mistakes and wrong-doing on the part of the railroads and other large corporations, and the corporations, as well as all good citizens, are glad that checks to stop them have been devised. I do not question the right, the wisdom, or the necessity for the supervision and regulation of railroads by the nation or state that creates them. Under our form of government the people rule, and the terms "rule" and "regulate" are synonymous.—*W. C. Brown.*

(Established 1832).

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**Contributions.**—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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## CONTENTS



## LOCOMOTIVE DATA TABLES.

The tables giving the general dimensions and ratios of recent locomotives, which usually appear in our June number, will this year accompany the July issue.

## ASH PANS.

The new ash pan law which goes into effect the first of next January requires all locomotives engaged in handling interstate traffic to be equipped with an ash pan that can be cleaned without requiring a man to go beneath the engine. There are many locomotives on every road not equipped in this manner at present and in order to assist those who have not yet decided upon the proper design there appears elsewhere in this issue an article briefly outlining a number of different ways in which the compliance with this law has been accomplished. In later numbers we will, from time to time, bring out other designs which have features of merit.

Although the principal problem in complying with this law is confined to the shallow type of ash pan on locomotives with narrow fireboxes between the frames, it is desirable, while the subject is under consideration, to also include a careful investigation of the best design for the hopper type of pan. Ash pans in general are a source of considerable expense on all roads and often are responsible for fires on wooden trestles or bridges, the burning of ties, etc., and need almost constant inspection and renewal of parts to be maintained in a safe condition.

Some of the roads have gone to cast steel ash pans, which do not crack easily and when warped or distorted can be straightened and repaired. There are a great variety of methods of closing the opening in hopper pans, some of which are very ingenious and evidently entirely practical. Considering everything probably the swinging door arrangement, with a turnbuckle in the connecting rod from the operating lever, and a self-locking arrangement to prevent the doors from opening, if the lever becomes unlatched, the doors being dished with inclined sides which will close around the bottom of the hopper and form an ash seal, is probably the most satisfactory for hopper pans. For shallow pans an arrangement of steam blowers for discharging the contents seems to be the most popular.

## EFFICIENT ORGANIZATION.

The attention that has been given to the various phases of this question by the technical press, the engineering associations and railroad clubs indicates that the more progressive officials and managers are awakened to the necessity of giving it their most careful attention.

Three of the papers presented before the New York Railroad Club during the past season referred to this subject. At the November meeting W. J. Harahan, assistant to the president of the Erie Railroad, spoke on "A Search for Those Elements, the Proper Combination of Which Constitutes the Successful Motive Power Official." At the January meeting J. E. Muhlfeld presented a paper on "The Education and Organization of Railway Engineering Labor," and at the May meeting Julius Kruttschnitt, director of maintenance and operation of the Harriman Lines, presented a paper on "The Organization and Operation of the Union and Southern Pacific Systems." At a recent meeting of the St. Louis Railway Club Prof. H. Wade Hibbard presented a paper on "Organization." Our readers are familiar with the work which has been done along these lines during the past few years by this journal.

Would it not be a splendid idea and productive of good results if the Master Mechanics' Association would give the matter of efficient organization a prominent place in its work for the next few years? Is there any question the investigation of which, by its members, will give greater returns?

## THE MOTIVE POWER MAN AS A SUCCESSFUL OPERATING OFFICIAL.

The motive power officials have been responsible to a certain extent for the condition which has led to placing them, in the past, in a subordinate position in the official list of operating officials, because of the fact that in the study of operation they have clearly taken a backward step by advocating a low tonnage for the purpose of saving the locomotives as much as possible Of late there has been a radical change in this position and we now find practically all the superintendents of motive power advocating as high tonnage per train as possible, knowing full well that the expense per thousand ton miles of maintaining locomotives, and all other operating expenses are reduced directly with the increase of train load. There is no danger whatever of overloading locomotives at the present time, since the tonnage must be regulated by the time that each train is required to make.

The operating efficiency of a road depends very largely upon the class and condition of power and the motive power department, when given all the money necessary to keep the power in first-class condition, can aid wonderfully in the operating efficiency by doing everything possible to increase the loading of trains to a point where the tonnage will not be either above or below the amount necessary to maintain the required schedule.

The motive power officials or those who have had experience in the motive power department, have done practically all of the work in connection with the question of train resistance and tonnage rating, and the result of their work is demonstrated in the decrease of operating expenses when they are working in thorough harmony with the other operating officials.

The mechanical officer is an operating as well as a mechanical official, as is shown by the fact that a large number of them have been recognized in the last few years and promoted to higher positions in the operating departments of the railroads. In each of these cases their rise in the service can be attributed to the fact that they had the capacity for grasping the operating problems as a whole and not from a mechanical standpoint only.

## SUPERHEATED STEAM.

Having decided that superheated steam is a good thing in locomotive practice, and it seems to be pretty generally admitted that it is, at least as far as the economy in the engine part of the locomotive is concerned, the next question for decision is the proper degree of superheat to use. There is a wide range of temperature of steam above saturation, which can be obtained on a locomotive and there are strong advocates for the use of both ends of the scale. Some very capable engineers are arguing in favor of a superheat in the neighborhood of 50 degs. above saturation temperature and others advocate from 125 degrees up. The article by Mr. Cole in this issue discusses the whole question in a rational manner and concludes that the greatest economy will be obtained at the higher degrees of superheat. The same conclusion is voiced by Robert Garbe in his articles on "The Application of Highly Superheated Steam to Locomotives," which are based on probably the most extensive experience with locomotive superheaters of any engineer. He states that an average temperature of 570 degs. F. must be maintained in the valve chamber and that the coal and water consumption are considerably increased whenever the temperature falls any appreciable extent below that figure. The tests reported in his articles all average well over 600 degs. temperature in the steam chest, in one case the temperature for a short time being over 700 degs. These were on locomotives carrying 170 lbs. of steam and thus gave a superheat of from 225 to 332 degs.

Steam as used in steam engine practice is simply and entirely a vehicle for transferring heat from the firebox to the cylinder, where the heat is utilized and the vehicle discarded, or in the case of condensing engines, sent back to be used over again. Its work is analogous to that of any other vehicle, as for instance a freight car. The operating and traffic departments of our railways devote a large amount of time and energy in obtaining high average loads per car mile on their lines, it being perfectly evident that an average lading of 30 tons per car is much more profitable in every way than 20 tons per car. A car has to be hauled even if it contains but 5 tons and it will cost but little more to haul it with 30 tons lading. The same thing applies to steam. We have a vehicle which must go over the route and as we want the heat at the other end of the line, why is it not advisable to load each cubic foot of steam with all of the heat that can be used at its destination—the cylinder. In other words, instead of using three 50-ton cars to carry 100 tons of coal, why not put it all on two, provided, of course, that 100 tons can be used at the end of the line. Of course, there are many things in connection with superheated steam which have no analogy in freight car lading, but on the other hand there are features which make them very similar.

## TEST OF LOCOMOTIVES WITH SUPERHEATER AND FEED WATER HEATER.

In 1907 the Central of Georgia Railway received from the Baldwin Locomotive Works an order of ten consolidation locomotives, seven of which were simple engines with Stephenson valve gear. Of the remaining, one was the same design of locomotive fitted with the Walschaert valve gear and numbered 1222; another, No. 1223, had the Walschaert valve gear and was fitted with an original design of feed water heater, which uses a duplex pump in place of an injector. (This locomotive and heater was fully described on page 71 of the February, 1908, issue of this journal.) The third locomotive, No. 1224, was of the same type, but had a Baldwin superheater, the steam pressure being reduced from 200 lbs. to 160 lbs. and the cylinders enlarged from 20 to 22 in. in diameter.

In January of this year it was decided to make an accurate practical comparison of these three different arrangements of locomotives and a train consisting of 15 cars loaded with coal was handled each way over the division from Macon to Columbus, a distance of about 100 miles, by each engine in turn, the test also including the data on locomotive No. 1081, which is of the same class, but had Stephenson valve gear. The locomotives were operated by the same engineer and fireman in each test, the tests being run on consecutive days. The train was identical in each case and the coal and water was, of course, of the same quality The tests were made primarily to find out the difference in coal and water consumption and these were very carefully weighed and measured.

The results shown in the accompanying table are very decidedly in favor of the locomotive with the feed water heater, which

| LOCOMOTIVE NO. | 1224 | 1223 | 1222 | 1081 |
|---|---|---|---|---|
| With | Baldwin Super-heater | Feed Water Heater | Walschaert Valve Gear | Stephensen Valve Gear |
| Steam pressure, lbs. | 160 | 200 | 200 | 200 |
| Cylinders, in. | 22 x 28 | 20 x 28 | 20 x 28 | 20 and 28 |
| Drivers, in. | 57 | 57 | 57 | 57 |
| Heating Surface, Sq. Ft. | 2458 | 2314.3 | 2314.3 | 2263.8 |
| Grate Area, Sq. Ft. | 44 | 44 | 44 | 44 |
| Tractive Effort. | 34000 | 34000 | 34000 | 34000 |
| TRAIN NOS. | 35 and 38 | 35 and 38 | 35 and 38 | 35 and 38 |
| Date, Jan. 1909. | 4 and 5 | 6 and 7 | 8 and 9 | 11 and 12 |
| Time on Road, Round Trip. | 13 h-29 m | 13 h-51m | 13 h-35m | 13 h-37 m |
| Stops, Number. | 19 | 18 | 23 | 17 |
| Stops, Time Consumed. | 2 h-29 m | 2 h-23 m | 2 h-40 m | 1 h-46 m |
| Ton Mileage, Total | 205740 | 205740 | 205740 | 205740 |
| Coal Consumed, lbs. total. | 24200 | 20050 | 23700 | 22650 |
| Coal Consumed, per 1000 T M | 118 | 98 | 115 | 110 |
| Water used, lbs. total. | 168866 | 144375 | 166100 | 156242 |
| Water used, per lb., Coal. | 6.98 | 7.13 | 7.01 | 6.90 |
| Miles run, per ton of coal. | 16.5 | 19.8 | 16.9 | 17.7 |

burned but 98 lbs. of coal per 1,000 ton-miles as compared with 110 for the simple locomotive with Stephenson valve gear and 118 for the superheating locomotive: it evaporated 7.13 lbs. of water per lb. of coal as compared with 6.98 for the superheater locomotive.

# SELF CLEARING ASH PANS.

*On and after the 1st day of January, 1910, it shall be unlawful for any common carrier engaged in interstate or foreign commerce by railroads to use any locomotive, in moving interstate or foreign traffic, not equipped with an ash pan which can be dumped or emptied and cleaned without the necessity of any employee getting under such locomotive.—Approved May 30, 1908.*

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The so-called ash pan law, the first section of which is given above, applies to all railways handling interstate traffic in any of the States or Territories of the United States and the District of Columbia. Its enforcement is intrusted to the Interstate Commerce Commission, whose powers are extended for that purpose and a penalty of $200 for each and every violation of the law is provided.

This law requires the application to all locomotives of a design of ash pan which does not require the use of a hoe or bar for cleaning unless these tools can be used by men standing alongside the locomotive. Practically all the wide firebox engines, both hard and soft coal burning, are already properly equipped, as are also a fair proportion of the narrow firebox type where the firebox rests on the frames. Practically none of the locomotives with narrow fireboxes set between the frames have had ash pans which are self-clearing, and it is for pans on and at the same time form a comparatively tight joint with its frame.

There are, in general, three designs of ash pan doors on hopper pans in use. First, and by far the most common, is a sliding door, which usually slides longitudinally in a guide on the bottom of the hopper. The second method is to use an ordinary hinged door, which is closed and held in place by connecting rods from an arm on the operating shaft. In a few cases only is this type of door automatically locked when closed. The third method is what might be termed a swinging door, *i. e.*, a door hung from links pivoted above and ahead of the center line of the hopper which allow the door to swing downward and forward to entirely clear the opening. In addition to these, there are several special arrangements which will be illustrated and described later in this article.

With the shallow type of ash pans applied to narrow firebox

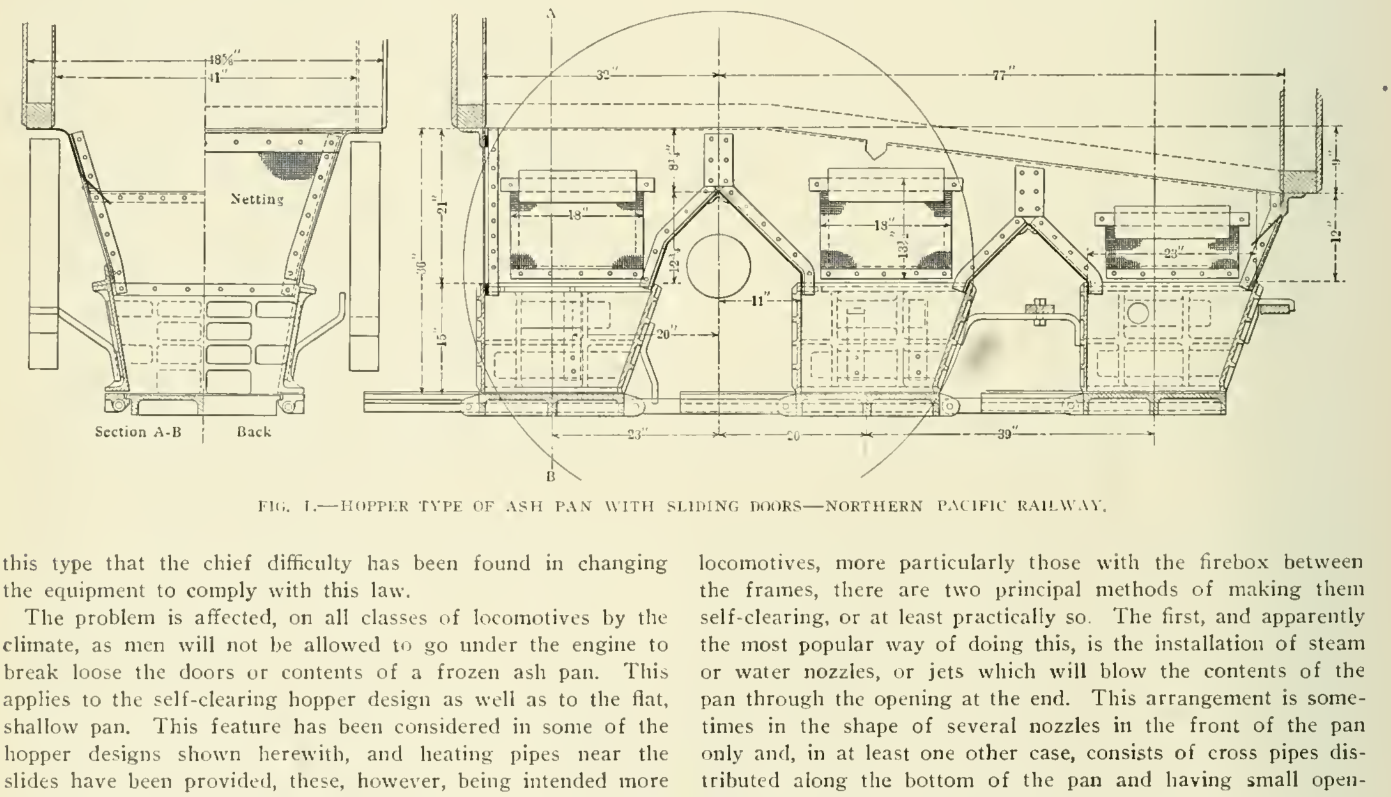


FIG. 1.—HOPPER TYPE OF ASH PAN WITH SLIDING DOORS—NORTHERN PACIFIC RAILWAY.

this type that the chief difficulty has been found in changing the equipment to comply with this law.

The problem is affected, on all classes of locomotives by the climate, as men will not be allowed to go under the engine to break loose the doors or contents of a frozen ash pan. This applies to the self-clearing hopper design as well as to the flat, shallow pan. This feature has been considered in some of the hopper designs shown herewith, and heating pipes near the slides have been provided, these, however, being intended more for loosening a frozen door than to thaw the contents, which will probably have to be loosened up by pounding on the outside of the hopper. In some of the designs of shallow pans illustrated, heater pipes for loosening the whole contents of a frozen pan have been provided.

With wide firebox locomotives the ash pans are usually of the hopper type which, if the opening is at the bottom, makes them self-clearing in the ordinary accepted sense of the term and the difference of design on these locomotives consists principally in the kind of a door used to close the hopper opening.

The principal requirements of a satisfactory ash pan door are that it be capable of being closed sufficiently tight to prevent hot cinders escaping and that it either will not warp or at least be capable of being properly operated when somewhat warped locomotives, more particularly those with the firebox between the frames, there are two principal methods of making them self-clearing, or at least practically so. The first, and apparently the most popular way of doing this, is the installation of steam or water nozzles, or jets which will blow the contents of the pan through the opening at the end. This arrangement is sometimes in the shape of several nozzles in the front of the pan only and, in at least one other case, consists of cross pipes distributed along the bottom of the pan and having small openings arranged to give jets which will force the contents toward the rear. The other method used on shallow pans is to provide openings in the bottom, usually closed by means of sliding doors. This scheme does not always give an absolutely self-clearing pan, but approaches it very closely. Several arrangements of the jet scheme will be illustrated and described later.

Considering in detail some of the designs which fulfil the requirements of the ash pan law and have been in successful use for some time, following the general scheme of classification given above, we will first take up

THE HOPPER TYPE.

*Sliding Doors.*—The ash pan shown in Fig. 1 is a design which has been in use for a number of years on the Northern Pacific and has proven to be entirely satisfactory. The arrange-

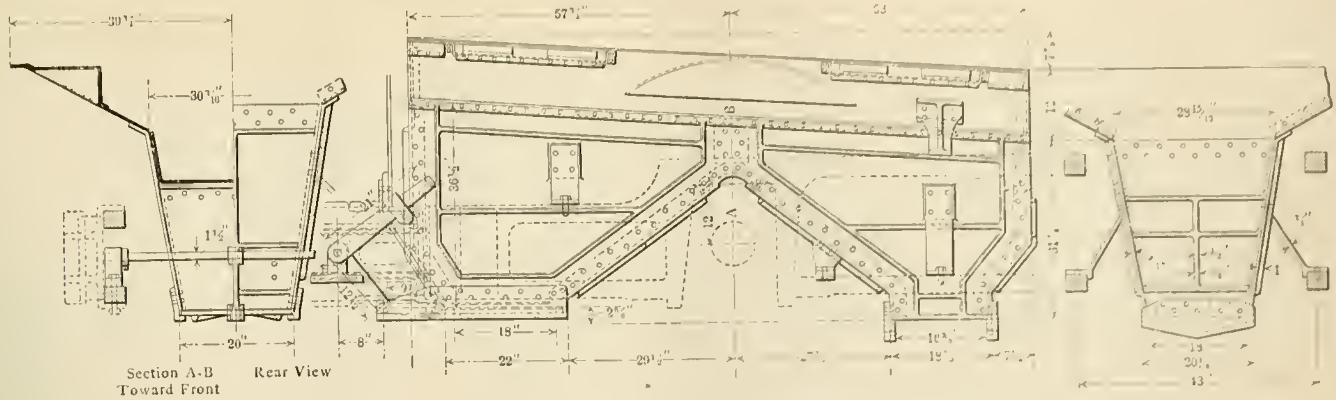


FIG. 2.—CAST IRON ASH PAN—CENTRAL RAILROAD OF NEW JERSEY.

ment, of course, is varied for different classes of engines, two hoppers being used instead of three in some cases. The pan proper is made up of sheet metal in the usual form, liberal air openings covered with netting being provided. The hoppers themselves are of cast iron or steel about 15 in. deep. The frame forming the guide bolted to the bottom of the hopper is cored out for its full length and tapped at the end for the introduction of a ¾ in. pipe. Several small holes are drilled from this cored passage to the bearing of the slide and steam for thawing out a frozen slide is introduced in this way. The sliding wedge on the guide castings, which forces the doors to a tight bearing against the bottom of the hopper after they are in a closed position. This feature also permits them to be given more clearance in the guide than would otherwise be advisable.

The ash pans on the Chesapeake and Ohio Railway are built up of steel plates, liberal provision for air openings being made in the upper sections. The hoppers proper are separate from the upper part of the pan, so that they can be removed and repaired or renewed as they become unsafe. A cast steel hopper bottom and slide or door is used on this road, the details of which are

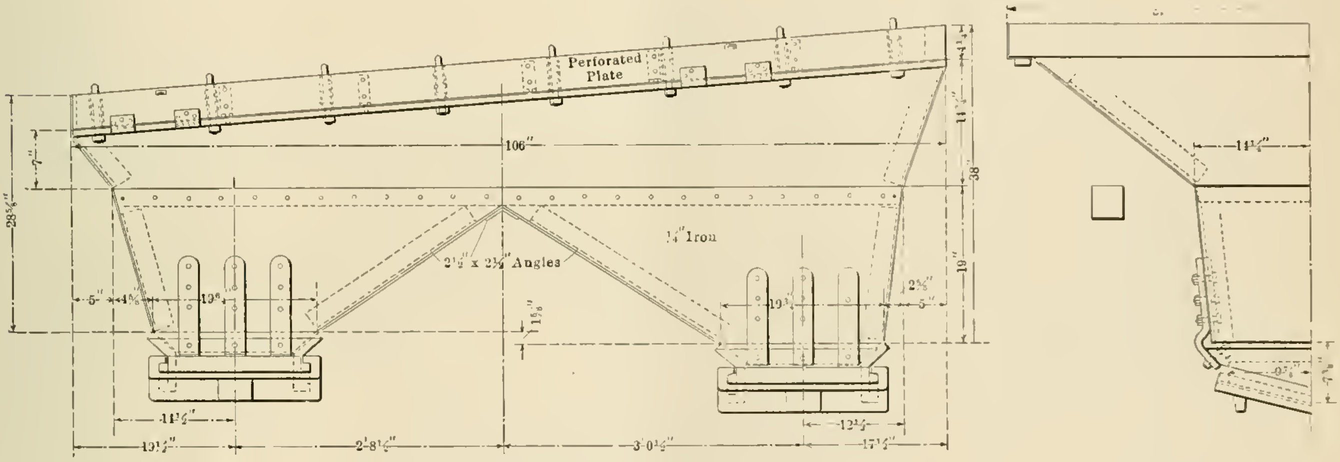


FIG. 3.—HOPPER TYPE OF ASH PAN—CENTRAL OF GEORGIA RAILWAY.

doors are of cast iron chilled on their bearing surfaces and deeply ribbed to prevent warping. All three doors are operated together, the operating mechanism connecting to each side of each door, thus preventing them getting cocked and binding.

Figure 2 shows a pan applied to Wooten fireboxes on the Central Railroad of New Jersey, which is largely constructed of cast iron. It has two hoppers, the rear one having a door sliding in a longitudinal direction and the front one, double doors each set on an incline and sliding in a lateral direction. The front hopper has no operating gear.

A design similar to this front hopper is used on the Lehigh Valley Railroad for both hoppers of pans on Wooten firebox locomotives. In this case, however, the pan is built up of steel plates, a casting being riveted on the bottom of the hopper to form the guide. The double sliding doors are arranged to hook over the guide on the frame instead of sliding in a slot. Almost identically the same design is also used on wide firebox locomotives on the Central of Georgia Railway, the details being shown in Fig. 3, and it is also standard on the Philadelphia & Reading Railway.

The ash pan used on culm burning locomotives on the lines of the Delaware & Hudson Company has two hoppers fitted with longitudinal sliding doors operated together by one gear, the connections between the doors being triple. A feature of this design which is admirable is the arrangement of an incline or shown in Fig. 4. All of the slides are operated from one shaft at the rear, the connecting links being of 2¼ x 1 in. bar. A somewhat similar type of door is used on the Norfolk and Western Railway, the slides, however, in this case being formed of 3 x 2 x 9/16 in. angles riveted to the bottom of the hoppers. The doors are fitted loose, a play of ⅜ of an inch being allowed between the bottom of the hopper and the top of the door. The doors in this case are operated by an air cylinder, which is supported directly back of the rear hopper and has its piston connected directly to the door of this hopper. A stop is provided

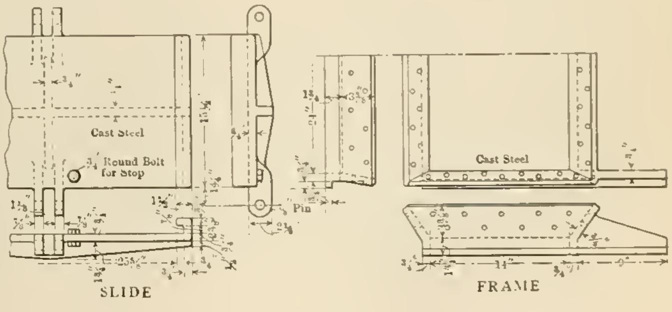


FIG. 4.—CAST STEEL ASH PAN SLIDE AND FRAME—CHESAPEAKE AND OHIO RY.

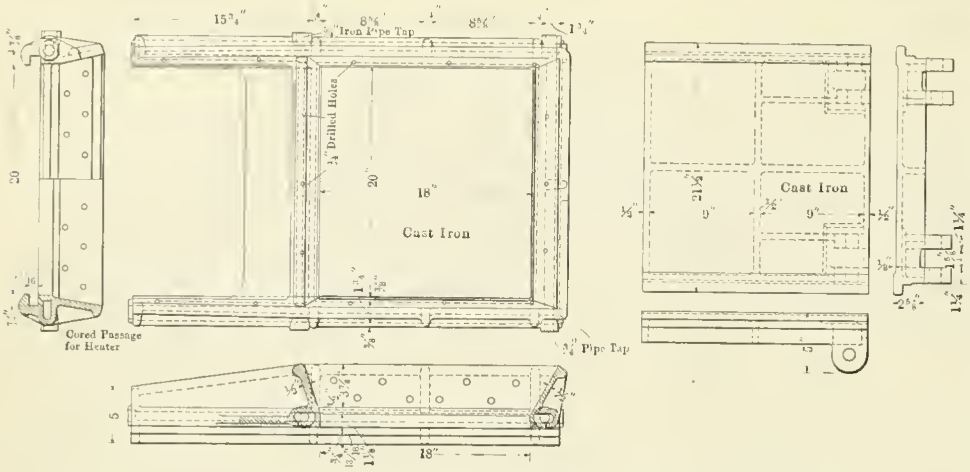


FIG. 5.—CAST IRON ASH PAN SLIDE AND FRAME WITH HEATING PASSAGES—BALTIMORE AND OHIO RAILROAD.

on the front hopper which prevents the piston striking the head of the air cylinder. A lock, consisting simply of a pin inserted through a hole in one of the angle irons in the bottom of the hopper and projecting down back of the slide, prevents the doors being opened accidentally. This arrangement has been in successful service on this road for several years.

On the Baltimore and Ohio Railroad a design of hopper frame and guide and sliding door, shown in Fig. 5, is used. This frame is provided with a cored passage all around the hopper opening with small vents to the slide bearing. The ash pans on this road are very liberally provided with nettings and have the hopper section constructed so as to be easily detachable. Double connecting rods connect all of the slides to one operating lever. A very similar design is employed by the Canadian Pacific Railway, the principal difference being that in this case the slides on each hopper are operated independently. This design is, however, still in the experimental stage on that road.

A double sliding door, operating laterally, is used on the Galveston, Harrisburg and San Antonio Railway on two-hopper ash pans. The two doors on each side of the locomotive are operated by an air cylinder through cranks and connecting rods. The arrangement is such that the doors are held closed by gravity in case of the failure of any of the connections.

A design for a hopper type of pan about 18 in. in depth which is being applied to six wheel switching locomotives on the Michigan Central Railway, is shown in Fig. 6.

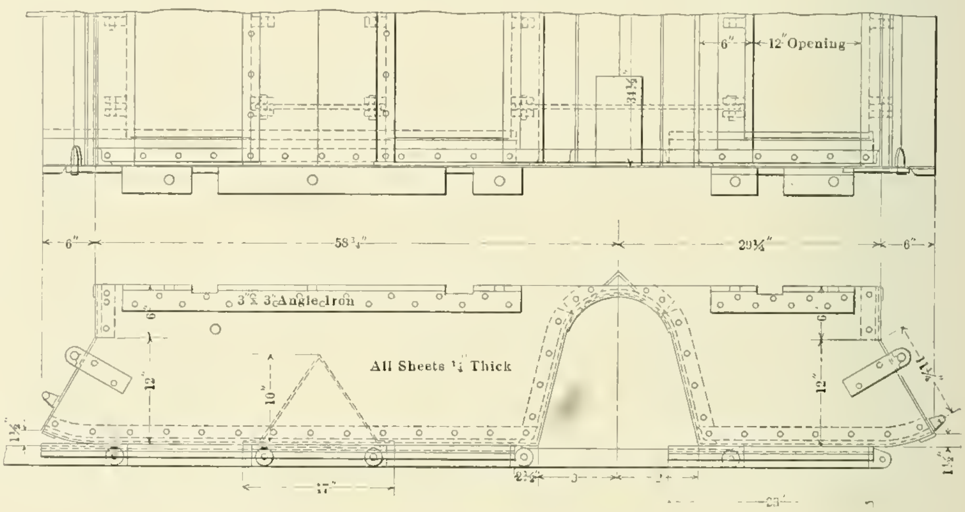


FIG. 6.—ASH PAN FOR SIX-WHEEL SWITCHERS—MICHIGAN CENTRAL RAILWAY.

Other railroads using the hopper type of pan with sliding doors all have designs which closely approach some of those already mentioned, the arrangement of the steam pipe around the hopper frame and guide being quite generally used on lines in cold climates.

The general plan seems to be to operate all of the slides or doors from one operating mechanism, the connecting rod normally being double, one on either side, between the different doors. Cast steel frames are used in a number of cases and in a few cases the slides themselves are made of cast steel. The usual custom is to form the hopper section of the pan separately from the upper and wider section and in several cases to form each hopper separately, the connections being made by angle irons on each part. Power operated slides are not as numerous as those arranged to be opened by hand levers. Adjustable dampers are applied but infrequently, the usual custom being to have liberal air openings in the sides and ends of the pan, near the top, which are covered with netting.

*Hinged Doors.*—Figure 7 shows a design of ash pan of the hopper type for hinged doors, which has proven very satisfactory after a long service on the Wabash Railroad. It will be seen that the operating gear, independent for each hopper, is so arranged that when the doors are closed they are also practically locked and the strain, due to the weight of the contents against the door will not force it open in case the operating lever becomes unlatched. This feature has caused considerable trouble with this arrangement of ash pan doors on many railroads where the doors have been held in place entirely by the locking of the operating lever.

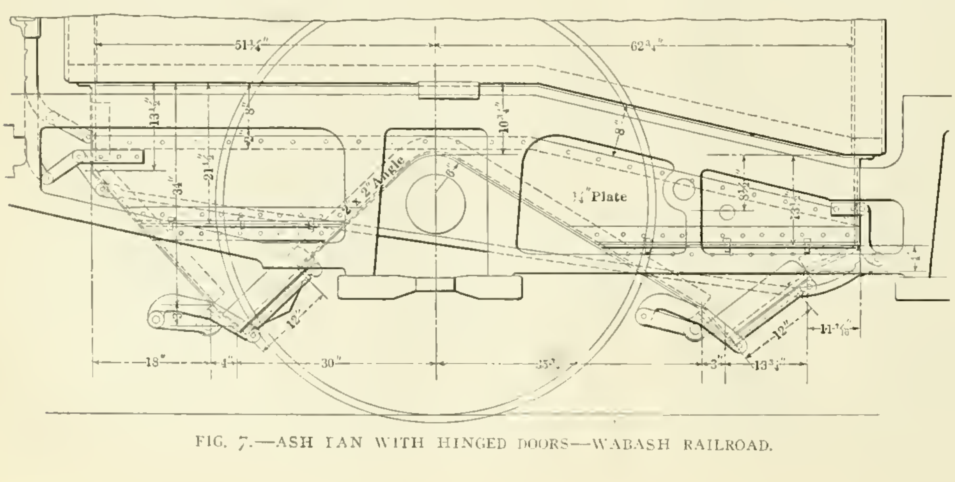


FIG. 7.—ASH PAN WITH HINGED DOORS—WABASH RAILROAD.

The hinged door type of pan has been in quite general use for a number of years and in some cases has proved to be very satisfactory. The chief objection to it seems to have been the difficulty of keeping a tight joint after the doors have become somewhat warped and this has been held responsible for a number of disastrous fires on bridges and trestles.

*Swinging Doors.*—This arrangement for closing the bottom of

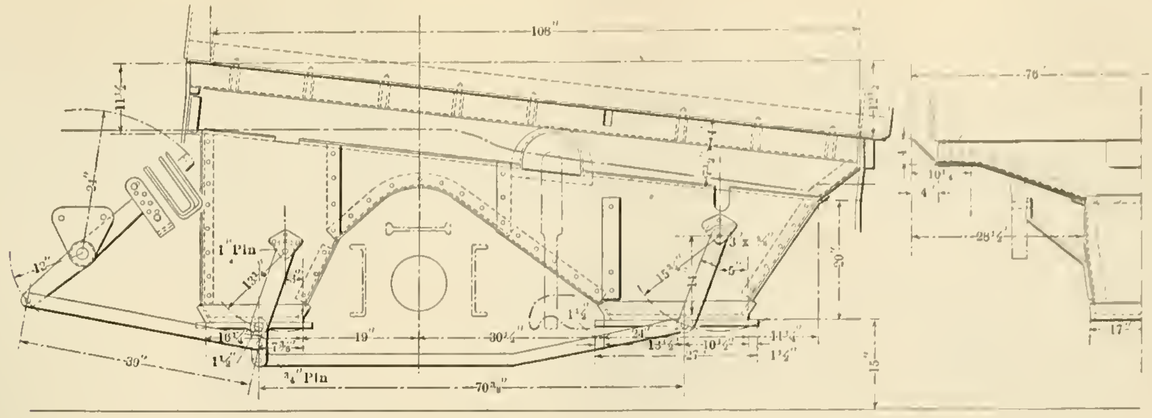

FIG. 8.—ASH PAN WITH SWINGING DOORS—CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY.

the hopper ash pan has many features of advantage and has been used with considerable success on a number of roads. Figure 8 shows the design on the Chicago, Milwaukee and St. Paul Railway, the construction of which is clearly shown in the illustration. The chief objection that can be brought against this arrangement is that the accidental unlocking of the operating lever permits the doors to swing open by gravity. A design on

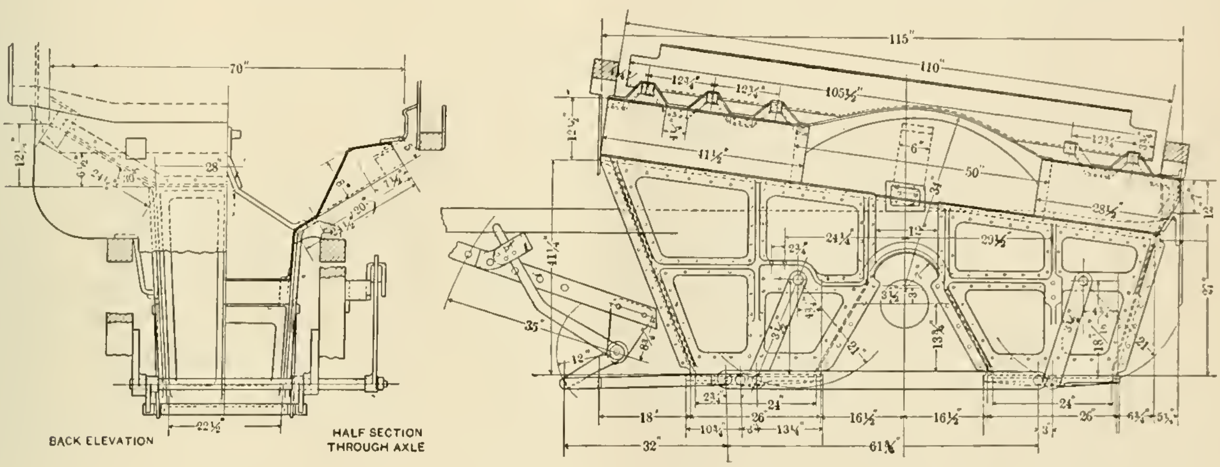


FIG. 9.—CAST IRON ASH PAN WITH SWINGING DOORS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

the same principle is in use on the Great Northern Railway. The pan in this case has cast iron hoppers of the same general design as illustrated in Figure 1. In this arrangement the operating lever is fitted with a pawl working in a tooth quadrant, which it would seem to be almost impossible to accidently unlatch and which will also permit the doors being brought to a tight bearing after the pins are worn or the connecting rods bent. The rod connecting the operating lever with the equalizing link in this case is fitted with a turnbuckle for adjusting its length to suit the notches in the quadrant.

The Central Railroad of New Jersey is using an ash pan with cast iron hopper which has swinging doors of this same general design, as is also the Lake Shore and Michigan Southern Railway, where the design shown in Figure 9, applied to consolidation locomotives, has been found to be very successful. In this case the hoppers are made of cast steel, which permits them to be straightened and put back into service after they have become badly warped. Cast iron sections which were first tried become warped and cracked beyond repair.

*Special Arrangements.*—A radial door type of hopper ash pan, shown in Figure 10, has been in use for some time on the Buffalo, Rochester and Pittsburgh Railway, and has proven to be very successful. This type of door will remain in the open or closed position by gravity. It can easily be swung open and is not inoperative when frozen. The frame is made of cast steel, the door is of cast iron and the shaft bushings are of malleable iron. Each door is operated independently, as shown. A patent has been applied for on this device.

A swinging gate type of pan, shown in Figure 11, is in use on the Atlantic Coast Line. In this the gate or valve closing the bottom of the hopper is made considerably larger than the opening and thus avoids any trouble with distortion of the pan or valve and also allows it to overlap the edges at the bottom of the hopper, so as to form what might be called an "ash seal." The arrangement of the operating lever is such that in its closed position the short arm of the bell crank has passed the dead

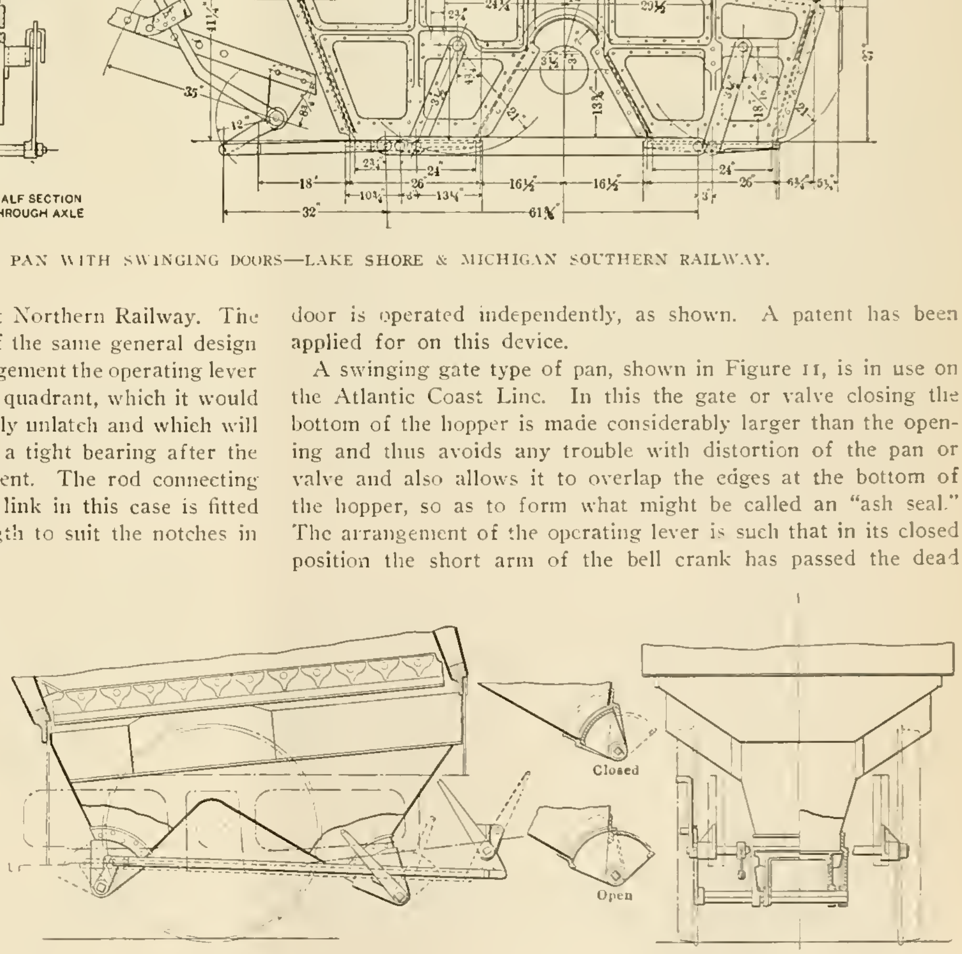


FIG. 10.—ASH PAN WITH PATENTED RADIAL DOORS—BUFFALO, ROCHESTER AND PITTSBURGH RAILWAY.

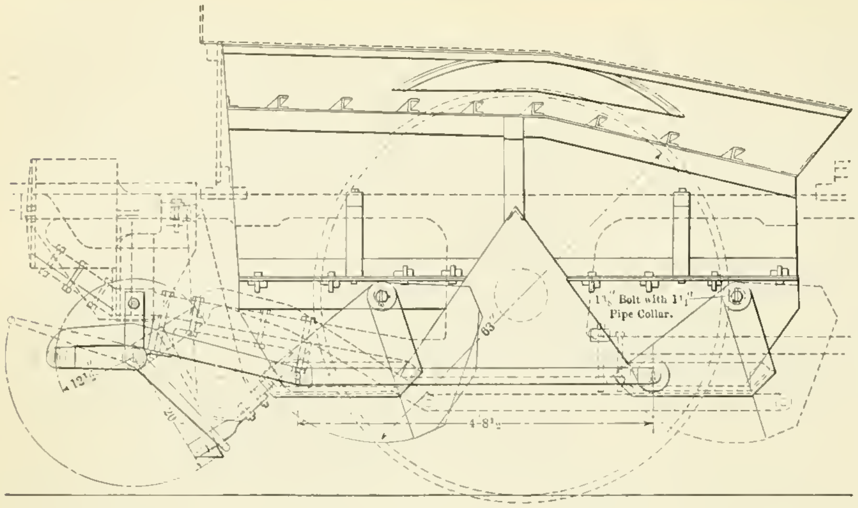


FIG. 11.—ASH PAN WITH SWINGING GATE—ATLANTIC COAST LINE.

center and any tendency of the valve to open by gravity is resisted in this way.

A hopper design of ash pan having a closed flat bottom and vertical hinged doors at the end is used on the Mobile and Ohio Railroad. The contents of this pan are discharged by a steam blower set in the forward end on the bottom of the pan, there being a single nozzle in each hopper. The connection to the blowers is through a 1¼ in. pipe.

### Shallow or Flat Ash Pans.

*Blower Discharge.*—The most generally adopted method of complying with the new law in the case of shallow ash pans has been by the introduction of steam jets which force the contents of the pan through an opening at the rear. One method of doing this which is in use on the Illinois Central Railroad, is shown in Figure 12. A 1¼-in. pipe with four nozzles, consisting of the same size pipe flattened down to a ¼-in. opening, is placed in the front end near the bottom of the pan, and connected to the bottom of the boiler ahead of the firebox, at which point a globe valve is provided. At the back end of the pan a shield or guide is fitted for forcing the discharging contents down into the cinder pit, and preventing them from being blown back on the tender truck. Practically the same thing is used on the Atlantic Coast Line for shallow pans, except that in this case the nozzles consist simply of a piece of ¾-in. pipe with a reducing bushing.

On the Central of Georgia Railway the same idea is employed, a difference, however, being made in the shape of the pan, which is curved on the bottom instead of flat and has one nozzle located near the bottom in the center and one at either side on a higher level. The pan in this case is 16 in. deep in the center.

On the Norfolk and Western Railway a plan is being tried which incorporates a series of cross pipes at the bottom of the pan, as is shown in Fig. 13. These pipes, as at first tried, were ¾ in. and had a series of 3/16 in. holes drilled in the forward side. Cast iron shields were provided back of each pipe, as is shown in the illustration. The arrangement as shown, however, did not prove to be entirely satisfactory and larger pipes are now being experimented with.

*Sliding Doors.*—Figure 14 shows a sliding door type of shallow ash pan which is in use on the Illinois Central Railroad. This pan is formed with a cast iron bottom which has three openings 10 in. wide for the full width of the pan. These are covered by sliding gates of the shape shown in the illustration operated by connecting rods, one on either side. A pair of ¾-in. heater pipes are provided along the bottom, one on each side of the pan. An arrangement of sliding doors with the shallow pan is used on the Galveston, Harrisburg and San Antonio Railway, which is practically self-clearing. The doors are double, and the pan is formed into three very shallow hoppers having openings 17 x 19½ in. The sliding doors are made of plates and work in cast iron guides. They are operated by air cylinders, one on either side of the locomotive. Another type which approaches this same principle is in use on the N. C. & St. L. Ry. and is shown in Fig. 15. The arrangement in this case is clearly shown in the illustration. The pan is tight in every particular, swinging dampers only being provided for air inlets. The doors are continuous for the full length of the pan and are connected to the operating cranks at two points.

*Side Opening Pans.*—A design of ash pan has been applied by the Boston and Maine Railroad which simply provides openings closed by slides in the side of the pan, and the contents are discharged by men standing outside of the engine and using a hoe.

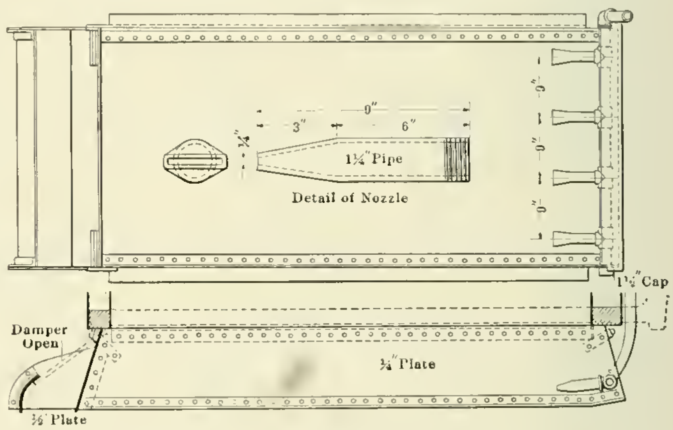


FIG. 12.—SHALLOW ASH PAN WITH BLOWERS—ILLINOIS CENTRAL RAILROAD.

*Special Arrangements.*—A self-clearing arrangement of shallow pan, designed on a very novel principle, is in use on the Chesapeake and Ohio. This might be termed a shutter type of ash pan, in that the bottom of the pan is formed of a series of cast iron shutters somewhat approaching a rocking grate in general principle, except that they are not provided with fingers. Each swings around trunnions resting in side bars on the bottom of the pan. They are operated by short arms projecting up at one end and connecting to bars in the same manner as grates are con-

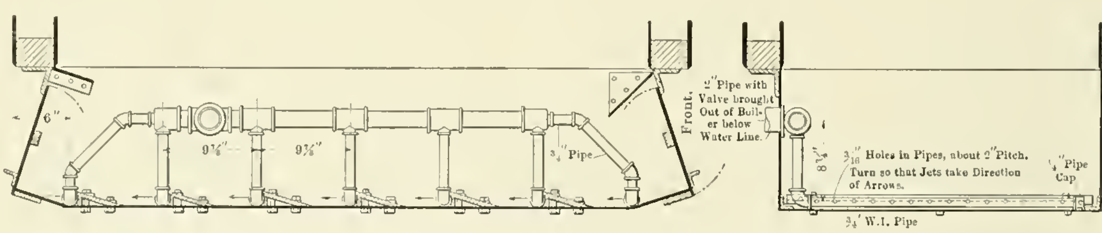


FIG. 13.—SHALLOW ASH PAN WITH A SERIES OF BLOWERS—NORFOLK & WESTERN RAILWAY.

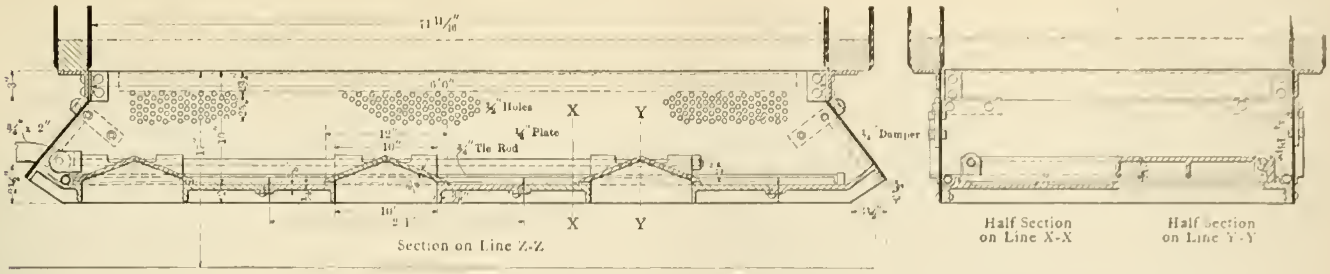


FIG. 14.—SHALLOW ASH PAN WITH SLIDING DOORS—ILLINOIS CENTRAL RAILROAD.

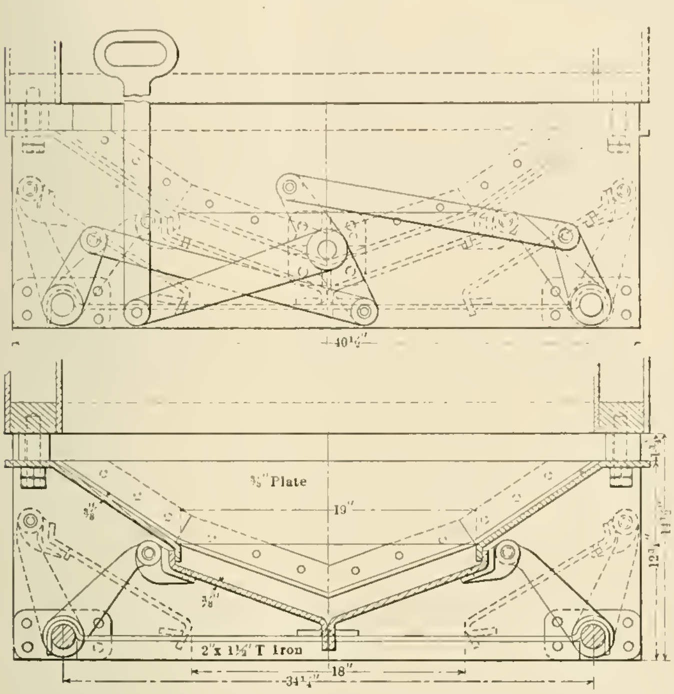


FIG. 15.—SHALLOW ASH PAN WITH LONGITUDINAL SLIDING DOORS—NASHVILLE, CHATTANOOGA AND ST. LOUIS RAILWAY.

nected. When the operating lever is moved the shutters will discharge the complete contents. This design has proven to be satisfactory in practice.

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## EXPERIENCE WITH THE JACOBS-SHUPERT FIREBOX

To the Editor:

The letters to your journal in reference to the new sectional type of firebox designed by Jacobs and Shupert have been so positive both pro and con of the advantages and disadvantages in the new type of construction, and the advantage claimed by one person having been considered a disadvantage by another party so positively, that I should like to clear away the mists and present some of the facts already developed in actual operation.

I have been in a position to watch the operation of this firebox in light and heavy service, having ridden on it half way across the continent and having observed it in actual service pulling 1030-ton trains up 1.8 per cent. grades. Up to the present time the firebox has proven a decided success, having already fulfilled many of the claims made for it on the part of its inventors; at this time it promises to make good on additional claims hardly anticipated during its construction.

The circulation in this firebox has been the cause of a great deal of comment. An authority of high standing, after having watched the temperatures of the water in the different portions of the boiler, in which thermometers were placed, was astonished at the results shown, and remarked that the circulation was either very poor or it was better than anything in water circulation that he had ever seen or conceived. Observations made since that time have confirmed his conviction that the circulation is far superior to that in the ordinary firebox.

The class of engine to which this boiler is applied is used by the Santa Fe for heavy duty freight service in the mountainous desert districts where the grades are heavy and the water is bad. The fuel used is California oil, and the length of the district is 148 miles from Needles, Cal., to Seligman, Ariz. The schedule time is eleven hours for certain classes of freight. There is a rise of 5,010 feet in 125 miles, much of the grade being 75 and 95 feet per mile.

After having pulled a heavy load for 11 to 13 hours on one day, one of these locomotives is called upon the next day to take a 20 per cent. greater load down the mountain when drifting conditions tend to be most destructive upon the life of the engine because of the almost instantaneous change from extremely heavy to very light service. Moreover, these engines are subject to unavoidable changes in temperature in the firebox due to the fact that they are oil burners. The temperature in the firebox is several hundred degrees higher than that in a coal burner. As soon as the engine pulls over a hard grade and starts to drift the oil is shut down and the cold air rushes in, tending to cool the box with great rapidity. In coal burning engines these severe conditions, due to temperature changes, do not exist, due to the radiation from the glowing coals.

In the October, 1908, issue of your journal there is a remarkably clear, comprehensive and practical article on "Care of Boilers at Terminals," by J. F. Whiteford. This article shows graphically the temperature changes in the boiler with an ordinary firebox due to different methods of handling. The first exhibit shows that there is a change of temperature of 210 degrees due to use of injector while standing. Thermometers inserted in the same relative positions show that the temperature change is not over 60 degrees, under same conditions for Jacobs-Shupert firebox. During a period of operation the water does not vary over 10 degrees in different portions of the firebox, above the brick work. This constancy in temperature is wonderful to note and means a great deal in prolonging the life and eliminating the repair work of the firebox.

Under adverse conditions, with heavy load on a hard grade, with bad water very liable to foam and without blowing out, as is done in regular practice, engine 917 equipped with the Jacobs-Shupert firebox, carried her water extremely well and never was on the point of raising it. This fact of operation is a proof of the practicability of the firebox.

The liability of the sections to change shape has been a much mooted point and the argument has been advanced that the vibration of the firebox due to temperature variations will break the stay sheets. Now the design is such as to prevent all vibration of the stay sheets, the sectional construction taking up all expansion and contraction and producing no stresses on adjacent sections.

The design has met with the approval of nature and natural forces. A template was constructed that conformed with extreme accuracy to the contour of several sections of the inner portion of the firebox most susceptible to change of form. After experiencing hard service the firebox was examined and found to be in absolutely perfect condition, not a leak developed, the mud-ring construction was firm and true, and the template showed absolutely no permanent change in the contour of the sections.

An inspection showed no accumulation of sediment in any portion of the boiler. The inspection also showed that there is still much truth in the old saying, "Do not cross a bridge until you get to it." "Circulation" has been losing lots of sleep for fear that much scale would form on the rivets, he may as well nap a bit, for after five weeks there has been absolutely no scale found on the rivet heads, in fact there is no tendency thus far for scale to form either on the rivet heads, on the outer walls, or on the stay sheets.

Mr. Wood on page 201 of the May issue evidently has had a different experience regarding incrustation. The only explanation that seems reasonable is that he has a different kind of a firebox, one not eliminating fully enough the objectionable features of the ordinary construction. This fact is perhaps more forcibly made evident upon consideration of the staybolt problem.

He emphasizes the fact that his construction eliminates as many as 350 staybolts in a single firebox. In the firebox displaced by the Jacobs-Shupert there are 902 staybolts on the sides, 390 in the door sheet and 336 radial stays in the crown sheet; the grand total is 1395 staybolts, and 336 radial stays. In the Jacobs-Shupert firebox there are 312 staybolts in the door sheet and 110 in the flue sheet; the sum is 422. There is an elimination of 973 staybolts and 336 radial stays. Moreover, the length of the Jacobs-Shupert firebox is 21 inches greater than the ordinary. Figured on the elimination of staybolts for the same length of firebox, we find that the Jacobs-Shupert firebox dispenses with 1125 staybolts and 400 radial stays.

In the latter construction there are 1764 rivets for the inner and 1204 rivets for the outer portion, a total of 2968 rivets.

The steam pressure carried is 225 pounds which involves the highest stresses the firebox will ever get in practical service; the water used is very hard on boilers; the service is excessively hard and necessitates a boiler being in fine condition at all times.

This engine carries her water exceptionally fine. It is able to hold 4 and 5 inches of water in the gauge glass when other engines of her class can carry scarcely 1 inch. The improved circulation in this boiler allows the water to keep comparatively clear in the top of the boiler while impure in the bottom.

The positive assertions of Mr. Wagstaff in the last issue of your journal on the perfect water circulation in this firebox have been fulfilled to a letter. His keen judgment and his extensive practical experience enabled him to predict with great accuracy on the essential points in the operation of this firebox.

NEEDLES, CAL. H. P. MACFARLAND.

## FLANGE WEAR OF DRIVING TIRES.

BY R. H. ROGERS.

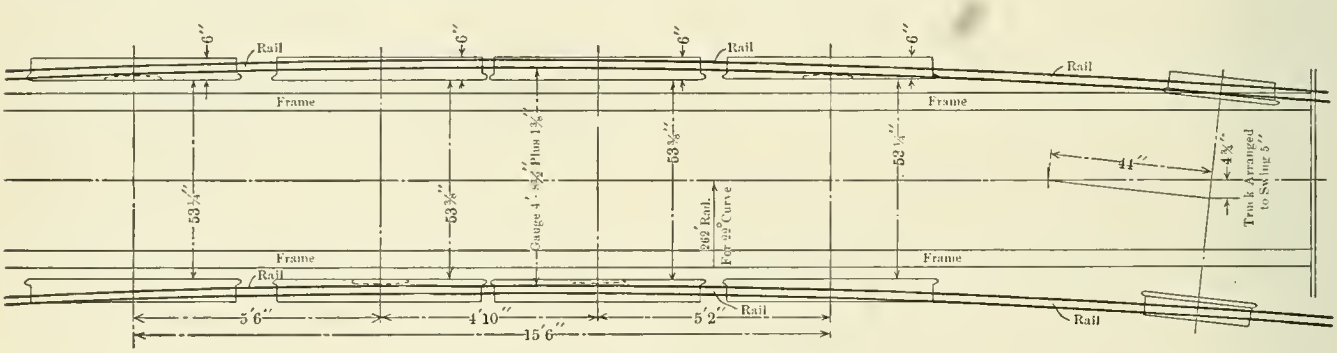
That the subject of flange wear on locomotive driving wheel tires has not been given more attention by the various railroad clubs and other railway mechanical associations is surprising in view of the fact that on many roads it has grown to be an important feature of expense which is well worthy of careful investigation. When it is considered that driving tires often have to be changed in three months from the date of application, and there are instances where they have been condemned in six weeks time because of sharp flanges, certainly an intelligent sifting ot this troublesome detail should afford interesting material for discussion which can not fail to be of general interest.

The question naturally occurs, "Can flange wear be eliminated?" Some roads have such a high percentage of curves that flange wear must inevitably ensue to a certain extent, and under such conditions it is no more susceptible of elimination than any other feature of locomotive deterioration, but after extended observation along this line the writer believes that even in extreme cases it can at least be controlled sufficiently to prevent the removal of the tires for turning between each general shopping of the locomotive and that in other cases it can be practically eliminated.

There are certain recognized standards for the spacing of the tires, measured across the engine, for each pair of wheels, and the mere matter of fully living up to these standards, and disregarding all contributing causes of flange wear, will in most cases reduce this trouble fifty per cent. This may appear an extravagant statement, as it would imply that a disregard of standards exists in all cases where tire troubles are in evidence. It should not, however, be so construed, but rather that there is a laxity in the shops in this important regard which escapes the management, who, with the knowledge that prints and instructions exist, thoroughly covering the matter in detail, are often lulled into a false security under the impression that the mere presence of these in the tire gang conveys the assurance that they will be lived up to.

So many errors in the correct setting of tires have been noted on so many railroads, that, in the consideration of flange wear, improper spacing of tires must be assigned as the primary cause. Improper spacing of tires in this sense is intended to mean carelessness in securing the exact measurement from one tire to another, on the same pair of wheels, as laid down in the standard practices.

To illustrate, we will assume a 2-8-0 engine, of 15 ft. 6 in.




CONSOLIDATION LOCOMOTIVE ON A 22 DEGREE CURVE.

rigid wheel base, and having all tires flanged. What may be considered as standard tire setting for this type is:—intermediate and main tires 53⅜ in. apart, measured of course between inside faces of the tires, front and back pair of tires set 53¼ in. apart. Thus the setting on the entire wheel base of this engine would be: No. 1, 53¼ in.; No. 2, 53⅜ in.; No. 3, 53⅜ in., and No. 4, 53¼ in. This arrangement is to relieve the flanges on Nos. 1 and 4 tires while rounding curves of short radius. There is no dispute but that this setting in of the front and back tires is not only permissible but actually necessary. This is well illustrated by the accompanying diagram, which represents this engine laid down on a 22 degree curve, 262 feet radius. Everything is to scale, and both engine and curve are as they actually exist on the Mexican Central Railroad.

This diagram graphically portrays the exact position of each and every wheel on the two rails. It will be noted, notwithstanding the degree of curvature, that the flanges of Nos. 2 and 3 wheels are evenly against the rail on the low side, and, as that rail is curving away from these flanges, in both directions, it can be readily appreciated that they are not receiving abuse other than what may be expected from natural wear. On the contrary the diagram plainly indicates that the flange of No. 1 wheel, on the high side of the curve, is grinding sharply against the rail, and that the flange of No. 4 wheel, on the same side, is dragging on the rail, although tending to move away from it.

It is this grind of No. 1 and drag of No. 4 flange, assuming the locomotive to be running ahead, or vice versa if running backward, which makes it mandatory that Nos. 1 and 4 tires shall be set closer together than Nos. 2 and 3. To appreciate that this setting in does constitute a relief, it should be borne in mind that Nos. 2 and 3 flanges are practically always against the rail on the low side. The elevation of the curve provides for this, and although the direction of the locomotive is toward the outside rail, it still may be considered as having the flange mentioned always in contact with the low rail, therefore the setting in of Nos. 1 and 4 tires, as in this illustration, tends to relieve their flanges just the amount of the difference made in the spacing.

From this it might be logically inferred that a still further setting in would be of greater advantage, and that the tires on Nos. 1 and 4 wheels could be spaced to advantage as much less than 53⅜ in., which is standard for all intermediate and main wheels, as the guard rails will permit. The face of the guard rail measures 1¾ in. from the stock rail, therefore, on this type of locomotive, which is generally representative, it would permit the setting of the tires on Nos. 1 and 4 wheels at 53⅛ in., and still clear the guard rail 1/16 in. This, as a matter of fact, is a logical and better setting than that in the diagram, and it is standard for engines of this type on many large roads.

From records covering the close inspection of hundreds of engines during the past few years, wherever flange cutting has been in evidence, the writer notes some remarkable variations from standard practices. One instance in particular should be mentioned, that of a 2-8-0 engine, 17 feet rigid wheel base with all flanged tires, which actually had front tires spaced 53¾ in., and, quoting from the report, "⅝ in. wider than spacing for best results, and ⅜ in. wider than any recognized spacing." This is, of course, a somewhat extreme case, but it actually occurred on one of the best handled railroads of the west, simply because the confidence in the tire foreman was misplaced.

Another engine of the same class had tires spaced as follows: No. 1, 53 7/16 in.; No. 2, 53 7/16 in.; No. 3, 53½ in.; No. 4, 53¼ in. Another engine, No. 1, 53⅜ in.; No. 2, 53½ in; No. 3, 53½ in., and No. 4, 53 5/16 in. In this arrangement the first pair of wheels in each engine had tires at least ¼ in. further apart than any recognized spacing, Nos. 2 and 3, ⅛ in. further apart than any practice, and No. 4 ⅛ in. in excess of the best practice. Another engine had front tires 5/16 in. too far apart, and another ⅜ in. Each of these engines showed pronounced flange cutting. A pleasing contrast, however, was afforded in still another engine of the same type. This had Nos. 1 and 4 set at 53⅛ in., and Nos. 2 and 3 at 53⅜ in., and exhibited no flange wear whatever, or even rubbing, although the tires had been on five months, and the engine had made the same if not more mileage than the others mentioned.

The above examples, while occurring on one road are merely illustrative of what the writer has encountered on several others, and every one of these roads it may be said, had shop practice cards and blue prints covering all necessary information for correct tire-setting. On one of these, which ran through a mountain country, with all the popular causes present against the longevity of flanges, such vigorous action was taken on the portrayal of these conditions that seventy-five per cent. of this abnormal flange wear was eliminated within the ensuing six months. The measures which brought about such a gratifying result were: (1) Replacing the measuring sticks of wood, and other makeshifts which had been in use in the wheel gang, by solid gauges with hardened points, one set for each class of engine, and by impressing on those concerned that they should wake up to the importance of the matter, (2) the issue of clear prints for shop use, giving the standard practice for setting tires on all engines, and (3) providing an inspector to gauge every set of tires after mounting in the wheel shop, and certify on a regular form to the correctness of the setting.

It should not be necessary in a well disciplined shop, such as the one in question undoubtedly was, to require this inspector, but it was nevertheless clearly evident that a better order of things must be brought about, and that speedily, so the check was run until the men were brought to fully realize that there must not be the slightest deviation from the standard measurements.

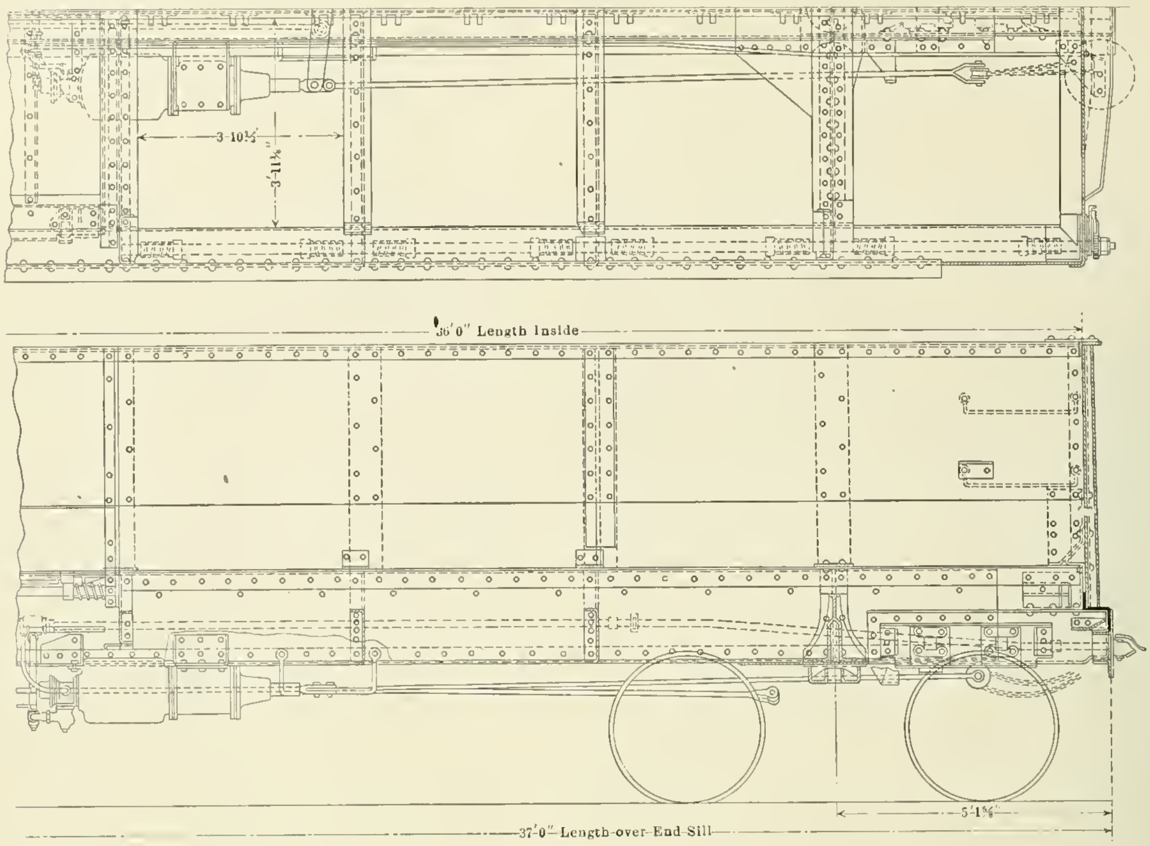
It has been stated that the insistence on attention to the details in the wheel shop will eliminate fifty per cent. of flange troubles, and the writer firmly believes this to be true. The correction of contributing causes must devolve upon the care and vigilance exercised in the roundhouse after the locomotive has been put in service.

First along these lines is to keep within reasonable limits the inevitable accumulation of lateral motion in the engine truck wheels. An excess of this, which should be taken to mean anything greater than ½ in. total, is without question one of the principal contributing causes to flange wear. Excessive end play in the truck wheels results in the leading driving tires being most affected by curves of short radius; in other words, the engine truck does not bear its share of the impact of the curve. When this lateral motion is combined with excessive wide spacing of the front driving tires there could be no other logical result than in excessive flange wear.

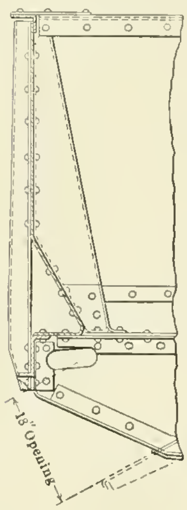
When comment is made regarding excessively worn flanges on any railroad the answer nine times out of ten is that the road or division is so curved that there could be no other condition. It is not the intention to dispute for a moment that roads exist with such curvature that no tires will live on them, but these are exceptional, and the argument would not carry weight unless all engines of equal mileage in the same territory displayed cut flanges. It has come under the observation of the writer that, because of pressure of other duties, and very often also indifference, only a half-hearted attempt is made by those in charge to determine the cause, or even arrive at a sensible conjecture. Occasionally engines cut flanges all along one side, and when these are carefully checked up it is found that they are some lower on the springs on that than on the opposite side; again, the engine may be found not to be properly squared across the pedestal jaws, or not in tram.

Ideal conditions will not have been reached until all wheel centers are standardized, and all tires are bored with a lip. The tire then applied to the center so far as the lip will allow is properly spaced in relation to the one on the opposite side. This is stated with a full realization that should the lip tire plan be adopted, a long time must elapse before the good results which will certainly follow can fully materialize. This is because wheel centers on old engines are frequently at variance with standards; many are too far apart, while some are too close, and in consequence, facing the outside of the rim to bring the standard lip tire to its proper position would have to vary with each individual case. The soundness of the lip tire idea, however, will be readily appreciated by those familiar with the hurry and handicap imposed when tires are changed in roundhouses. The chances for error in the setting of the tires, which are frequently in evidence under such conditions, would entirely disappear, as the tire could only be applied on the center as far as its lip would allow.

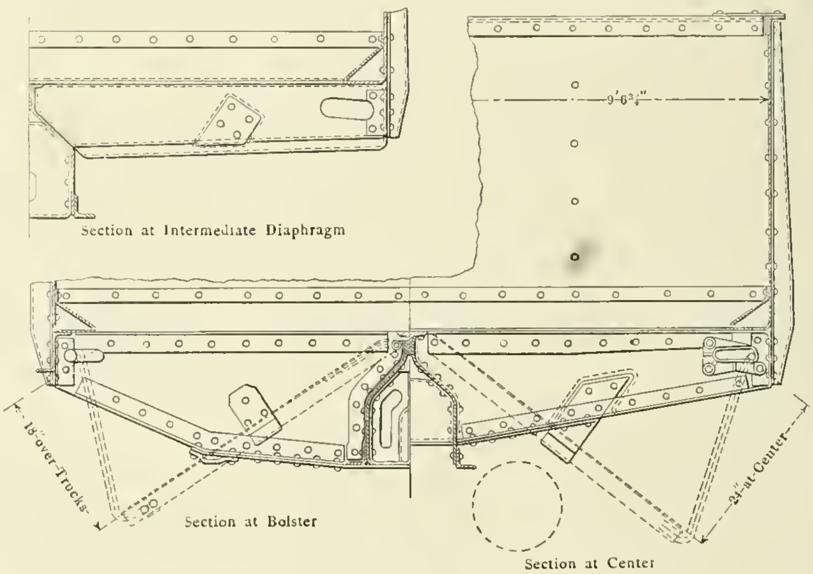
Flange wear is not by any means hopeless of solution. There is scarcely another detail of locomotive maintenance which will yield such a good return from the application of reason and insistence on standards as that of the tires. The writer's extended observations lead to no other conclusion but that it can be successfully combated and relegated to its proper position as a minor, instead of an important item of expenditure, on nine of every ten railroads in the country.




PARTIAL ELEVATION AND PLAN VIEWS OF DENVER & RIO GRANDE GENERAL SERVICE STEEL GONDOLA CAR.




SHOWING SIDE CONSTRUCTION OF D. & R. G. CAR.




TRANSVERSE SECTIONS THROUGH NORTHERN PACIFIC GONDOLA CAR.

## GENERAL SERVICE STEEL GONDOLA CARS.

The Denver & Rio Grande Railroad has a large number of general service steel gondola cars equipped with sixteen drop doors, allowing more than 90 per cent. of the lading to be dumped by gravity. When closed the doors are flush, making the car as suitable for shoveling, or general lading, as a plain gondola. While it has all the advantages of a twin hopper gondola, or a hopper car, for carrying such material as coal, coke, ore, sand, gravel, crushed rock and dirt it may be used to advantage for general purposes where there is no material of this kind for the return trip. This feature is also advantageous where a temporary or permanent change of conditions may sometimes render useless cars purchased for a special purpose, such as hauling coal or ore.

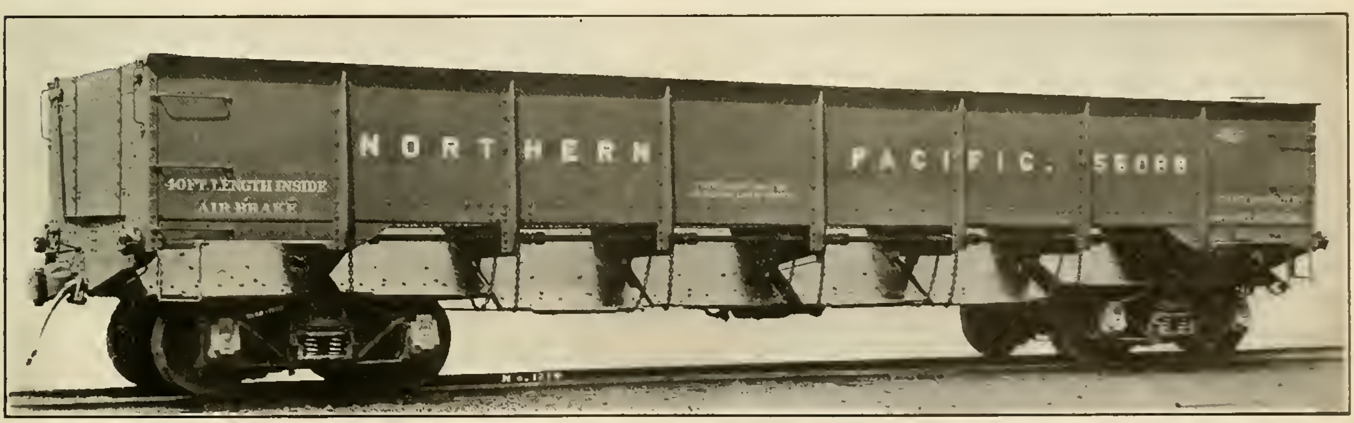
The car is substantially built, it has been developed to its present state by many years of study and experience on the part of the designers and builders, the Pressed Steel Car Company. In order to discharge all the lading by gravity the lower part of the side plate is bent inward, as shown on the cross-section view. Each side is stiffened by seven vertical pressed steel members on the outside and by the three pressed steel members on the inside.

The center construction consists of two plates arranged in a shape somewhat approximating an inverted V, riveted together at the top with the leg of a T iron between them. An angle is riveted along the lower edge of each of these plates. At the bolster they are tied together by a casting and at the cross bearers by pressed steel diaphragms. The cross bearer consists of pressed steel members with a plate riveted at the top.


GENERAL SERVICE 50-TON, 36-FOOT STEEL CAR—DENVER & RIO GRANDE RAILROAD.


D. & R. G. CAR WITH DOORS OPEN.

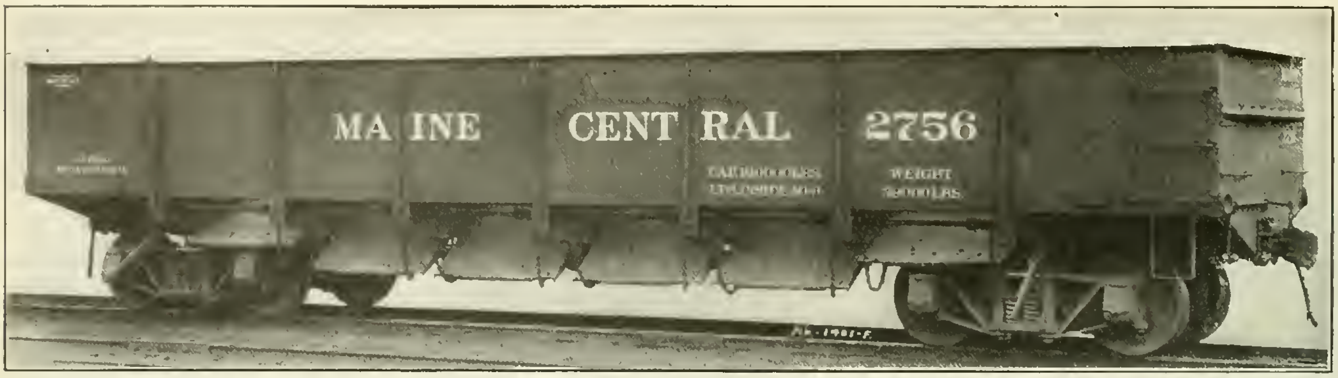

D. & R. G. CAR WITH DOORS CLOSED.



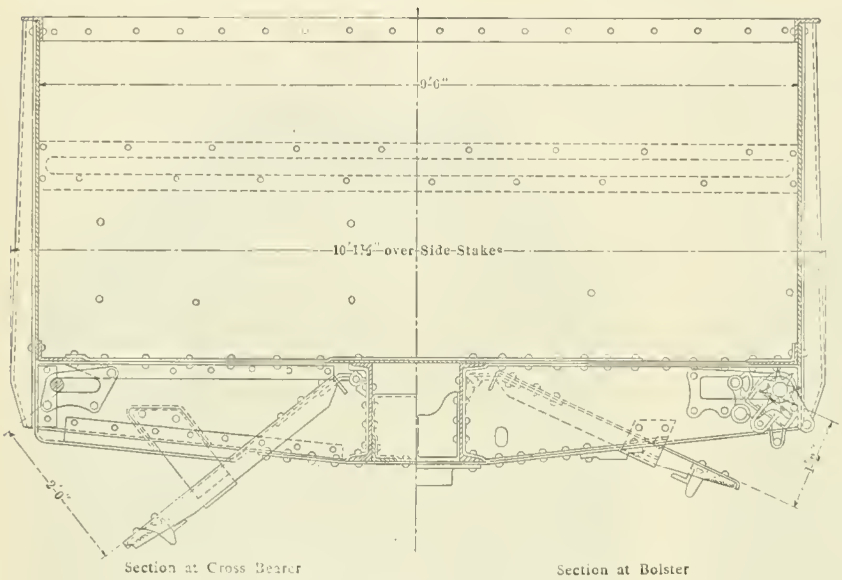

NORTHERN PACIFIC GENERAL SERVICE CAR WITH DROP DOORS OPEN.

At the bolster and at the center of the car these members are reinforced by angles at the top and bottom, as shown.

The doors may be opened or closed in less than two minutes by one man standing either on the ground or the platform. The shaft upon which the chains are wound is operated by a ratchet arrangement at the end of the car; this may be equipped with an operating lever, as shown, or with a socket which can be operated with a bar, a piece of pipe, or a pick handle. After the doors are closed the shaft creeps in under them, supporting them and relieving the chains from the load. Skilled labor is not required to operate them. As an extra check the shaft is locked by a latch and dog at the end of the car. The mechanism is thus simple and positive; the lading cannot be dumped accidently and there is nothing complicated to get out of order.




MAINE CENTRAL 50-TON GENERAL SERVICE STEEL CAR.




SECTION THROUGH MAINE CENTRAL CAR.

One of the illustrations shows a similar car built for the Northern Pacific Railway. Plates are riveted to the sides near the bottom on the inside, and are set at an angle so that all of the lading will be discharged. No inside stiffeners are used for the sides. The car also differs from the D. & R. G. in that it has one drop end of wooden construction, making it suitable for handling long material.

Another of the illustrations shows a car of this type built for the Maine Central, but having only twelve drop doors, those between the ends and bolsters being eliminated. It is thus necessary to shovel a small part of the lading. The car also differs considerably in construction, the center sills being of a box

| ROAD | D.& R.G. | Nor. Pac. | Maine Cen. | Frisco |
|---|---|---|---|---|
| Capacity | 100,000 lb | 100,000 lb | 100,000 lb | 100,000 lb |
| Length Inside Body | 36'—0" | 40'—0" | 40'—0" | 41'—9" |
| Length Over End Sills | 37'—0" | 41'—0" | .......... | 42'—9" |
| Width Inside | 9'—6¾" | 9'—6¾" | 9'—6" | 9'—6¾" |
| Width Over Side Stakes | 10'—2¼" | 10'—2¼" | 10'—1½" | 10'—2" |
| Height Inside | 4'—2" | 4'—2" | 4'—4" | 4'—4" |
| Rail to Top of Sides | 9'—0¼" | 9'—2½" | 8'—1¾" | 8'—9" |
| Number of Drop Doors | 16 | 16 | 12 | 16 |
| Width of Doors | 3'—11⅛" | 4'—0⅛" | 3'—1¾" | 4'—2½" |
| Length of Doors | 3'—10½" | 4'—5⅛" | 4'—1¼" | 4'—10" |
| Width of Clear Door Opening, Center | 27" | 24" | 24" | 26" |
| Width of Clear Door Opening, Bolster | 18" | 18" | 14" | 23" |
| Distance Between Truck Centers | 26'—8¾" | 29'—8¾" | 28'—9" | 31'—0" |
| Weight | 40,500 lb | 42,000 lb | 39,000 lb | 40,300 lb |

girder type made up of two channels with a top cover plate and with angles riveted at the bottom between the bolsters. General data for these cars and for a similar car for the Frisco, described on page 138, April, 1906, issue, are as shown above.

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American Railway Association.—At the spring meeting, held in New York on May 19, F. A. Delano was re-elected president; W. G. Besler, second vice-president, and T. E. Clark and G. L. Peck members of the executive committee. There were 158 delegates present. The next meeting will be held in Chicago on November 17.

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Gas Producer Tests.—A series of gas producer tests is now being conducted in the mechanical engineering laboraotry of the University of Illinois. The object of these tests is to provide impartial data on the efficiency and operation of small producer plants, using different grades of anthracite coal. An elaborate line of investigation has been planned, the results of which will be available during the coming summer.

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Common Standard Steel Passenger Cars.—We know what the history of the wooden freight car was in years past when every master car builder in the country had his own peculiar notions, adding to the difficulty of getting standard cars. I trust that we have advanced sufficiently to get away from that hair-splitting principle that was carried out in those days and that as the steel passenger coach comes into service there will be a standard, at least of the cross section, so that railway companies that want six or more coaches will be able to buy from builders at a price as favorable as the road that orders 100 cars or more.—*E. A. Miller, Central Ry. Club.*

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Oil Burning Locomotives must be used on railway lines through the Adirondack forests, according to an order recently issued by the Public Service Commission of the Second District of New York. The order is an outgrowth of the forest fires of the fall of 1908. From the evidence submitted in the case, the Commission concludes that about 40 per cent. of the land burned over in the Adirondacks during the fall of 1908 was by fires set from locomotives. An investigation was made of the possibility of introducing electricity for the operation of the lines, but this was found to be financially impracticable, and it was therefore decided that the only feasible plan of preventing fires was to adopt oil burning locomotives. The order of the Commission requires that the locomotives used between April 15 and November 1 in each year, between the hours of 8 P. M. and 8 A. M., shall be required to burn oil in the generation of steam. Locomotives burning coal anywhere in the Adirondack preserves must be subjected to the inspection of the Commission, and may not be used until a certificate is issued after such inspection by the Commission's authority. The equipment with oil burning apparatus must be completed not later than April 15, 1910, and at least two locomotives on the Mohawk & Malone R. R., and two on the Delaware & Hudson R. R. must be equipped and in service with oil burning apparatus not later than July 15 of the present year

## COMPARATIVE TESTS OF WATER TUBE AND STANDARD FIREBOXES.

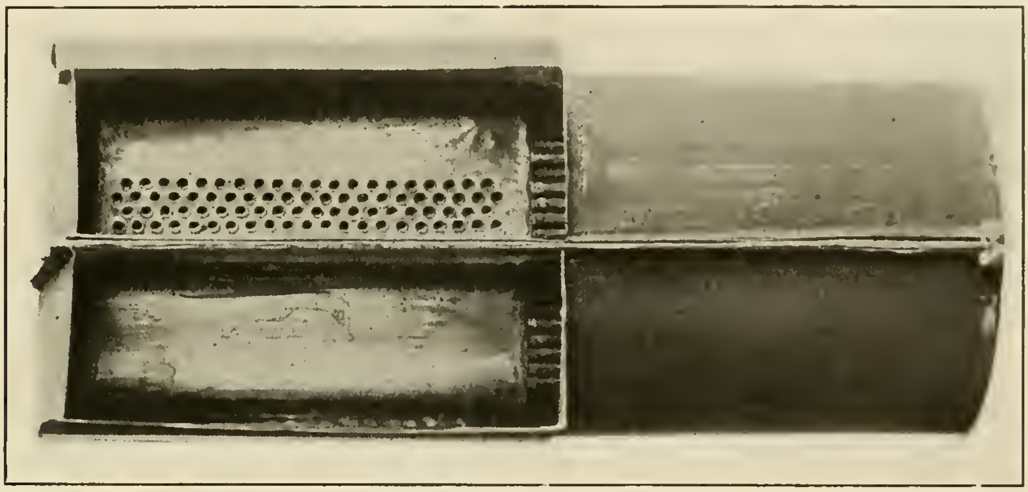
S. S. Riegel.

[Editor's Note.—On page 136 of the April, 1906, issue of this journal appeared an illustrated description of a water tube locomotive firebox designed and patented by Mr. Riegel, which, on account of its novelty and many evident advantages, attracted considerable attention and comment from our readers. It consisted, briefly, of replacing the mud ring of a wide firebox type Belpaire boiler with a large hollow steel casting which forms the lower terminus or drum for a nest of water tubes extending diagonally upward to the crown sheet, which is depressed in the center in order to keep the upper tube terminations flooded. These nests of 2½ in. tubes are set four deep, the rows extending the full length of the firebox, being so located as to permit the introduction between them of a boring bar, or other tools, for the removal or installation of stavbolts in the water leg. Spaces are also left at the front and back firebox sheets for easy inspection The cast steel lower drum is provided with hinged doors to permit the introduction and expanding of the water tubes.]

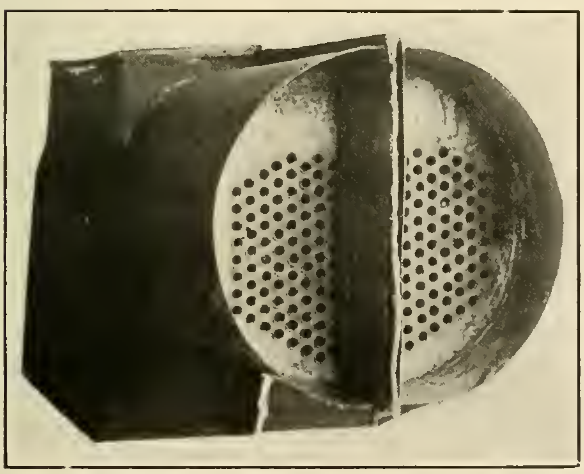
In order to determine exactly what could be expected from a boiler fitted with my type of water tube firebox in comparison with the ordinary standard firebox of the same size, at least as far as increased evaporation was concerned, I recently had constructed some models accurately made to a 1-in. scale, which are shown in the accompanying illustrations. These models are each a half section of a boiler fitted with my firebox and a half section of a boiler arranged with the ordinary standard firebox, the two sections being identical in all respects possible, but each being entirely independent as far as the water circulation is concerned. The principal difference in the two consists in the mud ring, arrangement of the crown sheet, the introduction of the water tubes and the addition of ten extra tubes in the barrel of the water tube design. The design of this firebox permits this increase in the number of fire tubes in the barrel. The two halves were secured together in the manner shown, there being a one-quarter-inch asbestos insulation placed between them in order to prevent the transfer of heat from one to the other. In this way the firebox was common to both halves and the amount of heat received from the fire was the same for both designs. The model was constructed without an outside crown sheet and the tests were all made at atmospheric pressure. In this way the actual circulation of the water around the firebox was accurately observed.

The models had the following dimensions:

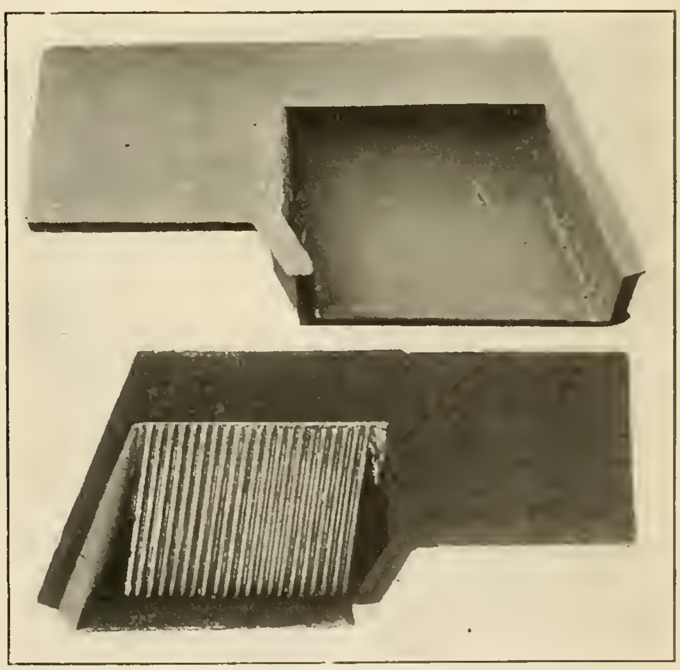
| | Water Tube. | Standard. |
|---|---|---|
| Grate area (6 x 9¼) | 55.5 sq. in. | 55.5 sq. in. |
| Water Heating Surface—Firebox | 216.5 sq. in. | 242.8 sq. in. |
| Water Heating Surface—Watertubes | 590.5 sq. in. | — |
| Water Heating Surface—Firebox: Total | 837. sq. in. | —— |
| Water Heating Surface—Flues | 1609. sq. in. | 964.8 sq. in. |
| Heating Surface—Total | 1846. sq. in. | 1147.6 sq. in. |
| Or for complete boilers | 3692. sq. in. | 2295.2 sq. in. |
| Weight Empty | 25 lbs. | 16 lbs. |
| Weight Full (21 half pints) | 37 lbs. | 28 lbs. |
| Percentage of increased heating surface | 60% | |
| (For boiler with full length of flues | 40%) | |
| Percentage of increased weight—empty | 56% | |
| Percentage of increased weight—full | 32% | |
| (For full-sized boiler | 20%) | |



VIEW LOOKING DOWN ON THE CROWN SHEETS OF THE MODELS.



MODELS JOINED READY FOR TESTS.



MODELS OF WATER TUBE AND STANDARD FIREBOXES.

Twenty-one tests, ranging from one to five hours each, were made on this model. In all cases the feed water was maintained at an initial temperature of 60 degs. and the amount of water used by each half of the model was accurately measured, being fed from same tank to it as required, a half pint at a time. All tests were started with the same water level in each boiler, and since the firebox was common to both the results show clearly the merits of each design.

Tests under widely varying conditions were made, several being included in which the maximum evaporative capacity of the standard design of firebox was reached. These tests are shown graphically and in tabular form in an accompanying illustration. In this table the column headed "vapor" is the time in which the first vapor appeared in each half of the model; the column headed "steam" being the same observation when actual steam was formed in each half.


| Test No. | Difference, Per Cent of Standard | Vapor | Steam | Fuel | Burner | Arch | Time | Conditions |
|---|---|---|---|---|---|---|---|---|
| Test No. 1 | 46 % | 4 Min. / 10 " | 17 M. / 22 " | Gas | Small | —— | 3 Hrs. | Preliminary |
| " " 2 | 50 % | 1 " / 3½ " | 10 " / 17 " | Gas | One Large | Low | 2¼ " | Maximum Capacity of Burner |
| " " 3 | 76 % | 1¼ " / 3¼ " | 12¾ " / 18 " | " | " | " | 2 " | Maximum Capacity of Burner |
| " " 4 | 42 % | 4 " / 6 " | 13 " / 15 " | Coal | —— | " | 2½ " | Poor Draft |
| " " 5 | 55 % | 1 " / 3 " | 12½ " / 19½ " | Gas | One Large | " | 4 " | Maximum Capacity of Burner |
| " " 6 | 51 % | 1 " / 4 " | 11 " / 18 " | Gas | " | " | 4 " | " " " |
| " " 7 | 15 % | 1½ " / 4½ " | 14 " / 18 " | Gas | " | " | 2 " | All Flues Plugged / " " Open |
| " " 8 | 80 % | 1 " / 4½ " | 11 " / 18 " | " | " | " | 2 " | " " " / " " Plugged |
| " " 9 | 56 % | 1 " / 3 " | 10 " / 18 " | " | " | Standard | 5 " | Maximum Capacity of Burner |
| " " 10 | 66 % | 1 " / 3½ " | 10 " / 17½ " | " | " | No Arch | 3 " | " " " |
| " " 11 | 58 % | 1 " / 3½ " | 12 " / 19 " | " | " | Standard | 2 " | " " " |
| " " 12 | 93 % | 1 " / 8 " | 25 " / 45 " | " | Small | " | 2 " | Combustion Rate, less than ½ |
| " " 13 | 53 % | 1 " / 3 " | 15 " / 23 " | " | One Large | " | 2 " | Maximum Capacity of Burner |
| " " 14 | 73 % | ½ " / 4 " | 7 " / 12½ " | " | Double | " | 2 " | Forced Burners to Maximum Capacity |
| " " 15 | 60 % | ½ " / 3½ " | 8 " / 13 " | " | " | " | 2 " | All Flues Plugged / " " Open |
| " " 16 | 41 % | 1 " / 3 " | 10 " / 17 " | Pine Sprigs & Needles | —— | " | 2 " | Fire so Smoky that 30% of Flues Plugged |
| " " 17 | 50 % | 1 " / 3½ " | 12¾ " / 19 " | Gas | Double | " | 1 " | |
| " " 18 | 48 % | 1 " / 5 " | 12 " / 18 " | " | Single | " | 2 " | |
| " " 19 | 43 % | 1 " / 4 " | 8 " / 13 " | " | " | " | 2 " | |
| " " 20 | 60 % | ½ " / 4 " | 7 " / 13 " | " | Double | " | 2 " | |
| " " 21 | 70 % | 1 " / 4 " | 12 " / 18 " | " | Single | " | 2¾ " | Reduced Rate of Combustion |

RESULTS OF EVAPORATION TESTS ON MODELS OF WATER TUBE AND STANDARD FIREBOXES.

The first six tests were made under different heat and draft conditions and show the gain in evaporation of from 42 to 76 per cent. in favor of the water tube firebox.

The seventh test was made with all of the barrel flues on the water tube side of the model blanked and shows a gain of 15 per cent. in favor of the water tube side, which means a gain of 15 per cent. for the water tube firebox alone against the full plain type of boiler.

In the eighth test these conditions were reversed and the plain type of firebox was operated in comparison with the whole boiler on the other side. This showed a difference of 80 per cent. in favor of the water tube side.

Tests 7 and 8 show the relative evaporations of the fireboxes alone.

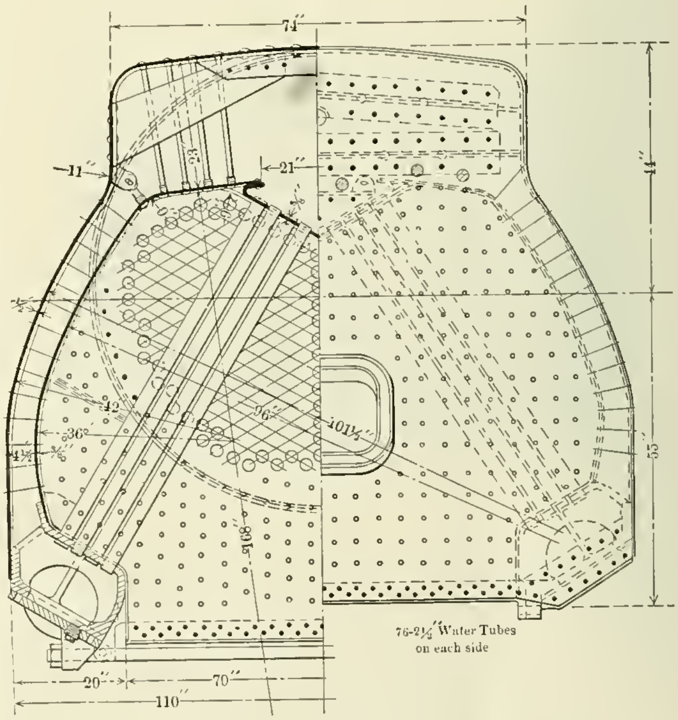
Test No. 12 shows the results with a reduced rate of combustion and gives the highest percentage of increase for the water tube firebox of any of the tests, showing that for a low rate of combustion this type of firebox is of unusual value.

Tests No. 14 and 15 were run at the maximum evaporative capacity of the plain firebox, which was found to be 34 half pints of water in two hours. It was not possible to force it beyond this point. The maximum evaporation of the water tube side, however, was not determined by any of the tests, as the means were not at hand to apply sufficient heat to determine it at this time.

Test No. 16 was run to show the effect of dirty and smoky fuel on the performance of the boiler.

Summing up the results of the tests as a whole we find that there was a total of 951½ half pints of water evaporated in 51½ hours from the water tube side of the model and 614 half pints in the same time from the other side, this being a gain of about 55 per cent. of the water evaporated in the ordinary type boiler in favor of the water tube firebox.

From the observations which it was possible to make by these tests it was discovered that with a low water level there was a decided tendency to bare the center of the crown sheet of the standard type of firebox under rapid evaporating conditions; whereas on the other half of the model the crown sheet was flooded even when the water level was low enough to show the top boiler tubes. This, of course, is due to the fact that the circulation about the firebox and up through the water tubes is so intense that the water is kept in circulation and the crown sheet flooded long after the danger point has been reached in the plain type. In the plain type of boiler the circulation was found to be very strong up the back tube sheet, up the back head and moderately strong up the side water legs. This was found to be practically reversed in the water tube type, the circulation, of course, being the strongest up the water tubes and was generally downward along the side and back legs, the current largely pass-




RIEGEL WATER TUBE LOCOMOTIVE FIREBOX.

ing forward from the top of the water tubes to the barrel of the boiler. It passed downward at the front end of the barrel back through the bottom row of flues and into the side water drum or hollow mud ring.

On inspecting the models at the end of the tests it was noticed that there was considerable scale deposits all over the surface of the firebox and on the flues of the plain type boiler, while these surfaces were practically clean in the water tube boiler, the circulation evidently having been strong enough to keep them scoured. The tests were made with water which scales very rapidly and results seem to uphold the contention that rapid circulation prevents scale formation.

In view of the fact that the water tubes in this model boiler were ¼ in. outside diameter, it not being possible to obtain a more exact size, and consequently were placed too close together, I believe that with a smaller number of tubes properly spaced, a boiler of this design and type would double the steaming capacity of the present type of plain firebox locomotive boiler, at the same time not occupying any more room on the engine. By thus doubling the capacity of the boiler it is evident that on account of the free steaming ability the rate of combustion could be very much reduced. This would be of advantage in two ways, one by reducing the amount of draft required and thus permitting an increased nozzle, and, secondly, the much more efficient combustion which it is possible to obtain at the lower rates.

## SPECIFICATIONS FOR LEATHER BELTING.

To the Editor:

In an editorial on belting, page 151 of your April number, you emphasize the necessity for using only the best grade of belting in order to reduce the cost of maintenance to a minimum. Do you know of a belting specification which would insure securing a good quality of belting?

Chicago, Ill. Master Mechanic.

The Santa Fe specifications for belting, as reproduced on page 456 of the December, 1906, issue, are very complete and belting bought under them has proved satisfactory. The best of specifications are, of course, useless unless rigidly enforced.

The United States Navy Department made a thorough investigation of this question and issued a specification, October 12, 1906, which is as follows:

"The belting shall be short lap. Must be of white leather of the very best quality, tanned with white or chestnut oak bark by the slow process, and no solutions, bark or wood extracts of any kind, or chemical processes shall be used, and the leather shall be thoroughly curried. Belting shall not crack open on the grain side when doubled strongly by hand, grain side out.

"No piece shall be more than 54 inches long, including laps; shall be cut lengthwise from the extreme end of butt, so as to exclude the shoulder, and shall be cut entirely from the center or back. No shoulder or belly pieces will be tolerated; all hides to be of the very best quality.

"Belting shall be waterproofed, if so specified, by an approved method; method shall be chemically neutral in character, containing neither tallow nor oil; the belting to have minimum stretch and a perfectly true run.

The weights shall be as follows for tanned belting not waterproofed; no loading of any description will be tolerated.

| Width | Weight per sq. ft. |
|---|---|
| SINGLE BELTS. | |
| 1 to 2 inches | 13 ounces. |
| 2¼ to 4 inches | 14 ounces. |
| 4½ to 5½ inches | 15 ounces. |
| 6 inches and over | 16 ounces. |
| DOUBLE BELTS. | |
| 1 to 2 inches | 26 ounces. |
| 2¼ to 4 inches | 28 ounces. |
| 4½ to 5½ inches | 30 ounces. |
| 6 inches and over | 32 ounces. |

Laps.

*Single belts.*—Belts 6 inches wide or less, no laps to exceed 6 inches in length or to be less than 3½ inches in length; single belts wider than 6 inches, no laps will be more than 1 inch longer than the belt is wide.

*Double belts.*—No lap to exceed 5½ inches nor be less than 3½ inches in length.

Cement.

All laps to hold securely at every part, and when pulled apart the surfaces then exposed shall show no resinous, vitreous, oily, or watery condition. No filling strips of any kind will be tolerated. All laps and layers of leather must, in addition to being cemented, be copper riveted.

Tests.

(a) Three strips cut lengthwise from any part of the same belt, including the lap, the inspectors may choose, 2 inches wide and 8 inches long and 2 inches between centers, and about 0.14 square inches in section at narrowest part, must stand an average ultimate tensile stress of 4,000 pounds per square inch of original area of test piece for all single belts and 3,600 pounds for all double belts. They should show an elongation of not more than 13.5 per cent. for single belts and not more than 12.5 per cent. for double belts when subjected to a stress of 2,250 pounds per square inch for one hour; elongation to be measured under stress.

(b) Note.—Under the strong magnifying glass the direction in which the leather has been cut can be determined by the direction of the follicles or hair pits, and if under this inspection the direction of the follicles is not clearly in a longitudinal direction, this defect will be cause for rejection of the length of belting containing this defect.

Commercial sizes of leather belting—that is, such sizes as would be found in the stock of any manufacturer—range from 1 inch upward, increasing by quarter inches as far as 4 inches, and then by half inches as far as 7 inches. Above this the increase is by inches.

Where belting is required for a special purpose, it would conduce toward obtaining the most suitable articles to inform the manufacturer of the nature of the work the belt is for, as well as the average horse-power that may be used to drive it and the speed of the belt in feet per minute.

The Harriman Lines and Public Opinion.—Each general manager receives current issues of practically all newspapers and periodicals published in his territory. A competent person in his office, after careful scrutiny of editorial and other matters, tabulates and compiles a record showing the general attitude toward railways and other corporations of each publication. Twice a month each general manager telegraphs the director of maintenance and operation a brief fortnightly synopsis of public sentiment as reflected in the press, showing number of publications examined, percentage favorable, neutral, and antagonistic, quoting criticisms, complaints and expressions of special interest, and commenting upon the general trend of opinion as voiced from political and commercial centers. The Chicago office briefs and consolidates these reports for telegraphic transmission to New York. These reports are of great benefit in detecting causes of friction and enabling the application of prompt corrective measures. The regular reports are supplemented by special telegrams covering items or incidents of more than usual importance or significance. In addition, numerous newspaper clippings are currently forwarded by mail through the Chicago office.—*J. Kruttschnitt before the New York Railroad Club.*

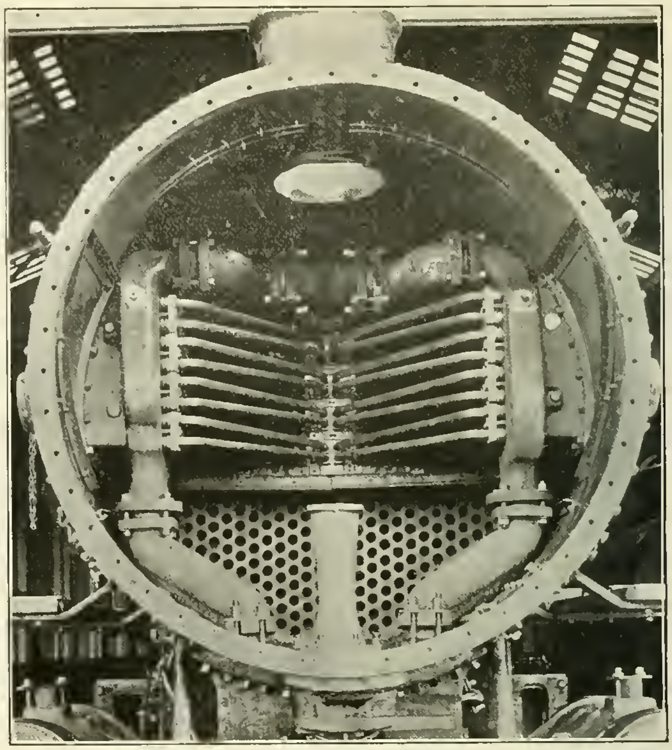
Railroads Doing Good Business.—The earning reports of twenty-five of the leading roads of the United States and Canada show a marked improvement over the same period last year as well as over the business done in March and April this year. These twenty-five roads show for the first week of May gross earnings $1,000,000 larger than for the corresponding period a year ago. This is an increase of 14 per cent. For the fiscal year 1909, or since July 1, 1908, to date, the combined earnings of these twenty-five roads have been slightly less than for the corresponding period last year, but the difference doubtless will be more than made up by July 1 next, as there is no doubt that business will continue to expand.—*Exchange.*

## CONSOLIDATION LOCOMOTIVE WITH NEW DESIGN OF FIRE TUBE SUPERHEATER.

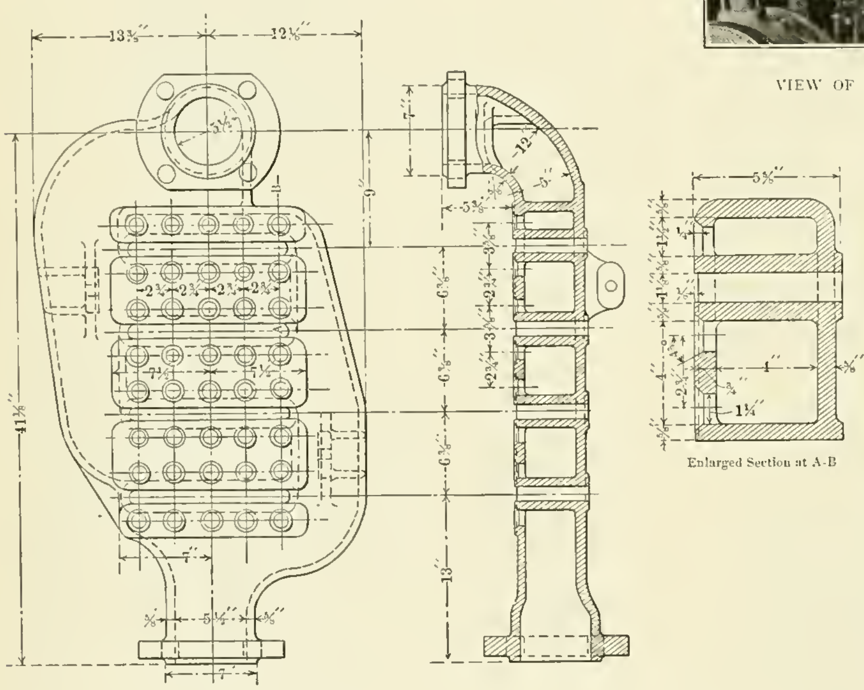
WABASH PITTSBURGH TERMINAL RAILWAY.

The Brooks Works of the American Locomotive Co. are delivering an order of ten consolidation locomotives to the Wabash Pittsburgh Terminal Railway, one of which is equipped with a new design of fire tube superheater. This locomotive carries 160 instead of 200 lbs. steam pressure and has 25 in. instead of 22 in. cylinders. In other respects, excepting of course the alterations in the boiler necessitated by the application of the superheater, it does not differ from the remainder of the order.

This design of superheater, the details of which are shown in the illustrations, is a distinct departure from the arrangement previously applied by locomotive builders in this country and overcomes most of the defects that service has shown the former arrangements to have. These defects for the fire tube superheaters have been, in general, the large number of steam joints to inspect and maintain, the difficulty of getting at the joints between the superheater pipes and the steam headers; the absence of an opportunity for taking care of the difference in expansion of the superheater pipes, thus leading directly to leaky joints; and to the liability of nuts and screw threads in the headers to corrosion.

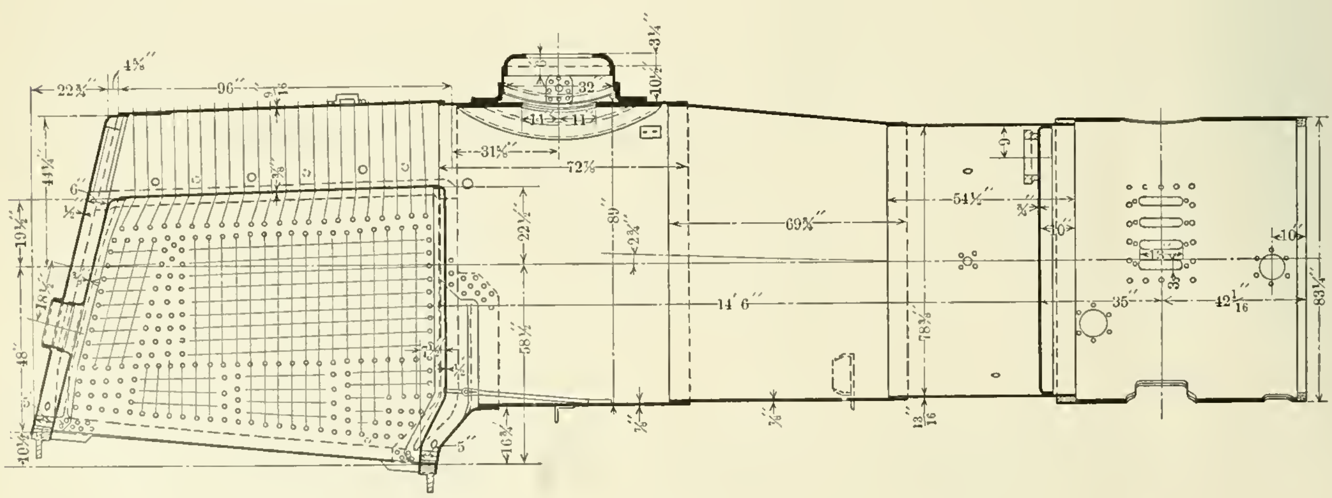


VIEW OF NEW SIDE HEADER FIRE TUBE SUPERHEATER.

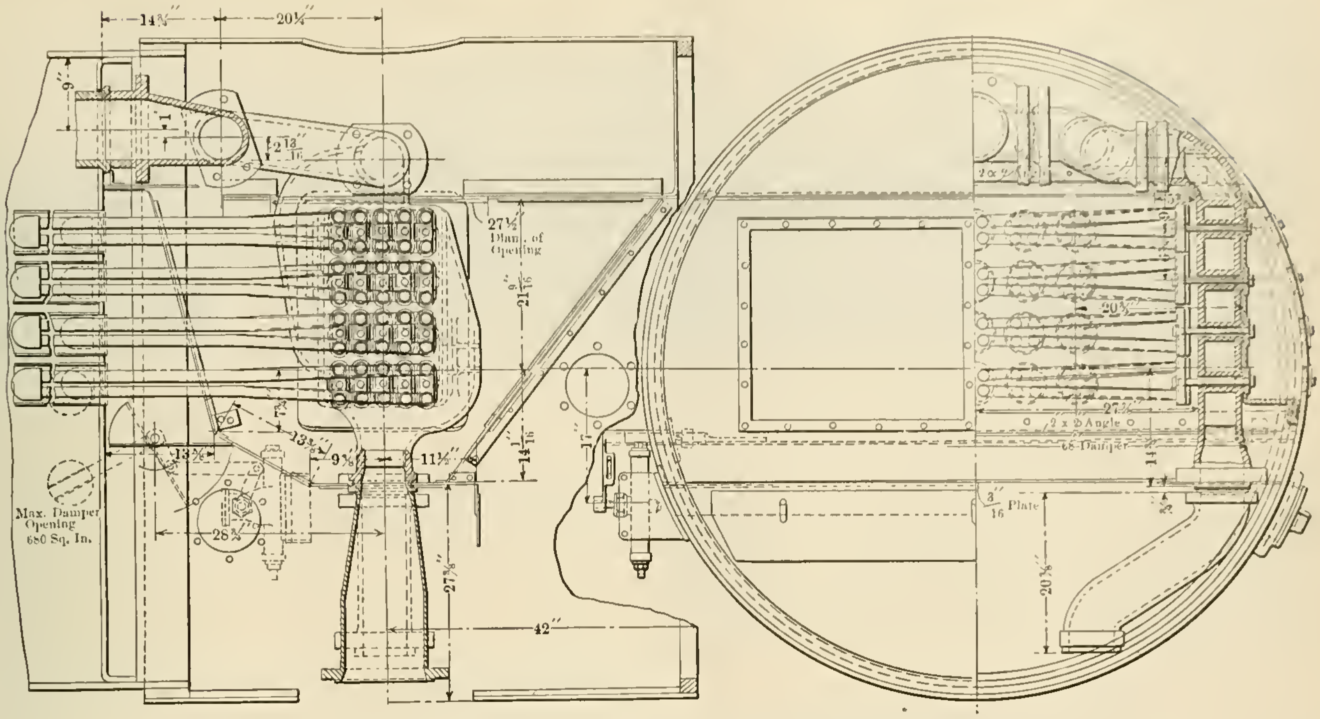



DETAILS OF SIDE HEADERS—NEW FIRE TUBE SUPERHEATER.

This new design has two steam headers located one on either side of the smokebox, each divided into saturated and superheated steam compartments, as is shown in the detailed drawing. A short curved pipe connects the saturated steam compartment of the header with the T head and the superheated steam comparement is connected by a short steam pipe to the cylinders. All the connections to the headers and steam pipes are made by cast iron ball joints. The headers are secured to a box casting bolted to the side of the smoke box, thus relieving the steam pipes and their connections from any strain due to the weight of the header. The large boiler tubes contain four seamless steel superheating pipes, 1½ in. outside diameter, arranged in pairs, the two pipes in each pair being connected at the back end by cast steel return bends. The superheating pipes on emerging from the boiler tubes are carried by an easy horizontal bend to



BOILER ON 2-8-0 TYPE LOCOMOTIVE TO WHICH NEW SUPERHEATER IS APPLILD.




SECTIONS OF BOILER IN WHICH THE SUPERHEATER IS FITTED.

their connection at the header. They are upset and machined to form a ball which is ground into the socket of the header. The two pipes forming an element are held to their seats by means of a double clamp with a bolt in the center between the pipes. These bolts pass through cored holes in the header and have nuts on the back, where they are protected from the smokebox gases. Covered openings are provided in the smokebox to give access to these bolts from the outside. There are no soft joints of copper or composition employed anywhere in the design.

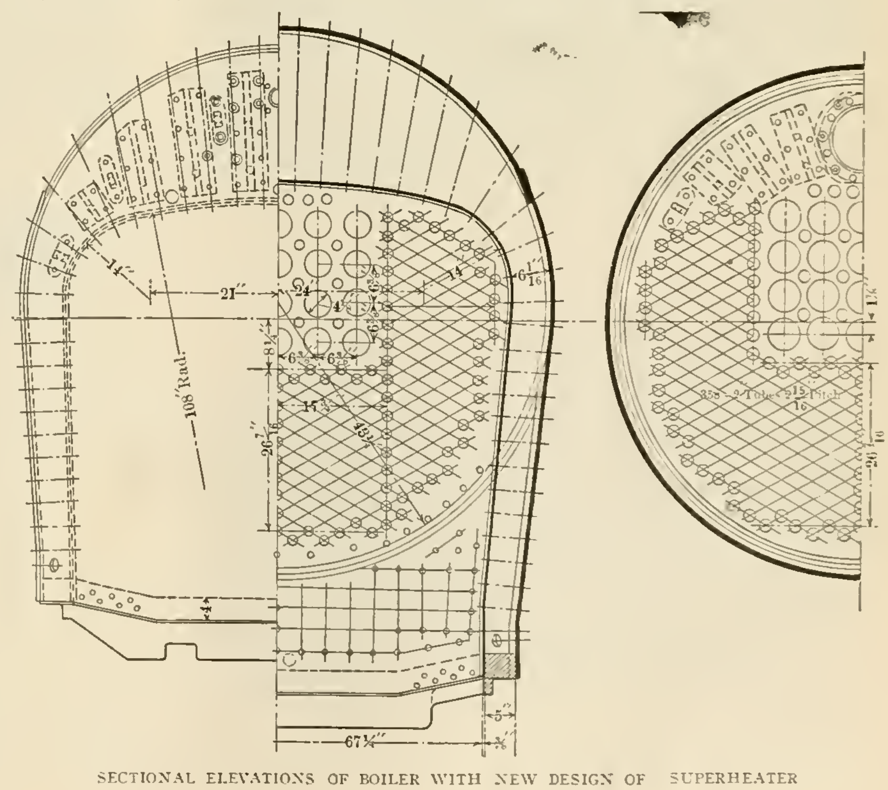
The design shown herewith is arranged for a superheat of from 100 to 125 degs. and hence requires but one loop in each superheating element. The same scheme, however, can be easily arranged to give higher degrees of superheat by having a double loop, or a four-pipe superheating element, in each superheating tube and a reduced number of connections to the header.

The passage of the gases through the 5¼ in. tubes and around the superheating pipes is controlled by a damper, which is automatically operated by a steam cylinder on the outside of the front end. This cylinder is directly connected to the steam chest and is operated by the pressure therein. When the throttle is open the pressure in this cylinder opens the damper, but when the steam is shut off a counterweight closes it. In arrangements for giving a higher degree of superheat it is possible to easily arrange this automatic damper, so that it can be partially or wholly closed from the cab when the locomotive is operating, in case too high a temperature is being attained.

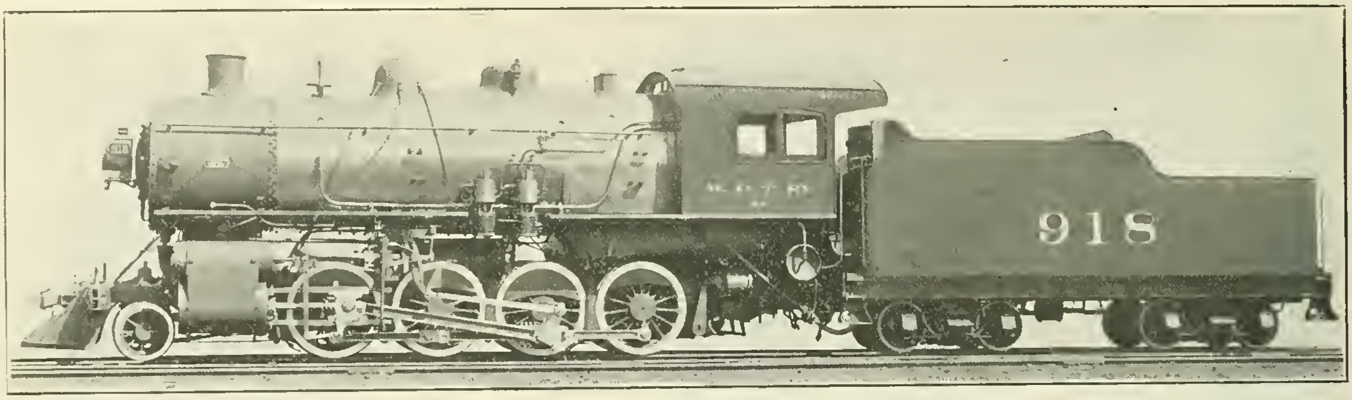
The boiler in which this superheater is applied is shown in the illustrations, and has a total heating surface of 3,283 sq. ft. The superheater has 374 sq. ft. of heating surface, bearing a ratio of 8.78 to the total. There are 20.6 sq. ft. of superheating surface to each cubic foot of cylinder volume, which is slightly lower than has been customary, because of the lower degree of superheat that has to be attained. The boiler has 14 ft. 6 in. tubes and the superheater elements reach within about 32 in. of the back tube sheet.

The other nine locomotives in this order have the same cylinders as are used on the superheater locomotive, their diameter, however, being reduced by a bushing 1½ in. thick, to 22 in. They are designed to carry 200 lbs. steam pressure, but by the removal of the bushing can readily be changed to superheater engines with reduced pressure if it is desirable. The locomotive shown in the photograph is not equipped with the superheater.

The general dimensions, weights and ratios of the superheater locomotive are given in the following table:



SECTIONAL ELEVATIONS OF BOILER WITH NEW DESIGN OF SUPERHEATER




CONSOLIDATION TYPE LOCOMOTIVE—WABASH-PITTSBURGH TERMINAL.

GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Service | Freight |
| Fuel | Bit. Coal |
| Tractive effort | 46,900 lbs. |
| Weight in working order | 236,000 lbs. |
| Weight on drivers | 207,000 lbs. |
| Weight on leading truck | 29,000 lbs. |
| Weight of engine and tender in working order | 390,000 lbs. |
| Wheel base, driving | 15 ft. 9 in. |
| Wheel base, total | 25 ft. |
| Wheel base, engine and tender | 59 ft. 11 in. |

RATIOS.

| | |
|---|---|
| Weight on drivers ÷ tractive effort | 4.41 |
| Total weight ÷ tractive effort | 5.03 |
| Tractive effort x diam. drivers ÷ heating surface | 825.00 |
| Total heating surface ÷ grate area | 65.00 |
| Firebox heating surface ÷ total heating surface, % | 5.80 |
| Weight on drivers ÷ total heating surface | 63.00 |
| Total weight ÷ total heating surface | 71.70 |
| Volume both cylinders, cu. ft | 18.20 |
| Total heating surface ÷ vol. cylinders | 181.00 |
| Grate area ÷ vol. cylinders | 2.78 |

CYLINDERS.

| | |
|---|---|
| Kind | Simple |
| Diameter and stroke | 25 x 32 in. |

VALVES.

| | |
|---|---|
| Kind | Piston |
| Greatest travel | 6 in. |
| Outside lap | 1 in. |
| Inside clearance | 0 in. |
| Lead, constant | 3/16 in. |

WHEELS.

| | |
|---|---|
| Driving, diameter over tires | 58 in. |
| Driving, thickness of tires | 4 in. |
| Driving journals, diameter and length | 10 x 12 in. |
| Engine truck wheels, diameter | 33½ in. |
| Engine truck, journals | 6½ x 12 in. |

BOILER.

| | |
|---|---|
| Style | E. W. T. |
| Working pressure | 160 lbs. |
| Outside diameter of first ring | 80 in. |
| Firebox, length and width | 109 x 68 in. |
| Firebox plates, thickness | ⅜ and ½ in. |
| Firebox, water space | 5 in. |
| Tubes, number firetubes | 358 |
| Tubes, number superheater firetubes | 20 |
| Tubes, diameter firetubes | 2 in. |
| Tubes, diameter superheater | 5¼ in. |
| Tubes, length | 14 ft. 6 in. |
| Heating surface, tubes | 3,093 sq. ft. |
| Heating surface, firebox | 190 sq. ft. |
| Heating surface, total | 3,283 sq. ft. |
| Superheater heating surface | 374 sq. ft. |
| Grate area | 50.5 sq, ft. |
| Smokestack, diameter | 19 in. |
| Smokestack, height above rail | 15 ft. 4 in. |

TENDER.

| | |
|---|---|
| Tank | Water bottom |
| Frame | 13 and 10 in. chan. |
| Wheels, diameter | 33 in. |
| Journals, diameter and length | 5½ x 10 in. |
| Water capacity | 8,000 gals. |
| Coal capacity | 14 tons |

## PERCENTAGE OF POWER BRAKES ON TRAINS.

The Interstate Commerce Commission held a hearing in Washington on May 5th, concerning an increase in the minimum percentage of power brakes on railroad trains. A large delegation from the Chicago General Managers' Association attended the hearing with C. A. Seley, mechanical engineer of the Rock Island Lines as chairman; he also acted as chairman of meetings in Washington to arrange for the reports and arguments on the part of the railroads. W. B. Scott, assistant director of maintenance and operation, Harriman Lines, presented an argument from the standpoint of the transportation department. The legal argument was participated in by most of the counsel present, including representatives from the Rock Island Lines, New York Central Lines, Louisville & Nashville and the Southern Railway. Mr. Hamilton, traveling air brake instructor of the Santa Fe, presented an argument for the air brake department. The argument of the motive power and car department was prepared by a committee consisting of R. Quayle, superintendent motive power, Chicago & Northwestern; J. F. Devoy, mechanical engineer of the Chicago, Milwaukee & St. Paul Ry., and F. F. Gaines, superintendent motive power of the Central of Georgia. It was read by Mr. Gaines and is as follows:

The original "Safety Appliance Act," passed by Congress in 1893, went into effect August 1, 1900, and required that a sufficient proportion of each train be equipped with power brakes, operated by the engineer on the locomotive, to control its speed without the need of hand brakes. The amendment of March, 1903, provided that after September 1, 1903, all trains should have a minimum of 50 per cent. of the cars with power brakes. By an order of the Commission, effective August 1. 1906. the minimum percentage of power braked cars to be used in any train was increased from 50 to 75 per cent. Let us consider what it would mean in practice if the law was changed to require a still higher percentage of cars equipped with air-brakes.

The law effective August 1, 1900, did not designate what percentage of the vehicles in each train should have power brakes, but did say that there should be sufficient power brakes in the train to control its speed, without the use of hand brakes. This was a very wise provision, and this law, to-day, applies better to the mountainous roads than any subsequent legislation or rules. It was comparatively easy for the railroad to do this as it was simply a matter of money expenditure.

When the amendment was passed in 1903, requiring that all trains should have a minimum of 50 per cent. of the cars with power brakes, it was a little more difficult from the standpoint of operation, but still it was complied with by the railroads and was not impracticable from an operating standpoint. When, however, the rule was passed making the percentage of air-braked cars in every train 75 per cent. it was found to be more difficult. The first 25 or 50 per cent. was easy, the next 25 per cent., making a total of 75 per cent., was considerably harder, and everything above 75 per cent. will tax the railroads from the operating standpoint to such an extent that not only will they be greatly inconvenienced by attempting to do it, but the traveling public and shippers will also be inconvenienced; the former because of trains being off schedule by having to make repairs on air brakes in the train, and by having to set out cars with defective brakes, should the number of working brakes be less than that prescribed by the Commission; the shippers would be inconvenienced because of the cars containing their commodities (whether perishable or otherwise) being set out to have such repairs made as would be necessary to maintain the percentage required by law.

The railroads, to-day, particularly the larger ones, where they haul a large number of cars, have great difficulty at times in making up their trains so as to conform to the present law of 75 per cent., and should this be increased, the hardship will increase in geometrical ratio. Especially is this true on the branch lines, where a train starts out with one or two cars and comes to a station and picks up another car, and so on, until it gets down to the end of the branch line; if one of these cars should be defective (perhaps one loaded with grain and another with stock) it would have to remain until employees were sent out to repair it.

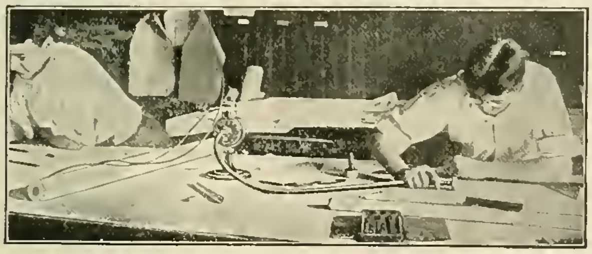
It may not be known to the Commission, but it is nevertheless a fact that it is not an infrequent occurrence on branch lines to pick up empty air-brake cars, solely for the purpose of maintaining the legal percentage of air brakes in working order, that we may be able to take through to destination some other load of freight upon which the air brake may be inoperative. Therefore, in such a case, as just noted, if the percentage was increased, the railroad companies would probably have to carry a lot of empty cars in both directions, in order to comply with the law; this, notwithstanding the fact that it is upon these very branch lines that the traffic is most safe, on account of the infrequency of train service.

It is generally agreed that in heavy service the percentage of inoperative air-brake cars in each train will average about 15 per cent., such cars being inoperative from all manner of defects of brake rigging, as well as from the many defects pertaining strictly to the air-brake apparatus. In this service these cars come into terminals with regular frequency, at which terminals there are competent air-brake men and testing plants; hence, when we consider that our efficiency in this particular service and under these favorable conditions is but 85 per cent. on an average, we can readily conceive that if we are to be confronted with a legal minimum higher than 75 per cent., such minimum is more than likely to interfere with the service and the prompt movement of freight.

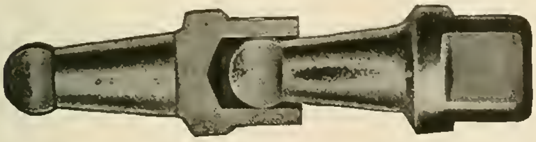
All railroads have what are known as way freight trains, or local trains, which do a great deal of picking up; the through trains often set out cars that are defective for various reasons, including air brakes, and these cars have to be picked up and brought to terminals for repairs; as the law does not make any discrimination as to the kind of service, the railroad company operating these local trains is obliged by law to have just the same percentage in them as they have in through and more important trains; inasmuch as it has been the practice of railroad companies to have the local trains do all the picking up of damaged and defective cars, and having been taxed to the limit to keep within the present requirements of the law, it would be impracticable for them to do much better without increasing the delay to merchandise.

## FLEXIBLE SHAFT APPLICATIONS OF INTEREST TO THE RAILROADS.

The flexible shaft used in connection with the following specialties is made by the Coates Clipper Manufacturing Company of Worcester, Mass. It consists of hardened steel units; one end of each unit is the shape of a spheroid which has been trimmed so that a transverse section is square while a section taken longitudinally through two of the diagonally opposite corners corresponds at the end to part of an ellipse. This fits into a squared socket in the preceding unit. The shaft is thus not only flexible but is very strong. The units are held together by a pin which does not, however, transmit any power. They are made in a number of sizes for transmitting from one-tenth to one hundred horse power. The shaft runs inside of a steel spring, which is covered with leather, and is equally efficient whether run forward or backward.



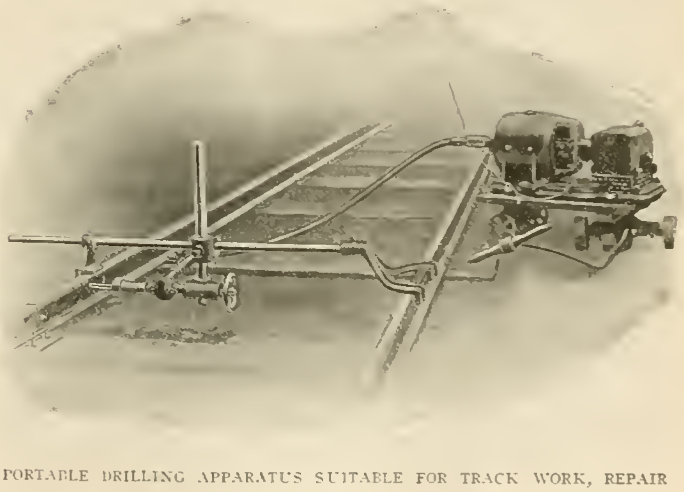
A HANDY DEVICE FOR ERASING IN THE DRAFTING ROOM.



SHOWING CONSTRUCTION OF FLEXIBLE SHAFT UNITS.

FLEXIBLE SHAFT USED IN CONNECTION WITH CAR WINDOW CLEANING DEVICE.

One of the illustrations shows a portable outfit for drilling rails; it may also be used for various purposes in the repair shops and yards. The motor and controller are mounted on a truck and power is transmitted to the drill press through the flexible shaft. The drill is attached to a fork or clamp which fits over the rails. This is much more easily adjusted than an "old man" and can quickly be removed. By means of a lever which throws different gears into mesh any one of three speeds may be obtained. The motor and the flexible shaft operate at a



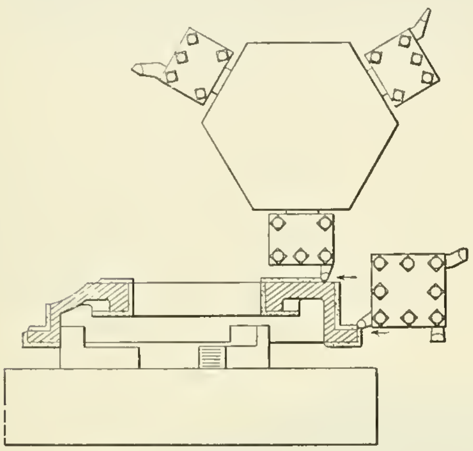
PORTABLE DRILLING APPARATUS SUITABLE FOR TRACK WORK, REPAIR YARDS AND REPAIR SHOP.

constant speed. An outfit of this kind has been used successfully and been found very efficient for driving cylinder boring machines.

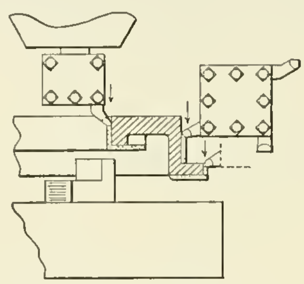
The flexible shaft in connection with a small motor may be used to advantage in a number of ways in the drafting room. An ink or a pencil eraser revolving at high speed does much better and neater work than by hand. A rubber cleaning brush may be used for cleaning drawings; a circular sand paper disk for sharpening pencils or a circular crocus for sharpening the needle points of the instruments or of drawing pencils or for removing rust from the instruments. One of the illustrations shows an application for cleaning car windows.

*Cylinder Head.*—This head is not of the locomotive type, but is similar to it in some respects and also to other classes of work that are common in railroad shops. The cylinder fit is 28 in. in diameter; the head may be machined in two settings and three operations, as shown, in one hour and thirty minutes.

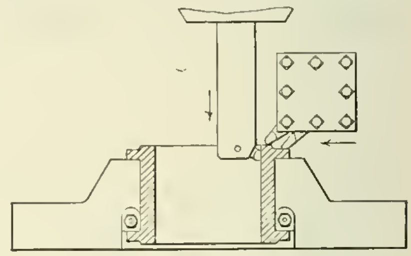
*Piston Head.*—At the first chucking of the piston head the back face, outside diameter, taper and grooves are machined as shown by the two sketches. The head is then chucked a second time and the front face and the recess for the retaining nut are machined; the balance of the outside diameter which could not be turned at the first chucking is also finished. The time required for a 20 in. head of this type varies from 1½ to 1¾ hours.



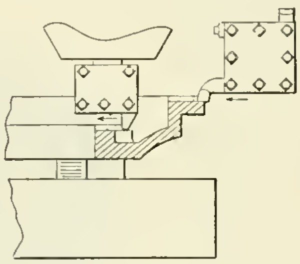
CYLINDER HEAD—FIRST SETTING, FIRST OPERATION.



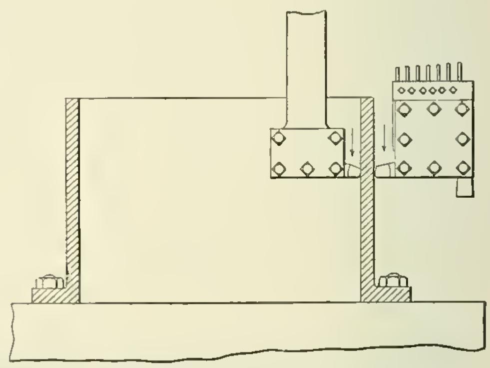
CYLINDER HEAD—FIRST SETTING, SECOND OPERATION.



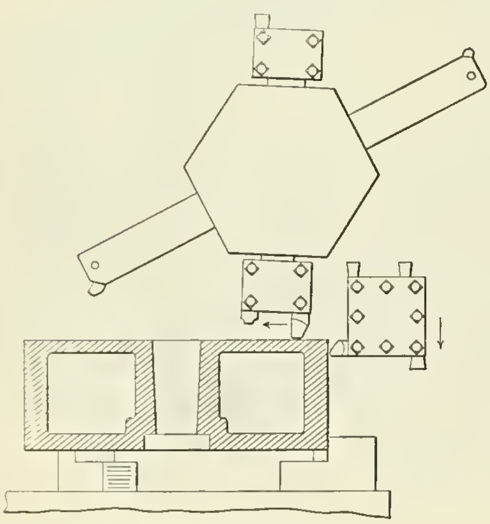
ROD BRASS HELD IN SPECIAL CHUCK JAWS.



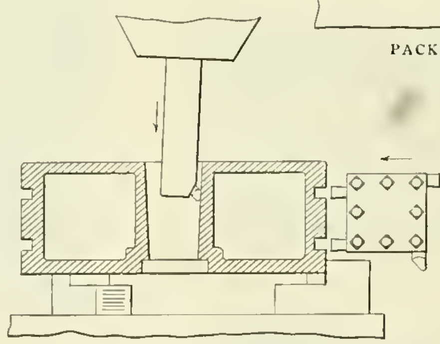
CYLINDER HEAD—SECOND SETTING, FINAL OPERATION.



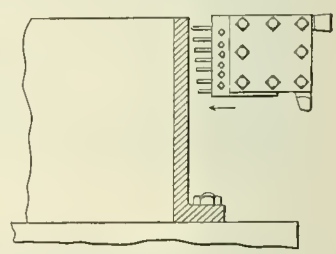
PACKING RINGS—FIRST OPERATION.



PISTON HEAD—FIRST SETTING, FIRST OPERATION.



PISTON HEAD—FIRST SETTING, SECOND OPERATION.



PACKING RINGS—SECOND OPERATION.

## THE VERTICAL TURRET LATHE IN RAILROAD SHOPS.

That the vertical turret lathe is well adapted for use in railroad shops is apparent from the large number of these machines that have been installed in such shops during the past few years. Some idea of the amount and range of work for which it is suited may be gained from the number of these lathes (designated as vertical rapid production lathes) specified for use in the Scranton shops of the Delaware, Lackawanna & Western Railroad, and the work for which they are intended, as shown in Mr. Pomeroy's article in the April issue.

A machine of this type was described on page 408 of the October, 1907, issue. It has a main turret head on the cross-rail, having a full universal movement, both vertical and horizontal. The side head is entirely independent of the main head and is carried on a rail at 90 degrees to the cross-rail. The accompanying sketches illustrate its adaptability to railroad shop work and also show how simple are its tool requirements.

*Rod Brasses.*—These may be held to the best advantage by special chuck jaws, as shown; the jaws have true surfaces for the flanges to rest upon—taper gibs are used to draw the brasses to a seat. They are bored and faced at the same time. Brasses for seven-inch pins may be bored and faced on both sides in two settings in fifteen minutes.

*Packing Rings.*—In the making of plain packing rings the tub casting is bolted to the table and is bored and turned at the same time; the rigidity of the two tools is greater than is possible with a straddle bar and on that account a tub of greater length may be machined without necessitating a reduction in the feed and speed used. In cutting off, a series of parting tools are held in a simple holder and seven rings are parted at one cut—the top tool has a slight lead over the second one, and so on down to the last tool, in order that all the tools will not break through at the same time. From 80 to 100 rings, 20 in. in diameter and ⅝ in. square, may be machined per day, according to the quality of iron used.

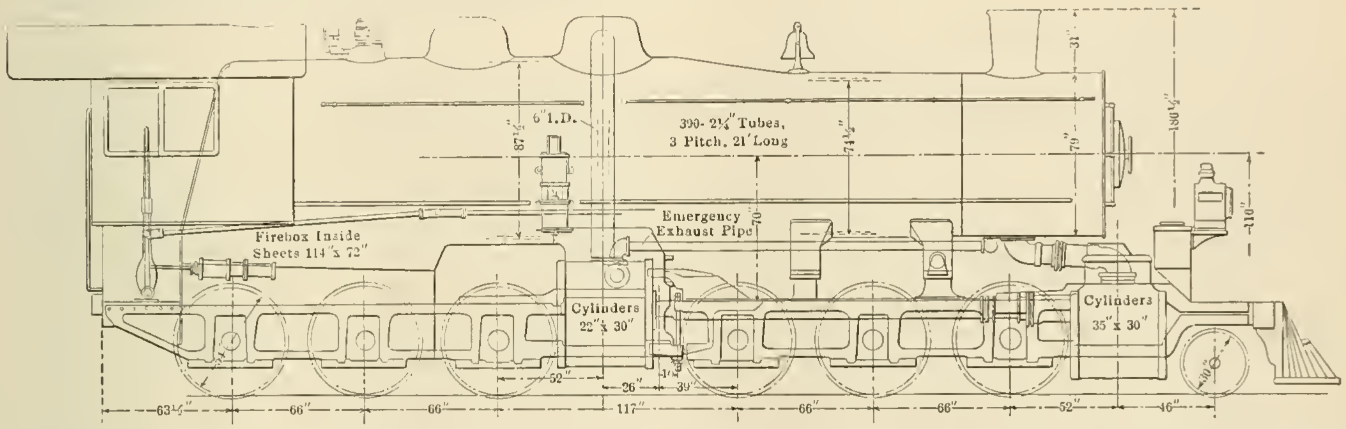
We are indebted for this data to The Bullard Machine Tool Company, Bridgeport, Conn., on whose machines this work is performed.

## MALLET ARTICULATED COMPOUND LOCOMOTIVES 2-6-6-0 TYPE.

VIRGINIAN RAILWAY.

In addition to the twelve Mikado type locomotives built by the Baldwin Locomotive Works, which are illustrated and described elsewhere in this issue, the Virginian Railway is also receiving four of the articulated compound type from the Richmond Works of the American Locomotive Company. The designs and specifications for all these locomotives were prepared under the direction of R. P. C. Sanderson, superintendent of motive power of the railway. In working order it is estimated that the articulated locomotives will have a total weight of 330,000 lbs., of which 312,000 is carried on driving wheels. The tractive effort, working compound, is 70,800 lbs. The Mellin intercepting valve is applied which will permit the tractive effort being increased 20 per cent. by working both sets of cylinders as simple engines, a separate exhaust pipe being provided from the high pressure cylinders to the front end for this purpose.

A two-wheel leading truck has been specified, making these engines of the 2-6-6-0 type, this being the first example of this wheel arrangement to be put in service in this country. A fully illustrated and detailed description of these locomotives will appear in the July number of this journal and but a brief mention of a few of the most prominent features will be made at this time.




A radial stayed extended wagon top type of boiler, 76 in. in diameter at the front ring, is used. It contains 390 2¼ in. tubes, 21 ft. long, and has a total heating surface of 5,065.9 sq. ft., of which 4,842 sq. ft. is in the tubes. The firebox is 114 in. long and 72 in. wide and has a grate area of 57 sq. ft. The mud ring is 5 in. in width at the sides and back and 6 in. wide in front. The location of the boiler, relative to the frames and cylinders, is shown in the outline diagram above.

The design of the frames and cylinders is much the same as has been used by these builders on locomotives for the Baltimore & Ohio and Erie Railroads. The application of the front truck made necessary some changes in the exhaust pipe from the low pressure cylinders and introduces two sliding supports on the front group of frames instead of one. The high pressure cylinders have piston valves and the low pressure Allen-ported slide valves. The front and rear systems of frames are equalized together by a vertical bolt, the load through the bolt to the rear section being transmitted through a coil spring. A flexible support at this point is required because of the three-point applications of weights to the front group of wheels.

The cylinders are 22 and 35 in. in diameter, with a stroke of 30 in. The wheels are 54 in. outside diameter and the rigid wheel base is 11 ft., the total wheel base being 39 ft. 11 in. The boiler carries 200 lbs. of steam pressure and soft coal is used for fuel.

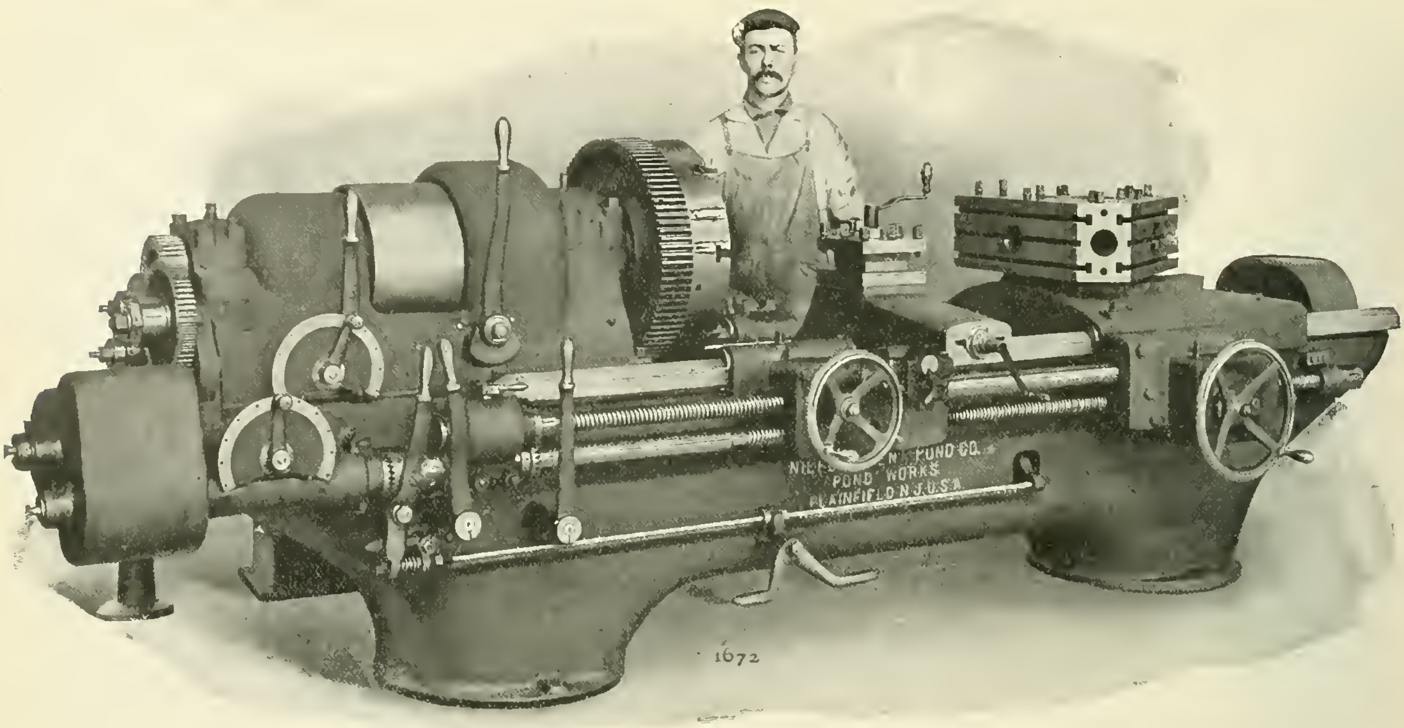
An interesting feature of the design is the arrangement of the draw gear between the engine and tender, in which the locomotive draw bar pin is horizontal and is inserted through the side of the foot plate. This construction will be illustrated when the locomotive is more fully described in the next issue.

The locomotives are designed for use as pushers with heavy coal trains on the Clark's Gap grade on this railway, which is 2.07 per cent., 14 miles in length. Later it is intended to use them in similar service on the White Thorne grade, which is .6 per cent., 10 miles in length.

RAILWAY STOREKEEPERS' CONVENTION.—The sixth annual convention of the Railway Storekeepers' Association was held in the Auditorium Hotel, Chicago, on May 17, 18 and 19. Committee reports and individual papers were presented on store department organization; locomotive tools and supplies; classification of material; pricing requisitions before purchasing and several papers on treatment and inspection of lumber. Dr. Von Schrenck, supervisor of timber preservation on the Rock Island, gave an illustrated paper on "The Treatment of Lumber," which attracted much interested attention. Details of comparative costs of ties and lumber during the past twenty years on the New York Central Lines west of Buffalo were presented. Topical discussions were given on the subjects of, "Prompt and safe transportation of company material in other than supply cars" and "Minimum stock, how influenced by prompt purchase and delivery." The reports, papers and discussions were of a very valuable nature throughout.

MASTER MECHANICS' SPECIAL TRAIN FROM CHICAGO.—The Pennsylvania Railroad will run a special train from Chicago to Atlantic City for the accommodation of the members of the mechanical associations. This train will leave Chicago at 5:30 P. M. June 14, and arrive in Atlantic City at 5:00 P. M. June 15. The fare will be $26 for the round trip. Tickets will be on sale June 1 and have a 30-day return limit with stop-over privileges. Reservations can be secured at the office of the city ticket agent, 248 South Clark street, Chicago.

PENNSYLVANIA ELECTRIC LOCOMOTIVES.—The Westinghouse Electric and Manufacturing Company has received orders for twenty-four electric locomotives for service in the New York tunnels of the Pennsylvania Railroad. Each locomotive will consist of two units permanently coupled together and the wheel arrangement of the complete machine will be of the 4-4-4-4 type. These engines will be larger and more powerful than any electric locomotives heretofore built, each having a capacity of about 4,000 horse power.




TURRET LATHE ADAPTED FOR EITHER PIN OR FACE PLATE WORK.

## A NEW TURRET LATHE FOR PIN WORK.

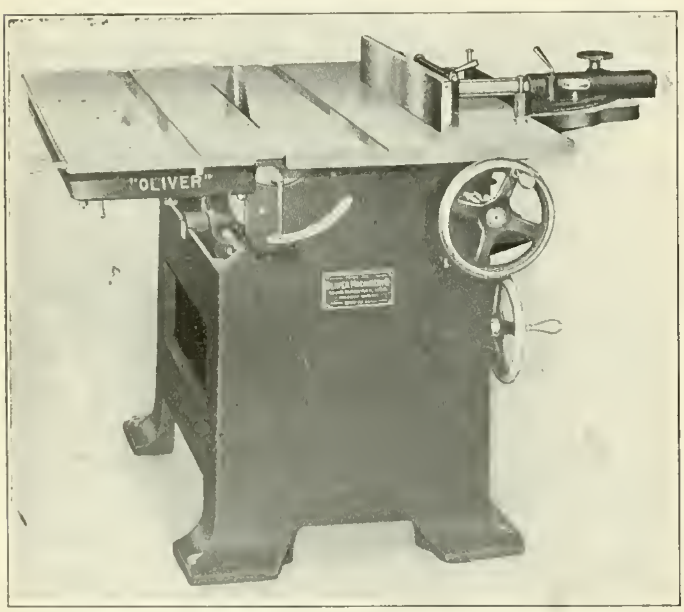
A turret lathe that will handle bar work up to six inches is a necessity in a large locomotive repair shop. Crosshead wrist pins, knuckle joint pins, the smaller sizes of crank pins, large washers, bushings, etc., can be turned in much less time than required on an engine lathe.

A combination turret lathe, adapted for either bar or face plate work, may be used to advantage in both the larger and smaller size repair shops. The illustration shows a machine of this kind built by the Pond Works of the Niles-Bement-Pond Company. It is driven by an eight-inch belt, but, if desired, may be furnished with a motor drive, the motor being mounted above the headstock. With the belt drive fifteen spindle speeds are provided, including those furnished by the countershaft. The automatic turret traverse and the revolving mechanism make the machine easy to operate.

The lathe is designed for handling work up to 28 in. in diameter; the swing over the carriage arms is 26 in. and over the carriage 24½ in. The face plate is equipped with a 24 in., three-jaw, universal chuck with special jaws for bar work. Other types of jaws may be furnished to suit special classes of work. The carriage is so designed that it passes under the chuck, permitting the faces of the turret to be run close to the chuck. This is a most desirable feature as it reduces the overhang of the boring bars and facing heads to a minimum. Six changes of independent feed are provided for both the carriage and the turret, each having a separate lead screw, so that the work may be turned while boring is being done at different rates of feed.

The turret has a travel of five feet. It has a rapid power traverse on the bed and rotates automatically at any desired point of traverse. These movements are controlled by one lever. Each turret face has an independent feed stop. The wide faces of the turret make it possible to rigidly secure the heaviest tools.

The lathe may be built with either a 6 or a 4½-in. hole through the spindle. Its design and weight are such that it is adapted for a heavy class of work.




UNIVERSAL SAW BENCH SHOWING RIPPING FENCE IN ITS NATURAL POSITION.

## UNIVERSAL SAW BENCH.

The universal saw bench, illustrated herewith, will rip any width up to 26 in., cut off any width up to 36 in., make any angular cut to 45 degrees, and by the use of a dado head groove any width up to 4½ in. It is fitted with self-locking and self-oiling devices and has quick and micrometer adjustments for locating the ripping fence and tilting the table. An endless belt transmits the power through a tightening device to pulleys on the two saw arbors upon the yoke, which may be revolved by a worm and worm gear mechanism so as to place either saw in operation.

The table may be tilted by turning the lower handwheel, which operates a worm, worm-wheel, arm and lever. A dial, placed so that it may be read easily while the table is being tilted, is provided showing accurately the degree of pitch. The table is divided into two parts, a stationary table 24x44 in. and a sliding table 17 x 44 in. Each table is furnished with sliding gauges graduated from 30 to 150 degrees; strips of steel are provided to fill the gauge slots when not in use. The sliding table is graduated from 30 to 150 degrees; a miter cut-off gauge is used in connection with this scale. The frame carrying the sliding table may be set back by loosening a cam lever at each end, permitting the use of dado or cutter heads up to 4½ in. in width.

The ripping fence is adjustable to rip 26 in. wide on the stationary table; it also operates on the sliding table for bevel sawing; it tilts from 90 to 45 degrees and has an adjustment of 10 in. without changing the pins. The fence is provided with an adjustment of 10 in. from the front edge of the table.

The arbor yoke carrying the cross-cut and rip saw is made in

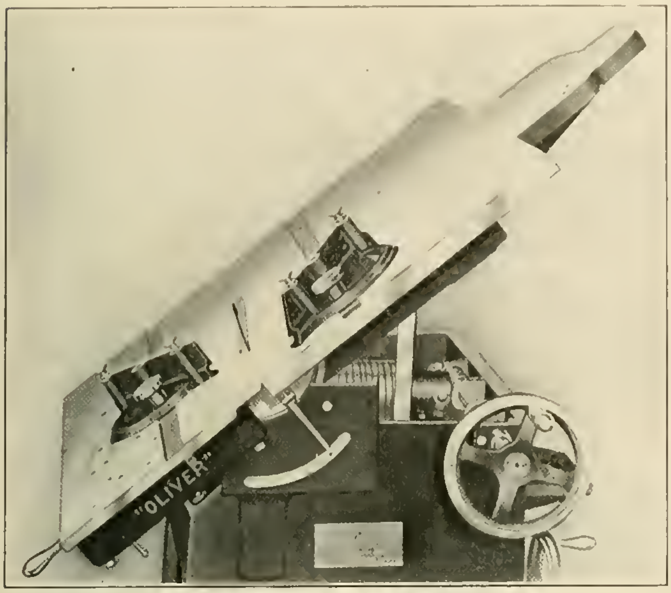
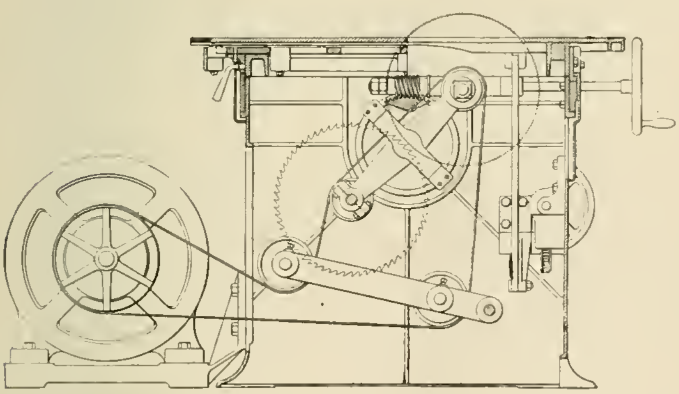



TABLE TILTED TO 45 DEGREES.

one casting and is 6½ in. in diameter where it passes through the yoke hole in the frame. It is locked in position by a threaded split cap bearing 9¼ in. in diameter. The other end of the yoke is supported by a substantial, removable, steady plug. The arbor bearings are long and self-oiling; the arbor pulleys are grooved and are 4½ in. in diameter, 5½ in. face. The arbors



[illegible] OF MOTOR DRIVE TO UNIVERSAL SAW BENCH.

are of crucible steel and one of them is arranged to receive dado cutters. A special device is provided for taking up all end play in the arbor.

The machine weighs 2,100, is designated as No. 60, and is manufactured by the "Oliver" Machinery Company, Grand Rapids, Mich. It may be arranged to drive either from a countershaft or motor; the motor may be mounted on a specially arranged bracket attached to the base of the machine, or may be set on the floor.

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SAFETY OF PASSENGER TRAVEL.—During the calendar year of 1908, of the 141,659,543 passengers carried on the Pennsylvania Railroad, not one was killed as a result of an accident to a train. The total number of passengers injured in train accidents numbered only 102 as compared to 452 in 1907.

## PERSONALS.

F. E. Fox, master mechanic of the Denver & Rio Grande R. R. at Denver, Colo., has resigned.

A. Shields, master mechanic of the Canadian Northern Ry., has been appointed also master mechanic of the Duluth, Rainy Lake & Winnipeg Ry.

Willard R. Collins has been appointed the purchasing agent of the Erie R. R., with office at New York, succeeding E. T. Campbell, assigned to other duties.

H. Carrick, assistant division master mechanic of the Oregon Short Line at Pocatello, has been appointed master mechanic of the Montana division, with office at Pocatello.

A. H. Gairns, division master mechanic of the Oregon Short Line, with office at Pocatello, Idaho, has been appointed master mechanic of the Idaho division only, with office at Pocatello.

A. R. Kipp, formerly superintendent of motive power of the Wisconsin Central Ry., has been appointed mechanical superintendent of the Chicago division of the Soo Line.

J. H. Davis, assistant electrical engineer of the Baltimore & Ohio R. R., has been appointed the electrical engineer, with office at Baltimore, Md., succeeding L. T. Gibbs, deceased.

W. M. Netherland, general storekeeper of the Southern Railway, has been appointed also the general storekeeper of the St. Louis-Louisville Lines, with office at Washington, D. C.

J. B. Finley has been appointed the general storekeeper of the Harriman Lines in Mexico and Southern Arizona, with office at Empalme, Sonora, Mex., succeeding G. V. Green, resigned.

George Ross, district foreman of the Oregon Short Line at Salt Lake City, Utah, has been appointed master mechanic of the Utah division, with office at Salt Lake City, and the office of district foreman has been abolished.

J. J. Ellis, for a number of years in the motive power and mechanical department of the Chicago, St. Paul, Minneapolis & Omaha Ry., and until the early part of this year superintendent of motive power, has retired from railway service.

T. A. Foque has been appointed general mechanical superintendent of the Minneapolis, St. Paul and Sault Ste. Marie Ry. This road has recently leased the Wisconsin Central Ry. and will operate it as part of its own system to be known as the Chicago division.

## CATALOGS.

AIR CYLINDER LUBRICATOR.—The Detroit Lubricator Company is issuing a small folder describing its sight-feed air cylinder lubricator. These lubricators were described in the columns of this paper, November, 1908, and since that time have been subject to a number of improvements, which are fully described in this leaflet.

VALUABLE GRAPHITE PRODUCTS.—What might be called a pocket edition general catalogue is being issued by the Joseph Dixon Crucible Company, Jersey City, N. J. This little pamphlet, which is of commercial envelope size, lists the principal products of this company, giving brief descriptions and prices, and will no doubt prove to be of value to any one who may have an occasion to use or specify graphite in any of its forms.

DIRECT-CURRENT GENERATORS.—Engine-type direct-current generators, designed for general lighting and power service, are illustrated and described in detail in Bulletin No. 1059, being isued by the Allis-Chalmers Company, Milwaukee, Wis. These machines are suitable for direct connection to steam, gas or oil engines and have many features of construction which have given them a well-established reputation for reliability.

Ratchet Wrenches.—The Lowell Wrench Co., Worcester, Mass., is issuing a leaflet giving illustrations, brief description and price list of reversible ratchet wrenches in a number of different styles.

Three Tools that Save.—The Cleveland Twist Drill Company, Cleveland, Ohio, is issuing a small folder calling attention to the catalogues which it has prepared descriptive of "Peerless" high-speed reamers, "Perfect" double-tang sockets and "Paradox" adjustable reamers. This leaflet briefly mentions the prominent advantages of each tool.

Distributing Transformers.—Circular No. 1502, issued by the Westinghouse Electric & Mfg. Company, contains much valuable information on alternating-current distribution, covering transformers, lightning arresters, insulators, etc. Considerable space is devoted to underground and overhead construction, applicable in congested and scattered districts. Information is also given on potential regulating systems. The circular contains 52 pages of information of value to any one concerned with the distribution of power by alternating-current lines.

Tribute to the Galena Signal Oils.—The address of Attorney John G. Milburn in the suit of the Government vs. the Standard Oil Company, in which he gave a deserved tribute to Gen. Chas. Miller, is being issued in small pamphlet form by the Galena Signal Oil Company, Franklin, Pa. He stated that no basis exists for any charge against the Standard Oil Company in the achievements of General Miller with the Galena Signal Oil Company, and that, on the contrary, he is entitled to much credit for his methods.

Tire Turning.—The May issue of "Progress Reporter," Niles-Bement-Pond Company, 111 Broadway, New York, is devoted to the subject of tire turning. It gives a number of excellent illustrations of wheel lathes in operation, both for driving and car wheels, and recounts some of the results that are being obtained in regular daily service on the various machines. The three tools that are necessary for proper turning of driving and car wheel tires are illustrated by photographs and full-dimensioned line drawings.

Locomotive Reducing Valves and Air Pump Governors.—The Mason Regulator Company, Boston, Mass., is issuing a small catalogue which fully describes the construction, operation and proper maintenance of the Mason locomotive reducing valves and air pump governors. Sectional illustrations with numbered parts make the descriptive matter and directions for cleaning very clear. These reducing valves are standard on the leading railway systems of this continent, as well as in Great Britain and Europe and wherever else steam heating of trains has been introduced.

Fairbanks-Morse & Co., Wabash Ave. and Eldredge Place, Chicago, are issuing a 640-page general catalogue, No. 60, which illustrates, briefly describes and gives tables of full dimensions and prices of the products handled by them. The products of this company are too extensive and diversified to be given individual mention in this place, and in general include machinery and tools of the following classes: Electrical machinery, which takes in both motors and generators for direct or alternating current; gas and gasoline engines and suction producers, including gas engines of all sizes and types; mining machinery, including air compressors, hoists, full electrical equipment, rock drills, etc.; pumping machinery for either high pressure or irrigation; steam engines and boilers of many types; scales, which, of course, include practically every known type of weighing machine; wind mills, pipe fittings, hose, etc., and railway machinery and supplies, which include coaling stations, hand cars, motor cars, track and shop supplies of all kinds, gasoline locomotives, water stations, turntable machinery, etc. The catalogue is bound in cloth, well printed and is profusely illustrated.

Car Heating and Lighting.—A 9 x 12-in. catalogue, arranged in loose-leaf form, with a special post binder and containing over 200 pages printed on heavy coated paper, is being issued by the Safety Car Heating & Lighting Company, 2 Rector St., New York. The contents of this catalogue makes clear the thorough manner in which this company is meeting the demand in the car lighting and heating field. Among the devices which have been given special attention are the axle dynamo electric lighting system and the thermo-jet system for heating, which have during the past few years deserved and been given special recognition by railroad managements. The axle light system has been perfected after sixteen years' experience, and in its present arrangement presents all that makes for efficiency, reliability and economy. The service that has been given by the new thermo-jet system of car heating has been most pleasing to this company, and this system, which is a form of heating by direct steam and provides absolute regulation of the temperature at all times, is fully described in the catalogue. The Pintsch gas mantle lamp is, of course, fully shown. This form of lighting has been received with great favor, and large numbers of the old flat-flame equipment are being altered to these mantle lamps, with great satisfaction and economy. The catalogue is fully illustrated, finely printed and attractively arranged.

## NOTES.

Homestead Valve Mfg. Company.—Woodward Wright & Co., of New Orleans, will represent the above company in that district and will carry a complete stock of Homestead valves.

T. H. Symington Company.—William A. Garrett, president of the Seaboard Air Line, has resigned and on Nov. 1 will become vice-president of the above company at Baltimore, Md.

Crocker-Wheeler Company.—Edmund Lang has been placed in charge of the repair shops of the above company at Ampere, N. J. Mr. Lang for the past five years has held an executive position with the Wheeler Condenser & Engineering Company.

Rogers Journal Packing Company.—Willis C. Squire, 307 Western Union Building, Chicago, has been appointed general sales agent of the above company, which is now manufacturing a much-improved journal packing, using the original Rogers steel wool in combination with high-grade cotton waste mixed with sponge.

Safety Car Heating & Lighting Company.—In order to enable the largest steamers to enter New York harbor at night, the government has ordered a large number of Pintsch gas buoys for indicating the channel. There are 2,200 buoys of this type now in service throughout the world, a clear indication of the reliability of Pintsch gas equipment.

Flannery Bolt Company.—This company reports that locomotives equipped largely with Tate flexible staybolts, are now running, which have been in service for over three years with no staybolt breakage, with no cracking of side sheets and no engine time loss due to staybolt repairs. They will be glad to give the locations of such engines to any one interested.

Slack Manufacturing Company.—W. W. Slack, president, and H. K. Parkman, secretary of Gilman & Son, Inc., Springfield, Vt., and G. C. Parker, sales manager of the Wm. J. Smith Company, New Haven, Conn., have formed a partnership for the purpose of manufacturing and selling abrasive metal cutters, under the name of Slack Manufacturing Company, Springfield, Vt., all parties to retain their present positions with their respective companies.

L. E. Waterman Company.—The business of this company in Canada has increased to such an extent that it became necessary to build a Canadian factory, which was recently completed and opened with proper ceremonies on the twenty-fifth anniversary of the company. It is located at St. Lambert, near Montreal, and contains 31,000 sq. ft. of floor space. It is of concrete construction and fitted throughout with the most modern machinery for making fountain pens.

Walter B. Snow, publicity engineer, 170 Summer street, Boston, announces the association with his staff of Carl S. Dow, S.B., engineering department, Harvard University, late publicity manager B. F. Sturtevant Co., and formerly in charge of instruction and text book departments, American School of Correspondence. Mr. Dow brings to the organization a diversified experience which will add materially to the value of the service rendered in all lines of technical publicity.

Falls Hollow Staybolt Company.—A large order for Falls hollow staybolt iron has recently been received from one of the largest railway systems in England. This railway wishes to test this iron, with a view of adopting it as a standard. Several new agencies have been established by this company during the past month. Among these are Brydges Engineering & Supply Company, 249 Notre Dame Ave., Winnipeg, Can., who will cover the territory in Canada west of Lake Superior. Mussens, Ltd., 299 St. James St., Montreal, Can., have been allotted the territory in Canada east of Lake Superior. H. J. Skelton & Co., Royal London House, Finsbury Square, London, E. C., has been made the representative for the British Isles and India.

Cardwell Friction Draft Gear.—The Union Draft Gear Company, of Chicago, has recently been organized, with the following officers: James R. Cardwell, president and general manager; Charles A. Jennings, vice-president; John D. Ristine, secretary and assistant treasurer; C. H. Tobias, treasurer and assistant secretary. The company has a paid-up capital of $2,000,000 and has bought the patents and business of the Cardwell Manufacturing Company. It will continue the manufacture and sale of the friction draft gear which was started by that company in the latter part of 1904. The evolution of draft gear has shown that a gear for simply lengthening the stop when cars are bumped or jerked will not suffice, but that the gear must absorb the blow. Reports of drop tests recently made of Cardwell friction gear show that a blow of 1,660,500 lbs. is reduced to 115,312 lbs. in passing through it, and a blow of 1,037,812 lbs. is reduced to 15,375 lbs. It is the failure of draft gears thus to absorb buffing shocks that adds so greatly to the repair bills. The Cardwell gear is designed to reduce by one-half the speed of the blow or impact in transmitting it to the car. This reduces the force of the blow to one-fourth. This fourth is resisted by springs on a floating spring rod, actuated by the operation of twelve transversely acting friction faces which continue the work of absorption, so that the shock to the car is enormously reduced. The gear is easily applied, is open to inspection and may be readily repaired. The Union Draft Gear Company starts in business with a large number of contracts and orders on hand. Its principal business will be the manufacture of the Cardwell friction draft gear, but it will also sell spring draft gears where they are desired.

# PRESIDENT'S ADDRESS—MASTER MECHANICS' ASSOCIATION

H. H. Vaughan

In 1868 six master mechanics attending the Master Car Builders' Convention at Dayton decided to call a general meeting at Cleveland to organize an association of the master mechanics of the United States and Canada. At that meeting, which was held later on in the same year, fifty were present, representing many of the most important lines of railways in the country, and a constitution was adopted with the following preamble:

"We, the undersigned railway master mechanics, believe that the interests of the companies by whom we are employed may be advanced by the organization of an association which shall enable us to exchange information upon the many important questions connected with our business."

These words outlined the object with which the new society began its career, adopting as its purpose the discussion of the best methods of construction and operation of the locomotive at a time when it had just emerged from the experimental stage and was assuming a permanent and fairly uniform design. It had already taken its place in the world as the most powerful and economical engine of transportation, but few even who were connected with it in those days could have foreseen the development it was to undergo or the extent to which it would render possible the cheapening and extension of the transportation facilities of the world, the chief factor in the wonderful change that has taken place in the relations of nations, the distribution of food supplies and the growth of manufactures, cities and continents.

The association so quietly started was well founded. It had chosen for its aim a work that was needed, and as the railways of the country grew, it grew with them, until now, forty-one years later, we have a membership of nine hundred and sixty-one (961), representing every railway in the United States and Canada, and a large number of those in foreign countries. It has been unique in its devotion to the locomotive and its problems alone, but its object has proved worthy of its attention, and we are to-day confronted with problems just as important as those which our predecessors considered, none the less vital to us because they are broader in scope and because financial considerations are now more closely connected with those which are purely technical.

I have always been deeply interested in the history of this association; I have been a great admirer of the work that it has done, and I am going to take this opportunity to speak to you of the success it has obtained, the methods it has used, and the opportunities that lie before it for the future.

It is impossible to review in detail the work which has been accomplished; the mass of information contained in our proceedings is too great for individual reference. To even touch on the more important subjects would necessarily result in a mere catalogue. Figures are but a poor way of illustrating results, but in the forty-one years of our proceedings three hundred and fifty-one (351) reports of committees, sixty (60) individual papers and one hundred and fifteen (115) topical subjects have been presented and discussed. Of these reports and discussions it may be stated that one hundred and twenty-six (126) contain information of special interest at the present time, while two hundred and eighty-three (283) are of specific value, either in whole or in part. While this classification is to a certain extent a matter of opinion, it shows most decidedly the general excellence of the work which this association has done. It has investigated almost every conceivable subject connected with the locomotive, its construction, operation and maintenance, developing, criticising and discussing it as it progressed from the little sixteen-inch eight-wheel locomotive of the sixties to the magnificent freight and passenger equipment of the present day. To say that the wonderful development that has taken place is entirely owing to the work of our association would be an exaggeration. Apart, however, from the facts determined in our reports, the improvements they have suggested, and the practice they have introduced, our meetings have year by year been attended by the men engaged in carrying on and advancing this work. They have presented their own views in our discussions, they have heard the views of others, and, whether speakers or listeners, have returned home from our conventions with their opinions modified, new ideas conceived and their experience broadened. With that renewed energy and interest in their work which invariably results from communication with other workers in the same field, they have put into practice suggestions which have been advanced and by their daily work have together built up that mass of knowledge and experience that has resulted in the production of the American locomotive of to-day. In such ways, as well as by the exchange of information, our association has succeeded in its object in being of benefit to the railways by whom our members are employed.

Our work has not been limited, however, to the exchange of information, but from the very beginning our committees have done far more than obtain and report existing facts or give the opinion they have formed as a result of their inquiries. This has been an important and valuable portion of their work, and our history shows that in the large majority of cases it has been done well. The answers received to the letters of inquiry have frequently indicated a great divergence of opinion or a lack of proper knowledge, while our later experience has justified the committee's decision. Their reports have presented carefully thought out and correct conclusions, which have through their evidence of thorough investigation and the standing of the members of the committees, been widely accepted and of valuable assistance in establishing advanced practice. A development of their work to which I wish to call your attention has not, I believe, been generally awarded the credit it deserved, yet it has been the source of the greatest influence exerted by our association, and of the importance of its service to the railways. I refer to the investigation of the scientific principles underlying the questions assigned to our committees, the tests and experiments they have carried out when necessary to determine additional data, and the correct and practical conclusions they have deduced. As a result their work stands to-day as the basis of most of our scientific knowledge of the locomotive, the engineering principles on which it is designed, and the reasons for the methods by which it is operated.

I do not mean that we have to look to our committees for all the knowledge that is available on the theoretical mechanics of the locomotive, or for such researches as those on the properties of steam, the strength of materials, or the chemistry of combustion. That has been the work of the mathematician or physicist, and its value in solving the practical problems of engineering is limited by the vast number of factors which enter into actual working conditions. Our work on the other hand, has been the observation and interpretation of results in a scientific manner, and through being carried on by practical men, who have established the relation between the facts they ascertained, and the theoretical principles underlying them, has been sound in its basis, and rendered general in its application.

What further can we do to increase our usefulness and develop into still more important fields of work? I feel that in making suggestions I am recording my own sins of omission, and yet when a man endeavors to seriously consider such a question, ideas occur to him that previously lay dormant or unthought of, and this must be my excuse for recommending now what I have not done. Our opportunities are somewhat different from those of our great sister society, the Master Car Builders' Association. We have no such business relationships to regulate between one road and another as those involved in the interchange of equipment. The possibilities of establishing additional standards that would be extensively used are few, and indeed it is very doubtful whether standards are of much value for the locomotives of an entire country. We must consequently ask ourselves whether we are obtaining all classes of information that are of possible value, and whether our committee reports, individual papers and topical discussions could be advantageously supplemented by any other activities.

We are face to face with several changes in the development of our motive power and the department having charge of it. The steam locomotive, that has been supreme for so many years, is finding its superiority questioned by a new invention, the electric locomotive. The small railway with its individual methods is being absorbed into large systems, and superintending and recording the work under the charge of our members is becoming more difficult. The growth of the large mechanical departments has made it impossible and in fact undesirable for their heads to retain the same touch with minor mechanical and operating details that they formerly had to, and has increased the importance of the financial and business questions they should control as compared to those of a mere technical nature. Unless this association and its members concern themselves seriously with these new and larger problems, there is danger of their work being undertaken by others in place of by ourselves.

The articulated locomotive has widened the field of the steam locomotive and enabled it to compete on more favorable terms with its younger and more powerful rival. We should be informed of every development in this line, the results and the experiences that are being obtained and the reduction in the cost of transportation that is being realized. We should also, I feel, know more of electric operation, so that as motive power officers we may be better informed as to its advantages and disadvantages, and may be in position to assist in deciding on the proper system to employ.

The advice of men experienced in motive power matters is needed by the railways in making decisions on this question. To be of value it must be based on a thorough understanding of the subject and a familiarity with its difficulties. I would urge your giving earnest attention to this important subject, which thus far has received too little consideration by the men who best understand railway motive power conditions.

Systems of organization are changing with the changes in our railways and new methods are being introduced for watching results. We should compare experience as to the efficiency of various types of organizations, obtain more information as to the best forms of records, statements that are actually found useful and successful in practical service; comparisons that can be made on a reasonable basis and are interchangeable.

I believe we should endeavor to pay more attention to the commercial side of our work than we have done in the past. Excellent as our work has been, it has with few exceptions investigated the technical rather than the business problems of the locomotive.

We certainly do not want to decrease our attention to technical matters, but could we not with advantage to our members and to the railways take more interest in, and exchange information with each other more fully on factors connected with the cost of operation?

It is true that some years ago a standard postcard performance sheet was adopted and for a time was extensively exchanged, but it fell into disuse, and yet a properly prepared performance sheet, giving figures useful and possible of comparison, would, I feel sure, be of considerable value and interest to us all. The benefits of a membership in this association would be increased by information as to each other's cost of engine house expenses and supplies, of repairs and fuel consumption, the percentage of power in shops and out of service, and a number of other figures that have to be continually watched. Knowledge of the results obtained by others would assist us all in gaging our own performance, in more easily locating the branches in which we are deficient, and in encouraging all to a higher uniformity of accomplishment.

In short, without in any way reducing the interest we have in locomotive engineering, we must take up in a far more businesslike and serious way the financial problems connected with the operation of the locomotive department, the form of organization that will give the best results, the commercial aspect of the work of a motive power official in conducting his department as though he were manager of a large business enterprise.

Take as an instance of comparing costs the operation of our repair shops. We manage the largest collection of factories in the world devoted to one substantially uniform product, the repairing of locomotives, and our total expenditure for this item alone amounts to about eighty million dollars per year. Each and all have the keenest interest in knowing whether our methods are the best and our costs among the lowest. A few years ago comparisons would have elicited little, but some statements of performances which were exceptionally worthy of imitation; to-day, with the progress that has been made in shop engineering, there is no reason why properly trained observers should not record time studies containing the necessary data to prepare intelligent and valuable statements about one operation after another that is performed on substantially the same parts in hundreds of shops from the Atlantic to the Pacific. Such work is possible and it has already been performed in several shops by experienced engineers. If carried on by a properly organized bureau under our auspices, it should be of the greatest value not only to the railways of this country as a whole, but to our members individually. By comparing operation by operation, their results with those of other roads, and by analyzing their methods and available machinery, they would be enabled to improve the one or justify their expenditure for additions to the other. This is but one of many questions connected with the operation of our mechanical department which will occur to you, on which some systematic interchange of information would be of material assistance.

What I wish most strongly to impress on you is that while still carrying on the technical work that has been so splendidly successful, we should pay more attention to the business problems under our control in which we can be of such mutual service.

Our methods of obtaining information might also, I consider, be supplemented to advantage by effecting closer relations with the various railway clubs. The circular letter has been a practical failure in obtaining general information, and I feel sure that the railway clubs would welcome reference to them of certain subjects for their opinion, especially those on which the experience of the men actually in touch with the work is required. They have a large membership, representing every section of the country and every class of men engaged in locomotive work. On many subjects their views would be of far greater value than those obtained in answer to circular letters, especially on questions similar to those suggested for topical discussion.

A valuable practice which obtained in the past, but which has been discontinued in recent years, was the appointment of a committee to report on the advancement in locomotive practice during the year. There are numerous small improvements devised in railway shops which would be collected by a committee gaining its information from the railway clubs. These improvements, while not of sufficient importance in themselves to justify a report or paper, are of considerable value in our successful operation, and presented by a committee would have sufficient indorsement to insure their being carefully considered.

Co-operation with the railway clubs would also relieve the association of the discussion of details of minor importance which have occupied so much time in the past. Such discussion is necessary, and, in fact, of the greatest value, but it more properly belongs to local societies where local conditions are understood and where it can be carried on just as efficiently and satisfactorily as when occupying the time of a national association.

Our association could, I believe, also be of considerable value with reference to the various legal questions that are arising in connection with locomotive construction and operation, by co-operation with the American Railway Association. We could provide a systematized organization for obtaining the opinions of the railways with the proper representation for each section of the country and a meeting at which important questions could be discussed.

Any development in this direction must, however, come at their request, and we can simply indicate our willingness to undertake any work in which we can be of use.

The present system of holding the conventions of the Master Mechanics' and Master Car Builders' associations in two separate weeks prevents many from attending one or the other. The consequence is the attendance is largely divided, and unfortunately so, as the majority of the members of either association are equally interested in the other. There are two remedies: the first, to hold the two conventions in one week; the second, to unite the two associations. When this was last proposed by the late Mr. Pulaski Leed in 1898, our executive committee was instructed to confer with that of the Master Car Builders' Association, but, although a report was made to the succeeding convention, suggesting that both conventions should be held during the same week, nothing was done.

It is a reflection on the business ability of our mechanical departments to continue an arrangement that necessitates a man being away from his work for practically two weeks at the meetings of important associations, which he should, for his own sake, and that of the railway employing him, attend and take part in.

There is to-day no valid reason for maintaining two separate mechanical railway associations. All the officers and members of the executive committee of the Master Car Builders' Association, with the exception of two, seventy-five per cent. of the members of the standing committees, and seventy per cent. of the members of the special committees, hold joint department titles.

These figures demonstrate most clearly the amalgamation that has taken place between the car and locomotive departments on our railways. They justify the statement that the time has arrived not for the absorption of one of our associations by the other, but for their uniting into one society, call it, if you please, the American Railway Mechanical Association, which would consider both car and locomotive matters. Such a step is demanded by the spirit of the times, to conserve the forces of our railway officers and economize their time. It is one of the most important questions we have to deal with, and I would impress on you the necessity for action being taken to remedy the present conditions.

The help of our association has been requested by the National Conservation Commission, and it has been informed that our resources would be at their command either for purposes of investigation or to ascertain the recommendations of our members in any respects in which we could be of service to them. A committee was also appointed which could co-operate with them if required, or with any of their committees, but so far this has proven unnecessary, and our position has been simply that of exhibiting our willingness to perform any work that might assist this important movement. We have, however, our own share to carry of the duty of the nation to posterity. The railways are one of the largest consumers of coal, and in most cases peculiarly indifferent to the economy with which it is used. About two hundred millions of tons are annually burned in locomotives alone, and we do not therefore need to ask in what direction we can be of service in assisting this commission. Our work is before us. We should individually, and as an association, use every means in our power to impress on our railways the importance of this expenditure, one of the largest we are responsible for. The reduction in the present rate of consumption that it is our duty to make will not only lead to an immense saving in expense, but will assist materially in the conservation of the natural resources of the country.

At our last convention several of our members were asked by members of the American Railway Association to introduce an alteration in our constitution whereby subjects involving legal, transportation, permanent way or traffic questions or for any other reason requiring such action may be submitted as recommendations to the American Railway Association. In response to this suggestion, a committee was appointed who have recommended the change which they consider advisable, which will be submitted to you at this convention. The executive committee has carefully considered the amendment and indorse it as a progressive step in the orderly grouping of the important associations which are all working toward the development and advancement of American railway work, associations of which our own is one of the largest and oldest. An innovation, however, this amendment certainly is, and it has led me to speak to you of the work this association has done for the railways, its history, its achievements and its problems.

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PEAT AS A FUEL IN THIS COUNTRY.—The statement is made by Federal experts that millions of dollars' worth of fuel lies undeveloped in the swamps and bogs of the country. Its value, on a basis of $3 a ton, roughly guessed at by experts of the Geological Survey, who have been studying the peat deposits for some time, is more than thirty-eight billion dollars—more money than is represented in all the property, stock, implements and buildings owned by the farmers of the United States. With the coal supply being used at a tremendous rate, peat is expected to become a most important auxiliary fuel and one that will prolong the life of the coal itself. An important fact which leads the experts to believe that peat will soon come into quite general use in certain parts of the country is that it is as a rule found in quantities in regions far removed from the coal fields, so far that the cost of transporting the coal amounts to several times the cost of the fuel itself at the mines. The states containing the greatest amount of peat are the eastern Dakotas, Minnesota, Wisconsin, Michigan, northern Iowa, Illinois, Indiana, Ohio, New York, the New England States, New Jersey, portions of Virginia, North and South Carolina, Georgia and Florida.

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CONSERVATION OF NATURAL RESOURCES.—The recovery of heat units in our domestic fireplaces and furnaces is far less than the recovery of heat from coal burned under our best boilers, when measured as power generated in our steam engines. And the waste in our kitchens and at our tables involves a greater national loss than the waste in our coal mines. In the one case the people at large are making no effort to minimize it, while every technical man of repute is putting his best endeavors into devising means of getting the highest efficiency out of nature's forces, with a view to turn nature's resources indirectly to the greatest good for the greatest number.—*James Douglass at the New Haven meeting of the Am. Inst. of Mining Engineers.*

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CARE OF BELTING.—The care of belting should be entirely taken out of the hands of the men who are running the various belt-driven machines, and belts should be systematically retightened at regular intervals, with belt-clamps fitted with spring-balances, each belt having the tightening strain carefully figured in advance. Belting should also be cleaned at regular intervals, and should be softened with a small amount of belt-dressing which is needed to keep it in perfect condition. A laborer can be quickly trained to tighten and care for all the belts in the shop during the noon hours and on Saturday afternoons, and at other times when the shop is not running.—*Fred W. Taylor before the A. S. M. E.*

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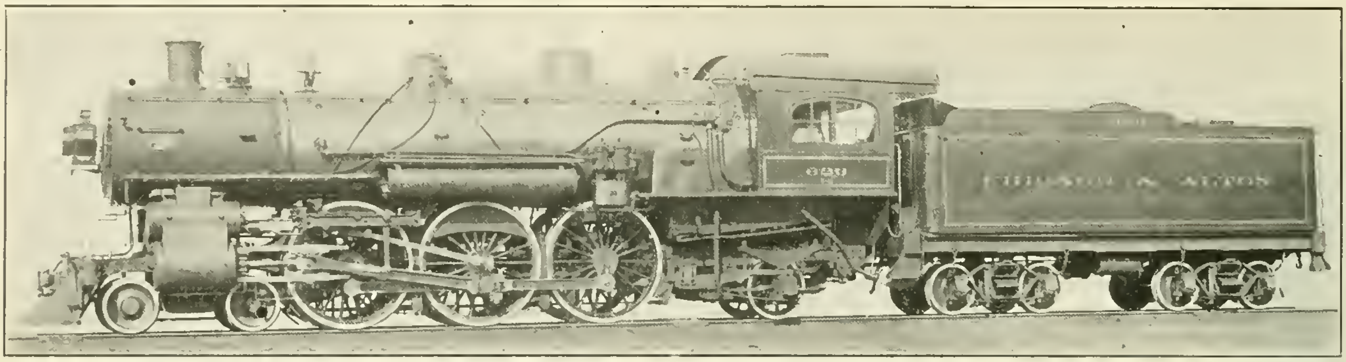
A GENERAL FREIGHT CAR POOL.—The Harriman freight car pool is not unlike those of the Pennsylvania and of the New York Central. When the principle is extended to the pooling of car pools, the car efficiency and traffic of American railways will be appreciably increased. The same methods that brought about a reduction of 54,000,000 miles movement of empty cars on the Harriman Lines in two years after their inauguration would make a proportionate reduction of 477,000,000 miles annually on the railroads of the United States.—*J. Kruttschnitt before the New York Railroad Club.*



PACIFIC TYPE LOCOMOTIVE WITH PILLOID VALVE GEAR—CHICAGO AND ALTON RAILROAD.

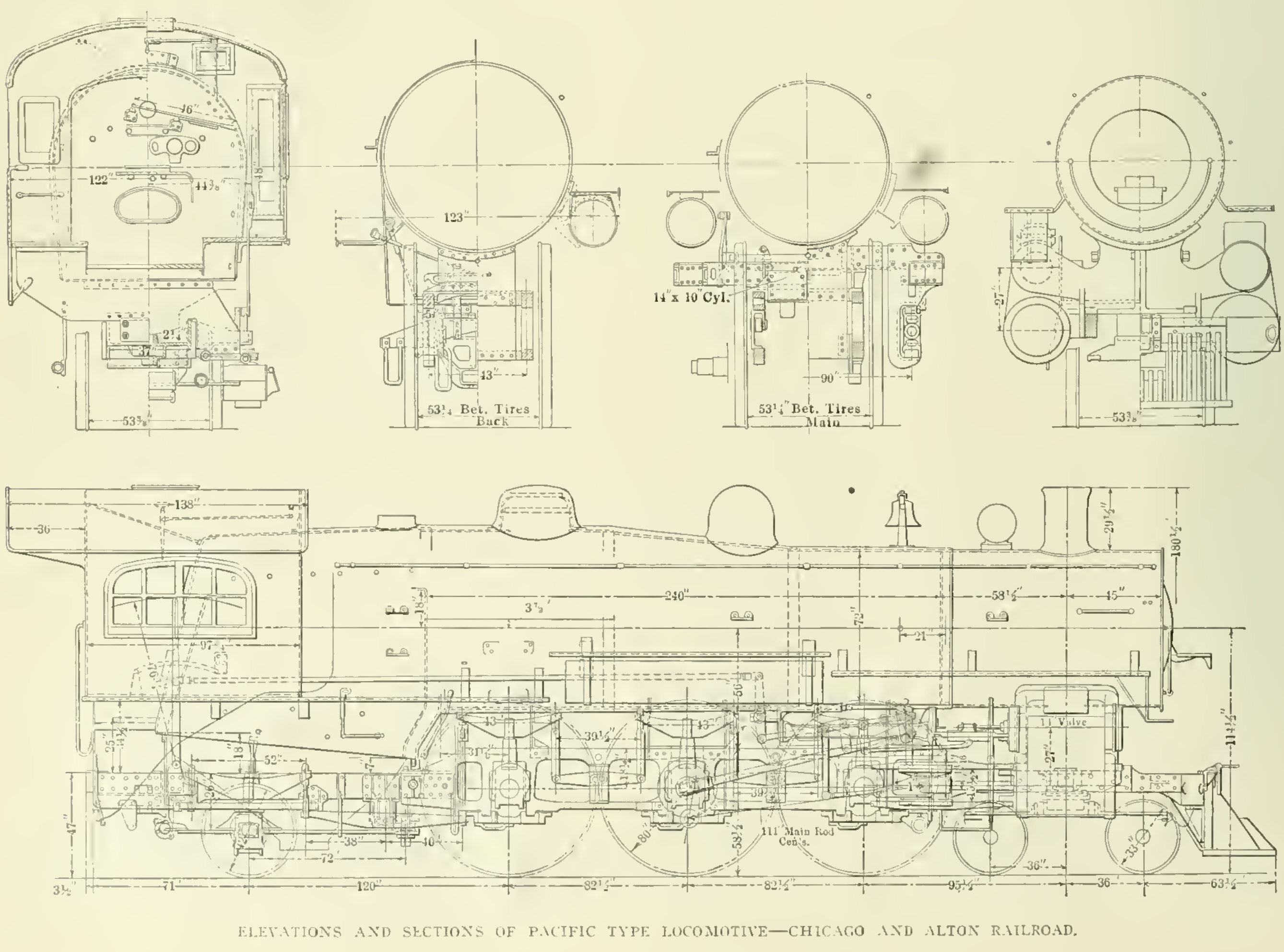
## PACIFIC AND CONSOLIDATION TYPE LOCOMOTIVES.

CHICAGO AND ALTON RAILWAY.

On page 399 of the October, 1908, issue of this journal appeared a very fully illustrated description of a design of Pacific type locomotive, five of which were built by the Baldwin Locomotive Works for the Chicago & Alton Railway. This design attracted much interested attention among motive power officials because it incorporated an old style narrow firebox on a very large modern high speed locomotive. The length and width of the firebox was 120⅛ x 40¼ in., giving a grate area of but 33 sq. ft. The locomotive had 23 x 28 in. cylinders, 200 lbs. steam pressure and a heating surface of 3,927 sq. ft. The ratio of heating surface to grate area was 119; a very large proportion gauged by modern practice.

It would seem that there is some doubt of the ability of these locomotives to handle some of the heaviest traffic on that railroad, which operates very high speed passenger trains, since the same company has just received five Pacific type locomotives from the American Locomotive Company which have wide fireboxes and a grate area of 49.5 sq. ft. The boiler in other respects is practically identical with that used on the previous order and the locomotives, as a whole, are very similar in size and power. They have 23 x 28 in. cylinders, 200 lbs. of steam and 80 in. instead of 73 in. drivers. By the use of the wide firebox it was possible to install 14 more tubes; the tube heating surface being thus increased to 4,071 sq. ft. The ratio of heating surface to grate area, however, has been reduced to 82.3, which, while still higher than the average for this type of locomotive, is not to be considered excessive, especially as this company is in a position to obtain a first-class grade of fuel.

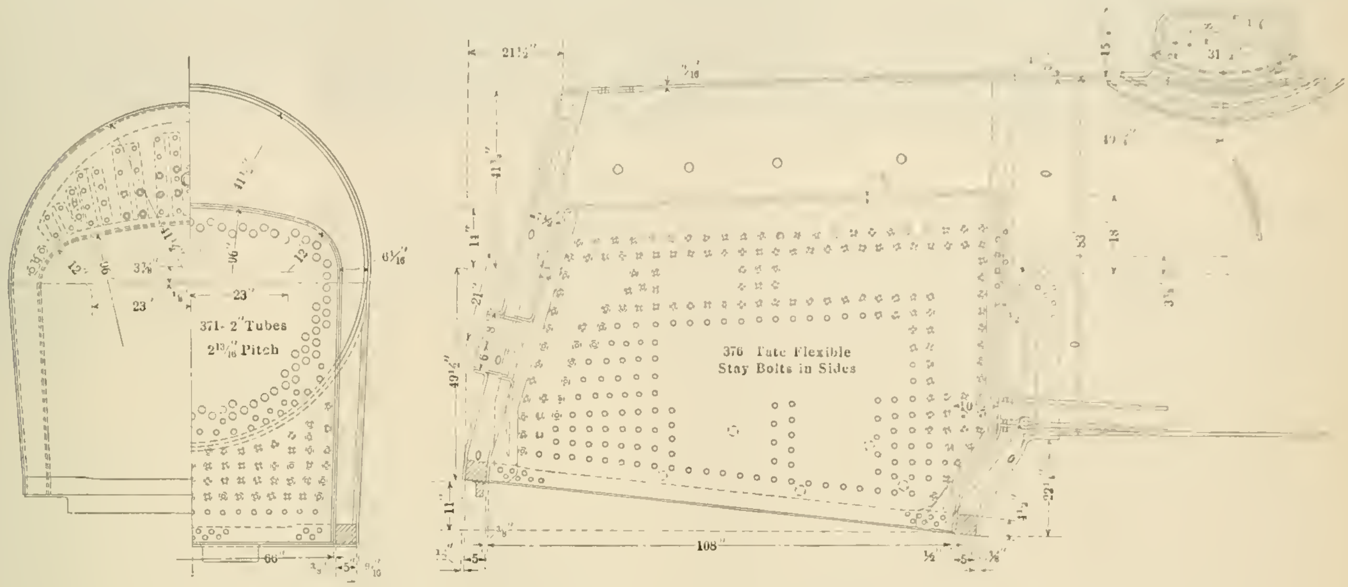
The construction of the later firebox is shown in one of the illustrations and it will be seen that while it is a typical wide firebox design it has outwardly inclining water legs, the firebox side sheet being 2 in. further out at the turn to the crown than




ELEVATIONS AND SECTIONS OF PACIFIC TYPE LOCOMOTIVE—CHICAGO AND ALTON RAILROAD.

at the mud ring, the space in the water leg at the same time being increased from 5 in. at the mud ring to 6 1/16 in. at the crown sheet. This will, to some extent, give the impinging action of the circulation in the water leg which it is believed is largely responsible for the good service of the ogee shape of side water legs.

This is one of the heaviest and most powerful Pacific type locomotives ever built, as a reference to the comparative table of locomotives in this issue will show. The total weight is 248,000 lbs., of which 149,500, or 60 per cent., is on driving wheels. The tractive effort is 31,475 lbs., giving a ratio of adhesion of 4.74. The B. D. factor of 618 falls well within the limits established by good practice.




DETAILS OF FIREBOX, PACIFIC TYPE LOCOMOTIVE—CHICAGO AND ALTON RAILROAD.

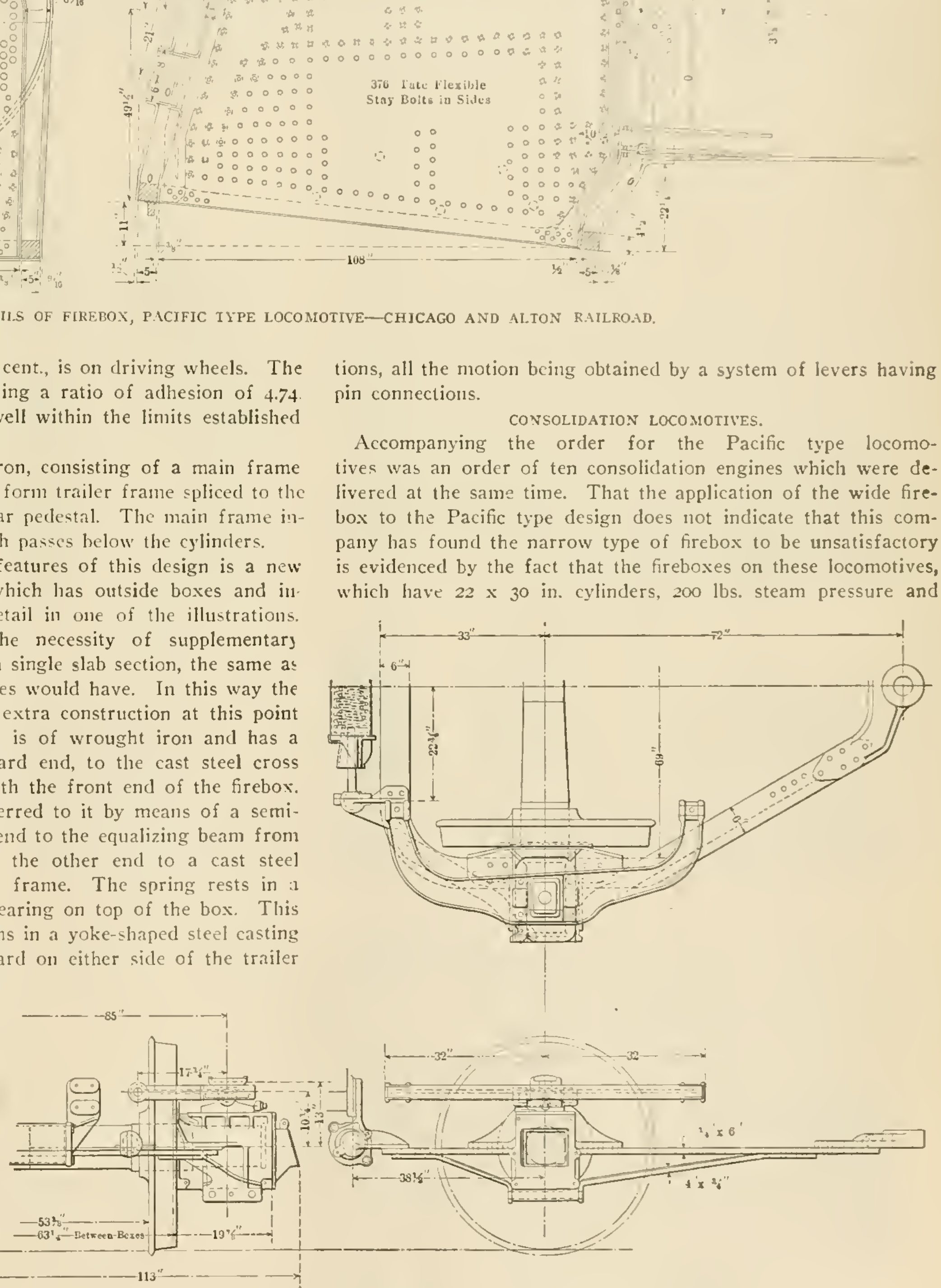
The frames are of wrought iron, consisting of a main frame 5 in. in width and a 2¼ in. slab form trailer frame spliced to the main frame just back of the rear pedestal. The main frame includes the single front rail which passes below the cylinders.

One of the most interesting features of this design is a new arrangement of trailer truck, which has outside boxes and inside frames. It is shown in detail in one of the illustrations. This arrangement eliminates the necessity of supplementary trailer frames and requires but a single slab section, the same as the trailer truck with inside boxes would have. In this way the complication and weight of the extra construction at this point is eliminated. The truck frame is of wrought iron and has a pivoted connection, at the forward end, to the cast steel cross tie between the frames underneath the front end of the firebox. The load on the truck is transferred to it by means of a semi-elliptic spring connected at one end to the equalizing beam from the rear driving spring and at the other end to a cast steel bracket extending out from the frame. The spring rests in a spring seat having a flat slide bearing on top of the box. This spring seat is carried by trunnions in a yoke-shaped steel casting of I-section, which extends inward on either side of the trailer wheel and is hinged in brackets secured to the frame. In this way the spring seat is able to easily adjust itself to the alignment of the box as the latter rises and falls relative to the frame. A spring centering device, the same as has previously been used by this company, is provided to bring the truck back to the normal center position after passing a curve.

The valve gear is of the Baker Pilliod design, which was fully illustrated and described on page 32 of the January, 1909, issue of this journal. This valve gear has been tried out in practice on this road on this same type locomotive and its specification for this order indicates that the results have been satisfactory. The gear, in general, might be described as a combination of the Walschaert and Marshall valve gear, having incorporate in it features of both, but differing from either. It gives a constant lead and obtains its motion from a return crank the same as the Walschaert, but does not require a link or any sliding connections, all the motion being obtained by a system of levers having pin connections.

CONSOLIDATION LOCOMOTIVES.

Accompanying the order for the Pacific type locomotives was an order of ten consolidation engines which were delivered at the same time. That the application of the wide firebox to the Pacific type design does not indicate that this company has found the narrow type of firebox to be unsatisfactory is evidenced by the fact that the fireboxes on these locomotives, which have 22 x 30 in. cylinders, 200 lbs. steam pressure and




TRAILER TRUCK WITH OUTSIDE JOURNAL BOXES, PACIFIC TYPE LOCOMOTIVE—C. & A. R. R.


CONSOLIDATION TYPE LOCOMOTIVE WITH NARROW FIREBOX—CHICAGO AND ALTON RAILROAD.

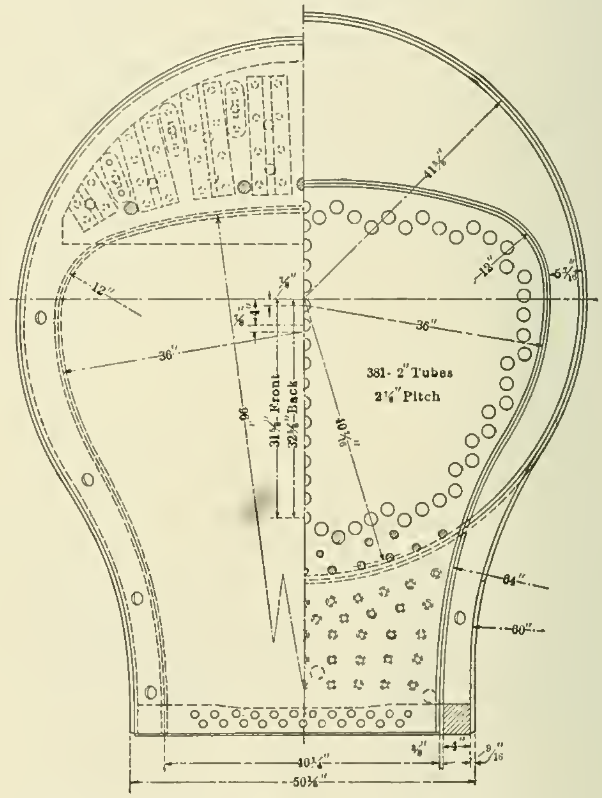
weigh 228,000 lbs., giving a tractive effort of 39,800 lbs., are 120½ in. long by 40½ in. wide, giving a grate area of 33.6 sq. ft., this being practically the same size grate as was used on the earlier order of Pacific type. The boiler itself is of the straight type, measuring 78⅜ in. inside diameter of the front sheet and 83¼ in. outside diameter at the dome course. The tubes are but 16 ft. in length, there being 381 2-in. tubes in the boiler, which gives a heating surface of 3,175 sq. ft. This with 197 sq. ft. in the firebox gives a total heating surface of 3,372 sq. ft. The ratio of heating surface to the grate area is 102, which is far larger than any other consolidation locomotive on our records. The B. D. factor, however, not being affected by the grate area, is normal.

The illustrations show the construction of this boiler and firebox very clearly and it will be seen that while the firebox side sheets have an ogee curve the radii used are large and there are no abrupt bends in the water legs. The mud ring is but 4 in. on the sides and the space is increased to 5 7/16 in. at the crown sheet. The crown and side sheets, both inside and outside, are in one piece.

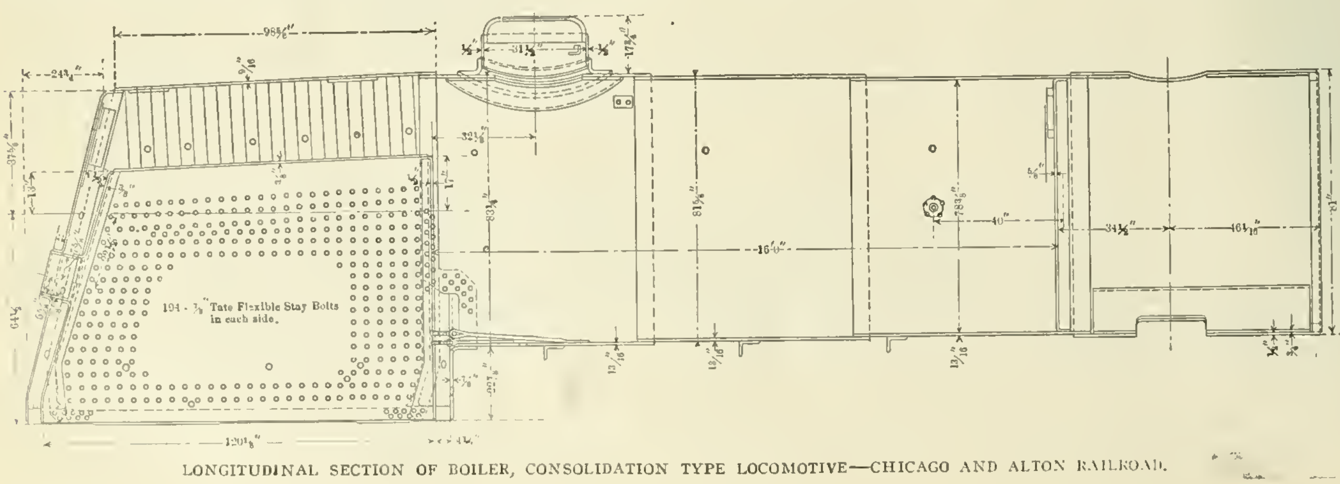
The frames in this case are also of wrought iron with an integral single front rail. The Baker Pilliod valve gear, being altogether outside of the frames, gives an opportunity for excellent frame bracing, which has been taken full advantage of.

The general dimensions, weights and ratios of both types of locomotives are given in the following table:

| | | |
|---|---|---|
| **GENERAL DATA.** | | |
| Type | 2—8—0 | 4—6—2 |
| Gauge | 4 ft. 8½ in. | 4 ft. 8½ in. |
| Service | Freight | Pass. |
| Fuel | Bit. Coal | Bit. Coal |
| Tractive effort | 39,800 lbs. | 31,476 lbs. |
| Weight in working order | 228,000 lbs. | 248,000 lbs. |
| Weight on drivers | 203,500 lbs. | 149,600 lbs. |
| Weight on leading truck | 24,500 lbs. | |
| Weight of engine and tender in working order | 393,100 lbs. | 413,120 lbs. |
| Wheel base, driving | 17 ft. 9½ in. | 13 ft. 9 in. |
| Wheel base, total | 26 ft. 9½ in. | 34 ft. 8½ in. |
| Wheel base, engine and tender | 64 ft. 1 11/16 in. | 66 ft. 4 in. |
| **RATIOS.** | | |
| Weight on drivers ÷ tractive effort | 5.10 | 4.74 |
| Total weight ÷ tractive effort | 5.72 | 7.90 |
| Tractive effort × diam. drivers ÷ heating surface | 730.00 | 618.00 |
| Total heating surface ÷ grate area | 102.00 | 82.30 |
| Firebox heating surface ÷ total heating surface, % | 5.83 | 4.88 |
| Weight on drivers ÷ total heating surface | 61.00 | 36.60 |
| Total weight ÷ total heating surface | 67.50 | 61.00 |
| Volume both cylinders, cu. ft | 13.20 | 13.30 |
| Total heating surface ÷ vol. cylinders | 256.00 | 302.00 |
| Grate area ÷ vol. cylinders | 2.55 | 3.67 |
| **CYLINDERS.** | | |
| Kind | Simple | Simple |
| Diameter and stroke | 22 x 30 in. | 23 x 28 in. |




SECTION THROUGH FIREBOX—C. & A. 2-8-0 LOCOMOTIVE.




LONGITUDINAL SECTION OF BOILER, CONSOLIDATION TYPE LOCOMOTIVE—CHICAGO AND ALTON RAILROAD.

| | | |
|---|---|---|
| **VALVES.** | | |
| Kind | Piston | Piston |
| Greatest travel | 6 in. | 6 in. |
| Outside lap | 1 in. | 1 in. |
| Inside clearance | 0 in. | 0 in. |
| Lead, constant | ¼ in. | ¼ in. |
| Gear | Baker-Pilloid | |
| **WHEELS.** | | |
| Driving, diameter over tires | 62 in. | 80 in. |
| Driving, thickness of tires | 3½ in. | 3½ in. |
| Driving journals, main, diam. and length | 10½ x 12 in. | 10½ x 12 in. |
| Driving journals, others, diameter and length | 9½ x 12 in. | 9 x 12 in. |
| Engine truck wheels, diameter | 33 in. | 33 in. |
| Engine truck, journals | 6½ x 12¼ in. | 6½ x 12¼ in. |
| Trailing truck wheels, diameter | —— | 42 in. |
| Trailing truck, journals | —— | 8 x 14 in. |
| **BOILER.** | | |
| Style | Str. | E. W. T. |
| Working pressure | 200 lbs. | 200 lbs. |
| Outside diameter of first ring | 80 in. | 72 in. |
| Firebox, length and width | 120⅛ x 40¼ in. | 108 x 66 in. |
| Firebox plates, thickness | ⅜ & ½ in. | ⅜ & ½ in. |
| Firebox, water space | F.—4½, S. & B.—4 in. | 5 in. |
| Tubes, number and outside diameter | 381—2 in. | 273—2 in. |
| Tubes, length | 16 ft. | 20 ft. |
| Heating surface, tubes | 2,175 sq. ft. | 3,869 sq. ft. |
| Heating surface, firebox | 197 sq. ft. | 202 sq. ft. |
| Heating surface, total | 2,372 sq. ft. | 4,071 sq. ft. |
| Grate area | 33.6 sq. ft. | 49.5 sq. ft. |
| Smokestack, diameter | 18½ in. | 18½ in. |
| Smokestack, height above rail | 15 ft. ½ in. | 15 ft. ½ in. |
| **TENDER.** | | |
| Frame | 13 in. Chan. | 13 in. Chan. |
| Wheels, diameter | 36 in. | 36 in. |
| Journals, diameter and length | 5½ x 10 in. | 5½ x 10 in. |
| Water capacity | 8,500 gals. | 8,500 gals. |
| Coal capacity | 14 tons. | 14 tons |

## JACOBS-SHUPERT FIREBOX.

*To the Editor:—*

I notice in reading your June issue, a letter headed "Experience with the Jacobs-Shupert Locomotive Fire Box," and it would appear that the writer of it seems to be rushing things, for this experience to be printed in your June issue, for I was informed that this fire box was not finished and tried until the 26th or 27th of April, and this experience is ready for your June issue. It would be well to print this six months hence, as during that time they may have unsurmountable difficulties to contend with in a locomotive fire box constructed in that way. My name is referred to in reference to a letter I wrote giving my ideas of the construction of this fire box, and in it I actually made a challenge to the world on locomotive fire boxes and tube plates, and up to this time no one has taken it up. However, I cannot help remarking that your correspondent's letter is written in language and thought so much like the letters of Jacobs, Wagstaff, etc., that you would almost imagine that the letters over the different signatures referred to had come from the same pen. Referring to my experience, which is quoted by this corrspondent, it was with the Daniel Adamson's patent furnace joint, which came out, as near as I can remember, about 1869 or 1870, in England, and the Jacobs-Shupert fire box is nothing more than the old Adamson patent joint, with the center plate continued outward, for staying, which we used to call "plate staying." My experience with this joint was in marine and Lancashire double furnace boilers. These furnaces are round and do not require staying. The idea of this joint was to strengthen the furnaces by making them in sections so that they would not require reinforcing with tee iron rings, etc.

It is needless to repeat that my experience, and the experience of other well-known engineers, was not satisfactory, and hence my letter only referred to what I knew from actual facts.

I note your correspondent states how many stays are dispensed with in forming this locomotive fire box with this old joint, but he does not tell us that in place of the staybolts he has put twelve riveted seams, extending up sides and over crown of fire box, and has used about 5,000 or 6,000 rivets in place of the stays. He tells us he has gained 21 inches in the length of the same sized fire box, but he does not tell us there is about 19 square feet of direct heating surface taken up by the twelve joints which is practically lost, but he does say that the contraction and expansion of the fire box will be equalized by the formation of these sections. The sections are riveted together, and at the bottom they are welded together (two things which do not harmonize) in order to allow the sections to be riveted in the mud ring.

My views differ from your correspondent's, that the formation of the sections will equalize the contraction and expansion of the box. I predict the expansion of the sections will all go toward the fire box tube plate, and that the front tube plate and the tubes will expand in the opposite direction toward the fire box tube plate, two opposing forces, meeting on the same tube plate, just the same as there is now in the standard fire box, and no provision made to take care of it. The sections, with the twelve riveted seams, the rivets of which you will find will incrustate, and the joint surrounded by scale, will burn and the sections will crack, and the sections cannot do otherwise than form mud pockets. Experience repeats itself.

Your correspondent states that I stated, that in designing a fire box I eliminated most of the parts that they have incorporated. And why did I do it? Because I deemed it requisite for success, and I can assure you it was a hard problem to feel sure that I had balanced the contraction and expansion in a locomotive fire box from front tube plate to back of fire box, and I studied hard for two years before I was satisfied to allow my name to be associated with it. When I was sure, I let her go, and by actual practice it is proving my experience, and is telling its own tale by the success with which the boilers are doing their work, as can be seen by referring to the locomotive expert's report, copy of which is given to this paper.

In conclusion, I wish to be put on record that the Jacobs-Shupert fire box will be a costly experiment for the Atchison, Topeka & Santa Fe Railroad Co., and one that will call for criticism from all parts of the engineering world, and I feel sure time will soon eradicate the sagacity of the remarks made on this subject by the writers referred to above.

WM. H. WOOD.

Media, Pa.

[The locomotive expert's report referred to above by Mr. Wood is substantially as follows:—ED.]

I have been engaged by the Wm. H. Wood Locomotive Fire Box and Tube Plate Co. to examine locomotives Nos. 2490, 2494 and 2481 respectively, equipped with the Wm. H. Wood patented fire box and tube plates, as well as engines Nos. 2487, 2492 and 2499, which have the ordinary fire box and are operating the same trains with the former three.

I have found the locomotives with the Wood fire box as compared with those of the standard fire box to be better steamers, to be coal savers, as is shown below and to be most satisfactory to the engineers and firemen operating them, who all speak in the highest praise of the working of these boilers. I have found the beading on the flues to be just as good after six months' service as they were when the engines were turned out, and although the flues have been rolled I have the evidence of the engineers that they have not reported a flue leaking in eight weeks' service and that the flues did not require rolling. There has not been a broken staybolt in these boilers since they were put into service. One staybolt in the throat sheet was removed because of the tell-tale hole being drilled at an angle. I have not found any leaks at the mud ring, and, in spite of the fact that the water being used is very poor, the boilers have not leaked in any respect as far as I have been able to discover.

I have carefully determined the amount of coal used on these engines, especially two equipped with the Wood fire box and two with the regular fire box, having boarded the engine upon its arrival and measured the volume of the coal left in the tender and determined how much had been used on these four engines. This has been done daily and the results are as follows:

No. 2481 (Wood's fire box), the average amount of coal consumed on each of fifteen trips, from April 23 to June 1, has been 5.67 tons.

No. 2492 (ordinary fire box), fifteen trips with the same trains and in exactly the same service, 9.01 tons.

No. 2490 (Wood's fire box), fifteen trips, 7.2 tons.

No. 2487 (ordinary fire box), fourteen trips, 8.62 tons.

Taking No. 2492 as a basis, engine No. 2481 shows a coal economy of 37 per cent. and engine No. 2490 an economy of 20 per cent.

Engine No. 2494 (Wood's fire box) is running opposite No. 2499 (ordinary fire box) and shows an average consumption of 9.35 tons per trip in two trips as compared with an average of 13.3 tons per trip in three trips of the No. 2499, an economy of about 30 per cent.

(Signed) FRED. H. SNELL,
Locomotive Expert.

*To the Editor:—*

So much has been said by correspondents in the columns of your paper concerning the circulation of water in the Jacobs-Shupert fire box that I feel impelled to present to these correspondents, and others, several photographs which tell a graphic story, and which still further illustrate the beneficial effect of the sectional construction upon circulation and upon the life of boilers.

The accompanying illustrations of an old fire box show very clearly how solids contained in feed water are collected by obstructions which impede circulation. The crown sheet is the hottest portion of the fire box, and ebulition above the crown sheet is vigorous and active, and any obstructions to the movement of the heated water and steam bubbles, as they rise from the crown sheet, produce eddies in the currents of rising steam and water, providing harbors where solid substances may collect undisturbed. Each particle that collects forms a nucleus to which other particles adhere.

This formation not only materially diminishes the evaporative value of the crown sheet and lowers the capacity of the boiler, but introduces an element of danger. Such accumulations are conducive to explosions, and an accumulation of mud and scale immediately upon the crown sheet is likely to cause mud burns, even though the water in the boiler is at the proper level.

The photographs therefore emphasize the necessity of unimpeded circulation above the crown sheet, and illustrate what takes place in locomotive boilers wherein the circulation above the crown sheet is impeded.

A side view of the Jacobs-Shupert fire box, in connection with the photographs just referred to, forms a striking comparison between a form of boiler construction wherein circulation above the crown sheet is impeded and a construction wherein there is practically no obstruction to the free movement of water and steam. Not only are the stay sheets of the Jacobs-Shupert fire box few in number and spaced far apart, but they are of a form which will neither harbor solids nor interfere with the free movement of currents rising from the crown sheet.

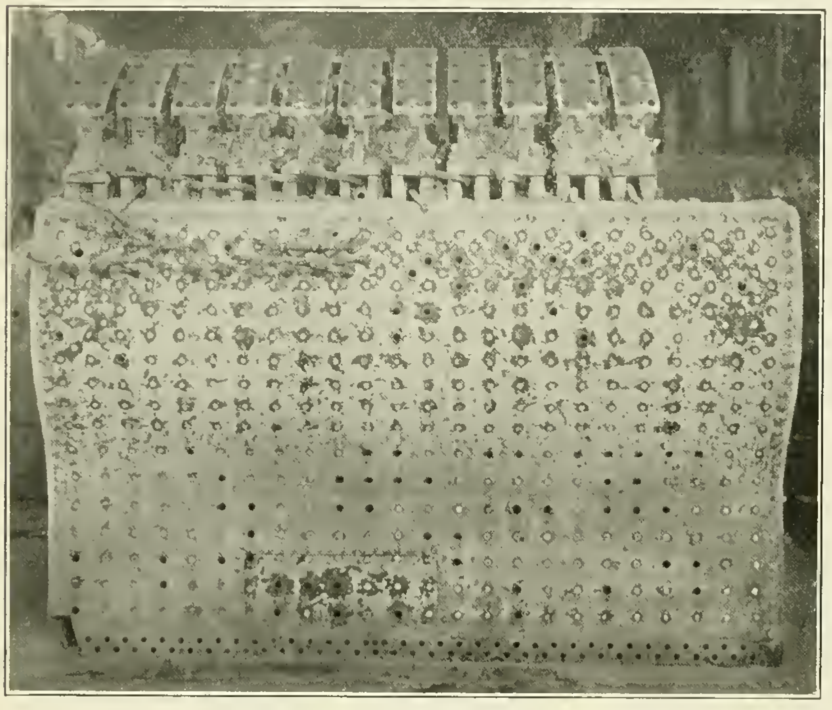
A still further advantage which this comparison emphasizes is the increased heating surface provided by the Jacobs-Shupert design. The total area covered by the crown-bar washers of the old fire box is 6.08 square feet. The area above the crown sheet occupied by the radial stay sheets of the Jacobs-Shupert fire box is only 2.26 square feet in a fire box 129⅝ inches long. The size of this crown sheet is materially larger than that of the old fire box, so that for a crown sheet of the same size the proportional gain in heating surface is even greater than that indicated by the above figures.

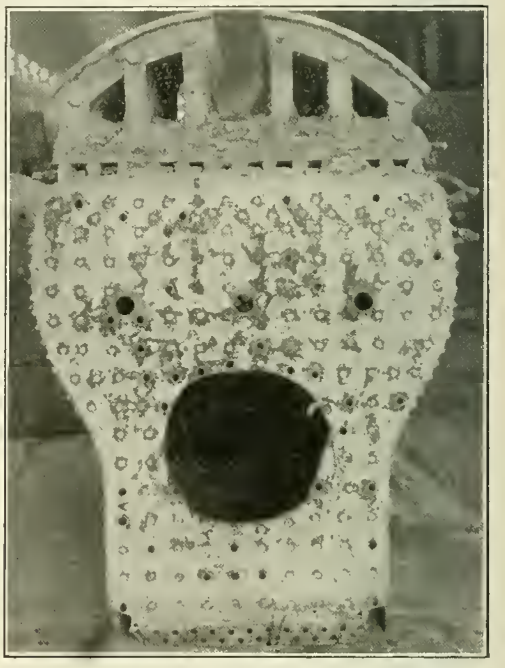
It is true that in boilers with radially stayed crown sheets, the stays do not offer the same amount of obstruction as the crown bars. Nevertheless, several rows of radial stays are usually replaced by three or four rows of sling stays at the forward end of the crown sheet. T-irons of these sling stays impede circulation as much as the ordinary crown bar and produce the same effect upon the accumulation of mud and scale. This formation is at the point of the crown sheet where the greatest difficulty from cracking occurs and is, therefore, the point where there should be the least accumulation of mud.

While the straight radial stay does not cause the same accumulation as the crown bar or the T-iron, the large number of stays offers much more impediment than the few thin stays of the Jacobs-Shupert construction and consumes more space which would otherwise be available as heating surface. Another objection to the radial stay is the crown head on the fire side of the crown sheet, which is always a prolific source of trouble.

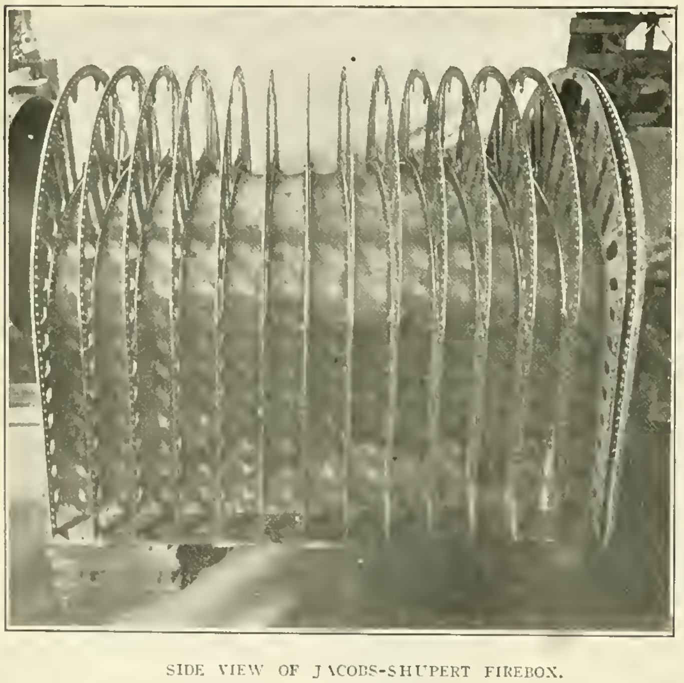
H. W. Jacobs.

Topeka, Kan.





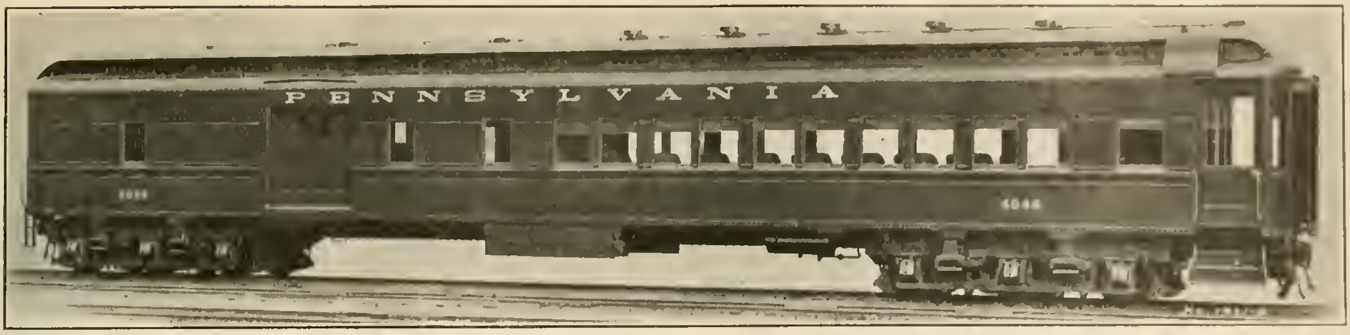
FIREBOX OF CROWN BAR BOILER SHOWING ACCUMULATION OF SCALE AND SEDIMENT.



SIDE VIEW OF JACOBS-SHUPERT FIREBOX.

The Value of the Railroad Club.—The officials of one road rub elbows with the officials of another, they compare notes, they learn how one man does the same thing they are doing in a different way, and does it with less actual labor or less wear and tear on his gray matter or reasoning powers, and the result to the employee is a capacity for greater responsibility, and to the company a more competent officer.—*A. W. Martin, New England Railroad Club.*

Explosion from Belt Friction.—An overlooked factory danger has been pointed out in Germany by Prof. M. M. Richter, who has found that machinery belts—especially in dry air and when rubbed with resinous substances—may become highly charged with electricity, and may give off sparks that, in an atmosphere laden with dust or combustible vapors, may produce a serious explosion. A five-inch belt running over a wheel making 600 to 2,000 revolutions a minute gave off a spark one to one and a half inches long. Coating the belts with bronze or aluminum powder proved an ineffective preventive, but acid-free glycerin, applied once a week, attracted moisture, and not only gave security against static charges, but increased the life of the leather.—*American Machinist.*




## PENNSYLVANIA ALL-STEEL COMBINATION PASSENGER AND BAGGAGE CAR.

In the June and July issues, 1907, the all-steel passenger cars for the Pennsylvania Railroad, including a through service passenger coach, a postal car, baggage car and suburban car, were described in detail. A number of combination passenger and baggage cars designed along the same lines have recently been manufactured for this company by the Pressed Steel Car Company. The general dimensions of these cars are as follows:

| | |
|---|---|
| Length over all | 77 ft. 8¾ in. |
| Length over body corner posts | 71 ft. 1 1/16 in. |
| Length inside, passenger end | 39 ft. 9 11/16 in. |
| Length inside, baggage end | 35 ft. 6 in. |
| Width over side sheets | 9 ft. 9¾ in. |
| Height from rail to top of car | 14 ft. ½ in. |

These cars have been constructed almost exclusively of steel, including the doors. The floors and headlinings are of fireproof material, and the very small percentage of inflammable material used is not a part of the structure, but merely of the trimming. In the main structure of each combination coach there have been used 17,500 lbs. of ¼-in. plates, 4,500 lbs. of angles, and 7,100 lbs. of shapes and small plates. In addition, considerable steel material for interior finishing has been utilized. The flooring consists of monolith laid on corrugated sheets. A ¾-in. maple floor is placed upon the monolith at the baggage end.

Six-wheel trucks are used having 5 x 9-in. axles and 36-in. Carnegie-Schoen rolled steel wheels.

SEAT ARMS AND WINDOW SILLS ON STEEL PASSENGER CARS.—The use of steel for window sills and arm rests on seat ends is not only objectionable because these parts soon lose their paint due to constant elbowing, but it has been found that steel is too cold in winter time to make comfortable supports for the arms and hands of the passengers; cars which were originally equipped with these parts of steel are now being changed to wood.—*Chas. Lindstrom, Central Railway Club.*

## RAILROAD CLUB STATISTICS

| | | Canadian | Central | Iowa | New England | New York | Northern | Pittsburgh | Richmond | St. Louis | Western |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ANNUAL MEETING, NUMBER | | 7th | 19th | | 26th | 35th | 3rd | 7th | 7th | 13th | 25th |
| ANNUAL MEETING, DATE OF | | May, '09 | Jan., '09 | | Mar., '09 | Nov., '08 | Nov., '08 | Oct., '08 | Nov., '08 | April, '09 | May, '09 |
| Members | Number Received During Year | 122 | 185 | | 70 | 174 | 244 | 107 | 53 | 142 | 183 |
| | Total Membership, Active | 722 | 569 | 273 | 515 | 1,416 | 529 | 742 | 236 | 1,202 | 1,574 |
| | Net Gain for the Year | 14 | 142 | | 23 | 66 | | | 19 | 54 | 74 |
| Receipts | Balance on Hand, previous report | $1,501.22 | $105.89 | $55.12 | $1,319.93 | $13,307.14 | $111.41 | $898.81 | $1,315.07 | $3,968.41 | $1,917.58 |
| | Dues and Fees | 1,238.00 | 1,167.00 | 766.75 | 1,232.00 | 3,451.00 | 753.00 | 2,202.00 | 442.00 | 2,206.00 | |
| | Advertising | 3,158.20 | 1,756.00 | 277.00 | 2,625.00 | 4,678.88 | 1,405.00 | 882.75 | 1,140.00 | 1,839.77 | |
| | Miscellaneous | 224.37 | 322.65 | 1,288.75 | 1,257.21 | 701.44 | 135.00 | 85.33 | 77.14 | 163.65 | 4,791.18 |
| | Total | 6,121.79 | 3,351.54 | 2,387.62 | 6,434.14 | 22,138.36 | 2,404.41 | 4,068.89 | 2,974.21 | 8,177.83 | 6,708.76 |
| Disbursements | Printing and Stationery, Postage | $1,659.29 | $1,143.32 | | $1,547.65 | $3,335.44 | $867.48 | $1,786.15 | $457.91 | $1,919.82 | $2,551.28 |
| | Entertainment | 709.70 | 1,005.05 | | 2,147.32 | 1,553.85 | 290.70 | 607.14 | 117.00 | 985.83 | |
| | Salaries and Stenographer | 812.49 | 650.00 | | 1,148.50 | 1,619.77 | 494.45 | 135.00 | 702.00 | 542.95 | 556.93 |
| | Miscellaneous | 652.90 | 254.63 | | 47.97 | 803.72 | 163.00 | 170.25 | 45.00 | 586.98 | 2,533.39 |
| | Total | 3,834.38 | 3,053.00 | $2,332.68 | 4,891.44 | 7,312.78 | 1,815.63 | 2,698.54 | 1,321.91 | 4,035.58 | 5,671.60 |
| Balance on Hand | | $2,287.41 | $298.54 | $54.94 | $1,542.70 | $14,825.58 | $588.78 | $1,370.35 | $1,652.30 | $4,142.25 | $1,037.16 |

*Canadian Railway Club* maintains a scholarship at McGill University. *Iowa.*—During the year covered by the above report the club held a reunion in conjunction with the Des Moines Commercial Club. This accounts for the apparently heavy receipts under the head of "Miscellaneous." *New England.*—This club has a dinner before each meeting. $1,125.25 under "Miscellaneous" receipts was received from the members for this purpose and for tickets to an "outing." *Richmond.*—About $400.00 should be added to expenditures for entertainment. *St. Louis* maintains a scholarship at one of the colleges. *Western* presents its members annually with bound volumes of the proceedings.

## MEETINGS

*Canadian*—First Tuesday in month except June, July, August.
*Central*—Second Friday, Jan., Mar., May, Sept., and Nov.
*Iowa*—Second Friday in month except July and August.
*New England*—Second Tuesday except June, July, Aug. and Sept.
*New York*—Third Friday except June, July and August.
*Northern*—Fourth Saturday in each month.
*Pittsburgh*—Fourth Friday except June, July and August.
*Richmond*—Second Monday except June, July and August.
*St. Louis*—Second Friday except June, July and August.
*Southern & Southwestern*—Third Thursday, Nov., Jan., April and Aug.
*Western*—Third Tuesday except June, July and August.
*Western Canada*—Second Monday except June, July and August.

# A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

## ARRANGED IN ORDER OF TOTAL WEIGHTS

### FREIGHT LOCOMOTIVES OF THE CONSOLIDATION OR 2-8-0 TYPE

| Name of road | N. Y. S & W | D. & H. | W. P. T. | L. S. & M. S. | L. S. & M. S. | C. & A. | P. R. R. | Wabash | A. T. & S. F. | B. & O. | Har. lines | C. S. N O. & P. | P. R. R. | C. N. O. & T. P. | C. B & Q | W. P. | C. R. I. & P. | C. P. R. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Road number or class | 140 | 1,011 | 918 | 5,962 | G-46 | 438 | 2.762 | | 1,950 | 2,503 | C-187 | | H 6 B | 734 | D4 | | 55D | M4 |
| Builder | Bald. | Amer. | Amer. | Amer. | Amer. | Amer. | Amer. | Bald. | Bald. | Amer. | Bald. | Bald. | Bald | Both | Amer. | Bald. | Bald. | Shops |
| When built | 1906 | 1906 | 1909 | 1906 | 1903 | 1909 | 1905 | 1906 | 1908 | 1905 | 1905 | 1907 | 1905 | 1907 | 1903 | 1906 | 1906 | 1904-6 |
| Simple or compound | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple | Simple |
| Tractive effort, lbs | 54,100 | 49,690 | 46,900 | 45,677 | 46,500 | 39,800 | 45,700 | 42,600 | 44,000 | 41,100 | 43,299 | 43,300 | 42,000 | 44,100 | 42,500 | 44,100 | 39,600 | 36,800 |
| Weight, total, lbs | 260,100 | 246,500 | 236,000 | 232,500 | 230,000 | 228,000 | 220,000 | 214,500 | 212,400 | 208,500 | 208,000 | 207,000 | 204,470 | 203,600 | 202,600 | 201,330 | 198,600 | 186,200 |
| Weight on drivers, lbs | 232,700 | 217,500 | 207,000 | 207,000 | 203,000 | 203,500 | 198,000 | 189,600 | 183,200 | 185,900 | 187,000 | 182,000 | 181,170 | 182,000 | 179,200 | 186,330 | 177,300 | 163,700 |
| Weight on trucks, lbs | 27,400 | 29,000 | 29,000 | 25,500 | 27,000 | 24,500 | 22,000 | 24,900 | 29,200 | 22,600 | 21,000 | 27,000 | 23,300 | 21,600 | 23,400 | 15,000 | 21,300 | 22,525 |
| Weight, tender loaded, lbs | 161,900 | 152,400 | 154,000 | 149,600 | 148,000 | 165,100 | 140,500 | | 175,200 | 143,500 | 135,050 | 148,000 | 143,000 | 146,400 | 150,200 | | 140,300 | 121,400 |
| Wheel base, driving | 17' 0" | 17' 0" | 15' 9" | 17' 6" | 17' 3" | 17' 9½" | 17' 6" | 15' 9" | 15' 6" | 16' 8" | 15' 8" | 16' 0" | 16' 3" | 16' | 15 8" | 15' 8" | 17' 0" | 15' 10" |
| Wheel base, engine | 26' 6" | 25' 11" | 25' | 26' 5" | 26' 5" | 26' 9½" | 26' 5" | 24' 6" | 24' 6" | 25' 7" | 24' 4" | 24' 4" | 34' 9" | 24' 3½" | 24' 6" | 24' 4" | 26' 0" | 24' 4½" |
| Wheel base, engine and tender | 60' 10" | 57' 7½" | 59' 11" | 60' 9½" | 57' 9¾" | 64' 1 11/16" | 60' 3¾" | 57' 10½" | 58' 5" | 59' 8¼" | 55' 11¾" | 56' 3" | 58' 1½" | 56' 7¼" | 69' 1¼" | 57' 11½" | 58' 0" | 53' 4¼" |
| Diameter of drivers | 63" | 57" | 58" | 63" | 58" | 62" | 63" | 58" | 57" | 60" | 57" | 57" | 56" | 56" | 57" | 57" | 63" | 57" |
| Cylinders, number | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cylinders, diameter and stroke | 28" × 32' | 23" × 30" | 25" × 32" | 23" × 32" | 23" × 30" | 22" × 30" | 23" × 32" | 22" × 30" | 24" × 32" | 22" × 30" | 22" × 30' | 22" × 30" | 22" × 28" | 22" × 30" | 22" × 28" | 22" × 30" | 23" × 30" | 21" × 28 |
| Valve gear, type | Wals. | Wals. | Wals. | Wals. | Steph. | Pilloid | Steph | Steph. | Wals. | Steph. | Steph. | Wals. | Wals. | Wals | Steph. | Steph. | Wals. | Steph. |
| Steam pressure, lbs | 160 | 210 | 160 | 200 | 200 | 200 | 200 | 200 | 160 | 205 | 200 | 200 | 205 | 200 | 210 | 200 | 185 | 200 |
| Boiler, type | Str. | Wooten | E. W. T. | Rad. stay | W. T. | Str. | Str. | W. T. | Str. | Str. | Str. | Str. | Belp. | Str. | Str | Str. | E. W. T. | E. W. T. |
| Boiler, smallest diameter | 84" | 83¾" | 80" | 81⅝" | 80" | 80" | 80" | 77" | 78¾" | 74' 5" | 80" | 78" | 71" | 76 11/16" | 79½" | 80" | 74" | 69" |
| Boiler, height center | 120" | 113" | | 118¼" | 119½" | | 117" | | 114" | 118" | 114" | 115½" | 108¼" | 114⅞" | 115" | | 117" | 111½" |
| Heating surface, tubes, sq. ft | 3,931 | 3,716 | 3,093 | 3492.18 | 3,725 | 3,175 | 3,600 | 3,053 | 2,773 | 2630.1 | 3,226 | 2,939 | 2675.9 | 3,051 | 3511.56 | 2,927 | 2,427 | 2,216 |
| Heating surface, firebox, sq. ft | 198 | 329.5 | 190 | 213.05 | 232 | 197 | 182 | 192 | 157 | 179.3 | 177 | 183 | 166 5 | 175 | 221.77 | 214 | 168 | 165 |
| Heating surface, total, sq. ft | 4,129 | 4045.5 | 3,283 | 3705.23 | 3,957 | 3,372 | 3,782 | 3,245 | 2,930 | 2809.4 | 3,403 | 3,122 | 2842.4 | 3,226 | 3733.33 | 3,141 | 2,595 | 2,381 |
| Heating surface, superheater, sq. ft | 834 | | 374 | | | 118½" | | | 600 | | | | | | | | | 375 |
| Grate area, sq. ft | 60.2 | 99.85 | 50.5 | 56.5 | 55 | 33.6 | 55.4 | 50.4 | 47.4 | 56.24 | 49.5 | 51 | 49.11 | 54 | 54.2 | 33.6 | 50 | 43 |
| Firebox, length | 120" | 126⅛" | 109" | 108⅛" | 108" | 120½" | 106" | 108⅛" | 95½" | 107⅝" | 108" | 108" | 107" | 108" | 108⅜" | 121" | 107" | 96⅝" |
| Firebox, width | 72¼" | 114" | 68" | 75¼" | 73¼" | 40½" | 75¼" | 67¼" | 71¼" | 75¼" | 66" | 68" | 66" | 71¼" | 72" | 40" | 67¼" | 65¼" |
| Fuel, kind | Bit. coal | Anth. coal | Bit. Coal. | Bit. coal | Bit. coal | Bit. Coal | Bit. coal | Bit. coal | Oil | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal |
| Tubes, number firetube | 472 | 493 | 358 | 446 | 461 | 381 | 446 | 360 | 355 | 282 | 413 | 386 | 373 | 403 | 450 | 390 | 340 | 244 |
| Tubes, number superheater | | | 20 | | | | | | | | | | | | | | | 22 |
| Tubes, diameter, firetube | 2" | 2" | 2" | 2" | 2" | 2" | 2" | 2¼" | 2" | 2¼" | 2" | 2" | 2" | 2" | 2" | 2" | 2" | 2" |
| Tubes, diameter, superheater | | | 5¼" | | | | | | | | | | | | | | | 5" |
| Tubes, length | 16' | 14' 6" | 14' 6" | 15' | 15' 6⅛" | 16' | 15' 4¾" | 14' 6" | 14' 11" | 15' 10" | 15' | 14' 6½" | 13' 8½" | 14' 6½" | 15' | 14' 5" | 15' 6" | 14' 1⅜" |
| Tender, coal capacity, tons | 15 | 14 | 14 | 12 | 16 | 14 | 13½ | | 3,300 G | 15 | 14 | 12 | 13½ | 12½ | 14 | 14 | 12 | 10 |
| Tender, water capacity, gals | 9,000 | 7,800 | 8,000 | 7,500 | 7,500 | 8,500 | 7,000 | 8,000 | 8,500 | 7,000 | 7,000 | 7,500 | 7,000 | 7,500 | 8,000 | 8,000 | 7,000 | 5,000 |
| Weight on drivers ÷ tractive effort | 4.3 | 4.37 | 4.41 | 4.5 | 4.37 | 5.10 | 4.3 | 4.44 | 4.17 | 4.5 | 4.3 | 4.2 | 4.3 | 4.13 | 4.2 | 4.2 | 4.5 | 4.4 |
| Weight, total ÷ tractive effort | 4.8 | 4.97 | 5.03 | 5,0 | 4.95 | 5.72 | 4.8 | 5. | 4.75 | 5.1 | 4.8 | 4.76 | 4.8 | 4.61 | 4.8 | 4 55 | 5. | 5.1 |
| T. E. × diam. drivers ÷ total H. S. | 825. | 700. | 825.00 | 775. | 680. | 730.00 | 760. | .760. | 855. | 875. | 725. | 790. | 830. | 768. | 650. | 800. | 965. | 800. |
| Total heating surface ÷ grate area | 68.50 | 40.5 | 65.00 | 65.8 | 72. | 102.00 | 68 | 64. | 62. | 50. | 69. | 61. | 58. | 59.80 | 69. | 93. | 52. | 55. |
| Firebox heat. surf. ÷ total H. S. % | 4.80 | 8.12 | 5.80 | 5.75 | 5.85 | 5.82 | 4.82 | 5.9 | 5.35 | 6.35 | 5.2 | 5.85 | 5.9 | 5.42 | 5.9 | 6.8 | 6.5 | 6.9 |
| Weight on drivers ÷ total heat. surf. | 56. | 53 5 | 63.00 | 55.8 | 51.2 | 61.00 | 52. | 58. | 62.50 | 66. | 55. | 58.2 | 63.5 | 56.40 | 48. | 59.5 | 68. | 69.5 |
| Weight total ÷ total heating surface | 63. | 60.8 | 71.70 | 6.25 | 58. | 67.50 | 58. | 66. | 72.50 | 74. | 61. | 66. | 72. | 63. | 54. | 64. | 77. | 78. |
| Total H. S. ÷ superheating heat. surf. | 5. | | 8.78 | | | | | | 4.90 | | | | | | | | | 6.35 |
| Cylinder volume, cubic feet | 22.70 | 14.4 | 18.20 | 15.4 | 14.4 | 13.20 | 15.4 | 13.2 | 16.80 | 13.2 | 13.2 | 13.2 | 12.4 | 13.20 | 12.4 | 13.2 | 14.4 | 11.2 |
| Total heating surface ÷ cyl. volume | 181. | 280. | 181.00 | 242. | 275. | 256.00 | 246. | 246. | 174.50 | 213. | 259. | 236.5 | 229. | 244.06 | 302. | 238. | 180. | 213. |
| Superheating heat. surf. ÷ cyl. vol. | 36 8 | | 20.6 | | | | | | 35.5 | | | | | | | | | 33.3 |
| Grate area ÷ cylinder volume | 2.65 | 6.92 | 2.78 | 3.66 | 3.8 | 2.55 | 3.6 | 3.8 | 2.82 | 4.3 | 3.75 | 3.87 | 3.95 | 4.10 | 4.4 | 2.55 | 3.48 | 3.8 |
| Reference in THE AMERICAN ENGINEER | 1907 p. 302 | 1907 p. 22 | 1909 p. 256 | 1906 p. 263 | 1903 p. 415 1904 p. 11 | Tbis issue | 1906 p. 73 | | 1908 p. 112 | 1906 p. 31 | 1905 p. 154 | 1907 p. 194 | 1906 p. 231 | 1908 p. 26 | 1903 p. 48 | | 1907 p. 147 | 1906 p. 165 |

# A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

## ARRANGED WITH RESPECT TO CLASSES AND WEIGHTS

### FREIGHT LOCOMOTIVES OF TYPES OTHER THAN THE CONSOLIDATION

| TYPE | MALLET | | | | | | | | SANTA FE | MIKADO | | | 12-WH'L | 10 WHEEL | | SWITCHING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2-8-8-2 | 0-8-8-0 | 2-6-6-2 | 2-6-6-2 | 0-6-6-0 | 2-6-6-0 | 0-6-6-0 | 2-6-6-2 | 2-10-2 | 2-8-2 | | | 4-8-0 | 4-6-0 | | 0-10-0 | 0-8-0 | 0-6-0 |
| Name of road | S. P. | Erie | G. N. | Mex. Cent. | B. & O. | V. R. R. | D.N.W.& P | G. N. | P. S. & N. | N. P. | C.M. & St. P. | V. R. R. | N. & W. | T. & P. | C. & E. I. | L.S. & M.S. | C. & O. | P. & L. E. |
| Road number or class | 4,000 | 2,600 | L-1 | 11 | 2,400 | ...... | 200 | ...... | 98 | 1,608 | 5202 | 421 | N1 | 375 | 289 | M. | 8 | 253 |
| Builder | Bald. | Amer. | Bald. | Bald. | Amer. | Amer. | Amer. | Bald. | Bald. | Amer. | Shops | Baldwin | Both | Amer. | Bald. | Amer. | Amer. | Amer. |
| When built | 1909 | 1907 | 1906 | 1908 | 1904 | 1909 | 1909 | 1907 | 1907 | 1906 | 1909 | 1909 | 1907 | 1907-8 | 1905 | 1905 | 1903 | 1906 |
| Simple or compound | Comp. | Comp. | Comp. | Comp. | Comp. | Comp. | Comp. | Comp. | Simple | Simple | Simple | Simple | Simple | Simple | Bal. comp | Simple | Simple | Simple |
| Tractive effort, lbs | 94,640 | 94,800 | 71,600 | 71,600 | 70,000 | 70,800 | 74,130 | 57,760 | 60,000 | 46,630 | 46,630 | 50,350 | 40,163 | 38,400 | 31,000 | 55,300 | 41,000 | 44,100 |
| Weight, total, lbs | 425,900 | 410,000 | 355,000 | 338,000 | 334,500 | 330,000 | 327,500 | 288 000 | 288,000 | 261,000 | 260 500 | 254,000 | 200,000 | 197,000 | 191,060 | 270,000 | 171,175 | 178,200 |
| Weight on drivers, lbs | 394,150 | 410,000 | 316,000 | 300,000 | 334,500 | 312,000 | 327,500 | 250,000 | 235,000 | 205,000 | 201,000 | 207,450 | 168,000 | 165,000 | 145,260 | 270,000 | 171,175 | 178,200 |
| Weight on trucks, lbs | 14,500 | ...... | 19,000 | 19,000 | ...... | 18,000 | ...... | 18,000 | ...... | 26,000 | 25,500 | 20,850 | 32,000 | 32,000 | 45,800 | ...... | ...... | ...... |
| Weight on trailer, lbs | 17,250 | ...... | 20,000 | 19,000 | | | ...... | 20,000 | ...... | 30,000 | 34,000 | 25,700 | | | | ...... | | |
| Weight, tender loaded, lbs | 170,100 | 167,700 | 148,000 | 157,000 | 143,000 | 162,300 | 159,800 | 152,000 | 162,000 | 177,800 | 154,000 | 173,000 | 116,600 | 132,867 | 120,000 | ...... | 121,160 | 121,300 |
| Wheel base, driving | 39′ 4″ | 14′ 3″ | 10′ 0″ | 9′ 2″ | 10′ 0″ | 11′ 0″ | 10′ 0″ | 9′ 10″ | 19′ 9″ | 16′ 6″ | 16′ 6″ | 15′ 6″ | 15′ 6″ | 14′ 10″ | 13′ 6″ | 19′ 0″ | 13′ 7½″ | 12′ 0″ |
| Wheel base, engine | 56′ 7″ | 39′ 2″ | 44′ 10″ | 44′ 2″ | 30′ 8″ | 39′ 11″ | 30′ 8″ | 43′ 7″ | 35′ 11″ | 34′ 9″ | 35′ 1″ | 33′ | 26′ 5″ | 26′ 4″ | 27′ 7″ | 19′ 0″ | 13′ 7½″ | 12′ 0″ |
| Wheel base, engine and tender | 83′ 6″ | 70′ 5¾″ | 73′ 2¼″ | 70′ 11″ | 64′ 7″ | 73′ 2⅛″ | 64′ 4″ | 72′ 0¼″ | 67′ 4¼″ | 63′ 1″ | 65′ 7¼″ | 65′ 10¾″ | 53′ 7″ | 55′ 9¾″ | 55′ 8″ | 54′ 5½″ | 45′ 8″ | 46′ 2¼″ |
| Diameter of drivers | 57″ | 51″ | 55″ | 55″ | 56″ | 54″ | 55″ | 55″ | 57″ | 63″ | 63″ | 56″ | 56″ | 63″ | 62″ | 52″ | 51″ | 50″ |
| Cylinders, number | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 2 | 2 | 2 |
| Cylinders, diameter | 26″ & 40″ | 25″ & 39″ | 21½ & 33″ | 21½″ & 33″ | 20″ & 32″ | 22″ & 35″ | 20½″ & 33″ | 20″ & 31″ | 28″ | 24″ | 24″ | 24″ | 21″ | 22″ | 15½″ & 26″ | 24″ | 21″ | 21″ |
| Cylinders, stroke | 30″ | 28″ | 32″ | 32″ | 32″ | 30″ | 32″ | 30″ | 32″ | 30″ | 30″ | 32″ | 30″ | 28″ | 26 | 28″ | 28″ | 30″ |
| Valve gear, type | Wals. | Wals. | Wals. | Wals. | Wals. | Wals. | Wals. | Wals. | Wals. | Wals. | Wals. | Wals. | Wals. | Wals. | Steph. | Wals. | Steph. | Steph. |
| Steam pressure, lbs | 200 | 215 | 200 | 200 | 235 | 200 | 225 | 210 | 160 | 200 | 200 | 180 | 200 | 210 | 225 | 210 | 200 | 200 |
| Boiler, type | Str. | Str. | Belp. | Str. | Str. | E. W. T. | Str. | Belp. | E. W. T. | E. W. T. | E.W.T. | Str. | W. T. | E. W. T. | W. T. | W. T. | W. T. | Str. |
| Boiler, smallest diameter | 84″ | 84″ | 84″ | 78″ | 84″ | 76″ | 84″ | 72″ | 78¾″ | 75¾″ | 75¾″ | 78¾″ | 70″ | 70⅛″ | 64″ | 80⅛″ | 67″ | 80″ |
| Boiler, height center | 120″ | 120″ | 120″ | ...... | 120″ | 116″ | 120″ | 116″ | 118″ | 118″ | 118″ | 112″ | 112″ | 114⅝″ | 109″ | 115″ | 112½″ | 108½″ |
| Heating surface, tubes, sq. ft | 4,941 | 4,971.5† | 5,473 | 4,311 | 5,380 | 4,842 | 5,035 | 3,708 | 4,586 | 3,192 | 3,332 | 4,277 | 2,605 | 2,731 | 2,933.7 | 4,422.6 | 2,573 | 2,906 |
| Heating surface, firebox, sq. ft | 232 | 343.2 | 230 | 201 | 220 | 223.9 | 206 | 198 | 210 | 245 † | 282† | 189 | 173 | 200 | 160.7 | 197. | 164 | 206 |
| Heating surface, total, sq. ft | 6,393 | 5,313.7 | 5,703 | 4,512 | 5,600 | 5,065.9 | 5,241 | 3,906 | 4,796 | 3,437 | 3,614 | 4,466 | 2,778 | 2,931 | 3,094.4 | 4,619.6 | 2,737 | 3,112 |
| Heating surface, superheater, sq. ft | 655 | ...... | ...... | | | | ...... | ...... | 762 | ...... | | | ...... | | | | | |
| Grate area, sq. ft | 68.4 | 100 | 78 | 61 | 72.2 | 57 | 72.2 | 53.4 | 58.5 | 43.5 | 48.8 | 51 | 45 | 46.3 | 46.69 | 55.4 | 38.8 | 33.3 |
| Firebox, length | 126″ | 126⅛″ | 117″ | 123½″ | 108⅛″ | 114″ | 108″ | 116⅛″ | 108″ | 96″ | 107″ | 102″ | 99⅓″ | 99″ | 101⅞″ | 108⅛″ | 80″ | 120″ |
| Firebox, width | 78¼″ | 114¼″ | 96″ | 71″ | 96¼″ | 72″ | 96″ | 66¼″ | 78″ | 65¼″ | 65¾″ | 72″ | 64⅝″ | 67¼″ | 66″ | 73¼″ | 70″ | 40″ |
| Fuel, kind | Oil | Bit. Coal. | Bit. Coal. | Oil | Bit. Coal | Bit. Coal. | Bit. Coal | Bit. Coal | Bit. Coal | Bit. coal | Bit. Coal | Bit. Coal. | Bit. coal | Bit. coal | Bit. coal | Bit coal | Bit. coal | Bit. coal |
| Tubes, number firetube | 401 | 404 | 441 | 350 | 436 | 390 | 409 | 301 | 391 | 372 | 366 | 374 | 242 | 326 | 278 | 447 | 351 | 430 |
| Tubes, number superheater* | | | | | | | | | | | | | | | | | | |
| Tubes, diameter, firetube | 2¼″ | 2¼″ | 2¼″ | 2¼″ | 2¼″ | 2¼″ | 2¼″ | 2¼″ | 2¼″ | 2″ | 2″ | 2¼″ | 2¼″ | 2″ | 2¼″ | 2″ | 2″ | 2″ |
| Tubes, diameter, superheater | | | | | | | | | | | | | | | | | | |
| Tubes, length | 21′ | 21′ | 21′ | 21′ | 20′ 10¾″ | 21′ | 21′ | 21′ 0″ | 20′ 0″ | 16′6″ | 17′ 6″ | 19′ 6″ | 18′ 4⅞″ | 16″ | 18′ 0″ | 19′ 0″ | 14′ 0″ | 13′ 0″ |
| Tender, coal capacity, tons | 2,850 | 16 | 13 | 3,500 | 16 | 14 | 12 | 13 | 14 | 12 | 14 | 16 | 10 | 12 | 12 | 12 | 7 | 10 |
| Tender, water capacity, gals | 9,000 | 8.500 | 8,000 | 8.000 | 7,000 | 9,500 | 9,000 | 8,000 | 8,500 | 10,000 | 8,000 | 9.500 | 6,000 | 6.500 | 6.000 | 8,000 | 6,000 | 7,000 |
| Weight on drivers ÷ tractive effort | 4.18 | 4.32 | 4.4 | 4.20 | 4.75 | 4.41 | 4.4 | 4.34 | 3.91 | 4.38 | 4.31 | 4.10 | 4.20 | 4.30 | 4.67 | 4.86 | 4.15 | 4.04 |
| Weight, total ÷ tractive effort | 4.51 | 4.32 | 4.95 | 4.70 | 4.75 | 4.67 | 4.4 | 5.00 | 4.8 | 5.6 | 5.80 | 5.05 | 4.98 | 5.13 | 6.15 | 4.86 | 4.15 | 4.04 |
| T. E. × diam. drivers ÷ total H. S. | 843. | 910. | 690. | 873. | 700. | 753. | 780. | 813. | 712. | 855. | 812.80 | 631.00 | 810.00 | 825.00 | 620. | 625. | 763 | 710. |
| Total heating surface ÷ grate area | 93.40 | 53.14 | 73. | 74. | 77.3 | 88.50 | 72.60 | 73. | 81.8 | 78.8 | 74.00 | 87.50 | 61.60 | 63.50 | 66. | 83. | 70.5 | 94. |
| Firebox heat. surf. ÷ total H. S., % | 3.63 | 6.46 | 4.13 | 4.45 | 3.92 | 4.42 | 3.90 | 5.05 | 4.38 | 7.12 | 7.80 | 4.23 | 6.25 | 6.80 | 5.18 | 4.25 | 5.98 | 6.6 |
| Weight on drivers ÷ total heat. surf. | 61.00 | 76.90 | 55.2 | 66.50 | 59.5 | 61.90 | 62.20 | 63.9 | 49. | 59.6 | 55.62 | 46.50 | 60.50 | 56.00 | 46.7 | 58.3 | 62.3 | 57.1 |
| Weight total ÷ total heating surface | 67.00 | 76.90 | 62. | 74.50 | 59.5 | 65.10 | 62.20 | 73.8 | 60. | 75.5 | 72.21 | 56.90 | 72.00 | 67.00 | 61.6 | 58.3 | 62.3 | 57.1 |
| Total H.S. ÷ superheating heat. surf. | ...... | | | ...... | | | | ...... | 6.3 | ...... | ...... | | | | | | | |
| Cylinder volume, cubic feet | 28.84 | 24. | 20.75 | 20.75 | 19. | 20.46 | 19.45 | 17.1 | 22.82 | 15.8 | 15.70 | 16.75 | 12.00 | 12.30 | 8.93 | 14.7 | 11.2 | 12. |
| Total heating surface ÷ cylinder vol | 220.00 | 222. | 275. | 217. | 295. | 247.00 | 270. | 229. | 210. | 218. | 230.19 | 266.00 | 231.00 | 236.00 | 346 | 314. | 245. | 260. |
| Superheating heating surf. ÷ cyl. vol | | | | | | | | | 33.4 | | | | | | | | | |
| Grate area ÷ cylinder volume | 2.38 | 4.70 | 3.75 | 2.93 | 3 85 | 2.79 | 3.70 | 3.14 | 2.57 | 2.76 | 3.10 | 3.05 | 3.75 | 3.78 | 5.2 | 3.78 | 3.48 | 2.77 |
| Reference in THE AMERICAN ENGINEER | 1909 p. 181 | 1907 p. 341 | 1906 p. 371 | 1908 p. 477 | 1904 p. 237, 262 | 1909 p. 261 | 1909 p. 61 | 1907 p. 213 | 1907 p. 88 | 1906 p. 392 | 1909 Aug. | 1909 p. 225 | 1907 p. 444 | 1908 p. 77 | 1905 p. 97 | 1905 p. 330 | 1904 p. 184 | 1906 p. 346 |

† Includes combustion chamber.

# A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

## ARRANGED WITH RESPECT TO CLASSES AND WEIGHTS

### PASSENGER LOCOMOTIVES OF THE PACIFIC (4-6-2) AND PRAIRIE (2-6-2) TYPES

| TYPE | PACIFIC | | | | | | | | | | | | PRAIRIE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of road | P. R. R. | N. Y. C. | C. & A. | C & A | N. P. | A. T. & S. F. | Erie | R. F. & P. | B. & O | N. Y., N.H. & H. | C. B. & Q. | Mex. Nat. | A.T & S F. | L.S. & M S. | C. B. & Q | N. P. | G. N. | Wabash† |
| Road number or class | K 28 | 3565 | 623 | 605 | 2,175 | 1290 | 2,511 | 84 | P | I 1 | S1 | 420 | 1800 | 4,724 | R5 | 2,378 | J1 | G1 |
| Builder | Amer. | Amer. | Amer. | Bald. | Amer. | Bald. | Amer. | Bald. | Amer. | Both | | Bald. | Bald. | Amer | Amer. | Amer. | Bald. | Both |
| When built | 1907 | 1908 | 1909 | 1908 | 1906 | 1908 | 1905 | 1907 | 1906 | 1907 | 1906 | 1907 | 1906 | 1906 | 1906 | 1906 | 1906 | 1907 |
| Simple or compound | Simple | Simple | Simple | Simple | Comp. | Simple | Simple | Simple | Simple | Simple | Simple | Comp. | Comp. | Simple | Simple | Simple | Simple | Simple |
| Tractive effort, lbs | 30,700 | 29,200 | 31,475 | 34,500 | 30,340 | 32,600 | 30,300 | 31,100 | 35,020 | 31,560 | 31,100 | 35,066 | 37,800 | 27,850 | 35,060 | 33,300 | 37,560 | 34,558 |
| Weight, total, lbs | 272,500 | 266,000 | 248,000 | 243,200 | 240,000 | 232,750 | 230,500 | 230,800 | 229,000 | 229,500 | 228,000 | 227,340 | 248,200 | 233,000 | 216,000 | 209,500 | 209,000 | 205,900 |
| Weight on drivers, lbs | 183,900 | 171,500 | 149,500 | 146,500 | 157,000 | 140,400 | 149,000 | 143,750 | 150,500 | 142,500 | 150,000 | 147,040 | 174,700 | 165,200 | 152,000 | 152,000 | 151,000 | 150,500 |
| Weight on trucks, lbs | | | | 47,600 | 53,000 | 54,950 | 41,000 | 46,850 | 40,500 | 46.500 | 42,000 | | 31,300 | 26,000 | 25,600 | | 21,000 | 21,900 |
| Weight on trailer, lbs | | | | 49,100 | 30,000 | 37,400 | 40,500 | 40,200 | 38,500 | 41.000 | 36,000 | | 42,200 | 41,800 | 38,400 | | 37.000 | |
| Weight, tender loaded, lbs | 143,800 | 164,000 | 165,120 | 161,800 | 141,350 | 165:200 | 163,000 | 350,000 | 147,000 | 134,000 | 148,200 | 142,660 | 175,000 | 159,900 | 148,200 | 139,500 | 151,000 | 153,000 |
| Wheel base, driving | 13' 10" | 14' | 13' 9" | 13' 9" | 12' 0" | 12' 8" | 13' 0" | 12' 10" | 13' 2" | 13' 1" | 12' 10" | 12' 0" | 13' 8" | 14' 0" | 13' 4½" | 11' 0" | 13' 0" | 13' 4½" |
| Wheel base, engine | 35' 2½" | 36' 6" | 34' 8½" | 32' 8" | 33' 5" | 34' 4¾" | 33' 8" | 32' 8" | 34' 3½" | 33' 5½" | 32' 9" | 33' 11" | 33' 9" | 34' 3" | 30' 8½" | 28' 11" | 30' 9" | 30' 8½" |
| Wheel base, engine and tender | 67' ¾" | 67' 11" | 66' 4" | 65' 8½" | 62' 10" | 65' 2" | 65' 1" | 61' 11½" | 66' 3¾" | 61' 2" | 64' 3¼" | 62' 11" | 65' 0" | 62' 5½" | 62' 2¾" | 57' 3½" | 63' 8" | 61' 4¼" |
| Diameter of drivers | 80" | 79" | 80" | 73" | 69" | 73" | 74" | 73" | 74" | 73" | 74" | 67" | 69" | 79" | 69" | 63" | 69" | 70" |
| Cylinders, number | 2 | 2 | 2 | 2 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 2 | 2 | 2 | 2 | 2 |
| Cylinders, diameter | 24" | 22" | 23" | 23" | 16½" & 27½" | 25" | 22½" | 22" | 22" | 22" | 22" | 17" & 28" | 17½" & 29" | 21½" | 22" | 21" | 22" | 22" |
| Cylinders, stroke | 26" | 28" | 28" | 28" | 26" | 28" | 26" | 28" | 28" | 28" | 28" | 28" | 28" | 28" | 28" | 28" | 30" | 28" |
| Valve gear, type | Wals. | Wals. | Pilloid | Wals. | Wals. | | Steph. | | Steph. | | Steph. | Steph. | Wals. | Wals. | Steph. | Steph. | Wals. | Steph. |
| Steam pressure, lbs | 205 | 200 | 200 | 200 | 220 | 160 | 200 | 200 | 225 | 200 | 200 | 220 | 225 | 200 | 210 | 200 | 210 | 210 |
| Boiler, type | Str. | Conical | E. W. T. | W. T. | E. W. T. | Str. | Str. | Str. | Str. | Str. | W. T. | W. T. | E. W. T. | E. W. T. | W. T. | E. W. T. | Belp. | E. W. T. |
| Boiler, smallest diameter | 78" | 72" | 72" | 72" | 72¼" | 72" | 74⅝" | 74" | 72" | 70" | 70" | 70" | 76" | 70" | 70" | 72⅛" | 72" | 70" |
| Boiler, height center | 119" | | | 113" | 115" | 114¼" | 113½" | 112½" | 112" | 110" | 109¾" | 109" | 115" | 114" | 107⅜" | 115" | 108" | 107⅞" |
| Heating surface, tubes, sq. ft | 4243 | 3981.6 | 3869. | 3721. | 2667. | 3202 | 3131. | 3917. | 3,234.6 | 3743. | 3,732. | 3,527. | 3,803. | 3,678. | 3,375. | 2,105. | 3,277. | 3370 |
| Heating surface, firebox, sq. ft | 205 | 228.3 | 202. | 206. | 241.8 | 190 | 195. | 190. | 179.4 | 204.4 | 200. | 186. | 217. | 227. | 200. | 235. | 210. | 190 |
| Heating surface, total, sq. ft | 4448 | 4209.9 | 4071. | 3927. | 2908.8 | 3392 | 3326. | 4107. | 3,414. | 3947.4 | 3,932. | 3,713. | 4020. | 3,905. | 3,575. | 2,340. | 3,487. | 3560 |
| Heating surface, superheater, sq. ft | | | | | | | 763. | | | | | | | | | | | |
| Grate area, sq. ft | 61.86 | 56.5 | 49.5 | 33. | 43.5 | 49.5 | 56.5 | 49' 5" | 56.24 | 53.5 | 54. | 52.1 | 53.8 | 55. | 54. | 43.5 | 53.15 | 54.25 |
| Firebox, length | 111" | 108⅛" | 108" | 120⅛" | 96" | 107⅞" | 108⅛" | 108" | 108⅛" | 108⅛" | 108⅛" | 113½" | 107⅛" | 108⅛" | 108⅛" | 96" | 116" | 108⅛" |
| Firebox, width | 80¼" | 75¼" | 66" | 40¼" | 65¼" | 66" | 75¼" | 66" | 75¼" | 71¼" | 72¼" | 66¼" | 71¼" | 73¼" | 72¼" | 65¼" | 66" | 72¼" |
| Fuel, kind | Bit. Coal | Bit. Coal | Bit. coal | Bit. coal | Bit. Coal. | Oil | Bit. Coal | Bit. Coal | Bit coal | Bit. Coal | Bit. coal. | Bit. coal | Bit. Coal | Bit coal | Bit. coal | Bit. coal | Bit coal | Bit coal |
| Tubes, number firetube | 343 | 382 | 373 | 357 | 306 | 273 | 195 | 318 | 276 | 310 | 303 | 301 | 342 | 322 | 303 | 306 | 301 | 303 |
| Tubes, number superheater | | | | | | | 32 | | | | | | | | | | | |
| Tubes, diameter, firetube | 2¼" | 2" | 2" | 2" | 2" | 2¼" | 2¼" | 2¼" | 2¼" | 2¼" | 2¼" | 2¼" | 2¼" | 2¼" | 2¼" | 2" | 2¼" | 2¼" |
| Tubes, diameter superheater | | | | | | | 5" | | | | | | | | | | | |
| Tubes, length | 21' | 20' | 20' | 20' | 16' 9" | 20' | 20' 0" | 21' | 20' 0" | 20' 6" | 21' 0" | 20' 0" | 18' 10 5/16" | 19' 6" | 19' 0" | 13' 3" | 18' 6" | 19' |
| [illegible]city, tons | 11 | 14 | 14 | 12½ | 12 | 33,009 | 16 | 12 | 15 | 14 | 13 | 12 | 14 | 15 | 13 | 12 | 13 | 15 |
| [illegible]pacity, gals. | 7000 | 8000 | 8500 | 8,250 | 7,000 | 8,500 | 8,500 | 6,000 | 7,000 | 6,000 | 8,000 | 7,500 | 9,000 | 8,000 | 8,000 | 7,000 | 8,000 | 7,700 |
| [illegible]rs ÷ tractive effort | 6.00 | 5.84 | 4.74 | 4.26 | 5.2 | 4.33 | 4.95 | 4.62 | 4.3 | 4.5 | 4.8 | 4.2 | 4.6 | 4.4 | 4.3 | 4.6 | 4. | 4.35 |
| Weig[illegible] tractive effort | 8.85 | 9.11 | 7.90 | 7.05 | 7.9 | 7.12 | 7.7 | 7.65 | 6.6 | 7.25 | 7.3 | 6.5 | 6.6 | 8.3 | 6.2 | 6.3 | 5.6 | 5.95 |
| T. E. × diame[illegible]r drivers ÷ total H S | 550.00 | 550.00 | 618.00 | 640.00 | 720. | 700.00 | 669. | 560.00 | 760. | 585.00 | 585. | 632. | 650.00 | 565. | 677. | 900. | 746. | 680.00 |
| Total heating surface ÷ grate area | 72.00 | 74.50 | 82.30 | 119. | 67. | 68.50 | 58.7 | 82.90 | 60.5 | 73.50 | 71.3 | 71.2 | 74. | 71. | 64.8 | 53.8 | 65. | 65.70 |
| Firebox heat. surf. ÷ total H.S. % | 4.62 | 5.35 | 4.98 | 5.24 | 8.3 | 5.60 | 5.85 | 4.64 | 5.23 | 5.20 | 4.85 | 5. | 5.4 | 5.8 | 5.34 | 10.1 | 6.0 | 5.32 |
| Weight on drivers ÷ total heat. surf. | 41.50 | 40.70 | 36.60 | 37.30 | 53.8 | 41.50 | 45. | 34.90 | 44. | 36.20 | 38. | 37.4 | 43.5 | 42. | 42.5 | 65. | 43.5 | 42.20 |
| Weight total ÷ total heating surface | 61.20 | 63.10 | 61.00 | 62.00 | 82.5 | 68.50 | 69.5. | 56.10 | 66.5 | 58.20 | 58. | 61.1 | 62. | 61. | 60.7 | 89.5 | 60. | 58.00 |
| Total H.S. ÷ superheating heat. surf. | | | | | | | 4.35 | | | | | | | | | | | |
| Cylinder volume, cubic feet | 13.60 | 12.32 | 13.50 | 13.00 | 9.9* | 16.00 | 12. | 12.30 | 12.3 | 12.30 | 12.3 | 11.6* | 12.1* | 11.7 | 12.3 | 11.2 | 13.2 | 12.32 |
| Total heating surface ÷ cyl. volume | 326.00 | 341.00 | 302.00 | 290.00 | 294. | 212.00 | 277. | 334.00 | 278. | 321.00 | 318. | 330. | 334. | 335. | 290. | 209. | 265. | 290.00 |
| Superheating heating surf. ÷ cyl. vol. | | | | | | | 63.5 | | | | | | | | | | | |
| Grate area ÷ cylinder volume | 4.55 | 4.58 | 3.67 | 2.44 | 4.3 | 3.10 | 4.7 | 4.03 | 4.56 | 4.20 | 4.39 | 4.54 | 4.43 | 4.68 | 4.46 | 3.89 | 4.03 | 4.41 |
| Reference in THE AMERICAN ENGINEER | 1907 p. 267 | 1908 p. 164 | This Issue | 1908 p. 399 | 1906 p. 411 | 1908 p. 112 | 1905 p. 172 | 1907 p. 407 | 1906 p. 257 | 1907 p. 431 | 1906 p. 300 | 1907 p. 70 | 1906 p. 435 | 1906 p. 204 | 1906 p. 300 | 1906 p. 392 | 1906 p.365 | 1908 p. 31 |

* Equivalent simple cylinders. † Designed for fast freight service.

# A TABULAR COMPARISON OF NOTABLE EXAMPLES OF RECENT LOCOMOTIVES

## ARRANGED WITH RESPECT TO CLASSES AND WEIGHTS

### PASSENGER LOCOMOTIVES OF TYPES OTHER THAN THE PACIFIC AND PRAIRIE

| TYPE | ATLANTIC. (4-4-2.) | | | | | | | | | TEN WHEEL. (4-6-0.) | | | | | | AMERICAN (4-4-0.) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name of road | U. P. | Erie | C. M. & St. P. | P. R. R. | N. Y. N. H. & H. | N. P. | C. B. & Q. | Har. Lines | C. R. I. & P. | R. & A. | S. P. | D. L. & W. | N. Y. C. | N. C. & St. L. | C. & N. W. | C. R. R. of N. J. | D. L. & W. | L. S. & M. S. |
| Road number or class | 21 | 537 | 951 | 2,760 | F1 | 603 | P3 | A-81 | 1,019 | 1,916 | 2,317 | 1,012 | 2,099 | 284 | | 852 | 955 | Pony |
| Builder | Baldwin | Amer. | Bald. | Amer. | Amer. | Bald. | Bald. | Bald. | Amer. | Amer. | Bald. | Amer. | Amer. | Bald. | Amer. | Amer. | Amer. | L. S & M. S. |
| When built | 1906 | 1905 | 1907 | 1905 | 1907 | 1909 | 1904 | 1905 | 1905 | 1908 | 1907 | 1905 | 1905 | 1908 | 1907 | 1905 | 1905 | 1906 |
| Simple or compound | Comp. | Comp. | Comp. | Comp. | Simple | Simple | Comp. | Simple | Simple | Simple | Simple | Simple | Simple | Bal. comp | Simple | Simple | Simple | Simple |
| Tractive effort, lbs | 24,281 | 23,860 | 22,200 | 23,300 | 24,670 | 24,760 | 21,400 | 23,560 | 24,700 | 31,000 | 36,570 | 35,100 | 31,000 | 29,200 | 30,900 | 23,120 | 23,710 | 15,700 |
| Weight, total, lbs | 209,000 | 206,000 | 204,119 | 200,500 | 200,000 | 197,050 | 196,600 | 196,000 | 191,300 | 208,000 | 203,300 | 201,000 | 194,500 | 181,400 | 179,500 | 161,300 | 151,200 | 126,600 |
| Weight on drivers, lbs | 110,000 | 115,000 | 105,966 | 117,200 | 105,500 | 100,800 | 101,200 | 105,000 | 107,100 | 158,000 | 160,000 | 154,000 | 148,000 | 134,000 | 135,500 | 111,300 | 100,000 | 85,100 |
| Weight on trucks, lbs | 53,000 | 52,000 | 52,353 | 52,500 | 48,000 | 51,950 | 54,200 | 45,000 | 42,400 | | | 47,000 | 46,500 | 47,400 | 44,000 | 50,000 | 51,200 | 41,500 |
| Weight on trailer, lbs | 46,000 | 39,000 | 45,800 | 30,000 | 46,500 | 44,300 | 41,200 | 46,000 | 40,800 | 155,800 | 43,300 | | | | | | | |
| Weight, tender loaded, lbs | 162,200 | 162,800 | 130,000 | 132,500 | 134,000 | 122,950 | 120,400 | 162,200 | 144,000 | | 141,366 | 120,000 | 143,500 | 118,000 | 139,500 | 122,200 | 110,000 | 105,200 |
| Wheel base, driving | 7′ 0″ | 7′ 0″ | 7′ 6″ | 7′ 5″ | 7′ 3″ | 6′ 10″ | 7′ 3″ | 7′ 0″ | 7′ 0″ | 15′ 10″ | 13′ 10″ | 14′ 4″ | 15′ 10″ | 12′ 0″ | 14′ 10″ | 8′ 3″ | 8′ 6″ | 9′ 0″ |
| Wheel base, engine | 27′ 10″ | 25′ 0″ | 32′ 2″ | 31′ 11″ | 28′ 2″ | 27′ 10″ | 30′ 2″ | 27′ 7″ | 27′ 5½″ | 26′ 10½″ | 25′ 10″ | 25′ 6″ | 26′ 10½″ | 26′ 0″ | 25′ 10″ | 23′ 1½″ | 24′ 5″ | 25′ 1¼″ |
| Wheel base, engine and tender | 58′ 5″ | 60′ 9″ | 66′ 9″ | 61′ 4″ | 56′ 1″ | 57′ 3″ | 57′ 6¾″ | 58′ 2″ | 57′ 2″ | 59′ 3″ | 58′ ¼″ | 54′ ¼″ | 59′ 2″ | 55′ 2″ | 57′ 9″ | 49′ 2″ | 51′ ⅝″ | 48′ 4¾″ |
| Diameter of drivers | 81″ | 78″ | 85″ | 80″ | 79″ | 73″ | 78″ | 81″ | 73″ | 69″ | 63″ | 69″ | 69″ | 66″ | 63″ | 69″ | 69″ | 63″ |
| Cylinders, number | 4 | 4 | 4 | 4 | 2 | 2 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 2 | 2 | 2 | 4 |
| Cylinders, diameter | 16″ & 27″ | 15½ & 26″ | 15″ & 25″ | 16″ & 27″ | 21″ | 21″ | 15″ & 25″ | 20″ | 21″ | 22″ | 22″ | 21½″ | 22″ | 16″ & 27″ | 21″ | 19″ | 20″ | 12½″ |
| Cylinders, stroke | 28″ | 26″ | 28″ | 26″ | 26″ | 26″ | 26″ | 28″ | 26″ | 26″ | 28″ | 26″ | 26″ | 26″ | 26″ | 26″ | 26″ | 20″ |
| Valve gear, type | Wals. | Steph. | | Steph. | | Wals. | Steph. | Steph. | Steph. | | | Steph. | Steph. | Wals. | Wals. | Steph. | Steph. | Wals. |
| Steam pressure, lbs | 200 | 220 | 220 | 205 | 200 | 185 | 210 | 200 | 185 | 200 | 200 | 215 | 200 | 210 | 200 | 200 | 185 | 180 |
| Boiler, type | Str. | E. W. T. | W. T. | Belp. | E. W. T. | Str. | E. W. T. | Str. | Str. | E. W. T. | W. T. | Str. | W. T. | W. T. | E. W. T. | W. T. | Str. | W. T. |
| Boiler, smallest diameter | 70″ | 70¾″ | 66″ | 65⅝″ | 68″ | 72⅛″ | 64″ | 70″ | 72″ | 72⅛″ | 72″ | 74⅝″ | 70⅝″ | 64″ | 66⅜″ | 62¼″ | 61 3/16″ | 50″ |
| Boiler, height center | 113″ | 111⅜″ | 114″ | 109″ | 110″ | | 108⅛″ | 113″ | 108″ | 115″ | 102″ | 116½″ | 115″ | 107″ | | 113″ | | 78″ |
| Heating surface, tubes, sq. ft | 2475. | 3453.6 | 3008. | 2680.2 | 3041. | 2112. | 3050.5 | 2475. | 2227.6 | 3104.5 | 2788. | 3156.3 | 3124.7 | 2550 | 2808.4 | 1838.1 | 1947.9 | 1,326. |
| Heating surface, firebox, sq. ft | 180. | 181 1 | 168. | 181.4 | 204.4 | 173. | 155.5 | 174. | 161.8 | 203 3 | 206. | 221.7 | 202.7 | 185 | 150.8 | 167.6 | 190.8 | 140. |
| Heating surface, total, sq. ft | 2655. | 3634.7 | 3194. | 2861.6 | 3245.4 | 2285. | 3206. | 2649. | 2389.4 | 3307.8 | 2994. | 3378. | 3326.7 | 2735 | 2959.2 | 2005.7 | 2138.7 | 1,466. |
| Heating surface, superheater, sq. ft | | | | | | 480. | | | 338. | | | | | | | | | |
| Grate area, sq. ft | 49 5 | 56.5 | 45. | 55.5 | 53 5 | 43.5 | 44.1 | 49.5 | 44.8 | 54.9 | 32.1 | 94.8 | 54.93 | 34.8 | 46.27 | 81 6 | 87.54 | 21. |
| Firebox, length | 108″ | 108⅛″ | 107″ | 111″ | 108⅛″ | 96″ | 96⅛″ | 108″ | 96″ | 105⅛″ | 124″ | 126⅛″ | 108⅛″ | 120″ | 102⅝″ | 122⅛″ | 126 3/16″ | 96″ |
| Firebox, width | 66″ | 75¼″ | 60⅛″ | 72″ | 71¼″ | 65¼″ | 66¼″ | 66″ | 67¼″ | 75¼″ | 37¼″ | 108¼″ | 75¼″ | 41⅞″ | 65¼″ | 96¼″ | 100″ | 31″ |
| Fuel, kind | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Bit. coal | Oil | Anth. coal | Bit. coal | Bit. coal | Bit. coal | Anth. coal | Anth. coal | Bit. coal |
| Tubes, number firetube | 297 | 388 | 268 | 315 | 347 | 1[illegible]6 | 264 | 297 | 173 | 400 | 355 | 398 | 400 | 256 | 337 | 280 | 280 | 187 |
| Tubes, number superheater | | | | | | 22 | | | 54 | | | | | | | | | |
| Tubes, diameter, firetube | 2″ | 2″ | 2¼″ | 2″ | 2″ | 2″ | 2¼″ | 2″ | 2″ | 2″ | 2″ | 2″ | 2″ | 2¼″ | 2″ | 2″ | 2″ | 2″ |
| Tubes, diameter, superheater | | | | | | 5⅜″ | | | 3½″ | | | | | | | | | |
| Tubes, length | 16′ 0″ | 17′ 0″ | 19′ | 16′ 3″ | 16′ 10″ | 16′ | 19′ 0″ | 16′ 0″ | 16′ 0″ | 14′ 11″ | 15″ | 15′ 3″ | 14′ 11″ | 17′ | 16′ 0″ | 12′ 6″ | 13′ 4¼″ | 13′ 6½″ |
| Tender, coal capacity, tons | 10 | 16 | 10 | 12½ | 14 | 9 | 12 | 10 | 12 | 12 | 2,940 | 10 | 12 | 10 5 | 10 | 12 | 10 | 10 |
| Tender, water capacity, gals | 9,000 | 8,500 | 7,000 | 5,500 | 6,000 | 6,000 | 6,000 | 9,000 | 7,000 | 8,000 | 7,000 | 6,000 | 7,000 | 5,500 | 7,500 | 5,000 | 5,000 | 4,300 |
| Weight on drivers ÷ tractive effort | 4.53 | 4 82 | 4.75 | 5. | 4.27 | 4.05 | 4.7 | 4.48 | 4.2 | 5 10 | 4.37 | 4.38 | 4.77 | 4.58 | 4.38 | 4.8 | 4.22 | 5.4 |
| Weight total ÷ tractive effort | 8.6 | 8.63 | 9.20 | 8.6 | 8.10 | 7.95 | 9.2 | 8.35 | 7.8 | 6.70 | 5.57 | 5.72 | 6.27 | 6.27 | 5.80 | 6.95 | 6.4 | 8 1 |
| T. E. × diam. drivers ÷ total H. S. | 740. | 513. | 610. | 650. | 600. | 790. | 518.8 | 717. | 754. | 647. | 770. | 717. | 647. | 705. | 655. | 800. | 765. | 670. |
| Total heat. surf. ÷ grate area | 53.8 | 64.3 | 70.50 | 51.6 | 60.50 | 52.30 | 73. | 53.6 | 53.3 | 60.20 | 93. | 35.6 | 60.5 | 78.50 | 64. | 24.7 | 24.4 | 69.5 |
| Firebox heat. surf. ÷ total H. S. % | 6.8 | 5. | 5.30 | 9.37 | 6.30 | 7.60 | 4.85 | 6.6 | 6.75 | 6.15 | 6.90 | 6.6 | 6.1 | 6.80 | 5.10 | 8.4 | 8.9 | 9.5 |
| Wgt. on drivers ÷ total heat. surf | 41.5 | 31.7 | 33.10 | 41. | 32.60 | 43 80 | 31.5 | 39.6 | 44.8 | 51. | 53.40 | 45.6 | 44.5 | 49.00 | 45.75 | 55.3 | 46.8 | 58. |
| Wgt. total ÷ total heat. surf | 78.9 | 56.8 | 64. | 70. | 61.80 | 79.50 | 61.3 | 74. | 80. | 67. | 68. | 59.8 | 58.7 | 67.00 | 60.50 | 80.5 | 71. | 86.5 |
| Total H. S. ÷ superheating heat. surf | | | | | | 4.76 | | | 7.08 | | | | | | | | | |
| Cylinder volume, cu. ft | 10.2† | 8.93† | 9.† | 10.2† | 10.40 | 10.40 | 8.3† | 10.2 | 10.4 | 11.40 | 12.30 | 10.9 | 11.4 | 10.20 | 10.4 | 8.6 | 9.5 | 5.7 |
| Total heat. surf. ÷ cyl. vol | 262. | 408. | 355. | 280. | 311. | 219.00 | 387. | 260.7 | 230. | 288. | 243. | 311. | 292. | 268.00 | 287. | 233. | 224. | 257. |
| Sup. heat. surf. ÷ cyl. vol | | | | | | 46.20 | | | 32.5 | | | | | | | | | |
| Grate area ÷ cyl. vol | 4.83 | 6.27 | 5. | 5.42 | 5.16 | 4.19 | 5.3 | 4 85 | 4 3 | 4.8 | 2.61 | 8 68 | 4.8 | 3.40 | 4.45 | 9.5 | 9.2 | 3.68 |
| Reference in THE AMERICAN ENGINEER | 1906 p. 308 | 1905 p. 287 | 1908 p. 37 | 1906 p. 73 | 1907 p. 471 | 1909 p. 195 | 1904 p. 212 | 1905 p. 154 | 1905 p. 329 | | 1907 p. 481 | 1905 p. 407 | 190[illegible] p. 59 | 1909 p. 52 | 1907 p. 247 | | | 1906 p. 293 |

† Equivalent simple cylinders.

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## M. M. AND M. C. B. CONSOLIDATION.

The following editorial appeared in our June, 1908, issue:

"There is a growing opinion that the Master Car Builders' and the American Railway Master Mechanics' Associations ought to consolidate. It is the rule of the times to get together. There are no reasons, but sentimental ones, against and many good reasons for such a course. Why not pool these interests, already so closely interwoven, and form one big, strong and influential mechanical railroad organization."

There has evidently been considerable thought given to this subject during the past year as there was a very decided current of opinion among the members attending the conventions this year that some action to this end was advisable. The subject was mentioned in the addresses of the presidents of both associations, Mr. Vaughan favoring a consolidation and Mr. McKenna opposing it. As was stated by the former, all of the officers and members of the executive committee, with the exception of two, seventy-five per cent. of the members of the standing committees and seventy per cent. of the members of special committees of the M. C. B. Association, hold joint departmental titles. These figures demonstrate the amalgamation which has taken place between the car and locomotive departments of railroads and appear to justify the statement that the time is approaching for the uniting of the two bodies. The objection presented by Mr. McKenna was based on the fact that the activities of the M. M. Association are largely technical, while those of the M. C. B. are largely legislative.

A committee was, however, appointed by both associations to thoroughly consider the question and submit recommendations at the next annual meeting. The suggestions of President Vaughan that both conventions should be held in the same week, with a resulting large saving in time to the members met with very general approval and it is probable that some action to this effect will be taken by the executive committees of the associations.

## SUPERHEATED STEAM.

Probably the most valuable contribution to the proceedings of the M. M. Association this year was the paper by Dr. W. F. M. Goss on "Locomotive Performance Under Saturated and Superheated Steam." It will be remembered that about two years ago an elaborate series of tests was carried on at Purdue under the patronage of the Carnegie Institution of Washington covering in detail the performance of a simple locomotive with various steam pressures from 120 to 240 lbs. The results of this series were presented before the M. M. Association in 1907 and have had a decided influence on locomotive steam pressures in this country. Following this series, the same locomotive was fitted with a superheater of the Cole type, giving about 150 degs. superheat and another series of tests at the same range of steam pressures have lately been made under the same patronage.

A comparison of the results of these two series presents probably the most accurate data on the value of superheated steam for locomotive service that is now available. The results bear out the claims of those experienced with superheated steam in actual service and show that it will permit the economical use of comparatively low steam pressures, and give a saving of from 15 to 20 per cent. in the amount of water used and 10 to 15 per cent. in the amount of coal used while running, or will give an increase of from 10 to 15 per cent. in the amount of power developed by a locomotive, accompanied by a total reduction in water consumption of not less than five per cent. and no increase in the amount of fuel.

These figures are not as large as have been claimed from road tests, which was explained by Mr. Vaughan by the fact that in comparing the locomotives on the road the fireman on the saturated steam locomotive is usually working at his highest capacity and in somewhat of an uneconomical manner. This reduces the economy for the saturated steam engine with which the superheated engine is being compared and hence shows a greater comparative difference in favor of the latter than would a testing plant where these conditions do not hold. Dr. Goss's paper is given in liberal abstract in this issue.

# MASTER MECHANICS' ASSOCIATION.

FORTY-SECOND ANNUAL CONVENTION.

The convention was called to order at Young's million-dollar pier at Atlantic City on Wednesday morning, June 16, by President H. H Vaughan.

Following a prayer by the Rev. Dr. Caldwell, the president delivered a most excellent address, which is very largely reprinted on page 265 of this issue. The address included some most valuable suggestions for the future work of the association and considered the advisability of the uniting of the M. M. and M. C. B. Associations. The resolutions presented by a committee appointed to consider the suggestions of the president are given later.

The secretary's report showed a total membership of 961, of which 902 were active members. He reported a balance from the yearly financial transactions of $71.50. A legacy of $5,000 from Emma A. Tillotson, deceased, widow of Luther C. Tillotson of New York, to the American Railway Master Mechanics' Association was announced. This has been invested by the executive committee and the interest will be applied to such investigations as they may recommend. The dues for the ensuing year were fixed at $5.00.

Under the head of new business Mr. Seley moved a resolution that a committee be appointed to act with a similar committee of the M. C. B. Association and the Railway Storekeepers' Association to formulate recommendations for standards of the association as to the grading of lumber for railway use. This resolution was carried.

Mr. Crawford requested that a committee be appointed to decide upon what action the association should take in regard to a bill now before the Federal Congress in regard to the inspection of locomotive boilers. The report of this committee will be given later.

## OFFICERS.

The officers for the ensuing year were elected as follows:

President, G. W. Wildin, N. Y., N. H. & H.; first vice-president, C. E. Fuller, Union Pacific; second vice-president, H. T. Bentley, C. & N. W.; third vice-president, D. F. Crawford, Pennsylvania Lines; treasurer, Angus Sinclair, Railway and Locomotive Engineering. Members of the Executive Committee —C. A. Seley, C., R. I. & P.; D. R. MacBain, N. Y. C. & H. R.; F. M. Whyte, N. Y. C. & H. R., and J. F. Walsh, C. & O.

## SUBJECTS.

Committee.—R. Quayle, Chairman; Wm. McIntosh, P. Maher.

The committee, appointed to suggest subjects for committee work for the 1910 convention, reports as follows:

COMMITTEE REPORTS.

1. The importance of shop and operating costs and the best methods of grouping in concise or graphic form for information of officials to whom this information is of vital importance.
2. What are the causes of the reduction in the life of locomotive fire boxes at present as compared with designs of former years?
3. Uniform grading and inspection of lumber for railroad use. (For joint consideration, provided a similar committee is appointed by the Master Car Builders' Association.)
4. Investigation of design of driving-boxes, brasses, shoes, wedges, binders and frames that will give increased mileage to locomotives between shoppings.
5. The operation and maintenance of electric locomotives.
6. How can locomotives be handled by the departments responsible for their movement so as to increase their efficiency? For example, so that four will do the work now requiring five locomotives.
7. Feed-water heaters in locomotive practice.
8. Management and discipline of employees.

INDIVIDUAL PAPERS.

Engineering Experiment Stations, Prof. Lester P. Breckenridge, University of Illinois Experiment Station.

In addition to the report, the subject of "Frame construction for engines with outside valve gear" was also suggested and adopted as part of the report.

The committee (L. G. Parish, F. H. Clark and B. P. Flory) which was appointed to report on the recommendations in the President's address presented the following resolutions, which were adopted by the association:

Resolved, That the executive committee appoint the following:

A committee to report at the next convention upon the heavy articulated locomotive, considering its advantages, disadvantages, possibilities and limitations, from the operating standpoint.

A committee to report at the next convention upon the electric locomotive, considering its advantages, disadvantages, possibilities and limitations, from the operating standpoint.

A committee to report next year a plan whereby the work of the railway clubs and that of the association may be coordinated for the assistance of our committees, for the discussion of subjects in detail in their relations to local conditions, for the educational advantage of minor officials, and for the conservation of time in the conventions of our association; the purpose being to gain for the Master Mechanics' association the assistance of the railway clubs as it is enjoyed by the Master Car Builders' association in connection with local discussions of interchange rules.

That a committee of three members be appointed by the president to confer with a similar committee of the Master Car Builders' association and present for discussion next year a constitution and by-laws of a new association to combine the American Railway Master Mechanics' association and the Master Car Builders' association into a consolidated association, this committee to also report the advantages and disadvantages of such consolidation, considering the question from every standpoint.

A committee to report next year to consider a systematic plan for stating operating costs controlled or influenced by the motive power department, in order to facilitate recommendations as to motive power policy and to render it possible to make intelligent and fair comparisons.

## AMENDMENTS TO THE CONSTITUTION.

The report of the committee on "The Revision of the Constitution and By-Laws" was adopted by the association. This provides for two changes in the constitution, both of which refer to the reference of papers on certain subjects to the American Railway Association.

The changes in the by-laws were in connection with the committee reports, which must be in the hands of the secretary not later than April 1 and May 1, depending on the grade of the committee.

## MECHANICAL STOKERS.

Committee:—T. Rumney, chairman, D. F. Crawford, C. E. Gossett, F. H. Clark, Geo. Hodgins.

This committee has been advised that further development and extended use of the Victor and Crosby stokers has ceased, and will confine its remarks to the Strouse and Hayden stokers, the remaining two reported upon at the last convention. We have also investigated, as far as possible, all types of mechanical stokers which have reached an interesting state of development, but, with the exception of one stoker, have been unable to procure any figures of tests.

The Strouse overfeed stoker,* as manufactured by The American Automatic Stoker Company, is now said to be at a marketable stage, twenty-two of them having recently been furnished to the Chicago & Alton Railroad for application, and two to the Iowa Central, and it is hoped that in the near future there will be available data covering practicability and efficiency; but as yet we have been unable to procure any data of value on the subject, the tests, apparently, having been more on the order of proving the mechanical possibility of the apparatus and observing the effect on the reduction of black smoke. The Strouse stoker is of the steam-driven horizontal reciprocating plunger

* See AMERICAN ENGINEER, April. 1908, page 151.

type. The coal is fed through a detachable hopper to the plunger distributor, which distributes it in the firebox by the forward movement of the plunger. The firebox door is replaced by a special door hinged at the top and opening inwardly, being operated automatically. In event of resorting to hand firing the suspension rods which support the stoker in position are disconnected, the stoker moved into the gangway and the original fire door reapplied. The stoker successfully handles any grade of coal from slack up to what will pass through a five-inch screen. We are advised that the coal is well distributed and raking is unnecessary.

The Pennsylvania Railroad is developing an underfeed stoker of its own design, which so far seems to give promising results, but there is no data at hand showing its performance. This stoker uses coal up to sizes of four or five-inch cubes, and requires no change of the locomotive other than the application of a special form of grate. The application of the mechanism is such that the fire door is in no way obstructed, so that hand firing may be resorted to on the road without any change or removing of apparatus. At the present time the coal is shoveled from the tank to the hopper of the stoker, but it is intended to install some means of mechanical conveyance.

The Barnum underfeed stoker, of the Chicago, Burlington & Quincy Railroad, requires screenings of one and one-half inches. The application of this stoker is such that hand firing cannot be accomplished without changes such as to require the work to be done in the shop. The installation of the stoker necessitates the removal of the grates, extension of the back frames, and the remodeling of the ash pan and draft appliance in the front end. The distribution of coal in the firebox is such as to seldom necessitate raking of the fire. With this stoker also the coal is delivered to the hopper by hand, but it is the intention to make this automatic later.

The "Black" or "Dodge" stoker, which is being developed on the Erie Railroad, is of the overfeed type. The only change to the locomotive necessary to the application of this stoker is the replacing of the firebox door by a specially designed box-shaped door, in the center of which is a pivoted shelf which can be tilted to any angle to the plane of the fire by means of a lever at the front of the door. Two four-blade gears revolving at about two hundred and fifty revolutions per minute on the top of the shelf spray the coal over the fire as it falls on the shelf from the hopper, which hopper is attached to the top of the door and forms a part thereof. The distribution of the coal is controlled by means of tilting the shelf and thus directing the spray of coal to any desired part of the grate. The whole operation can be observed through peep holes in the fire door. The coal is conveyed to the hopper by a worm conveyor extending from the forward end of coal space in the tank to the hopper, coal being delivered to this worm from the full length of the coal space by means of another worm. In order to fire by hand, the front worm conveyor is thrown back on its hinge and secured to the tank; the door requires no change, being all in one piece and hinged on the original fire-door hangers and can be operated similarly to the ordinary door. The size of coal for which this stoker is adapted is everything that will pass through a three or four-inch screen.

The Hayden automatic stoker,† in use on the Erie Railroad, was fully described in the Proceedings of 1908. A number of tests have been made of this stoker. While the results of the tests were not favorable to the stoker, its possibilities were felt to be such as to warrant the construction and placing in service of five additional ones. It is evident that the operation of the stoker will be best shown by comparison of the equivalent evaporation per pound of combustible and the combustible-hours per ton-mile, which latter item takes into consideration the time in which the run is accomplished. Engine 1627 (cyl. 22 x 32 in., 62 in. drivers and 200 lbs. steam), which made the first test in April, 1907, showed .734 per cent. more equivalent evaporation per pound of combustible with the stoker, while engine 1653 (same class) in the second test, made in April, 1908, showed 11.16 per cent. less. The fuel used with engine 1627 was run-of-mine, the lumps being broken to about three-inch size by the fireman, to suit stoker requirements; whereas engine 1653 was furnished with coal passed through a three-inch screen, resulting in the latter containing a very large proportion of fine coal, which would affect the evaporation per pound of combustible. While the combustible hours per ton-mile takes in, to a certain extent, all the varying conditions which make it impossible to obtain two similar results of like tests, it is of fairly good comparative value. With engine 1627, the stoker showed a loss of 17.02 per cent., while with engine 1653 the combustible-hours per ton-mile were only 8.7 per cent. greater with the stoker.

It was realized that although the stoker might show an increase in fuel consumed per ton-mile, as the provision of automatic firing would induce the engineer to work the engine harder since the firemen's labor and endurance were not concerned, it was felt that the time on road would thus be reduced and economy shown in fuel-hours per ton-mile when used as a basis of comparison, but the results were not as anticipated.

† See American Engineer, April, 1908, page 147.

The committee directs attention to the fact that automatic stokers are in their infancy, and it should be realized that efficiency over hand firing could hardly be expected at such an early stage.

The gradual retirement of old cars with structural weaknesses, and the advent of improved draft gears and triple valves, render it possible to increase the train length without resultant troubles from trains parting; consequently it is reasonable to assume that the average tractive power of locomotives will increase. It is possible, therefore, that the increased fuel consumed per mile will render it advisable to provide mechanical means for firing locomotives in order that they may develop a high sustained tractive effort, and render the service attractive to men who possess qualifications to become successful locomotive engineers.

A successful automatic stoker should render locomotive firing more attractive, raise the standard of the service, permit close attention to economic handling of fuel and reduction of black smoke, enable firemen to become better acquainted with the general duties of a locomotive engineer, and reduce tube and firebox troubles.

*Discussion.*—Mr. Nelson (P. R. R.) called attention to the fact that the term "fuel hours per ton mile" probably meant fuel per ton mile.

Mr. Henderson presented a detailed estimate of the probable advantage of a mechanical stoker on a larger Mallet locomotive, as follows:

"The division to be covered by this locomotive was 100 miles in length, against the traffic, of which there is a 0.5 per cent. compensated up-grade 40 miles long, and the remaining 60 miles are practically all down-grade. The locomotive upon which our figures were based was of the Mallet type, having a tractive force of 65,000 lbs., which would enable it to haul at slow speeds 4,200 tons up the 0.5 per cent. grade, on which our figures were made, ascending the grade at 6, 10 and 15 miles per hour. It was assumed that one fireman could handle 3,000 to 4,000 lbs. per hour throughout the 40 miles up-grade, or that two men, by working in relays, would be needed to supply 6,000 to 8,000 lbs. an hour, but for quantities over this a mechanical stoker would be necessary. As the grate area of this locomotive is 78 sq. ft., it will be seen at once that it would be possible to burn from 12,000 to 15,000 lbs. of coal per hour if found desirable or necessary. In making these figures, the following units were assumed: The actual time between terminals would be 20 per cent. greater than the running time, this allowing for lay-overs, etc.; the down-hill speed would be 30 miles an hour; the cost of the coal was taken at $1 per ton and of water at 5 cents per thousand gallons. Allowances were also made for repairs, renewals, pay of enginemen, handling at terminals and interest on investment. It was considered that there would be 5 hours consumed in turning the engine at the terminals of the division, and the cost of train supplies, car repairs, pay of trainmen, etc., were included, so that the figures show the actual cost of operating the train, but, of course, do not cover the general expenses of superintendence, maintenance of track, buildings, bridges and other data except the usual train operation, which figures really comprise only about 40 per cent. of the total cost due to all expenditures of the road. The cost was figured out for the total movement on one trip, also for 1,000 ton miles of train back of engine, including the weight of the cars and ton miles per hour performed by the engine, with the allowance of five hours for turning, as above mentioned. These figures, therefore, enable one to see at a glance the variation in cost and capacity due to one or two firemen, or to a mechanical stoker. The figures are given below:

| | | | | | | |
|---|---|---|---|---|---|---|
| Speed, up hill, m. p. h. | 6 | 10 | 10 | 15 | 15 | 15 |
| Cost, movement, per trip | $79.93 | $82.35 | $62.18 | $87.05 | $67.00 | $50.38 |
| Cost, per 1,000 ton-miles | .19 | .20 | .21 | .22 | .22 | .25 |
| Ton-miles, per hour | 27,300 | 34,400 | 24,600 | 38,000 | 28,300 | 19,000 |
| Weight of train, tons* | 4,200 | 4,200 | 3,000 | 4,000 | 3,000 | 2,000 |
| Method of firing | 1 fireman. | 2 firemen. | 1 fireman. | Stoker | 2 firemen. | 1 fireman. |

* Train back of tender.

"It is seen, therefore, that by far the greatest amount of work done by the engine is with the use of a stoker and running up hill at a speed of 15 miles per hour, the assumption being in this case that there would be 15,000 lbs. of coal burned per hour, while running up the grade. The cost per 1,000-ton miles is less than if we attempted to run with half the load at the same speed up hill with only one fireman, and it is only 3 cents greater than if we went up the hill at six miles an hour with a single fireman. At ten miles an hour two firemen would give nearly the same capacity of the locomotive and at somewhat lower cost, but it is rather uncertain whether two firemen can be managed satisfactorily on a locomotive, and where a large amount of traffic is to be gotten over the road, the advantage of being able to push the engine to its full capacity and at a fairly high speed is shown without any uncertainty.

"At 15 miles an hour, considered economical speed for general operation, one fireman could handle 19,000-ton miles at a cost of 25 cents, two firemen 28,000-ton miles at a cost of 22 cents, and the stoker 38,000-ton miles per hour at a cost of 22 cents. You will see, with a slight additional increase of cost of stoker over one man at slow speeds, a much larger amount of ton-miles can be obtained, and at speeds of 15 miles an hour the cost of the stoker is considerably less than that of one fireman, and double the amount of ton mileage can be made with the engine."

Mr. Maher (C. & A.) stated that in the case of the first stoker applied on his road, it was necessary to remove it almost immediately, and it was set up in connection with a temporary fire box in the power house and worked for almost a week, giving the men an opportunity to become acquainted with its operation. Following this it was put back on the locomotive and has been in constant use for about sixty days and is still working. This road has twelve engines now equipped and will have a total of twenty within a short time. The troubles up to this time have been but minor. Some runs made by a consolidation locomotive with 22 x 30 in. cylinders and by a Pacific type locomotive, with 23 x 28 in. cylinders, were mentioned as being the most satisfactory. Mr. Maher did not believe that the stoker would reduce smoke to any great extent. In reply to questions by different members he stated that they were not using a brick arch and that the Strouse stoker would give a uniform depth of fire over the whole box, but that the coal could be placed at almost any desired point at any time. They had not had any trouble in connection with the fire box filling up with clinkers or ashes.

D. R. MacBain (N. Y. C.) told of his observations on a consolidation locomotive with a stoker on the Alton. At the end of a 122-mile trip, made in six hours and seventeen minutes, during which time about 20 tons of coal was burned, he found the fire to be clean and in good shape to start out again immediately.

Mr. Gossett (Ill. Cent.) recounted a recent trip he made on a locomotive equipped with a Strouse stoker on the Alton. In this case the train weighed 3,300 tons or 500 tons more than the rating, and averaged 17 miles per hour for 88 miles. The steam pressure did not vary four lbs. during this time and the fireman was able to work leisurely. He expressed himself as being convinced that the stoker had passed the experimental stage, so far as principle is concerned. Mr. Tonge (M. & St. L.) was present on the same trip and agreed with all that Mr. Gossett had said. He also stated that the stoker had not required repairs of any kind for a month.

D. F. Crawford (P. R. R.) stated that he was experimenting with an underfeed type of stoker with some success. This stoker gave a decided reduction in the amount of smoke. The Chicago, Burlington & Quincy Railroad is also experimenting with a similar type of stoker. It is the intention to put an engine equipped with the P. R. R. stoker on the testing plant at Altoona, as well as some other designs, as the opportunity offers. The results of these tests will probably be reported to the Association next year.

## REVISION OF STANDARDS.

Committee:—W. H. V. Rosing, chairman; T. W. Demarest, C. B. Young, E. T. White, G. W. Wildin.

The committee called attention to several errors in the 1908 Proceedings. It also recommended that the vertical clearance between the side lugs of the journal bearing and the journal bearing wedge for standard 4¼ by 8 in. and 5 by 9 in. journals be increased to ⅛ in., as with the rough castings used in these articles the present allowance of 1/16 in. is scarcely sufficient to satisfactorily overcome the irregularities of manufacture. Attention was also called to the fact that ⅛-in. clearance was heretofore adopted for the 3¾ by 7 in. and 5½ by 10 in. bearings and wedges, and it should be the same for the 4¼ by 8 in. and the 5 by 9 in. bearings and wedges.

There are a number of gauges now in use for measuring sheet metals based on a numerical system, for which there is no check gauge. The thickness of sheets ordered by the Master Mechanics' standard decimal gauge can always be checked by a micrometer caliper, so there should be no practical opportunity for error or misunderstanding, and the committee urges the early adoption by all of the members of the Master Mechanics' standard decimal gauge in ordering sheet metals.

It was also recommended that committees be appointed for the ensuing year to report on the following subjects:

1. Safety appliances for locomotives—this to include grab irons, steps, handholds, uncoupling levers, etc., for engine and tender in both yard and road service. As legislation in some States is inclined in this direction, we believe that the Association should take the initiative to furnish a guide for future legislation that will tend to secure uniformity.

2. To revise the present instructions relating to air brake and train air signals, to meet the requirements of the recent improved developments in air brake construction and practice, for both locomotives and trains.

*Discussion.*—On a motion by Mr. Wildin a recommendation to change the clearance from 1/16 to ⅛ in. was to be taken up with the executive committee of the M. C. B. Association, with the recommendation that the change be adopted

After some discussion in regard to the standard gauge for sheets and wire it was decided to appoint a committee to meet a similar committee of the American Steel Manufacturers' Association and thoroughly discuss the subject.

The other recommendations of the committee were referred to the executive committee for further consideration.

## SUPERHEATERS.

The report of the committee on superheaters stated that previous papers before the association had recited the history of superheating thoroughly, and that practical demonstrations had not yet reached a point where sufficient information of definite value can be obtained to warrant the committee making their report at this time.

Upon presentation of this report Mr. Seley submitted some information obtained since the superheater committee report was printed, which gives the results of some passenger engine tests made in the Illinois Division of the C. R. I. & P. Ry.

This division is 181.2 miles between terminals, with no heavy grades or curves.

The trains were Nos. 11 and 6. The average total time was 4 hrs. 24 min., and the average running time, 4 hrs. 9 min. The average number of stops was 7, and the average speed, actual running time, 43.7 m.p.h. The average number of cars in trains was 7.58 and the average weight of trains 425 tons.

The coal was sacked and weighed and the water measured by tank calibration and three round trips run with each engine. There were five engines tested, two with superheaters and three non-superheater simple engines. The performance is shown in the following table:

| Ref. | Eng. No. | Kind of Engine. | Mileage Before Test. | Lbs. Water Per Ton Mile. | % of No. 4. | Lbs. Dry Coal Per Ton Mile. | % of No. 4. |
|---|---|---|---|---|---|---|---|
| 1 | 1019 | Atl. Sup. | 62,347 | 1.36 | 84. | .1816 | 99.4 |
| 2 | 847 | Pac. Sup. | 35,504 | 1.37 | 84.5 | .1655 | 90.6 |
| 3 | 1013 | Atl. Non-Sup. | 5,260 | 1.53 | 94.4 | .1926 | 100.5 |
| 4 | 863 | Pac. Non-Sup. | New | 1.62 | 100. | .1826 | 100. |
| 5 | 833 | Pac. Non-Sup. | 77,281 | 1.774 | 109.5 | .2309 | 126. |

Test engine No. 4 gave a practically perfect performance and, for the purpose of comparison with the other engines, was taken as 100 per cent. Test engine No. 1 had made 62,347 miles before the test was made. Its performance was 1.36 lbs. of water per ton-mile, or 84 per cent. of the performance of the base engine. Due to the poor condition of its boiler, on account of the time it had been running, the performance in coal was 0.1816, or 99.4 per cent. of the base engine performance. Test engine No. 2 had made 35,504 miles before the test. Its record was 1.37 lbs. of water per ton-mile, or only 0.01 of a pound difference from the first engine, and its percentage of base engine was 84.5. Its coal performance was 0.1655 lbs. of dry coal per ton-mile and 90.6 per cent. of the performance of the base engine. No. 3 had only made 5,260 miles and was in very good condition. The pounds of water per ton-mile were 1.53, or 94.4 per cent. of the base engine. I consider the explanation of this is that the engine was somewhat better suited to the weight of the train than the base engine. The performance of this engine in coal was 0.1926, or 100.5 per cent. of the base engine. No. 5 was a shop candidate, and in fact went to the shop directly after the test, having made 77,281 miles. Her performance in water was 1.774, or 109.5 per cent. of the base engine. The pounds of dry coal per ton-mile was 0.2309, or 126 per cent. of the base engine.

The two superheater engines, notwithstanding the fact that they had made respectively 62,347 and 35,504 miles before the test, did their work with 16 per cent. less water than a new non-superheater engine. The coal performance is not so good as the water, as would naturally be the case in comparing the performance of a new clean boiler and one after 62,000 miles' service, so that No. 1 shows but a trifle of advantage, but No. 2 nearly 10 per cent., which in connection with the 15.5 per cent. water economy is certainly a fine performance.

The low record of No. 5, aside from its general condition, is no doubt partly due to having a different proportion of cylinders and smaller wheels than on engine No. 4.

The fine performance of engine No. 3 is no doubt due to its proportions being very well adapted to the weight of train and character of road, while no doubt engine No. 4 could have taken a heavier train with as good or better results, these engines being designed for heavier service than the trains on which tests were made.

Some of the dimensions of the engines tested are given in the following table:

| No. | Cylinders. | Drivers. | Steam pressure. | Grate area. | Total weight, engine and tender loaded. | Tractive power. |
|---|---|---|---|---|---|---|
| 1 | 21 x 26 | 73 | 185 | 44.86 | 335,300 | 24,700 |
| 2 | 22 x 26 | 69 | 190 | 44.86 | 366,000 | 31,000 |
| 3 | 21 x 26 | 73 | 185 | 44.86 | 330,300 | 24,700 |
| 4 | 23 x 28 | 73 | 185 | 45.00 | 376,000 | 31,600 |
| 5 | 22 x 26 | 69 | 190 | 44.86 | 362,000 | 31,000 |

The Rock Island superheater engines were acquired in 1905 and put in service to ascertain their ability to do business without causing train delays or unduly increasing maintenance expense due to the superheater features. It was felt that these were matters of detail that should be worked out before any records or tests for economies were necessary or advisable. We had a number of difficulties of one kind and another, but through them all the advantages due to the superheater features were sufficiently apparent to warrant the effort to overcome them, which we have now done in large measure and feel confident that the showing here made is an honest, consistent one.

## LOCOMOTIVE PERFORMANCE UNDER SATURATED AND SUPERHEATED STEAM.

W. F. M. Goss.

[One of the most valuable contributions before the association was Dr. Goss' paper on the above subject, which, in his absence, was admirably presented, in abstract, by Prof. E. C. Schmidt.

This paper was presented together with the report of the superheating committee and was discussed at the same time as that report. It is altogether too voluminous for complete reprinting and only its more general features and conclusions are given below.]

*The Origin of the Work.*—Under the patronage of the Carnegie Institution of Washington, there have been completed, at the laboratory of Purdue University, two elaborate series of locomotive tests. The first had for its purpose the determination of the performance of a locomotive using saturated steam; the second, that of a locomotive using superheated steam. A description of the methods and results of the first series has been published by the Carnegie Institution,* and a similar description of the second series is now in preparation for publication.† The facts presented herewith are drawn from the more elaborate presentation of these two sources.

*The Equipment.*—The locomotive upon which the tests were made is that regularly employed in the laboratory of Purdue University. As used in the tests involving saturated steam, it was known as Schenectady No. 2, and since its reconstruction with a superheater, it has been known as Schenectady No. 3. The superheater was made and installed by the American Locomotive Works at Schenectady, and is of the Cole type.

The principal characteristics of Schenectady No. 2 (saturated steam) are as follows:

| | |
|---|---|
| Type | 4-4-0 |
| Total weight (pounds) | 109,000 |
| Weight on four drivers (pounds) | 61,000 |
| Driving-axle journals: | |
| Diameter (inches) | 7½ |
| Length (inches) | 8½ |
| Drivers, diameter front tire (inches) | 69.25 |
| Valves—Type, Richardson balanced: | |
| Maximum travel (inches) | 6 |
| Outside lap (inches) | 1⅛ |
| Inside lap (inches) | 0 |
| Ports: | |
| Length (inches) | 12 |
| Width of steam port (inches) | 1.5 |
| Width of exhaust port (inches) | 3 |
| Total wheel base (feet) | 23 |
| Rigid wheel base (feet) | 8.5 |
| Cylinders: | |
| Diameter (inches) | 16 |
| Stroke (inches) | 24 |
| Boiler (style, extended wagon-top): | |
| Diameter of front end (inches) | 52 |
| Number of tubes | 200 |
| Gage of tubes | 12 |
| Diameter of tube (inches) | 2 |
| Length of tube (feet) | 11.5 |
| Length of fire box (inches) | 72.06 |
| Width of fire box (inches) | 34.25 |
| Depth of fire box (inches) | 79.00 |
| Heating surface in fire box (square feet) | 126 |
| Heating surface in tubes (square feet) | 1,196 |
| Total heating surface (square feet) | 1,322 |
| Grate area (square feet) | 17 |
| Thickness of crown sheet (inches) | 7/16 |
| Thickness of tube sheet (inches) | 9/16 |
| Thickness of side and back sheet (inches) | ⅜ |
| Diameter of stay bolts (inches) | 1 |
| Diameter of radial stays (inches) | 1⅛ |

The locomotive Schenectady No. 3 (superheated steam) is different from its predecessor, just described, only in so far as changes were necessary in the process of applying a superheater. The Cole superheater consists chiefly of a series of return tubes extending inside of certain of the flues which make up a portion of the water-heating surface. To give room for these superheater tubes, the upper central portion of the usual flue space is taken up by sixteen 5-inch flues, within each of which there is an upper and lower line of superheating tubes. Each loop of the superheater tubes extends from a header in the smoke box, back into its flue to a point near the back tube sheet, where it meets and is screwed into a return bend fitting of special design. From the second of the two openings in this fitting a similar pipe extends forward through the flue and into the smoke box to the header which opens into the branch pipes leading to the cylinders. Altogether there are thirty-two of these loops. The construction of the tee-head and of the four branch headers is such that all steam passing the throttle of the locomotive must pass some one of the several loops.

The characteristics of Schenectady No. 3, so far as these were changed from those of Schenectady No. 2, are as follows:

| | |
|---|---|
| Number of 2-inch flues | 111 |
| Number of 5-inch flues | 16 |
| Length of flues | 11.5 |
| Heating surface in flues (square feet) | 897 |
| Heating surface in fire box (square feet) | 126 |
| Total water-heating surface (square feet) | 1,023 |
| Outside diameter of superheater tubes (inches) | 1¼ |
| Number of loops | 32 |
| Average length of pipe per loop (feet) | 17.27 |
| Total superheating surface based on outside surface of tubes, neglecting surface of headers (square feet) | 193 |
| Total water-heating and superheating surface (square feet) | 1,216 |

### Tests With Saturated Steam.

*The Tests Under Saturated Steam,* the results of which are summarized in table IV, include a series of runs for which the average pressure was, respectively, 240, 220, 200, 180, 160 and 120 pounds, a range which extends far below and well above pressures which are common in present practice. All tests were run under a wide-open throttle. The tests of each series are sufficiently numerous to define completely the performance of the engine operating under a number of different speeds and when using steam in the cylinders under several degrees of expansion.

The first of these tests was run February 15, 1904, and the last August 7, 1905. A registering counter attached to the locomotive showed that between these dates the locomotive drivers made 3,113,333 revolutions, which is equivalent to 14,072 miles.

*The Performance of the Boiler.*—The fuel which was regarded as standard for these tests was Youghiogheny lump, an average analysis of which, based on air-dried samples, is as follows:

| | |
|---|---|
| Moisture | .87 |
| Volatile matter | 34.10 |
| Fixed carbon | 57.62 |
| Ash | 7.41 |
| Heating value per pound of dry coal (B. T. U.) | 14,295 |
| Heating value per pound of combustible (B. T. U.) | 15,585 |

The pounds of water evaporated per pound of coal, in terms of rate of evaporation, are given in the following table:

| Boiler Pressure. | Equations. |
|---|---|
| 240 pounds | $E = 11.040 - .221\ H$ |
| 220 pounds | $E = 11.040 - .221\ H$ |
| 200 pounds | $E = 11.373 - .221\ H$ |
| 160 pounds | $E = 11.469 - .221\ H$ |
| 120 pounds | $E = 11.357 - .221\ H$ |

Where E is the number of pounds of water evaporated from and at 212° F. per pound of coal and H is the number of pounds of water evaporated from and at 212° per sq. ft. of heating surface per hour. The area of heating surface employed is based upon the interior surface of the fire box and the exterior surface of the tubes.

The results show that the lowest efficiency is obtained with the highest pressure. They do not show that the highest efficiency results from the use of the lowest pressure. With one exception, however, the lines representing performance

* "High Steam Pressures in Locomotive Service," published by the Carnegie Institution, Washington, D. C. See also American Engineer and Railroad Journal, Jan., 1907, p. 13.

† "Superheated Steam in Locomotive Service," the Carnegie Institution, Washington, D. C.

TABLE IV.
A SUMMARY OF OBSERVED AND CALCULATED DATA
LOCOMOTIVE SCHENECTADY NO. 2. (SATURATED STEAM.)

| Designation of Tests. Number. | Laboratory Symbol. | Speed, Miles per Hour. | Dry Coal per Square Foot of Grate Surface per Hour, Pounds. | Smoke-box Temperature, Degrees F. | Equivalent Evaporation per Sq. Ft. of Heating Surface per Hour, Pounds. | Equivalent Evaporation per Pound of Dry Coal. | Cut-off, Per Cent of Stroke. | Mean Effective Pressure, Pounds per Square Inch. | Indicated Horse-power. | Pounds of Steam per Indicated Horse-power Hour. | Pounds of Coal per Indicated Horse-power Hour. | Draw-bar Pull, Pounds. | Draw-bar Horse-power. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | 20-2-240 | 19.4 | 55.2 | .... | 6.68 | 9.40 | 14.18 | 60.19 | 276.5 | 26.29 | 3.40 | 6,990 | 242.4 |
| 1a | 20-2-240 | 20.0 | 57.4 | 635 | 6.90 | 9.40 | .... | 55.53 | 262.6 | .... | .... | .... | .... |
| 2 | 20-4-240 | 20.1 | 76.2 | 743 | 9.15 | 9.32 | 19.02 | 82.67 | 392.5 | 25.33 | 3.30 | 6,690 | 357.6 |
| 3 | 20-6-240 | 19.9 | .... | 745 | 10.31 | .... | 26.95 | 99.05 | 466.8 | 24.09 | .... | 7,626 | 405.0 |
| 3a | 20-6-240 | 19.8 | 97.3 | 730 | 10.76 | 8.60 | .... | 95.72 | 449.3 | .... | .... | .... | .... |
| 4 | 20-8-240 | 19.9 | .... | .... | .... | .... | 32.88 | 120.50 | 568.0 | .... | .... | .... | .... |
| 5 | 30-2-240 | 30.0 | 72.0 | .... | 8.64 | 9.33 | 16.04 | 52.29 | 371.3 | 25.48 | 3.29 | 4,554 | 364.0 |
| 5a | 30-2-240 | 30.8 | 93.9 | 698 | 9.75 | 8.08 | .... | 51.30 | 363.0 | .... | .... | .... | .... |
| 6 | 30-4-240 | 30.0 | .... | 759 | 10.52 | .... | 19.70 | 66.36 | 470.6 | 24.43 | .... | 4,897 | 391.1 |
| 7 | 30-6-240 | 27.5 | .... | .... | .... | .... | 25.15 | 83.12 | 540.3 | .... | .... | .... | .... |
| 8 | 40-2-240 | 40.0 | 82.6 | 809 | 9.35 | 8.79 | 15.24 | 41.64 | 421.8 | 24.16 | 3.33 | 3,370 | 358.5 |
| 9 | 40-4-240 | 40.0 | .... | .... | 12.39 | .... | 20.75 | 60.06 | 566.3 | 23.86 | .... | 4,259 | 453.5 |
| 10 | 40-6-240 | 42.5 | .... | .... | .... | .... | 27.82 | 67.17 | 675.6 | .... | .... | .... | .... |
| 11 | 50-2-240 | 51.0 | 85.8 | .... | 10.57 | 9.57 | 15.15 | 38.59 | 465.5 | 24.97 | 3.07 | 2,979 | 404.7 |
| 12 | 50-4-240 | 50.0 | .... | .... | .... | .... | 21.12 | 53.70 | 635.5 | .... | .... | .... | .... |
| 13 | 20-2-220 | 19.9 | 49.0 | 682 | 6.72 | 10.65 | 14.44 | 54.27 | 255.3 | 27.65 | 3.24 | 4,431 | 234.7 |
| 14 | 20-4-220 | 20.0 | 64.0 | 703 | 8.23 | 10.00 | 19.52 | 72.39 | 342.8 | 25.80 | 3.18 | .... | .... |
| 15 | 20-6-220 | 20.0 | 92.0 | 764 | 10.29 | 8.69 | 26.98 | 91.23 | 431.4 | 25.51 | 3.62 | .... | .... |
| 16 | 20-8-220 | 20.1 | 122.2 | 806 | 12.70 | 8.08 | 35.28 | 111.92 | 533.0 | 25.86 | 3.89 | 9,190 | 491.6 |
| 17 | 30-2-220 | 30.0 | 64.3 | .... | 8.00 | 9.75 | 13.45 | 45.15 | 320.3 | 26.60 | 3.41 | 3,360 | 268.4 |
| 18 | 30-4-220 | 30.0 | 86.5 | 743 | 9.75 | 8.77 | 21.14 | 62.88 | 446.5 | 21.23 | 3.29 | 4,764 | 380.9 |
| 19 | 30-6-220 | 30.0 | 109.9 | 813 | 12.01 | 8.49 | 26.41 | 78.89 | 559.5 | 23.59 | 3.34 | 6,239 | 499.1 |
| 20 | 30-8-220 | 31.2 | .... | .... | .... | .... | 35.87 | 96.94 | 715.3 | .... | .... | .... | .... |
| 21 | 40-2-220 | 40.1 | 71.5 | 716 | 8.77 | 9.54 | 14.38 | 39.16 | 371.5 | 25.58 | 3.27 | 2,927 | 313.0 |
| 22 | 40-4-220 | 40.0 | 94.3 | 786 | 10.95 | 9.03 | 20.45 | 53.81 | 509.1 | 23.68 | 3.15 | 3,963 | 406.2 |
| 23 | 40-6-220 | 40.2 | .... | .... | .... | .... | 29.82 | 70.60 | 672.7 | .... | .... | .... | .... |
| 24 | 50-2-220 | 40.0 | 76.9 | 728 | 9.18 | 9.29 | 14.51 | 32.64 | 378.8 | 26.29 | 3.45 | 2,255 | 300.2 |
| 25 | 50-4-220 | 40.0 | 118.2 | 810 | 12.25 | 8.06 | 21.15 | 47.56 | 562.3 | 24.08 | 3.57 | 3,617 | 481.6 |
| 26 | 50-6-220 | 50.0 | .... | .... | .... | .... | 32.57 | 61.85 | 732.4 | .... | .... | .... | .... |
| 27 | 60-4-220 | 60.0 | .... | .... | .... | .... | 26.92 | 43.24 | 614.2 | .... | .... | .... | .... |
| 28 | 60-6-220 | 60.0 | .... | .... | .... | .... | 34.52 | 55.70 | 791.4 | .... | .... | .... | .... |
| 29 | 20-2-200 | 19.9 | 45.5 | .... | 5.89 | 10.07 | 13.35 | 47.25 | 223.5 | 28.32 | 3.47 | 3,571 | 189.6 |
| 30 | 20-4-200 | 19.9 | 59.4 | 682 | 7.20 | 9.43 | 19.76 | 61.05 | 287.6 | 26.24 | 3.51 | 4,943 | 262.2 |
| 31 | 20-6-200 | 20.0 | .... | 685 | 8.92 | .... | 26.95 | 79.31 | 375.8 | 26.01 | .... | 6,309 | 337.1 |
| 32 | 20-8-200 | 19.9 | 97.8 | 780 | 11.27 | 8.96 | 35.95 | 100.10 | 472.9 | 26.31 | 3.52 | 8,375 | 455.5 |
| 33 | 30-2-200 | 30.0 | 55.0 | 673 | 6.96 | 9.82 | 14.19 | 37.88 | 268.9 | 27.01 | 3.48 | 2,965 | 237.4 |
| 34 | 30-4-200 | 30.0 | .... | 682 | 8.56 | .... | 18.87 | 51.69 | 367.1 | 25.70 | .... | 3,847 | 307.4 |
| 35 | 30-6-200 | 30.0 | 98.0 | 788 | 11.12 | 8.83 | 26.75 | 68.90 | 489.2 | 24.91 | 3.40 | 5,380 | 430.1 |
| 36 | 30-8-200 | 30.6 | .... | .... | .... | .... | 34.75 | 87.83 | 635.7 | .... | .... | .... | .... |
| 37 | 40-2-200 | 40.0 | 60.6 | 676 | 7.59 | 9.75 | 13.28 | 32.42 | 306.6 | 26.88 | 3.35 | 2,257 | 240.5 |
| 38 | 40-4-200 | 39.9 | 86.7 | .... | 10.10 | 9.06 | 19.72 | 47.42 | 448.8 | 24.66 | 3.28 | 3,622 | 386.1 |
| 39 | 40-6-200 | 40.0 | 123.6 | 833 | 13.38 | 8.41 | 27.89 | 62.47 | 605.3 | 24.43 | 3.47 | .... | .... |
| 40 | 40-8-200 | 40.2 | .... | .... | .... | .... | 34.82 | 76.35 | 728.9 | .... | .... | .... | .... |
| 41 | 50-2-200 | 49.9 | 62.5 | 687 | 7.75 | 9.64 | 13.39 | 27.82 | 329.1 | 25.74 | 3.23 | 1,799 | 239.5 |
| 42 | 50-4-200 | 50.1 | 92.7 | 768 | 11.13 | 9.34 | 20.75 | 39.18 | 461.2 | 25.78 | 3.27 | 3,434 | 458.0 |
| 43 | 50-6-200 | 50.0 | .... | .... | .... | .... | 33.45 | 57.05 | 675.4 | .... | .... | .... | .... |
| 44 | 60-4-200 | 60.0 | .... | .... | .... | .... | 27.45 | 36.68 | 521.1 | .... | .... | .... | .... |
| 45 | 60-6-200 | 60.0 | .... | .... | .... | .... | 30.50 | 46.52 | 660.9 | .... | .... | .... | .... |
| 46 | 20-2-180 | 20.1 | .... | 595 | 5.07 | .... | 11.91 | 40.42 | 192.0 | 28.78 | .... | 2,814 | 150.5 |
| 47 | 20-4-180 | 20.1 | .... | 628 | 6.47 | .... | 18.97 | 55.48 | 263.6 | 26.76 | .... | 4,195 | 224.5 |
| 48 | 20-6-180 | 20.1 | .... | 673 | 7.75 | .... | 26.94 | 70.65 | 334.1 | 25.44 | .... | 5,377 | 287.3 |
| 49 | 20-8-180 | 20.0 | .... | 718 | 9.74 | .... | 34.17 | 86.77 | 411.7 | 25.91 | .... | 6,900 | 268.6 |
| 50 | 20-10-180 | 20.1 | .... | .... | .... | .... | 41.60 | 103.81 | 494.4 | .... | .... | .... | .... |
| 51 | 30-2-180 | 30.1 | .... | 654 | 5.76 | .... | 13.87 | 33.01 | 235.2 | 26.54 | .... | 2,179 | 174.9 |
| 52 | 30-4-180 | 29.8 | .... | 639 | 7.35 | .... | 19.23 | 44.97 | 317.2 | 25.36 | .... | 3,283 | 261.1 |
| 53 | 30-6-180 | 30.0 | .... | 688 | 8.81 | .... | 26.42 | 55.44 | 393.3 | 24.62 | .... | 4,188 | 334.5 |
| 54 | 30-8-180 | 30.1 | .... | 762 | 12.42 | .... | 34.20 | 77.29 | 546.3 | 24.61 | .... | 5,856 | 470.2 |
| 55 | 30-10-180 | 30.6 | .... | .... | .... | .... | 41.87 | 91.72 | 663.8 | .... | .... | .... | .... |
| 56 | 40-2-180 | 40.0 | .... | 636 | 6.13 | .... | 14.84 | 27.39 | 259.1 | 25.89 | .... | 1,726 | 181.6 |
| 57 | 40-4-180 | 40.6 | .... | 687 | 8.53 | .... | 20.82 | 40.71 | 386.2 | 24.08 | .... | 2,890 | 308.5 |
| 58 | 40-6-180 | 39.8 | .... | 750 | 11.47 | .... | 26.14 | 56.14 | 524.1 | 23.68 | .... | 4,039 | 427.9 |
| 59 | 40-8-180 | 40.4 | .... | 831 | 14.34 | .... | 34.80 | 64.16 | 609.9 | 25.85 | .... | 5,142 | 553.3 |
| 60 | 40-10-180 | 40.2 | .... | .... | .... | .... | 42.60 | 80.04 | 761.96 | .... | .... | .... | .... |
| 61 | 50-2-180 | 50.0 | .... | 639 | 6.53 | .... | 15.17 | 22.65 | 268.0 | 26.61 | .... | 1,305 | 173.8 |
| 62 | 50-4-180 | 49.9 | .... | 707 | 9.22 | .... | 21.13 | 34.85 | 410.62 | 24.43 | .... | 2,219 | 298.9 |
| 63 | 50-6-180 | 50.7 | .... | 778 | 12.55 | .... | 29.12 | 46.11 | 553.3 | 24.87 | .... | 3,355 | 453.4 |
| 64 | 50-8-180 | 50.0 | .... | .... | .... | .... | 35.20 | 58.46 | 692.0 | .... | .... | .... | .... |
| 65 | 60-4-180 | 60.0 | .... | .... | .... | .... | 28.20 | 30.98 | 440.1 | .... | .... | .... | .... |
| 66 | 60-6-180 | 60.0 | .... | .... | .... | .... | 34.35 | 42.24 | 600.2 | .... | .... | .... | .... |
| 67 | 20-4-160 | 20.0 | 42.5 | 631 | 5.55 | 10.16 | 18.89 | 46.43 | 219.5 | 28.03 | 3.29 | 3,281 | 174.7 |
| 68 | 20-6-160 | 20.0 | 56.3 | 667 | 7.04 | 9.72 | 25.65 | 62.95 | 298.4 | 26.14 | 3.20 | 4,731 | 252.2 |
| 69 | 20-8-160 | 20.0 | .... | 678 | 8.61 | .... | 33.50 | 72.92 | 345.1 | 27.52 | .... | 5,939 | 316.4 |
| 70 | 20-10-160 | 20.1 | .... | .... | .... | .... | 39.92 | 94.43 | 449.5 | .... | .... | .... | .... |
| 71 | 30-4-160 | 29.9 | 51.9 | 662 | 6.60 | 9.89 | 17.84 | 38.39 | 272.1 | 26.86 | 3.24 | 2,655 | 211.9 |
| 72 | 30-6-160 | 30.0 | 68.9 | 707 | 8.75 | 9.87 | 25.67 | 54.08 | 383.9 | 25.28 | 3.05 | 3,786 | 302.5 |
| 73 | 30-8-160 | 30.0 | .... | 763 | 10.91 | .... | 33.06 | 65.58 | 465.1 | 25.69 | .... | 5,130 | 410.86 |
| 74 | 30-10-160 | 30.0 | .... | .... | .... | .... | 43.30 | 79.47 | 564.3 | .... | .... | .... | .... |
| 75 | 30-12-160 | 30.8 | .... | .... | .... | .... | 46.80 | 90.38 | 658.6 | .... | .... | .... | .... |
| 76 | 40-4-160 | 40.1 | 63.4 | 690 | 7.94 | 9.73 | 19.62 | 33.49 | 317.5 | 26.48 | 3.39 | .... | .... |
| 77 | 40-6-160 | 39.9 | 87.6 | 761 | 10.32 | 9.16 | 26.11 | 45.65 | 431.7 | 25.82 | 3.45 | .... | .... |
| 78 | 40-8-160 | 40.2 | .... | 790 | 13.16 | .... | 34.80 | 57.02 | 543.9 | 26.44 | .... | 4,466 | 478.4 |
| 79 | 40-10-160 | 39.4 | .... | .... | .... | .... | 39.72 | 71.68 | 668.5 | .... | .... | .... | .... |
| 80 | 50-4-160 | 50.0 | 65.5 | 691 | 8.23 | 9.76 | 19.40 | 28.58 | 338.3 | 27.01 | 3.39 | 1,918 | 255.6 |
| 81 | 50-6-160 | 50.1 | 101.3 | 786 | 11.57 | 8.88 | 28.06 | 40.19 | 475.9 | 26.12 | 3.61 | .... | .... |
| 82 | 50-8-160 | 50.0 | .... | .... | .... | .... | 35.25 | 51.91 | 614.4 | .... | .... | .... | .... |
| 83 | 60-4-160 | 60.0 | .... | .... | .... | .... | 26.20 | 25.46 | 361.7 | .... | .... | .... | .... |
| 84 | 60-6-160 | 60.0 | .... | .... | .... | .... | 30.50 | 36.51 | 518.7 | .... | .... | .... | .... |
| 85 | 20-4-120 | 20.0 | 31.4 | 581 | 3.91 | 9.67 | 17.95 | 28.36 | 134.0 | 32.47 | 3.99 | 1,960 | 104.5 |
| 86 | 20-8-120 | 19.9 | 52.4 | 630 | 6.45 | 9.56 | 33.37 | 53.59 | 252.8 | 28.40 | 3.52 | 2,700 | 143.4 |
| 87 | 20-12-120 | 19.9 | 76.4 | 718 | 9.25 | 9.41 | 48.69 | 75.69 | 356.9 | 28.88 | 3.64 | 6,157 | 326.7 |
| 88 | 30-4-120 | 30.0 | 35.4 | 608 | 4.70 | 10.32 | 17.62 | 24.09 | 171.0 | 30.63 | 3.52 | 1,277 | 102.1 |
| 89 | 30-8-120 | 30.1 | 63.6 | 676 | 7.99 | 9.77 | 32.79 | 45.82 | 325.5 | 27.46 | 3.32 | 3,369 | 269.5 |
| 90 | 30-14-120 | 29.9 | 130.7 | 835 | 13.99 | 8.38 | 56.25 | 72.56 | 514.0 | 30.31 | 4.28 | 6,258 | 500.6 |
| 91 | 40-4-120 | 40.0 | 38.2 | 606 | 4.98 | 10.15 | 17.74 | 19.42 | 184.0 | 30.18 | 3.52 | 1,190 | 126.9 |
| 92 | 40-8-120 | 40.0 | 77.8 | 727 | 9.60 | 9.59 | 34.25 | 40.94 | 389.1 | 27.51 | 3.41 | 2,697 | 278.7 |
| 93 | 40-12-120 | 40.1 | 134.2 | 842 | 14.20 | 8.27 | 49.97 | 58.41 | 554.8 | 28.52 | 4.11 | 5,060 | 540.8 |
| 94 | 50-4-120 | 50.0 | 40.5 | 630 | 5.34 | 10.34 | 19.10 | 15.29 | 176.0 | 33.84 | 3.91 | 866 | 115.4 |
| 95 | 50-8-120 | 49.9 | 92.3 | 765 | 10.76 | 9.07 | 35.60 | 36.13 | 427.6 | 28.12 | 3.67 | 2,804 | 373.5 |
| 96 | 50-11-120 | 50.5 | 133.4 | 838 | 14.45 | 8.41 | 46.68 | 46.26 | 553.5 | 29.17 | 4.08 | 3,513 | 472.9 |
| 97 | 60-8-120 | 60.0 | .... | .... | .... | .... | 30.45 | 31.29 | 444.6 | .... | .... | .... | .... |

under different pressures fall in order, inversely with the pressure.

The results clearly define three general facts, which may be stated as follows:

1. The evaporative efficiency of a locomotive boiler is but slightly affected by changes in pressure.

2. Changes in steam pressure between the limits of 120 pounds and 240 pounds will produce an effect upon the efficiency of the boiler which will be less than 0.5 pound of water per pound of coal.

3. The equation $E = 11.305 - 0.221\,H$ represents the evaporative efficiency of the boiler of locomotive Schenectady No. 2 when fired with Youghiogheny coal for all pressures between the limits of 120 pounds and 240 pounds with an average error for any pressure which does not exceed 2.1 per cent.

*Smoke-box Temperatures* (Col. 5, Table IV).—The results show that in all cases the temperature of the smoke-box gases increases as the rate of evaporation increases and that it is very little affected by changes in pressure. Plotted diagrams showing the exact relationship indicate a marked similarity for all pressures; all have the same slope and if superimposed, they would fall very closely together. The equations of the mean line of such diagrams are given in the following table:

| Boiler Pressure. | Equations. |
|---|---|
| 220 pounds | $T = 496.3 + 25.66\,H$ |
| 200 pounds | $T = 491.0 + 25.66\,H$ |
| 160 pounds | $T = 487.7 + 25.66\,H$ |
| 120 pounds | $T = 478.9 + 25.66\,H$ |
| Average | $T = 488.5 + 25.66\,H$ |

The data sustain the following conclusions:

1. The smoke-box temperature falls between the limits of 500° F. and 850° F., the lower limit agreeing with a rate of evaporation of four pounds per foot of heating surface per hour and the latter with a rate of evaporation of fourteen pounds per foot of heating surface per hour.

2. The smoke-box temperature is so slightly affected by changes in steam pressure as to make negligible the influence of such changes in pressure for all ordinary ranges.

3. The equation $T = 488.5 + 25.66\,H$ where T is the temperature of the smoke box expressed in degrees F., and H is pounds of water evaporated from and at 212° F. per foot of heating surface per hour, possesses a high degree of accuracy.

*The Steam per Indicated Horse-power Hour* (Col.

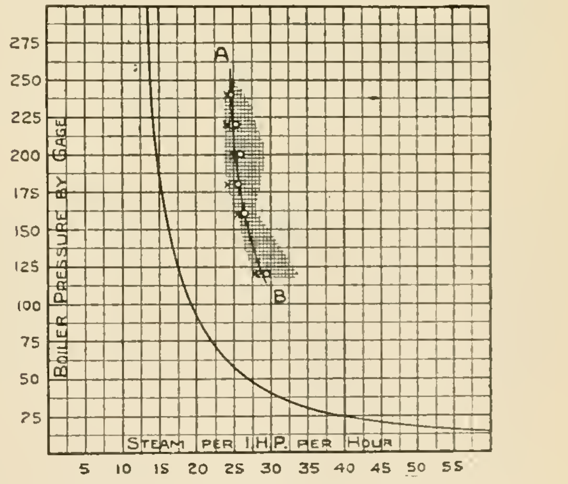



FIG. I.

11, Table IV).—The steam consumption per indicated horse-power shown by the results of the tests implies a remarkably high efficiency. The narrow range which they represent, taken in connection with the comprehensive character of the running conditions involved, are matters of more than ordinary importance. For example, at a pressure of 240 pounds, the engine, when working under a fully open throttle, gave a horse-power hour in return for the consumption of less than 24 pounds of saturated steam, and under any condition of speed or cut-off for which it was found possible to operate the engine under a wide-open throttle, the consumption never exceeded 26.3 pounds. At lower pressures, involving the possibility of a wider choice in the condition of operating, the range is somewhat increased. Thus, at 120 pounds pressure the minimum value is 27.5 and the maximum 33.8, ranges which, while greater than those just referred to, are nevertheless extremely narrow as compared with those which are incident to the operation of other classes of engines.

It appears from the data that the steam consumed by the cylinders varies for each different pressure with changes in speed and cut-off, and it has been sought to summarize the facts derived from the experiments into a single expression. This appears in the form of the curve AB, Fig I, which is to be accepted as representing the performance of the cylinders under different pressures without reference to speed or cut-off. Combining this general statement expressing cylinder performance with that obtained covering boiler performance, it should be possible to secure an accurate measure of the coal consumption per indicated horse-power hour, which will represent the results of all tests. The steps in this process are set forth by the several columns of Table III, in which the final results appear as Column 7. These representative values show a consumption of 3.3 pounds of fuel per indicated horse-power hour under a boiler pressure of 240 pounds, the consumption gradually increasing as the pressure is reduced until, under a boiler pressure of 120 pounds, it reaches its maximum value of four pounds per indicated horse-power hour.

TABLE III.

COMBINED ENGINE AND BOILER PERFORMANCE UNDER DIFFERENT PRESSURES, AS DERIVED FROM SUMMARIZED STATEMENTS COVERING THE PERFORMANCE OF ENGINE AND BOILER.

| Boiler Pressure. | Steam per Indicated Horse-power per Hour Values from Curve. | B. T. U. given to each Pound of Steam. Feed-water Temperature, 60 Degrees F. | Equivalent Pounds of Water per Indicated Horse-power Hour. | B. T. U. per Indicated Horse-power per Minute. | Equivalent Pounds of Water per Pound of Dry Coal. | Pounds of Coal per Indicated Horse-power Hour. |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 240 | 24.7 | 1,176.6 | 30 09 | 483 | 9 10 | 3 31 |
| 220 | 25.1 | 1,174 4 | 30 52 | 491 | 9 06 | 3 37 |
| 200 | 25 5 | 1,172 0 | 30.94 | 498 | 9 03 | 3 43 |
| 180 | 26 0 | 1,169 5 | 31 48 | 507 | 8 99 | 3 50 |
| 160 | 26 6 | 1,166 8 | 32.14 | 517 | 8 94 | 3 59 |
| 140 | 27.7 | 1,163.8 | 33 38 | 537 | 8 85 | 3 77 |
| 120 | 29.1 | 1,160 5 | 34 97 | 563 | 8.73 | 4 00 |

*Results Corrected for the Several Tests.*—The preceding paragraph constitutes a general statement setting forth the performance of the locomotive as affected by changes in pressure under conditions of speed and cut-off which are assumed to be typical of average running conditions. Corrected results applicable to the conditions of the several tests are presented by Table V (not reproduced). That is, the results of this table represent the performance on the assumption that the evaporation of the boiler is always represented by the equation,

$$E = 11.305 - 0.221 H.$$

## TESTS WITH SUPERHEATED STEAM.

*The Tests With Superheated Steam,* the data for which are summarized in Table X, were run at four different pressures, namely, 240, 200, 160 and 120 pounds respectively, a range sufficient to afford an excellent comparison with results obtained by the use of saturated steam. The tests at 160 pounds pressure are sufficiently numerous to define the performance of the locomotive when operating under all conditions of speed and cut-off which can be maintained with a wide-open throttle. Tests at the other pressures involve the more usual positions of reverse lever and three different speeds.

*The Evaporative Efficiency of the Combined Boiler and Superheater.*—The standard fuel for these tests was Youghiogheny lump, an average analysis of which is as follows:

| | |
|---|---|
| Moisture | 1.89 |
| Volatile matter | 31.94 |
| Fixed carbon | 57.71 |
| Ash | 8.46 |
| Heating value per pound of dry coal (B. T. U.) | 14,047 |
| Heating value per pound of combustible (B. T. U.) | 15,372 |

The pounds of water evaporated from and at 212° F. per pound of dry coal, in terms of the rate of evaporation, are given by the following equations:

| Boiler Pressure. | Equation. |
|---|---|
| 240 pounds | $E = 11.532 - .214 H$ |
| 200 pounds | $E = 11.612 - .214 H$ |
| 160 pounds | $E = 11.568 - .214 H$ |
| 120 pounds | $E = 11.928 - .214 H$ |

where E is the number of pounds of water evaporated from and at 212° F. per pound of dry coal, and H is the number of pounds of water evaporated per square foot of water and superheating surface per hour. The area of the heating surface employed is based upon the interior surface of the fire box and the exterior surface of the boiler and superheater tubes.

It will be seen that the highest efficiency is obtained in connection with the lowest boiler pressure, and conversely that the lowest efficiency is obtained in connection with the highest boiler pressure. These results are in agreement with those obtained from locomotive Schenectady No. 2, using saturated steam. The explanation is not entirely apparent, though for some reason it appears easier to maintain a satisfactory condition of fire when the operation is under low pressure. In general, longer cut-offs were employed in connection with the lower pressures and the resulting difference in draft action may constitute the chief cause.

As noted in connection with the tests under saturated steam, differences due to changes in pressure are not great and for the purpose of defining the performance of the boiler in simple terms, they may be neglected. The equation of an average line is,

$$E = 11.706 - .214 H,$$

where E is the equivalent evaporation from and at 212° F. per pound of dry coal for boiler and superheater and H is the equivalent evaporation per square foot of water and superheating surface. It is proposed to accept this equation as representing the performance of the combined boiler and superheater.

*Evaporative Efficiency of the Boiler, Exclusive of the Superheater.*—The pounds of water evaporated in the boiler from and at 212° F., exclusive of the superheater, per pound of coal, in terms of equivalent pounds of water evaporated per square foot of water heating surface in the boiler, is given by the equation,

$$E = 11.105 - .2087 H.$$

This equation takes into account only that work done by the boiler.

*The Degrees of Superheating.*—The temperature of the superheated steam was measured by high-grade mercurial thermometers placed in the branch pipes at a point directly adjoining the connection to the superheater headers. The degree of superheat thus determined increases as the rate of evaporation increases and diminishes as the boiler pressure is increased. Equations derived from diagrams showing this relationship, which represent the experimental results with a high degree of accuracy, are as follows:

| Boiler Pressure. | Equation. |
|---|---|
| 240 pounds | $T = 54.4 + 7.28 H$ |
| 200 pounds | $T = 74.2 + 7.28 H$ |
| 160 pounds | $T = 85.0 + 7.28 H$ |
| 120 pounds | $T = 87.1 + 7.28 H$ |

where T equals the degrees superheat and H equals the equivalent pounds of water from and at 212° F. per square foot of water heating surface per hour. Assuming a constant rate of evaporation for the several boiler pressures, as, for example, 11 pounds, it appears that the amount of superheating increases when the boiler pressure is reduced, as follows:

When the pressure is 240 pounds, the degree of superheat is 135.
When the pressure is 200 pounds, the degree of superheat is 154.
When the pressure is 160 pounds, the degree of superheat is 165.
When the pressure is 120 pounds, the degree of superheat is 170.

The equation of an average straight line through these points is

$$T = 123 - .265 P + 7.28 H,$$

where T equals the degrees superheat, P the boiler pressure by gage, and H the equivalent evaporation per square foot of water-heating surface in the boiler.

*The Ratio of the Heat Absorbed per Square Foot of Superheating Surface to that Absorbed per Square Foot of Water-Heating Surface* expresses the relative efficiency of the water and of the superheater surface. This ratio increases in value as the rate of evaporation increases. Thus, when the boiler pressure is 160 pounds, it has a value of 34 per cent. when the rate of evaporation is 6, and 53 per cent. when the rate of evaporation is 14. The data show that at all other boiler pressures employed, the value of the ratio varies in exactly the same way, which is equivalent to the statement that the ratio is independent of boiler pressure.

*Smoke-box Temperatures.*—The temperature of the smoke-box gases was read by a mercurial thermometer placed midway between the diaphragm and the front tube sheet. The results show, as would be expected, that the temperature increases with the rate of evaporation as in the case of those obtained in connection with saturated steam. Equations representing the exact relationship and which were obtained by drawing an average line through the actual points plotted against rate of evaporation are given in the following table:

| Boiler Pressure. | Equation. |
|---|---|
| 240 pounds | $T = 468.1 + 26 H$ |
| 200 pounds | $T = 482.6 + 26 H$ |
| 160 pounds | $T = 464.6 + 26 H$ |
| 120 pounds | $T = 446.1 + 26 H$ |
| Average | $T = 465.35 + 26 H$ |

The values indicated by these equations are somewhat less than those established by the tests with saturated steam.

*Steam per Indicated Horse-power Hour.*—Since tests representing the entire range of performance of the locomotive were run for only one pressure, 160 pounds, the variation of steam consumption from its maximum to its minimum value will be found only in the results of this series. (Table X.) Thus, at this pressure for a speed of fifty miles per hour and the reverse lever in the second notch from center forward, the actual steam consumption is 26.06 pounds per indicated horse-power per hour, which is the maximum value recorded. A minimum value of 20.29 is to be found when the speed is 40 miles per hour and the position of the reverse lever is eight notches from the center forward. If, however, these extreme values are omitted, the steam consumption for the remaining conditions of running varies but slightly.

TABLE X.

A SUMMARY OF OBSERVED AND CALCULATED DATA.

LOCOMOTIVE SCHENECTADY NO. 3. (SUPERHEATED STEAM)

| Designation of Tests. Number. | Designation of Tests. Laboratory Symbol. | Speed, Miles per Hour. | Dry Coal per Square Foot of Grate Surface per Hour, Pounds. | Smoke-box Temperature, Degrees F | Superheating—Degrees F | Equivalent Evaporation per Sq. Ft. of Heating Surface per Hour, Pounds. | Equivalent Evaporation per Pound of Dry Coal, in Boiler and Superheater. | Cut-off, Per Cent of Stroke. | Mean Effective Pressure, Pounds per Square Inch. | Indicated Horse-power. | Pounds of Steam per Indicated Horse-power Hour | Pounds of Coal per Indicated Horse-power Hour | Draw-bar Pull, Pounds. | Draw-bar Horse-power. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 101 | 30-2-240 | 30.2 | 69.2 | 726 | 138 | 9.43 | 9.75 | 15.52 | 51.80 | 369.8 | 23.43 | 3.20 | 3,905 | 314.2 |
| 102 | 30-4-240 | 29.1 | 93.8 | 775 | 153 | 11.52 | 8.79 | 21.40 | 69.30 | 476.7 | 22.11 | 3.35 | 5,258 | 407.3 |
| 103 | 30-5-240 | 29.4 | .. | .. | 149 | .. | | 25.41 | 76.75 | 534.1 | 21.68 | | 5,910 | 463.2 |
| 103a | 30-5-240 | .... | 114.4 | 815 | 151 | 13.69 | 8.56 | .. | | 546.6 | | 3.13 | | |
| 104 | 40-2-240 | 39.7 | 76.1 | 714 | 127 | 9.83 | 9.24 | 16.34 | 44.17 | 415.1 | 21.89 | 3.56 | 3,295 | 348.8 |
| 105 | 40-4-240 | 39.9 | 107.9 | 798 | 154 | 13.08 | 8.67 | 23.40 | 58.81 | 551.4 | 21.32 | 3.33 | 4,596 | 485.3 |
| 106 | 50-2-240 | 50.6 | 82.2 | 761 | 143 | 10.96 | 9.52 | 17.32 | 38.78 | 463.9 | 21.64 | 3.02 | 2,723 | 367.0 |
| 107 | 30-2-200 | 30.2 | 52.7 | 662 | 132 | 7.16 | 9.72 | 14.68 | 39.29 | 280.4 | 22.93 | 3.20 | 2,816 | 226.3 |
| 108 | 30-4-200 | 30.0 | 73.9 | 724 | 152 | 9.17 | 8.88 | 20.86 | 53.99 | 383.4 | 21.59 | 3.28 | 4,154 | 332.2 |
| 109 | 30-6-200 | 30.4 | 90.8 | 787 | 169 | 11.47 | 9.04 | 27.13 | 71.94 | 517.0 | 19.93 | 2.99 | 5,471 | 442.9 |
| 110 | 40-2-200 | 39.9 | 55.5 | 687 | 138 | 7.71 | 9.94 | 16.33 | 32.76 | 309.6 | 22.41 | 3.05 | 2,396 | 255.4 |
| 111 | 40-4-200 | 40.4 | ... | | 153 | | .... | 22.41 | 48.83 | 466.5 | 21.09 | . | 3,549 | 382.2 |
| 111a | 40-4-200 | 40.3 | 91.1 | 747 | 153 | 10.89 | 8.55 | | .. | 445.2 | | 3.48 | | |
| 112 | 40-6-200 | 40.8 | 101.1 | 824 | 178 | 13.18 | 9.34 | 29.51 | 60.95 | 588.6 | 20.07 | 2.92 | 4,714 | 512.6 |
| 113 | 50-4-200 | 48.2 | 99.2 | 778 | 159 | 10.82 | 7.82 | 22.75 | 42.74 | 487.5 | 20.03 | 3.46 | 3,219 | 413.7 |
| 114 | 20-2-160 | 19.9 | 38.7 | 633 | 180 | 4.88 | 9.10 | 14.48 | 35.35 | 166.8 | 27.11 | 3.95 | 2,367 | 125.8 |
| 115 | 20-4-160 | 19.9 | 44.2 | 627 | 133 | 5.91 | 9.56 | 21.46 | 49.19 | 232.2 | 23.71 | 3.24 | 3,457 | 183.5 |
| 116 | 20-6-160 | 20.0 | 58.6 | 691 | 154 | 7.58 | 9.26 | 27.09 | 63.41 | 300.2 | 23.03 | 3.32 | 4,466 | 238.0 |
| 117 | 20-8-160 | 20.0 | 76.0 | 690 | 145 | 9.09 | 8.56 | 35.56 | 77.30 | 366.7 | 22.82 | 3.52 | 5,836 | 311.6 |
| 118 | 30-2-160 | 30.1 | 38.1 | 601 | 125 | 5.56 | 10.46 | 14.29 | 26.91 | 191.5 | 26.18 | 3.38 | 2,028 | 162.5 |
| 119 | 30-4-160 | 29.9 | 49.9 | 669 | 142 | 7.02 | 10.06 | 20.47 | 40.39 | 285.4 | 22.93 | 2.98 | 3,043 | 242.1 |
| 120 | 30-6-160 | 30.0 | 74.8 | 695 | 163 | 9.40 | 8.99 | 27.12 | 54.59 | 387.4 | 22.11 | 3.28 | 4,065 | 324.9 |
| 121 | 30-8-160 | 30.0 | 82.7 | 764 | 173 | 11.27 | 9.74 | 34.22 | 67.80 | 481.8 | 21.20 | 2.92 | 5,342 | 427.5 |
| 122 | 40-2-160 | 40.9 | 39.6 | 613 | 123 | 5.89 | 10.65 | 14.94 | 21.85 | 211.5 | 25.46 | 3.18 | 1,291 | 140.7 |
| 123 | 40-4-160 | 40.2 | 63.6 | 682 | 154 | 7.86 | 8.85 | 21.29 | 36.07 | 343.3 | 21.52 | 3.15 | 2,279 | 244.2 |
| 124 | 40-6-160 | 40.1 | 75.4 | 722 | 165 | 10.07 | 9.55 | 27.83 | 45.35 | 429.8 | 21.44 | 2.98 | 3,688 | 393.8 |
| 125 | 40-8-100 | 40.1 | 97.9 | 775 | 180 | 13.29 | 9.72 | 36.90 | 63.13 | 598.7 | 20.29 | 2.78 | 4,577 | 488.9 |
| 126 | 50-2-160 | 49.9 | 40.8 | 600 | 118 | 5.80 | 10.19 | 15.66 | 15.27 | 180.2 | 29.06 | 3.85 | 1,115 | 148.3 |
| 127 | 50-4-160 | 49.9 | 67.0 | 676 | 152 | 8.41 | 8.98 | 22.33 | 29.09 | 343.1 | 22.21 | 3.32 | 2,107 | 279.9 |
| 128 | 50-6-160 | 50.0 | 107.7 | 797 | 214 | 13.71 | 9.12 | 28.00 | 43.96 | 520.0 | 23.59 | 3.52 | 3,140 | 418.3 |
| 129 | 30-4-120 | 30.1 | 31.7 | 568 | 117 | 4.86 | 10.98 | 19.38 | 23.00 | 163.3 | 27.27 | 3.30 | 1,715 | 137.2 |
| 130 | 30-8-120 | 30.3 | 58.1 | 676 | 156 | 8.25 | 10.16 | 35.31 | 46.84 | 335.3 | 23.05 | 2.95 | 3,654 | 294.6 |
| 131 | 30-10-120 | 29.8 | 89.1 | 702 | 175 | 9.90 | 7.95 | 42.73 | 58.12 | 409.7 | 22.07 | 3.70 | 4,638 | 368.2 |
| 132 | 30-14-120 | 30.0 | 130.9 | 772 | 191 | 12.77 | 6.98 | 57.04 | 72.95 | 517.5 | 22.56 | 4.30 | 5,758 | 459.9 |
| 133 | 40-4-120 | 39.9 | 35.8 | 579 | 121 | 5.12 | 10.24 | 20.47 | 18.89 | 178.6 | 26.39 | 3.41 | 1,325 | 141.0 |
| 134 | 40-8-120 | 39.9 | 74.3 | 692 | 171 | 9.30 | 8.95 | 35.60 | 40.52 | 382.9 | 22.27 | 3.30 | 3,195 | 340.0 |
| 135 | 40-12-120 | 39.9 | 133.9 | 782 | 190 | 13.30 | 7.10 | 51.19 | 57.93 | 547.6 | 22.20 | 4.16 | 4,697 | 500.0 |
| 136 | 50-8-120 | 50.1 | 80.2 | 715 | 169 | 10.20 | 9.10 | 35.54 | 34.76 | 411.8 | 22.74 | 3.32 | 2,731 | 364.3 |

*Steam Consumption Under Different Pressures.*—The steam consumption in pounds per indicated horse-power per hour plotted with boiler pressure is presented graphically by Fig. 2. The shaded zone encloses an area within which the results of all tests fall. For purposes of comparison, however, it is desirable to define this performance by a single line. In reducing this zone to a representative line, the results of all second-notch tests at 160 pounds pressure, which represent very low power and which are, therefore, abnormal, have been omitted, and in a few cases extrapolated values for other pressures have been inserted. The average of results thus set apart for the purpose is shown by the circles, Fig. 2. The line AB drawn through these circles is assumed as the representative line sought. The points indicated by crosses near the left-hand margin of the shaded zone represent the average of the minimum steam consumption for the several speeds under each different pressure.

*Coal Consumption Based on the Derived Performance of the Locomotive.*—The coal consumption as set forth in the numerical data represents values actually obtained. Values forming a more logical basis for comparison may be derived from equations expressing the performance of the boiler and superheater and the engine as already developed. Thus, the equation defining the performance of the boiler and superheater combined is,

$$E = 11.706 - .214\ H,$$

and that defining the performance of the superheater is,

$$T = 123 - .264\ P + 7.28\ H,$$

and that of the engine is defined by the curve AB shown in Fig. 2.

It is now proposed to determine the coal consumption per indicated horse-power, per hour, assuming the efficiency of the locomotive to be that defined in the above relationship. Several steps in the process appear in order in the several columns of Table IX, the results sought being those of Column 7.

From the values given in the table, it will be seen that the coal consumption per indicated horse-power hour varies from 2.97 to 3.31. The minimum value, 2.97, is found at 200 pounds boiler pressure.

*Corrected Results.*—Following the method already described for correcting the results of tests with saturated steam to eliminate incidental discrepancies, the values of Table X representing steam and coal consumption have been recalculated and are presented as Table XI (not reproduced). They are those which would have been obtained if the evaporative efficiency for all tests had been that expressed by the equation,

$$E = 11.706 - 0.206\ H.$$

## A DISCUSSION OF RESULTS OBTAINED WITH SATURATED AND WITH SUPERHEATED STEAM.

The two locomotives tested were identical except with reference to those details of construction involved by the presence of the superheater. The machinery of

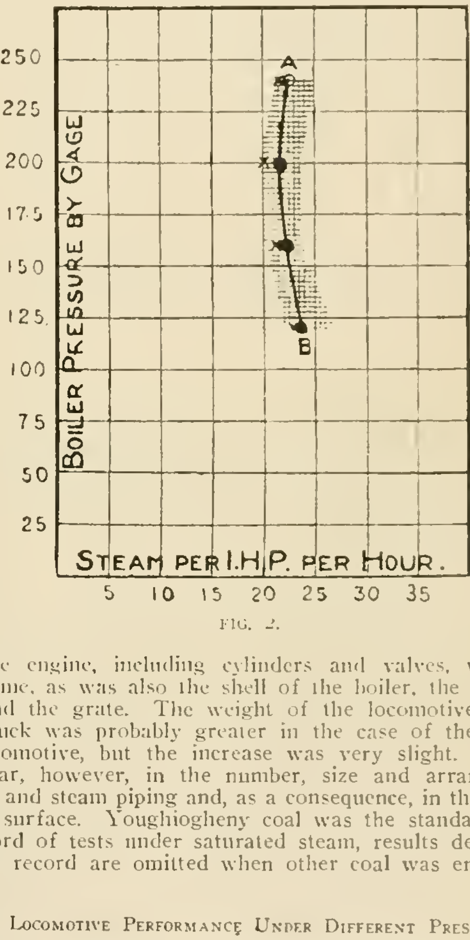



FIG. 2.

the engine, including cylinders and valves, was the same, as was also the shell of the boiler, the fire box and the grate. The weight of the locomotive on its truck was probably greater in the case of the superheating locomotive, but the increase was very slight. Differences appear, however, in the number, size and arrangement of the flues and steam piping and, as a consequence, in the extent of heating surface. Youghiogheny coal was the standard fuel. In the record of tests under saturated steam, results dependent on the fuel record are omitted when other coal was employed,

TABLE IX. LOCOMOTIVE PERFORMANCE UNDER DIFFERENT PRESSURES.

| Boiler Pressure. | Pounds of Steam per Indicated Horse-power Hour. Values from Curve. | B. T. U per Pound of Steam. Feed 60 Degrees F. and Superheat from Equation. | Equivalent Pounds of Steam per Indicated Horse-power Hour. | B. T. U per Indicated Horse-power per Minute. | Equivalent Pounds of Steam per Pound of Dry Coal. | Pounds of Coal per Indicated Horse-power Hour. |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 240 | 22.6 | 1,258.7 | 29.45 | 474 | 9.426 | 3.12 |
| 220 | 21.8 | 1,261.8 | 28.48 | 459 | 9.501 | 3.00 |
| 200 | 21.6 | 1,263.1 | 28.25 | 455 | 9.518 | 2.97 |
| 180 | 21.9 | 1,261.7 | 28.61 | 461 | 9.491 | 3.01 |
| 160 | 22.3 | 1,259.3 | 29.07 | 468 | 9.455 | 3.08 |
| 140 | 22.9 | 1,256.4 | 29.79 | 481 | 9.399 | 3.17 |
| 120 | 23.8 | 1,252.7 | 30.87 | 497 | 9.316 | 3.31 |

and in the record of tests under superheated steam it has been possible to reduce results obtained with other coal to equivalent results which would have been obtained had the standard fuel been used.

*A Comparison of Boiler Performance.*—The boiler of Schenectady No. 2 as designed to deliver saturated steam gave an efficiency which is expressed by the equation,

$$E = 11.305 - .221\ H,$$

while the boiler of Schenectady No. 3 as equipped with a Cole superheater gave an efficiency expressed by the equation,

$$E = 11.706 - .214\ H.$$

Obviously, on the basis of these equations, the superheating boiler has the advantage. The comparison is, however, not a fair one, since in both cases the equations are based on the extent of heat-transmitting surface, and this, in Schenectady No. 2, was greater than the combined water-heating and superheating surface of No. 3. To make the equation fair, the term in the equation representing equivalent pounds of water per square foot of heating surface (H) must be expressed in terms of the total power delivered by the boiler. Comparisons on this

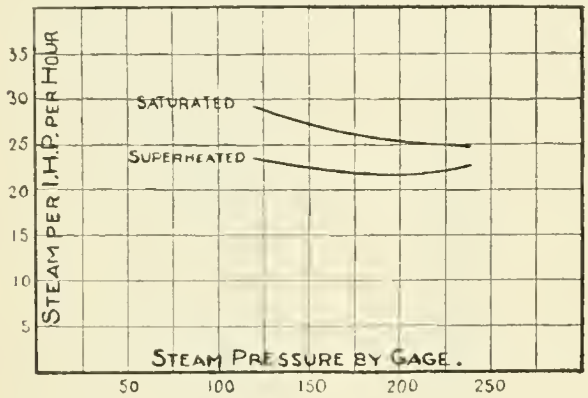



FIG. 3.

basis, showing the performance of the boiler in one case and of the boiler and superheater in the other case, expressed in terms of equivalent evaporation, show that even upon this basis the efficiency of the combined boiler and superheater is superior to that of the boiler alone, the increase averaging between three and four per cent.

*Comparisons Involving Engine Performance.*—The steam consumption per indicated horse-power hour for the saturated steam locomotive, as determined by the results of eighty-seven tests, has been defined by the line AB, Fig. 1, while that of the superheating locomotive, as determined by the results of thirty-eight tests, has been defined as the line AB, Fig. 2. Replotting the results presented by these figures upon a single sheet gives the diagram shown by Fig. 3. This exhibit, or perhaps better, the numerical value given in Columns 2 and 4 of Table XII, shows well the saving of water which is realized by the substitution of steam superheated approximately 150° F., for steam which is saturated. The saving ranges from 18 per cent. when the boiler pressure is 120 pounds to 9 per cent. when the boiler pressure is 240 pounds. It appears, also, that with superheated steam, the least consumption, 21.6, is secured when the boiler pressure is approximately 200 pounds and that variations in the consumption resulting from changes in pressure are slight. For example, the water consumption for all pressures between 160 pounds and 220 pounds falls between the limits of 21.6 pounds, the minimum value obtained, and 23.2 pounds, a range of approximately four per cent.

The saving of water in locomotive service is always a matter of moment. By reducing the time required to take water, the exactions of certain conditions in operation are diminished, and in some districts where water is bad or hard to obtain, difficult problems either in locomotive maintenance or in the maintenance of the water supply are simplified. The fact, therefore, that superheating affords a material saving in the amount of water required is not to be overlooked in estimating the value of superheating as a practice. But the saving in heat is not proportional to the saving in water, for each pound of superheated steam represents a larger amount of heat than a pound of saturated steam at the same pressure. As an indication of the thermal advantage to be derived from the use of superheated steam in comparison with that of saturated steam, it is desirable to reduce the consumption in each case to the same thermal basis. This has been done with results which are shown numerically by Table XII. From these exhibits it is evident that the saving effected by the use of superheated steam when the pressure is 120 pounds is not less than twelve per cent., and when the pressure is 240 pounds approximately two per cent. Under a boiler pressure of 180 pounds, the substitution of superheated steam for saturated steam improves the efficiency of the engine 9.1 per cent. The results show, also, that the performance of the superheating locomotive is affected by changes of pressure to a much smaller extent than that of the saturated steam locomotive.

TABLE XII.

STEAM PER INDICATED HORSE-POWER HOUR

| Boiler Pressure. Pounds. | Saturated Steam | | Superheated Steam. | |
|---|---|---|---|---|
| | Pounds of Steam per Indicated Horse-power per Hour. | B. T. U. per Indicated Horse-power per Minute. | Pounds of Steam per Indicated Horse-power per Hour. | B. T. U. per Indicated Horse-power per Minute. |
| 1 | 2 | 3 | 4 | 5 |
| 240 | 24.7 | 483 | 22.6 | 474 |
| 220 | 25.1 | 491 | 21.8 | 459 |
| 200 | 25.5 | 498 | 21.6 | 455 |
| 180 | 26.0 | 507 | 21.9 | 461 |
| 160 | 26.6 | 517 | 22.3 | 468 |
| 140 | 27.7 | 537 | 22.9 | 481 |
| 120 | 29.1 | 563 | 23.8 | 497 |

*Comparisons Involving the Performance of the Locomotive as a Whole.*—The performance of the locomotive as a whole, in terms of coal consumed per indicated horse-power hour, both for saturated steam and superheated steam, is shown numerically by Table XIII. This shows that the gain resulting from the use of superheated steam is most pronounced at the lower pressures. Thus, at a pressure of 120 pounds it is seventeen per cent., while at a pressure of 240 pounds it is but six per cent. They show, also, that the performance of the locomotive using superheated steam is only slightly affected by changes of pressure for the entire range of pressure between 120 pounds and 240 pounds. With superheated steam the difference in coal consumption from minimum to maximum is but a third of one pound, while for pressures between 175 pounds and 225 pounds it is practically constant and always near the minimum. The least coal consumption per indicated horse-power hour as it appears in the summarized statement is 2.97. It was obtained under a steam pressure of 200 pounds. The results sustain a claim which has been put forward by advocates of the practice of superheating to the effect that the adoption of such practice permits a material reduction in steam pressure as compared with pressures now common in locomotive service without materially sacrificing efficiency. A detailed numerical statement showing the saving in coal resulting from a change from saturated to superheated steam is set forth in Columns 4 to 7, inclusive, of Table XIII.

TABLE XIII.

SAVING IN COAL EFFECTED BY THE USE OF SUPERHEATED STEAM.

| Boiler Pressure Pounds. | Pounds of Coal per Indicated Horse-power per Hour. | | Saving Effected by the Use of Superheated Steam. | | | |
|---|---|---|---|---|---|---|
| | | | Over Values Obtained with Saturated Steam at Same Pressure. | | Over Values Obtained with Saturated Steam at 180 Pounds Pressure. | |
| | Saturated Steam. | Superheated Steam. | Pounds per Indicated Horse-power per Hour. | Per Cent. | Pounds per Indicated Horse-power per Hour. | Per Cent. |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 240 | 3.31 | 3.12 | .19 | 5.72 | .38 | 10.86 |
| 220 | 3.37 | 3.00 | .37 | 10.98 | .50 | 14.29 |
| 200 | 3.43 | 2.97 | .46 | 13.31 | .53 | 15.15 |
| 180 | 3.50 | 3.01 | .49 | 14.00 | .49 | 14.01 |
| 160 | 3.59 | 3.08 | .51 | 14.21 | .42 | 12.00 |
| 140 | 3.77 | 3.17 | .60 | 15.98 | .37 | 10.57 |
| 120 | 4.00 | 3.31 | .69 | 17.25 | .19 | 5.43 |

*Comparisons Involving Capacity.*—The maximum power presented by the data derived from the locomotive using superheated steam is not to be accepted as a measure of its capacity. Except in the case of the series of tests run at 160 pounds pressure, the number of tests was insufficient to permit the establishment at each speed of a maximum cut-off for which the boiler could be made to supply steam. But while the direct evidence is lacking, the data contain much which goes to show that the superheating locomotive is a more powerful machine than the locomotive using saturated steam. For example, it has been shown that, for the development of equal amounts of power, the combined boiler and superheater of the superheating locomotive has an efficiency which, if it does not exceed, certainly equals that of the saturated steam locomotive. But each unit of power delivered from the boiler in the form of superheated steam is more effective in doing the work in the cylinder than a similar unit of power delivered in the form of saturated steam. Hence, at the limit, the superheating locomotive is the more powerful locomotive and the gain equals that which measures the difference in the economy with which the cylinders use steam.

The same question may be dealt with through another series of facts as follows: It can be shown that the power of any locomotive is limited by its capacity to burn coal, and coal-burning capacity is a function of the draft. The data show that for the development of a given cylinder power, the draft values of Schenectady No. 3 (superheating) were in all cases less than those of Schenectady No. 2 (saturated). These differences are of small value for tests under high pressure, but they increase as the pressure is reduced. For example, tests at 160 pounds pressure show that the power developed in return for a given draft is from ten to sixteen per cent. greater for the superheating locomotive than for the locomotive using saturated steam. Obviously, there is no reason why the draft for the former should not be increased to limits practicable for the latter and when this is done, the power developed by the superheating locomotive would exceed that which is possible with the saturated steam locomotive by from ten to sixteen per cent.

*Concerning the Possible Degree of Economy Which May Result from the Use of Superheated Steam.*—In the preceding paragraphs an attempt has been made to define with accuracy the increased efficiency resulting from the substitution in locomotive service of steam superheated to approximately 150° for steam which is saturated. The facts upon which comparisons have been based have been derived from carefully selected processes and the results can safely be accepted as the measure which has been sought. All discussion might well end with the presentation of these facts were it not that out of them arises a group of questions of great practical significance. To some of these attention may well be given.

*As a general proposition, the gain which in any service will result from the introduction of a superheater is a function of the degree of superheat which is employed.* The experience of the Prussian State Railway shows that superheaters may be designed and operated which deliver steam having a temperature of from 300° to 350° C. The latter value, however, is regarded as the maximum limit which must never be exceeded. Under normal conditions of running, however, the degree of superheat with a boiler pressure of 180 pounds considerably exceeds 200° F., which is not less than thirty-three per cent. in excess of the degree of superheat used in the experiments herein discussed. *It has been shown, also, that the production and use of steam at this temperature introduce no difficulties either in the maintenance of the superheater nor in the parts of the machine which come under its influence.* It is claimed that the advantage to be derived from the use of superheated steam *increases more rapidly than the degree of superheat. But assuming the gain to be no more than proportional to the degree of superheat employed,* it is evident that the curves showing performance under superheating would be lower by *thirty-three per cent.* of the saving shown, had the temperature of the delivered steam in the locomotive experimented upon equaled that prevalent in German practice.

Upon this basis it can be shown that, under a boiler pressure of 180 pounds, there would be a reduction of water consumption from 26 pounds to 20.5 pounds, *a saving of twenty-one per cent.*, and a reduction of coal consumption per drawbar horsepower of from 4 pounds to 3.25 pounds, a saving of *nineteen per cent.* These values may be accepted as not far from those which should be expected from the adoption of superheating in locomotive service.

It will be a mistake, however, for one to assume that a railway company's bills for locomotive fuel may be diminished by the percentages set forth in the preceding paragraph, merely through the introduction of the superheater. It should be clear, for example, that no part of the fuel used in firing-up a locomotive in the roundhouse, nor of that consumed in maintaining the temperature of a locomotive between the roundhouse and the time of its starting at the head of its train can be saved by the application of a superheater. Again, fuel which is used in maintaining the normal temperature of all parts of the machine when the locomotive is at rest at stations and at passing points, in making good steam losses by safety valve and by leaky valves and pistons or which comes through glands and cylinder cocks must be regarded as fuel which cannot be saved through the presence of the superheater. Estimates based upon careful observations on several roads have shown that the fuel used in these ways amounts to about twenty per cent. of the total fuel delivered to the locomotive. It appears, therefore, that the saving which is to be brought about by the adoption of the superheater is applicable to approximately eighty per cent. of the fuel which, under service conditions, is delivered to the tenders of locomotives using saturated steam.

*A Summary of Significant Conclusions.*—The substitution of superheated for saturated steam under conditions where the power to be developed is fixed, will permit:

1. The use of comparatively low steam pressures, a generally accepted limit being 160 pounds.

2. A saving of from fifteen to twenty per cent. in the amount of water used.

3. A saving of from ten to fifteen per cent. in the amount of coal used while running, or of from eight to twelve per cent. in the total fuel supplied.

4. Assuming the power developed to equal the maximum capacity of the locomotive in each case, the substitution of superheated for saturated steam will permit an increase of from ten to fifteen per cent. in the amount of power developed, accompanied by a reduction in total water consumption of not less than five per cent. and by no increase in the amount of fuel consumed.

*Discussion.*—Robert Quayle related an experience with a fire tube superheater which had been in service on his road for seventeen months. This superheater has not had repairs of any kind, nor has it been changed in any way during that time. The engineer operating the locomotive, covering 276 miles per day, had stated that if he could not have the superheater on the engine otherwise he would like to buy one out of his own pocket. The locomotive was considered to be at least one sleeping car better than the same engine without it. Records did not show, however, that there was any noticeable saving in fuel, but the extra work which the locomotive did more than made up for this. This road is planning on making exhaustive tests on some superheating locomotives which are now under construction.

J. B. Elliott (C. P. R.) stated that the division superintendents on his road were very anxious to get superheating locomotives for their heavy passenger trains. It has been found that much better time could be made with them than with the other engines and that engine failures were much less frequent.

Mr. Fuller (U. P.) stated that on his road there had been trouble with the slide valves cutting when used with superheated steam. The difficulty had been overcome by using bronze false seats.

In speaking on this subject President Vaughan said:

"Apart from my own impression, I'll say that our talks with our various master mechanics, and the superintendent of motive power of our Western lines, which really constitute an independent organization to a great extent, are such that the question of applying superheaters with us never comes up. We look upon it just as much as an attachment to the locomotive to-day as we do the cylinders. We would not think of giving it up. The only question is as to what type of superheater we shall use, or what shall be done to take care of it and things of that sort. We have not for the past two or three years really seriously considered the question whether we should use the superheaters or not—they have been used as a matter of course. We have between 200 and 300 compound engines, and the other day a request came from the general manager of the western lines that he wanted some compounds, that were bought only four years ago, converted to superheaters for the sake of the economy in the maintenance. Superheater engines are so much cheaper to maintain that he wanted the change made for the sake of his accounts."

He also stated that the experience on his road with a large number of superheating locomotives had been a greater economy than that shown by Dr. Goss' paper, and explained this by the fact that inasmuch as his engines were larger, the boiler heating surface was not disturbed to so great an extent by the application of the superheater, and also that the fireman was not worked so hard on the superheating locomotives and were thus capable of doing better work than on the saturated steam engines with which they were being compared. On the testing plant equally good work was done by the fireman on both locomotives.

In speaking about trouble in the cylinders and valves with superheated steam, he stated:

"We have had a great deal of trouble in the past few years with piston rings, but very little trouble with valve rings; but we did have considerable valve trouble. Now, strangely enough, when we first went into superheating, we did not have much trouble in that respect, and I can only say that I am not at all satisfied yet whether our trouble is due to superheated steam or due to changes in our foundry practice. Roads using saturated steam have occasionally had serious packing troubles, the wear of piston rings, etc., depending on the metal being porous. We are going into the question of improving our packing, and think we are obtaining considerably better results. The trouble does not occur in all cases, but it is a serious question with us; that is to say, we have rings that have worn out as quickly as six weeks or two months, and others will last eight or nine months. We have experimented with the substitution of Dunbar for split-ring packing, and we have found that it has lasted some nine or ten months without renewal, and we believe, after we use the Dunbar packing generally, we will have no serious trouble with the cylinders. The bushings in both the cylinders and the valve chests are not hurt, the valve rings are not hurt, but we have a certain amount to learn about the proper material and proper style of packing ring to use. We do not consider the matter very serious and it does not show up on our repair bills."

In connection with engine failures on superheated steam locomotives he had recently had records compiled for eight months, during which time there were but five superheater failures giving 300,000 miles to a failure. Three of these failures were on the same engine on successive days.

F. F. Gaines (Cent. of Ga. Ry.) reported success with a locomotive fitted with a Baldwin superheater. The locomotive is a favorite with engineers and repairs have been very light, no trouble having been found with valves or pistons. He also stated that a feed water heater locomotive shows a much greater fuel economy than does the superheater engine. (See American Engineer, June, 1909, page 241.)

President Vaughan, in reply to a question by Mr. Wildin, stated that he would recommend the application of superheat to all passenger locomotives, irrespective of the price of coal in any district on account of the increased capacity which could be obtained. The application to freight locomotives would be determined largely by the price of coal.

Prof. Hibbard drew attention to the fact that the tests reported by Dr. Goss were at 150 degrees of superheat and gave the most efficient point at about 200 lbs. boiler pressure. He suggested that possibly with higher degrees of superheat the most efficient boiler pressure might be raised, and that this possibly might give a still greater degree of efficiency.

L. R. Pomeroy stated that since a locomotive with 180 lbs. of steam pressure with a superheater gave better results than one of 210 lbs. pressure without a superheater, the matter of first cost and repairs, which are somewhat proportional to the pressure, should be considered, and the added economy of this should be added to that obtained by the superheater directly.

H. W. Jacobs (Santa Fe) stated that the superheater locomotives on his road had required decidedly less repairs than the others of the same class without superheaters.

F. C. Cleaver (Rutland) reported success with superheaters on his road. The engines were decidedly quicker and more snappy than were either the compounds or saturated steam engines.

Several other gentlemen reported success with superheated steam, and there were no great difficulties mentioned or criticisms offered to its use.

## FEDERAL BOILER INSPECTION BILL.

The report of the special committee on the bill for Federal Boiler inspection, which is now before the U. S. Senate, was as follows:

It is the opinion of the association that such a law is entirely unnecessary and will not promote any greater safety of operation, for the following reasons:

First—That the railways maintain efficient systems of inspection and tests of locomotive boilers and appurtenances under carefully prescribed rules, which are prepared to best meet general and local conditions, the railways having the greatest possible interest in the thoroughness of this protection.

Second—Experience covering a period of many years has shown conclusively that such failures of locomotive boilers as have occurred would not be eliminated by the proposed law, as investigation has shown that they were not due to defective design, construction, weakness or lack of proper appurtenances or periodical inspection.

We would, in addition to the above, recommend that the subject be given full consideration by the executive committee.

## WIDENING GAGE OF TRACKS.

The committee on this subject was appointed to co-operate with a committee of the American Railway Engineering and Maintenance of Way Association, and also co-operate with the wheel committee of the M. C. B. Association. It reported that the former association at its last convention had adopted 1¾-in. width of flangeway as a standard, and it had also taken action to the effect that the gage of track should be corrected when, due to worn rail heads, it had increased ½ in. beyond the standard gage. The subject, however, of the widening of gage on curves, is not yet completed, and the committee asked to be continued.

Mr. Fowler recounted some very interesting tests which he has in progress on an electric railway in connection with this subject. The committee was continued.

[*Abstract of committee reports and outline of the discussion thereon will be continued in the August issue, the following subjects being given: Bank vs. Level Firing, Individual paper by E. D. Nelson; Castle Nuts; Lubricating Material Economies; Motor Cars; Fuel Economics; Tender Trucks, and Safety Valves. The topical discussions on the floor of the convention will be reviewed in the same issue.*]

Publicity of Railroad Accidents.—The policy of the Harriman Lines is to be frank with the public in company matters. When a serious accident occurs, an open board of inquiry is promptly convened by the division superintendent, consisting of himself, the master mechanic, the division engineer, and two or more prominent representative citizens. This board, a high class jury, hears evidence and publishes its findings in the local press. Not infrequently a newspaper man is a member of the board. If this board does not get to bottom facts, a second is convened, composed of general officials and of prominent citizens of the state; for example, an ex-governor, a well known banker, a leading editor, a retired general officer of the army, etc. This policy has greatly improved discipline and educated public sentiment. The men are eager to avoid the published censure of their fellow citizens. The public is pleased with the frankness of the companies and sympathizes with their difficulties. Personal injury settlements are no heavier—if anything, are lighter—under this policy. It is idle to argue that liability can be avoided by a suppression of information.—*J. Kruttschnitt before the New York Railroad Club.*

The Need of Better Educational Methods.—Not more than one out of 130 children go to colleges or universities; not more than one out of 30 go to the high schools, while less than 25 per cent. of all our children fail to pass through the primary grades. The result is an extraordinary amount of inefficiency for the work that these young people have to perform. The present system of education is one in which the schools are so correlated and co-ordinated as to take for granted that each boy and girl is to go through college. All this may be very perfect in form, but each fails absolutely in doing that which is demanded of a good school system, namely: to prepare students for their life work. It is time to take hold of this great big question of education and establish methods of making, not working men and working women, but men and women working. —*Prof. J. C. Monaghan, Secretary, Nat. Soc. for Promotion of Industrial Education.*

# MASTER CAR BUILDERS' ASSOCIATION

FORTY-THIRD ANNUAL CONVENTION.

The meetings were held in the Greek Temple on Young's Million Dollar Pier at Atlantic City, June 21, 22 and 23.

PRESIDENT'S ADDRESS.

In his presidential address, R. F. McKenna, master car builder of the Delaware, Lackawanna & Western Railway, spoke in part as follows:

"Rigid economy by railway companies throughout the country has prevailed during the past year. It has been largely compelled by federal and state legislation that caused investors to hesitate in accepting securities offered, and mechanical departments of railways have suffered. This condition has been more acute during the period mentioned than at any time since 1894, and at no time in the history of railways has their ownership and management been subjected to so much adverse criticism from those who have no intimate knowledge of railway affairs.

"With an ill-advised desire to gain popularity, certain public men and some of the press have constituted themselves guardians of public welfare. To achieve their ends they have caused great injury to commercial life, and corresponding damage to railway companies. Until legislative bodies repeal the disastrous federal and state laws they have enacted, the public at large, which includes railway owners, managers, employees and patrons of the transportation companies, will continue to be more or less affected.

"Railway companies in their zeal to economize, to protect themselves, and to conserve the best interests of all concerned, are buying only such materials and employing no more labor than is absolutely essential to the daily conduct of affairs, husbanding their resources until conditions again become stable. Appearances suggest that there is to be a respite from unfair legislation, and incidentally unjust criticism.

"The arbitration committee has devoted studious care to the preparation of the rules of interchange, and the rules promulgated by them are eminently fair, both to car owners and to companies making repairs. Practices that should be frowned upon have become general on certain lines, resulting in great annoyance, and often in decided financial loss to car owners. Mechanical departmental and divisional heads should therefore instruct foremen, inspectors, repairmen, billing clerks and others that bills must of necessity be prepared in accordance with the prescribed rules of the association. The unfair practices that are being followed by certain car owners can be made a matter of history if mechanical department heads issue necessary instructions, and in fairness to all concerned this should be done.

"Care should be taken by the various committees of the association, and also by the association itself, in adopting new standards or advancing recommended practices to standards; but when, after due care and thought on the part of committees of the association, standards are adopted, they should be more generally followed by car owners.

"The question of an M. C. B. standard coupler deserves the most careful thought and research on the part of car owners and coupler manufacturers. Something should be done without any unnecessary delay to relieve the railway companies of the necessity of carrying vast quantities of repair parts for various makes of couplers. Interchangeability is possible and should be worked out to a satisfactory conclusion. It would perhaps be well if the association at this time recognized the side as well as the center unlocking arrangement for couplers.

"For years the question of consolidating the Master Car Builders' and the American Railway Master Mechanics' Associations has been the subject of discussion. Such action has heretofore not been deemed either necessary or desirable, and conditions at present do not indicate that it would now result in any benefit to railway companies. Unless improvement is possible, changes should not be favored. The two associations are separate and distinct so far as their line of action is concerned. The Master Mechanics' is of a technical character, having no legislative powers, and as the Master Car Builders find it impossible to devote sufficient time to the proper consideration of the various reports submitted to them, the proposed consolidation seems unwise, especially as new topics, new subjects and new discussions would be introduced into our deliberations. There is sufficient work for each association in its own particular field, and as the method of procedure in handling work incident to locomotive repairs and construction, car repairs, construction and interchange, differs so very materially, it would seem desirable to handle them as two separate and distinct branches, so that the questions incident to each will be considered by two separate and distinct associations."

*Secretary's Report.*—The membership is as follows: Active, 447; representative, 292; associate, 13; life, 17; total, 769. There are 2,403,961 cars represented in the association, a gain of 120,363 over last year. Twenty-three railways and private car lines have during the past year become subscribers to the rules governing the interchange of freight cars. Two railways have signified their acceptance of the rules governing the interchange of passenger cars.

*Treasurer's Report.*—There is a balance of $526.11 on hand.

*Life Members.*—E. W. Grieves, a past president, and W. C. Ennis were elected life members.

*Height of Drawbars.*—On motion of C. E. Fuller, S. M. P., Union Pacific, the following resolution was adopted:

"Resolved, That the maximum height of drawbars for freight cars measured perpendicular from the level of the tops of rails to the centers of drawbars for standard gage railways in the United States shall be 34½ inches, and the minimum height of drawbars for freight cars measured in the same manner shall be 31½ inches." This simply makes more clear the intent of the resolution presented to the Interstate Commerce Commission in 1893.

*Tillotson Bequest.*—Through the will of Mrs. Emma A. Tillotson, the association was bequeathed the sum of $5,000. It was decided that the bequest be received and invested, and the interest thereon applied to such investigations as the executive committee may recommend to the association, the form of investment to be left with the treasurer subject to the approval of the executive committee.

*Specification for Lumber.*—A resolution was adopted to the effect that the executive committee appoint a committee to cooperate with a committee from the Railway Storekeepers' Association in drawing up of uniform specifications for lumber to meet railway requirements.

*Election of Officers.*—The following officers were elected:

President—F. H. Clark (C., B. & Q.); first vice-president—T. H. Curtis (L. & N.); second vice-president—LeGrand Parish (L. S. & M. S.); third vice-president—A. Stewart (Southern); treasurer—John Kirby, Adrian, Mich.

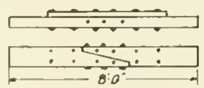
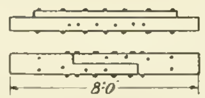
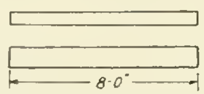
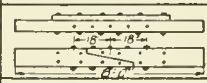
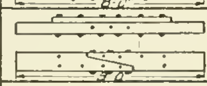
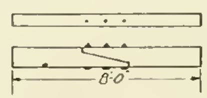
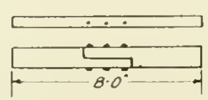
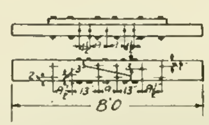
Executive Committee—D. F. Crawford (Pa. Lines); F. W. Brazier (N. Y. Cent.); C. A. Schroyer (C. & N. W.); J. D. Harris (B. & O.); C. E. Fuller (U. P.) (hold over); H. D. Taylor (P. & R.) (hold over).

## REVISION OF THE CONSTITUTION.

A number of changes were made in the constitution and by-laws. The most important was that active members retiring from railway service are either dropped from membership or transferred to associate membership. The allowable number of

# TEST of WOOD SILL SPLICES

SHEET A

| TEST NO | M.C.B. FIGURE | EXCEPTION | SKETCH | KIND OF WOOD IN SILL TOP | KIND OF WOOD IN SILL BOTTOM | KIND OF WOOD IN LINER | DIMENSIONS OF SILL | DIMENSIONS OF LINER | WEIGHT IN LBS | DROP IN FEET — ONE BLOW FOR EACH HEIGHT 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 A | NONE |  | YELLOW PINE | FIR | OAK | 4 7/8" x 8 5/8" | 1 15/16" x 8 7/8" | 145 | SPLIT AT BOTH BUTTS | | | | | |
| 2 | | | | YELLOW PINE | YELLOW PINE | OAK | 4 13/16" x 8 13/16" | 1 15/16" x 8 7/8" | 151 | BOTH BUTTS SPLIT FOR SHORT DISTANCE. | BOTH BUTTS CRUSHED, AND SPLIT TO ENDS OF TIMBER. | | | | |
| 3 | | | | YELLOW PINE | YELLOW PINE | OAK | 4 3/4" x 8 13/16" | 1 15/16" x 9 1/16" | 140 | SPLIT AT BOTH BUTTS. BOTTOM TIMBER DEFECTIVE | | | | | |
| 4 | | | | FIR | FIR | OAK | 4 7/8" x 8 3/4" | 1 15/16" x 9" | 134 | SPLIT AT BOTH BUTTS | | | | | |
| 13 | 9 B | NONE |  | YELLOW PINE | NORWAY PINE | PINE | 4 7/8" x 8 3/4" | 2 1/2" x 9" | 123 | OLD CRACK AT TOP BUTT EXTENDED 1 1/2 INCHES. | NO CHANGE | CRUSHED BETWEEN 2ND AND 3RD VERTICAL BOLTS, ON SIDE, SPLIT IN TOP SECTION. | CRUSHED IN THREE PLACES. SPLIT IN TOP AND BOTTOM SECTIONS. | | |
| 14 | | | | YELLOW PINE | YELLOW PINE | PINE | 4 3/4" x 8 11/16" | 2 1/2" x 8 15/16" | 146 | O K | O K | O.K | SPLIT AT LOWER END. CRUSHED AT 2ND VERTICAL BOLT. SPLIT BETWEEN TWO CENTER VERTICAL BOLTS. | SHATTERED BADLY BETWEEN BUTTS | |
| 15 | | | | FIR | FIR | PINE | 4 13/16" x 8 3/4" | 2 1/2" x 9" | 126 | SLIGHT SPLIT IN SPLICE NEAR UPPER BUTT | NO CHANGE | NO CHANGE. | SPLIT IN TOP SECTION NEAR BUTT EXTENDED TO END OF TIMBER. | TOP SECTION BADLY CRUSHED BOTTOM SECTION SLIGHTLY CRUSHED AT BOLT IN SPLICE. | |
| 16 | | | | YELLOW PINE | FIR | PINE | 4 7/8" x 8 7/8" | 2 7/16" x 9" | 152 | O K | O K | O.K. | SLIGHT CRACK IN LOWER SECTION AT BUTT. | CRUSHED ON ONE SIDE, TOP AND BOTTOM | |
| 25 | STRAIGHT SILL WITHOUT SPLICE | NONE |  | YELLOW PINE | | | 4 15/16" x 8 15/16" | | 116 | O K | O K | O.K. | SLIGHT SPLIT 18" FROM TOP. OLD CRACK OPENED UP 1/2" NEAR TOP. CRUSHED 2 FT FROM BOTTOM | SPLIT ENTIRE LENGTH | |
| 26 | | | | YELLOW PINE | | | 5 1/16" x 8 3/4" | | 110 | O K | O K | O K. | CRUSHED SLIGHTLY AT TOP. | CRUSHED AND SHATTERED AT TOP. | |
| 27 | | | | FIR | | | 4 3/4" x 8 3/4" | | 84 | O K | O K | O.K. | BADLY CRUSHED AND SPLIT AT BOTTOM | | |
| 28 | | | | FIR | | | 4 13/16" x 8 3/4" | | 87 | O K | O K | O.K | O K | SHATTERED AT BOTTOM | |
| 37 | 9 A | VERTICAL BOLT ADDED EITHER SIDE 18" FROM CENTER OF SPLICE |  | YELLOW PINE | YELLOW PINE | OAK | 4 13/16" x 8 3/4" | 1 7/8" x 8 7/8" | 141 | SPLIT AT BOTH BUTTS | BADLY CRUSHED AT BOTH BUTTS. | | | | |
| 38 | | | | YELLOW PINE | YELLOW PINE | OAK | 4 7/8" x 8 13/16" | 1 15/16" x 9" | 148 | SLIGHT CRACK AT BOTH BUTTS | BADLY CRUSHED AND SPLIT AT BOTH BUTTS. | | | | |
| 43 | 9 A | BOLT OPPOSITE END OF SPLICE LEFT OUT IN EACH END. |  | FIR | FIR | OAK | 4 7/8" x 8 7/8" | 2" x 9" | 130 | SPLIT FROM BOTH BUTTS TO ENDS OF TIMBER | | | | | |
| 44 | | | | YELLOW PINE | YELLOW PINE | OAK | 4 7/8" x 8 3/4" | 2" x 8 15/16" | 137 | SPLIT AT LOWER BUTT | CRUSHED IN SPLICE AND BADLY SPLIT AT LOWER BUTT | | | | |
| 49 | 8 | NONE |  | NORWAY PINE | NORWAY PINE | | 4 7/8" x 8 13/16" | | 73 | SPLIT AT UPPER BUTT. SPLIT AND CRUSHED AT LOWER BUTT. | BADLY CRUSHED AT BOTH BUTTS. | | | | |
| 50 | | | | YELLOW PINE | YELLOW PINE | | 4 13/16" x 8 3/4" | | 108 | SPLIT AT BOTH BUTTS | BADLY CRUSHED AT BOTH BUTTS. | | | | |
| 51 | | | | YELLOW PINE | YELLOW PINE | | 4 3/4" x 8 7/8" | | 98 | SPLIT FROM BOTH BUTTS TO ENDS OF TIMBER | CRUSHED IN LOWER SECTION AWAY FROM BUTT | | | | |
| 52 | | | | FIR | FIR | | 4 7/8" x 8 11/16" | | 84 | SPLIT FROM BOTH BUTTS TO ENDS OF TIMBER. | | | | | |
| 61 | 8 | BUTT SPLICE |  | YELLOW PINE | YELLOW PINE | | 4 13/16" x 8 11/16" | | 101 | O K | O K | O.K | LOWER SECTION BADLY SPLIT UPPER SECTION SPLIT THROUGH BOLTS IN SPLICE | | |
| 62 | | | | YELLOW PINE | YELLOW PINE | | 4 13/16" x 8 3/4" | | 95 | O K | SPLIT IN LOWER SECTION DUE TO DEFECTIVE TIMBER. | | | | |
| 63 | | | | YELLOW PINE | YELLOW PINE | | 4 15/16" x 8 11/16" | | 117 | O K | O K | SLIVERED AT ONE CORNER OF LOWER SECTION-ENTIRE LENGTH. | SPLIT THROUGH VERTICAL BOLTS AND AT LOWER BUTT THROUGH OLD CRACK | | |
| 64 | | | | YELLOW PINE | YELLOW PINE | | 4 3/4" x 8 9/16" | | 112 | O K | O K | O K | O.K | O K | UPPER SECTION SPLIT THROUGH VERTICAL BOLTS. UPPER BUTT CRUSHED. |
| 73 | 9 A | LOCATION OF BOLTS CHANGED |  | YELLOW PINE | FIR | OAK | 4 13/16" x 8 3/4" | 1 15/16" x 9" | 134 | SPLIT AT BOTH BUTTS | LOWER BUTT BADLY SPLIT | | | | |
| 74 | | | | YELLOW PINE | YELLOW PINE | OAK | 4 15/16" x 8 11/16" | 2" x 9" | 143 | O K | SHATTERED FROM BOTH BUTT TO ENDS OF TIMBER. | | | | |
| 75 | | | | FIR | YELLOW PINE | OAK | 4 7/8" x 8 13/16" | 1 15/16" x 9" | 124 | SLIGHTLY SPLIT AT BOTH BUTTS. | CRACKS EXTENDED AND BOTH BUTTS CRUSHED | BADLY CRUSHED AT BOTH BUTTS. | | | |
| 76 | | | | YELLOW PINE | NORWAY PINE | OAK | 4 15/16" x 8 11/16" | 1 15/16" x 9" | 150 | SLIGHTLY SPLIT AT BOTH BUTTS. | CRACKS EXTENDED TO ENDS OF TIMBER SHATTERED ON ONE SIDE IN UPPER SECTION. | | | | |
| 77 | | | | FIR | FIR | OAK | 4 15/16" x 9" | 2" x 9" | 121 | SLIGHTLY SPLIT AT BOTH BUTTS. | BADLY SPLIT AND CRUSHED AT BOTH BUTTS. | | | | |
| 78 | | | | FIR | FIR | OAK | 5" x 8 13/16" | 1 15/16" x 9 1/16" | 124 | SLIGHTLY SPLIT AT UPPER BUTT | CRACK EXTENDED AT UPPER BUTT. BOTH BUTTS SLIGHTLY CRUSHED. | BOTH BUTTS CRUSHED UPPER BUTT BADLY CRUSHED. | | | |

SUPPORTS 7 FT APART FOR TEST OF SPLICES
SUPPORTS 40 FT 6 IN APART FOR TEST OF LINERS

## TRANSVERSE TEST OF WOOD SILL SPLICES

SHEET G

| TEST NO. | M.C.B. FIGURE | EXCEPTION | SKETCH | KIND OF WOOD IN SILL | | KIND OF WOOD IN LINER | DIMENSIONS OF SILL | DIMENSIONS OF LINER | WEIGHT IN LBS. | DEFLECTION AT LOAD OF LBS. 5,000 | DEFLECTION AT LOAD OF LBS. 10,000 | MAX. LOAD | DESCRIPTION OF FAILURE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 9A | NONE | | YELLOW PINE | YELLOW PINE | OAK | 4 13/16 x 8 11/16 | 2" x 8 15/16 | 141 | .40 | 1.07 | 14,470 | FAILED AT CENTER OF SPLICE |
| 6 | | | | YELLOW PINE | YELLOW PINE | OAK | 4 13/16 x 8 3/4 | 1 15/16 x 8 15/16 | 142 | .32 | 1.04 | 11,970 | POOR LINER |
| 7 | | | | FIR | FIR | OAK | 4 7/8 x 8 13/16 | 1 15/16 x 9 1/16 | 125 | .305 | .88 | 13,500 | FAILED AT CENTER OF SPLICE |
| 8 | | | | YELLOW PINE | YELLOW PINE | OAK | 5 x 8 7/8 | 2 1/16 x 9 1/16 | 143 | .24 | .70 | 16,700 | FAILED AT CENTER OF SPLICE |
| 17 | 9B | NONE | | YELLOW PINE | YELLOW PINE | PINE | 4 15/16 x 8 7/8 | 2 1/2 x 9" | 144 | .22 | .53 | 17,980 | LINER CRACKED AND ONE SECTION FAILED NEAR END OF SPLICE |
| 18 | | | | FIR | FIR | PINE | 4 3/4 x 8 3/4 | 2 9/16 x 9" | 132 | .255 | .59 | 17,870 | FAILED NEAR END OF SPLICE |
| 19 | | | | YELLOW PINE | YELLOW PINE | PINE | 4 7/8 x 8 3/4 | 2 1/2 x 9 1/16 | 143 | .24 | .58 | 14,000 | FAILED AT VERTICAL BOLT IN END OF SPLICE |
| 20 | | | | YELLOW PINE | YELLOW PINE | PINE | 4 15/16 x 8 11/16 | 2 7/16 x 9" | 160 | .23 | .54 | 14,890 | FAILED AT ONE END OF SPLICE |
| 29 | STRAIGHT SILL | NONE | | YELLOW PINE | | | 4 15/16 x 9" | | 68 | .15 | .33 | 14,000 | BROKE THROUGH SUN CRACK |
| 30 | | | | YELLOW PINE | | | 4 7/8 x 8 7/8 | | 97 | .14 | 28 | 24,480 | SPLIT FROM CENTER TO ONE END |
| 31 | | | | YELLOW PINE | | | 4 7/8 x 8 11/16 | | 93 | .12 | .24 | 24,000 | FAILED NEAR CENTER |
| 32 | | | 8'0" | FIR | | | 4 27/32 x 8 9/16 | | 83 | .10 | .23 | 24,000 | SPLIT FROM CENTER TO ONE END |
| SEE SHEET B FOR CURVES OF ABOVE TESTS | | | | | | | | | | | | | |
| 39 | 9A | VERTICAL BOLT ADDED EITHER SIDE 18" FROM CENTER OF SPLICE | | YELLOW PINE | YELLOW PINE | OAK | 4 7/8 x 8 3/4 | 2" x 9" | 148 | .24 | .69 | 14,130 | FAILED AT CENTER OF SPLICE |
| 40 | | | | FIR | FIR | OAK | 4 13/16 x 8 13/16 | 2" x 8 15/16 | 122 | .365 | .97 | 11,000 | FAILED AT CENTER OF SPLICE |
| 45 | 9A | BOLT OPPOSITE END OF SPLICE LEFT OUT IN EACH END | | FIR | FIR | OAK | 4 25/32 x 8 7/8 | 2" x 8 7/8 | 135 | .26 | .65 | 14,980 | VERTICAL BOLT AT ONE END OF SPLICE BROKE |
| 46 | | | | YELLOW PINE | YELLOW PINE | OAK | 4 13/16 x 8 11/16 | 1 15/16 x 8 15/16 | 125 | .31 | .77 | 13,000 | ONE SECTION BROKE AT CENTER OF SPLICE |
| SEE SHEET C FOR CURVES OF ABOVE TESTS | | | | | | | | | | | | | |
| 22 | 9B | LINER AND OUTSIDE VERTICAL BOLTS REMOVED | REMOVED FOR TEST 22 | FIR | FIR | | 5" x 8 13/16 | | 89 | .57 | | 8,400 | FAILED OUTSIDE OF SPLICE |
| 23 | | LINERS REMOVED | | YELLOW PINE | YELLOW PINE | | 4 15/16 x 8 7/8 | | 104 | .66 | | 5,900 | FAILED IN SPLICE NEAR END |
| 24 | | | | FIR | FIR | | 5" x 8 7/8 | | 79 | | | 4,800 | FAILED IN SPLICE NEAR END |
| 53 | 8 | NONE | | FIR | FIR | | 4 27/32 x 8 3/4 | | 88 | .54 | | 7,600 | FAILED AT CENTER OF SPLICE |
| 54 | | | | YELLOW PINE | YELLOW PINE | | 4 3/4 x 8 11/16 | | 103 | .50 | | 7,900 | FAILED AT CENTER OF SPLICE |
| 55 | | | | FIR | FIR | | 4 7/8 x 8 13/16 | | 93 | .43 | | 9,850 | FAILED AT CENTER OF SPLICE |
| 56 | | | | YELLOW PINE | YELLOW PINE | | 4 7/8 x 8 11/16 | | 112 | .55 | | 6,800 | FAILED AT CENTER OF SPLICE |
| 65 | 8 | BUTT SPLICE | | FIR | FIR | | 4 13/32 x 8 11/16 | | 99 | .78 | | 5,900 | FAILED NEAR END OF SPLICE |
| 66 | | | | YELLOW PINE | YELLOW PINE | | 4 13/16 x 8 3/4 | | 106 | .56 | | 9,000 | FAILED NEAR END OF SPLICE |
| 67 | | | | FIR | FIR | | 4 13/16 x 8 13/16 | | 80 | .66 | | 6,870 | FAILED NEAR END OF SPLICE |
| 68 | | | | YELLOW PINE | YELLOW PINE | | 4 15/16 x 8 13/16 | | 115 | .50 | 1.98 | 10,000 | FAILED NEAR END OF SPLICE |
| SEE SHEET D FOR CURVES OF ABOVE TESTS | | | | | | | | | | | | | |
| | 3 OAK LINERS | | SEE CURVE SHEET | | | | 5 7/8 x 9" | | 114 | .03 | .07 | 50,250 | SPLIT AT BOTH ENDS |
| | 3 PINE LINERS | | | | | | 7 7/16 x 9" | | 102 | .03 | .06 | 42,950 | SPLIT AT BOTH ENDS |
| SEE SHEET E FOR CURVES OF ABOVE TESTS | | | | | | | | | | | | | |

associate members was increased from twenty to fifty. Another important addition was the following: "Subjects involving legal, transportation, permanent way or traffic questions, or for any other reason requiring such action, may be submitted as recommendations to the American Railway Association."

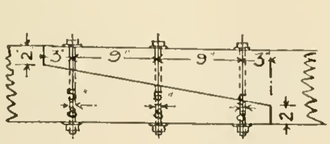


FIG. 8

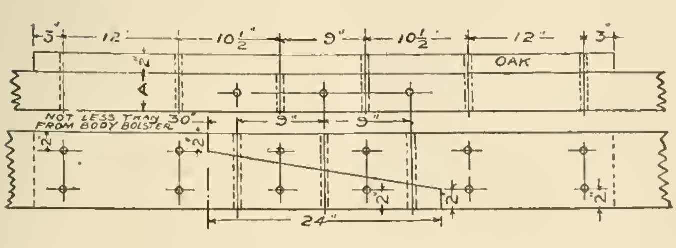



FIG. 9-A

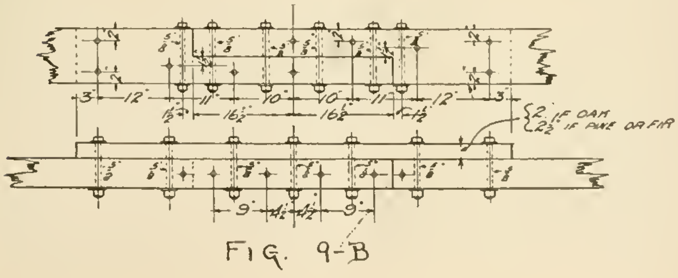



FIG. 9-B

## SPLICING SILLS.

Committee: R. E. Smith, Chairman; W. F. Bentley, I. S. Downing, H. L. Trimyer, F. A. Torrey.

The committee concluded that, to thoroughly investigate this subject, it would be necessary to submit to drop tests a number of sills spliced in accordance with each of the two styles permitted by the Rules of Interchange, in order that conclusions might be drawn from average results, and that transverse and tensile tests should be included. It was considered wise to make similar tests upon variations in the standard splice, in the hope that this procedure would throw additional light upon the subject. The tests were made in the presence of the full committee at the C. B. & Q. Railroad Company's laboratory, Aurora, Ill. The test samples were eight feet in length and were made from select second-hand, sound 5 by 9-inch car sills.

### DROP TESTS.

These tests were made on M. C. B. drop machine and represent conditions that cause the largest number of failures to sills in service. The test was started, using a one-foot drop, and with each succeeding drop raising the distance one foot. Data sheet "A" shows results of these tests. Comparing results of tests 1 to 4 representing splices per Fig. 9-A; tests 13 to 16, representing splices per Fig. 9-B; and tests 25 to 28, which were made with straight sills without splice, we get the following:

| Figure | 9-A | | 9-B | | Straight Sill | |
|---|---|---|---|---|---|---|
| | Test No. | Failed at drop of | Test No. | Failed at drop of | Test No. | Failed at drop of |
| | 1 | 1′ | 13 | 3′ | 25 | 4′ |
| | 2 | 1′ | 14 | 4′ | 26 | 4′ |
| | 3 | 1′ | 15 | 4′ | 27 | 4′ |
| | 4 | 1′ | 16 | 4′ | 28 | 5′ |
| Average Drop | | 1′ | | 3.75′ | | 4.25′ |
| Strength compared with straight sill | | 23.5% | | 88% | | 100% |

This shows that the splice made as per Fig. 9-B will stand 88 per cent. of the abuse that solid sills will stand, while the splice made as per Fig. 9-A will stand only 23.5 per cent. of the abuse that the solid sill will stand. Comparing the two kinds of splices, the splices Fig. 9-B are 375 per cent. stronger than Fig. 9-A.

The weak place in the splice Fig. 9-A is the small cross-section at the ends; with splice Fig. 9-B we get practically the solid timber to withstand the blows which occur in the bumping of cars.

TRANSVERSE TESTS.

These tests were made with supports seven feet apart. The splices made to Fig. 9-A give the largest deflections, while the straight sill gives the least deflections. The results are shown in the accompanying table (curves in report are not reproduced).

TENSILE TESTS.

(Curves in report not reproduced.)

These tests show in favor of the splice made as per Fig. 9-B.

SUMMARY.

A comparison of tests indicates that there is very little, if any, strength added to the butting resistance of splice 9-A by the side plank and that this form of splice is not appreciably improved by the addition of the vertical bolts 18 inches each side of the center of the splice, nor by the omission of one of the horizontal bolts near each butt of the splice.

In fact, all forms of the scarfed splice failed under very much less severe butting strains than the square butt splice; the weakness of this splice is due, in the judgment of the committee, to the fact that pressure or a blow upon the end of the sill causes the inclined surfaces of the scarf to slide sufficiently upon each other to interlock the fibers of the sills at the shoulders.

As it is not usual, if not impracticable, under the conditions under which splicing of freight-car sills is usually done, to fit them up without a certain amount of slack in the bolt holes and at the shoulders, the movement described above probably takes place under comparatively light butting shocks, and it could not be altogether prevented by the use of tightly fitting bolts and superior workmanship on account of the compression of the timber around the bolts and the small areas of the shoulders.

As the movement is continued, the two members of the splice tend to slide up, over and past each other, tearing loose by a lifting movement the upper portion of the sill, which splits along the grain, starting invariably at the base of the shoulders. Any further movement results in buckling the detached portion or in shattering it.

It is clear that the weakest form of splice would be that with a plain scarf, without shoulders; a similar splice with shoulders of small area would be stronger than the plain splice under butting or compressive strains; with shoulders of still larger area, the splice would be still stronger, and so on until a form of splicing, having shoulders of combined area equal to the full cross section of the sill, is evolved; splice 9-B is such a splice. This form of splice, then, logically, is the strongest, and under the drop tests, conducted by the committee, it was proven to be.

Supplementing the above, the committee desires to call attention to the report of the Committee on Splicing Passenger Car Sills, made at the convention of 1902; that committee arrived at virtually the same conclusions as the present committee, regarding the superiority of the butt splice under compression; the photographs contained in that report indicate that the various forms of scarfed splices failed in identically the same manner as those tested by the present committee; the brevity of the discussion following the presentation of that report indicates little interest on the part of the members, and when the recommendation of the committee that the butt or step splice be adopted as Recommended Practice in splicing passenger-car sills was submitted to a letter ballot, it lacked 37 of receiving the required number of votes (682), the count showing affirmative 645, negative 378.

The graphic records of the behavior of the two forms of splice under investigation, when subjected to transverse strains, indicate convincingly the superiority of splice 9-B over 9-A. As the strength of both forms is in excess of the transverse strains developed under the worst possible conditions met with in service, the series of transverse tests are not considered of special importance, and merely accentuate the results derived from the drop tests.

The transverse tests of the side planks, however, considered in connection with similar test of the splices without the reinforcing side planks, show the large part the former play in stiffening both forms of splices, 9-A and 9-B.

When subjected to tensile strains, the behavior of both forms of splice the committee was instructed to investigate was practically uniform under such strains as are probably developed in actual service; whatever difference there appears to be in the strength of the two samples is probably accidental and due to workmanship, difference in compression around bolts, friction between parts, and not to any difference in form.

While the committee felt that the subject assigned to it was of sufficient importance to warrant it in extending its investigations outside of the limits prescribed in its instructions, making tests of various modifications of both forms of splice prescribed by the Rules of Interchange, in the hope that all possible light might be shed on the subject, yet it realized from the beginning that the ability to resist butting or compression strains would be the chief consideration in determining the comparative merits of the two forms of splice under investigation.

The butt splice has a further advantage over the scarf splice, arising out of the greater ease with which it can be framed without removing the sound portion of the sill from the car, and some lines, for this reason, allow a lower piece-work price for the butt than for the scarf splice. It is believed that as great skill is not required to frame the butt as the scarfed splice, and that, therefore, this class of work can be done at such points and under such conditions as would not admit of the use of the scarfed splice. The committee unanimously recommends, for work to be done after September 1, 1909:

1. That splice 9-B be adopted as standard for the splicing of center or draft sills of freight cars.

2. That five-eighths of an inch in diameter for bolts and eleven sixteenths of an inch for bolt holes be adopted as standard in assembling sill splices of freight cars.

3. That the butt, or step splice, without side plank, be adopted as standard for the splicing of all freight car sills, other than center or draft sills.

## SALT WATER DRIPPINGS FROM REFRIGERATOR CARS.

Committee:—M. K. Barnum, chairman, G. W. Lillie, W. E. Sharp, E. W. Pratt, P. Maher, D. C. Ross, W. C. Arp.

At the convention of 1898 a committee reported on this subject as follows:

1. "That more interest is being taken in the subject by the officials in charge of the track and bridges than by those in charge of rolling stock, which is accounted for by the fact that the track and bridges are being more damaged by salt-water drippings than the car trucks."

2. "That in refrigerator cars loaded with dressed beef the mixture used for cooling purposes is composed of ice and salt, the proportion of the salt to the ice varying from 6 to 11 per cent."

3. "That one refrigerator car will produce about 200 gallons of salt water or brine every twenty-four hours, which, on an average, will contain 8½ per cent. of salt."

The committee at that time started out with the idea of having refrigerator cars fitted with one or more reservoirs, to be attached underneath the car body, into which the salt-water drippings could be conveyed, the reservoirs to be large enough so that they would not have to be emptied more than once every twelve hours at terminals where proper provision could be made for taking care of the salt water, but the idea met with so much opposition that the committee abandoned it, and recommended two methods of allowing the water to drip in the center of the track, one of which was adopted by the Association as recommended practice, and is shown on Sheet M. C. B.—A, Proceedings, 1907.

The appointment of a committee to reconsider this question would indicate, first, that the complaints of damage to track, bridges, etc., have continued, and with increasing force, and, second, that the recommended practice has not been found satisfactory. Sufficient evidence has been collected by the committee to convince any fair-minded person beyond question that the drippings from refrigerator cars using salted ice do serious damage to the rails and fastenings, bridges and other metal parts pertaining to the roadway, in proportion to the amount of this kind of business handled; the damage being greatest on elevated curves, at coaling and water stations, and other localities where such cars are started and stopped.

The committee finds that the present recommended practice has only been used experimentally on a few cars, which developed the following objections:

1. The numerous turns in the pipes prevent cleaning out sawdust and other obstructing matter.

2. The pipes freeze in cold weather.

3. The location is such that the pipes are easily torn off by the brake rigging.

The committee therefore concludes that the device shown on Sheet M. C. B.—A is unsatisfactory and impracticable, but favor retaining it pending investigations and tests now under way. The committee has done some experimental work which does not yet justify drawing conclusions, but it is being continued with the expectation that during the coming year the tests will be completed, and definite recommendations made.

Three methods have been suggested for taking care of salt-water drippings.

1. Tanks located inside of the car, below the ice tanks, to catch and retain the drippings until arrival at an inspection point, where they could be drained.

2. Tanks suspended underneath the car between the trucks.

3. That drippings be conducted to a narrow pathway alongside the track at the ends of the ties and so scattered that they

will do the least damage, and that the roadbed be given special attention at this point, about four feet or four feet six inches from center of track, to provide against this damage. This is a modification of the present practice and probably will not meet the approval of the maintenance of way department.

The principal objections raised to the first two of these plans are that they would cause serious delays to refrigerator trains in yards where the draining of the tanks is to be done. The handling of refrigerator products is essentially a main line business, similar to passenger service, and any delays incident to the transfer of such business to a switch track with drains for receiving the salt water would not be tolerated by transportation officials. Another objection to such systems would be the necessity for installing a system of conduits for carrying off the salt water.

The first plan is also open to the following objections: The use of water tanks inside the car would necessitate reducing either the size of ice tanks or the space for the revenue load, because refrigerator cars are now built to receive an exact number of cases of a standard size and any encroachment on this space will reduce the carrying capacity of the car. The successful transportation of meat products requires a constant or gradually lowering temperature in the car. The use of such tanks inside of the car might have a tendency to increase the temperature, thereby affecting the condition of the contents on arrival at destination. The location of tanks inside of car would also make it more difficult to repair draft rigging and sills.

The second plan suggested would only be usable during warm weather, because the pipes would freeze in winter. Furthermore, the space underneath a refrigerator car is now so taken up with trucks, brakes, needle beams, truss rods, etc., that it would be difficult to find space for tanks which must hold at least 200 gallons.

All three of these plans are being studied in detail with the view of determining their cost and testing their efficiency. If any of the members have other suggestions for disposing of salt-water drippings, the committee will be glad to consider them. It has been impossible to make all desired tests in time for this convention and the committee would therefore recommend that the subject be continued so that the work, as outlined, can be completed.

*Discussion.*—The committee made some tests, after the report was printed, retaining the salt water in the ice tanks. The tests were made on refrigerator cars standing in the shops of the Armour Car Lines. In both tests the overflow pipes were closed and all the brine retained in the ice tanks during the entire test.

The first test covered a period of four days, during which time the outside temperature varied from a minimum of 49 deg. to a maximum of 79 deg. The first icing reduced the temperature of the car to about 35 deg. within 5 hours. The car was again iced after about 20 hours and the temperature reduced to below the freezing point and maintained there for three days by means of re-icing at intervals of 24 hours.

The second test extended over a period of four and one-half days, during which the outside temperature varied between 50 deg. and 80 deg. In this test the temperature reduced more slowly, but was kept below freezing for three days. After about 48 hours it gradually increased, in spite of several re-icings, to about 32 deg. at the end of test, indicating that after the brine has absorbed a certain amount of heat, it must be discharged from the tanks in order to maintain the necessary degree of refrigeration.

To definitely determine whether this plan of retaining the brine in the ice tanks and draining it off at regular icing stations will work satisfactorily, it will be necessary to make additional standing tests and then to make road tests with cars under load during hot weather.

*Action.*—The report was received and the committee continued.

## PAINTING STEEL CARS.

Committee: G. E. Carson, Chairman; T. Rumney, G. A. Schmoll, J. M. Shackford, J. T. Wallis.

Last year the committee made a report of progress and reported a number of cars under test, also a few recommendations; we can see no reason why the former recommendations should be changed. They are as follows: Suitable buildings should be provided for the painting of cars, so that the painting of the equipment would not necessarily be confined to certain seasons of the year, for it is essential that the equipment, regardless of the season, be well covered with a protective coating, in order to arrest deterioration, which otherwise is very rapid.

In the preparation of the assembled parts of new cars they should not be exposed to the weather or permitted to rust before their assemblage. In all cases where metal is placed against metal, either riveted or bolted, it should be free from flash or rust and covered with one or two coats of red lead, and the mixture be heavy enough to exclude moisture, but this protection will avail little unless extra care is taken that all the steel parts fit evenly and are applied in like manner.

After cars are ready for the first coating it is necessary that all flash and rust be removed. This should be done under rigid inspection. Unless the flash is removed it will invariably fall off inside of one year and continue as long as any remains, regardless of the number of coats of paint applied. It is recommended that flash and rust be removed by sand blast, where possible. Would next recommend dry cleaning (which we do not believe so satisfactory), by using steel scratch brushes, sandstone or any tools which will answer the purpose, being particular to remove all the dust with suitable brushes or dusters. After following either of these cleanings we suggest the application of three coats of paint at twenty-four hour intervals. In the preparation of cars for repainting we again recommend cleaning by sand blast, but if this cannot be done under all conditions, then use the dry cleaning process, as previously mentioned. After the dry cleaning we would recommend two coats of standard paint applied at twenty-four hour intervals. We cannot be too emphatic as to the necessity of taking the proper care of the exterior, and regret that we are not able to give the interior the same care.

The committee has examined a number of cars under test which were in ordinary service; the results of the various tests are as follows:

One car, thoroughly dry cleaned and given two coats of a special black paint, was then coated over with crude petroleum oil. After fifteen months' service it was found that the painted surface of the car was in fine condition, and there was a showing of the crude oil still clinging to the paint surface.

One car, thoroughly dry cleaned and given two coats of a special black paint, was then coated over with locomotive cylinder oil. After fifteen months' service it was found that the painted surface of the car was in fair condition. We are inclined to believe that the application of the locomotive cylinder oil had a tendency to extend the elastic life of the paint.

One car, thoroughly dry cleaned and given two coats of a special black paint, was then coated over with a good quality of fish oil, applied with brush. After being in service fifteen months the condition of the paint was very fine indeed, but there was no indication of the surface oil at time of inspection.

One car, thoroughly dry cleaned and given two coats of common red car paint generally used by railroads, was then covered with equal parts of raw linseed oil and pure glycerin. After being in service fifteen months, it proved to be the slowest in drying. The painted surface was in good condition.

One car, thoroughly dry cleaned and painted with two coats of common red car paint generally used by railroads, was then given a coating of "Cleanola." After being in service fifteen months the paint was found to be in fair condition. It also shows some preservation.

One car, thoroughly dry cleaned and given two coats of common red car paint generally used by railroads, was then covered with a coat of well-rubbed-in commercial tallow. After this car had been in service fifteen months the paint was found to be in fair condition, but no traces of the overcoat of tallow remained.

One car was thoroughly dry cleaned and covered with two coats of a special black paint. (No preservative applied.) After being in service eight months the paint was found in remarkably good condition, notwithstanding the fact that there appeared to be much material brittleness, also loss of weight in scrapings.

One car, thoroughly dry cleaned and given two coats of a special black paint, was covered with a special manufactured over-oil. After being in service eight months the paint was found to be broken in places, and scrapings appear to be soft, broken and tacky.

Six cars were thoroughly cleaned out on the inside, and with an atomizing machine were given two coats of crude petroleum oil. After being in service fifteen months the interior was examined. To the eye and touch these surfaces did not give the slightest indication of the previous bountiful oil coating. Inspection convinced us that if this treatment acts as a preservative in any form the insides should be treated at least every six months.

The committee at the present time has under test twenty-five steel cars which have had the insides sand-blasted and the seven following mixtures applied heavily and not brushed out:

| | | |
|---|---|---|
| No. 1 | Petrolatum | 30 pounds |
| | Raw linseed oil | 210 pounds |
| No. 2 | Petrolatum | 30 pounds |
| | Corn oil | 210 pounds |
| No. 3 | Petrolatum | 30 pounds |
| | Crude oil | 210 pounds |

| | | |
|---|---|---|
| No. 4 | Tar | 30 pounds |
| | Aniline oil | 40 pounds |
| | Corn oil | 170 pounds |
| No. 5 | Tar | 30 pounds |
| | Aniline oil | 40 pounds |
| | Raw linseed oil | 170 pounds |
| No. 6 | Tar | 30 pounds |
| | Aniline oil | 40 pounds |
| | Portland cement | 30 pounds |
| | Corn oil | 140 pounds |
| No. 7 | Tar | 30 pounds |
| | Aniline oil | 40 pounds |
| | Portland cement | 30 pounds |
| | Raw linseed oil | 140 pounds |

Two cars bearing mixture No. 1 were examined after being in service four months and twenty-nine days and were found to have the sides and ends in fair condition, but the paint was gone from the bottom, and no scale accumulated on the inside of the car.

One car bearing mixture No. 2 was examined after being in service four months and twenty-six days and was found to have the sides and ends fairly well preserved, but the paint gone from the bottom and no accumulation of rust.

Two cars bearing mixture No. 3 were examined after being in service four months and twenty-one days and showed the sides and ends somewhat protected, but considerable rusting going on. This mixture did not retard rusting as well as mixtures Nos. 1 and 2.

One car bearing mixture No. 4 was examined after being in service four months and seventeen days and showed the inside well preserved, but considerable of the paint gone from the bottom, yet there seemed to be retardation of the rusting, and no accumulation of scale. This mixture shows better results than mixtures Nos. 1, 2 and 3.

One car bearing mixture No. 7 was examined after being in service four months and showed the sides well preserved, but the bottom somewhat rusted. This car was in a better condition than any of the other cars inspected and would indicate that No. 7 mixture is preferable and would be especially valuable from the tests so far made. To get the best results from a coating of this kind, one coat should be applied about once every six or eight months.

However, it is not fair for us to draw a conclusion as to which of these inside mixtures is the best, for the reason that the cars have not been in service long enough to determine this feature. Until these inside mixtures are thoroughly tested out the committee is not in a position to recommend their use. The committee realizes the necessity of a continuation for another year, in order to further determine the results of the tests now being made. The desire is to give the Association, in the final report, a formula for the inside and outside coating of steel cars.

*Discussion.*—It developed that the cars under test were all-steel hoppers and gondolas which had previously been in service two or three years. Before being covered with the test paint they were sand blasted. The paint was applied in the open and under favorable weather conditions.

It seems to be impossible to get a preservative for the inside of the car. There is very little deterioration in the inside when the cars are kept in constant service, but, as stated by Mr. Carson, one month idle is equal to two or three years in service as far as deterioration is concerned. Rust should not be removed from the inside of the car as it protects the metal from further corrosion. It was suggested that the committee in carrying on its work confer with the American Society for Testing Materials, which is making extensive tests along these lines.

*Action.*—The recommendations of the committee were adopted and it was continued for another year.

## SAFETY APPLIANCES.

Committee—C. A. Seley, Chairman; A. LaMar, T. H. Curtis, C. B. Young, LeGrand Parish, H. Bartlett, T. M. Ramsdell.

In the first place, we would call attention to the misleading title of this committee, which, by instruction, confines its work to those standards formerly designated "for the Protection of Trainmen." Safety appliances are generally considered to include the fixtures on cars which are referred to in the Safety Appliance Acts, and embrace the air brakes, coupler and unlocking attachments in addition to the handholds, steps, etc. Two other standing committees have these matters in hand, so that this committee has not supervision over all that its title would imply. This is not generally understood, as was proven by the receipt of several communications from members in reference to matters outside of our supervision.

The result of the letter ballot of 1908, being so overwhelmingly in favor of the adoption of the standards as proposed by the special committee reporting to the last convention, was an indication that they were so favorably considered that very little revision would be suggested, and we have to report very few answers to our circular of inquiry sent out September 10, 1908. The cordial support of the committee's report indicated a belief that the revision had not departed from the spirit and intent of the old standards, but that they had been clarified as to language and expression and extended on proper lines to cover the developments in car types and construction not existing when the standards were first promulgated. The practically unanimous ballot also proves the wisdom shown by those originating and building up these standards, which are now the expression of an expert, authoritative body, the weight of whose opinion should be most carefully considered.

A very significant indication of the status of the M. C. B. standards is shown in an executive order issued by the President of the United States, dated January 6, 1909, extending to the Canal Zone and the railways in navy yards, docks, and government property, requiring that the various appliances for the protection of trainmen, as designated in existing standards of the Master Car Builders' Association, shall be used on all freight cars in above described territory. The date of this order was subsequent to that of the letter ballot, so that the standards referred to are the present standards, and if they are good law in Panama and other Government property, they should be equally so in these United States and in every State, State laws and individual opinions to the contrary, notwithstanding.

Our standards have always permitted substitutions for handholds, extending their function to the coupler unlocking rod, lower rounds of ladders, brake-step brackets, etc. The opinion of the Association in this respect has been sustained in a recent United States Court proceeding. Judge Dodge, in the District Court of Massachusetts, in the case of the United States vs. Boston & Maine Railroad, in his charge to the jury used the following language in reference to end handholds on a box car as required by Section 4 of the Safety Appliance Act:

"Now, taking that section as it stands, and giving due weight to the language in which the requirements are expressed, we have to consider just what they mean as applied to the question arising in this case, and I shall instruct you, gentlemen, that Section 4 requires secure grabirons or handholds at those points on the end of each car where they are reasonably necessary in order to afford to men coupling or uncoupling cars greater security than would be afforded them in the absence of any grabiron or handhold at that point or of any appliance affording equal security with a grabiron or handhold. If at any place on the end of this car there was not a grabiron or handhold, properly speaking, but some other appliance, such as a ladder or brake lever, or whatever else you please, which afforded equal security with a grabiron or a handhold at that point, then I shall instruct you that the law has not been violated so far as a grabiron or a handhold at that point is concerned. Having something there which performs all the functions of a grabiron or a handhold is just the same thing as having what is properly called a grabiron or a handhold at that point. It may not be possible to say that a coupling lever or a ladder is a grabiron or a handhold, but if it affords the same security to a man who may need to use one that a grabiron or a handhold, properly speaking, would afford, then, in my judgment, the statute has not been violated."

It was the Master Car Builders' Association that originally affirmed these substitutions as early as 1896, and by almost unanimous letter ballot extended the principle of substitution to apply to the platform posts and railing of open platform passenger train cars and cabooses as effective handholds in 1908. The application of handholds to such platform cars is certainly not in accord with M. C. B. standards; practical trainmen do not want them, and it is difficult to understand why some roads are applying them, unless to fulfil a strictly technical interpretation of the law, which is contrary to the opinion held by Judge Dodge, as quoted above.

Several members have written this committee regarding the use of the coupler unlocking rod as an effective handhold. We would reply that, with proper clearance, it is just as much of an M. C. B. standard as any which are included under that title and should be so held until the courts require otherwise. There are several fundamental questions to be adjudicated before a full understanding of the statutes is arrived at and this substitution theory is one of them.

Two or more devices for the same purpose are not desirable for economic reasons, and their presence leads to an uncertainty in time of need, which is not present if a single device only is available. Something to grab quickly and surely will give confidence, and if handholds are added where there is already an efficient substitute, it crowds the location and distracts the attention, so that accidents are more likely to occur than if they were omitted.

Several members urge the abolition of lag screws as fasteners for handholds and steps. Your committee has very carefully considered this question, but can not approve the suggestion. A lag screw properly applied is undoubtedly a secure fastening.

It is quite true that with less care in the application lag screws may be less safe than bolts, although no fastening, whether bolt, lag screw or rivet, may be deemed safe unless properly applied. Many roads are discontinuing the use of lag screws and in repairs are replacing them with bolts with nuts outside wherever practicable. There are, however, some locations that a bolt for fastener is almost prohibitive on account of construction details, and if the standards required bolts "wherever practicable," a question would frequently be raised as to the practicability, whereas the true question is as to whether the lag screw was properly applied. There is nothing to prevent roads making the change on their own cars from lag screw securing to bolt securing for safety appliances; and, if this is done by the roads desiring the discontinuance of the use of lag screws, it will greatly reduce the number of lag screws in use.

In answer to the circular of inquiry, asking for suggestions as to revision, a number of communications were received and considered, and the committee submitted its decisions to the association for approval.

## TESTS OF BRAKE SHOES.

Committee:—W. F. M. Goss, Chairman; B. D. Lockwood, William McIntosh.

By agreement, soon after notice of the committee's appointment was received, an outline of the work which should be undertaken was framed and approved. This outline, together with an estimate of the expense which would be involved by its execution, was submitted to the secretary for the executive committee. Formal authority to proceed with the execution of the full program was received November 25, 1908. This program is as follows:

1. To hold a meeting not later than October 10, 1908, at some point such as Cleveland, Indianapolis or Chicago, where considerable numbers of freight cars are handled. To select from freight cars, in coöperation with local railway officials, not less than twenty partially-worn shoes. In making a selection the committee shall seek to secure shoes which are representative of those used by the railroads of the country. The shoes selected shall be numbered, and the terms to be employed in designating them shall be determined by the committee prior to its adjournment.

2. Of the twenty shoes selected, ten shall be sent to the American Brake Shoe Company in care of F. W. Sargent, consulting engineer, with the request that said company test them for the committee, said company having already expressed its willingness to serve the committee by such service. Ten shoes shall also be sent to the Master Car Builders' Laboratory, Purdue University, in care of Dean C. H. Benjamin, to be tested under the immediate direction of the committee.

3. Each shoe shall be tested both upon a cast-iron wheel and upon a steel-tired wheel. Each shoe shall be tested, first, under the Master Car Builders' specifications governing frictional qualities, after which it shall be tested to determine its wearing qualities under the code proposed by the committee in its report to the Association in June, 1908.

4. Following a suggestion of the committee at the last convention to the effect that provision should be made for determining the wearing effect of the brake shoe upon the wheel, the William Sellers Company, of Philadelphia, has been requested to outline a simple form of weighing lever of sufficient capacity to handle a car wheel, and of such delicacy as will serve to detect differences in weight as small as 1/500 of a pound. It is hoped that by the aid of such a device, weighings can be made of the test wheel before and after the wearing test of each brake shoe, and that the loss of weight sustained by the wheel in the process may be determined with a sufficient degree of accuracy to disclose the rate of wear of the shoe upon the wheel. If the executive committee should think it wise to add to the equipment of its laboratory such a weighing device, the committee will make its study of the twenty shoes selected for test include a study of the wearing effect of these shoes upon the wheels to which they are applied. The authorities of Purdue University agree to receive and to install the proposed weighing device in case the executive committee sees fit to provide for it.

5. At the conclusion of the work outlined all results of tests, both those obtained by the American Brake Shoe Company and those obtained by the committee at the laboratory at Purdue University, are to be brought together into one complete record. Upon the facts presented by this record, it is proposed to base a formal specification covering the wearing qualities of brake shoes. The committee may also consider whether there should be any change in the present specifications governing frictional qualities.

6. It is the opinion of the committee that if this outline is successfully carried out, the research work of the brake shoe committee may cease for some years to come.

Proceeding under this program, the committee in January personally selected fourteen brake shoes from cars in service in the Chicago yards of the Chicago & North-Western Railway; and by the aid of others it has since received fourteen additional shoes also taken from cars in service. These twenty-eight shoes are of fourteen different kinds, each kind in duplicate. They have been selected as representative of brake shoes now in use by the railroads of the country. It is proposed that these shoes shall be subjected to the tests outlined above.

It will be noted that the committee now considers its principal work to be the determination of the wearing qualities of shoes and the determination of the effect of the shoe upon the wear of the wheel. The determination of wheel wear requires a weighing device of unusual sensitiveness. Negotiations for a scale designed for this purpose were entered into as early as June 30 of last year with the William Sellers Company, of Philadelphia, and the order for the scale was placed as soon as the executive committee had approved the program as given above. The scale thus provided for has not yet been delivered, and as a consequence it has been impracticable to proceed in the working out of the program. The delay in the manufacture of this apparatus has grown out of the fact that the problem of constructing a device of sufficient capacity to receive a car wheel and sufficiently sensitive to detect differences of one five-hundredth of a pound has proved more difficult than was anticipated, and changes in the preliminary design have been necessary. Responsibility in all such matters is with the manufacturer, and the committee finds satisfaction in assurances received that the completed scale will soon be delivered.

In view of these facts the committee would ask that it be continued for one year, and that its budget, already approved, be allowed to stand, all in the expectation that its program of work can be completed prior to the 1910 convention.

*Discussion.*—The scale for weighing the wheels has been received and Prof. Endsley reported that it is possible to weigh them accurately within one-thousandth of a pound.

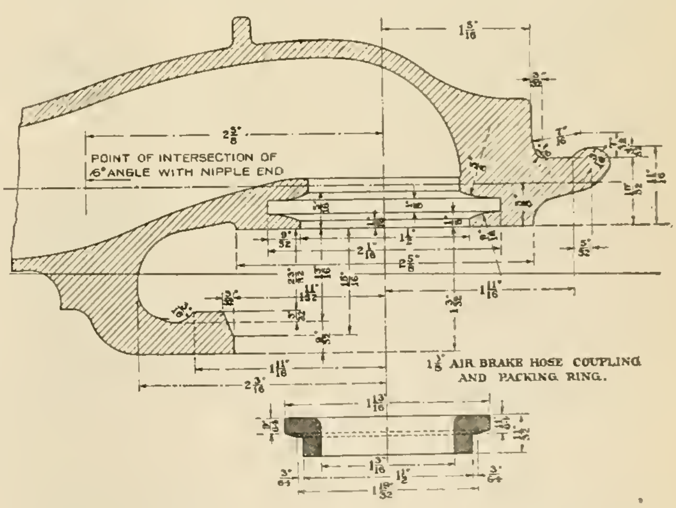
*Action.*—The report of the committee was received and the work ordered continued.

## AIR-BRAKE HOSE.

Committee:—LeGrand Parish, chairman; J. Milliken, R. W. Burnett, J. R. Onderdonk, J. A. Carney.

The committee on air-brake hose strongly recommends that the railways make extensive experiments with devices designed to distribute the bending strain over nipple end of hose and afford protection from the damage by being struck with coupling when hose are uncoupled under pressure, without parting by hand. This latter condition of damage might be considerably reduced by some improvements in the design of hose coupling which would materially decrease the strains of uncoupling when parted under pressure other than by hand.

Upon request of the Executive Committee, we submit herewith recommendations for standard dimensions of air-brake hose couplings and gaskets. We also recommend the following change




1¼" AIR BRAKE HOSE COUPLING AND PACKING RING.

in Rule 33, page 17: Omit "and hose applied without swelled end and not conforming to M. C. B. standard hose," making it read:

"Cars equipped with air-brake hose other than M. C. B. standard, on and after June 1, 1909, except 1¼-in. M. C. B. standard hose, and so branded, which hose has been manufactured previous to June 1, 1909. } Owners responsible.

"Except cars offered in interchange, where delivering company is responsible." } Delivering Company responsible.

The recommendation in regard to change in Rule 33 is made on account of the fact that under the present rule old M. C. B. standard 1¼-in. hose would not be permissible after June 1, 1909. This change is suggested to clear up a misunderstanding relative to this question.

This recommendation has been referred to the Arbitration Committee.

*Action.*—The recommendation as to the date at which the new rule should go into effect was adopted in connection with the report of the arbitration committee. The remainder of the report was referred to the committee on standards.

## ELECTRICALLY LIGHTED PASSENGER EQUIPMENT.

The equipment of passenger cars with electric light, either by the straight storage or axle-lighting system, is being rapidly extended by a large number of railroads. In the interchange of these electrically lighted cars some trouble is experienced in charging the batteries or operation of the systems, by reason of lack of information concerning the make, type, charging rate, etc.

It has been suggested that the Master Car Builders' Association prepare a form of card to be pasted in the interior of all such electrically lighted cars to assist in the proper operation of the electric light equipment.

The Executive Committee believes the suggestion to be a good one, and, in order that it may be made operative at as early a date as possible, would recommend that the members of the Association owning or operating such cars at once take steps to place in each car so equipped a placard containing the following information:

A. B. C. R. R. CO.

System..................

Kind of equipment.............................. Type............
Kind of drive....................................................
Ampere capacity ..................................................
Voltage of system.................................................
Kind of field regulation..........................................
Location field regulation.........................................
Voltage of regulator set at.......................................

BATTERIES.

No. of cells of battery............in series and............sets in parallel.
Capacity of battery (8 hour rate)...............ampere hour.
Specific gravity of electrolyte at full charge....................
Specific gravity of electrolyte for acid renewals..................
Maximum charging rate in amperes..................................
Maximum discharge rate in amperes.................................
Normal charging rate in amperes...................................
Size of overhead cables or main feed wires........................
Kind of train connectors..........................................
Where placed .....................................................
Kind of charging terminals........................................
Position of positive pole.........................................

## BOX-CAR DOORS AND FIXTURES.

Committee—C. S. Morse, chairman; J. P. Young, G. N. Dow, J. A. McRae, C. F. Thiele.

At the 1908 convention this committee was continued to consider suggestions made during the discussion of the report offered at that time. The committee has revised its drawing for M. C. B. Sheet F to meet the criticisms offered.

BOX-CAR DOORS AND FIXTURES.

The door-hanger bolt holes have been given definite location, and the door-hanger bolts have been increased from ⅜ inch to ½ inch in diameter. In place of the door guide plate there has been substituted a Z-bar, which stiffens the lower part of the door and renders unnecessary the use of the lower angle-iron stiffener recommended last year. By the use of this Z-bar a shorter door-guide bracket is obtained. The bolts securing the door handle have been increased from ⅜ inch to ½ inch, and lugs have been added, rendering the two screws unnecessary. The door hasp staple bolts have been increased in size from ⅜ inch to ½ inch, but the committee did not consider it advisable to increase the number of bolts.

TEMPORARY GRAIN DOORS.

Since the last convention the Executive Committee has requested the committee to consider also the subject of grain doors for box cars. Replies to the circular of inquiry indicate that the members are almost unanimously in favor of temporary grain doors. The committee has made a careful study of the various designs of temporary grain doors submitted and has prepared a drawing which would seem to be satisfactory from standpoints of price and efficiency. We would recommend specifications for grain doors as follows:

Temporary grain doors for box cars shall be made of two courses of lumber (long course, 6 ft. 10 in. long; short one, 4 ft. 11¼ in. long for a 6-ft. door opening), laid lengthwise, with two end strips 23 in. long and 6 in. wide, one strip at each end of the short course (the grain door is 24 in. high). Lumber of any suitable wood may be used. The lumber may have loose or unsound knots, except at the ends of the long course, but it must be free from rot or shakes that would prevent the nails from holding securely. The lumber in each door must be of uniform thickness and must be not more than 1 in. or less than 13/16 in. thick and may be of any width—3 in. or over—but each longitudinal joint shall be covered by a board that extends not less than 2 in. on each side of the joint. The short course must be nailed to the long course with four rows of clinch nails, and each end strip with twenty nails, all staggered and spaced as shown on the drawing, driven home and properly clinched; where the width of the lumber used makes them necessary, a greater number of nails must be used to secure a strong and workmanlike job. The door, when completed, must be grain tight, with no holes or cracks extending through it; also top and bottom edges of the door must be straight. Clinch nails must not be less than 2¼ in. in length.

In order to identify the ownership of temporary grain doors and to aid in their return, the doors should be stenciled with the owners' initials. The present cost of grain doors is a very considerable item, and a large saving would be made if the doors were returned to the owners.

*Discussion.*—This report was very thoroughly discussed. There was some question as to whether additional bottom door brackets should be provided for the box car side door.

The temporary grain door is a source of great expense; $90,000 a year is expended on this item by the Canadian Pacific and $200,000 by the C. B. & Q. Mr. Fowler (C. P. R.) thought that it would be necessary to give protection to the owner of the car or exclude it from owner's responsibility, or go to metal grain door. His road had been experimenting with a simple sheet metal door stiffened with angles or T irons, which is giving satisfactory results.

The 25,000 box cars on the C. B. & Q. average only eight trips apiece per year with grain or other commodities requiring the use of grain doors. Part of the trouble is being overcome on the C. B. & Q. by additional supervision at the elevators and along the line.

Mr. La Rue (C. R. I. & P.) stated that the General Managers' Association of Chicago was making an extended investigation of the problem of reclaiming grain doors which might effect a solution of this problem.

*Action.*—The report was accepted and the committee continued.

## SUBJECTS.

Committee: H. D. Taylor, Chairman; A. W. Gibbs, J. S. Lentz.

The committee recommends that the subjects for committee work for the 1910 convention be limited to the following:

1. Steel hopper and drop-bottom gondola cars—clearance for third-rail construction, and design of the door itself to enable it to be kept tight when handling heavy commodities, such as ore, etc., and under the rough usage incident to the loading of billets, pig-iron, and other heavy commodities loaded from a considerable height.
2. Construction of car roofs, end bracing of box car superstructure, and bracing for side doors.
3. Maximum height of flange of wheels in service to prevent damage to track without danger to the wheels.
4. Springs for freight car trucks—revision of specifications, covering design, material, and requirements as to heat treatment.
5. Damage to cars by car-dumpers, and the remedy.

The committee in restricting the list of subjects, is not unmindful of the fact that before the convention other subjects of immediate importance may develop, and room is thus given for the inclusion of such subjects. It is also aware that some of the subjects for topical discussion at the 1909 convention may, as a result of such discussion, be desirable for committee action during the coming year, and it would reiterate the importance of limiting the number of subjects so as to secure better opportunity for discussion.

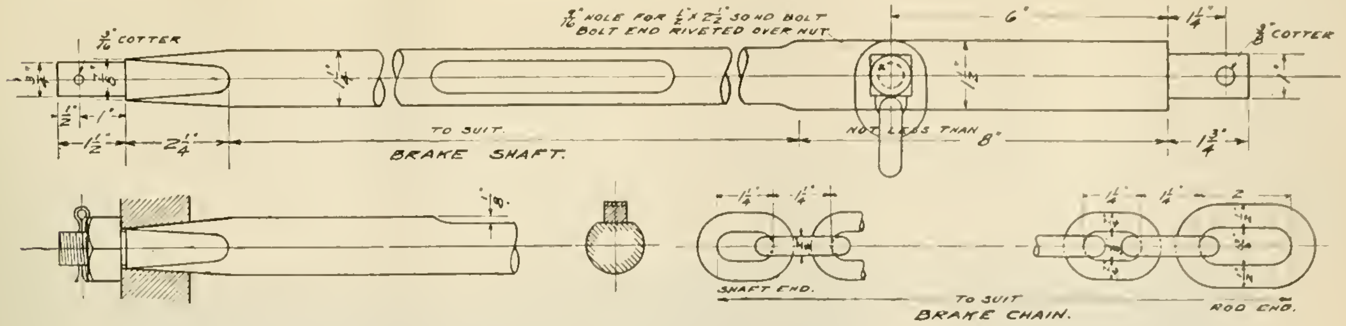
It is recommended that the following subjects be referred to the regular committees having such work in charge:

Breakage of bottom arch bars, to Committee on Freight Car Trucks.

Side-bearing clearance and location, to Committee on Side Bearings.

Leverage for hand brakes, to Committee on Train Brake and Signal Equipment.

Strengthening of air hose with some covering or otherwise so as to lessen the wrecks caused by burst hose, to Committee on Air-brake Hose, with definite instructions to investigate and report.




## TRAIN BRAKE AND SIGNAL EQUIPMENT.

Committee:—A. J. Cota, chairman, F. H. Scheffer, R. K. Reading, E. W. Pratt, R. B. Kendig, T. L. Burton, E. Posson.

At a meeting of the Executive Committee held in Chicago on July 13, 1908, the name of the Committee on Air Brake Tests was changed to read, "Train Brake and Signal Equipment," and it was decided to increase the scope of the committee's work to take in the entire subject of air brake and signal equipment of cars for both automatic and foundation brakes.

*Test Rack.*—The new 100 car triple valve test rack for 10-inch freight equipment, which was authorized to be erected at Purdue University, Lafayette, Indiana, is now installed in a new building provided for that purpose.

*Code of Triple Valve Tests for 100-Car Train.*—One of the principal duties assigned to the committee is the formulation of a revision of the present code of tests for triple valves. This subject has been taken up with the various air-brake manufacturers, but we regret to report that on account of the inability of more than one manufacturer to furnish triple valves in time for such tests the committee is unable to submit a revised code for the 1909 convention, and asks that further time be given to consider this subject.

*Standard Brake Shaft, Brake Wheel, etc.*—(a) To design a standard brake shaft, brake wheel, brake-wheel fit, ratchet wheel and ratchet-wheel fit.

(b) A uniform method of fastening brake wheel and ratchet to staff, the brake shaft to be made of one piece.

(c) Location of the attachment of the brake chain to the winding barrel.

(e) Increase in size of brake chain and bolt fastening the chain to brake staff.

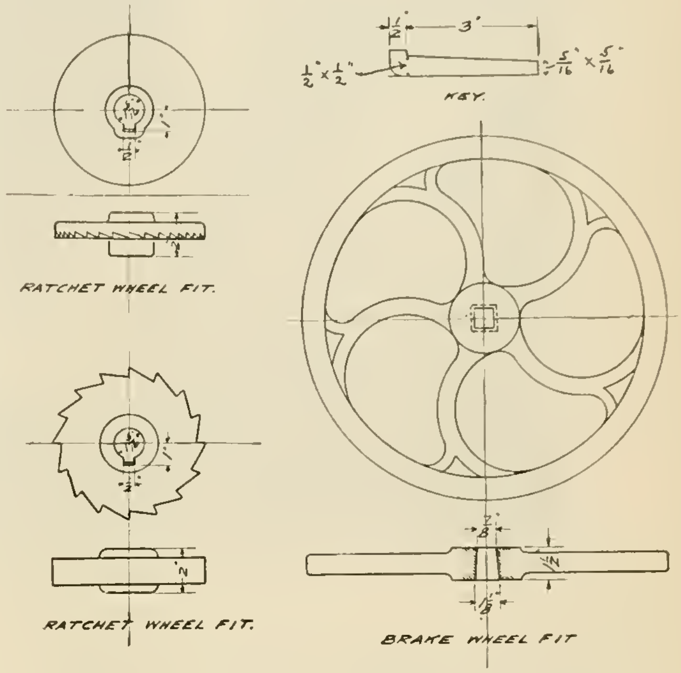
A circular of inquiry was addressed to the members asking for certain information concerning the present practice regarding brake shafts and their attachments; replies received to this circular covered over thirty-eight per cent. of the total number of cars represented in the Association. When these replies were received and tabulated there were found to be such marked differences in the dimensions that no definite decision as to the proper dimensions could be arrived at without arbitrarily taking dimensions which would represent the greatest number of cars interested. This is what your committee has done.

After determining the dimensions in this way, a separate plate has been prepared showing recommendations for the brake shaft, brake chain, manner of fastening brake chain to brake shaft, size of wheel fit for brake wheel, and a size and form of fit for the ratchet wheel and a key for securing the ratchet wheel to the brake shaft. The committee recognizes that these dimensions are more or less arbitrary, on account of the manner in which they were obtained, and would recommend their use only on new cars to be built hereafter, or in rebuilding old cars.

On account of the great difference and variety of ratchet wheels the committee is not at this time able to recommend any more than the shaft fit in the ratchet. The same can be said about the form and diameter of brake wheel; the committee did not deem it as being of sufficient importance to arbitrarily make a design for the acceptance of the Association.

*Foundation Brake Gear.*—To propose sizes for rods and other details of foundation brake gears to suit the different types of air brake equipment. This question was raised principally from the extensive use being made of the 10-inch brake cylinder. During the transition period the committee thought best not to work over the several details, but instead to add a note under "levers and connections," Sheet M. C. B. 9, stating that for brake cylinders larger than 8 inch or for brake cylinder pressures above 50 pounds per square inch, the size of brake rods and brake levers shown would be increased, if necessary, so that the fiber stress shall not exceed 15,000 pounds per square inch for rods and 23,000 pounds per square inch for levers.

A suggestion from the Committee on Standards was to consider the question of discontinuing the use of malleable iron material for bottom or truck lever connections. The committee, after carefully considering this question, recommends the erasure




from Sheet M. C. B. 9 of all reference to malleable iron construction, leaving the alternate note in force, namely, that the truck connections be made of round iron or steel not less than 1⅝ inches in diameter.

*Ball Joint Unions.*—The question of ball joint unions and the interchangeability of parts. The committee is not prepared to report on this subject and asks for further time.

*Action.*—After considerable discussion it was decided to refer the report to letter ballot.

## LOADING LONG MATERIAL.

The committee reported that it had no recommendations to make. Some matters had been presented to it, but they involved phases to which more time should be given before making definite recommendations.

## ARBITRATION COMMITTEE.

A large number of changes in the interchange rules were suggested to this committee, a few of which were approved of by the committee. The recommendations of the committee were adopted; also some additional changes which were decided upon after the report was published. The decisions of the arbitration committee made during the year were also approved of.

## REVISION OF STANDARDS AND RECOMMENDED PRACTICE.

COMMITTEE:—T. S. Lloyd, chairman; J. E. Buker, T. M. Ramsdell, W. E. Dunham, R. L. Kleine.

*Action.*—A number of suggestions were made to this committee in response to its circular of inquiry. Many of these were not approved by the committees; the others were approved or referred to other committees for investigation.

A minority report was presented by Mr. Kleine concerning the stenciling of cars and was adopted by the association. With this exception the report of the committee was also adopted.

One of the most important recommendations was that the drawings in connection with the standards and recommended practice be revised and enlarged and that the text also be carefully revised.

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*[An abstract of the reports of the committees on Coupler and Draft Equipment, Car Wheels, Freight Car Trucks and Revision of the M. C. B. Repair Card, together with discussions thereon, will appear in the August issue.]*

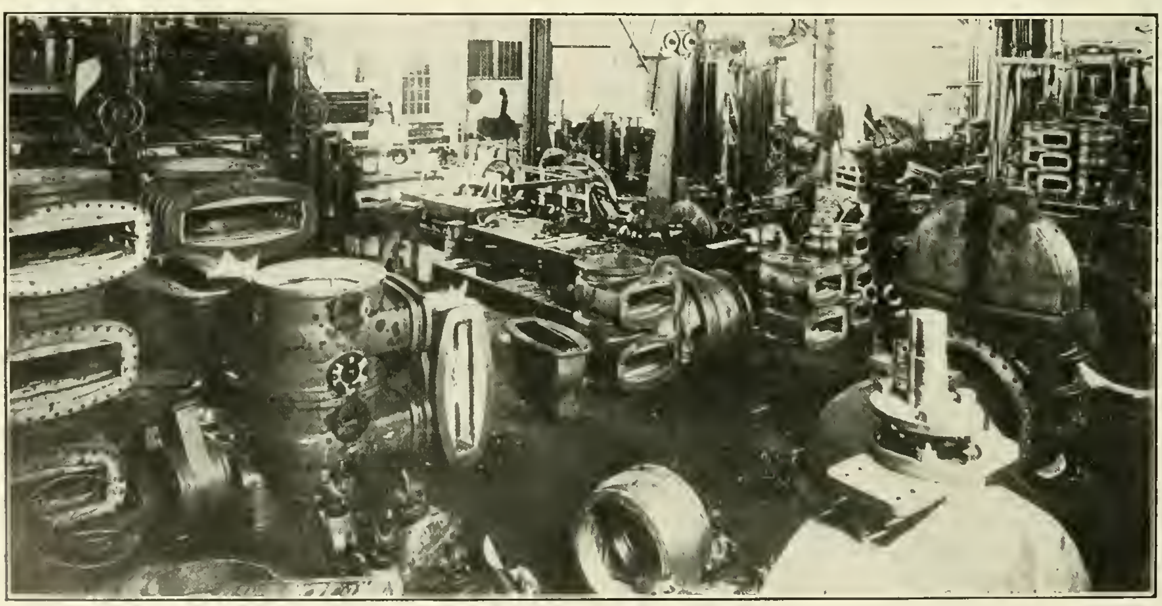
## THE LIGHTING OF ERECTING SHOPS AND HEAVY MACHINE SHOPS.

S. H. Knapp.

The artificial lighting of the work in erecting shops and heavy machine shops, such that the employees can have working conditions equal to daylight, has in the past been a difficult problem. The great height of the heavy cranes has made it necessary to place most, if not all, of the lighting units underneath the cranes. In many instances it has been impossible to install lamps anywhere except on the side walls, although it is readily apparent that with an arc or incandescent cluster in that position much of the light is absorbed by the dark walls, and consequently the lighting is most unsatisfactory in the center of the room. Again, with low lighting from the side walls, locomotives or high machines may hide the source of light, producing large shadows in the center of the floor. Were it possible to obtain from skylights all the daylight required for satisfactory lighting, this arrangement would unquestionably give the best distribution and diffusion. Accordingly, if these satisfactory conditions can be artificially duplicated by placing the light source directly over the machines and workmen, a better distribution and the avoidance of eclipsing shadows will be obtained.

The Cooper Hewitt lamp, with its perfect diffusion resulting from a large luminous surface, makes possible the satisfactory illumination of a floor surface from a much greater height than was formerly considered possible. At the same time the comparative length of light source in the 50-inch tubes makes it possible for heavy cranes to pass underneath without causing any

LOCOMOTIVE ERECTING SHOP ILLUMINATED BY COOPER HEWITT LAMPS.



COOPER HEWITT ILLUMINATION OF MACHINE SHOP, RENSSELAER MANUFACTURING COMPANY.

sharply defined shadows. This, with the absence of glare, as obtained from other illuminants, makes it possible for the mechanic to distinguish details in his work with accuracy.

The accompanying photograph shows an erecting shop of one of the large railroad systems lighted by 34 type F Cooper Hewitt lamps, giving 28,900 candle-power at a current consumption of 13.6 kilowatts. The building is 442 by 94 feet, or has 41,550 square feet of floor area. The height of the lamps from the floor is 50 feet, and 1,225 square feet of floor surface is allowed per lamp. In an adjoining erecting shop of three-fourths the size, two and one-half times as much power is being used to furnish arc lighting from the side walls, with most unsatisfactory results.

In heavy machine work, some idea of Cooper Hewitt illumination may be obtained from the accompanying view of a section in a room of the Rensselaer Manufacturing Company, at Troy, N. Y., where hydraulic valves to the weight of twenty-six tons are manufactured. This room contains 10,180 square feet of floor surface and is lighted by ten Type K Cooper Hewitt lamps, giving 7,000 candle-power. This installation has been in service since October, 1907, and the total cost for maintenance has been $24.00 to June 1st, 1909. It is interesting to compare this maintenance item for almost two years (in which the labor element is almost wholly eliminated), with that of any of the other systems of lighting, and to contrast it with the attention demanded by arc-lighting systems, particularly of the flaming type, which if used many hours per day total a maintenance cost almost prohibitive.

By using Copper Hewitt lamps the manufacturer can obtain a great volume of serviceable light at a minimum expenditure of electrical energy; the source of light may be installed at a great height and still give satisfactory floor illumination; the shadows can be almost wholly eliminated, and a perfect diffusion of pleasing light, the equal of daylight for manufacturing purposes, can be obtained. The very long life of the tubes—numerous installations having averaged over seven thousand hours' burinng—assures an economical maintenance, and the user is not subject to the annoyance and delay often caused where it is necessary to retrim arc lamps during working hours. Many of the large railroad systems throughout the country after testing different forms of illumination have installed and extended their systems of Cooper Hewitt lighting.

## CORRECTION.

By accident in the press room, the denominator of the fraction within the parenthesis in Mr. Curtis' article on page 233 of the June number was lost. The formula should read:

$$C = G - \left(\frac{2HE}{G}\right)$$

Nut Locks.—The wonderful growth during recent years of the use of nut locks in locomotive and car construction may be indicated by the fact that 60,000,000 Bartley nut and bolt fasteners are now in use, although the manufacture of these was only commenced in July, 1902. In 1902 The American Nut & Bolt Fastener Company, of Pittsburgh, employed twelve men who made about 400 of these per day by hand. To-day a large factory is equipped with automatic machinery which has a capacity of 200,000 per day. Over 700 different kinds, shapes and sizes of Bartley fasteners are manufactured.

The Abuse of Belting.—It is a fact that in the average shop very few belts become unfit for use through legitimate wear, but rather through accidents or improper care. Where the care of the belts is left to the workman, the belts are usually far too loose, and when a belt slips it is less trouble for the workman to reduce his speed, feed, or depth of cut, or as a last resort to use rosin to make the belt pull. This use of rosin will ruin any belt in a very short time.—*Prof. C. H. Benjamin before the A. S. M. E.*

## CANADIAN PACIFIC RAILWAY SAFETY LEAGUE.

The Canadian Pacific Safety League, of West Toronto (said to be the first of its kind in America), held a grand smoking concert on Friday evening, May 21st. About 300 employees were present. Thirteen meetings of the League have been held to date with much benefit to those who have attended. Upwards of thirty rules and other practical topics have been discussed, some of them several times, and as a result a number of rulings have been obtained. The league has 63 members enrolled, while upwards of two to three hundred employees have attended one or more meetings and come under its influence. A league has also been formed at Havelock, which is doing good work.

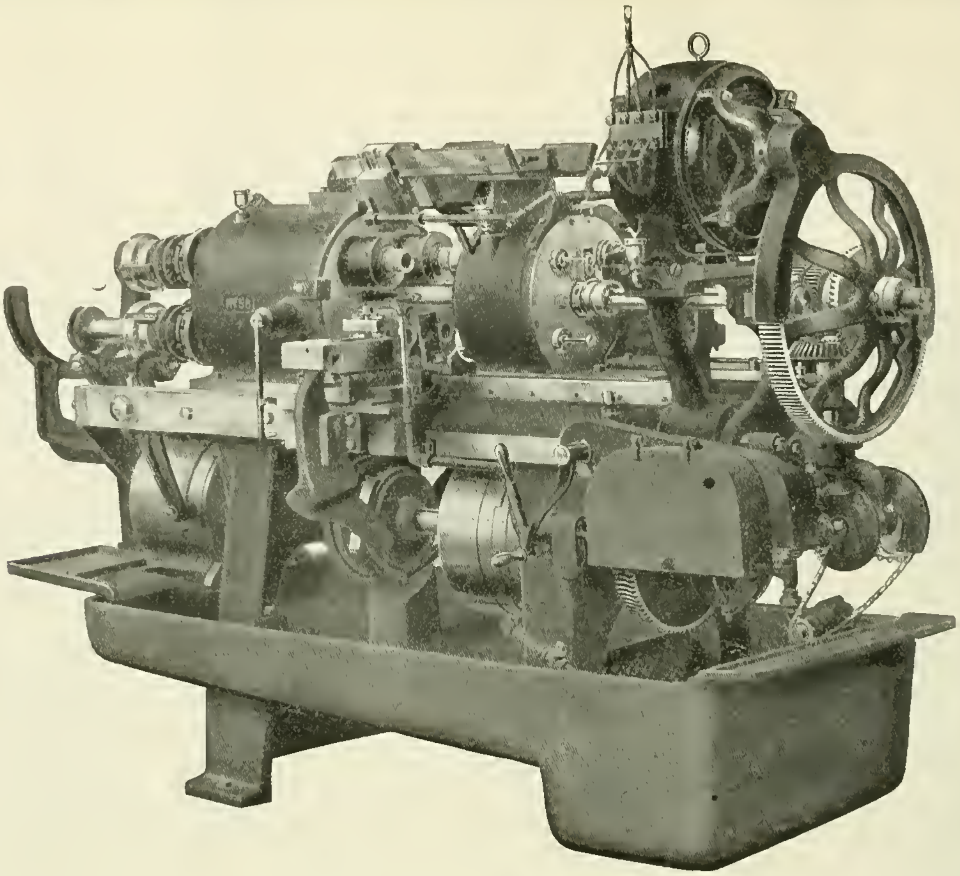
It is believed that every man belonging to the league and entering into the spirit of it, will become a more careful and competent employee; not one of the members has come under the stigma of a demerit mark since joining it. The aim of the league is to mutually benefit one another by lessons gained from daily experience on the road, in the shop, etc.; lessons which will teach the members to strictly observe the rules, to exercise the best possible judgment by pointing out the wrong way to do things and to observe caution in carrying out the high and important duties connected with the handling of trains, etc.

It may be added that the league was organized expressly for the employees, and while high officials are not excluded from the meetings they are not supposed to attend. The Safety League, therefore, is a place where employees may meet and express themselves freely on any matters affecting their work. All complaints discussed and suggestions made, etc., are strictly confidential and are acted on impersonally. C. Hudson, of the fuel department at West Toronto, is secretary.

Standardization Need Not Check Progress.—It must not be understood that the standards are so inflexibly maintained as to check improvement and initiative. Every officer and employee concerned knows that suggestions and criticisms are welcome, and as soon as proof can be offered that a new device or practice is better than the old its adoption quickly follows. Our plan requiring all officers concerned to vote on the adoption of a new device certainly curbs costly and ill-considered experiments. Nothing in our policy forbids experimenting with new devices, but it does forbid their adoption and use on a large scale until their merit has been thoroughly demonstrated to the satisfaction of all the general officers interested. Our officers appreciate that they are working out an experiment in railroad operation, and the knowledge that a new idea or successful device of any sort, if proven successful, will be adopted as standard practice on all of the Associated Lines acts as a powerful stimulus to originality and initiative.—*J. Kruttschnitt before the New York Railroad Club.*

Railroad Employees and the Public.—It is unfortunately true that all railway employees are not uniformly courteous and considerate in their dealings with the public. The improvement of the service of this company in this respect is a matter to which I am giving a great deal of personal consideration. There are necessarily many cases of improper treatment of passengers and shippers that can never come to our attention, unless they are made the subject of complaint. I appreciate the fact that people are often deterred from making complaint by the fear that it might result in the discharge of the offending employee, but discharge in such a case would only be resorted to after all other methods had failed.—*W. W. Finley.*

Individual Drinking Cups.—The D., L. & W. Railroad has installed in the cars on some of its best passenger trains, an apparatus for delivering individual paper drinking cups to the passengers. The arrangement is such that each cup used must be either destroyed or carried away and each passenger takes a fresh cup which has been manufactured and put in the machine without being touched by the hands.



## MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE.

The standardization of parts and the concentration of manufacture on railroads has made possible the introduction of highly specialized labor-saving machinery in railroad shops. The automatic screw machine will turn out a much greater amount of work than the hand screw machine; it occupies about the same floor space and requires only ¼ to 1/6 the attention, one man being able to operate several of these machines. The automatic machine is not so complicated as might be expected and even a multiple spindle machine of this type can be attended to by practically the same class of labor as used on a hand screw machine. The saving in the labor cost, great as it is for the automatic over the hand machine, is still greater with the multiple spindle machine, since all the operations on a piece are performed at the same time.

The application of the individual motor drive to these machines has also done much to increase their productiveness and efficiency by preventing the breakage of tools, allowing the high speed of the machine to be used to a greater extent and by bringing the entire control of the machine under the hand of the operator, while in a position to observe the work.

Some idea of the work which may be done by the multiple spindle automatic screw machine (an "Acme" No. 56, 2¼ in. chuck capacity, 10½ in. feed and 8 in. mill) may be gained from the following data.

The hexagon cap screw, shown in Fig. 1, is made from 1⅝ in. hexagon black steel at the Montreal shops of the Canadian Pacific Railway. They are produced at the rate of sixteen per hour.

The drilled piece without threads, Fig. 2, is made from 1 15/16 in. cold rolled steel by the Chicago & Northwestern Railway at the rate of eight pieces per hour. The larger hole is 1⅜ in. in diameter and 3½ in. long, making a heavy drilling cut.

The small wrist pin, Fig. 3, was made by the H. K. Porter Company, Pittsburgh, Pa., at the rate of 9½ pieces per hour.

The staybolt sleeve at the left in Fig. 4 is made from 1⅞ in. cold rolled steel at the Juanita shops of the Pennsylvania Railroad at the rate of 32½ pieces per hour. Both threads are cut at one time in the third position; the smaller one is a pipe thread and the larger one a machine thread. The sleeve at the right is made from 1⅞ in. cold rolled steel at the rate of 37½ pieces per hour.

The "Acme" multiple spindle automatic screw machine has four spindles, each of which carries a rod or bar of metal. Eight

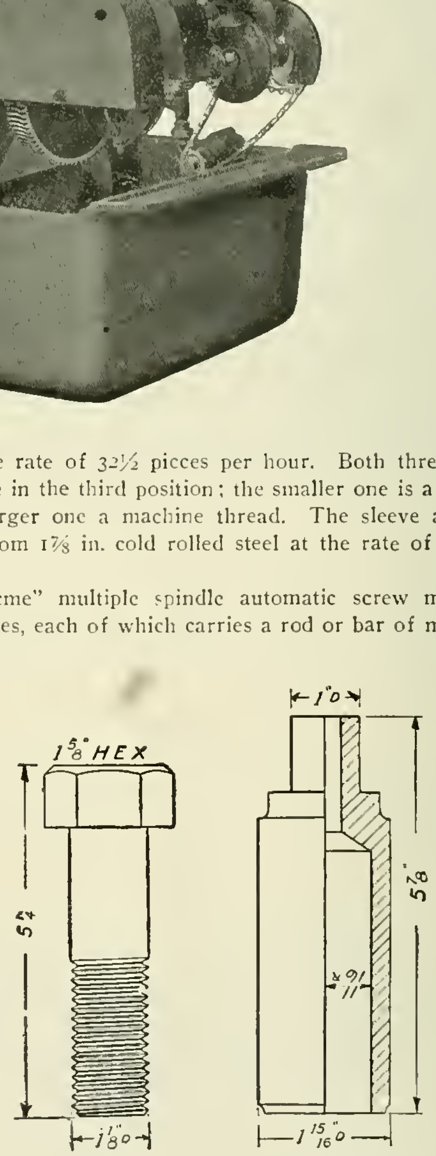



FIG. 1. FIG. 2.

tool positions—four from the side and four from the end—allow an exceptional number of operations. More than this are frequently possible by a combination of tools in one or more positions, or by the use of special attachments.

All the operations are performed simultaneously, consequently the time for finishing any one piece is that required to perform the longest single operation on it. The method is a progressive one, a finished piece being cut from each bar after it has been successively operated on in the four positions.

Accuracy of alignment is maintained by a positive locking of the spindle carrying cylinder, compensation for wear being provided. All rotary movements are continually in one direction, thus eliminating the strains due to reversing the revolving parts. The threading operation is accomplished while the stock is stationary, the tool being rotated at the speed best suited to the

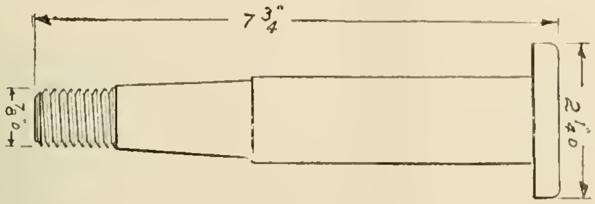



FIG. 3.

size of the piece, the pitch of the thread, and the cutting qualities of the stock. No force, other than the rotary, is required, the lead of the tools being governed entirely by the pitch of the thread. A positive start for the thread is provided by a lever movement. All the tools are flooded with oil while in operation.

The absence of multiple belts simplifies the application of power to the machine, and makes the relation between the revolutions of the stock and the lead of the tools constant and positive, making possible accurate timing of changes from so-called idle movements (withdrawal of tools, indexing cylinder, etc.)

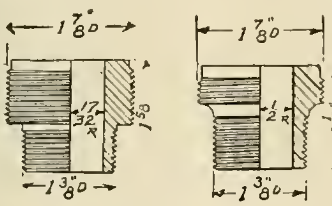



FIG. 4.

to the cutting movements. The maximum use of the high speed is made possible, resulting in a larger production; the cost of maintenance and repairs is reduced; operation is simplified and made more convenient.

An individual motor drive may be applied by the substitution of a driving gear in place of the driving pulley and the addition of a motor platform and support, with the motor and the controller. Either direct or alternating current motors may be used. No additional floor space is required and the motor driven machines are symmetrical and compact in appearance. These machines are manufactured by The National-Acme Manufacturing Company, Cleveland, Ohio.

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Dinner to Hugh M. Wilson.—As a mark of appreciation of his work and of regard for his personality, about 200 friends of Hugh M. Wilson, formerly publisher of the *Railway Age*, gathered at a banquet at the Hotel Chelsea, Atlantic City, on the evening of June 19 and paid to him one of the most remarkable tributes ever given to a man in this field of work. The sincerity of the speakers in their almost extravagant praise, and they included some of the most prominent men in the railway and railway supply worlds, as well as of the applause of the listeners, was unmistakable. His ability, resourcefulness, energy, patience, cheerfulness and loyalty were recounted with ready eloquence, and every eulogistic remark was greeted with enthusiastic plaudits.

Representatives from railroads in all parts of the country, some of the largest manufacturing firms and all of the railroad press were present to greet their common friend.

This fully deserved tribute was arranged under the direction of the following general committee:

F. A. Delano, Daniel Willard, W. F. Allen, A. W. Gibbs, F. H. Clark, J. F. Deems, Wm. McIntosh, C. A. Schroyer, C. A. Seley, F. A. Barbey, G. M. Basford, Scott H. Blewett, J. Alexander Brown, George H. Bryant, S. P. Bush, O. H. Cutler, Frank Dinsmore, Harry W. Frost, B. A. Hegeman, Jr., J. M. Hopkins, George A. Post, Charles Riddell, W. M. Simpson and Albert Waycott.

## ASBESTOS PROTECTED METAL.

For roofing, headlining or sheathing of passenger cars, for use in box car roofs or for the roofing or siding of buildings Asbestos Protected Metal is in many respects an ideal material. It consists of a sheet of steel dipped in a special asphalt compound. The steel is thus hermetically sealed within the compound so that air, moisture, gases or acids cannot attack it. Pure asbestos felt is then rolled into the compound on both sides of the sheet.

While the sheet is very light in weight it is thoroughly protected from rust and corrosion. It thus has an important advantage over iron and sheet steel, which must be frequently repainted to keep them in a serviceable condition. Another important advantage is that it is not subject to condensation on the inner surface when used in building construction. The material is fireproof and will stand a very great amount of heat without drawing or buckling. Where beaded or corrugated sheets are used in building construction, wood sheathing may be eliminated, greatly reducing the fire risks. It offers special advantages for use as headlining of passenger coaches as it may be easily bent or shaped to suit the contour of the roof without danger of cracking or breaking. The asbestos surface is treated with a special process so that it will take any desired finish in solid colors, tints or imitation of grained woods.

This material is made in two qualities, one with a grade of asbestos suited for interior finish and the other on which a special hard waterproof felt is used suited for general roofing and siding purposes in building construction. It is manufactured in several forms and in three colors—white, gray and terra cotta—by the Asbestos Protected Metal Company, Canton, Mass.

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## HYDRAULIC JACKS.

It is difficult to handle a hydraulic jack from place to place, especially if it weighs more than a hundred pounds, whether it is carried by hand or is loaded on a truck after each using. To overcome this the Watson-Stillman Company has designed a line of jacks having wheels on the base, as shown by one of the illustrations. By tilting the jack so as to throw the weight on the wheels it can readily be moved about from place to place


NEW HYDRAULIC JACK.

by means of the handle. These jacks are made in eleven sizes of from 20 to 50 tons capacity and lifts of from 12 to 18 inches. The wheels touch the floor only when the jack is tilted and are not in the way during the lifting operation. If it is desired to use the jack at an angle, it can be tilted in the opposite direction to the wheels; when it is laid flat upon the side, the ram will push out to its entire lifting length.

The head is enlarged sufficiently so that the jack will not stop working for lack of filling, even if there has been a slight leakage. An independent steel claw (not shown in the illustration) can be used, when desired, for lifting from near the ground. This is more convenient than a permanently attached claw, as the independent part is easily applied when a low lift is required, and its removal at other times allows the jack to be made of considerably lighter weight. The weight is comparatively small because the whole jack is made from steel, and the parts under greatest strain, such as the ram and cylinder, are machined from a solid bar of higher carbon steel than is usually found in hydraulic or other jacks. This jack, though plain in construction, has proved very reliable in service, and on account of its special design greatly facilitates the handling of heavy equipment.

It is sometimes inconvenient to work the lever of a jack of the internal pump type because of the lack of room, or insufficient footing. There are also places where only a short space is available to place the jack—another condition which cannot be met successfully with the ordinary internal pump jack. In some instances it is advisable for the operator for his safety to be some distance from the jack. To meet these conditions the Watson-Stillman Company has put on the market an independent pump hydraulic jack shown in the second illustration and which is furnished in fifty-three sizes of from 2 to 1,200 tons capacity. The various sizes of the jack proper have maximum ram movements of from 4 to 8 inches. The pump is connected to the jack by means of flexible copper tubing, which may be of any length suitable to the work in question. The jack may be operated up to a pressure of 450 pounds per square inch on the ram by means of the extension lever. The gauge may read in pounds per square inch, or in tons load upon the jack, or both. When equipped with the gauge the jack may be used between two fixed platens for making compression tests, testing the tightness of forced fits, etc.


INDEPENDENT PUMP HYDRAULIC JACK.

A Good Convention Issue.—*The Railway & Engineering Review* is to be congratulated on the issue of June 19th. It is a difficult task to get hold of good material in the line of new car designs just at this time and the editors rather surprised their friends by bringing out in detail a new design of fifty-ton steel gondola car as well as the details of an all-steel sleeping car which is being built for the Pennsylvania Railroad by the Pullman Company.

## PERSONALS.

B. R. Moore has been appointed master mechanic of the Mississippi Central Ry.

William M. Saxton has been appointed the master mechanic of the North Coast Railroad, with office at Spokane, Wash.

R. Preston has been appointed master mechanic of the Central division of the Canadian Pacific Ry., with office at Winnipeg.

Henry Montgomery has been appointed master mechanic of the Allegheny division of the Pennsylvania R. R., with office at Oil City, Pa.

J. A. Baker has been appointed master mechanic of the Vera Cruz & Isthmus Ry., with headquarters at Tierra Blanca, Vera Cruz, Mex.

W. E. Fowler, master car builder of the Canadian Pacific Ry. and a past president of the Master Car Builders' Association, has resigned on account of ill health.

R. W. Burnett, assistant master car builder, Eastern Lines, Canadian Pacific Ry., has been appointed master car builder, succeeding W. E. Fowler, resigned.

The jurisdiction of T. O. Sechrist, master mechanic, with office at Ferguson shops, Ferguson, Ky., has been extended over the entire Cincinnati, New Orleans & Texas Pacific Ry.

B. D. Lockwood, mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., has resigned. Mr. Lockwood has been appointed assistant chief engineer of the Pressed Steel Car Co.

H. R. Brigham has been appointed road foreman of engines of the Buffalo division of the Pennsylvania R. R., with office at Buffalo, N. Y., succeeding G. O. Taylerson, assigned to other duties.

W. G. Seibert has been appointed master mechanic of the Missouri Pacific and the St. Louis, Iron Mountain & Southern Rys., with office at Fort Scott, Kan., succeeding T. F. Carbery, assigned to other duties.

M. E. Hamilton has been appointed the general air-brake inspector of the Atchison, Topeka & Santa Fe System, with office at Topeka, Kan. He will have full charge of all matters pertaining to air-brakes.

T. F. Carbery, master mechanic of the Missouri Pacific and the St. Louis, Iron Mountain & Southern Rys., at Fort Scott, Kan., has been appointed general foreman of the shops of these roads, with office at St. Louis, Mo.

A. H. Powell has been appointed master mechanic of Salt Lake and Humboldt division of the Western Pacific Ry., in charge of the motive power and car department, with headquarters at Salt Lake City, Utah.

R. G. Turnbull has been appointed master mechanic of the Missouri Pacific Ry., the St. Louis, Iron Mountain & Southern and leased, operated and independent lines, with office at Osawatomie, Kan., succeeding M. M. Myers, resigned.

G. W. Robb, assistant master mechanic Grand Trunk Pacific Ry. at Rivers, Man., has been appointed master mechanic, in charge of motive power, cars and shops, with office at Rivers, succeeding Wm. Gell, resigned on account of ill health.

J. H. Murphy, master mechanic of the Cincinnati, New Orleans and Texas Pacific Ry., at Ludlow, Ky., has been appointed general foreman at the Ludlow shops, with jurisdiction over the mechanical department forces from Cincinnati to Lexington, inclusive, and his former office has been abolished.

C. E. Chambers has been appointed general master mechanic of the Central Railroad of New Jersey and will have charge of the assignment of motive power over the entire system and will perform such other duties as may be assigned to him. The office of division master mechanic at Ashley has been abolished.

T. R. Brown.—For the purpose of enlarging their New York interests and developing the engineering end in connection with large steam power station installations, E. Keeler Company, of Williamsport, Pa., have associated with them T. R. Brown as chief engineer, with headquarters at 29 Broadway, New York.

Mr. Brown is an engineer of wide practical and theoretical experience. He was formerly connected with the Pennsylvania Railroad as master mechanic of the Juniata shops at Altoona; also with the Westinghouse interests and lately with the American Car & Foundry Company. He is particularly well equipped for the new work he has taken up.

## BOOKS.

Westinghouse E-T Air Brake Instruction Pocket Book. By Wm. W. Wood. Cloth. 5 x 7 in. 236 pages. Fully illustrated. with colored plates. Published by Norman W. Henley Publishing Co., 132 Nassau street, New York. Price, $2.00.

The new Westinghouse engine and tender brake equipment is most completely described in detail in this book, which is written by an air brake inspector. It is profusely illustrated with colored plates, enabling the reader to trace the flow of pressures throughout the entire equipment. It is written in such form to be equally as good for a beginner or for an advanced engineer. It contains questions and answers on this equipment, telling what the brake is; how it should be operated and what to do when it is defective. It is claimed by the publisher that not a question can be asked of a man up for promotion on either the No. 5 or No. 6 E-T equipment that is not answered in this book. The arrangement is logical, the descriptive matter clear and the illustrations exceptionally good.

## CATALOGS.

Interurban Railway Equipment.—Bulletin No. 1053 from Allis-Chalmers Co., Milwaukee, Wis., includes very complete illustrated descriptions of the equipment of several of the best interurban electric railways of the country.

Engine Room Gauge Boards.—The American Steam Gauge & Valve Mfg. Co., 208 Camden street, Boston, Mass., is issuing a small catalog illustrating many different arrangements of slate and marble engine room gauge boards.

Induction Motors.—The Triumph Electric Co., Cincinnati, O., is issuing Bulletin No. 351 devoted to the subject of induction motors in all sizes. The construction of the details is fully covered and illustrations are shown of direct connected sets for various purposes.

Grinding and Polishing Machinery.—The Webster & Perks Tool Co., Springfield, O., is issuing a catalog given up to illustrations and full specifications of grinding and polishing machinery, which is shown in many different sizes and types. The prices are included.

Electric Headlight.—The Dake-American Steam Turbine Co., Grand Rapids, Mich., is issuing a leaflet fully illustrating and describing the Dake Electric headlight, which is claimed to consume less than one-sixth the amount of steam required by any other headlight set on the market, candle power considered.

Pipe Cutting Machinery.—The Curtis & Curtis Co., Bridgeport, Conn., is issuing a 36-page catalog devoted entirely to apparatus for pipe cutting and threading. The Forbes patent die stock used with both hand and power is fully illustrated and described in practically any desired size or arrangement. Various accessories demanded in work of this kind are also shown.

Electrical Apparatus.—Among the recent bulletins being issued by the General Electric Co., Schenectady, N. Y., is No. 4669, illustrating and describing the various types of Curtis steam turbine for low and mixed pressures. No. 4662 illustrates and describes the various types of Thompson recording wattmeters for both direct and alternating current.

Motor Cars and Velocipedes.—The Buda Foundry & Mfg. Co., Railway Exchange, Chicago is issuing catalog No. 134 devoted to illustrations and brief descriptions of motor velocipedes, inspection cars, section gang cars, bridge gang cars and power cars. All of these cars are driven by gasolene engines and have proven to be most satisfactory in hard service. The Buda pressed steel wheels are used on all cars.

Lubricators.—The Detroit Lubricator Co., Detroit, Mich., is issuing a new 61-page catalog which fully illustrates and describes oiling devices of all kinds, as well as special gate and globe valves and other pipe fittings. In addition to sight feed lubricators for stationary and locomotive work in many sizes, there are oil cups, oil pumps, grease cups, special oiling devices for large engines, water glasses, etc. Numbered sketches are included giving the names and prices of various repair parts for different sight feed lubricators. A telegraph code is provided.

Lubrication Versus Friction.—The Dearborn Drug and Chemical Co., Postal Telegraph Bldg., Chicago, is issuing a very interesting booklet under the above title. It is devoted to an extended and semi-technical discussion of the value of different lubricants and the proper lubricants to be used under any set conditions. The manufacture and blending of various kinds to best meet the demand is fully considered and the methods of testing lubricants for all the various qualities are fully described. This booklet will be found to be most interesting to all machinery users.

Gasolene Locomotives.—The Milwaukee Mfg. Co., Milwaukee, Wis., is issuing a 28-page catalog illustrating and describing several different models of gasolene locomotives, which include sizes suitable for light shifting around manufacturing plants up to large sizes capable of handling a number of passenger or freight cars for some distance. These locomotives require but one operator and tables are included in the catalog giving the specifications and the hauling capacity on various grades at various speeds. The locomotives are said to be particularly well adapted for motor car service.

Hydraulic Machinery.—William H. Wood, Engineer, Media, Pa., is issuing a book of particulars of his improved hydraulic machinery. It contains 56 pages, giving half-tone and line drawing illustrations, with brief descriptions, of a great variety of riveters, flangers, presses, etc. There are also included hydraulic wheel presses, and flanging clamps specially adapted for railway shops use. Hydraulic pumps and various accessories for machinery of this kind are also shown. Many testimonial letters are reprinted in the back of the catalog, which speak most highly of the machinery manufactured by this company, now in operation.

Vertical Turret Lathe.—The Bullard Machine Tool Co., Bridgeport, Conn., is issuing a very attractive catalog, fully illustrating and describing what is called "the vertical turret lathe" which actually performs most of the functions of a high class turret lathe, the centers being in a vertical instead of a horizontal position. This is a machine tool of exceedingly high character of design and construction and the illustrations in the catalogue are so arranged as to make clear its many valuable features. Operating instructions are fully given and sketches showing the surprising adaptability of the machine to work on special shapes, several tools being in operation at one time, are very convincing. The catalog is arranged and printed in excellent taste throughout.

## NOTES.

Lima Locomotive & Machine Co.—George L. Wall, who has been mechanical engineer of this company, has been promoted to assistant general manager.

H. W. Johns-Manville Co.—Henry J. Bellman has been appointed manager of the hair felt department of this company with office at 100 William street, New York.

North-Western Metal Manufacturing Co.—A. Munch, formerly sales-manager of the Northern Metallic Packing Co., of St. Paul, Minn., has become identified with the above company, of Minneapolis, Minn., as sales-manager of the Railway Department.

Quincy-Manchester-Sargent Co.—In order to simplify details in connection with correspondence, telephoning, etc., the Quincy-Manchester-Sargent Co., Plainfield, N. J., has deemed it advisable to change its name and hereafter will operate under the corporate name of "The Q M S Co."

Safety Car Heating & Lighting Co.—The axle-driven dynamo system of electric car lighting is reported as coming into favor very rapidly as business improves. Among the recent orders for equipping cars with this system are the following: Rock Island, 157 cars; Southern, 125 cars; New York Central, 25 cars; Lehigh Valley, 15 cars, and Pullman Co., 10 cars.

Wolfe Brush Co.—I. R. L. Wiles, until recently Supply Agent of the Missouri Pacific Ry., has resigned his position to become Second Vice-President of the above company with office at Pittsburgh, and will have charge of the railroad department. This company has made railroad brushes almost exclusively since 1851.

LINCOLN MOTOR WORKS COMPANY.—This company announces that it has changed its name to the Reliance Electric & Engineering Co., the management, however, remaining the same. This company is now specializing in machine shop practice and is equipped to design and manufacture all mechanical details and driving mechanism necessary in applying motor drives to any class of machinery.

SAFETY CAR HEATING & LIGHTING CO.—This company calls attention to the fact that the wreck on the Union Pacific Ry. at Castle Rock, Utah, on March 1, which caught fire, due, it was believed at first, to the rupturing of a Pintsch gas tank, has now been more fully investigated. It has been definitely established that the baggage car on which the fire occurred was lighted by oil lamps and not by Pintsch gas. None of the other cars, which were equipped with Pintsch gas, had their tanks ruptured.

BALDWIN LOCOMOTIVE WORKS.—Application has been granted by the Governor of Pennsylvania for the incorporation of the Baldwin Locomotive Works of Philadelphia to take over the business now conducted under the name of Burnham, Williams & Co. This business was founded in 1831 by Matthias W. Baldwin. The capital of $20,000,000, which the firm has heretofore had invested in the business, will be the capital stock of the company, and no stocks or bonds will be placed on the market. The present partners will be the officers and board of directors of the new corporation. In addition to the Baldwin Locomotive Works of Philadelphia, the company also owns the Standard Steel Works and a large branch plant at Eddystone, Pa. The transfer to the new company will occur July 1.

## CONVENTION EXHIBITS.

The exhibits at the Master Mechanics' and Master Car Builders' conventions at Atlantic City were even more extensive than last year, which was a record breaker. It is also understood that a number of firms who applied too late found it impossible to secure accommodations. Among the exhibitors were the following:

Adams & Westlake Company, Chicago, Ill.
Ajax Manufacturing Company, Cleveland, Ohio.
American Balance Valve Company, Jersey Shore, Pa.
American Blower Company, Detroit, Mich.
American Brake Company, St. Louis, Mo.
American Brake Shoe & Foundry Company, Mahwah, N. J.
American Car & Foundry Company, New York, St. Louis and Chicago.
American Locomotive Company, New York, N. Y.
American Mason Safety Tread Company, Boston, Mass.
American Nut & Bolt Fastener Company, Pittsburgh, Pa.
American Specialty Company, Chicago, Ill.
American Steel Foundries, Chicago, Ill.
American Tool Works Company, Cincinnati, Ohio.
American Vanadium Company, Pittsburgh, Pa.
Armstrong Brothers Tool Company, Chicago, Ill.
Asbestos Protected Metal Company, Canton, Mass.
Ashton Valve Company, Boston, Mass.
Atha Steel Casting Company, Newark, N. J.
Barnett Equipment Company of America, New York, N. Y.
Besly & Company, Charles H., Chicago, Ill.
Bettendorf Axle Company, Davenport, Iowa.
Boker & Company, Herrmann, New York, N. Y.
Booth Company, L. M., New York, N. Y.
Bordo Company, L. J., Philadelphia, Pa.
Bowser & Company, Inc., S. F., Fort Wayne, Ind.
Brighton Brass & Bronze Company, Pittsburgh, Pa.
Brown & Sharpe Manufacturing Company, Providence, R. I.
Buckeye Steel Castings Company, Columbus, Ohio.
Buffalo Brake-Beam Company, New York, N. Y.
Bullard Machine Tool Company, Bridgeport, Conn.
Carborundum Company, Niagara Falls, N. Y.
Cardwell Manufacturing Company, Chicago, Ill.
Carnegie Steel Company, Pittsburgh, Pa.
Carter Iron Company, Pittsburgh, Pa
Celfor Tool Company, Chicago, Ill.
Chase & Company, L. C., Boston, Mass.
Chicago Car Heating Company, Chicago, Ill.
Chicago Pneumatic Tool Company, Chicago, Ill.
Chicago Railway Equipment Company, Chicago, Ill.
Chisholm & Moore Manufacturing Company, Cleveland, Ohio.
Chrome Steel Works, Chrome, N. J.
Cincinnati Bickford Tool Company, Cincinnati, Ohio.
Cincinnati Planer Company, Cincinnati, Ohio.
Cleveland Twist Drill Company, Cleveland, Ohio.
Clow & Sons, James B., Chicago, Ill.
Coale Muffler & Safety Valve Company, Baltimore, Md.
Coe Brass Manufacturing Company, Ansonia, Conn.
Commercial Acetylene Company, New York City, N. Y.
Commonwealth Steel Company, St. Louis, Mo.
Consolidated Car-Heating Company, Albany, N. Y.
Consolidated Railway Electric Lighting & Equipment Company, New York, N. Y.
Cooper-Hewitt Electric Company, New York, N. Y.
Crane Company, Chicago, Ill.
Crosby Steam Gage & Valve Company, Boston, Mass.
Curtain Supply Company, Chicago, Ill.
Dake-American Steam Turbine Company, Grand Rapids, Mich.
Damascus Brake-Beam Company, Cleveland, Ohio.
Davis-Bournonville Company, New York, N. Y.
Davis Expansion Boring Tool Company, St. Louis, Mo.
Davis Solid Truss Brake Beam Company, Wilmington, Del.
Dayton Malleable Iron Company, Dayton, Ohio.
Dearborn Drug & Chemical Works, Chicago, Ill.
Detroit Lubricator Company, Detroit, Mich.
Diamond Rubber Company, Akron, Ohio.
Dickinson, Paul, Incorporated, Chicago, Ill.
Dixon Crucible Company, Joseph, Jersey City, N. J.
Dudgeon, Richard, New York, N. Y.
Duff Manufacturing Company, Pittsburgh, Pa.
Duntley Manufacturing Company, Chicago, Ill.
Edwards Company, O. M., Syracuse, N. Y.
Electric Hose & Rubber Company, Wilmington, Del.
Electric Storage Battery Company, Philadelphia, Pa.
Fairbanks, Morse & Company, Chicago, Ill.
Farlow Draft Gear Company, Baltimore, Md.
Fisher & Norris ("Eagle" Anvil Works), Trenton, N. J.
Flannery Bolt Company, Pittsburgh, Pa.
Forsyth Brothers Company, Chicago, Ill.
Foster, Walter H., New York, N. Y.
Franklin Manufacturing Company, Franklin, Pa.
Franklin Railway Supply Company, New York, N. Y.
Frost Railway Supply Company, Detroit, Mich.
Galena-Signal Oil Company, Franklin, Pa.
Garlock Packing Company, Palmyra, N. Y.
General Electric Company, Schenectady, N. Y.
General Railway Supply Company, Chicago, Ill.
Gold Car Heating & Lighting Company, New York, N. Y.
Gould Coupler Company, New York, N. Y.
Grip Nut Company, Chicago, Ill.
Hammett, H. G., Troy, N. Y.
Hanlon Locomotive Sander Company, Winchester, Mass.
Harrington, Edwin, Son & Company, Inc., Philadelphia, Pa.
Home Rubber Company, Trenton, N. J.
Hunt-Spiller Manufacturing Corporation, South Boston, Mass.
Hutchins Car Roofing Company, Detroit, Mich.
Illinois Malleable Iron Company, Chicago, Ill.
Jenkins Brothers, New York, N. Y.
Johns-Manville Company, H. W., New York, N. Y.
Joliet Railway Supply Company, Joliet, Ill.
Joyce, Cridland Company, Dayton, Ohio.
Keller Manufacturing Company, Philadelphia, Pa.
Kelly-Arnold Manufacturing Company, Wilkes-Barre, Pa.
Lackawanna Steel Company, New York, N. Y.
Landis Machine Company, Waynesboro, Pa.
Landis Tool Company, Waynesboro, Pa.
Link-Belt Company, Philadelphia, Pa.
Lodge & Shipley Machine Tool Company, Cincinnati, Ohio.
Love Brake Shoe Company, Chicago, Ill.
Lupton's Sons Company, David, Philadelphia, Pa.
Manning, Maxwell & Moore, New York, N. Y.
Mason Regulator Company, Boston, Mass.
Monarch Steel Castings Company, Detroit, Mich.
Moran Flexible Steam Joint Company, Louisville, Ky.
McConway & Torley Company, Pittsburgh, Pa.
McCord Company, Chicago, Ill.
McIlvain & Company, J. Gibson, Philadelphia, Pa.
Mogul Paint Company, New York, N. Y.
Nathan Manufacturing Company, New York, N. Y.
National-Acme Manufacturing Company, Cleveland, Ohio.
National Boiler Washing Company, Chicago, Ill.
National Lock Washer Company, Newark, N. J.
National Malleable Casting Company, Cleveland, Ohio.
National Railway Service Co., Chicago, Ill.
National Tube Company, Pittsburgh, Pa.
Newhall Engineering Company, George M., Philadelphia, Pa.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
New York Air Brake Company, New York, N. Y.
Niles-Bement-Pond Company, New York.
Norton Company, Worcester, Mass.
Norton Grinding Company, Worcester, Mass.
Parkesburg Iron Company, Parkesburg, Pa.
Pilliod Company, Swanton, Ohio.
Pittsburgh Equipment Company, Pittsburgh, Pa.
Pratt & Whitney Company, New York, N. Y.
Pressed Steel Car Company, Pittsburgh, Pa.
Queen City Machine Company, Cincinnati, Ohio.
Railway Business Association, New York, N. Y.
Railway Materials Company, Chicago, Ill.
Ritter Folding Door Company, The, Cincinnati, Ohio.
Robinson Company, Boston, Mass.
Royersford Foundry & Machine Company, Inc., Royersford, Pa.
Rubberset Brush Company, Newark, N. J.
Russell, Burdsall & Ward Bolt & Nut Company, Port Chester, N. Y.
Ryerson & Son, Joseph T., Chicago, Ill.
Safety Car Heating & Lighting Company, New York, N. Y.
St. Clair Air-Brake Company, Indianapolis, Ind.
Scullin-Gallagher Iron & Steel Company, St. Louis, Mo.
Scully Steel & Iron Company, Chicago, Ill.
Sellers & Company, Wm., Incorporated, Philadelphia, Pa.
Spencer Turbine Cleaner Company, Hartford, Conn.
Standard Coupler Company, New York, N. Y.
Standard Steel Car Company, New York, N. Y.
Standard Steel Works Company, Philadelphia, Pa.
Standard Tool Co., The, Cleveland, Ohio.
Sterling Steel Foundry Company, Pittsburgh, Pa.
Stoever Foundry & Mfg. Co., New York, N. Y.
Storrs Mica Company, Owego, N. Y.
Symington Company, T. H., Baltimore, Md.
Taylor Manufacturing Company, James L., Bloomfield, N. J.
Tindel-Morris Company, Eddystone, Pa.
Topping Brothers, New York, N. Y.
Underwood & Co., H. B., Philadelphia, Pa.
Union Draft Gear Company, Chicago, Ill.
Union Fibre Company, Winona, Minn.
Union Spring & Manufacturing Company, Pittsburgh, Pa.
U. S. Metal & Manufacturing Company, New York, N. Y.
Ward Equipment Company, New York, N. Y.
Watson Insulated Wire Company, New York, N. Y.
Watson Stillman Company, New York, N. Y.
Waugh Draft Gear Company, Chicago, Ill.
Welsbach Company, Gloucester, N. J.
West Disinfecting Co., Inc., New York, N. Y.
Western Railway Equipment Company, St. Louis, Mo.
Western Steel Car & Foundry Company, Chicago, Ill.
Western Tool & Manufacturing Company, Springfield, Ohio.
Westinghouse Automatic Air & Steam Coupler Company, St. Louis, Mo.
Westinghouse Air-Brake Company, Pittsburgh, Pa.
Westinghouse Electric Manufacturing Company, Pittsburgh, Pa.
Westinghouse Machine Company, The, Pittsburgh, Pa.
Wheel Truing Brake Shoe Company, Detroit, Mich.
Wood, Guilford S., Chicago, Ill.
Wood Locomotive Fire Box & Tube Plate Company, W. H., Media, Pa.
Wright Safety Air Brake Company, Greensboro, N. C.
Yale & Towne Manufacturing Company, New York, N. Y.

# MIKADO TYPE LOCOMOTIVE

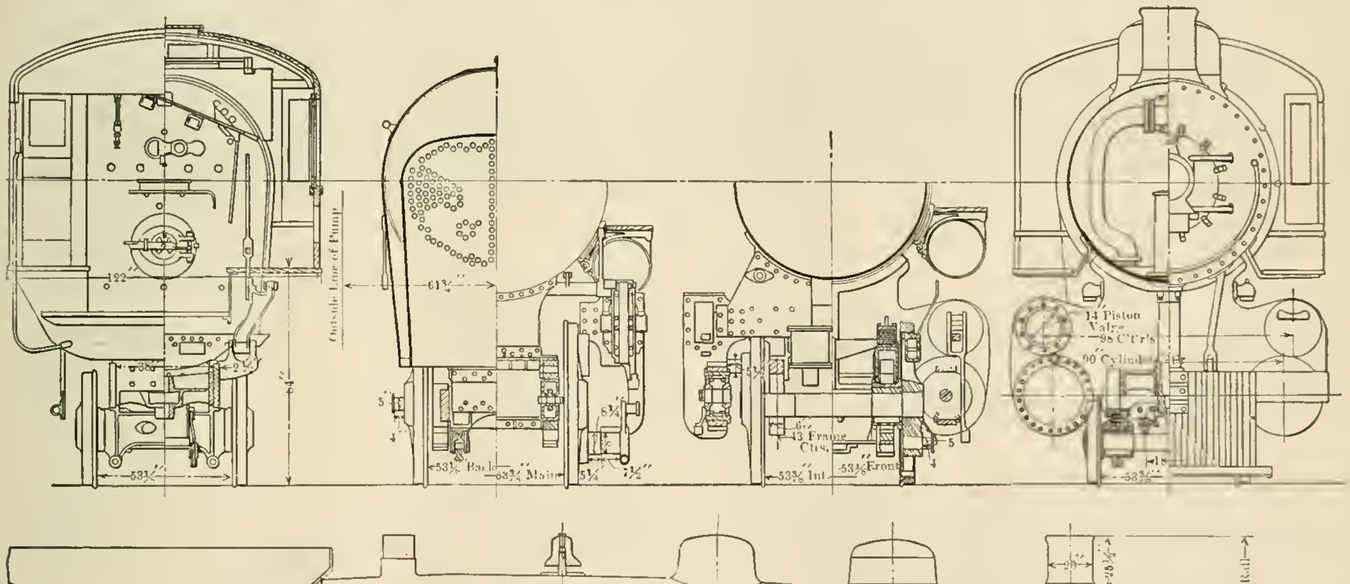
CHICAGO, MILWAUKEE & PUGET SOUND RAILWAY.

For use on its new line from the Missouri River to Puget Sound, the main line of which was recently completed, the Chicago, Milwaukee & St. Paul Railway is building in its shops at West Milwaukee, 20 Mikado type locomotives, which are constructed from drawings prepared in the mechanical engineer's office. This design is based on a most careful study of the conditions under which the locomotives are to operate and of the latest features of successful locomotive practice and contains nothing of an untried or unproven nature.

These locomotives are intended primarily for mountain service and are designed to handle 1,500-ton trains over all except a few of the heaviest grades. There are some 2 per cent. grades on this line on which two of these locomotives, or one with a pusher, will be required to handle this tonnage. Trains of 1,500 tons are brought to the foot of the mountains by Prairie type locomotives having 21 x 28 in. cylinders, 63 in. drivers and weighing 206,000 lbs., of which 142,000 is on drivers. The heaviest grade to the foot of the mountains is one-half to one per cent., which the Prairie type engines will negotiate with ease. The first locomotive of the Mikado type has been in service for two months and has proven itself capable of doing all that was expected of it. They have also shown that in cases of emergency they will be able to handle passenger trains over the mountains at almost schedule speed.

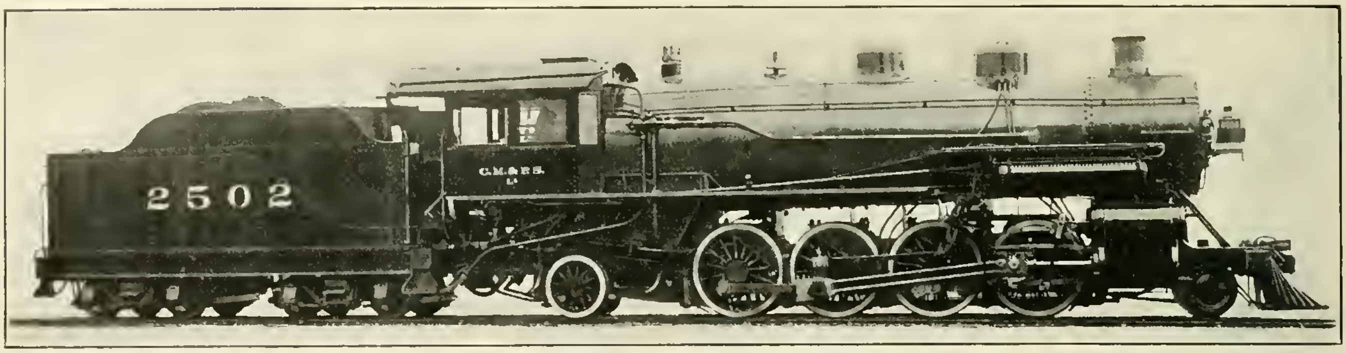
As far as power, size and weight are concerned these locomotives are practically duplicates of the same type of engine in service in a very similar region on the Northern Pacific Ry.* The design throughout is conservative and normal and a reference to the illustrations and tables of dimensions will show the general features.

The point of greatest interest is the boiler, which differs in a number of details from designs on most other railways, although it is very similar to former arrangements on this road. It incorporates a 3 ft. combustion chamber, which several years experience has shown to be a decidedly good thing for service of this character, and has 366 2-in. tubes set about 2⅞ in. centers. The tubes, 17 ft. 6 1/16 in. in length over tube sheets, give 3,332 sq. ft. heating surface. The illustration shows the scheme of locating the tubes for using the area available to the best advantage. The combustion chamber has a water space of about 8 in. at the bottom which narrows somewhat at the sides. The throat of the firebox is 28½ in. in depth to the bottom of the mud ring, a practice which was started on this road a number of years ago and has been consistently followed since. The firebox is radially stayed, there being five rows of sling stays near the front of the crown sheet, no crown bars, however, being used. Four 2-in. combustion flues, two on either side, are located in the side water legs just above the normal fire




MIKADO TYPE LOCOMOTIVE, CHICAGO, MILWAUKEE & PUGET SOUND RAILWAY.

* See AMERICAN ENGINEER, 1905, page 5, and 1906, page 392.



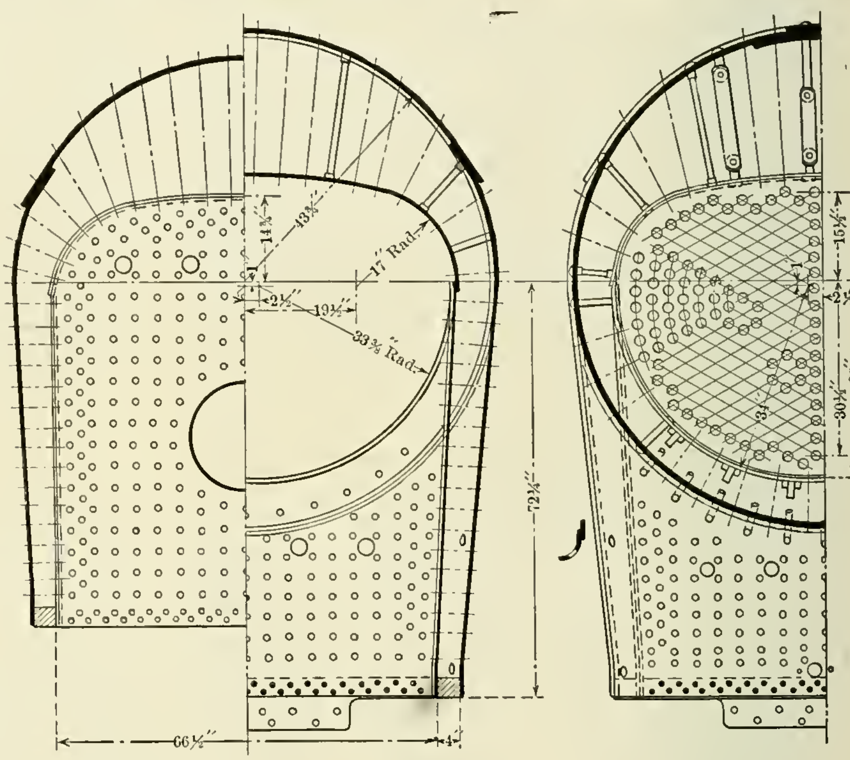

MIKADO TYPE LOCOMOTIVE FOR MOUNTAIN SERVICE.

level for air admission to improve combustion. The location of the dome on the second or central barrel sheet places it out of the range of the greatest ebullition and will doubtless give drier steam than if it was located further back.

The DeVoy type of trailer truck, which it will be remembered was used on the Vauclain compound Atlantic type locomotives, built by the Baldwin Locomotive Works for this road, and illustrated on page 115 of the March, 1909, issue of this journal, is used in this design. This truck was fully illustrated and described on page 135 of the April, 1905, issue. It is probably the simplest design of trailer truck now in successful use.

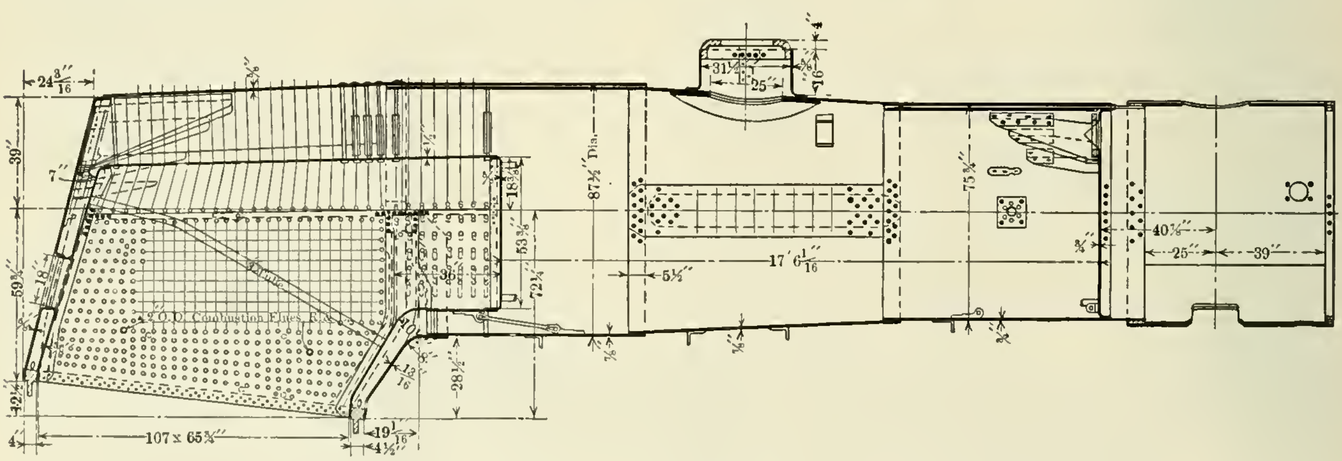
The design of these locomotives was prepared by J. F. DeVoy, mechanical engineer, under the direction of A. E. Manchester, superintendent of motive power.

The general dimensions, weights and ratios are given in the following table:



GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Service | Freight |
| Fuel | Bit. Coal |
| Tractive effort | 46,630 lbs. |
| Weight in working order | 260,500 lbs. |
| Weight on drivers | 201,000 lbs. |



BOILER, 2-8-2 TYPE LOCOMOTIVE, CHICAGO, MILWAUKEE & PUGET SOUND RAILWAY.

| | |
|---|---|
| Weight on leading truck | 25,500 lbs. |
| Weight on trailing truck | 34,000 lbs. |
| Weight of engine and tender in working order | 414,500 lbs. |
| Wheel base, driving | 16 ft. 6 in. |
| Wheel base, total | 35 ft. 1 in. |
| Wheel base, engine and tender | 65 ft. 7¼ in. |

RATIOS.

| | |
|---|---|
| Weight on drivers ÷ tractive effort | 4.31 |
| Total weight ÷ tractive effort | 5.80 |
| Tractive effort × diam. drivers ÷ heating surface | 812.80 |
| Total heating surface ÷ grate area | 74.00 |
| Firebox heating surface ÷ total heating surface, % | 7.80 |
| Weight on drivers ÷ total heating surface | 55.63 |
| Total weight ÷ total heating surface | 72.21 |
| Volume both cylinders, cu. ft | 15.70 |
| Total heating surface ÷ vol. cylinders | 230.19 |
| Grate area ÷ vol. cylinders | 3.10 |

CYLINDERS.

| | |
|---|---|
| Kind | Simple |
| Diameter and stroke | 24 x 30 in. |

VALVES.

| | |
|---|---|
| Kind | Piston |
| Diameter | 14 in. |
| Greatest travel | 6¼ in. |
| Outside lap | 1 in. |
| Inside clearance | 0 in. |
| Lead, constant | ¼ in. |

WHEELS.

| | |
|---|---|
| Driving, diameter over tires | 63 in. |
| Driving journals, main, diameter and length | 10 x 12 in. |
| Driving journals, others, diameter and length | 9½ x 12 in. |
| Engine truck wheels, diameter | 33 in. |
| Engine truck, journals | 6½ x 12 in. |
| Trailing truck wheels, diameter | 43 in. |
| Trailing truck, journals | 8½ x 14 in. |

BOILER.

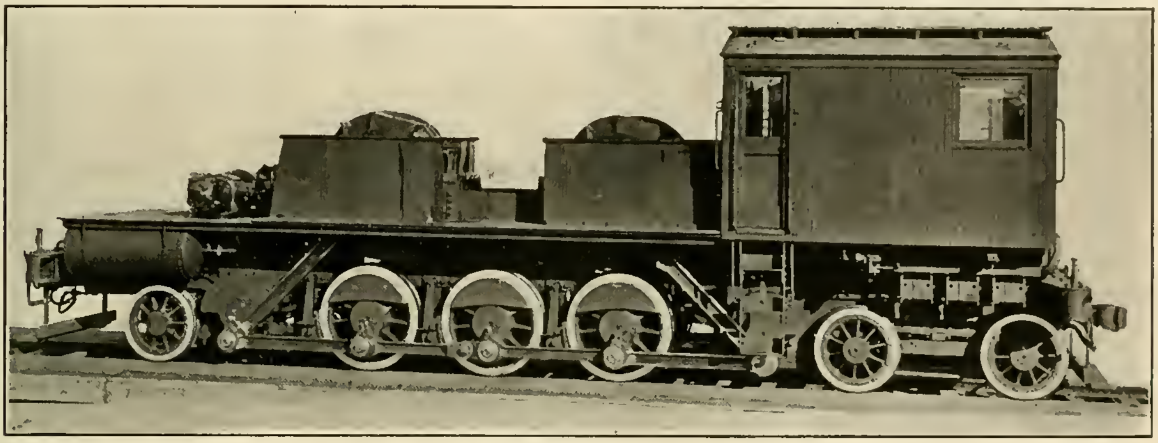
| | |
|---|---|
| Style | E. W. T. |
| Working pressure | 200 lbs. |
| Outside diameter of first ring | 75¾ in. |
| Firebox, length and width | 107 x 65¼ in. |
| Firebox plates, thickness | ⅜ in. |
| Firebox, water space | 4½ and 4 in. |
| Tubes, number and outside diameter | 366—2 in. |
| Tubes, length | 17 ft. 6 1/16 in. |
| Heating surface, tubes | 3,332 sq. ft. |
| Heating surface, firebox | 282 sq. ft. |
| Heating surface, total | 3,614 sq. ft. |
| Grate area | 48.8 sq. ft. |
| Smokestack, height above rail | 15 ft. 3 in. |
| Center of boiler above rail | 118 in. |

TENDER.

| | |
|---|---|
| Tank | Water bottom |
| Wheels, diameter | 33 in. |
| Journals, diameter and length | 5½ x 10 in. |
| Water capacity | 8,000 gals. |
| Coal capacity | 14 tons |

The motors can also be located so as to concentrate a greater portion of the weight near the center of the locomotive and allow its distribution to be adjusted as desired. It also facilitates inspection and repairs of the motors and the renewal of brushes, and also places them where they are protected from the dirt of the roadbed.

Reference to the line drawing and photograph shown herewith makes clear the general arrangement of the connections between the motors and drivers. In this case the locomotive is of the 4-6-2 type and has two large alternating current motors, mounted on the locomotive frames, within the cab. The frames are of the steam locomotive pedestal type similar to the New York Central design. The shaft of each motor is fitted with a crank at either end, the connection between the armature shaft and crank plate being made through a flexible coupling, which is also illustrated. From the motor cranks the power is transmitted through connecting rods to jack shafts, the bearings of which are secured to the locomotive frame. These shafts have a counter balance weight and are located with their center on a line with



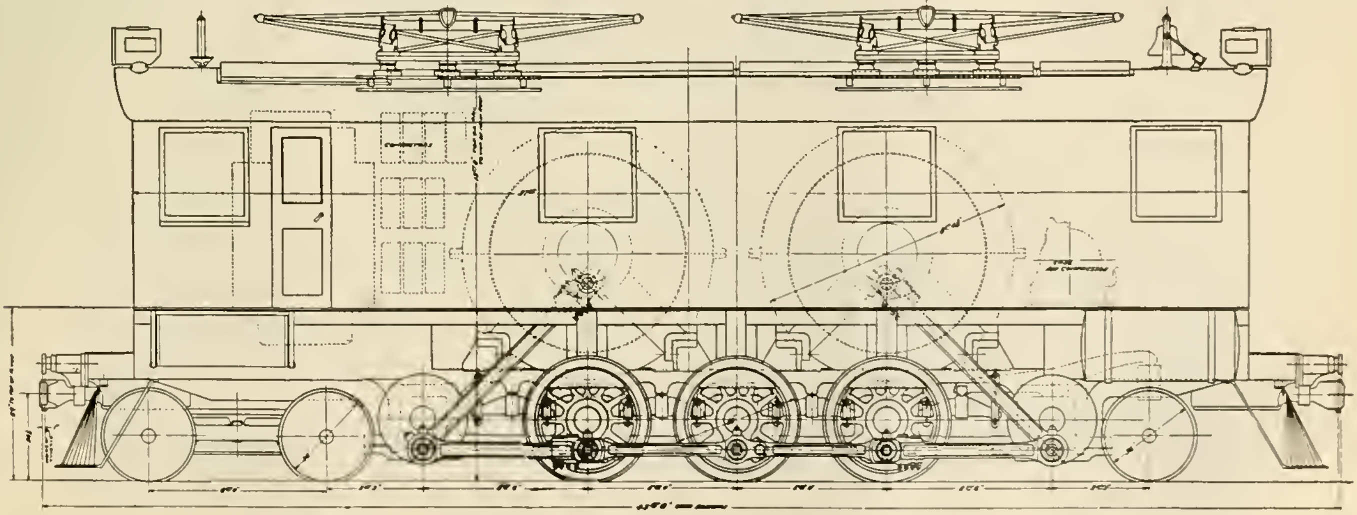
SIDE-ROD ELECTRIC LOCOMOTIVE AS EXPERIMENTALLY EQUIPPED AND HAVING A TEMPORARY CAB.

## ELECTRIC LOCOMOTIVE WITH CONNECTING RODS.

An experimental locomotive has been designed and constructed by the General Electric and American Locomotive Companies for the purpose of trying out a scheme of transmitting power from the motors to the drivers through connecting rods. The advantage of an arrangement of this kind is that motors of large diameter and small air gap can be used in connection with small diameter driving wheels and that the motors can be entirely spring supported. This permits a marked economy in the construction of the motors, as the same horse power can be obtained in two motors at a less cost and with less weight than in four.

the centers of the driving wheels. The cranks on opposite sides are set at 90 degrees. From the pins on the two jack shafts side rods connect directly to the crank pins on the drivers, arranged the same as on a steam locomotive. The object of the jack shafts is to permit a horizontal drive between the spring supported part of the locomotive and the driving wheels, this being necessary in order to allow for the vertical play between the frames and the drivers. The variation in distance between centers of the drivers and jack shafts is negligible. Since there are no reciprocating parts in the machine a perfect balance can be obtained by means of counterbalance weights.

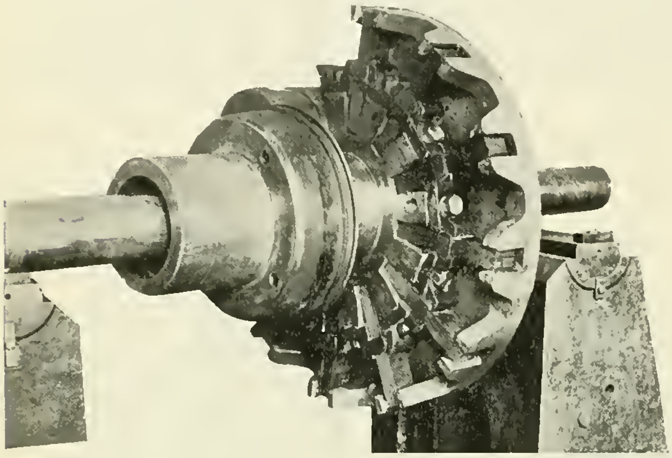
The motors used on this locomotive are arranged to start as



SIDE ELEVATION OF SIDE-ROD ELECTRIC LOCOMOTIVE.

repulsion motors with short circuited armature and are changed over to series repulsion motors for the higher speeds. This arrangement eliminates running with a short circuited armature on high voltage and at the same time gives a high torque in starting. This type of locomotive is perfectly adapted for operation with direct current motors as well as with alternating current.

The experimental engine is designed for a tractive effort of 30,000 lbs., at a speed of 18 miles and for a maximum speed of



FLEXIBLE COUPLING BETWEEN MOTOR SHAFT AND CRANK ARM.

50 miles per hour. It has been tried out with temporary motors of somewhat smaller capacity and has successfully demonstrated that the design is entirely satisfactory in every way. The general dimensions of the completed locomotive are as follows:

| | |
|---|---|
| Weight on drivers | 162,000 lbs. |
| Total weight | 250,000 lbs. |
| Rigid wheel base | 10 ft. |
| Total wheel base | 33 ft. 6 in. |
| Diameter of driving wheels | 49 in. |
| Trolley voltage | 10,000 |
| Cycles | 15 |
| Horse power, motors, total | 1,600 |

## HIGH SPEED MILLING CUTTERS WITH INSERTED BLADES.

The output of the modern high speed milling machine has been restricted by the limited capacity of the inserted blade type of milling cutter, which by reason of its cheapness in first cost and maintenance has been universally adopted for heavy shop milling. Wilfred Lewis and William H. Taylor, in a paper before the December meeting of the American Society of Mechanical Engineers, described a new design of inserted blade cutter which they have recently developed.

Their investigations showed that there was no existing standard, or suitable rule, governing the construction of milling cutters with inserted blades, nor was there any record of exhaustive tests made to determine the most effective pitch, proper clearance angles or front slope and lip angles to be employed. The first point considered in designing the new cutter was the shape of the blade and it was concluded that to maintain a prescribed slope and lip angle throughout its entire length, the blade must be bent to form a helix. With the blades helical in shape, a continuous cutting edge with a constant lip angle would be maintained throughout any length of cutter. Experiments indicated that the most effective angle for the pitch, or lead of the blade, was about 20 degrees. To facilitate computation a formula (diameter $\times$ 9 = pitch) was adopted which gives 19 degs., 15 min. as the angle of the helix.

The grooves in the cutter blank had previously been planed approximately rectangular in section with a slight amount of undercutting to hold the blade and the wedges used for fastening


HIGH POWERED MILLING MACHINE, BEMENT-MILES.

it in place. It was thought, however, that this grooving of the cutter blank could be done better and faster by milling than by planing, and that an undercut groove might be produced at once by a saw set in a certain relation to the cutter blank. This proved practicable, and although the groove so formed was not so easily fitted with a cutter blade on account of its curved sides, the curved sides gave the cutter a lip angle which was of great value in actual service. To form the blades accurately to the shape of the groove, it was necessary to design a bending machine of great power, capable of squeezing the blades at once to

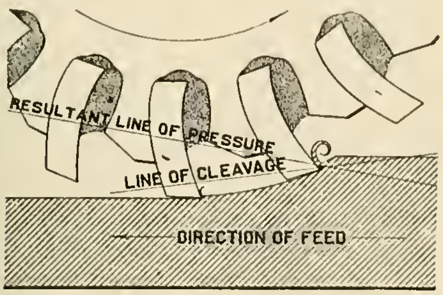



FIG. 4

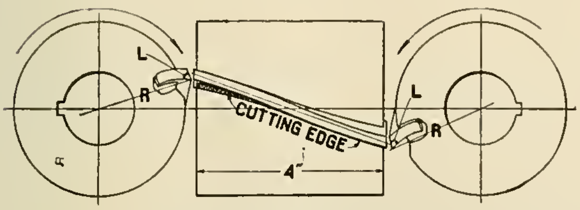



FIG. 5

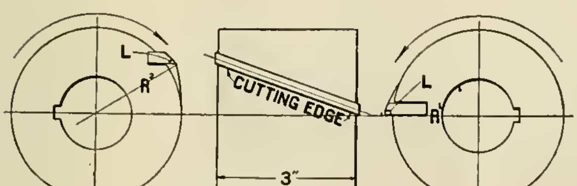



FIG. 6

proper form not only as helices of correct pitch, but of correct curvature in a direction normal to the helix.

Experience had shown that ordinary mechanical fastenings for securing the blades were unsatisfactory, either because of excessive cost or by inability to withstand vibration and remain rigid. Experiments were, therefore, made with various alloys until a proper combination was obtained, capable of flowing freely, of cooling without shrinkage, of withstanding great strains without crumbling, and of permitting quick removal of the blade. A device was designed for compressing the alloy in the slots after it had been poured, and another one for removing the alloy when it was necessary to replace the blades. With the alloy compressed in the slots, the blades are so firmly secured that they may be broken off by force without affecting it.

It is claimed that this construction produces a cutter of moderate diameter and with a greater number of blades for a given diameter than on other cutters of the inserted blade type, and that it has a capacity in excess of the requirements of high powered milling machines.

Fig. 4 shows the form of the slot and blade and the space occupied by the alloy. Fig. 5 shows a constant lip angle, L,

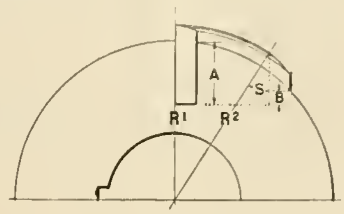



FIG. 7

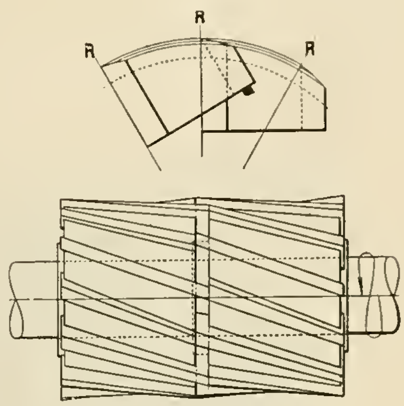



FIG. 8

throughout the entire length of the blade, which is set at an angle of 20 deg. to an axial plane, this angle remaining constant throughout any length by reason of the blade's curvature. Fig. 6 shows a varying lip angle, L, from maximum at line R1 to minimum at line R2, in a straight blade set at an angle of 20 deg. to an axial plane. This condition limits the length of blades. In Fig. 7 a straight blade is set in a plane radiating from the axis, designated by line R1, and by carrying it across the face of the housing at an angle set at 20 deg. to an axial plane. The develop-

TABLE 8.—MILLING CHANNELS, TAYLOR-NEWBOLD HIGH-SPEED STEEL MILLING CUTTER 4⅜-IN. FACE, 8-IN. LISTED DIAMETER, 8½ IN. ACTUAL DIAMETER, 18 IN. INSERTED BLADES, 3½-IN. BORE. TEST MADE AT BEMENT-MILES WORKS, OCTOBER 20, 1908

MACHINE USED: 42-IN. BEMENT-MILES MILLING MACHINE

DRIVING MOTOR: WESTINGHOUSE DIRECT-CURRENT CONSTANT SPEED TYPE 40-H.P AT 220 VOLTS, 153 AMPERES

MATERIAL CUT: 35 PER CENT. CARBON STEEL FORGING

| Cut | | | | | | | | Speed of Cutter | | Electrical Readings | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feed | | | | Material Removed | | | | | | Driving Motor | | | H.p. per cubic inch removed |
| Table advance per minute Inches | Advance per blade Inches | Depth Inches | Width Inches | Cubic Inches per minute | Pounds per minute | Pounds per hour | Duration of test | R.p.m. | Feet per minute | Amperes | Volts | H.p. | |
| | | | | | | | | 39 | 82.95 | 35 | 220 | 10.32 | |
| 6⅞ | .01320 | 5/16 | 4⅜ | 9.40 | 2.66 | 159.78 | 3m. 25s. | 37 | 78.69 | 85 | 200 | 22.74 | 2.42 |
| 1 15/16 | .00307 | 1 | 4⅜ | 8.48 | 2.40 | 144.14 | 7m. 12s. | 35 | 74.44 | 95 | 185 | 23.56 | 2.77 |
| 1½ | .00231 | 1 | 4⅜ | 6.56 | 1.86 | 111.51 | 4m. | 36 | 76.57 | 85 | 193 | 21.85 | 3.33 |
| 2⅝ | .00394 | 1 5/16 | 4⅜ | 15.07 | 4.27 | 256.15 | 2m. 40s. | 37 | 78.69 | 113 | 200 | 30.29 | 2.00 |
| 3⅝ | .00544 | 1 5/16 | 4⅜ | 20.81 | 5.89 | 353.72 | 1m. 56s. | 37 | 78.69 | 135 | 195 | 35.28 | 1.69 |
| 5 | .00750 | 1 5/16 | 4⅜ | 28.71 | 8.13 | 488.01 | 1m. 24s. | 37 | 78.69 | 200 | 190 | 50.93 | 1.77 |

ment from no front slope to a positive front slope is designated by the letter S. In milling, a blade with this irregularity in front slope causes the cutter to drag on one side and gouge on the other. Blades of this type cause excessive vibration to the cutter, due to the varying angle of the front slope, and necessarily consume more power.

Experiments have conclusively demonstrated that nicking the blades of milling cutters does not constitute an altogether desirable feature. The part of the blade behind the nick, which covers the gap formed by the nick in the blade preceding, must take care of double the feed of the remainder of the tooth; this causes chatter and produces an uneven machined surface.

Fig. 8 shows a cutter with straight inserted blades made up in sections, each alternate blade overlapping the blades in the opposite section, so as to obtain the desired width of face. The sections are so set that the cutting edge forms a continuous line. Above the cutter is a diagram showing the relation of the blades in one section to those in the other.

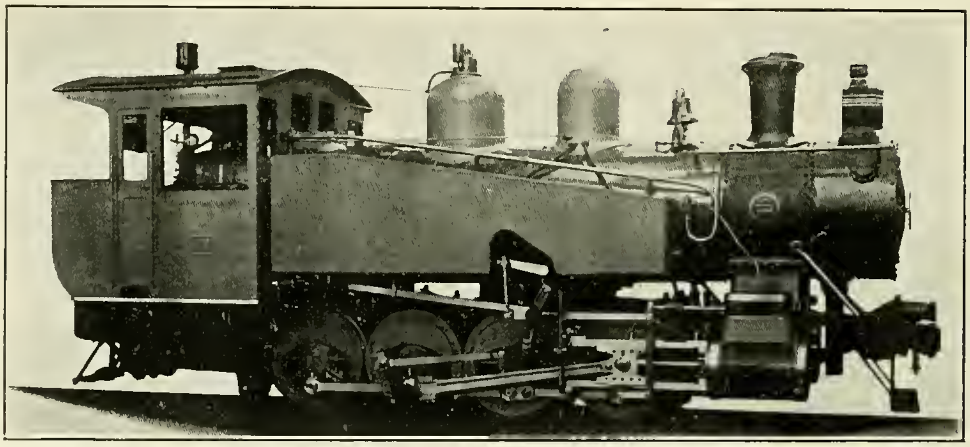
Too much stress cannot be laid on the use of a lubricant during the process of milling. A copious stream of lubricant falling at slow velocity should be thrown directly upon the chip at the point of removal. Heat generated by the pressure of the chip is the chief cause for wear, and if allowed to become too great it will soften the lip surface of the blades and cause them to crumble or spall off. An ample supply of lubricant during the milling operation carries off the heat, materially lessening the dulling of the cutting edges. It has been conclusively shown that a gain of 33 per cent. in the cutting speed in milling steel and wrought iron is made by throwing a heavy stream of lubricant upon the cutter and along its entire face; and a gain of 15 per cent. in milling cast iron.

The accompanying table shows the results of a test made with these cutters. The material cut was 35 per cent. carbon steel. The tests were made on a 42 inch Bement-Miles milling machine driven by a Westinghouse direct-current, constant speed, 40 horse power motor.

## EIGHT WHEEL SWITCHING LOCOMOTIVE.

Western Railway of Havana.

As an example of a very compact source of tractive effort the switching locomotive, shown in the illustration, and recently completed by the Baldwin Locomotive Works for the Western Railway of Havana, Ltd., is very interesting. It provides a tractive effort of practically 32,000 lbs. in a machine which occupies but little over 33 ft. of total track space and is carried on a wheel base of less than 12 ft., with a pressure on the rail of about 16,520 lbs. for each wheel. This gives a locomotive that is capable of going into all kinds of odd corners over poorly ballasted track and able to handle a good load even on a stiff grade under those conditions. As can be seen, it is of the tank type, an arrangement which for a switching locomotive has many advantages and, under the special conditions that such a design would operate, very few disadvantages.



SWITCHING LOCOMOTIVE, WESTERN RAILWAY OF HAVANA.

The details of construction are markedly simple throughout. The Walschaert valve gear, with a slide valve, has been employed, an arrangement having been designed which is exceptionally free from complications and of very few parts. The valves are set with a constant lead of 3/16 of an inch. It was necessary to cut away the bottom of the side tanks to clear the lift shaft arms, but a suitable arrangement of equalizing pipes has been fitted to keep the water level the same in all parts of both tanks.

The boiler is of the Belpaire type, with an extension front end. An interesting detail in boiler design is found in the shape of two equalizing stays, which it was necessary to arrange in the transverse staying above the crown sheet in order to clear the longitudinal stays from the back head. This construction is shown in detail in one of the illustrations.

In other respects the details of the boiler and running gear are not unusual. Parts, as far as possible, have been made interchangeable with those on previous engines for the same road, many of which were built by these works.

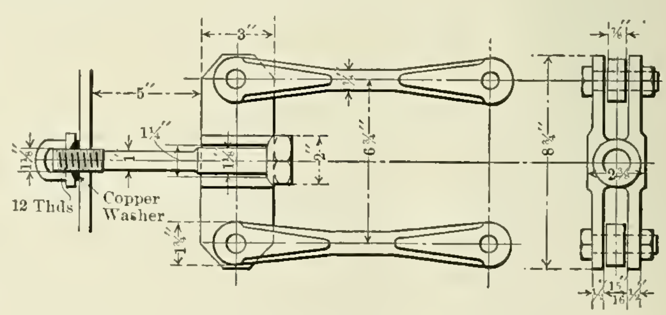
The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Service | Switching |
| Fuel | Coal |
| Tractive effort | 31,930 lbs. |
| Weight in working order | 130,000 lbs. |
| Weight on drivers | 130,000 lbs. |
| Wheel base, driving | 11 ft. 9½ in. |

RATIOS.

| | |
|---|---|
| Weight on drivers ÷ tractive effort | 4.07 |
| Total weight ÷ tractive effort | 4.07 |
| Tractive effort × diam. drivers ÷ heating surface | 980.00 |
| Total heating surface ÷ grate area | 61.60 |
| Firebox heating surface ÷ total heating surface, per cent | 7.80 |
| Weight on drivers ÷ total heating surface | 87.00 |




ARRANGEMENT OF STAYS ABOVE CROWN SHEET TO CLEAR LONGITUDINAL STAYS.

| | |
|---|---|
| Volume both cylinders, cu. ft | 8.70 |
| Total heating surface ÷ vol. cylinders | 172.00 |
| Grate area ÷ vol. cylinders | 2.78 |

CYLINDERS.

| | |
|---|---|
| Kind | Simple |
| Diameter and stroke | 20 x 24 in. |

| | |
|---|---|
| **VALVES.** | |
| Kind | Slide |
| Kind of Gear | Walschaert |
| Lead, constant | 3/16 in. |
| **WHEELS.** | |
| Driving, diameter over tires | 46 in. |
| Driving, thickness of tires | 3 in. |
| Driving journals, diameter and length | 8 x 9 in. |
| **BOILER.** | |
| Style | Belpaire |
| Working pressure | 180 lbs. |
| Outside diameter of first ring | 56 in. |
| Firebox, length and width | 84 1/16 x 42⅞ in. |
| Firebox plates, thickness | 5/16, C—⅜, T—½ in. |
| Firebox, water space | F—4, S & B—3 in. |
| Tubes, number and outside diameter | 180—2¼ in. |
| Tubes, length | 13 ft. 1 in. |
| Heating surface, tubes | 1,378 sq. ft. |
| Heating surface, firebox | 116 sq. ft. |
| Heating surface, total | 1,494 sq. ft. |
| Grate area | 24.2 sq. ft. |
| Smokestack, diameter | 14 in. |
| Center of boiler above rail | 88½ in. |
| Tank | 2 Side Tanks |
| Water capacity | 1,500 gals. |
| Coal capacity | 65 cu. ft. |

## THE SHOP SURGEON.

The shop surgeon is an important member of the official staff at the Collinwood shops of the Lake Shore & Michigan Southern Railway. In addition to the two thousand men employed in the locomotive and car shops there are about two hundred and sixty-five employees at the Collinwood engine house. The following information concerning the work of the shop surgeon is taken from a paper on "The Locomotive Shop and Its Proper Organization" presented by M. D. Franey, superintendent of the Collinwood shops, before a recent meeting of The Cleveland Engineering Society.

In the month of January, 1908, the office of shop surgeon was established in the main office building at Collinwood shops. Previous to this time the shop surgeon was located in the Village of Collinwood, about half a mile from the shop, which location was more convenient than that of the average shop surgeon. The results obtained from this change have been so satisfactory, morally and financially, that this department is now considered a very essential part of the organization.

It is a well-known fact that where accident cases can receive immediate attention from the surgeon, chances for infection that might exist in a dirty shop wound, are in a great measure eliminated; it also insures prompt returning to the shop of skilled workmen, their services and the output of valuable machines, otherwise non-productive due to the operators' absence. It is also true that if an employee is sent out of the shop grounds to a doctor's office, unavoidable delays are caused owing to waiting the regular turn in the office. A careful daily record is maintained by the surgeon of the condition of each patient during treatment and on discharge, thus providing permanent information of value from a legal standpoint.

Loss to the company due to blood poisoning is avoided by correct early treatment. The surgeon ascertains from each individual after an accident whether he has any suggestions as to how similar accidents may be avoided in the future. In addition to this, the surgeon visits the scene of each accident and makes recommendations to the proper authority for the removal of the cause. He makes a close study of safety appliance laws, and inspects and criticises the plant with a view of complying with these laws. On these inspection trips, sanitary conditions are criticised and corrected. The surgeon formulates laws regulating the workman's presence at the plant if contageous diseases exist in the household. Suspicious cases of chronic individualism are reported to the surgeon, who makes proper decision as to the disposition of each case, particularly in tubercular cases.

A part of this organization consists of a systemized call for assistance in case of wreck or unusual accidents. On the shop surgeon's desk is a carefully prepared list of doctors in the order of their proximity to the plant, and the same information is recorded for ambulance and hospital calls. This department aids and maintains discipline by quickly and gently removing to the operating room, all injured individuals thus avoiding the depressing influence of gruesome sights. It is of great assistance to the organization, as the men feel that the surgeon is there for their protection and appreciate the services rendered by him. It also aids the claim department by furnishing them promptly with information, and by courtesy and tact, allaying the first feeling of resentment on the part of the injured.

All road men and apprentices are examined for physical fitness, color blindness, visual defects and hearing. Periodical lectures are given to apprentices and employees with proper instructions on "First Aid to the Injured."

## INSPECTION ON THE HARRIMAN LINES.

The adoption of standards implies seeing that they are maintained. Each general manager and the members of his staff may in the utmost good faith report that a standard practice or device has been installed. Investigation may disclose the fact that due to honest differences in interpretation two adjacent properties have in reality widely varying practices. Such non-standard conditions can only be ascertained and corrected by open and above board inspection from the Chicago office.

The director of maintenance and operation and the members of his personal staff spend much of their time on the road, seldom traveling together, and seldom all being in Chicago at once. They cannot, however, do all of the inspecting necessary for proper co-ordination. To avoid dwarfing the general managers by building up a large permanent staff in Chicago, the condition is met by detailing for temporary special duty as inspectors or special representatives various officials of the Associated Lines. This serves a double purpose. It secures not only proper information of actual conditions for the Chicago office, but it broadens the individual selected. He returns to his own property with the viewpoint of the Chicago office, some knowledge of the other properties, and a better appreciation of the problems of correlation. During his absence, an understudy in his own position has been tried out for future advancement. The effort is to develop all-around men. For example, a general superintendent was detailed to act as chairman of a committee which traveled over the Associated Lines and other railways to recommend the best practices in handling brakes on heavy grades. In addition to a valuable report on this subject he also, among other things, made useful recommendations as to standardization of trainmen's uniforms.

The effort is to use intelligent, high class inspection as a means of disseminating education to officials. The financial depression of 1907 caused drastic reductions in maintenance expenses. To make certain that the point of safety was not passed, and to assist in meeting the exceptional state of affairs, a maintenance of way inspector traveled over the lines for several months conferring freely with local officials. When it became manifest that the desired result had been reached, this inspection work was discontinued. Frequently, a prescribed report can be made to answer certain purposes of inspection without sending out an inspector. When the effect has been produced, when the lesson has been learned, the report is withdrawn. Examples of current reports to the Chicago office which have been discontinued are, cast iron wheels removed per 100,000 car miles run; hot boxes per 100,000 car miles run; engine failures; comparative cost of repairs as between steel and wooden cars.

The inspectors and special representatives are forbidden to exercise authority. They can observe, inquire, investigate, confer, advise, suggest and report, but must not order or interfere with local administration.—*J. Kruttschnitt before the New York Railroad Club.*

THE SUPPLYMAN.—He keeps in touch with all the best things in the market; and after we get so we know and trust him, he is really a great help to us; he keeps us posted as to what is going on, what the other fellow is doing, how he does it, what economies he makes in operation or maintenance, and thus enables us to get into the game and handle our business with greater efficiency and more economic results.—*A. W. Martin, New England Railroad Club.*

(Established 1832).

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## CONTENTS



## EMPIRICAL FORMULA FOR DESIGNING LOCOMOTIVE AND CAR PARTS.

The detailing of a member of the drawing room force to have charge of making all the more difficult calculations and to whom the data concerning all broken or worn out parts of locomotives and cars is referred promises to bring about some important improvements in the design of such equipment. The stresses and the conditions to which car and locomotive parts are subjected are so complicated that the design of the various details requires special treatment. Methods of design used in other engineering work do not always prove suitable for these parts. The calculator, whose duty it is to study these matters carefully, can gradually accumulate enough data to indicate where the various parts are proving weak and can develop special formula which are applicable to them. It was somewhat in this way that the formulæ were developed by which a certain line of equipment was designed on one of the railroads, which has since become notable because of the successful results in service.

## GOOD PRINCIPLES WRONGLY APPLIED.

Two letters have recently been received by the editors, both of them strongly criticising the policy of this journal in advocating a certain movement or principle. It was pointed out that a road on which it was being tried did not seem to be getting any better, if as good results as its neighbors. We are always glad to receive such expressions of opinion; in fact, we wish more of our readers would do likewise.

In some cases it is a misfortune that in advocating a principle or a new movement it is necessary to connect it with a road or a shop in which it is being tried out. Because a road or a plant fails to gain results from its application is no reason why the principles underlying the movement are not correct. It is quite possible that they may not have been correctly applied or they may have been lost sight of in the development of the work.

A technical journal is not published to tell its readers how to do certain things, but rather to suggest ideas to them, by telling what other people are doing, which they may apply to suit their own particular conditions, as their judgment directs. It happens that in the case above referred to, to which some of our friends seem to object most seriously, that even though there might be some ground for their skepticism because of the results that are apparently being gained on the railroad in question, yet the results obtained in other fields by following the same principles positively indicate that they are capable of producing the very best of results.

## INDUSTRIAL EDUCATION.

At a recent meeting of the American Institute of Electrical Engineers, Professor Herman Schneider, of the University of Cincinnati, stated that of the 18,000,000 children in the public schools in this country over 17,000,000 drop out when the law permits them to and go into commercial, industrial and agricultural life. These children have no industrial training before going to work and receive practically no schooling thereafter. That they are not fitted for their life work is apparent from the fact that the leaders in our industrial and commercial life have found it necessary to give this matter so much time and attention during the past few years.

Professor Schneider, who introduced co-operative work in the engineering department of the University of Cincinnati, as described on page 199 of the May issue, presented a very logical solution of the problem of industrial education. The following extracts from his address give a rough idea of what he proposes:

"Every industrial center has a group of school buildings with its quotas of trained teachers. It also has many factories and commercial houses. Under present conditions most of the children who leave the public schools go at once into the industries or stores, and there is no connection whatever between school and shop. The children go to work not because they want to, but because they have to become little bread-winners. Here, then, are many children working in some capacity, and a series of public schools carried on only for those who are fortunate enough to be able to continue in their school work. Since the public school system is the only organized institution capable of dealing with all these children at work, and since the children are also learning a trade and earning money sufficient for their simple wants, it seems that the only complete solution of the problem is a system of co-operation between the schools and the factories for efficiency training and civic training of the young people after they have found their work.

"The fundamental principle of the co-operative system is very simple. It is this: the technique or the practical side of the work is taught only in a shop or store which is working under actual commercial conditions, and the science underlying the technique can be taught properly only by skilled teachers. All questions as to who shall supply the school teachers (the shops or the public); the hours the student works, and the hours he is taught; the periods of alternation of shop and school work, if alternating periods be used; and the curricula of the schools —all these are matters of detail to be considered for each particular case.

"The economy of the system is at once apparent. In an engineering school, for instance, twice the number of students can be taught at about two-thirds the expense as compared with the four-year theoretical system. The same is probably true in industrial education, for under the co-operative plan the schools will not require any physical equipment; all their money can be used for brains and for buildings for teaching purposes only. There is a further economy to the student. In this case he is earning while he is learning, while under the trade school system he does not earn until he has completed his course.

"At Fitchburg, Mass., the co-operative system is a part of the public school system. The students are divided into two groups which alternate every week. That is to say, this week one-half of the students are in the day school and one-half are in the factories. Next Monday morning these groups will change, and those who are in the school this week will go to the shops, and those who are in the shops this week will go to the school. Since the public school becomes a part of the apprenticeship system, it has a voice in the organization of the apprentice course in the shop, and is *in loco parentis* to the boy, so far as his shop work is concerned. It ought to be obvious that the boy will receive a fair training in the shop because the school is in a measure watching over this phase of his work.

"It is not intended, of course, that this plan should apply only to factories. It will apply to a boy learning the tailor trade, the butcher trade, the baker trade, or any other trade. It is necessary, however, to obtain two boys to alternate in the shops."

# THE WORK OF THE RAILWAY BUSINESS ASSOCIATION.

The opinion grows that the whole country is under obligation to the Railway Business Association for its effective part in restoring confidence and starting business. This many of the railroad presidents declare, while expressing their appreciation of the beneficial effect upon railroad companies. The head of an Eastern trunk line said the other day: "The good which has been done by that association has not been limited to the railroads alone; in fact, the general public, who were suffering from the effects of business inactivity, have been the largest beneficiaries. The association has done much toward better general business conditions, and for this is deserving of the thanks of the public at large." Another official, vice-president in charge of maintenance and operation of an important line running out of Chicago, remarked recently: "We do not regard the Railway Business Association as being in any wise organized in behalf of corporations, but it is to advance the welfare of every honest employer and employee."

These officials are not quoted with any apprehension that their approval will be misunderstood. At the beginning of the campaign the officers of the association showed anxiety lest the public should believe the effort was being financed by the railroads, instigated and controlled by them. Nobody who has followed the career of the organization can now reasonably suffer misapprehension on that score. Not only is it perfectly evident to experienced observers that the policy and efforts have been distinctly those of business men accustomed to mercantile activities, rather than of railroad officials adjusting themselves to new conditions as to public relations, but the most emphatic acknowledgment is heard on every hand from railroad presidents themselves of the independence of the railroads which the association has maintained.

An extremely conservative railroad president, head of one of the most extensive systems, went so far as to concede: "Above all, the Railway Business Association is to be congratulated upon the perfect frankness which has characterized everything it has done. Its independence has added materially to its influence." Similar approval from another important source high in railroad management was that: "The Association has unhesitatingly urged publicity of corporate accounts and corporate actions, coupled with fair legal restraints and a reasonable degree of government control."

It is impossible for a representative of a journal in this field to travel about without becoming aware that the railroad officials are surprised and delighted with the policy of the organization. As one of them operating in the far West expressed it: "While the railroads would undoubtedly be willing to help with contributions, I do not think this step could be taken without impairing the usefulness of the work."

The officers of the association express themselves as deeply gratified at the results of their work thus far. The executive and special committees are in constant conference, so that everything undertaken is carefully studied and discussed. There has recently been a steady increase of new members, indicating that whatever doubt there may have existed in some minds as to the feasibility and permanence of the organization is disappearing. To have won the confidence first of the railroad supply interests as indicated by the membership roll, next of the railroad officials as shown by the quotations given above, and finally of the public as proved by the respectful heed given to the suggestions of the association in the matter of pending legislation, may well be looked upon as extraordinary success for an association only eight months old.

The foregoing paragraphs were submitted at the headquarters of the association with a request for additional notes and met with the following statement:

"The Railway Business Association has every reason to be gratified by the reception which has been accorded its efforts. If any qualification of this expression were to be made it would be to say that there are still many concerns vitally concerned in restoring and maintaining the purchasing power of the railroads who have not yet handed in their applications for membership. The potency of our organization is directly proportioned to the number and influence of the units composing it. The more employees of industrial establishments we represent through their employers who are members of the association, the more careful attention to our requests we may expect from legislators and administrative officials. At this time, when the federal administration is understood to be seeking permanent solutions of the problems in regulation of corporations, railroad as well as others, it would measurably assist our efforts for conservatism if we might have immediately a large number of new members."

# MASTER MECHANICS' ASSOCIATION

(*Continued from page 288.*)

## FUEL ECONOMIES.

Committee:—W. C. Hayes, Chairman; R. P. C. Sanderson, D. R. MacBain, T. B. Purves, Jr., W. H. Wilson.

The committee prepared and had sent out to all members of the association a list of questions bearing on the subject of the progress made in fuel economy from a practical standpoint, and to those questions many replies have been received, the tenor of which is that the question of fuel economy is receiving considerable attention from the officers of many railroads in this country. From a few of them it is getting specific and close study, with a fuel department detailed to work out the problem, commencing at the mines to inspect and select the coal and have it prepared for use as well as it can be before shipment is made to the different points on the various systems. The idea is to make an effort to have the coal thoroughly cleaned and as free from slate and all other noncombustible matter as is possible, so that when it is distributed to the several coaling stations the best results can be secured from it. If this is done as fully as possible there will be an inspiration for the engine crew using it, and for all those whose duty it is to supervise its use from the mines to the fire box, so that much greater fuel economy must result.

Comparative tests have been made of bituminous and briquetted fuel. While the data obtained were quite interesting, it was quite clearly demonstrated that the value of briquettes as a fuel in comparison with coal is far from favorable, as shown from the fact that only 6.30 pounds of water were evaporated per pound of briquetted fuel from and at 212° F. as compared with 8.83 pounds of water evaporated per pound of bituminous coal.

In connection with this test it was observed that the flame was very much shorter with briquettes than with bituminous coal, while it is quite essential that the long flame should be maintained at all times in the deep fire boxes. On account of the briquettes not producing a long flame those making the test were under the impression that fuel of this kind would be more satisfactory in shallow fire boxes instead of deep ones, although the engine in which the test was conducted was not what might be considered a deep fire box.

It was also found that the action of gases upon the eyes of the firemen was unfavorable, as complaint was made in regard to it, due, it was assumed, to the binder employed in making briquetted fuel.

As an example of the amount of fuel wasted at the pops some tests made by the C. M. & St. P. Ry. in 1905 with four different types of engines to determine the average coal consumption in a locomotive while standing on a side track coupled to a train of twenty-five air-brake cars are given. During the test the boiler pressure was uniformly maintained at within 10 pounds of maximum pressure, the reservoir air pressure maintained at 85 pounds and the train-line pressure kept at 66-68 pounds. The temperature was about 50 degrees above zero.

| Engine Class. | Kind. | | Coal Per Hour. |
|---|---|---|---|
| H-5 | 17 by 24 inches, | 8 wheel | 128.125 |
| G-4 | 19 by 26 inches, | 10 wheel | 131.25 |
| B-3 | 15 and 25 by 26 inches, | 10 wheel | 161.25 |
| B-5 | 15 and 25 by 30 inches, | 10 wheel | 177.5 |

In some instances, particularly on one of the larger systems, it is intended to purchase coal from specifications made up by the mechanical department, but as yet this practice has not been developed far enough to give an elaborate explanation of it to this convention. It is sufficient to say that there is at present a thorough coal inspection system installed with competent coal inspectors located at the mines to continually inspect and mark all cars set aside for company use. The inspector has authority to reject any and all coal that does not meet the specifications of the company. He also makes it his business to frequently send samples of coal from any and all cars loaded for company use for test and analysis to the chemist, to whom the coal inspectors report. It is also within the province of the mechanical department to see that the coal is distributed to the different points on the system at the least possible cost; price and hauling, as well as handling and quality best suited to use in certain territories, being considered.

The mixture of the poorer with the better grade of bituminous coal and of anthracite and bituminous coals in specified percentages, have been established by the proper officials of the mechanical department.

The placing of coal on engines in large sizes is not conducive to fuel economy, as, by doing so, too much of the fireman's time is taken from watching the fire in order to properly prepare the coal for use, or it is introduced into the fire box just as it comes from the mines, altogether too large for economic results. It is very evident that it will pay to see that coal is placed upon the engines in suitable sizes for firing, so that the fireman may be able to devote his entire time to watching, controlling and feeding his fire.

In the opinion of the committee, the base of the whole question of fuel economy is contained in beginning at the mines, so as to be absolutely sure that no imposition is practiced by having noncombustible material palmed off for coal, and to see that the coal is properly cleaned. To do this it will be found necessary to keep competent inspectors at the mines with authority to reject all coal before shipment that does not come up to certain standard specifications upon which all coal should be purchased.

It is believed that the time is rapidly approaching when the production of all mines will be purchased upon their value as shown by a complete chemical analysis. This is true of coal at the present time only to a small extent, but the number of contracts made based upon the number of B. T. Us. that can be furnished for one dollar is bound to increase every year. The road above referred to furnishes data sheets showing just what B. T. Us. are furnished in each kind of coal used for one dollar, to officials engaged in the extension of fuel economy. The purchase of coal on specification is as much of an advantage to a railroad company, or to any buyer, as a definite understanding of a building operation or engineering project is to the engineer, because when coal is bought to a specification you get what you pay for and pay for what you get.

When the bidder is allowed to specify the quality of coal he proposes to furnish as determined from a chemical analysis, he is placed on a strictly competitive basis with other bidders. This broadens the field for both the bidder and the purchaser. The cities of Chicago, Indianapolis, Minneapolis, St. Paul, St. Louis and Cleveland purchase coal on this basis, as do some of the other large cities. There is, however, some variation in the B. T. Us. allowed by the different cities which purchase coal on this plan, but in general a standard is fixed at nearly 14,000 B. T. Us. Coal falling below that standard may be used or not by the purchaser. If, when an inferior grade is used, an average is struck when the monthly settlements are made, it can be plainly seen that the material reduction in the prices of the coal will soon cause the mine owners to sit up and take notice. The result will be that the standard fixed in the bid will be maintained.

One of the essential things which many of the railroads are now trying to establish is to figure on the grade of coal best suited to a certain territory, to then assign this coal to that territory and have it definitely understood that no change will be made except in case of a grave emergency, such as a miners' strike, floods, storms, washouts, etc. This will enable engine crews to become acquainted with the quality of fuel furnished. Engines can then be drafted to suit, and thus insure greater improvement in fuel economy than if the old plan was continued.

The proper essentials of fuel economy and the conditions obtaining in a locomotive boiler on which that depends, should be as follows:

1. A clean boiler whose shell, tubes, sheets, and stays (and in addition "the crown bars," in the crown bar type of boiler), are kept free from mud and scale.
2. Properly drafted and good steaming engines.
3. A good quality of fuel properly prepared for use.
4. Efficient operation of the locomotive.
5. Individual fuel records.
6. A full and fair accounting.

Economy in the use of fuel on a railroad is at all times a very interesting, though perhaps a perplexing problem. There are so many items, which enter into its make up, both from a mechanical and an operating standpoint, that the fuel question is always bobbing up and presenting itself for solution. The fuel account being one of the chief items of expense on every railroad, all officials having charge of train and engine men should work together in order to secure best results. To do this, we are very much inclined to think there should be a mutual understanding concerning the leaks, and a combined effort should be made to stop every one of them.

1. *A clean boiler.*—The first essential to be dealt with in considering the question of fuel economy is the boiler or source of supply.

The reason that it is so important that the sheets be kept free from mud and scale is that the heat given off by the burning of the fuel may be more readily absorbed by the water through the sheets than would otherwise be absorbed by the mud and scale, representing an absolute loss in heat and a consequent waste in fuel, with all the other evils which travel in the wake of boilers not properly taken care of, such as leaky flues, stay bolts and fire-box sheets, which carries with it the delays on line incident to that condition of boiler.

Provision should be made in the design for a good free circulation of the water and also to see that flanges are properly turned, so that no traps are formed to accumulate dirt and scale. The care of the boiler should be closely looked after, both as to proper blowing out at terminals and on line during every trip. This, together with good washing at terminals and proper care in handling, will extend its life and usefulness and materially aid fuel economy. The study and attention now given to locomotive boiler design as compared with some years ago is marvelous. This is a good thing. The care now given to locomotive boilers in service by all railroad companies will undoubtedly materially assist in the promotion of fuel economy.

2. *Properly drafted engines.*—Improperly drafted engines are perhaps one of the greatest sources of trouble on many of our railroads to-day. It therefore goes without saying, that it is entitled to and requires constant and close supervision and attention, because on account of some defect in the draft apparatus that has escaped notice, much waste of fuel occurs.

Insufficient draft may be caused in a number of ways. First, in the fire box, by the grates being clinkered. Second, by the heat of the fire not being fully utilized because the engine crew are not educated up to a point of appreciating the importance of the subject, or through their neglect of the proper essentials of fuel economy in the performance of their work. Third, through a lack of the proper vacuum being formed in the front end or smoke box by the exhaust steam

The proper remedy can and must be applied after a thorough investigation of the subject has located the difficulty.

It is not considered necessary in view of the knowledge of the members of this association concerning draft appliances, to mention the value of the different devices other than to say that what is known as the master mechanics' standard, strictly adhered to, gives most satisfactory results.

3. *Good quality of fuel properly prepared for use.*—In order to get the best results, the coal should be placed on the tenders of the engines in such a size that the firemen can devote his entire time and attention to watching and feeding the coal to the fire. Anything which interferes with his doing so is at the expense of a certain amount of coal wasted. We do not undertake to say how the above can be accomplished on any railroad, on account of the different methods of handling fuel, employed on docks or coal tipples, and thence to the tenders of engines, but we contend that the better the coal is prepared before being placed on engines the more economical its use will be. The first section of the proposition hardly needs restating, that is, furnishing a good grade of fuel tends to its economical use; it is our firm belief that all classes of enginemen will do better work, and will use greater effort to save the good coal in all ways than will be the case when a poor grade of fuel is furnished. We are fully aware, however, that in some instances this has not proved to be the case, but the causes which led up to that belief are so indefinite as to be of no value in determining the above question. If this is true, it follows, then, that the proper preparation of coal for firing has considerable influence on the completeness and rapidity of combustion, and consequently on the temperature obtained in the fire box and on the prevention of black smoke.

The rapidity with which a lump of coal will burn depends, among other things, on the amount of its surface presented to the fire, so that if the lump is broken into a number of small pieces it will present a much greater surface, will burn faster, and will create a much higher temperature with the same quantity of coal on the grates. Other advantages are that the smaller coal can be spread more evenly over the fire, a thinner fire can be maintained and the thickness of the fire can be regulated more readily for the proper admission of air through the grates, thereby securing a higher and more even temperature in all parts of the fire box, and, as naturally follows, also a better combustion of the fuel.

The portion of the air supply furnished through the ash pan cuts a very important figure, and, doubtless all will agree, is very essential in assisting combustion to an extent that the best means for furnishing it should receive considerable attention.

4. *Efficient handling.*—This involves the work of both the engineer and fireman, and, to our minds, constitutes one of the most, if not the most important element in fuel economy.

The question of running an engine in order to get most economical results involves the work of both the engineer and fireman, and is so important from that point of view that we shall introduce this portion of the subject by making the following statement:

An engine may be built of the very best material, and of the most approved design, *i. e.*, mechanically perfect, with all the modern conveniences to assist in its perfect manipulation, and you place that machine in the hands of an incompetent engineman and you have almost nullified the combined expert mechanical skill necessary to turn out the finished product. We think you will all agree it is most important that the finished machine should have skilful operation.

This is largely a question of education by beginning with the future engineer and training him from the time he enters the service in the way you would have him go in regard to the duties of a fireman, and subsequently with regard to the duties of an engineer, establishing an educational qualification as a condition of employment, and later requiring such examinations from time to time as will tend to bring out his fitness for the duties of a fireman, and his application of them.

The manner of firing and feeding water to a boiler has much to do with its steaming qualities. To get best results, these two operations must be performed in harmony with each other.

The engineer should so regulate the water in his boiler as to have a sufficient quantity to enable him, when starting from a station, to shut off the injector while his train is being brought to speed, in order that the fire may be given every advantage and the steam pressure maintained at the maximum. The fireman may be ever so capable and may do his best to make a good coal record, but if the engineer does not perform his work with a view to economy, the fireman's efforts will prove futile. The fireman may save by the ounce while the engineer wastes by the pound, if they work independently of each other. This would certainly be considered very poor management, as both must work together in order to get best results. The engineer should be taught never to work his engine harder than is necessary, consistent with the train to be hauled and the time to be made, and that it is not always the man who makes the most noise pulling out of a station who makes the best time on the trip, because by that very act the draft on the fire may be of such a character as to cause his engine to fail before she gets to the next station, and the engineer in charge may be unable to assign it a cause. The fireman should be taught that heavy firing is wasteful, and should always be avoided; that the introduction of large quantities of coal at one firing absorbs very large quantities of heat, and reduces the temperature of the fire box below the igniting point of the volatile gases, allowing them to pass out of stack unconsumed in the form of black smoke. Then, again, the greater the volume of gases the more difficult it is to mix them with air, which is absolutely necessary in order to effect complete combustion.

Variation in the temperature of the fire box has also other bad effects. It causes alternate contraction and expansion of the sheets, which in due time result in leaky flues, cracked sheets and broken stay bolts.

The above effects will be present in a much less degree when the coal is fired in smaller quantities, and for this reason it is desirable to use only a small amount at a time and fire more frequently. The quantity to be fired at a time depends largely on the work to be done, the quality of the coal used, and the size of the engine. No hard-and-fast rule can be made, but it is safe to say that the best results can be obtained by using small quantities and firing often. The firing should be done at regular intervals, and the fire door closed after the introduction of each shovelful, and it will be found to be a good practice to keep the door closed a few moments after each shovelful, so that the temperature of the fire box will have time to recover from the effects of the last opening.

Every shovelful should be spread over the surface of the fire as evenly as possible, and the sides and the corners should be kept well built up and covered. If the coal is piled into the fire box in heaps it will burn slowly like so many individual chunks of coal, besides acting as a blanket at that spot, the result being that clinkers are formed and the engine steams poorly.

Did you ever stop to think what it is costing railroad companies for the steam wasted through pop valves unnecessarily? If you have not, the following figures will doubtless surprise you. The figures can only be based on estimates as to the number of engines that may be included in the list. Nearly 15 pounds of coal are wasted through a 3-inch pop valve every minute during which it remains open, and a pop rarely opens and closes in less than a minute. Our observation, as far as the control of pop valves is concerned, unless exceptional care be practiced, is that 3 per cent. of the boilers upon any railroad are blowing off continually during the twenty-four hours. If this be true, a few figures will demonstrate just what the waste is: 2 per cent. of 1,000 engines is about the number that will be found to be blowing off day and night. This we consider a conservative estimate. This would waste in the vicinity of 78,840 tons of fuel per year; computed on the present average price per ton would amount to the snug sum of $111,164.40. Just think of paying that amount for a leak which ought to be stopped and can be, if all railroad officials will unite to stop it. Is it worth the effort? We are inclined to think you will decide in the affirmative.

5. *Individual fuel records.*—This subject has a far greater influence on the coal pile than might at first be thought possible. Our plan would be to have a performance sheet showing the individual fuel record of every engineer and fireman in each dis-

trict, the coal to be charged to the engineer instead of the engine as at present, establishing an average, a maximum and a minimum cost per ton-mile on each district.

We are fully satisfied that, after this sheet has been issued a few times so as to give enginemen an idea of its working, it will stimulate a great interest in the direction of fuel saving. Once let it be understood that such a scheme is on foot, and it will establish a spirit of competition among the men that will mean dollars to the company.

6. *Full and fair accounting.*—This is an item having considerable influence on the fuel. Let the idea become circulated among the enginemen that they are getting the worst of it, in having more or less coal charged to them than should be the case, and you will find that it has a disheartening and a demoralizing tendency, which will militate against the coal pile by creating a "don't care" spirit induced by the idea that they do not get credit for what they do. This feeling should be carefully guarded against.

In conclusion, let it be emphasized that, after going thoroughly into the subject of fuel economy as far as the practical side of it is concerned, we will say that we are of the opinion that best results can be obtained by having the engineers and firemen subject to instruction from the mechanical department only; and for this purpose the road foreman of engines should be on the mechanical staff and report to and receive his instructions from the chief mechanical officer, or his representative. When this is the case the field work is not divided, and much more can be accomplished than when the subject is worked out between two departments.

*Discussion.*—Mr. Seley stated that the importance of this subject and the one on "Lubrication" was so great that he believed that standing committees on these two subjects should be appointed. Although a motion to this effect was not passed it seemed to be the general impression that the executive committee would provide for an action of this nature.

Angus Sinclair referred to the great importance of purchasing coal on its chemical properties, stating that he believed the fuel purchasing business needed more reforming than the boiler design.

Robert Quayle (C. & N. W.) spoke as follows:

"We will suppose we have the fuel right and the specification is all right, the purchasing agent is all right and the delivery on the ground all right. I made this statement to 22 locomotive firemen within the last two weeks—that I could select 100 locomotive firemen on the Chicago & North Western, and I would guarantee that if I had every other man on the railway equally as good firemen as the hundred I could select, that I could save easily $500,000 a year in fuel. Now, then, if that be true it is a matter of education. It is first a matter of the man's fitness for the job he is filling. Second, it is the education of the man to get him up to that standard where he knows just when to put a scoop of coal into the firebox, and he knows just where to put it; then he knows all the conditions necessary to get the maximum result out of a pound of coal. If he knows all that, the most important thing to follow is to get him to do it, and that is where the railway men are up against it. The problem I have in mind is to get the men to do their best in line with the information they have. I know that when the road foreman of engines or the traveling fireman is on the engine the men do their work splendidly. They keep the decks clean and every pound of coal they handle is utilized in the fire-box, and, as suggested in the paper, their pops are not open and they are not losing a quarter of a pound of coal per second of time the pop is open, but are utilizing the steam generated in the boiler for the engine. They secure the best results from the engine under those circumstances. If there is any man who can point me to the direction I should follow in my efforts to discover how you can get your men to do the best they can all the time, I shall be glad to hear it. I believe there is nothing which you and I can do which will bring greater financial results to the treasury of the railways with which we are connected than to go after the fuel problem and the men who use it."

P. G. Baker (Panama) stated that he believed the sixth proposition of the committee, "full and fair accounting," was the most important and valuable one of all.

Mr. Tonge (M. & St. L.) referred to the effect of dispatching on fuel economy; how often a locomotive is kept on the side track for two-thirds of the time between terminals and the fuel consumed during this time was charged to the engine, although it was no fault of the engine crew that the record is so poor.

Mr. Quayle, in again speaking on the subject, referred to the very great importance of the engineer and fireman working closely together, and said that it is necessary to have complete harmony in the cab if the best results are to be obtained.

Mr. Wildin drew attention to the roundhouse foreman as an important third in the campaign for harmony leading to fuel economy.

Mr. Gaines reported great success with a blank form which was filled out every month and posted in the roundhouse as well as sent to officers interested. This gave engine mileage, coal burned, size of nozzles, etc.

Mr. MacBain (N. Y. C.) suggested that a sufficient number of high-class engine instructors, each to take care of 50 to 75 firemen, whose whole duty should be confined to the matter of saving fuel, would prove a very profitable investment. He stated that most traveling firemen were now largely engaged in post-mortem work and believed that the duties of these men should be altogether instruction of men and not digging out the reason for something that happened weeks before.

## TENDER TRUCKS.

Committee:—H. T. Bentley, Chairman; John Hair, A. E. Manchester, J. F. Walsh, T. H. Curtis.

After making investigations and getting replies to certain questions asked, and also from personal observation and experience, we believe that the arch bar, cast-steel side frame, and pedestal trucks, which are now in very general use in all kinds of service, will, if correctly designed, be thoroughly reliable for high and low speeds.

The pedestal type of truck, whether having side equalizers and half-elliptic springs, or with the double-elliptic springs, or with coil springs over the boxes, is a more expensive truck to maintain than either the arch bar or cast-steel side frame type, with the journal boxes rigidly attached.

Under general conditions we do not advise or recommend the use of coil springs over journal boxes, as they increase the wear on box and pedestal without giving correspondingly better results in other directions.

The use of elliptic springs is strongly recommended. For slow service, such as switch and transfer work, coil springs can be used, but we would not recommend them for any other kind of service, because of their excessive movement and number of vibrations before coming to a state of rest.

Side bearings should be used on each truck and in all cases we recommend that their location be less than width of track, or in other words, inside of wheel flanges; if any difference of spread of side bearings is made in the two trucks, it should be greater at rear truck than front one with above limitations, and we would suggest 36-inch centers for front truck and 50-inch maximum for rear truck.

From replies received and from personal experience, we find roller or other kinds of so-called frictionless side bearings are not in general use, and although we have reports of flange wear being reduced where they are used, we are not satisfied that they are necessary, as, with proper clearance between solid side bearings, practically the same results can be obtained.

The use of roller center bearings does not seem to be very general, and the committee does not believe they are necessary for tenders.

While twenty-three replies to letter of inquiry object to the arch-bar truck, and have various reasons—among others, rigidity, breakage of arch bars, number of parts, load not properly equalized, not as smooth riding as pedestal type, difficult to keep in alignment, etc.—yet the committee believes that when properly designed and good material used in its construction, it is entirely satisfactory, and is less expensive to build and maintain than the pedestal truck.

The question of side-bearing clearance is something that has had a great deal of thought on our part, and we recommend that it should be from ⅛ inch to ¾ inch, and when the side-bearing spread is the same on both trucks, the greater clearance should be on the front bearings, but where the spacing is less on front truck than on rear one, the clearance should be arranged so that both bearings on same side touch together, or at same time.

In regard to tender-truck derailments: The committee, as a result of investigation, find that some tender trucks are more liable to derailment than the trucks under other railroad vehicles, and in answer to a circular of inquiry, the following were reported as some of the causes of tender derailments:

Bad track conditions, high center of gravity of tank, rolling action of water on account of splash plates being out of place, coil springs, short wheel base, shallow center plates, center plates not fitting, too much rigidity, improper location and clearance of side bearings, lack of clearance between drawbar and end sill; on Prairie type engines by excessive lateral swing of engine, depression of track by rear engine driver ahead of front tender truck causing more front trucks to be derailed than rear ones, the steadying effect of cars helping to keep rear trucks on track.

In two cases that can be specifically mentioned, it was found that derailments of tenders on lines where they were frequently occurring ceased when the changes were made as shown below:

No. 1. Arch-bar trucks having swing motion bolster with side bearings spaced 50-inch centers on both trucks, and with about ¼-inch vertical clearance on all side bearings, substituted for arch bar and pedestal truck without swing motion bolster.

No. 2. The trucks in use were arch bar with rigid bolster and cast-steel side-frame types; one tender was equipped with pedestal truck having side equalizers. With each of above type, derailments were of frequent occurrence. The side bearings on above trucks were spaced in some instances 56-inch centers, and others 48-inch centers. The derailments were stopped by spacing side bearings 36-inch centers on front trucks, with ⅛-inch clearance, and 48-inch centers on rear truck with ¼-inch clearance, each side.

*In conclusion:* We are of the opinion that tender derailments can be practically overcome by the use of properly designed trucks having rigid or swing motion bolsters supported by suitable bolster springs, either elliptical or half elliptical, double or triple, and when side bearings are properly located, having a spacing of 36 inches front where possible, and 48 to 50 inches at rear end. The types of truck may be of the arch-bar or steel side-frame pattern, with journal boxes rigid with the arch bars or side frames; or of the pedestal type having arch bars or solid frames with springs over the journal boxes; or of the pedestal type having side equalizers with half elliptical springs between the equalizers.

The tender should be as long and low as possible. Spring buffers between engine and tender give flexibility and reduce liability of derailment due to solid chafe irons binding or sticking, on account of wear. The buffer face and bearing on engine should be amply large and well rounded to prevent locking. We do not believe that splash plates in tank help to overcome derailments.

Where proper clearance is not allowed between center pin and truck-center casting there is a possibility of truck not curving, and derailments under such a condition are possible; ¼-inch clearance is recommended. Center plate should be flat, and not less than 11-inch diameter set down at least ¾ inch in center plate.

Tender trucks should be built low as possible, consistent with proper clearance. It is absolutely necessary that ample clearance be allowed for free movement of drawbars at both ends of tenders. The front drawbar should be straight, with its center the same height above the track as that of rear coupler, if possible.

The responsibility for either method of hanging brakes (inside or outside) actually causing derailments could not be verified, as both methods are being used successfully, with perfect freedom from derailments when applied to properly designed trucks.

Wheel base of truck should not be less than 5 feet 6 inches, although shorter ones are in service.

Where safety chains are used, they should be of sufficient length to enable truck to go around the shortest curve, and when tender is rocking.

*Discussion*.—An active discussion followed the reading of this paper. It was decided, however, not to make it public until it had been passed upon by the executive committee. This action was due to the possibility of some statements in the discussion being misunderstood or misconstrued by people who were not thoroughly familiar with it.

## MOTOR CARS.

The committee on motor cars, owing to the resignation of its chairman in February, has not been able to make a full and complete report on the subject. Under date of February 17, 1909, the writer (C. E. Fuller) was requested to undertake the work of the chairmanship of this committee.

After due correspondence with the members of the committee and secretary, it was the president's suggestion that a report be made giving a history of the committee's endeavors, and that at the same time I introduce a personal report based upon the experience of the Union Pacific R. R. in operating motor cars.

Within the last few years many types of railway motor cars have been designed, built and operated, some with success, but most types have been discontinued after a period of experiment, due to their inability to meet all requirements from a mechanical and operating standpoint. These cars may be divided into three general classes, as follows:

1. Steam motor cars.
2. Internal combustion motor cars.
3. Electric cars in combination with storage battery, or with one of the above prime movers.

I believe it can be safely said that within the last three years the general trend has been toward the internal combustion motor.

Quite a number of cars of the internal combustion motor type are in operation on steam roads in various parts of the country, and the creditable performance of these cars during the last few years has, I feel safe in saying, done quite a little to allay the original feeling that the internal combustion motor, as adapted to railway service, would always be an experiment. Some of the advantages of the internal combustion cars, as developed in the use of this type of car on the Union Pacific, are:

1. Light motor weight, permitting lighter truck and body construction.
2. Elimination of the energy-generating unit, such as boilers, tanks and battery.
3. Convenience and compactness in carrying fuel.
4. Elimination of smoke, cinders and sound of exhaust
5. Instant readiness of car for service
6. No power losses nor expenses when shut down

The present considered standard motor car, put in service by the Union Pacific R. R., is a 55-foot all-steel car, equipped with 200 horse-power motor, and carrying 75 passengers, car weighing 60,000 pounds. A similar car 70 feet long has been built, seating over 100 passengers and weighing 80,000 pounds. It will be seen that the dead weight carried amounts to from 600 pounds to 800 pounds per passenger, which compares favorably with modern automobile practice. Fuel sufficient for a 300-mile run is stored in a single tank of convenient size, located in an out-of-the-way place, and it is fed automatically until the last drop is used. Dead cars have actually been placed in commission on five minutes' notice.

These advantages particularly fit this type of car for operation where fuel cost is excessive or where conveniences for handling and maintaining steam or electric cars do not exist.

At the present time the Union Pacific has fifteen motor cars in service, the following services being operated:

| Run | State | Cars Assigned | Distance in Miles | No. Road Trips Daily | Total Mileage |
|---|---|---|---|---|---|
| Kearney-Callaway | Neb. | 2 | 65 | 2 | 260 |
| Loup City-St. Paul | Neb. | 1 | 39 | 2 | 156 |
| Beatrice-Lincoln | Neb. | 1 | 40 | 2 | 160 |
| Omaha-Valley | Neb. | 1 | 34.8 | 2 | 139 |
| Lawrence-Leavenworth | Kan. | 1 | 34.3 | 1 | 68 |
| Lawrence-Kansas City | Kan. | 1 | 38.9 | 1 | 78 |
| Sterling-Greeley | Colo. | 3 | 97.6 | 2 | 390 |
| Boulder-Brighton | Colo. | 1 | 27.7 | 2 | 111 |
| Omaha-Council Bluffs, over Mo. River Bridge | Neb. | 1 | 2.8 | 24 | 134.4 |

This leaves three cars for protection of the various runs and for swing cars when any of the above assigned cars are shopped.

On the Kearney-Callaway, Loup City-St. Paul, Omaha-Valley, Lawrence-Leavenworth, Sterling-Greeley and Boulder-Brighton runs the motor cars haul a trailer, trailer being used for baggage and express and for mail where required.

Seven of the earlier cars placed in service on the Union Pacific were equipped with 100 horse-power engine. Five of these 100-horse-power cars are still in service. The regular or standard type of car in service is equipped with a 200 horse-power six-cylinder reversible gas engine, coupled with a Morse silent chain and a friction clutch to the front axle of the car, which carries 24,000 pounds, or approximately forty per cent. of the entire weight of the vehicle, and gives ample adhesion under all circumstances. Two speeds are used—a low, or geared, speed for starting, and a high, or direct, speed for running. Both speeds are available for running backward. The more recent cars differ from the earlier car only in slight details. The side entrance has been introduced instead of rear entrance, with the idea of doing away with the accumulation of ice and snow on car steps, also obviating the use of step box. Owing to the fact that some of the services have now outgrown the capacity of the 55-foot cars, we are arranging to introduce a 70-foot type of car.

The cars are operated on branch lines by a crew of two men, consisting of motorman in the engine room and a conductor to take tickets, handle orders, etc.

The motor cars have no difficulty whatever in maintaining a passenger-train schedule, and in addition stopping for passengers, when flagged, at road crossings. The operation of these cars shows a very heavy passenger traffic development, which, while partially due to the increased frequency of service, is, however, due to the accommodation in making these road-crossing stops.

*Discussion.*—For special branch line operation, Mr. Seley reported that the Rock Island Railroad had tried two different types of steam cars, one of which was entirely unsatisfactory, and the other, now in operation, is fairly satisfactory. He stated that the success of a motor car depended more on operating conditions than mechanical features, and thus far this road had found difficulty in placing a motor car where it could meet with continued service that would be satisfactory from the operating standpoint.

President Vaughan, in speaking on this subject, said:

"I might say, gentlemen, that we have had some experience with the motor car. Before we got a motor car, the passenger business of the road depended on our developing a motor car. After we got a motor car we could not find any place in which we wanted to use it. That has been our experience for the last three years. Personally, I do not believe, unless the gasolene motor car can be made a satisfactory car, that there is anything in a motor car for railway service. The whole matter of the combining of a steam engine in a passenger coach is, to my mind, radically wrong. The proper place to put a passenger coach at night is in the passenger car yard. The proper place to put a steam engine at night is in the roundhouse. If you put a passenger car in the roundhouse, which is full of smoke, the car becomes dirty and grimy and you have got to send your car cleaners from the car yard to the roundhouse to clean the motor car. If you put the car in the passenger car yard, that means that you must send your men from the roundhouse to the passenger car yard to repair the engine.

"There is nothing radical about a motor car. It is simply a small steam engine; it takes about as much coal per mile as any other engine, possibly a little less; it is easier to fire, because it is small; and its capacity is limited.

"We have had cases where our people thought the motor car should pull two or three trailers with ease, and the car will not do it. It is simply applicable for a light service, which, in most of our conditions, which are, of course, rather different from those further south, can be handled by mixed trains better than they can by motor car service. You must, in the majority of cases, run three men, an engineer, a fireman and a conductor, and it seems to me that a very much better solution of the question is to build a little tank engine with a baggage compartment on it, in which you can get a fireman to attend to the baggage and let the conductor look after the tickets. We have prepared designs for such a car, and now await the passenger department to find a place where they want to run it. The motor car question is going along very quietly with us and we are not spending any money on it."

Mr. Sinclair stated that a recent careful examination of the McKeen motor cars at Omaha had impressed him most favorably, particularly in regard to their construction for easy repairs.

Mr. Jacobs (A. T. & S. F.) reported that two McKeen cars on his road were operated most satisfactorily and had developed a most profitable passenger business, there being very little trouble in operation.

C. B. Smith (B. & M.) stated that his road had given the matter of motor cars the most careful study and had decided that they would not be a profitable proposition under their conditions. He drew attention to the fact that a motor car should be arranged for operation at both ends of the car.

E. I. Dodds (Erie) reported that they had had a McKeen car in operation for about two years on several divisions with entire satisfaction.

Mr. Fuller, in closing the discussion, said that a motor car would most certainly not haul a train and should not be expected to, it will haul a trailer, however. A motor car will need attention and repair the same as any other piece of motive power, and it should be put in service on branch lines or sections where the greatest return for the money can be made. It should not be operated between two or three express trains.

## BANK VERSUS LEVEL FIRING.

E. D. Nelson.

The method of level firing has been followed largely on the road, and instructions covering methods of firing have described this as the most economical method. The advantages of bank firing were brought forward in the summer of 1908 and tests were undertaken to settle generally and definitely the advantages of this latter method. There were decided differences of opinion on the road as to which method was the better in order to secure freedom from smoke and economy in the use of fuel. To settle this question, the work was undertaken on the locomotive testing plant where uniform conditions and accurate measurements can be obtained.

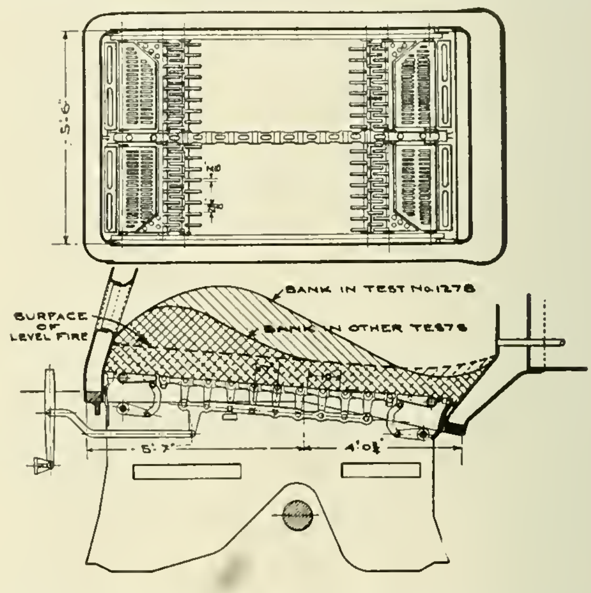
The method referred to as bank firing consists in building up, at the back end of the fire, a bank or ridge of fuel, just inside of the fire door. This ridge of fuel when built up to its full height, has its top at about the level of the top of the fire door. Coal is fired over the top of this bank and slides down the incline toward the front of the fire box, being assisted by the slope of the grate. Coal is distributed along the ridge or bank and finds its way down to the level portion of the fire at the front end of the grate.

The claims of superiority for this method over the level firing are—the fuel, heaped up at the back of the fire box, is coked, the hydrocarbons are driven off slowly and, traversing the whole length of the fire box, are burned with little smoke; the bank of green coal, extending up over the door opening, protects the fireman from part of the heat that is radiated from the fire; the work of placing the fuel is simplified, the coal being fed to the top of the bank instead of being distributed over the grate.

The locomotive used for these tests was the Pennsylvania Railroad standard class "H6b" locomotive, consolidation type, having a total heating surface of 2,505 square feet based on the fire side of the tubes. This is the basis upon which all calculations referring to heating surface are based. The heating surface of the water side of the tubes and the fire side of the fire box, which is usually taken as representing the heating surface of the locomotive, is approximately 2,840 square feet. The grate area of this locomotive is 48.66 square feet, so that the ratio of heating surface to grate surface is 51.49. The steam pressure was 205 pounds.

One series of tests was conducted running the locomotive at about 13½ miles per hour with a cut-off of forty per cent. This gave a drawbar pull of about 22,000 pounds and a drawbar horse-power of about 700. Another series of tests was then run at about 16½ miles per hour with a cut-off of forty-five per cent, giving a drawbar pull of approximately 23,400 pounds, with a drawbar horse-power of 1,030.

The running conditions for these series were selected largely because the conditions stated required approximately eleven pounds of steam from and at 212° F. for each square foot of heating surface for the first series, and about fifteen pounds for the second series. Road conditions fall generally between these limits. Furthermore, it was arranged that part of each series was run with one kind of coal and part with another. We therefore obtained comparisons with two grades of fuel and two rates of evaporation for both the bank firing and the level firing.




The selection of firemen for this work was not difficult. They were two men who were strong advocates of bank firing and three who believed in level firing. These men were all from the same section of road and the coal hereafter designated as No. 2 is what they were accustomed to using. In addition there were the two regular testing plant firemen and one other fireman from a different section of the road. For the purpose of reference on tables and in the text, these will be designated as follows:

B1—Advocate of bank firing.
B2—Advocate of bank firing.
L1—Advocate of level firing.
L2—Advocate of level firing.
L3—Advocate of level firing.
T1—Testing plant fireman.
T2—Testing plant fireman.
R —Road fireman.

The proximate analysis of the coal used is as follows:

| | No. 1 | No. 2 |
|---|---|---|
| Fixed carbon | 60.10 | 48.17 |
| Volatile combustible | 30.36 | 36.37 |
| Moisture | .74 | 2.04 |
| Ash | 8.80 | 13.42 |
| | 100.00 | 100.00 |
| Sulphur | 2.08 | 3.18 |

### The Level Fire.

The methods used in firing the level fire were very much the same in the case of each of the men advocating a level fire. The coal was broken rather fine, to two inches in thickness or less, and was fired in single shovelfuls or at a uniform rate. Fig. 1 shows the section of level fire on the grate.

### The Bank Fire.

The bank fire firemen did not follow strictly the method of firing the bank fire as given above. A bank, as shown in Fig. 1, was built up, but with the exception of test No. 1278, the bank served only as a protection from the heat and glare of the fire, the coal being fired in small quantities and uniformly over the entire grate, except over the bank. The bank top was about eighteen inches inside of the fire door, and with the bank so short on a practically level grate, it is evident that the coal would not slide by gravity to the front of the fire box. In test No. 1278 an attempt was made to fire by placing all of the coal on the top of the bank. The bank in this case extended about 3½ feet inside of the fire door and the fire at the front of the fire box was very thin.

### The Tests.

In tests 1277 and 1278, bank fire tests, the same fireman fired throughout the test, but in the other bank-fire tests the fire was prepared by the testing-plant fireman and then turned over to the bank-fire fireman to build up the bank and continue firing to the end of the test. In these later bank-fire tests the bank was allowed to burn out just before the end of the test and the fire had been restored to its first condition at the end of the test. The bank would be burned out in less than seven minutes. All of the firing, both level and bank, was continuous, small quantities being fired at one time and the coal was broken down before firing.

TABLE No. 1.

Evaporation and Smoke.—No. 1 Coal.

| Test Number. | Fireman. | R. P. M. | Cut-off. | Throttle. | Boiler Pressure, Average. | Equivalent Evaporation from and at 212 Degrees F. Per Square Foot Heating Surface per Hour. | Equivalent Evaporation from and at 212 Degrees F. Per Pound of Dry Coal. | Relative Efficiency, Best Evaporation Equals 100%. | Carbon Monoxide, in Gases, Average. | Kiod of Fire. | Smoke Number, Average. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1276 | L1 | 80 | 40 | F | 197.4 | 10.84 | 8.33 | 91.8% | 0.35% | Level | 1.4 |
| 1275 | T1 | 80 | 40 | F | 201.6 | 11.36 | 9.07 | 100.0% | 0.60% | Level | 1.8 |
| Avg... | ... | ... | ... | ... | ...... | ...... | ...... | 95.9% | | | |
| 1277 | B1 | 80 | 40 | F | 202.0 | 11.07 | 9.04 | 99.7% | 0.95% | Bank | 1.4 |
| Avg... | ... | ... | ... | ... | ...... | ...... | ...... | 99.7% | | | |
| **No. 2 Coal.** | | | | | | | | | | | |
| 1285 | L3 | 80 | 40 | F | 202.3 | 10.88 | 8.68 | 91.9% | 0.10% | Level | 1.2 |
| 1288 | T1 | 80 | 40 | F | 201.0 | 10.86 | 9.17 | 97.0% | ......... | Level | 1.6 |
| 1284 | L1 | 80 | 40 | F | 203.3 | 11.08 | 9.18 | 97 1% | ......... | Level | 1.4 |
| Avg... | ... | ... | ... | ... | ...... | ...... | ...... | 95.3% | | | |
| 1286 | B2 | 80 | 40 | F | 203.3 | 11 09 | 8 66 | 91.6% | 0 35% | Bank | 1.4 |
| 1287 | B1 | 80 | 40 | F | 202.9 | 11.04 | 9.45 | 100.0% | 0.10% | Bank | 1.2 |
| Avg... | ... | ... | ... | ... | ...... | ...... | ...... | 95.8% | | | |

On tables 1 and 2 a summary of the results of the tests are given. The tests on table No. 1 were run at a speed equivalent to about 13½ miles per hour and a cut-off of forty per cent, giving an evaporation of eleven pounds of water per square foot of heating surface per hour. The tests on table No. 2 were run at a higher speed, namely, 16½ miles per hour and forty-five per cent. cut-off, giving an evaporation of fifteen pounds of water per square foot of heating surface per hour.

In column 4 of the tables a comparison is made between the evaporation obtained by the different firemen. The highest evaporation for each group of tests is taken as 100 per cent.

Considerable differences are shown between the level-fire firemen. It is very clear, too, that the second test made by some of the men shows a very decided improvement over the first trial on the testing plant.

In the case of fireman "B2" with a bank fire, in test No. 1278, an evaporation of 6.89 pounds is shown, while on the next test, No. 1282, made by the same fireman, an evaporation of 7.99 pounds was obtained, an increase of about 14 per cent. and a saving of 961 pounds of coal in the second test. This would be a saving of about 2,800 pounds over a 100-mile division.

### Temperature Near Firedoor.

At a point near the firedoor a thermometer was suspended and observations of the temperature were made for each kind of firing, with the following results:

In test No. 1283, level fire, the temperature was 117° F.
In test No. 1281, level fire, the temperature was 114° F.
In test No. 1282, bank fire, the temperature was 104° F.
In test No. 1280, bank fire, the temperature was 94° F.

### Evaporation per Pound of Coal.

In the tests at 100 revolutions per minute the range of coal fired per square foot of grate is from 85 to over 105 pounds. The best results, or highest evaporation per pound of coal, are for the bank fire as fired by fireman "B1." Firemen "T1" and "T2" had had considerable experience at the plant, firing between them seventy-five tests, and the results of their tests with the level fire are very close together.

### Smoke.

Observations of the smoke by the Ringelmann method were made at 10-minute intervals during each test, and the results are conflicting. (See tables 1 and 2.) With No. 1 coal at eighty revolutions per minute the level fire shows the most smoke. At eighty revolutions per minute and No. 2 coal the level fire again shows the most smoke. At 100 revolutions per minute and with No. 2 coal the bank fires show the most smoke.

### Gas Analysis.

The amount of carbon monoxide (CO) in the smoke-box gases is dependent upon the completeness of the combustion, a large amount of CO indicating poor air supply and consequent incomplete combustion.

An inspection of the smoke-box gas analyses does not show any marked difference between the two methods of firing. The least quantity of CO was obtained in bank-fire test 1291.

TABLE No. 2.

Evaporation and Smoke.—No. 2 Coal.

| Test Number. | Fireman. | R. P. M. | Cut-off. | Throttle. | Boiler Pressure, Average. | Equivalent Evaporation from and at 212 Degrees F. Per Square Foot Heating Surface per Hour. | Equivalent Evaporation from and at 212 Degrees F. Per Pound of Dry Coal. | Relative Efficiency, Best Evaporation Equals 100%. | Carbon Monoxide, in Gases, Average. | Kiod of Fire. | Smoke Number, Average. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1279 | L2 | 100 | 45 | F | 197.7 | 14 89 | 7 35 | 83 2% | 1 05% | Level | 2.4 |
| 1283 | R | 100 | 45 | F | 199.7 | 14.85 | 7.72 | 87.4% | 1.30% | Level | 2.1 |
| 1289 | L1 | 100 | 45 | F | 200.3 | 14.59 | 8 07 | 91.4% | 0.15% | Level | 1.5 |
| 1290 | L3 | 100 | 45 | F | 198.4 | 14.59 | 8 14 | 92.2% | 0.35% | Level | 1.9 |
| 1293 | T1 | 100 | 45 | F | 197.3 | 14.29 | 8.53 | 96.6% | 0 80% | Level | 1.7 |
| 1281 | T2 | 100 | 45 | F | 202.0 | 15.07 | 8.57 | 97.1% | 0.45% | Level | 2.0 |
| Avg... | ... | ... | ... | ... | ...... | ...... | ...... | *91.3% | | | |
| 1278 | B2 | 100 | 45 | F | 193.5 | 14 21 | 6 89 | 78.0% | 0.30% | Bank | 2.6 |
| 1292 | B2 | 100 | 45 | F | 198.7 | 14 66 | 7 82 | 88 6% | 0.85% | Bank | 2.1 |
| 1282 | B2 | 100 | 45 | F | 200.5 | 14 88 | 7.99 | 90.5% | 0.70% | Bank | 2.3 |
| 1280 | B1 | 100 | 45 | F | 201.8 | 15 07 | 8.16 | 92 4% | 0 45% | Bank | 2.5 |
| 1291 | B1 | 100 | 45 | F | 200 5 | 14 51 | 8.83 | 100.0% | 0 0 % | Bank | 1.4 |
| Avg... | ... | ... | ... | ... | ...... | ...... | ...... | 89.9% | | | |
| Avg... | ... | ... | ... | ... | ...... | ...... | ...... | †92.8% | | | |

*3½ feet bank. The other tests are with an 18-inch bank.
†Omitting test No. 1278.

### Draft and Thickness of Fire.

The intensity of the draft at any speed and cut-off depends upon the thickness of the fire, and as the draft does not seem to have been affected by the method of firing, we may assume that the average thickness was the same in both the level and bank firing. The reason for the draft not being greater in test No. 1278, where a thick fire was carried at the back end, is that the fire was very thin in front and most of the air supply for the fire came through that portion of the grate.

### Conclusions.

Of the two methods of firing, the results for the bank firing as practiced at the locomotive testing plant during these tests, show a slightly higher evaporation of water per pound of coal. This is based on the results of the level firing and the bank firing where a short bank was used. The large bank will be referred to later. The result in favor of the bank firing is due, possibly, more to the skill of the fireman than to the methods used. It would, therefore, seem safe to conclude that the amount of coal used with the low bank fire and with the level fire are the same.

If, however, the method of firing as practiced by fireman "B2" in test No. 1278 is followed, the results are much less satisfactory than with the level fire. As the bank firing employed in test No. 1278 was used in the first test with No. 2 coal, to which the advocates of bank fire were accustomed, it would appear that the size of the bank, in this test, and the method of firing it were that which had been claimed to be more economical than the level fire. This method of bank firing is undoubtedly proved to be far from economical as compared with level firing, and the fact that fireman "B2" who formerly advocated this method of firing, changed to the small form of bank after seeing the results, seems to be corroborative evidence that the large bank, as first tried, was, in his estimation, not to be compared in economy with level firing.

It should be emphasized particularly that in speaking of bank firing as a method, the size of the bank which is to be employed must be clearly understood. The general statement that bank firing and level firing can be placed on a par, so far as economy in fuel is concerned, is misleading, unless a description of the bank method of firing is given.

The idea of the larger bank seems to be that it forms some protection for the fireman against the heat from the fire box and permits the firing to be done largely at the back end of the fire box, the coal or partly consumed coal working its way forward. It is this method of bank firing which has been shown to be uneconomical.

The method of bank firing with the low bank does not require all the coal to be fired at the back end, but requires firing in much the same way as with the level fire. The temperature from this form of bank has been shown to be from 10 to 23° F. less near the fire door than with the level fire.

*Discussion.*—The president drew attention to the value of a testing plant for obtaining information of this kind which a few years ago would not have been obtainable, and stated that he considered it a great privilege for the association to be able to receive it.

J. F. DeVoy (C. M. & St. P.) stated that he considered the design of fire box had a large amount of influence on the question of the best methods of firing and that his experience showed that a method of firing which was successful on a straight grate would not be successful on a grate with a hump in it.

H. T. Bentley (C. & N. W.) did not agree with Mr. DeVoy that the design of the fire box had as large an influence on the best method of firing as did the character of the fuel used.

C. E. Chambers (C. of N. J.) stated that he had been brought up to fire by the level method and when he came on to a road using the bank system he attempted to change the methods with disastrous results, as it was necessary with the fuel being used to fire by the bank system.

It was reported that the test did not show any noticeable difference in clinkering between the two methods of firing.

## CASTLE NUTS.

Committee:—R. B. Kendig, Chairman; J. F. DeVoy, H. P. Meredith, J. N. Mowery, G. S. Edmunds.

(Note.—Messrs. John Player and W. L. Austin, members of the committee, did not approve of certain details contained in the report.)

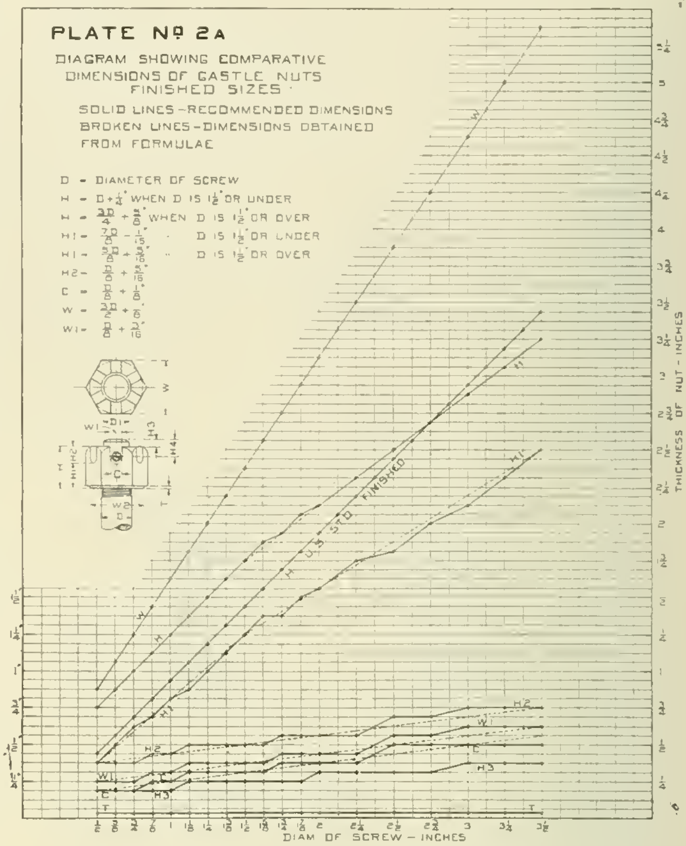
At the convention last year the dimensions of castle nuts as formulated by the committee were recommended for use during the current year, with a view to adopting them as standard if found satisfactory. The committee was continued to get in touch with the manufacturers of castle nuts and with other parties interested, with a view of establishing them as a regular standard of the association.

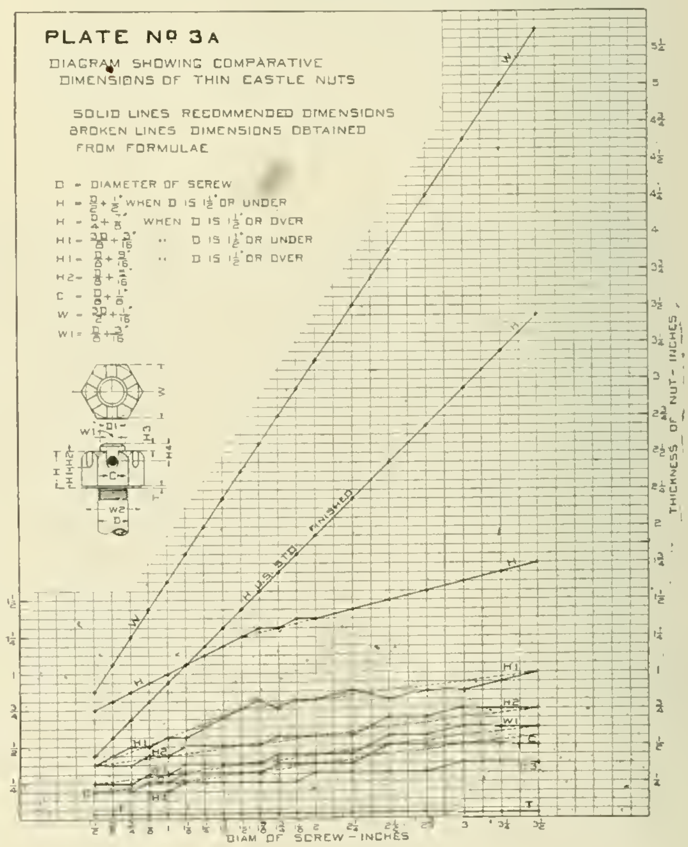
A circular of inquiry was addressed to the members of the association, and similar information was requested from a number of nut manufacturers, with the idea of determining whether or not the dimensions submitted last year were entirely satisfactory. The response to the committee's inquiry would indicate that the subject is awakening more than ordinary interest. The replies received were very complete, and the committe is thus enabled to make some few revisions and some correction of errors in the dimensions, which we believe will now make the dimensions acceptable.

Calling attention to plate No. 4 of last year's report, the committee has prepared plate No. 4-A as a substitute. This revised plate shows all the changes in dimensions, covering corrections and modifications as a result of the answers to our circular of inquiry, as well as the former dimensions which were unchanged.

The committee made inquiry as to the use of the castle nut by members of the association, and find that it is being extensively used on locomotives in all sections of the country. The various parts of the locomotive on which the castle is being used, as reported in replies to the circular of inquiry, include the following: Rod bolts, frame pedestal binder bolts, cross-head pins, cross-head shoe bolts, guide bolts, all valve-motion bolts and pins, brake-connection pins, driving box wedge bolts, spring-hanger bolts, air-pump bracket bolts, chafing-iron bolts, engine-truck radius bar and radius-bar brace bolts, engine-truck frame bolts, radius-bar carrier bolts, engine-truck pedestal bolts, brake-connection pins on tenders, brake-hanger pins, arch-bar and column bolts, and, in fact, on all bolts subject to any motion or wear.

There were reported, however, a number of roads not yet using the castle nuts on account of the excessive cost of manufacture. It is believed by the committee that the adoption of standard dimensions will have a tendency to put the castle nut on a proper manufacturing basis, with the consequent reduction in cost of manufacture. Several of the railroads, on account of the exces-




sive cost, have found it advantageous to equip their forging machines for the manufacture of the castle nut, and from their experience it is evident that the nuts can be thus manufactured at considerably less cost, in the larger sizes at least, than they can now be obtained from the bolt and nut manufacturers.

Plates Nos. 1, 2 and 3, showing the development of formula, have been reissued, having corrections made in dimensions previously referred to as shown on plate No. 4-A. The corrected plates which accompany this report bear the numbers 1-A (not reproduced), 2-A, 3-A.

Several users of the castle nuts suggested drilling two cotter holes spaced 90 degrees in the larger bolts, for the reason that on the coarser threads 1/12th turn instead of 1/6th would be decidedly preferable. The committe decided not to make any recommendation on this point, preferring only to consider that feature of the bolt necessary to determine dimensions for the castle nut.

The committee would make the following recommendations, the dimensions for each of which is given in detail on plate No. 4-A, under the heading "Recommended Dimensions":

1. A series of castle nuts having U. S. standard thread with dimensions as shown.
2. A series of thin castle nuts having U. S. standard thread with dimensions as shown.
3. A series of special thin castle nuts having outward proportions the same as thin castle nuts, but having special number of U. S. threads, as shown.
4. Rough castle nuts to have diameter across the flats as shown. These dimensions correspond with U. S. standard dimensions for hexagon nuts. Finish of flats to be obtained by grinding and buffing, or by milling, the same practice as obtains with the U. S. standard nuts.
5. Finished nuts to have facing washer on bottom with dimension as shown. Rough nuts to have bottom corner slightly chamfered.
6. A series of standard cotter pins with dimensions as shown.
7. A series of Player cotter pins with dimensions as shown.
8. A series of taper pins with dimensions as shown.
9. Bolt ends projecting with cotter-pin hole location as shown.

Following the reading of the report the secretary presented a communication from W. L. Austin, a member of the committee, saying that he approved the report with the following exceptions:

1. The nuts should be U. S. standard in thickness, not more.
2. The threads should be turned off the outer end of the bolt, but the bolt should have a bearing of the full thickness of the nut in order to utilize all of the thread.
3. There should be but one style of cotter, namely, the common cotter pin.

John Player, a member of the committee, disagreed with the report in that on plate 3A the dimension H1 for the 1⅝ and 2¼ in. nuts should be minus 1-16 and H2 should be plus 1-16.

*Discussion.*—The report was given a very general and thorough discussion, and a motion by Mr. Wildin, which stated that the association accepted the committee's report as to thickness of the nut as a standard, was carried. Mr. Seley's motion that the cotter pin shown on plate 4A be accepted as a standard of the association was also carried.

An extended discussion was given to the matter of the number of threads for thin nuts and a motion by Mr. Wildin that the dimensions shown on Plate 4A, referring to the bolt and to special threads in the nut, be eliminated was defeated.

*Action.*—Mr. DeVoy's motion that the report as a whole be accepted and referred to letter ballot of the association for adoption as a standard was carried.

PLATE Nº 4A

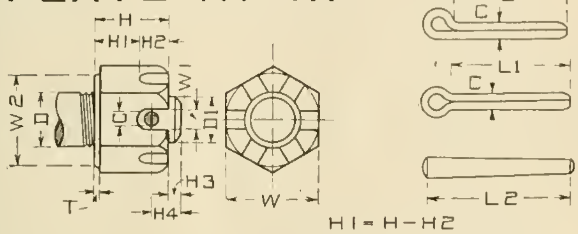



TABLE OF DIMENSIONS FOR CASTLE NUTS AND THIN CASTLE NUTS

DIMENSIONS GIVEN ARE IN INCHES

RECOMMENDED DIMENSIONS

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NUT | D | DIAMETER OF SCREW | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1 1/8 | 1 1/4 | 1 3/8 | 1 1/2 | 1 5/8 | 1 3/4 | 1 7/8 | 2 | 2 1/4 | 2 1/2 | 2 3/4 | 3 | 3 1/4 | 3 1/2 |
| | | NO. OF THREADS PER INCH U S STANDARD CASTLE AND THIN CASTLE NUT | 13 | 11 | 10 | 9 | 8 | 7 | 7 | 6 | 6 | 5 1/2 | 5 | 5 | 4 1/2 | 4 1/2 | 4 | 4 | 3 1/2 | 3 1/2 | 3 1/4 |
| | | NO OF THREADS PER INCH FOR SPECIAL THIN CASTLE NUT | 13 | 11 | 10 | 9 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 6 | 6 |
| | W | DIAMETER ACROSS FLATS ROUGH SIZE | 7/8 | 1 1/16 | 1 1/4 | 1 7/16 | 1 5/8 | 1 13/16 | 2 | 2 3/16 | 2 3/8 | 2 9/16 | 2 3/4 | 2 15/16 | 3 1/8 | 3 1/2 | 3 7/8 | 4 1/4 | 4 5/8 | 5 | 5 3/8 |
| | W2 | DIAMETER OF FACING COLLAR | 13/16 | 1 | 1 3/16 | 1 3/8 | 1 9/16 | 1 3/4 | 1 15/16 | 2 1/8 | 2 5/16 | 2 1/2 | 2 11/16 | 2 7/8 | 3 1/16 | 3 7/16 | 3 13/16 | 4 3/16 | 4 9/16 | 4 15/16 | 5 5/16 |
| | T | THICKNESS OF FACING COLLAR | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 | 1/32 |
| | H | THICKNESS OF CASTLE NUT-ROUGH | 13/16 | 15/16 | 1 1/16 | 1 3/16 | 1 5/16 | 1 7/16 | 1 9/16 | 1 11/16 | 1 13/16 | 1 15/16 | 2 | 2 1/8 | 2 3/16 | 2 3/8 | 2 9/16 | 2 3/4 | 2 15/16 | 3 1/8 | 3 5/16 |
| | H | THICKNESS OF CASTLE NUT-FINISHED | 3/4 | 7/8 | 1 | 1 1/8 | 1 1/4 | 1 3/8 | 1 1/2 | 1 5/8 | 1 3/4 | 1 7/8 | 1 15/16 | 2 1/16 | 2 1/8 | 2 5/16 | 2 1/2 | 2 11/16 | 2 7/8 | 3 1/16 | 3 1/4 |
| | H | THICKNESS OF THIN CASTLE NUT-ROUGH | 13/16 | 7/8 | 15/16 | 1 | 1 1/16 | 1 1/8 | 1 3/16 | 1 1/4 | 1 5/16 | 1 3/8 | 1 3/8 | 1 7/16 | 1 7/16 | 1 1/2 | 1 9/16 | 1 5/8 | 1 11/16 | 1 3/4 | 1 13/16 |
| | H | THICKNESS OF THIN CASTLE NUT-FINISHED | 3/4 | 13/16 | 7/8 | 15/16 | 1 | 1 1/16 | 1 1/8 | 1 3/16 | 1 1/4 | 1 5/16 | 1 5/16 | 1 3/8 | 1 3/8 | 1 7/16 | 1 1/2 | 1 9/16 | 1 5/8 | 1 11/16 | 1 3/4 |
| | | NO. OF SLOTS IN CASTLE | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| | W1 | WIDTH OF SLOT IN CASTLE | 1/4 | 1/4 | 1/4 | 5/16 | 5/16 | 3/8 | 3/8 | 3/8 | 3/8 | 3/8 | 7/16 | 7/16 | 7/16 | 7/16 | 9/16 | 9/16 | 5/8 | 5/8 | 5/8 |
| | H2 | DEPTH OF SLOT IN CASTLE | 3/8 | 3/8 | 3/8 | 7/16 | 7/16 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 9/16 | 9/16 | 9/16 | 9/16 | 11/16 | 11/16 | 3/4 | 3/4 | 3/4 |
| BOLT | C | DIAMETER OF COTTER PIN HOLE IN BOLT | 3/16 | 3/16 | 3/16 | 1/4 | 1/4 | 5/16 | 5/16 | 5/16 | 5/16 | 5/16 | 3/8 | 3/8 | 3/8 | 3/8 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 |
| | H3 | PROJECTION OF BOLT BEYOND TOP OF NUT | 3/16 | 3/16 | 3/16 | 3/16 | 3/16 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 | 5/16 | 5/16 | 5/16 | 5/16 | 3/8 | 3/8 | 3/8 |
| | D1 | DIAMETER OF REDUCED END OF BOLT | 3/8 | 7/16 | 9/16 | 11/16 | 13/16 | 7/8 | 1 | 1 1/8 | 1 1/4 | 1 5/16 | 1 7/16 | 1 9/16 | 1 11/16 | 1 7/8 | 2 1/8 | 2 5/16 | 2 9/16 | 2 3/4 | 3 |
| | H2+H3 | LENGTH OF REDUCED END OF BOLT | 9/16 | 9/16 | 9/16 | 5/8 | 5/8 | 3/4 | 3/4 | 3/4 | 3/4 | 3/4 | 13/15 | 13/16 | 7/8 | 7/8 | 1 | 1 | 1 1/8 | 1 1/8 | 1 1/8 |
| | H4 | DISTANCE FROM CENTER OF COTTER PIN HOLE TO END OF BOLT | 3/8 | 3/8 | 3/8 | 7/16 | 7/16 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 9/16 | 9/16 | 5/8 | 5/8 | 11/16 | 11/16 | 13/16 | 13/16 | 13/16 |
| COTTER | C | NOMINAL DIAMETER OF COTTER PIN | 3/16 | 3/16 | 3/16 | 1/4 | 1/4 | 5/16 | 5/16 | 5/16 | 5/16 | 5/16 | 3/8 | 3/8 | 3/8 | 3/8 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 |
| | L | LENGTH OF PLAYER COTTER PIN | 7/8 | 1 | 1 1/4 | 1 1/2 | 1 1/2 | 1 3/4 | 1 3/4 | 2 | 2 | 2 | 2 1/2 | 2 1/2 | 3 | 3 | 3 1/2 | 3 1/2 | 4 | 5 | 5 |
| | L1 | LENGTH OF COMMON COTTER PIN | 1 1/4 | 1 1/2 | 1 3/4 | 2 | 2 | 2 1/4 | 2 1/2 | 2 1/2 | 3 | 3 | 3 1/2 | 3 1/2 | 3 1/2 | 4 | 5 | 5 | 5 | 6 | 6 |
| TAPER PIN | | SIZE OF TAPER PIN USED IN PLACE OF COTTER | •2 | •2 | •2 | •4 | •4 | •6 | •6 | •6 | •6 | •6 | •6 | •6 | •7 | •7 | •8 | •8 | •9 | •9 | •9 |
| | L2 | LENGTH OF TAPER PIN | 1 1/4 | 1 1/4 | 1 1/2 | 1 3/4 | 2 | 2 1/4 | 2 1/4 | 2 1/2 | 2 3/4 | 3 | 3 1/4 | 3 1/4 | 3 1/2 | 3 3/4 | 4 1/4 | 4 1/2 | 5 | 5 1/4 | 5 3/4 |

## WHAT PROGRESS HAS BEEN MADE IN LUBRICATING MATERIAL ECONOMIES.

Committee:—T. S. Lloyd, Chairman; E. D. Bronner, E. F. Needham, T. Roope, G. J. DeVilbiss.

[The nature of the report submitted by the committee was essentially one of the comparison of earlier-day methods with present-day practices. It is summarized as follows.—Ed.]

Great progress has been made in lubricating economies, and in summarizing factors conducing thereto the following are most prominent:

Designs of locomotives with features whereby lubricated parts have been made readily accessible.

More general use of types of valve gear with lubricated parts accessible, and further permitting easier access to other lubricated parts.

Improved construction and location of lubricators and piping, namely, locating all lubricators where feed can be readily observed, both day and night by enginemen, high enough that all oil delivery pipes have gradual fall from lubricator to steam chest or point of delivery.

Close attention to choke plugs.

Careful attention to material entering into the construction of journals and bearings, and condition thereof.

The use of grease for lubrication of crank pins and driving-box journal bearings.

The adoption of proper devices and methods for the use of greases.

Improved method of packing engine trucks, trailers, oil-lubricated driving journal cellars and tank-journal boxes with properly saturated waste.

Improved storage and measuring facilities for oil.

Careful attention to renovating and reusing prepared packing and greases.

Uniformity in accounting, etc.

The report of this committee, which is given in abstract above, did not receive any extended discussion. The committee was continued for another year.

## SAFETY VALVES.

The report of the committee on the size and capacity of safety valves for use on locomotives stated that owing to the financial condition during the past year no experimental work had been done and requested that the committee be continued to complete its work. There was no discussion on this subject and the committee was continued.

## TOPICAL DISCUSSIONS.

*Brick Arches and Water Tubes in Locomotive Fire Boxes.*—This subject was opened by Mr. Walsh (C. & O.), who stated that not only was the arch itself a very desirable feature, but the increased heating surface and the circulation afforded by the water tubes added materially to the steaming qualities of the engine. He was most decidedly in favor of brick arches and reported that about 20 lbs. of coal per mile could be saved on one class of engine on one of his divisions by the application of the brick arch. The cost of the arch would be saved in one round trip of the engine. Arches were found to last from two to six weeks in large locomotives.

Prof. Hibbard drew attention to the desirabiilty of obtaining tough in preference to high-temperature fire brick. President Vaughan stated that he had found the application of arches to be a matter of conditions. They were of great value in some districts and of no value in others.

Mr. Parish stated that practically all locomotives on the Lake Shore were equipped with brick arches, including switch engines, and that the saving obtained in this way was very large.

Mr. Manchester stated that it had been the practice on the Milwaukee for twenty years to use a brick arch. They were firmly convinced that it was the most desirable thing.

*Is Previous Railway Experience of Advantage to Locomotive Firemen?*—D. R. MacBain (N. Y. C.) opened this subject and summed up his remarks as follows:

1. Should it be the good fortune of a road to get men who have fired elsewhere and been laid off on account of reduction in force, the experience they have had ought to be of some value to the employing company. Thy have, as a rule, the advantage of being young men, which is a desirable feature.

2. If intelligent young men could be induced to enter the track, bridge, car repair and freight house gangs with a prospect of advancement to the locomotive service, if they can qualify, it would seem that the scheme ought to work out advantageously to the railway companies.

3. In our opinion the next best material from which to choose firemen is from the farm. The farmer's son, after he is broken in, is usually appreciative of his position and will develop into a good, reliable locomotive fireman.

Much can be accomplished toward improving efficiency among locomotive firemen by having good men as firemen's instructors who shall have no other duties to perform and who can apply their whole mental and physical energy toward instruction.

*Is the Additional Cost of Flexible Staybolts Justifiable?*—H. D. Brown (Erie) in opening this subject stated that he had written to a number of the members for their experience in this matter and had found to his great surprise that all of the answers agreed with his own opinion that this cost was justifiable. He suggested that a committee be appointed to determine the best method for proper adjustment of flexible staybolts, who should also make experiments to determine the exact amount and location of expansion in the fire box.

Mr. Bentley thought the application of flexible staybolts should be based on the number of staybolt breakages, and where there was a small staybolt breakage the use of the flexible bolt would be unnecessary. He stated that one of their engines gave them trouble, but by redesigning the fire box, so as to get longer staybolts, it had been practically eliminated.

Mr. DeVoy drew attention to the possible value of flexible staybolts in reducing cracked side sheets. He was of the opinion that by applying flexible staybolts in the proper places trouble with cracked sheets could be eliminated.

*Is the Usual Front Row of Crown Bolts in a Locomotive Boiler Beneficial or Otherwise?*—M. Seley, in opening this discussion, read a report, which was prepared by one of his subordinates, to the effect that the flexible crown stays in the front end of a fire box were not of any value.

Geo. F. Fowler drew attention to some experiments which had been made a long time ago by Mr. Eddy on the Fitchburg Railway, for determining the movement at the front end of the crown sheet. He found that in getting up steam the front end of the crown sheet actually lifted as the water became hot, and this was followed, after pressure had been generated in the boiler, by a downward movement, bringing it back to the same location as it was when the boiler was cold.

Mr. Fuller explained the fact that the crown sheet was often ¼ of an inch below the top of the flue sheet just back of the flange, the flange being bent down in the same manner, by stating that this was due to the constant rolling of the flues and the consequent stretching of the flue sheets.

*Are By-Pass Valves Necessary on Piston Valve Locomotives?*—Mr. Bentley, in opening this subject, spoke as follows:

"When piston valves were first used on locomotives it was very naturally supposed that, on account of the shape of the valve and its inability to lift as a slide valve does, it was necessary to have some arrangement or by-pass that would take care of a higher pressure in the cylinder, due to compression, than the steam pressure carried in the boiler, and numerous devices were used, all having the same object in view, but each design differing somewhat in the manner of operation.

"In one of the valves tested it required over 200 lbs. above boiler pressure to operate, and therefore was practically useless. Others performed their function satisfactorily, while they remained intact, but the hammering they were subjected to caused them to break, which resulted in a bad steam leak that was often difficult to locate.

"A double-seated valve gave considerable trouble on this account. The seat closing the steam from the atmosphere would be tight, while the other, separating steam chest and cylinder pressure, would not close, owing to the expansion of the metal, and a continuous blow would take place and much coal was wasted in this manner.

"After using various types for several years, with unsatisfactory results, we made a series of tests in September, 1907, and found that under ordinary service conditions the by-pass valves were unnecessary and therefore took them off. After running the engines without them for nearly two years, but having suction valves of ample capacity, we do not find any bad effects, neither have we had any more cylinder heads broken than we did before.

"Where by-pass valves are used simply to by-pass the air from one end of the cylinder to the other, when drifting, they may give satisfactory results, and probably will be better than the suction valve located outside, as the air will pass back and forth from one end of the cylinder to the other and not through the walls of cylinder to the extent it would do if drawn in through regular suction valves from outside.

"With water in the cylinders the by-pass or cylinder relief valve might give some relief, but under ordinary running conditions we find no advantage.

"While at a locomotive builder's recently, in talking about some proposed engines having 25 in. by 32-in. cylinders and a boiler pressure of 170 lbs. without a superheater, it was the opinion of their engineering department that a by-pass valve would be necessary, probably on account of the greater condensation that would occur in the cylinder of the sizes given, and using a comparatively low boiler pressure without a superheater. But for engines having ample steam space, using good water, and with cylinders suited for a boiler pressure of 190 to 225 lbs., we do not believe a by-pass valve necessary."

In answer to questions he stated that there had been no difference noticed in the loosening of valve heads, or the breaking of valve bushings or valve packing rings. This was on inside admission piston valve engines. The earlier trouble with broken packing rings had been overcome by the substitution of a T ring for the rectangular ring.

President Vaughan called attention to the fact that there is a wide difference between putting a by-pass valve on and saying that you are using it and in having it used, as it has been found that many of these valves are blanked by the engineers and roundhouse forces on account of various personal objections.

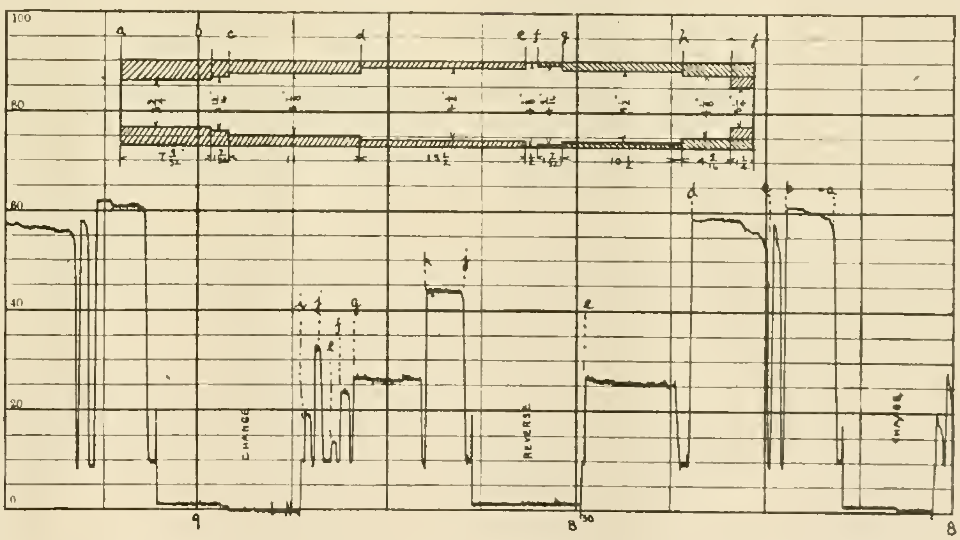
## GRAPHIC RECORDING WATTMETER.

With the help of electrical apparatus it is possible to obtain from any motor-driven machine tool a complete graphic record of exactly what the machine is doing. In the case of a planer, for instance, every stroke may be clearly seen on the record, and with any tool every stop for change of work or other cause, every adjustment of a tool, may be observed and the length of time for each shown at a glance. In addition the amount of power required to do any given piece of work may be determined with accuracy. These records may be obtained by the use of a Westinghouse curve-drawing instrument in connection with individual motors driving machine tools.

The meter consists of a pen, instead of the usual indicating needle, arranged to deflect over a scale. Under this pen is a large roll of specially graduated paper moved by clockwork, the usual speed being 8 inches an hour. The pen produces a fine mark on the paper, its length above the zero line showing the power consumed by the motor. A typical record, very much reduced, is shown, illustrating the operation of roughing out a motor shaft on a Lodge & Shipley lathe. The curve is read from right to left, with zero at the bottom. The outline of the shaft worked on is shown also; the lettering on the shaft and the record correspond. With such a curve any foreman, superintendent or other person interested in investigating the actual working conditions of the shop, can have exact records of any or all operations which he desires to consider.

At 8 o'clock the workman was just completing a shaft and then shut his motor down in the interval marked "change" to take out the completed shaft and put a new one in about 8.10 o'clock. Work was begun on the new shaft by starting the motor and cutting from *a* to *b*. For about a minute after starting, the motor ran light while the workman was getting his tool ready, but the power speedily increased showing a heavy cut was being taken. At *b* the diameter changed and the cutting was stopped momentarily, as shown by the drop in the curve, to readjust the tool. Cutting began again and continued to *c*, but the power required was less because of a smaller amount of metal being removed. At *c* the diameter changed and the tool was adjusted to make the cut from *c* to *d*, which was evidently taken at a faster speed as the power was nearly as high as when cutting from *a* to *b*, though the cut was somewhat lighter. At 8.30 the motor was shut down for the interval marked "reverse," in which the shaft, half completed, was taken out and reversed in position in order to cut from *j* to *e*. the interval during which the motor took no current, from 8.30 to 8.39, shows that 9 minutes were required to reverse the shaft. After reversal the cutting began at *j* at the right hand end of the shaft, while, of course, the record continues from the point where cutting ceased, continuing always from right to left. The lettering on the shaft and the record correspond, so that there is no possibility of confusion. The motor was finally shut down at 8.52, when the work on the shaft was completed. During the interval from 8.52 to 9.03, marked "change," the completed shaft was removed and a new one placed in position, when the cycle of operations was begun again.

As an example of a saving which the use of these meters produced by indicating a source of delay the following case may be noted: A comparison of records obtained from lathes which were roughing out motor shafts showed that in one there were stops averaging five minutes each while the shaft was being taken out and a new one put in, or a shaft half completed was being reversed in position; in the other the delays averaged 10 minutes, just twice as long. Naturally some explanation of this discrepancy was looked for. It was found that the shorter time for changes and reversals occurred on a shaft small enough to be handled entirely by hand, but the other shaft was so heavy as to require the services of a crane in handling. The delays were due to the impossibility of obtaining the overhead traveling crane at once. To remedy this defect a jib hoist was installed beside the lathe and the material was handled in and out of the lathe by it. The result was a saving of 10 minutes on the time of each shaft which meant the completion of two more shafts a day.



GRAPHICAL RECORD OF POWER REQUIRED BY A LATHE IN TURNING A MOTOR SHAFT

Business Failures This Year.—There have been fewer business failures for the first six months of this year than for the same period in 1908. R. G. Dun & Co. report 6,831 failures, with liabilities of $88,541,373, since January 1, as compared with 8,709 failures and $124,374,833 in the first half of 1908. Bradstreet's figures make the number of failures so far this year 6,149, with liabilities amounting to $80,651,976, compared with 7,562 failures having $178,782,769 liabilities, during the first six months of 1908.

# MASTER CAR BUILDERS' ASSOCIATION

(*Continued from page 298.*)

## CAR WHEELS.

Committee: Wm. Garstang, Chairman; W. C. A. Henry, A. E. Manchester, R. L. Ettenger, O. C. Cromwell, W. E. Fowler, R. F. McKenna.

Since the 1908 convention the scope of this committee has been largely increased and now includes in its work "steel and steel-tired wheels" in addition to cast-iron wheels. As a consequence, the personnel, also the name of the committee, have been altered and under its new title, "Standing Committee on Car Wheels," will include in its recommendations in this report subject matter referring to cast-iron, solid-steel and steel-tired wheels intended for service under both passenger and freight equipment cars and will deal with each separately, and will also deal with points that have been raised by the different railway administrations through the executive committee, as well as points in reference to the text of subject matter now appearing in the 1908 Proceedings of the Association and the Code of Interchange Rules of 1908 issue which the committee themselves have found to conflict.

ARTICLE 1. As a prelude, a recapitulation of the points raised in the 1908 report is apropos, as it will be remembered that a minority report was presented by one member of the committee, and as a result the entire report was recommitted. The 1908 report included a "Wheel Defect and Worn Coupler Limit Gauge," having two slots for gauging worn flanges, one slot being 1 1-16 inches wide and the other slot 1 inch wide, and the committee, after further investigation, accepts the modification proposed in which these slots are made respectively 1 inch and 15-16 inch wide and endorses as correct the wheel defect and worn coupler limit gauge now appearing on page 7 of the 1908 Code of Interchange Rules, and the cuts showing the method of using it, as shown on pages 10, 11 and 12 of the same issue.

ART. 2. The shape of brackets or ribs on cast-iron wheels in the report for 1908 was altered from the long radius type to a short radius type, the curve of the brackets being made such that the outer end of the bracket would flow into the rim at the back of the flange in a line following the circumference of the wheel, the bracket originating on the double plate portion in a line radial to the center of the hub. This shape of bracket has been adhered to for the promotion of good foundry practice and to prevent unequal construction strains, and the drawings presented by the committee in connection with this report include brackets of this form.

ART. 3. The question of regulation of foundry practice in the manufacture of cast-iron wheels to promote uniformity of product in the different sections of this country, also the question of proper chemical analysis for materials entering into these wheels, has during the past year received a full share of the attention of the committee working jointly with a committee representing the Association of Manufacturers of Chilled Car Wheels, which association, during the year 1908, was regularly incorporated and is empowered to act for the wheelmakers who are members of the association.

The result of the conference on the regulation of foundry practice and chemical analysis phases has in no wise settled the subject, and this committee has, at the solicitation of the wheelmakers' committee, agreed that the study thus far has not been sufficient to permit the formation of a recommendation, and we, therefore, report progress on this portion of the work and ask another year's consideration before submitting any definite recommendations. We submit, as an appendix (not reproduced here), extracts from the "Record of Proceedings of the Association of Manufacturers of Chilled Car Wheels," submitted to the committee, which deals with the subject from the view-point of the manufacturers, and the items contained therein will be taken up and dealt with later in accordance with the conclusions reached by this committee.

ART. 4. From the convention of 1908 to and including the present time, the committee has directed its attention to instructions received from the executive committee, namely:

(a) To prepare drawings showing the limit of wear of solid-rolled steel wheels in connection with the minimum thickness for steel tires shown on Sheet M. C. B.—A.

(b) To confer with similar committees from the Master Mechanics' and Maintenance of Way Association on the widening of the gauge on curves, owing to the fact that the minimum tread of car wheels has an important bearing on this subject.

(c) To confer with the committee of the American Railway Engineering and Maintenance of Way Association regarding the allowable length of flat spots on car wheels in connection with the effect such defects produce on bridges and track, and to report back to the executive committee regarding the procurement of apparatus for making tests.

ART. 5. The committee's attention has been called to corrections necessary in the M. C. B. specifications for cast-iron wheels relating to the form of chills, weights of wheels, and the necessity of casting the initials of the railroad or private line company on all wheels used in interchange service, and has also been directed to a necessary change in the form of the double plate portion of the 60,000 pounds capacity wheel from that now shown in the 1908 Proceedings, to insure sounder wheels than are now produced from the drawings for this wheel.

ART. 6. Considerable comment has been directed against the slight taper at the sand rim in the present tread contour on account of "chipped rims"; also evidence has been presented showing that a greater mileage could be secured from all wheels if the sand rim taper was increased and lengthened toward the flange, and that further freedom from broken flanges would result if the height of the flange "when new" was reduced, owing to the fact that shorter flanges would not be as apt to strike fillers in the track, when a wheel having a tread worn hollow passed over a frog where the head of the rail had been worn down considerably.

ART. 7. Attention has also been directed to subject matter pertaining to gauges, also the text in the Standards and Recommended Practice now appearing in the Proceedings and in the Rules of Interchange, all of which must be corrected to prevent conflict and will be dealt with in the recommendations contained in this report.

ART. 8. Consistent action on the part of the committee, in view of the fact that its 1908 report was recommitted, will be to condense the 1908 report and the report for 1909 into one and present them at the 1909 convention, and the conclusions of the committee on all points involved for both years appear in the following recommendations:

### RECOMMENDATIONS

IN REFERENCE TO CAST-IRON WHEELS COVERING POINTS REFERRED TO IN ARTICLES 2, 5 AND 6.

1. The cancellation of the present cut covering the 33-inch, 600-pound wheel now appearing on M. C. B. Sheet "J" of Recommended Practice in 1908 Proceedings, and the substitution of a cut reduced from that shown in Fig. 1, covering the entire new form of 625-pound wheel for use under 60,000 pounds capacity cars.

2. The cancellation of the present cut covering the 33-inch, 650-pound wheel now appearing on M. C. B. Sheet "J" of Recommended Practice in 1908 Proceedings, and the substitution of a cut reduced from that shown in Fig. 2, for 675-pound wheel, which covers the present form through the hub, double-plate and single-plate parts, with the new form of tread and flange and curve of brackets added.

3. The cancellation of present cut covering 33-inch, 700-pound wheel now appearing on M. C. B. Sheet "J" of Recommended Practice in 1908 Proceedings, and the substitution of a cut reduced from that shown in Fig. 2 for 725-pound wheel, which covers the present form through the hub, double-plate and single-plate parts, with the new form of tread and flange and curve of brackets added.

4. The cancellation of cuts covering wheel tread now appearing on Sheets 7 and 12 of M. C. B. Standards in the 1908 Proceedings and the substitution of a cut reduced from that shown in Fig. 4 to appear as M. C. B. Sheet 12.

5. The cancellation of cuts covering "Maximum Flange Thickness Gauge" and "Minimum Flange Thickness Gauge" now appearing on Sheet 12 of M. C. B. Standards in 1908 Proceedings and the substitution of cuts shown in Figs. 5 and 6, which have been revised to show the new flange and tread contour proposed in this report.

6. The cancellation of cut showing "Wheel Defect and Worn Coupler Limit Gauge" now appearing on Sheet 12 of M. C. B. Standards and the substitution of a cut, Fig. 7, to appear on M. C. B. Sheet 12. The necessity for such change is referred to in Article 1.

7. The cancellation of the cuts showing "Terms and Gauging Points for Wheels and Track, Standard Reference Gauge for Mounting and Inspecting Wheels, Wheel Check Gauge, Guard Rail and Frog Wing Gauge, and Standard Reference Gauge for Mounting and Inspecting Wheels (as used for inspecting)," and the substitution therefor of cuts of the same gauges shown in Fig. 8. This is imperatively necessary on account of an error of 1-64 inch shown in a main dimension in the original drawings for these gauges and which made corrections necessary in several

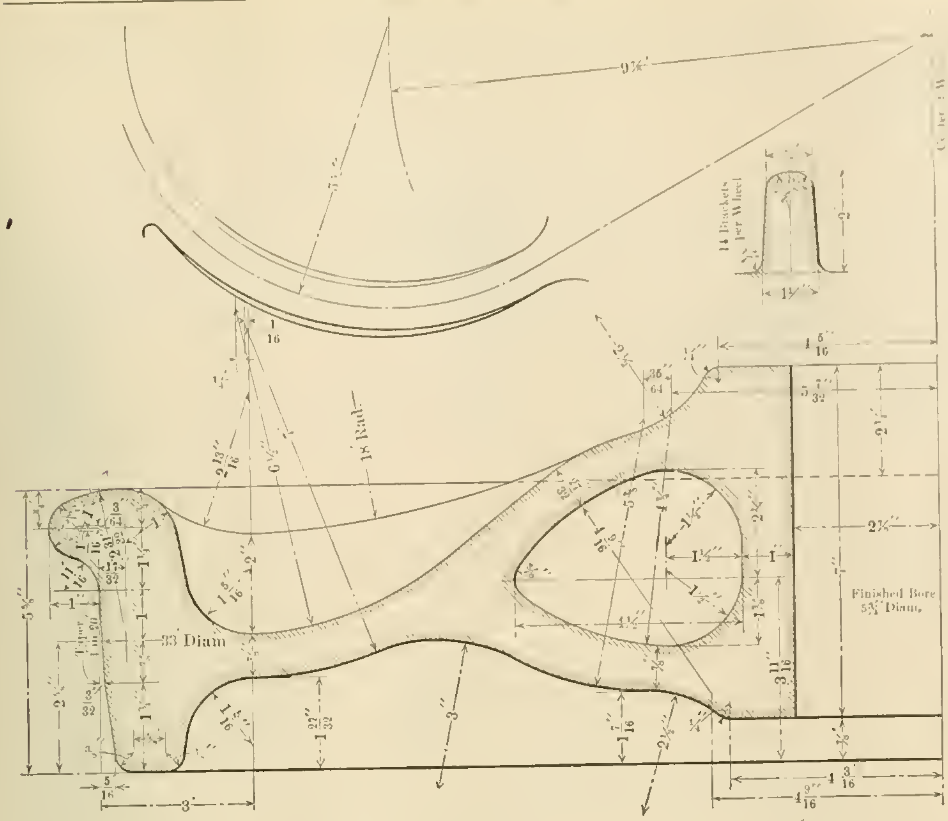
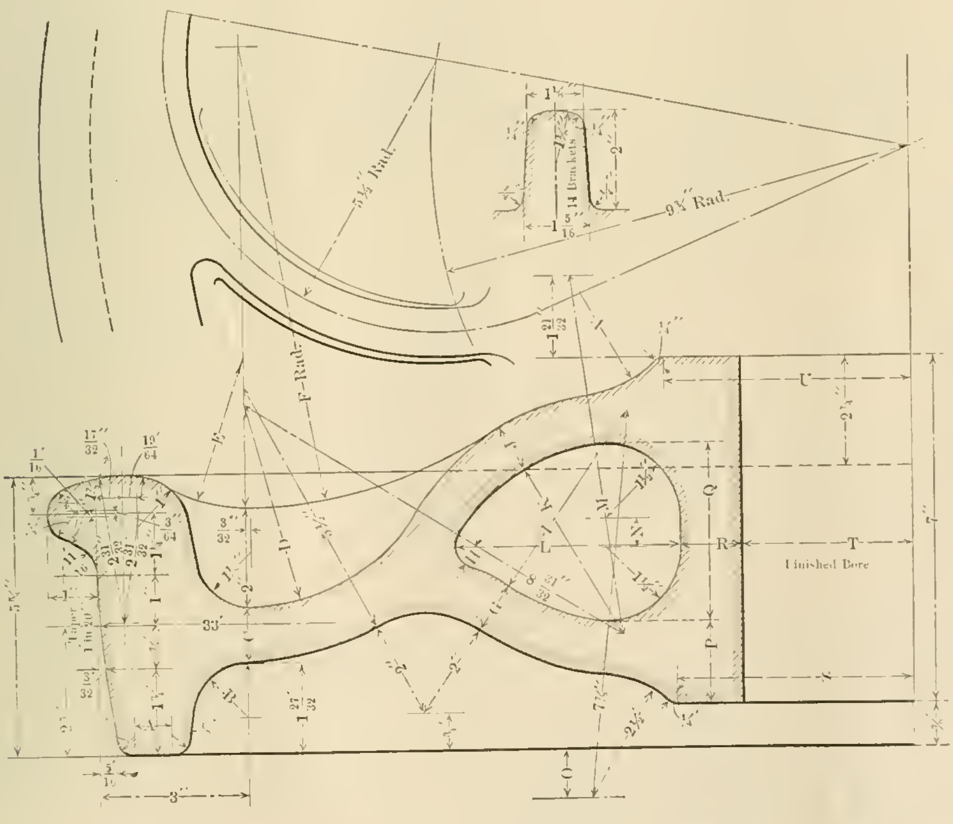



FIG. 1.—CAST IRON WHEEL FOR 30-TON CARS. MAX., 625 LBS. MIN., 615 LBS.




| | 80,000 # | 100,000 # | | 80,000 # | 100,000 # | | 80,000 # | 100,000 # | | 80,000 # | 100,000 # |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 11/16" | 3/4" | G | 15/16" | 1 1/16" | M | 7⅜" | 7 11/32" | S | 4 11/16" | [illegible] |
| B | 1 3/16 | 1¼" | H | ⅝" | 13/32" | N | ¾" | 9/16" | T | 3¼" | [illegible] |
| C | 1" | 1 3/32 | I | 4 7/16 | 4 5/16" | O | 1 1/32" | 1" | U | [illegible] | [illegible] |
| D | 4 3/32 | 4 1/16" | J | [illegible] | 1" | P | [illegible] | 1 11/16" | V | [illegible] | [illegible] |
| E | 2 7/16 | 3" | K | 3 15/16" | 3 29/32" | Q | 3¾" | 3 9/16" | | | |
| F | [illegible] | [illegible] | L | 4 61/64" | 4 9/16" | R | 1⅛" | 1¼" | | | |

FIG. 2.—CAST IRON WHEELS FOR 40 AND 50-TON CARS. MAX., 675 AND 725 LBS.; MIN., 665 AND 715 LBS., RESPECTIVELY.

sub dimensions. It is also necessary on account of a reversal of the words "Inspection" and "Mounting" in regard to the use of the Standard Reference Gauge.

8. The cancellation of the "Specification for 33-inch Cast-iron Wheels" now appearing on pages 658, 659 and 660 of the M. C. B. Standards of the 1908 Proceedings, and the substitution of the revised specifications attached to this report, which have been corrected in reference to all points appearing in Article 5. (Not reproduced.)

9. The correction of the "Text" in the Standards and Recommended Practice now appearing in the Proceedings and referred to in Article 7 is as follows. (See page 635, 1908 Proceedings.)

*Entry No. 4.* To be corrected to read as follows:

INSIDE GAUGE OF FLANGES is the distance between backs of flanges of a pair of mounted wheels measured on the base line.

*Entry No. 5.* GAUGE OF WHEELS is the distance between the outside faces of flanges of a pair of mounted wheels measured on a line parallel to the base line, but ⅝ inch farther from the axis of the wheels.

The dimensions in the wheel gauge distances given are correct with the exception of that now shown for the THICKNESS OF FLANGE. This should be corrected to read 1 15-64 inches.

## RECOMMENDATIONS

### IN REFERENCE TO CODE OF RULES GOVERNING INTERCHANGE OF TRAFFIC.

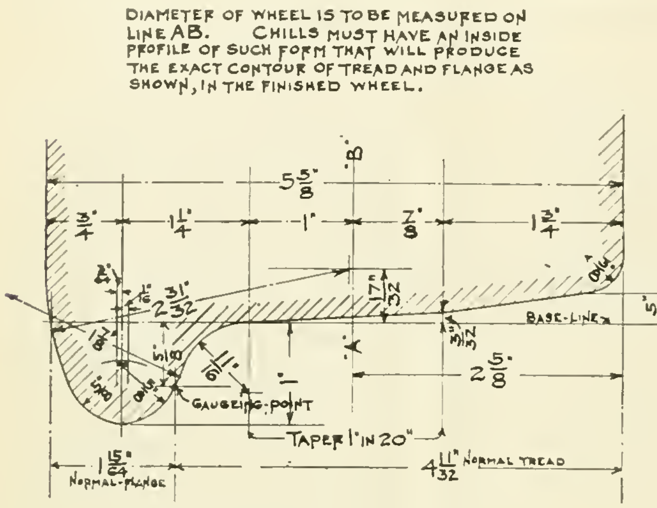
A revised "Form of Bill" covering wheels removed and applied is presented, and it is proposed that this convention adopt the revised form as a standard, replacing the form now appearing on pages 496 of the 1908 Proceedings and 39 of the Code of Interchange Rules. The alterations appear at the 5th and 11th columns (from the left side) and consist in adding these columns covering "Railway Company's Initials or Name on Wheel," instead of omitting this information as per present form.

Rule 17 to be corrected to read as follows: Wheels loose or out of gauge (see Fig. 6), for wheels cast prior to the M. C. B. Standard Tread and Flange adopted in 1907, or (Fig. 6-A) for wheels cast after January 1, 1908.

Rule 21, in the Code of Interchange Rules, refers to Figs. 2 and 2-A, the Fig. 2 representing the Maximum Flange Thickness Gauge for wheels cast prior to the M. C. B. Standard Tread and Flange adopted in 1907, and the Fig. 2-A representing the Maximum Flange Thickness for wheels cast after January 1, 1908, *but the Rule does not so state,* and the committee proposes that the Rule shall be revised to read:

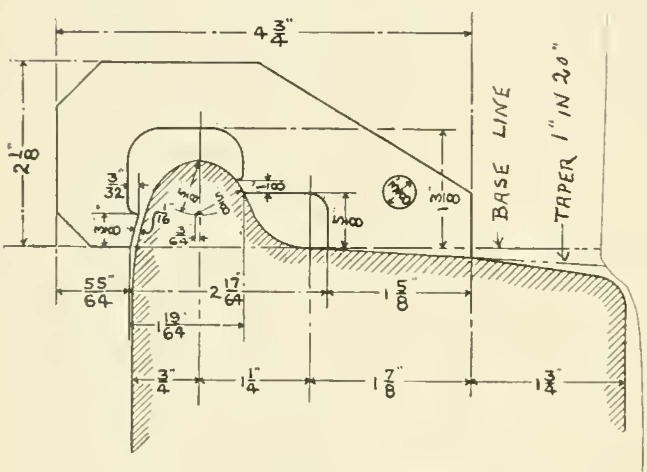
"The determination of flat spots, worn flanges and chipped treads shall be made by gauge, as is shown in Fig. 1.

"The determination of thick flanges for all wheels cast prior to the M. C. B. Standard Tread and Flange adopted in 1907, shall be made by a gauge shown as Fig. 2, and for all wheels cast after January 1, 1908, shall be made by a gauge shown as Fig. 2-A."




WHEEL TREAD AND FLANGE FOR CAST IRON WHEELS

FIG. 4.




MAXIMUM FLANGE THICKNESS GAUGE.

FIG. 5.

From advice presented to the committee it is evident that the gauge for detecting worn flanges is not being properly used, and Fig. 4, pages 478 of the 1908 Proceedings and 10 of the Code of Interchange Rules, should have the following added to protect against improper use, namely:

"This gauge must always be held in horizontal position and have the lip at the end of the gauge bearing on the tread when being used."

## RECOMMENDATIONS

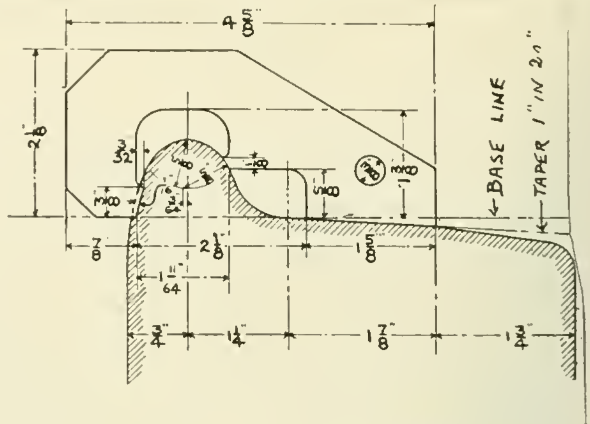
IN REFERENCE TO MOUNTING NEW CAST-IRON WHEELS; TO PROVIDE PROPER CLEARANCE WHEN PASSING THROUGH TRACK FROGS AND AT GUARD RAILS HAVING 1¾-INCH WIDTH OF FLANGE WAY.

Mechanical difficulties in the manufacture of cast-iron wheels require a variation of 1-16 inch in thickness, over or under the normal size for flanges, and as this is permitted under M. C. B. Rules, it was requested at a joint conference of this committee with the committee representing the American Railway Engineering and Maintenance of Way Association that a similar amount of latitude in reference to track construction be recognized, and after a thorough discussion of the subject from all standpoints it was agreed to recommend to the M. C. B. Association that a rule be formulated prohibiting the mounting of two wheels having maximum thick flanges on the same axle; therefore we propose that the M. C. B. Association adopt the following as a standard rule governing interchange of traffic.

### RULE 66-A.

In no case may two new wheels having maximum thick flanges be mounted on the same axle.

Wheel check gauge, now appearing on page 682 of the 1908 Proceedings in connection with the paragraph covering the "Mounting of Wheels," is incorrect, and the cut now shown should be replaced by cut of wheel check gauge (Fig. 8) presented with this report.




MINIMUM FLANGE THICKNESS GAUGE.

FIG. 6.

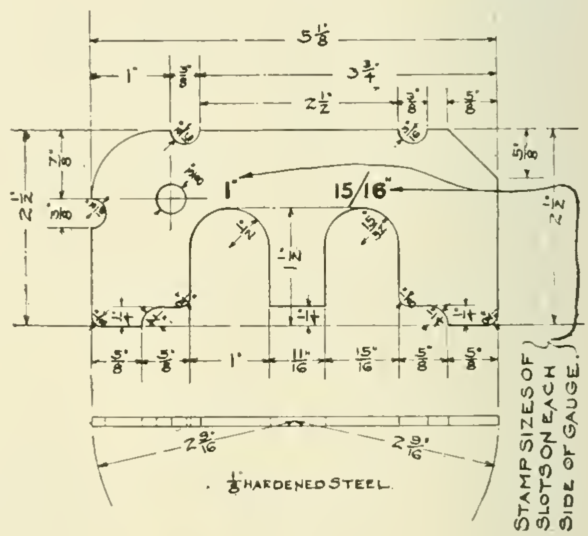
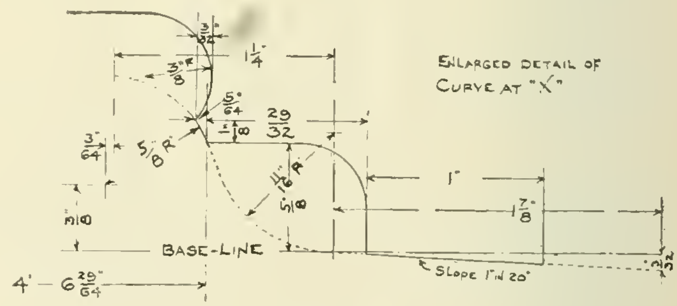



FIG. 7.




SEE FIG. 8.

## CONCLUSIONS AND RECOMMENDATIONS

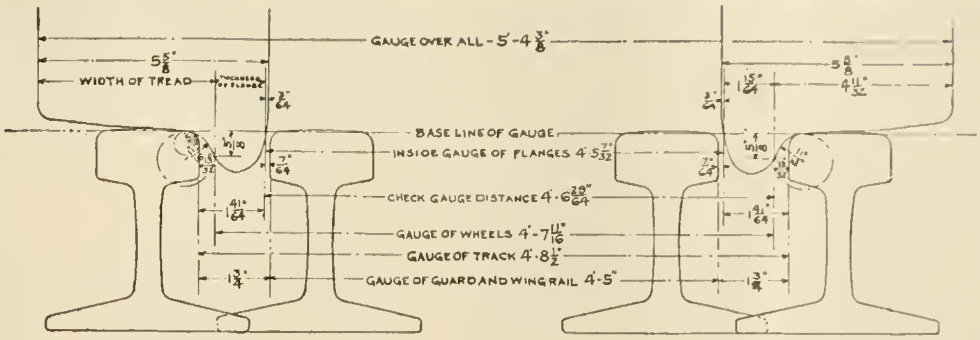
RELATING TO STEEL AND STEEL-TIRED WHEELS FOR FREIGHT AND PASSENGER CARS REFERRED TO IN ARTICLES 4 AND 7.

See Article 4, Executive Committee's Instructions (a).

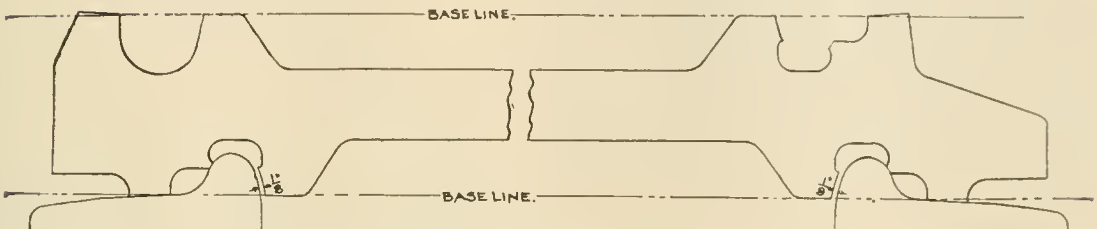
The committee has prepared and presents Fig. 9, covering limits of wear for steel and steel-tired wheels under both passenger and freight cars, and recommends that it be adopted as Recommended Practice governing the service operation of such wheels under both passenger and freight cars, and that the cuts now appearing on M. C. B. Sheet "A" of Recommended Practice and pages 529 and 530 of the 1908 Procedings, and 95, 96 and 97 of the Code of Interchange Rules be cancelled, and the four cuts on Fig. 9 be substituted therefor.

Location of limit of wear groove to be ¼ inch below the tread face on steel and steel-tired car wheels, when they have worn to condemning limit of wear. The shape of the groove to be as shown on these figures, and measurements to be taken from the horizontal or inside edge of same.

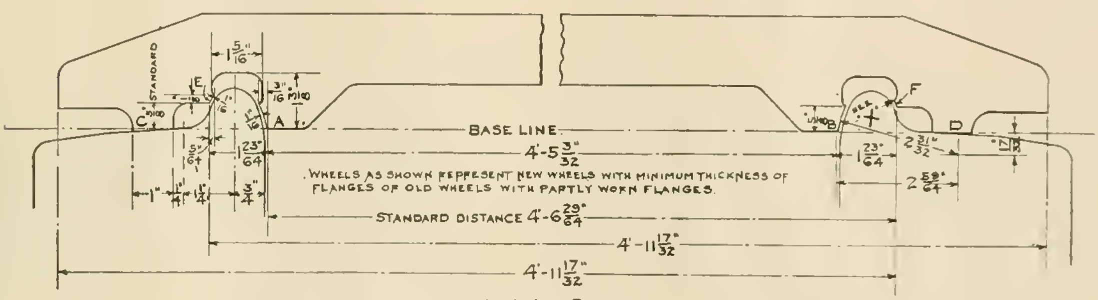
Existing M. C. B. Rules in Code of Interchange and referring to passenger cars require a removal of steel and steel-tired wheels "for worn flanges," when such flanges are greater in section than is prescribed for steel and steel-tired wheels when used under freight cars. Wheel loads under passenger cars will vary from 12,000 to 14,000 pounds and wheel loads under 80,000 pounds



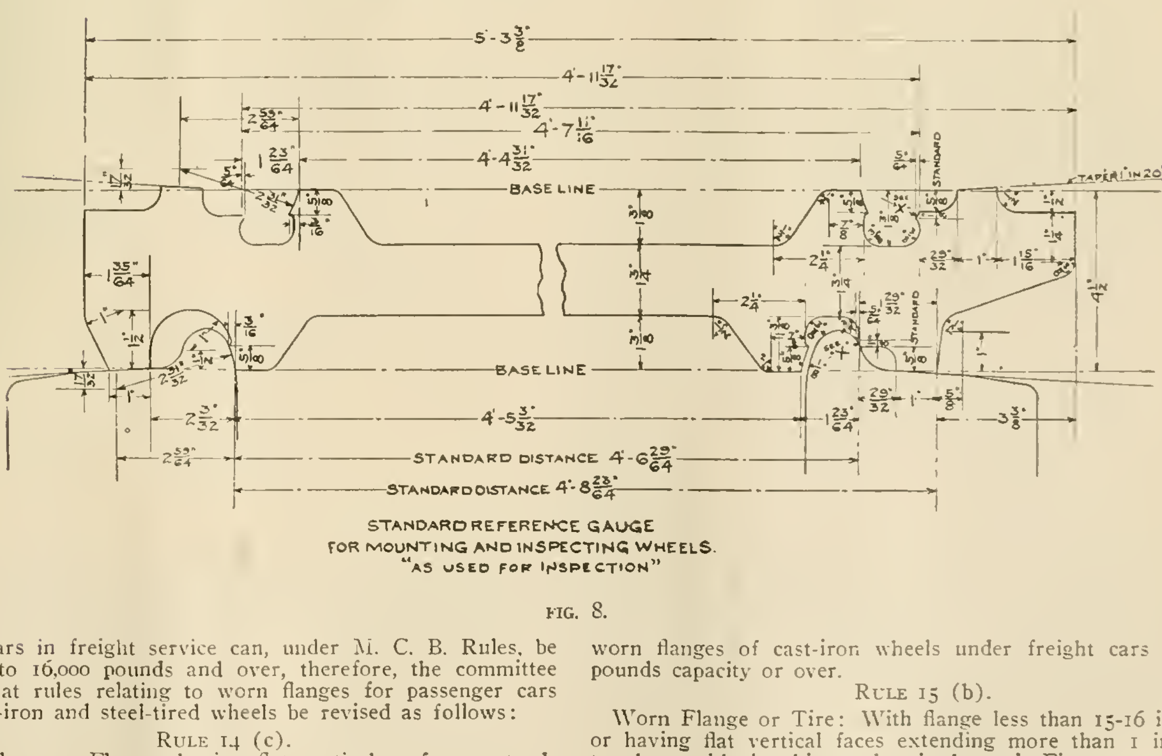

TERMS & GAUGEING POINTS FOR WHEELS AND TRACK.




STANDARD REFERENCE GAUGE FOR MOUNTING AND INSPECTING WHEELS. "AS USED FOR MOUNTING"




WHEEL CHECK GAUGE.




STANDARD REFERENCE GAUGE FOR MOUNTING AND INSPECTING WHEELS. "AS USED FOR INSPECTION"

FIG. 8.

capacity cars in freight service can, under M. C. B. Rules, be increased to 16,000 pounds and over, therefore, the committee propose that rules relating to worn flanges for passenger cars using cast-iron and steel-tired wheels be revised as follows:

Rule 14 (c).

Worn Flanges: Flanges having flat vertical surfaces extending more than 7/8 inch from tread, or flange less than 1 inch thick, gauged at a point 3/8 inch above tread.

Gauge: For condemning worn flanges of cast-iron wheels under passenger cars to be the same as is used for condemning worn flanges of cast-iron wheels under freight cars of 80,000 pounds capacity or over.

Rule 15 (b).

Worn Flange or Tire: With flange less than 15-16 inch thick or having flat vertical faces extending more than 1 inch from tread, or, with tire thinner than is shown in Fig. 9.

*Gauge:* For condemning worn flanges of steel and steel-tired wheels under passenger cars to be the same as is used for condemning worn flanges of steel and steel-tired wheels under freight cars.

The committee proposes and recommends that the "Tread and Flange Contour" for steel and steel tired wheels be revised as shown in Fig. 10, which is exactly similar to the new proposed tread and flange contour included in this report for cast-iron wheels, *from the point of the flange to the outside of the tread only*, and the development of the flange from the "point to the back face of the wheel or tire" has been made of such form that the same mounting and inspecting gauges used for cast iron wheels can be used for the new section of steel and steel-tired wheels.

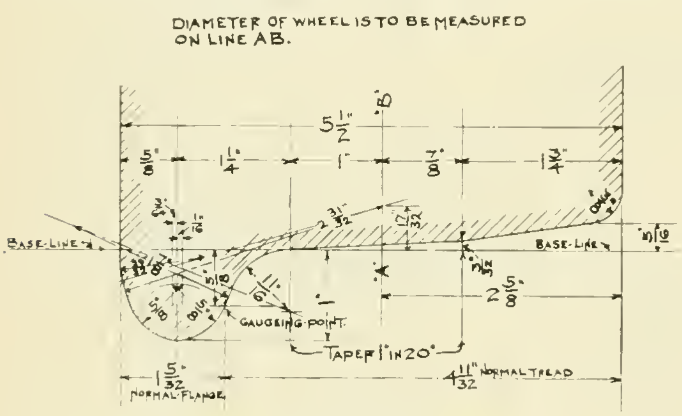
In conclusion, the committee's report on sections (b) and (c) of the instructions received from the Executive Committee is as follows: (See Article 4 for detail instructions.)

Section (b). The committee, working jointly with committees representing the Master Mechanics' and Maintenance of Way Associations, have not to date disposed of this, since the discussion at the single joint session was confined solely to *the width of flangeway in track through frogs and at guard rails*, and another meeting must be held with the representatives of the associations named to finally dispose of the subject.

Section (c). The committee, after working jointly with a committee representing the American Railway Engineering and Maintenance of Way Association, begs to report as follows:

No evidence has yet been presented showing that damage to bridges and track can be charged to flat spots on car wheels, whose lengths are within the limits prescribed by present M. C. B. Rules, and the committee, therefore, does not feel warranted in recommending to the Executive Committee that any expense be incurred for the procurement of apparatus for making tests.

Explanatory of the points raised in article 6, we beg to say the lengthening of the sand rim taper by moving the starting point of this taper closer to the flange, also the increase of the slope of the




WHEEL TREAD AND FLANGE FOR STEEL AND STEEL-TIRED WHEELS

FIG. 10.

tread at the sand rim will assist in reducing the number of chipped rims and will materially aid in increasing the mileage of all wheels before the tread becomes worn hollow, since it brings the starting point of the said rim taper within the zone of rail wear, and the starting point becomes gradually effaced from its original position and moves toward the rim of the wheel or downward on the sand rim taper, thus retarding the formation of a double flanged or worn hollow tread. The points in favor of the reduction of the height of flange for all wheels are two, namely: Flange condemned on account of being worn vertical on wheels having a 1-inch height of flange, will give a greater mileage before reaching this condemning limit on account of the flattening at the point of the flange in the proposed design and by reason of the shorter original height, will be less liable to strike filling blocks in track at crossings, frogs and switches when a wheel having the tread worn comparatively hollow passes over rails which have worn down considerably, and the committee feels that a reduction in the height of the flange can consistently be made when it is shown that the original angle of the flange to resist derailment is in no wise changed.

Recommendations presented to the Committee on Standards and Recommended Practice and referred to the Standing Committee on Car Wheels, contained several suggestions, all of which have been acted upon by this committee, with the exception of the following, which refers to "Reference Gauge for Mounting and Inspecting Wheels, and Check Gauge," page 636, M. C. B. Sheet 12, and is reported by the Pennsylvania Railroad Company with the suggestion "That the so-called reference gauge for mounting and inspecting wheels be dropped from standard practice and a gauge similar to print attached (not reproduced), be introduced for mounting of wheels; also a check gauge similar to print (not reproduced) attached, be introduced, which latter gauge is at the same time to be used by inspectors in yards and terminals." In the opinion of the committee, the gauge shown is a modified and improved form of check gauge that can be endorsed by the committee for use by all railroad companies who care to go to the expense entailed in the first cost of such gauge and we feel that the adoption of this form should be left to the individual members, as the points controlled by this gauge are exactly similar to those controlled by the present M. C. B. Standard Gauge, and the improvement consists in reversible hardened steel bearing points at contact with the gauging point on the flange. The check gauge shown has been arranged to govern the mounting of new wheels, also the remounting of partly worn wheels *centrally*

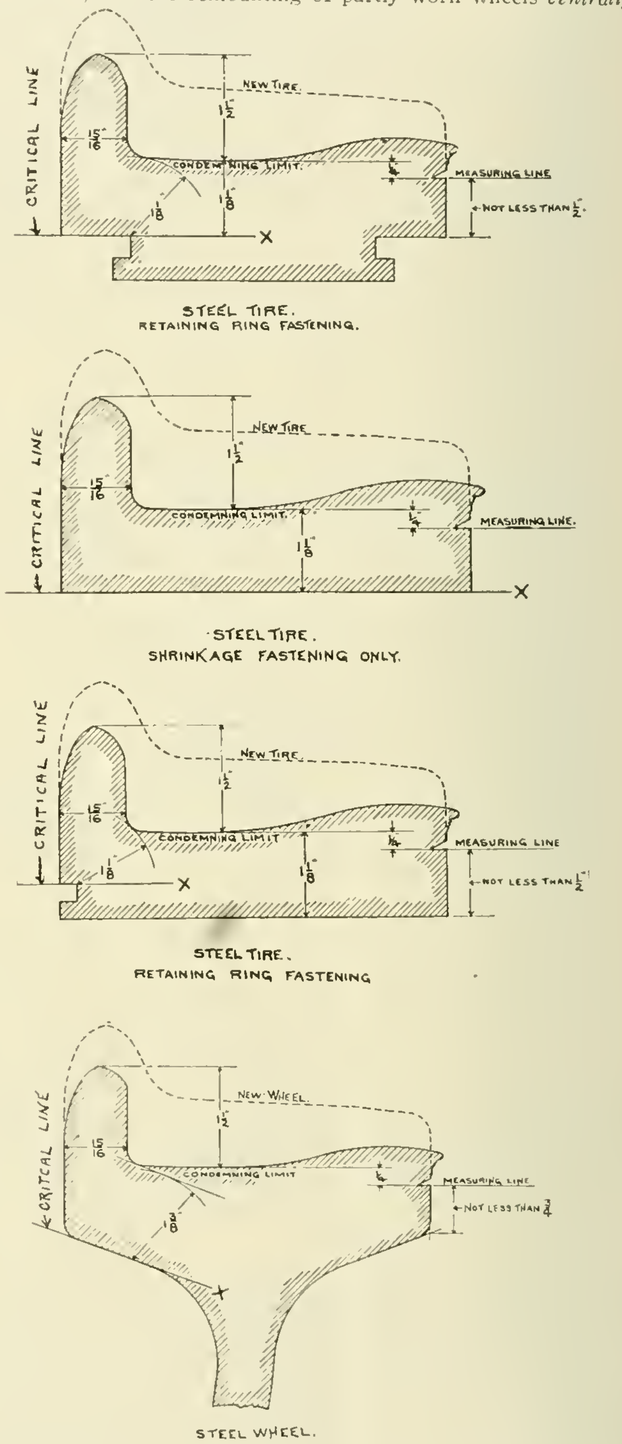



FIG. 9.

*on one axle*, and the design of the gauge is such that all axles, whether new or second-hand, must be provided, with a center-punch-mark in the middle of the axle, or equi-distant from the center of each journal. It is largely customary in railroad and contract shops to mount the first wheel on the axle gauging from the outside face of the collar, and then mount the mate wheel with the mounting gauge to the gauging points. At the solicitation of this committee, the M. C. B. Association several years since cancelled the use of a gauge designed for a similar purpose to that now proposed by the Pennsylvania Railroad, and the committee therefore does not feel warranted in recommending a gauge of the type proposed at this writing, preferring to leave the latter to the action of the convention.

The first, second and third recommendations, in reference to cast-iron wheels, are to govern the construction of all new patterns, chills, etc., for wheels made after the date this report and its recommendations are adopted, and are also to govern the construction of all patterns, chills, etc., that may be classed as renewals, from the same date, it being understood that all existing patterns and chills for wheels conforming to M. C. B. Standards in effect prior to this report may be used by the manufacturers until worn out in the regular course of business, at which time they shall be scrapped and replaced by new equipment conforming to the recommendations set forth herein.

*Discussion.*—The clause in the report—"All wheels must be numbered in accordance with instructions from the railroad company purchasing them, and must have the initials of such railroad company"—received considerable discussion. The idea of the committee was that a check would thus be placed on rejected wheels. Others thought that unless the initials were removed from rejected wheels complications might arise if they were purchased and placed in service by another company.

*Action.*—The report was referred to letter ballot for recommended practice.

## COUPLER AND DRAFT EQUIPMENT.

*Committee*—R. N. Durborow, Chairman; F. W. Brazier, T. H. Curtis, T. Roope, G. W. Smith, F. H. Stark, G. W. Wildin.

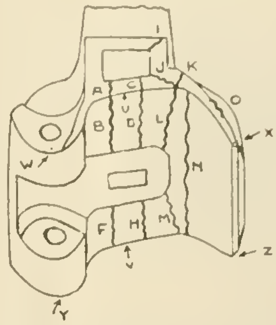
### Face Tests.

In the coupler reports for 1907 and 1908, figures were given showing the result of extensive investigations of coupler breakages, which demonstrated conclusively that a large percentage of all coupler failures are due to breakage through the face or front wall. The tests embodied in the present specifications do not cover this weak point in couplers, therefore, your committee made some preliminary experiments last year with a view of devising some test which would break the couplers through the face similar to the manner in which they are broken in service. The results of these preliminary trials were given in last year's report. The investigation has now been completed and the results from sixty-nine couplers tested to destruction, with drawings of apparatus for testing, are shown herewith.

These couplers, furnished both by different railroad companies and by manufacturers, were tested with the apparatus shown in Fig. 1. Fifty-seven of the couplers tested represented the standard types on the market at the time of testing; nine were special couplers manufactured for the face test and were tested by request of the manufacturers; the remaining three were malleable iron couplers. The following conclusions, from which the details of the new test are recommended, are based on the fifty-seven regular couplers. The nine special couplers gave slightly better results, showing the feasibility of procuring additional strength.

The coupler shank is wedged and bolted in the base-block casting with the striking horn and butt resting on the block and anvil, respectively. The wedging block, slightly modified from the one shown in the report of last year, to give more wedging action, is placed in the coupler head bearing on the lugs and guard arm of the coupler. Blows imparted by the drop on the wedging block produce a spreading action on the coupler head, forcing the lugs and guard arm apart, which almost invariably breaks the coupler through the front wall. Fig. 2 shows the location and percentage of breaks in each place, showing the similarity to the service failures.

The couplers were subjected to three blows of five feet, followed by blows of ten feet until failure occurred. A coupler was considered to have failed when it was broken or when any cracks appeared more than 1-16 inch wide or more than one inch long. The average number of blows sustained by the fifty-seven regular couplers was three at five feet and one and one-half at ten feet, but as there were four out of eleven types which averaged better than this, and four additional types which had one or more couplers do better, the committee believes it proper to recommend that the test embody three blows at five feet and two blows at ten feet, with provision for retests provided the coupler stands three blows at five feet




DEFLECTION OF GUARD ARM MEASURED FROM "W" TO "X" AND FROM "Y" TO "Z"

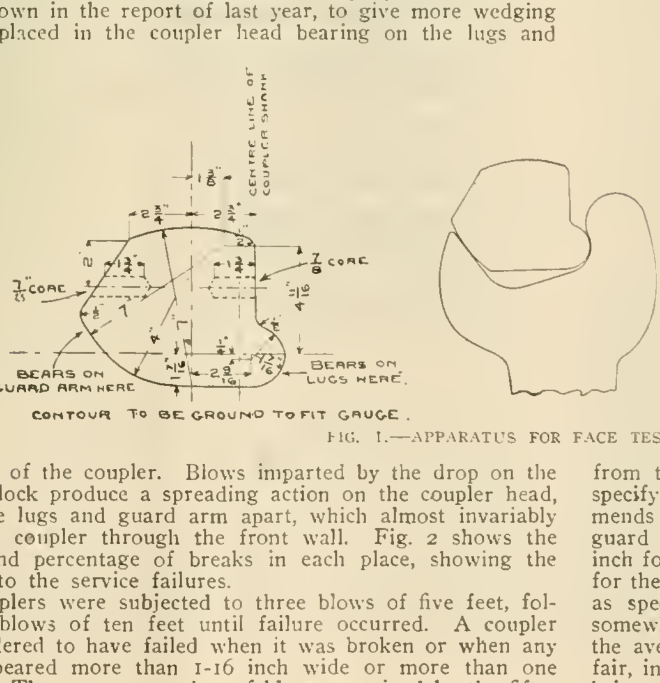
DEFLECTION OF HEAD FROM CENTER LINE OF SHANK, MEASURED AT "U" AND "V".

| Location. | Number. | Per Cent |
|---|---|---|
| B | 20 | 29 |
| L | 20 | 29 |
| A | 18 | 26 |
| M | 17 | 25 |
| K | 15 | 22 |
| C | 8 | 12 |
| D | 6 | 9 |
| I | 5 | 7 |
| J | 5 | 7 |
| F | 4 | 6 |
| H | 3 | 4 |
| N | 1 | 1 |
| O | 1 | 1 |

Couplers usually break in more than one place. Number of couplers tested, 69.

FIG. 2.

As explained above, the action of the wedging block when subjected to blows, spreads the lug and guard arm apart; it also bends the head on the shank just back of the striking horn. These deflections were carefully noted during each test and are shown on sheets "D" and "E," for all couplers on which these distortions could be measured after the second blow at ten feet. The deflections on the top of the coupler vary slightly from those on the bottom, but it does not seem necessary to specify limits for both top and bottom. The committee recommends that the limit for allowable deflection be ¾ inch for the guard arm for both 5 by 5 and 5 by 7 inch couplers; and 7-16 inch for 5 by 7 inch, and 9-16 inch for 5 by 5 inch shank couplers for the head and shank; both to be measured in the same manner as specified in the present guard-arm test. These limits are somewhat more liberal than might be considered advisable from the average of the recent experimental tests, which seems only fair, in that some of the couplers failed on account of the metal being too hard or brittle, which could possibly have been made



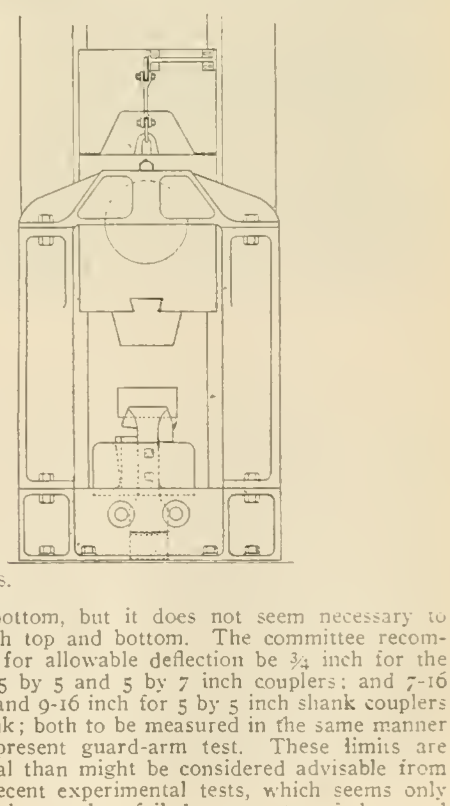
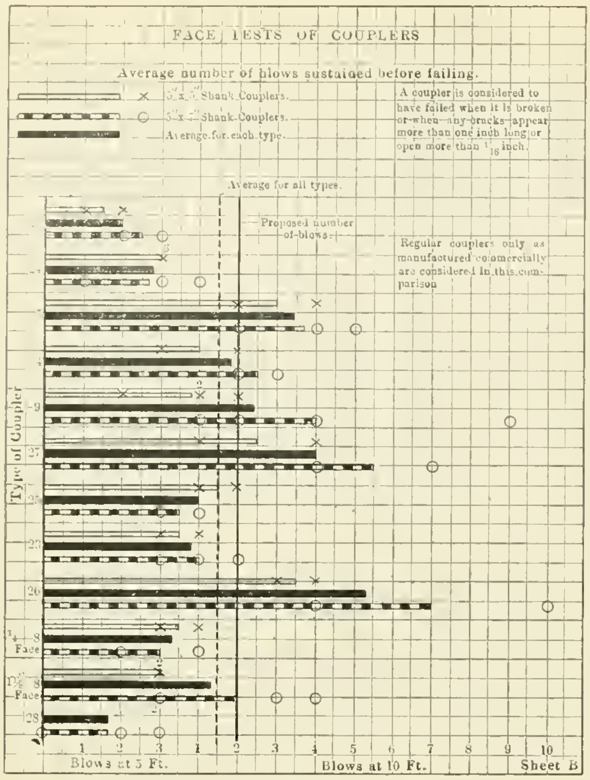
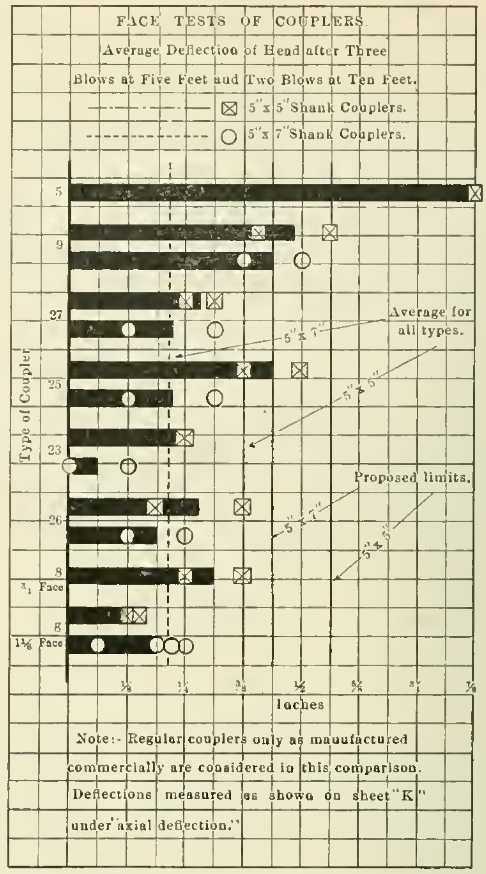



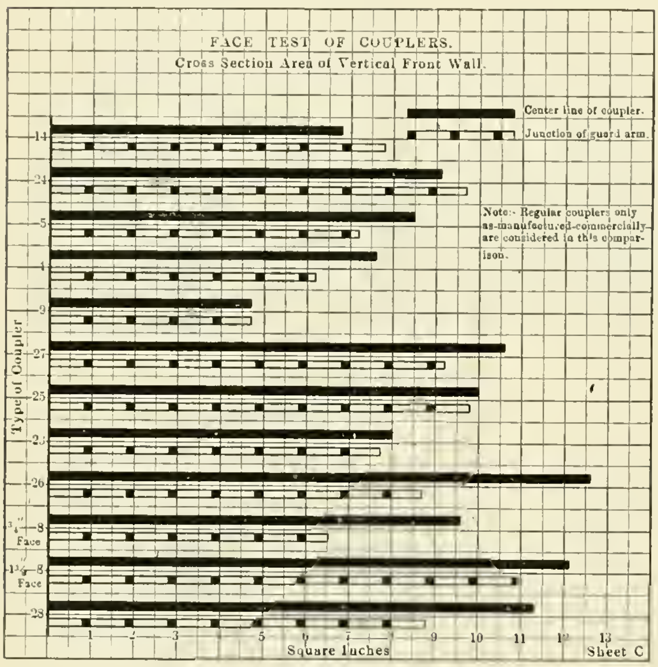
FIG. 1.—APPARATUS FOR FACE TESTS OF COUPLERS.



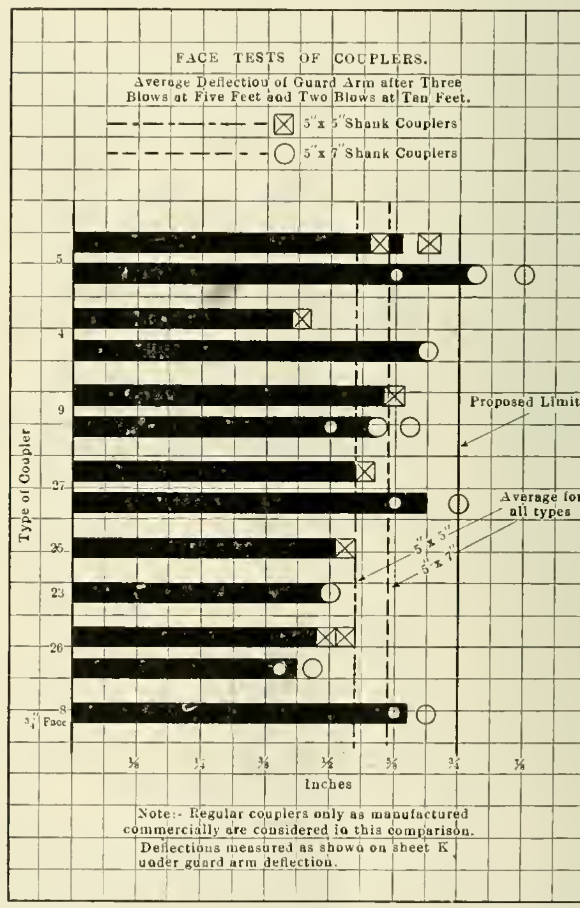

SHEET B.




SHEET D.




SHEET C.




SHEET E.

of softer material without injuring their fitness for service.

In the 1908 coupler report it was recommended and the recommendation subsequently passed the letter ballot, that all new types of couplers put on the market after January 1, 1909, have the dimension from the back of striking horn to inside face of knuckle increased one-half inch, and that the face or front wall must have a minimum thickness of 1¼ inches. The wisdom of this recommendation has been brought out by the experimental face tests, in which the couplers having the thickest front wall generally stood the largest number of blows. There were exceptions to this, but a careful study will show that these exceptions were due to one or the other of the following two reasons: First, some of the comparatively thick-faced couplers did not stand as many blows as some having thinner walls, due to kind of metal, improper annealing or defective castings. Second, some of the thin-faced couplers stood a comparatively large number of blows, due to soft metal allowing the guard arm to spread without breaking, but in most of these cases this guard arm deflection was excessive and indicated that the coupler would not be sufficiently rigid to properly withstand service shocks. The required number of blows and the allowable limits of guard arm and head deflections should prevent this.

The committee believes that physical tests will insure satisfactory couplers, and that the chemical composition should be left to the judgment of the manufacturer. The manufacturers strongly object to the chemical specifications in addition to the physical tests, claiming that this restricts them to such an extent that they would have difficulty in meeting the physical tests.

It was found that the face test, in addition to the special vital features mentioned above, performs all the functions of the present guard-arm test, with the exception of the manner in which the shank is bent. The guard-arm test usually bends the shank throughout its entire length, while the face test only distorts it a few inches back of the striking horn, but as the shank-bending feature is also covered in the striking test, it is recommended that the guard-arm test be abolished and the face test substituted.

Recommended Changes in Coupler Specifications.

The present pulling test requires the use of two couplers. When a failure occurs, one coupler almost invariably gives out before the other and hence the one coupler only is being tested to destruction. This being the case the second coupler seems superfluous, and it is, therefore, recommended that one coupler be subjected to this test and that a dummy be used in place of the second coupler. This has been tried in several places for some time and found perfectly satisfactory. Previous to 1904 the jerk test embodied the use of two couplers, but has been found just as effective with one.

An outline of the proposed tests to be embodied in the specifications compared with the present is as follows:

| Present Tests. | | Proposed Tests. | |
|---|---|---|---|
| Striking test | 10 couplers. | Striking test | 10 couplers. |
| Guard-arm test | 1 coupler. | Face test | 2 couplers. |
| Jerk test | 1 coupler. | Jerk test | 1 coupler. |
| Pulling test | 2 couplers. | Pulling test | 1 coupler. |
| Total | 14 couplers. | Total | 14 couplers. |

Knuckle Pins.

A large number of bent and badly worn knuckle pivot pins are still found in service, necessitating very frequent renewals. Thorough examinations of pins removed from service have clearly demonstrated that the types which meet the specifications give comparatively very little trouble, and with the following exception these specifications have been found satisfactory: The specifications for knuckle pivot pins require that the pins must enter the plus end and must not enter the minus end of the recommended M. C. B. limit gauge for 1⅝ inch round iron. This allows a total variation of .022 inch, or only .011 inch above or below 1⅝ inch. As it has been found extremely difficult to procure steel within these limits, and as the committee believes them unnecessarily severe, it is recommended that a variation of 1-64 inch above or below 1⅝ inch diameter be allowed.

Tests have been made of nine different types of pins. The average angular distortion of only three types and all the pins of only one type meet the specifications. From this it is quite evident that many railroads are not buying knuckle pivot pins in accordance with the specifications. The committee, therefore, strongly urges the members to insist upon the observance of these requirements, and recommends that the specifications for knuckle pivot pins, which have been Recommended Practice for two years, be advanced to a standard of the Association with the changes herein recommended.

It has been found that the regular jerk, striking and pulling tests embodied in the specifications for automatic couplers are not severe enough on the knuckle pins. The committee, therefore, recommends that when couplers are inspected that a certain number of knuckle pivot pins be tested in accordance with the pivot-pin specifications.

The present coupler specifications and the separate knuckle specifications require that the holes for knuckle pins must not be more than 1-16 inch larger than the pin. Inasmuch as the specification for knuckle pivot pins allow a variation of only 0.011 inch each way, or 1-64 inch if the recommended change is adopted, 1-32 inch variation in the hole will insure the entrance of the pin without difficulty. Larger holes mean loose pins, with consequent wear and decrease in the life of the couplers. This change is therefore recommended.

A slight modification has been made in the apparatus for testing knuckle pins. The guide of the striking block was found to be of insufficient depth; 2¼ inches have, therefore, been added to the guide and to the block.

Some types of couplers are equipped with a device for preventing the lower portion of a broken knuckle pin from falling out. This tends to protect the upper lug from breaking when it receives the increased strain occasioned by a portion of the pin dropping out of the lower lug, but an arrangement of this kina makes it difficult for inspectors and others to detect broken pins. If a coupler is properly designed and fitted, the knuckle tail hook should prevent excessive strain to the upper lug. Under these circumstances the committee does not consider it wise at the present time to recommend a device for supporting broken knuckle pins.

Knuckles

The coupler specifications require that the name of the coupler appear on each knuckle, but this requirement does not appear in the specifications for separate knuckles. The similarity of some knuckles of different makes as well as the large number of different types in service make it extremely desirable to have the name of the coupler shown on each knuckle. This is a great help to repairmen and often is the means of avoiding rather serious mistakes.

Proposed Inspector's Gauges, Attachment of Yoke to Butt and Changes in Drawings.

Inasmuch as it is not practicable to work to absolutely square corners in foundry and blacksmithing practice, the committee recommends that all drawings show ⅛-inch radius on the inside of yoke lip and 3-16-inch radius on corner of coupler butt.

In the 1907 report your committee made reference to the method of attaching yokes to butts. To insure proper fitting, gauges for both couplers and yokes have been designed and tried out, and it has been found that where couplers and yokes have been fitted to these gauges very little trouble is experienced. The gauges are shown on sheet "N." No. 1 is used on 6½-inch butt couplers to gauge rivet holes and lug for yoke fitting, length of butt and height of butt. No. 2 is the same for 9⅛-inch butt couplers. The tubes on gauges Nos. 1 and 2 are of sufficient length to pass completely through the coupler butt, therefore, if they are applied from both the top and bottom of the coupler, they will insure the top and bottom of the butt being in line as well as the proper spacing of the rivet holes. No. 3 gauges the width and height of shank and width of butt on both 5 by 5 and 5 by 7 inch shank couplers. No. 4 gauges the length of shank from back of striking horn to back of butt on both 5 by 5 and 5 by 7 inch shank couplers. No. 5 gauges the rivet holes and the lips on all yokes. As commented upon in the 1908 report, the trouble developed with the present method of attaching yokes to butts is due to improper fitting, such that the yoke lips stand away from the coupler butt and place all the strain on the rivets, which causes the latter to shear. If the use of the above gauges is rigidly observed the fitting will be such as to place nearly all the pull on the yoke lips and relieve the rivets from practically all shearing strain.

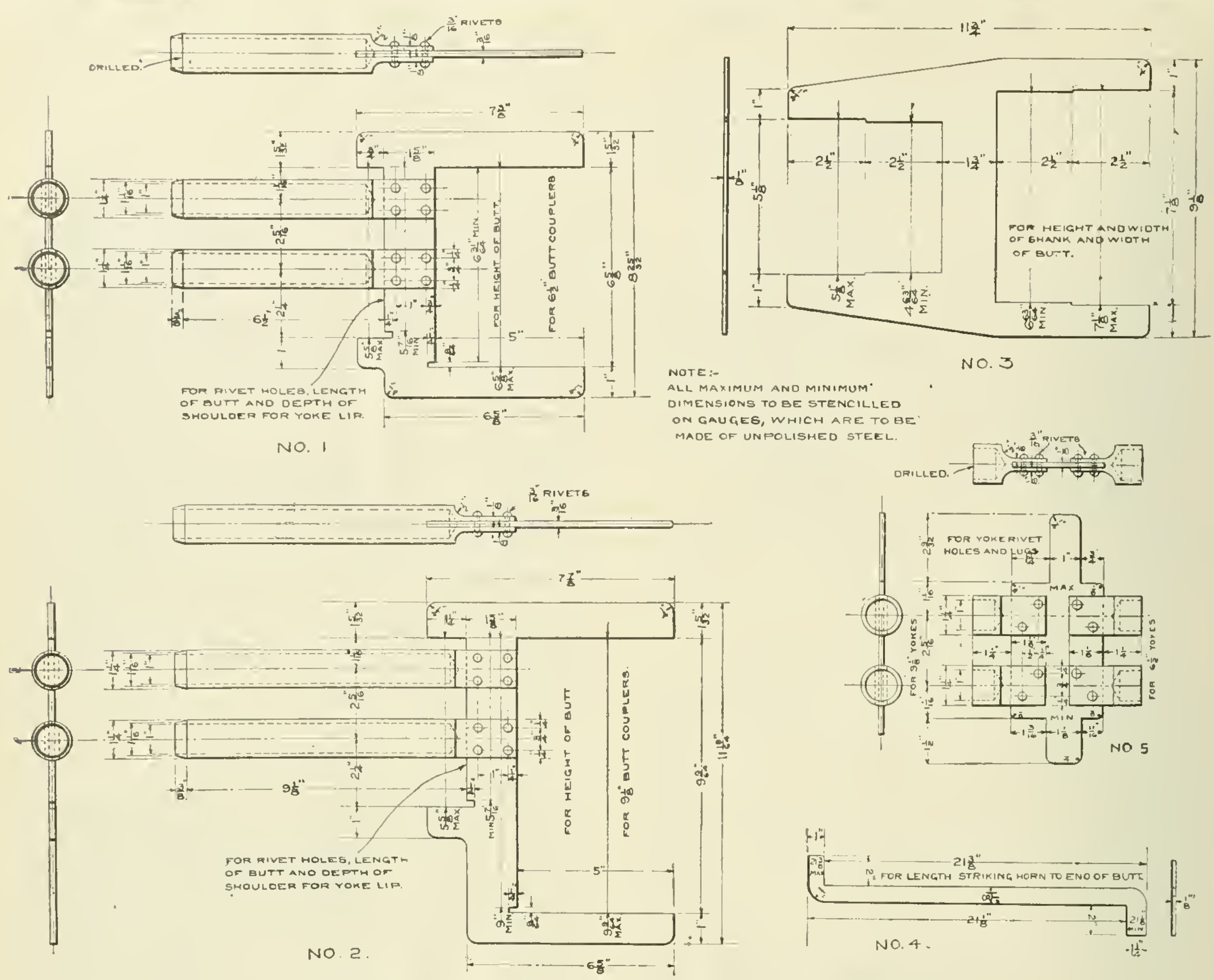
Mating of Couplers.

As mentioned in the report of last year, the contour of the knuckle tail on many couplers does not coincide with the contour of the coupler head; this leaves an opening between the knuckle lines and the lines of the coupler head when the knuckle tail is closed and often prevents easy couplings, as the point of the mating knuckle can not engage the knuckle tail continuously until the lock drops. If both knuckles of two engaging couplers are of the correct contour, the couplers will mate readily at very slow speed, but if the knuckles have the above-mentioned incorrect lines, they are only closed by coming sharply in contact with the front wall of the coupler heads. In other words, the knuckles should close each other and should not be pushed shut by the face of the opposing coupler. A note has been incorporated in the recommended revision of sheet M. C. B.-11, requiring the knuckle contour to coincide with the contour of the coupler head to the point where the lines of the knuckle tail diverge from the lines of the coupler face when the knuckle is closed, insuring the knuckle lines coinciding with the coupler contour lines as far as practicable.

Many couplers do not provide for a full knuckle opening; this lessens the available space into which the opposing coupler knuckle must enter and often prevents couplers from mating. The position and shape of the lugs on some couplers cause the same trouble by not providing sufficient opening across the coupler head from lugs to guard arm. To avoid the above, your committee recommends that the line tangent to the inside of the lugs must not be less than one inch from the longitudinal center line of coupler and that the knuckle must open sufficiently to clear this line.

Friction Draft Gear.

The committee regrets that it is unable at this convention to report on any definite investigation of the subject of draft gear performance. Broadly, the information desired is the proper resistance during the various stages of compression and the most desirable maximum capacity. A tentative discussion was given on this phase of the subject in the report of last year, as well as the results of a number of static tests, from which some useful information of a preliminary nature was derived. In order to procure definite information on the performance of existing gears, as well as information from which to base future designs, it is believed that the following policy should be followed: First, the carrying out of a comprehensive series of service tests with accurate recording devices; and, second, the design of a laboratory testing arrangement which will subject the gears to approximately the same pressures and shocks received in service. With the above in view, a study of previous tests has been made, but although data of exceeding interest has been placed at the disposal of your committee, by both railroad com-




INSPECTORS' GAUGES FOR COUPLER SHANK AND YOKE. (SHEET N.)

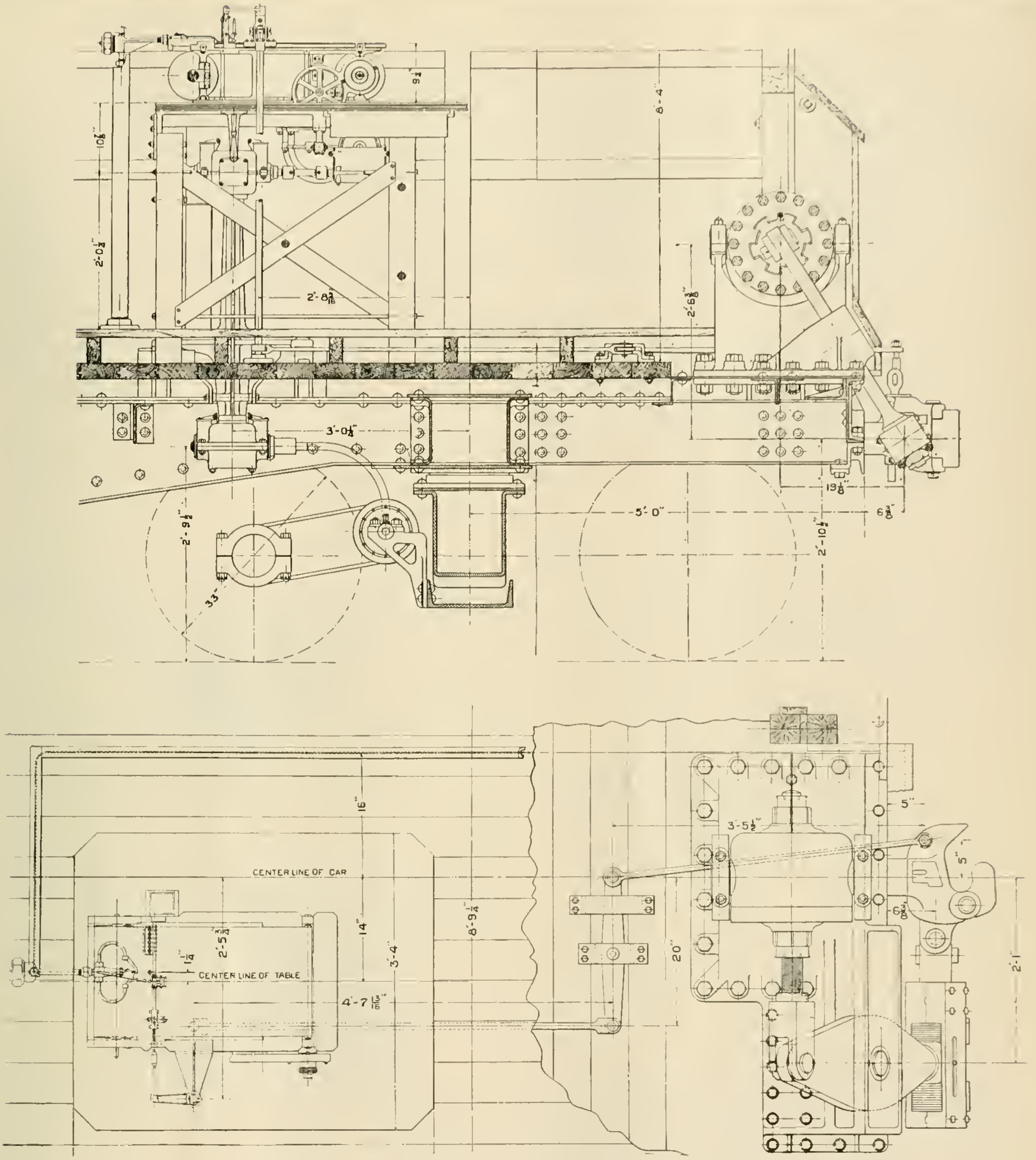
panies and manufacturing concerns, there is really little definite knowledge available.

An arrangement (shown on sheets "Z-2" and "Z-3") attached to a car coupler which recorded the position of the coupler, and hence the compression of the draft gear at any instant, was used in conjunction with the coupler side clearance tests referred to elsewhere in this report. Three types of gears were tested, two friction and one tandem spring. The average compression of those gears, and the drawbar pull is shown on sheets "R-1," "R-2," "R-3," "S" and "T" (not reproduced), giving the results of the coupler side clearance tests, but the compression at any instant, resulting from changes in pressure could not be determined, as the dynamometer measuring the drawbar pull is not designed to instantaneously record sudden changes or shocks. It was obvious, however, that one of the friction gears, called type "B" in this and last year's report, was not sufficiently sensitive, after the capacity of the preliminary spring, 19,000 pounds, had been reached. This was apparently due to sticking of the wedges. The amount of compression did not change until the drawbar pull had varied considerably and when the wedges did finally slip there was a noticeable shock, which must, in the long run, be injurious to couplers and their attachments and possibly to the car framing. The tandem spring gear responded readily to changes in drawbar pull, but in these tests no shocks, such as are encountered in making up trains and in shifting operations, exceeding the capacity of the gear, were experienced. As mentioned in the report of last year, the good friction gears are undoubtedly an improvement in protecting equipment from constant severe shocks due to their greater capacity and to their ability to absorb the force of the blows instead of returning it to the cars in the form of recoil as is done by the spring gears.

### Coupler Side Clearance Tests.

The committee during the past year has conducted some very extensive coupler side clearance tests. The object of these tests was to determine the proper amount of lateral play for the coupler shank at the end sill on freight cars. It has been quite generally thought that couplers when curving exerted a very considerable side pressure on the end sill, and that this pressure was eventually transferred through the car framing and trucks to the wheel flanges. Some considered that this materially increased train resistance, while others thought that the pressure on the end sill was directed toward the inside rail and would, therefore, tend to pull the flanges away from the outer rail, thereby reducing flange wear and train resistance on curves.

A 100,000 pound capacity steel underframe gondola car, of forty-four feet eleven inches coupled length, thirty-three feet between truck centers, was equipped with a diaphragm dynamometer for measuring the coupler side pressure at clearances ranging from ½ inch to 5 inches in one-half inch stages. The clearances referred to in this report are total clearances, *i. e.*, by five-inch clearance is meant two and one-half inches on each side. A drawing of the dynamometer is shown on sheet "Z-1," and the general arrangement of the auxiliary testing apparatus is shown on sheets "Z-2" and "Z-3." A description of the dynamometer, which has been but slightly modified, was given in the report of last year. The side pressures are transferred through a yoke, having plates to vary the amount of clearance, and a lever to the dynamometer. A very slight movement of the dynamometer diaphragm, which has an area of forty-two square inches, displaces the liquid which, by means of a small copper pipe, spreads the arms of a recording gauge, of the Bourdon tube type. The capacity of the dynamometer is 50,000 pounds, and the recording gauge pen has a movement of two and one-half inches corresponding to this pressure. The gauge pen marks on paper driven by the wheels of the car, and the pressure at any instant is obtained by measuring the distance between the line made by the gauge-pen and the datum line made by a stationary pen. To facilitate working up the data the following information was also recorded on the traveling paper. Distance marks for each thousand feet, time every five minutes, locations such as mile posts, stations, point of curves, point of tangents, and marks showing whether or not the coupler clearance was taken up. The pens giving the above information are actuated by electro-magnets operated by observers conveniently




ARRANGEMENT OF APPARATUS FOR SIDE CLEARANCE TESTS ON GONDOLA CAR. (FROM SHEETS Z-2 AND Z-3.)

stationed. The dynamometer was specially manufactured and furnished by Messrs. William Sellers & Co., at a cost of $680.00. The recording gauge was supplied by The Schaeffer & Budenberg Manufacturing Company for $105.00. These devices were purchased at the expense of the Association. An initial pressure of 1,000 pounds is permanently locked in the dynamometer to permit the pressures on both sides to be registered without lost motion, hence only pressures in excess of this amount are recorded. The yoke transferring the pressures from the coupler to the dynamometer is somewhat in front of the end sill, therefore, the actual pressures recorded are less than those to which the end sills are subjected. The figures given in this report represent the correct end-sill pressures and are computed by adding twenty per cent to each recorded pressure. The dynamometer was calibrated previous to the tests on a static testing machine and it was retested after the tests, and the readings were found to correspond with the original calibrations.

The test train consisted of dynamometer car for measuring the drawbar pull, and thirteen 100,000 pounds capacity steel underframe gondola cars of the same dimensions as the test car described above. Each gondola car was loaded with 110,000 pounds of scrap iron, making the total gross weight of the train, including the dynamometer car and side pressure test car, 1,084 tons, or an average of 77.4 tons per car. Each carrier iron on the gondola cars were equipped with sixteen ¼-inch plates for varying the coupler side clearance between one inch and five inches. The tests on the Bellwood Division were made with eight cars only, due to the heavy ascending grade; the gross tonnage in this test was 612 tons. The dynamometer car measuring the drawbar pull was placed at the head of the train on the pulling tests and at the rear of the train on the pushing tests. The side clearance test car was placed third in the train with the test coupler forward on most of the tests, but other positions were tried.

The tests were conducted on portions of three different branch-line divisions of the Pennsylvania Railroad, and the length of the test runs, exclusive of the distance required to start and stop, was as follows: Cresson Division 5.87 miles, Bellwood Division three miles and Monongahela Division nine miles. In addition to the road tests, trials with the test car and one other, were conducted through a No. 8 switch and a No. 6 slip switch with only sixteen feet of tangent track intervening, and also on an industrial curve having a minimum radius of sixty-eight feet.

From the results of twenty-three tests on the Cresson Division it was found that the drawbar pull, or train resistance, varies very slightly, 28.22 pounds per ton being the maximum, and 25.86 pounds per ton, the minimum, and from the following averages of all the tests on the division, it is seen that the train resistance is not affected by the coupler side clearance.

Comparison of average train resistance and coupler side clearance, Cresson Division:

| Side Clearance. | Average train resistance—pounds. |
|---|---|
| 1 inch | 28,885 |
| 2 inches | 28,992 |
| 4 inches | 28,525 |
| 5 inches | 29,303 |

It would be difficult to find a better location for tests of this character, as the curves are sharp and close together and are not compensated. There are only four places on the stretch of 5.87 miles where the entire train is on a tangent, and in these cases it is only a few feet before the next curve is entered. The train resistance due to a thirteen-degree curve in addition to level tangent and grade resistance is about thirteen pounds per ton, therefore, if it were affected by variations in coupler side clearance, it would readily be detected on a division of this character. In order to eliminate any variations in train resistance, which might be attributed to changes in temperature between the different tests, the car journals were warmed by running the train nine miles at a speed of about fifteen miles an hour immediately before each test. The tests on the other two divisions, while not so numerous, checked the results obtained on the Cresson Division, showing no variation in train resistance due to lateral coupler play.

A summary of the maximum coupler side pressures with the corresponding amount of side clearance and the degree of curve on which they were obtained, is given below. The

Coupler Side Clearance Tests.

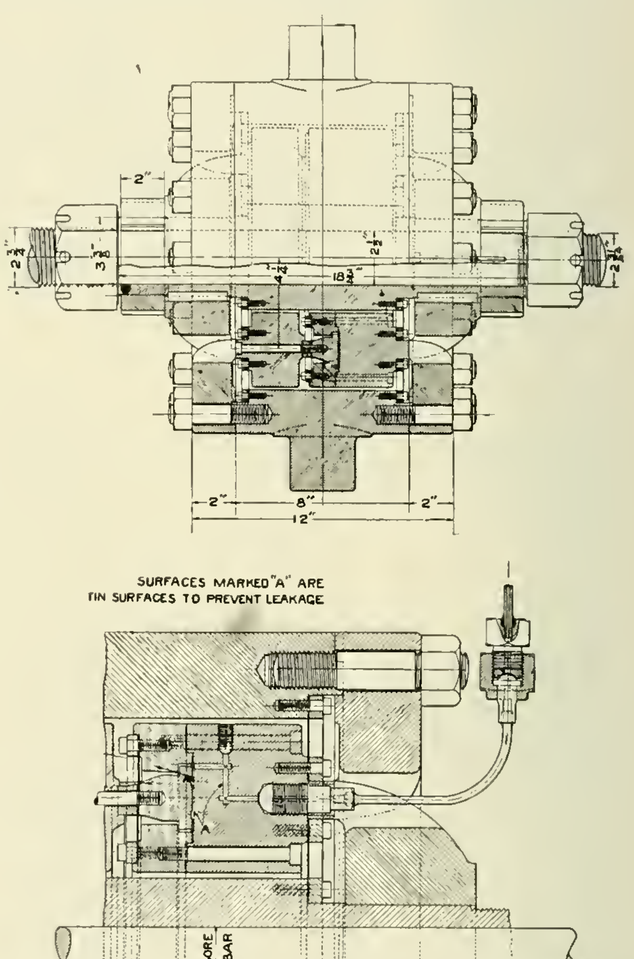
Summary of Maximum Side Pressures at End Sill. Lbs.

| Total Side Clearance | Cresson Division. Sharpest Curve 13°00′ Average Draw Bar Pull at Test Coupler 25033 Pounds. | Bellwood Division. Sharpest Curve 22°30′ Average Draw Bar Pull at Test Coupler 32306 Pounds. | Monongagela Div'n. Sharpest Curve 16°00′ Average Draw Bar Pull at Test Coupler 15286 Pounds. |
|---|---|---|---|
| One Inch | 4800 | 7100 | 5200 |
| Two Inches | 2400 | 3000 | 2600 |
| Three Inches | .... | 1600 | .... |
| Four Inches | 0 | .... | .... |
| Five Inches | 0 | .... | .. . |

.... Indicates no tests made.
0 Indicates no pressures.

maximum pressure recorded on the unusual curve of 20° 30′ was, with one-inch clearance 7,100 pounds, two-inch clearance 3,000 pounds and three-inch clearance, which is standard to the car, 1,600 pounds. None of these could be considered injurious to the equipment, when the vast number of shocks and strains to which cars are almost continually subjected are considered. The recorded pressures on all the pulling tests were exerted toward the inner rail of the curve, but in so far as the observers could ascertain they did not have any effect tending to pull the wheel flanges away from the outside rail. The side pressures are, roughly, the resultant force formed by the drawbar pull and the angularity between the coupled cars on a curve. With the class of cars used in these tests, this angle is about seven degrees on a thirteen-degree curve, which gives a theoretical side pressure of about 3,000 pounds with a drawbar pull of 25,000 pounds. The actual side pressure is sometimes in excess of and often less than this amount, due to numerous variables, such as swinging of the cars and binding of the coupler knuckles. There are portions on sharp curves where a clearance as small as one inch is not taken up, due to the above-mentioned variables. The plots on sheet "Y" gives approximately the relation between this phase of coupler clearance and the degree of the curves and also the relation between side pressure and degree of curve. The pressures obtained in the pushing tests were not as large as on the pulling tests, and apparently bore no fixed relation to the degree of the curves; in fact, slight pressures were recorded on tangent tracks due to the coupler contour lines allowing the heads to be pushed out of the direct alignment. Similar conditions were obtained on the drifting tests; in the latter, however, the slight pressures seemed mainly to be due to the swerving of the cars. It was thought that the length of the coupler yoke might affect the side pressures, therefore, one test, No. 42, was made with a long tandem spring yoke attached to the test coupler, but no difference in the lateral pressure was obtained. With this exception all of the cars were equipped with friction draft gears and their corresponding yokes. It must be kept in mind that all the results given in this report are based on one class of car, the side pressures on shorter cars would doubtless be somewhat less, varying with the overhang and distance between truck centers.

The yard tests with two loaded cars on a curve with a minimum radius of sixty-eight feet developed very excessive side pressure even with five-inch side clearance; in fact, it was not practicable to push the cars all the way around the curve, as the pressures were in excess of the dynamometer capacity. These same tests with empty cars gave practically the same results, except that the wheels at the test-coupler end of car were lifted about one inch off the outer rail during the trial with one-inch clearance. The side pressure on these tests is principally due to severe cornering of the end sills. Service of this kind, however, may be considered abnormal and would




Coupler Side Clearance Dynamometer. (Sheet Z-1.)

require a total lateral coupler play on reverse curves of thirty-eight or forty inches, which would make necessary excessive and expensive changes in car construction, and more or less elaborate centering devices. The committee does not consider that curves of this character are encountered often enough to make these changes advisable, and can only suggest that auxiliary couplers, or some other method of handling the cars, be adopted under these conditions. A side pressure of 12,000 pounds was obtained with one-inch clearance in pushing the test train through a No. 6 slip switch followed by a No. 8 switch with sixteen feet of tangent track intervening. The following results were obtained by running two loaded cars through these same switches: one-inch clearance, 4,800 pounds; two-inch clearance, 2,200 pounds; three-inch clearance, 1,400 pounds.

*Conclusions.*—In concluding the portion of the report relative to coupler side clearance, the committee would like to make special mention of the following deductions, drawn from the results of the tests: First, train resistance and, therefore, the amount of tonnage hauled under general road conditions is not influenced by coupler side clearance; second, the side pressures exerted on the end sills of cars by the couplers are not excessive with two and one-half-inch clearance on any road or on any normal yard curves, and third, it is recommended that the present standard side clearance of "Not less than 2½ inches," be changed to read simply "2½ inches," as this is ample and there is a liability of couplers not mating if more clearance is allowed without centering devices.

Summary.

A summary of the recommendations which the committee offers to be submitted to letter ballot to be adopted either as standard or recommended practice is as follows:

Standards.

Specifications for M. C. B. automatic couplers:

1. That the guard-arm test be abolished and the face test substituted in its place, two couplers to be so tested.

2. That one coupler instead of two be submitted to the pulling test.

3. That the holes for knuckle-pivot pins must not be more than 1-32, instead of 1-16 inch, larger than 1⅝-inch diameter pivot pin.

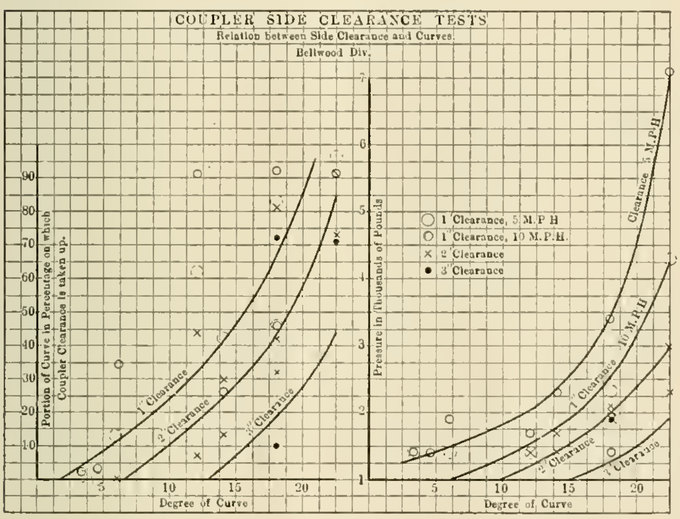
4. That six knuckle pivot pins be tested in accordance with the specifications for knuckle pivot pins for every one thousand couplers purchased.

5. That the gauges shown on sheet "N" be adopted as Standard of the Association and that Section 6 and Section 1 under "Inspection," be modified to require their use.

Specifications for Separate Knuckles.

6. That the holes for knuckle pivot pins must not be more than 1-32 instead of 1-16 inch, larger than 1⅝-inch diameter pivot pin.

7. That each knuckle must bear the name of the coupler




SHEET Y.

legibly stamped or cast at some point where it will not be subject to wear.

Specifications for Knuckle Pivot Pins.

8. That these specifications be adopted as a Standard of the Association.

9. That all pins must not be more than 1 41-64 inch or less than 1 39-64 inch in diameter, determined by a suitable gauge.

10. That word "weight" be replaced by words "standard weight of 1,640 pounds," in first sentence under "Physical Test."

Drawings:

11. That sheet M. C. B.-11 be changed to conform to sheet "O" accompanying the report.

12. That the present standard coupler side clearance of "Not less than 2½ inches" be changed to "2½ inches."

Recommended Practice.

1. That sheet M. C. B. "B" be changed to conform to sheet "P" accompanying the report.

*Discussion.*—Mr. Sanderson suggested increasing the limit of 150,000 lbs. for the pulling test. He also directed attention to the fact that the cars in the trains on which the side clearance tests were made were all of the same length, but that in actual service a 40 ft. and a 60 ft. car might be coupled together resulting in a greater stress on the coupler shanks than indicated by the tests. In replying to him Mr. Kleine called attention to the fact that the limit of the pulling test had been increased only last year and while there were couplers which had been tested to over 300,000 lbs., it would hardly be wise to make another change at this time. He also stated that the different lengths of overhang would not make much difference on regular road curves, but would on sharp curves often found on industrial sidings or even on cross-overs.

Mr. Brazier emphasized the importance of adopting a standard coupler and presented data as to the large amount of money tied up by the necessity of carrying the different types in stock. He also emphasized the doing away with of the top uncoupling arrangement in favor of a side or bottom arrangement. Mr. Gaines suggested that while the proper fitting of the yoke to the coupler was satisfactory still it is difficult to get it properly done by the average workman and that it might be well to provide a wall about the rivet through the butt.

Mr. Fowler (Can. Pac.) stated that a yoke properly fitted to the coupler butt would give satisfaction and that during the past five years 60 per cent. of yoke failures had been eliminated on the Canadian Pacific by careful attention to this matter.

Mr. Onderdonk (B. & O.) suggested that a flexible connection between the coupler and the yoke would probably give better service than the present arrangement.

*Action.*—The report was accepted and ordered referred to letter ballot.

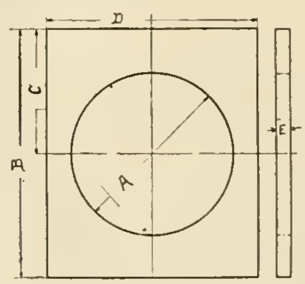
## FREIGHT CAR TRUCKS.

Committee: A. Stewart, Chairman; J. J. Tatum, A. S. Vogt, J. F. DeVoy, G. A. Hancock.

(A) To submit standard dimensions for dust guards for the four standard journal boxes.

The dimensions for the four dust guards recommended are shown on Sheet No. 1. There is no recommendation for material from which standard dust guards should be made, it being the opinion of the committee that there are a great many different materials proper for this purpose.

(B) To add to Sheet M. C. B. 22 journal-box bolt and dimensions




| Journal | A | B | C | D | E |
|---|---|---|---|---|---|
| 3¾"×7" | 4 13/16" | 7½" | 3¾" | 6" | ⅝" |
| 4¼"×8" | 5 5/16" | 8¾" | 4⅜" | 7¼" | ⅝" |
| 5"×9" | 6 3/16" | 9¾" | 4⅞" | 8" | ⅝" |
| 5½"×10" | 6 11/16" | 10¼" | 5⅛" | 8¾" | ⅝" |

FIG. 1.—STANDARD DIMENSIONS FOR DUST GUARDS.

The above instructions are followed by submitting Sheet No. 2, which is recommended to be substituted for the similar parts shown on Sheet M. C. B. 22, with the addition of the journal-box bolt.

(C) To specify single nut with nut lock under head and nut of bolt.

We submit Sheet No. 2, which it is suggested be used in place of similar parts shown on Sheet M. C. B. 22, and to which has been added the journal-box bolt with nut lock under head and nut of bolt, and a revised column bolt with one nut in place of two, and a nut lock under the nut and head of the bolt; with a notation that where a cast washer is used under the head of the bolt in place of a nut lock, it shall be constructed to prevent the head from turning.

(D) To specify a nut lock under head of column bolt on which single nut with nut lock is used, where washer is used under head in place of nut lock, the same to be constructed to prevent head from turning.

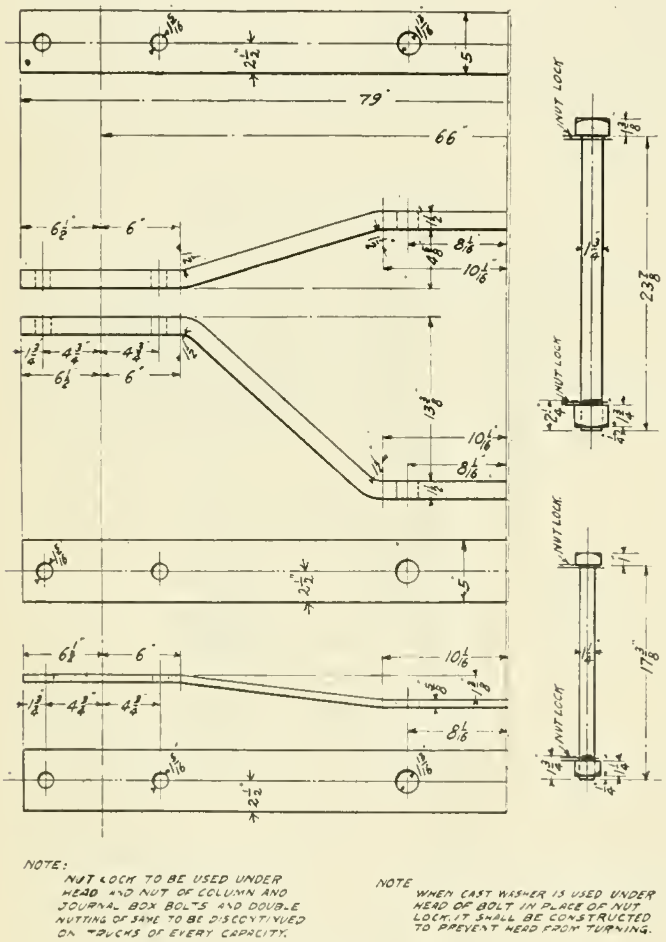
We submit, in answer to this, the same Sheet No. 2 which is recommended to be added to Sheet M. C. B. 22, in place of similar parts as now shown. This sheet and the notations take care of the references under heading (d).

(E) To specify the use of nut locks at top and bottom of all column and journal-box bolts, and discontinue the double nutting of such bolts.

We submit Sheets Nos. 2 and 3, on which are shown the column and journal-box bolts for both 80,000 and 100,000 lb. trucks, with specifications to cover a suitable nut lock at the top and bottom of these column and journal-box bolts, and a further notation which is to be used in connection with this report in recommending that the practice be discontinued of double nutting column and journal-box bolts on trucks of every capacity.

(F) To submit standard designs for arch bars and column and journal-box bolts for 100,000 lb. capacity trucks.

To cover this, we submit Sheet No. 3, showing proposed design for arch bars, column and journal-box bolts. In suggesting this design of arch bar, it has been largely based on the reports of satisfactory performance of cars now in service, of 100,000 lb. capacity. The average area of the top and bottom arch bars of all the 100,000-lb. capacity trucks we could get a record of is 7½ in., and the majority have both the top and bottom arch bars of the same dimension, or 5 by 1½ in., with a cross-section area of 7½ in.




PROPOSED STANDARD ARCH BARS FOR 50-TON CARS.

(G) To ascertain whether there is any necessity for higher spring capacity for 100,000-lb. capacity trucks.

All of the replies received, except one, indicate that 10 per cent. overload is the universal practice. The average 100,000-lb. capacity car will weigh 40,000 lb., and the standard Class D spring is designed to carry 38,000 lb. at a height of 7¼ in. and 64,000 lb. when solid, making the normal working capacity 152,000 lb., which is also the capacity of the 100,000 lb. or D axle, having journals 5½ by 10 in.

It is the suggestion of a number of roads to increase the spring capacity, but the committee was divided on this, two members advocating an increase in the spring capacity to allow for an overload of 25 per cent., the other three members taking the view that, as the present spring has a capacity equal to the designed capacity of the truck and axle, a greater capacity should not be recommended unless taken up in connection with a larger axle and increased capacity of truck.

The following subjects were referred to this committee by the Committee on Standards and Recommended Practice:

The vertical clearance between the side lugs on the journal bearing and the journal wedges is ⅛ in. for 3¾ x 7 in. and 5½ x 10 in. journals, and 1/16 in. for 4¼ x 8 in. and 5 x 9 in. journals.

In the opinion of the committee, 1/16 in. is too small a clearance, taking into consideration that the parts are rough castings; it is recommended that the clearance be increased to ⅛ in. for the four standard sizes of bearings and 1/16 in. reduction be made in the brass for the 4¼ x 8 in. and 5 x 9 in. boxes, as shown on Sheets M. C. B. 6 and 15.

There is no dimension given for a standard depth of hood of M. C. B. standard journal-box lid. The committee feel that, provided the lug on the journal box is maintained standard, it will be better not to limit the manufacturers in the design of their box lids, provided they properly fit the standard lug.

Attention is called to the opening in the back of the box for 5 x 9 in. and 5½ x 10 in. journals. It is recommended to change M. C. B. Sheet 14, showing 5 x 9 in. journal box, and this recommendation is concurred in by the committee, which suggests that the dust-guard opening and back of the 5 x 9 in. box for freight cars be made similar to the 5 x 9 in. box for passenger cars, as shown on M. C. B. Sheet C. Consideration has also been given the 5½ x 10 in. box, as shown on M. C. B. Sheet 17, but the committee has no changes to recommend.

*Action.*—There was no discussion of the report and the recommendations of the committee were ordered referred to letter ballot as recommended practice.

## TANK CARS.

The committee recommended a change in the rules of interchange to provide for the stenciling of limit weights on tank cars. It also presented designs and recommendations for vents for cars carrying non-inflammable or non-volatile material. Recommendations were also made as to the center sill construction and as to longitudinal anchorage of the tank. The preferable method of securing the tank against end shifting is by anchoring it to the underframe at or between the bolster, rather than by means of head blocks, inasmuch as the latter method results in damage to the underframe forward of body bolster.

The report of the committee was ordered submitted to letter ballot and the committee was continued.

## TOPICAL DISCUSSIONS.

Thos. Paxton presented some facts concerning the need of suitable lugs on steel and steel underframe cars for the jacking up of car bodies; also the application of suitable push-pole pockets to avoid damage to cars.

A rather warm discussion was precipitated by H. D. Taylor, who spoke on—Is a brake burn on wheel due to prolonged brake application properly an owner's defect? How is it to be distinguished from the defect known as shelled out? The matter was finally referred to the arbitration committee.

The abuse of the M. C. B. repair card was considered by W. H. Lewis. The facts which he presented and the remarks made by other members indicated a rather deplorable state of affairs in some instances. The following resolution, presented by Mr. Parish, was adopted:

That all of the members of the association who have any evidence of dishonesty in the use of the repair card submit such evidence to the executive committee, who will undertake to investigate the whole matter thoroughly and handle it in such a manner as seems best to the interests of this organization. It must be distinctly understood that no case should be presented to this committee until it has been sent to the head of the department that is questioned.

W. T. Gorrell presented some data concerning wheel mounting pressures for various sizes of cast iron and steel wheels. The question will probably be referred to a special committee to report at the next convention.

T. L. Burton read a comprehensive paper on the cleaning of triple valves and brake cylinders. J. R. Alexander, chief air brake inspector of the Pennsylvania Railroad, told of some investigations in the matter of lubricating triples which indicate that the proper operation of the valve does not depend on lubrication; in fact, valves have given no trouble when run without a lubricant during the cold weather season.

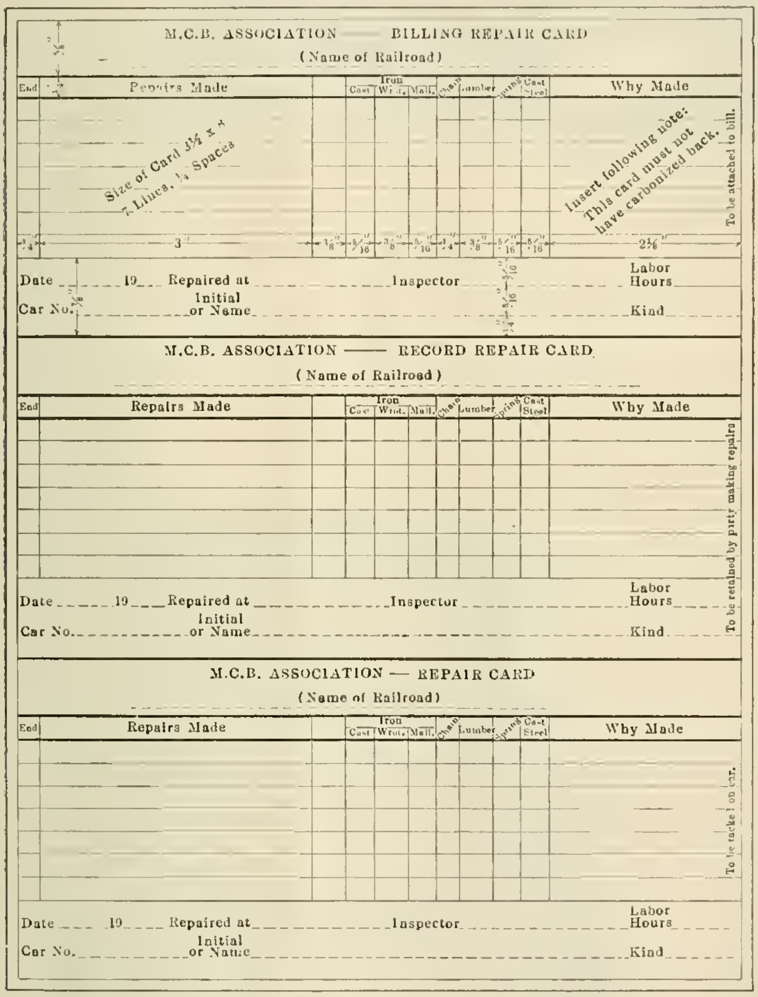
## REVISION OF THE M. C. B. REPAIR CARD AND QUESTION OF SETTLING CAR REPAIR BILLS ON A MILEAGE BASIS.

Committee: J. F. Deems, Chairman; D. F. Crawford, F. H. Clark and J. G. Neuffer.

The committee submits the following recommendations:

Because of a desire to have a card that can be made in triplicate and that will contain additional information to facilitate the making of bills, a great many roads have gotten away from the standard form of M. C. B. repair card. After considering the various cards in use, it is believed the form provided below will answer the requirements and should be used by all railroads.

The principal changes in the repair card are in providing a form that can be made out in triplicate, in one writing if desired, by using carbon sheets instead of having to fill out two stubs and repair card separately; also providing columns to show weights and miscellaneous charges for different items of material to facilitate the making and checking of bills. The proposed repair card consists of a billing repair card to be attached to the bill, a record repair card to be retained by party making repairs, and a repair card to be tacked on car.


M.C.B. ASSOCIATION BILLING REPAIR CARD
(Name of Railroad)
End | Repairs Made | Cast | Iron Wrt. | Mall. | Lumber | Cast Steel | Why Made
Size of Card 3⅝ x ... Lines, ... Spaces
Insert following note: This card must not have carbonized back.
To be attached to bill.
Date ____ 19__ Repaired at ________ Inspector ________ Labor Hours
Car No. ________ Initial or Name ________ Kind ________

M.C.B. ASSOCIATION —— RECORD REPAIR CARD
(Name of Railroad)
End | Repairs Made | Cast | Iron Wrt. | Mall. | Lumber | Cast Steel | Why Made
To be retained by party making repairs
Date ____ 19__ Repaired at ________ Inspector ________ Labor Hours
Car No. ________ Initial or Name ________ Kind ________

M.C.B. ASSOCIATION — REPAIR CARD
(Name of Railroad)
End | Repairs Made | Cast | Iron Wrt. | Mall. | Lumber | Cast Steel | Why Made
To be tacked on car.
Date ____ 19__ Repaired at ________ Inspector ________ Labor Hours
Car No. ________ Initial or Name ________ Kind ________

Note.—The printing on back of repair card should be the reverse of that shown here. The billing repair card must not have carbonized back.

M. C. B. REPAIR CARD.

The repair card to be tacked on car shall be printed on cardboard, on both sides, with black ink, and shall be filled in on both sides, one side to be filled in with ink or indelible pencil. The billing repair card shall show the same information as on the repair card and be attached to the bill as authority for charge, and must not have carbonized back. The record repair card shall be retained by the party making repairs.

The use of above cards will be effective June 1, 1910.

The committee recommends the following addition to Rule 88, providing a special repair card, if desired, for changes in wheels and axles: "In exchanging wheels and axles under foreign cars, reports on repair card of M. C. B. standard size, embodying all information required by the following statement, will be acceptable."

It is further recommended that the reporting of shop marks be discontinued, as this information does not appear to be necessary for the proper record of wheels and axles.

Concerning the suggestion of making repair bills on a mileage basis, the committee does not consider such a plan feasible. Any such arrangement would have to be based on average conditions, and the committee does not feel that the cost of maintaining cars in the various sections of the country is sufficiently alike at the present time to warrant it in assuming that such a basis would be an equitable one. While the operation of the present rules calls for a large expense from a clerical standpoint, the making of bills on M. C. B. defect cards, destroyed cars and charges for owners' defects, would still have to be carried on if the proposed plan was adopted, and the possible saving would be offset by the additional cost of inspection, loss to car owners' account of deterioration of their equipment on foreign lines and additional clerical help that would be necessary to adjust discrepancies, which would, no doubt, develop under the proposed system.

*Action.*—The recommendations of this committee were included in the report of the arbitration committee and adopted so that no action was necessary other than that of receiving the report.

## SIDE BEARINGS AND CENTER PLATES FOR FREIGHT AND PASSENGER CARS.

Committee—R. D. Smith, chairman; R. P. C. Sanderson, J. H. Manning, J. F. Walsh, G. C. Bishop, F. F. Gaines, C. A. Schroyer.

The committee found that it would cost at least $4,000 to make the necessary laboratory tests and therefore asked the superintendents of motive power of five roads owning dynamometer cars if they could arrange to make certain practical tests to determine:

1. The resistance to turning of different types of center plates.
2. The effect of lubricating center plates.
3. The resistance to turning of different types of side bearings.
4. The effect of varying the clearance of side bearings with a view to determining the best clearance.
5. The effect of varying the spread of side bearings with a view to determining the best spread.

These tests were to be made on stretches of level track about three miles long, consisting of two tangents with a curve of from 8 deg. to 12 deg., 500 ft. to 600 ft. long between them. By means of a dynamometer car the pull of a train of five or six 80,000 or 100,000 lbs. capacity cars was to be measured under various conditions, the cars being loaded with material of such nature as car wheels which would allow of varying the distribution of the load.

All of the roads replied that owing to the depression in business and the fact that forces had been greatly reduced, they did not care to undertake the tests at this time.

The committee again recommended that an appropriation sufficient to have tests made at some engineering university be considered at some future time when business conditions warrant.

*Discussion.*—A lengthy discussion took place, following the presentation of this report, as to the value and accuracy of results which could be gained from dynamometer car tests. It was finally decided to refer the matter to the executive committee.

NON-MAGNETIC YACHT.—The non-magnetic yacht *Carnegie*, in the construction of which practically no iron or steel was used, was launched at Brooklyn, N. Y., June 12. The only metal in the entire ship that is not non-magnetic is that of the pistons, the gas producer and the range grates. It will be used for obtaining correct records of magnetic variations and will be manned by a picked crew selected by the Carnegie Institution, Washington, D. C., for which the vessel was built.

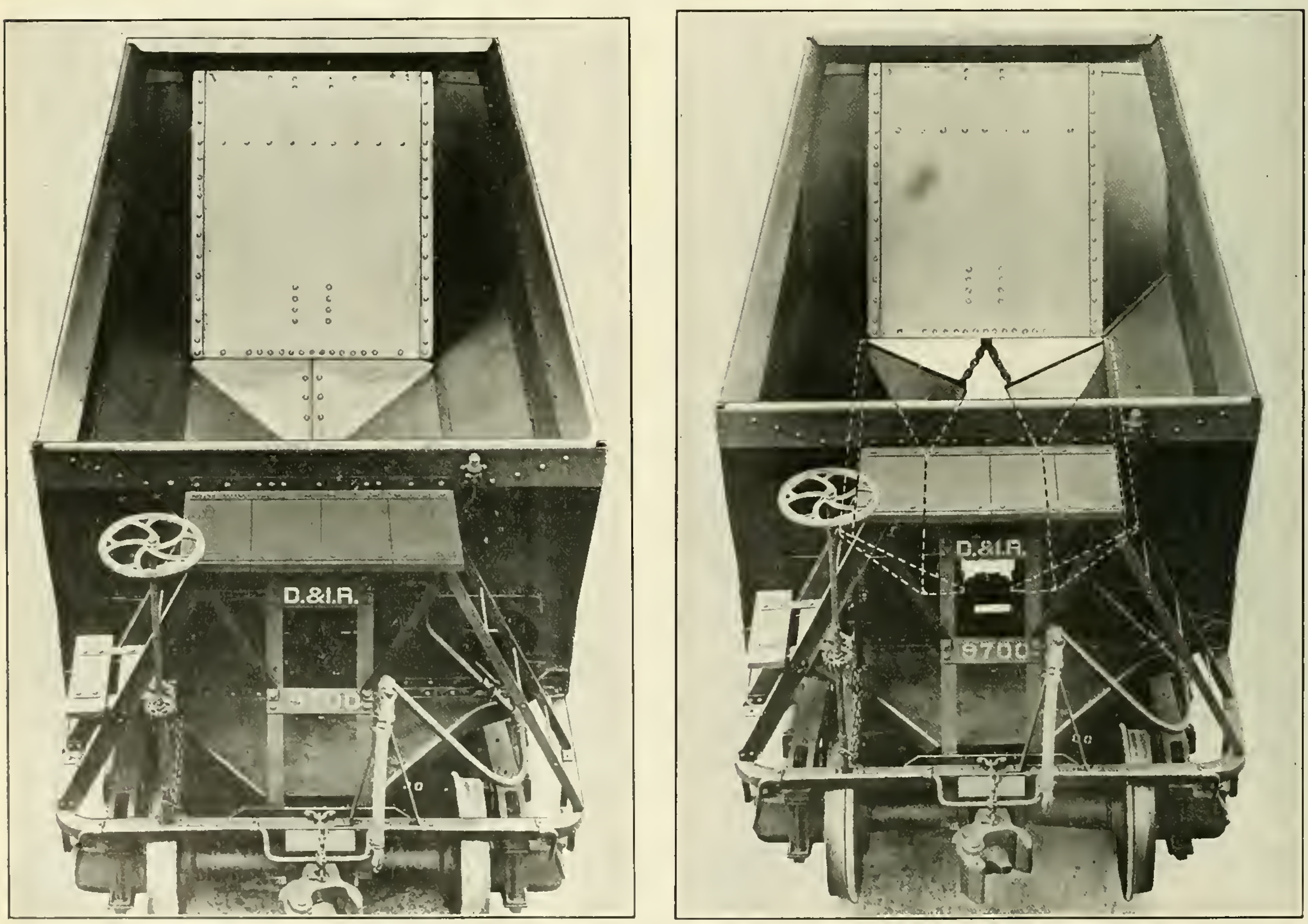
THE PENNSYLVANIA RAILROAD COMPANY has 6,292,156 shares outstanding. This is divided among 57,540 shareholders. 47.96 per cent. of the shareholders are women; 17,332 are located in Pennsylvania and 18.79 per cent. of the capital stock is held abroad.


FIFTY-TON STEEL ORE CAR—DULUTH & IRON RANGE RAILROAD.

## SUMMERS' STEEL ORE CAR.

The Duluth & Iron Range Railroad has eight hundred Summers' ore cars that have been in service for some time and are making enviable records as compared with other types of cars in the same service. These cars were illustrated and described in our February issue, page 49. It has been found that the workmen, when working at their usual rate of speed, will unload from 40 to 50 of the Summers cars in the same time required for unloading one of the ordinary steel hopper cars.

As an example, the following data was taken while the men were working at their usual rate, not realizing that they were being watched closely or that the time of the various operations was being observed:




SUMMERS' ORE CAR WITH THE DROP DOORS CLOSED AND OPENED.

| MAKE | NO. CARS | NO. MEN | COMMENCE TO OPEN DOORS | ALL ORE OUT AT | DOORS CLOSED AT | TIME CONSUMED Min. Sec. | AVER. PER MAN PER CAR Min. Sec. |
|---|---|---|---|---|---|---|---|
| Summers | 10 | 6 | 3:35:15 P.M. | 3:38:38 P.M. | ............ | 3 : 18 | 2 : 0 |
| " | 10 | 6 | 3:29 P.M. | 3:32:20 P.M. | ............ | 3 : 20 | 2 : 0 |
| Old Type | 10 | 42 | 3:54 P.M. | 4.19 P.M. | ............ | 25 : 00 | 105 : 0 |
| Summers | 8 | 3 | 4:47 P.M. | ............ | 4:54 P.M. | 7 : 00 | 2 : 37½ |
| " | 16 | 6 | 5:07 P.M. | ............ | 5.13 P.M. | 6 : 00 | 2 : 15 |

The first three items of ten cars each all contained the same kind of ore and the time did not include closing the doors after the loads were out. The time for the last two items of 8 and 16 Summers cars included closing the doors ready to load again.

A number of the cars have recently been equipped with an air operating mechanism for opening and closing the doors. The total time required to open the doors, drop the load and close them, ready for reloading, is from 10 to 15 seconds per car. A 50-ton load has been unloaded and the door closed in as low as 8 seconds. The air equipment is used only to open and close the doors, they being held mechanically in the closed position with a positive lock. As iron ore is a very sticky material to handle, it is preferred to give each car individual attention. It is possible though in this way for one man to unload a thousand cars in a ten-hour working day. For years it has been the practice to have from six to ten men per car, punching the ore out through the trap bottom. The new type of car makes it possible to dispense with hundreds of men at each dock.

The Summers' cars are unloaded immediately on being spotted over the pockets in the dock and are pulled off at once, the engine and crew making but the one trip to and from the dock with each lot of cars, while with the older cars two trips were necessary and they were delayed in movement, it being impractical, after the engine has once left them, to go back after them as soon as they were unloaded.

Following are some of the more important advantages of the Summers' car:

First.—Cost of unloading is only about 1 per cent. of that for the old cars.

Second.—Cars are kept on the move and a less number are required to handle a given tonnage.

Third.—The tonnage capacity of the dock is increased almost directly with the increased number of cars that may be unloaded over a given pocket.

Fourth.—The number of men required will very much reduce the possibility of a labor tie-up when the movement of a great tonnage is necessary.

Fifth.—The lake vessels can be loaded with greater dispatch. Ships and cars earn money only when moving under load.

## BELTING.

The following plan has been suggested by the New York Leather Belting Company for endorsement by belt users whereby the user may be assured of securing a good grade of belting.

*Demoralizing Practices in Belting.*—The average buyer of belting is not a leather expert. It is difficult to distinguish a good quality leather belt from a glossed-over imitation of quality. The buyer at present must depend on "claims of value" made by the seller. His lack of ability to test belting on delivery makes it impossible for him to tell whether he is having delivered best-quality goods or slick and shiny third-grade belly stock. Knowing this condition to be so prevalent, unscrupulous belting manufacturers have practiced flagrant fraud on the consuming public, making "claims of highest value" to get an audience, and prices low enough to get the business, and then delivering any sort of belting they saw fit.

*Plan to Protect Users of Belting.*—1. Have all belting manufacturers who have facilities for building best quality belting adopt a standard specification for first grade belting, viz.:—

(a) Belting made from oak-bark tanned butts.

(b) Only center portions of hide used.

(c) Strips put into belts not to exceed 4 feet 6 inches in length.

(d) Weight about 16 ounces to the square foot.

(e) Every strip for each width of belt taken from a definite fixed location in the hide.

2. As physical proof to the user that these claims are fulfilled in the belting delivered, we offer this absolute test, easy to apply and sure in its proof. Each manufacturer shall furnish to every dealer who represents him, a belting butt, having sides and centers attached, with strips to illustrate the exact nature of material which enters into every width into which the belting will be manufactured. By comparing the roll of belting with strips in the sample butt, and by comparing the pit of the leather in the roll with that in the corresponding strip in the belt, a novice in belting may prove to himself just what he is getting. Every large user of belting should have a sample butt of this sort at his plant.

3. A stamp shall be adopted which will be recognized as a national quality stamp for first grade belting. All manufacturers who can prove they are capable of building belting according to standard specifications, shall be allowed to place this stamp as a guarantee on their first-grade goods.

4. This stamp shall be the property of a national committee representing the supply dealers of the country, since they supply 50 per cent. of the belting used by consumers. This committee shall withdraw the use of this stamp from any manufacturer who uses it on goods which do not meet standard specifications.

5. The verified complaints of any belting users that goods bearing this stamp which do not fulfil the specifications, have been delivered, shall be sufficient to have the stamp withdrawn from that manufacturer. This would hold an axe over the head of every manufacturer and insure absolute fulfilment of specifications.

*The Protection This Plan Gives.*—The adoption of this plan will eliminate the possibility of fraud in the delivery of belting, since it gives the user a double check: (1) Physical proof that he can apply for himself. (2) A guarantee in the shape of a national quality trade-mark.

## SUPERHEATED STEAM.

The following data and corrections will make more clear certain parts of Mr. Cole's article on "Low, Moderately and Highly Superheated Steam," which appeared in the June issue.

The values of specific heat of superheated steam used in computing the table near the top of the left hand column of page 223 are those appearing in the table in the opposite column. The total heat for 160 lbs. pressure and 40 degs. of superheat should be 1,220 in place of 1,222, as shown.

The fourth word in the first line at the top of the right hand column on page 223 should read "pressure" instead of "volume," thus making the complete sentence read: "The average specific heat of superheated steam of different pressures at various temperatures, but of constant pressure for the different curves, is given in Fig. 2."

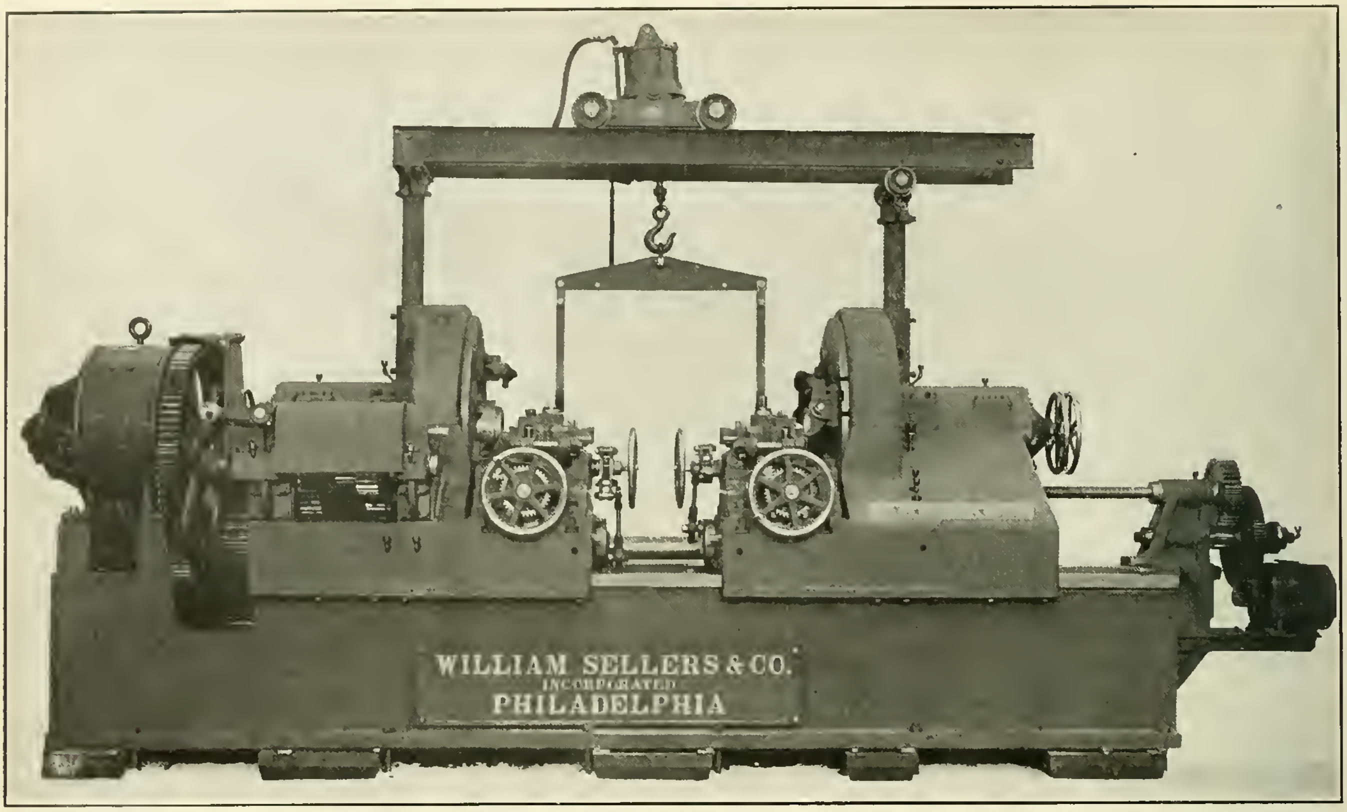
At the top of Fig. 3 on page 223 a reference is made to a formula which appears on page 661 of Kent. The formula is not, however, in quite this form, but is derived from the one shown in the following manner:

$$PV = 93.5\ T - 971\ p^{1/4}$$

From which $$V = \frac{93.5\ T - 971\ p^{1/4}}{P}$$

and since $$W_t = \frac{1}{V}$$

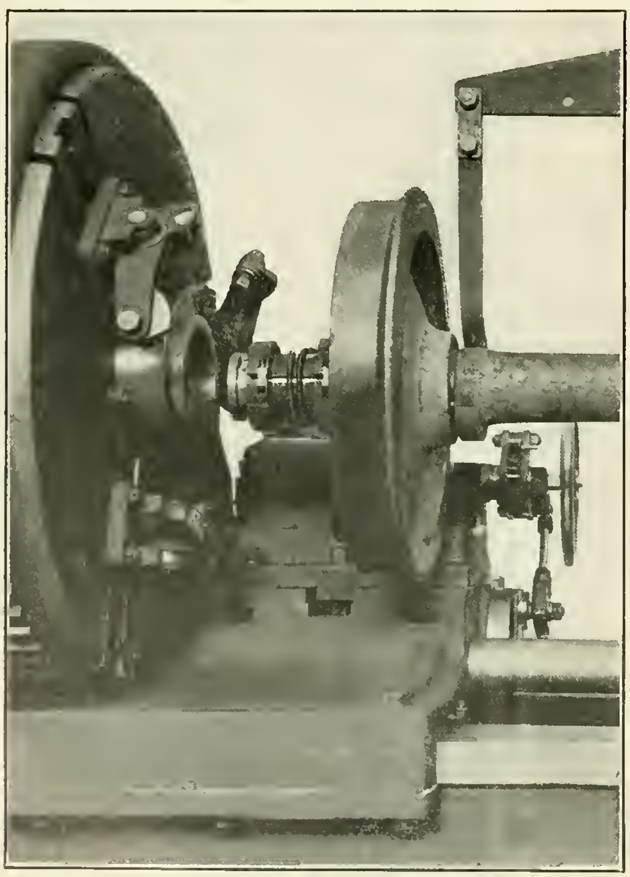
then $$W_t = \frac{P}{93.5\ T - 971\ p^{1/4}}$$



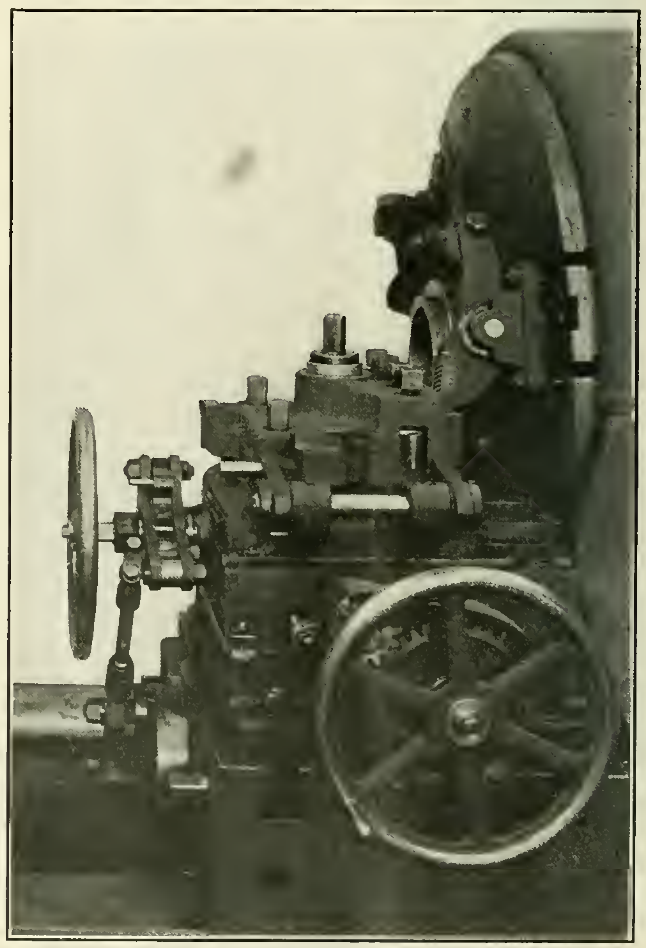

SELLERS' MOTOR DRIVEN CAR WHEEL LATHE.

## CAR WHEEL LATHE.

A test was recently made at the works of William Sellers & Company, Philadelphia, of a car wheel lathe, lately designed by them. William Anthony, an operator from the Philadelphia & Reading shops at Reading, was in charge of the machine. Four pairs of steel-tired wheels (three 36 in. with outside journals and one 33 in. with inside journals) were turned in 72 min. 28 sec. This includes the time required to place them in the lathe,



SHOWING FACE PLATE DRIVERS, BUSHING ON JOURNAL AND TRACK CAST ON EXTENSION OF HEADSTOCK.



TURRET TOOL HEAD, CARRIAGE, AND FACE PLATE DRIVERS.

turn them and replace them on the floor. It does not include 6 min. for changing the lathe for the pair of wheels with inside journals and 27 sec. for replacing a burned tool.

The lathe is designed to turn car wheels of any type, with either inside or outside journals, and from 28 to 42 in. in diameter. The bed, of massive construction, carries one fixed and one movable head, the latter being traversed by an electric motor driving a screw through a slip clutch, which is adjusted to slip if the head should come in contact with a solid obstruction. The two face plates are driven in unison by a large driving shaft.

For centering wheels with outside journals three-part taper bushings, held assembled by a couple of turns of coiled spring, are slipped over the journals. These bushings enter taper-mouthed spindles in the headstocks, thus centering the wheels. These spindles are provided with springs to maintain a uniform pressure on the taper bushings. For engine truck wheels, having inside journals, pointed centers and bushings are provided to fit the taper holes in the spindles.

Each face plate carries three positive toggle grip drivers for holding the wheels. The toothed cam at the end of the lever is brought into contact with the wheel by a slight turn of a small wrench, forcing the serrated block at the other end of the lever to engage the tire. Any tendency to slide when the tool starts to cut causes the cam to revolve and increases the pressure of the serrated block against the tire, preventing further slipping.

The main casting of each head is extended forward along the bed forming a support for the slide rest and the stresses due to the cut are therefore self-contained in the head and there is no tendency to lift the head off the bed. The four tools required for turning the tire are held in a turret head. A partial turn of the wrench is sufficient to tighten or release the turret which may be readily turned when free. It is locked in position by two cams which bear against one of its sides. These are operated by a crank and the turret is turned by a wrench which engages with the square head bolts near the corner. The roughing tool is placed in a slot through the turret and clamped by four screws. If the tool should become dull or broken it may be passed out backward and replaced without stopping the lathe or revolving the turret. The finishing tools are mounted on ledges cast on the sides of the turret.

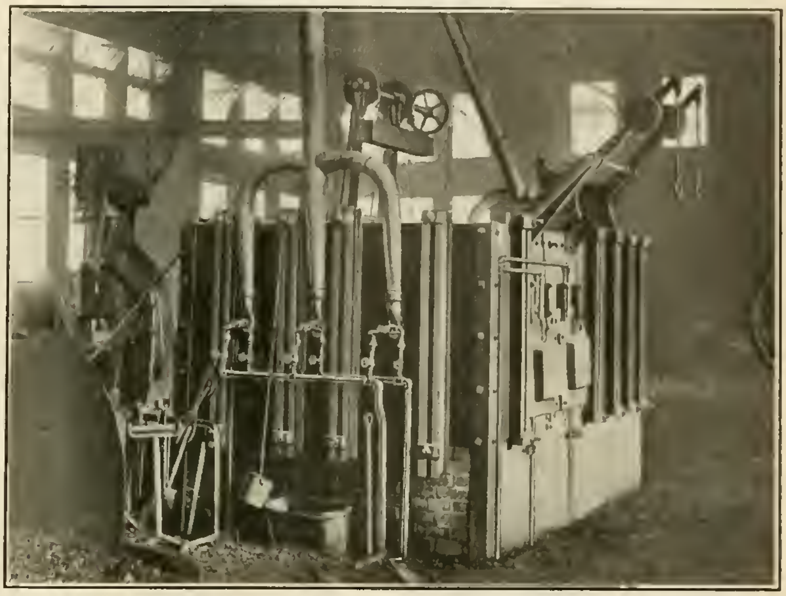
As there is no part of the machine between the wheels it is possible to place a pair in the lathe having gears or even armatures on the axle. On the back of each saddle is cast a track to match tracks on the shop floor so that wheels may be rolled directly below the lathe centers. They may thus be handled to and from the lathe without a crane and, if desired, it will only be necessary to furnish a hoist as shown in one of the illustrations.

The lathe is driven by an adjustable speed motor controlled by an automatic solenoid switch panel. By the use of these switches the operator is able to start and stop the machine and reduce to an extremely low speed without stopping when passing hard spots. After the hard spots have been passed the lathe will resume the speed at which it was running by merely releasing the slow-down switch. The perfect control of the cutting speed thus obtained has a marked effect on the productive capacity. A brake stops the machine promptly when the current is shut off.

## OIL FURNACES FOR RAILROAD SHOPS.

The advantages of oil for use in heating furnaces in railroad shops are being quite generally recognized. The labor of bringing coal to the furnace and hauling ashes away is done away with; no storage space for fuel is required in the shop; a uniform heat is obtained, and it is under perfect control; the fire is quickly started.

A Kirkwood heating furnace in the smith shop of the Jacksonville, Florida, shops of the Seaboard Air Line is shown in the illustration. A combination high and low pressure burner is used; the oil is fed to the burner at a pressure of from 15 to 25 pounds and is there atomized by a small quantity of compressed air at a slightly lower pressure, after which an air blast of from two to six ounces is used to supply the necessary amount of oxygen for complete combustion. The amount of compressed air required is very small. This type of burner is said to be responsible for a very considerable reduction in the oil consumption.



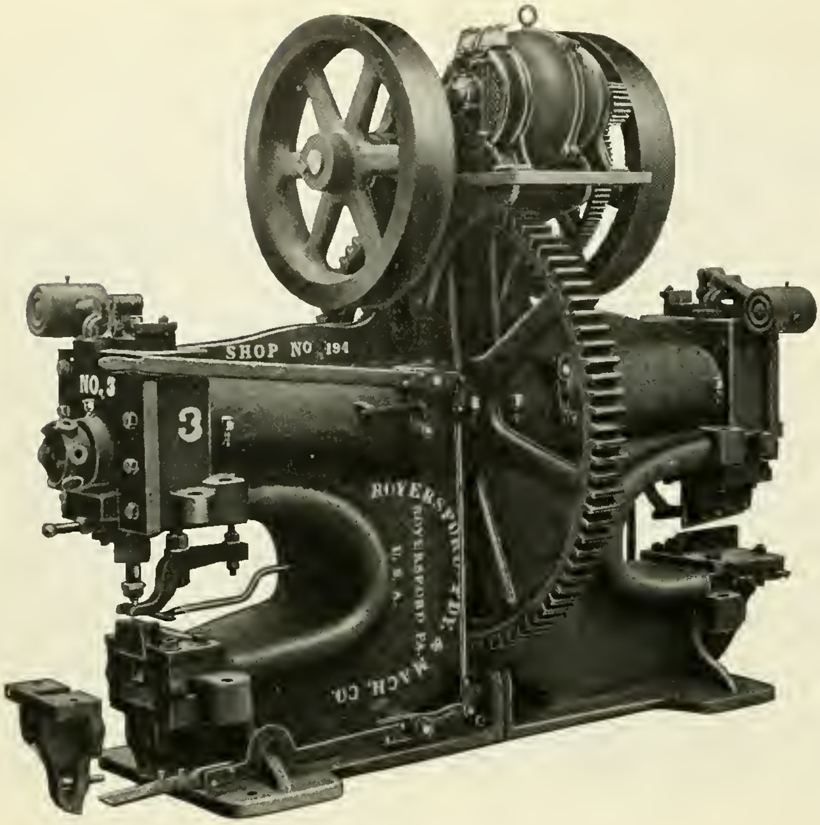
KIRKWOOD OIL FURNACE IN SEABOARD AIR LINE SHOPS AT JACKSONVILLE.

Another important feature is that the supply of oil and compressed air is controlled by one lever, thus keeping the ratio between these two constant. This ratio is carefully adjusted before the furnaces leave the factory, and is beyond the control of ignorant or careless workmen. The nature of the fire may be regulated by varying the amount of the air blast. These furnaces are made in a number of different types and sizes by Tate, Jones & Company, Inc., of Pittsburgh.

## BARTLEY NUT AND BOLT FASTENER.

Following is a memorandum designating some of the bolts on cars on which Bartley nut and bolt fasteners are being used by different railroads: Air brake and pipe clamp, air brake cylinder, air brake reservoir, box car roof fascia, brake lever fulcrum, brake hanger, brake lever guide, carry iron, center plate, column and column guide, dead lever guide, draft rigging, draft timbers, end sill gusset and brake mast, grab iron, journal box, ladder rung, pedestal brace, queen post, safety chain, safety hanger, side step and pocket, spring plank, tie bar, truss rod; also on all bolts and nuts on both wood and steel cars that are liable to work loose from vibration or other causes.

It may readily be seen that the above bolts will require fasteners of different types. Among these are the arch bar style, used on the heads of bolts and the nuts on journal boxes and columns and any other place on iron or steel surfaces where the center of the bolt hole is within about three inches or less of a square edge over which the flange of the fastener will lap. For channels or similar places the fasteners of the above type are furnished with inverted flanges. The slotted arch bar style is used under the column bolts on old cars; the bolt is driven up about an inch and the fastener is pushed under the head until its flange slips into position over the arch bar—this saves time and possible injury to the bolt in driving it




ROYERSFORD MOTOR DRIVEN PUNCH AND SHEAR.

clear out. A multiple style is used where bolts are uniform distances apart, or where they do not come near enough to the square edge to permit the use of the arch bar style. They are desirable for air brake cylinders, draft rigging and such places and may be furnished in one strip for from two to six or more bolts.

A diamond tang style is used on wood, dispensing with the use of a separate washer and combining the washer and nut lock in one. The rail type is without flanges and is applicable to cars or locomotives where a projecting bearing for the lower edge of the fastener comes within moderate distance of the bolt. The lower edge of the fastener can be shaped to fit bearing surfaces of irregular shape. Special shapes and styles may be furnished to suit almost any conditions. The fasteners are manufactured from a uniform grade of mild steel. The locking ar·n is bent into locking position at a long radius, and will not, therefore, break or crack when necessary to release the nut. The same fastener may be used quite a number of times without breaking.

These fasteners are made by The American Nut and Bolt Fastener Company, of Pittsburgh, represented in the east by Robert Spencer & Co., 20 Vesey street, New York, and in the west by Christopher Murphy & Co., 164 Dearborn street, Chicago. The plant at Pittsburgh has a capacity of sixty million fasteners a year.

## MOTOR DRIVEN PUNCH AND SHEAR.

The punch and shear, illustrated herewith, has a shearing capacity of 8 by 1 in. flat, or 2 in. round. It will shear 5 by 5 by ⅝ in. angles. Equipped with tie rods it will punch up to 1½ in. through 1 in. It may be furnished with either 26 or 32 in. throats and with a 4 in. extension on the punch side, which may be used for light punching up to 1 in. through ¾ in.

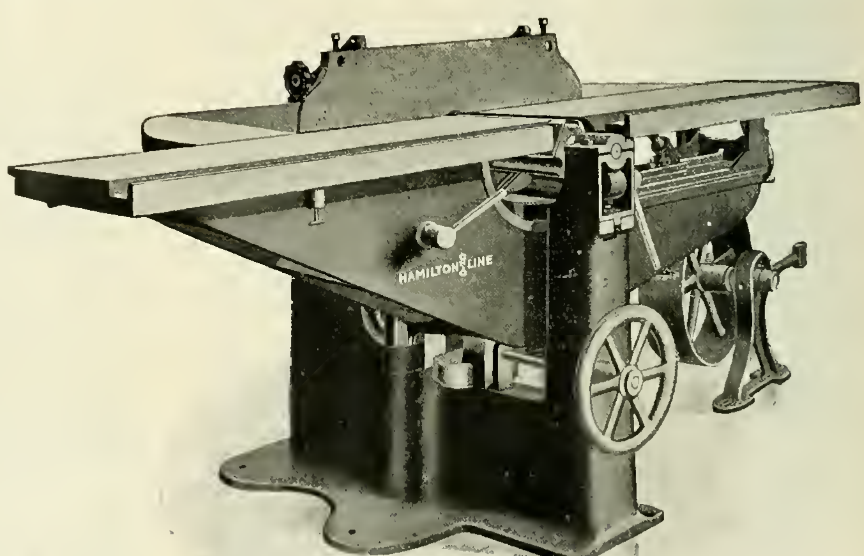
The main shaft, in two parts, is 5½ in. in diameter, and is eccentrically turned near the ends to provide a movement of 1¾ in. to the plungers, or moving heads. Each side is independent of the other, although both sides may be operated together if desired. The operation is controlled by the hand lever or foot treadle; forcing them down throws the clutches into contact with the large gear; when released the springs on the side of the machine throw the clutches out.

The machine is provided with a gag on the punch side for accurate punching; also with an architectural jaw for conveniently punching I-beams and channels. Angle and slitting shears may be attached if required. The machine may be furnished with a 12-in. instead of a 26-in. throat on the shear side. With 26-in. throats on both sides it weighs 18,300 pounds equipped with the motor. This is one of a line of punches and shears (single or double), made by the Royersford Foundry & Machine Company, Inc., Royersford, Pa.

## UNIVERSAL OR VARIETY WOODWORKER.

The Hamilton universal woodworker is constructed in a most substantial manner for handling the large and heavy work required in railroad shops. It is carefully designed to withstand the strains to which it may be subjected in performing various operations, including jointing, smoothing, planing out of wind, squaring, beveling, tapering, rabbeting, gaining, plowing, cornering, beading, mitering, tenoning, panel raising, hand matching, moulding, rip and cross cut sawing, boring and routing.

It is made in four sizes, eight, nine, ten and twelve inch, and has three table tops, which are adjustable independently and collectively. The two front tables are carried on a heavy bracket that is adjustable up and down on the front face of the frame without disturbing the adjustment of the two tables relative to each other. The front or forward table has an independent adjustment up and down and to and from the cutter-head through four incline slides mounted on the bracket. The third table or back top is found on this make of machine only and is of great importance for handling large and heavy work; it has an independent adjustment up and down. For cross gaining or similar work the three tables may be brought to a uniform level, furnishing a table support of large dimensions. The front tables are provided with wide grooves for the reception of slide boards, gauges, and other accessories.

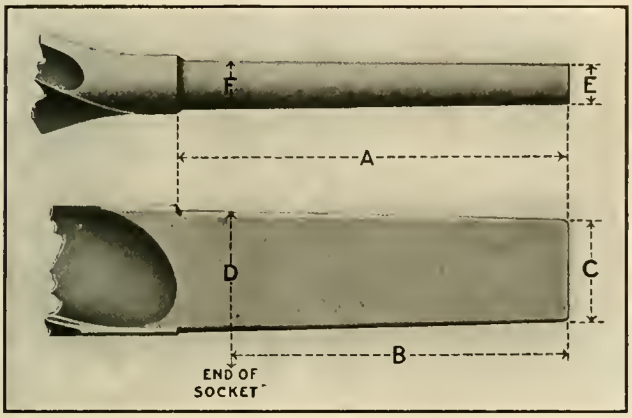


HAMILTON 10-INCH AND 12-INCH SOLID WOODWORKER.

If desired the machine may be provided with an additional cutter-head, mandrel and housing set vertically at right angles to, and in the rear of the horizontal cutter-head. This head is used when planing and squaring material on two sides at one time. When so arranged an additional fence is provided, which may be set for any amount of cut on the side head. The other fence, shown in the illustration, is used when the horizontal head only is in use. Either the single or the double machine may be equipped with a universal adjustable boring and routing table by the manufacturers of the machine, the Bentel & Margedant Co., Hamilton, O.

## A NEW SHANK AND SOCKET FOR FLAT TWISTED DRILLS.

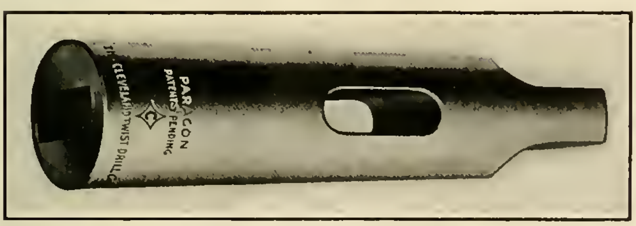
The Cleveland Twist Drill Company is about to place on the market a high speed twisted drill with a new type of flat taper shank, known as the "Paragon"; also "Paragon" sockets to fit




SHANK ON "PARAGON" FLAT TWISTED DRILLS.

these shanks. The drill itself is twisted from flat stock and the shank is forged and ground to size from the original bar without weld or joint. The shank has a uniform taper on the flat sides, as well as on the rounded edges.

A regular taper shank sleeve outside, with a flat tapered hole




"PARAGON" DRILL SOCKET.

inside to correspond to the shank, is all that is required to hold the drill. A good true fit is thus secured, resulting in a firm accurate drive, with the strain distributed over the entire length of the shank—leaving no weak point to break or twist off. The


"PARAGON" FLAT TWISTED DRILL.

sockets are simple and inexpensive, and are furnished in either rough, fitted, or sleeve styles. The combination is thus simple and strong, and it would seem that it was the logical way in which to drive a drill of this type.

## PERSONALS.

J. F. Casey has been appointed foreman of the car department of the Fort Worth & Rio Grande.

Oscar J. La Paugh has been appointed division storekeeper of the Delaware & Hudson at Green Island, N. Y.

C. B. Dobson, car foreman of the Chicago, Rock Island & Gulf at Dalhart, Tex., has been appointed district car inspector.

C. W. Van Buren has been appointed master car builder of the eastern lines of the Canadian Pacific with office at Montreal, Que.

C. Kyle has been appointed general master mechanic of the eastern lines of the Canadian Pacific, with office at Montreal, Que.

S. S. Shields has been appointed general air-brake inspector of the Atlantic Coast Line Railroad Company, with office at Wilmington, N. C.

A. M. McGill, general inspector of motive power and rolling stock of the Lehigh Valley, has been appointed shop superintendent at Sayre, Pa.,

E. L. Sudheimer, master mechanic of the Chicago Great Western, has resigned to go with the Peteler Car Company of Minneapolis, Minn.

H. S. Wall, master mechanic of the Arizona division of the Atchison, Topeka & Santa Fe, has been appointed superintendent of shops at San Bernardino, Cal.

J. A. Conley has been appointed master mechanic of the New Mexico division of the Atchison, Topeka & Santa Fe, with office at Raton, N. Mex.

L. A. Mattimore has been appointed master mechanic of the Arizona division of the Atchison, Topeka & Santa Fe, with headquarters at Needles, Arizona.

C. J. Morrison, standardizing engineer of the Atchison, Topeka & Sante Fe has resigned to engage in other business, and is at present located in New York City.

M. F. McCarra has been appointed general foreman of the Kingsville shops of the St. Louis, Brownsville & Mexico, to succeed A. J. Conrad who has resigned.

A. W. Whiteford, shop superintendent of the Lehigh Valley at Sayre, Pa., has been appointed assistant superintendent of motive power with office at South Bethlehem, Pa.

J. T. Connor has been appointed superintendent of motive power and machinery of the Houston, East & West Texas and the Houston & Shreveport at Houston, Texas.

C. H. Temple, formerly master mechanic of the Central division of the Canadian Pacific, has been appointed assistant superintendent of motive power, with headquarters at Winnipeg, Man.

C. F. Richardson has been appointed assistant to the superintendent of motive power of the Chicago, Rock Island & Pacific, in charge of fuel economy, with office at Chicago.

P. H. Cosgrave, formerly with The Colorado Midland Railway Company, has been appointed general car foreman of the Denver & Rio Grande, with office at Salt Lake City, Utah.

C. Setzkorn, district car inspector of the Chicago, Rock Island & Gulf at Dalhart, Texas, has been appointed a general car foreman of the Chicago, Rock Island & Pacific at Cedar Rapids, Iowa.

James Kiely, master mechanic of the New Mexico division of the Atchison, Topeka & Sante Fe, has been appointed master mechanic of the Rio Grande division, with office at Clovis, N. Mex.

A. V. Manchester, assistant district master mechanic of the Chicago, Milwaukee & St. Paul, at Minneapolis, Minn., has been appointed a master mechanic of the Chicago, Milwaukee & Puget Sound, with office at Miles City, Mont.

D. E. Fitzgerald, for the past five years chief clerk to the general superintendent of motive power, has been appointed assistant general superintendent of motive power of the St Louis & San Francisco, with office at Springfield, Mo.

W. E. Ballantine, chief electrician of the Chicago, Rock Island & Pacific, will work in future under the jurisdiction of the mechanical department officials, and, subject to their approval, will have charge of car and engine electric lighting and will give such assistance with regard to electric appliances for shop use as may be required. The electric lighting at all points on this road where the current is supplied by mechanical department facilities will be under the direct supervision of the mechanical department. At other points the electric lighting will be under the supervision of the superintendent of telegraph.

## BOOKS.

Poor's Manual for 1909. Published by Poor's Railroad Manual Co., 68 William street, New York. Price, $10.

This is the forty-second annual number and has 100 more pages than the 1908 edition and 400 more than the 1907 book. The statistics cover the 1908 fiscal and calendar years, and in some cases information is given which was received after June 1, 1909. In addition to the railroad data, there is a comprehensive industrial section.

The total mileage of the steam railroads in the United States, December 31, 1908, was 232,046 miles, an increase during the year of 3,918 miles. The surplus for 1908 was $49,444,376, or only 30 per cent. of that for 1907, which was $172,572,926. The surplus in 1906 was $151,474,773; in 1905, $121,876,014; in 1904, $92,620,020. The following items are of interest:

| | 1908. | 1907. |
|---|---|---|
| Passengers carried | 891,275,003 | 860,648,574 |
| Passenger mileage | 28,985,670,148 | 28,166,116,577 |
| Revenue per passenger mile | 1.950 cents. | 2.040 cents. |
| Tons freight moved | 1,521,065,494 | 1,722,210,281 |
| Freight mileage | 215,698,911,350 | 233,137,507,807 |
| Revenue per ton mile | 0.765 cent. | 0.782 cent. |

## CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Electric Motors for the Office, Store and Shop.—The Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has issued a handsomely printed booklet describing a few typical applications of its line of small motors for office, store and shop services. It includes illustrations and descriptions of a motor-driven adding machine, mailing machine, eraser, graphophone, envelope sealer, vacuum cleaner, buffing and polishing wheel, blower, air pump, sign-flasher, box-covering machine, hand drill, hack saw, coffee grinder, etc.

A Revolution in Lighting.—This is the title of a booklet, No. 3841, just issued by the General Electric Company. It tells in a simple way of the advantages of the tungsten lamp.

Electric Power for Domestic Purposes.—The Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has prepared an attractive little folder, which offers many valuable suggestions for the use of small motors in the home. Among the labor-saving applications of electric power noted are the sewing machine, vacuum cleaner, washing machine, ice-cream freezer, coffee grinder, meat chopper, ironing machine, silver polisher, dish washer, and the motor-driven pump.

Power Punching and Shearing Machinery.—An attractive catalog of 208 pages has just been received from The Long & Allstatter Company, Hamilton, Ohio. It is known as catalog No. 21 and opens with an illustrated description of the various tools used in connection with punching and shearing machines. This is followed by diagrams of both a single and a double punch and shear showing the names of the different parts. The remaining 194 pages contain half-tone illustrations and descriptions of the different types of punches, shears, bending machines, welding machines, horizontal bending and forming machines, riveting machines, helve and drop hammers and bending rolls made by this company.

The Proper Care of Belts.—This is a booklet of 24 pages published by the Joseph Dixon Crucible Company, Jersey City, N. J. It is divided into three sections—Belts, Belt Dressings and Hints, Kinks, Tables. The first section deals with the running condition of belts; the second takes up treatment with various preparations; and the third, as the title indicates, has some general points upon belting and its use. This last section gives the economic speeds at which leather belts should be run; has some matter concerning the different styles of joints, illustrating three methods of leather lacing; contains rules for calculating speed of pulleys; gives horse power transmitted by various sizes of single and double belts, etc.

Car Window Fixtures.—It is a rather difficult matter to illustrate clearly the design and operation of window fixtures. The Grip Nut Company, Old Colony Building, Chicago, Ill., has, however, succeeded in doing this in a very satisfactory manner in its window fixture catalog No. 17. The construction of the Universal window fixtures is splendidly shown in detail by means of colored plates. In addition to describing these fixtures and their advantages in detail, a clever arrangement has been devised by which it is possible to furnish the inquirer with exact information as to the fixtures to suit any conditions, so that definite specifications may be drawn up which admit of no misunderstanding.

Water Glass Guard.—Under the caption of "Lawsuits and Accidents Prevented," the American Steam Gauge and Valve Manufacturing Company, 208 Camden street, Boston, Mass., is sending out a folder describing the "Positive" water glass guard and considering its advantages. This guard consists of two frames or doors of malleable iron swinging on hinges attached to a bracket secured to the boiler head by studs. The doors completely cover the water glass and stand at such an angle with the boiler head that the light is reflected through sight glasses. The sight glasses are made of heavy plate glass with woven wire insert, and placed in slots in each door directly in front of the water glass, giving a perfect view of the water level at all times.

Baker-Pilliod Valve Gear.—The Pilliod Company, with a general sales office at 1545 Old Colony Building, Chicago, Ill., and the main office and factory at Swanton, Ohio, is issuing an attractive catalog under the title of "A Few Facts." It presents a carefully prepared and well illustrated detail description of the valve gear including drawings of each of the parts with data as to their weights. Then follows a statement of the claims made for the gear and the proof in the shape of indicator cards, valve motion reports and tests. A number of locomotives equipped with the gear are illustrated, including a consolidation type and a Pacific type on the Chicago & Alton, an Atlantic type on the Chicago & Northwestern, a Pacific type on the Central of Georgia, a Prairie type on the Chicago & Great Western and a ten-wheel type on the Toledo, St. Louis & Western.

## NOTES

Commonwealth Steel Company.—Boone V. H. Johnson, who for the past two years has represented the Scullin-Gallagher Iron & Steel Company in St. Louis, has resigned to accept a vice-presidency of the Commonwealth Steel Company.

Crocker-Wheeler Company.—At a meeting of the directors in July, Dr. Schuyler Skaats Wheeler was re-elected president, and the following officers were elected for ensuing year: Vice-president, Gano Dunn; 2nd vice-president, A. L. Doremus; chief engineer, Gano Dunn; secretary, Rodman Gilder; treasurer, W. L. Brownell; assistant treasurer, G. W. Bower.

The Barney & Smith Car Company.—Hugh M. Wilson, formerly editor and publisher of *The Railway Age*, will, on August 1st, become associated with this company, at Dayton, Ohio, of which he has been elected a director and a vice-president. Mr. Wilson disposed of his publishing business over a year ago and has only recently returned to the United States after nearly a year spent in foreign travel.

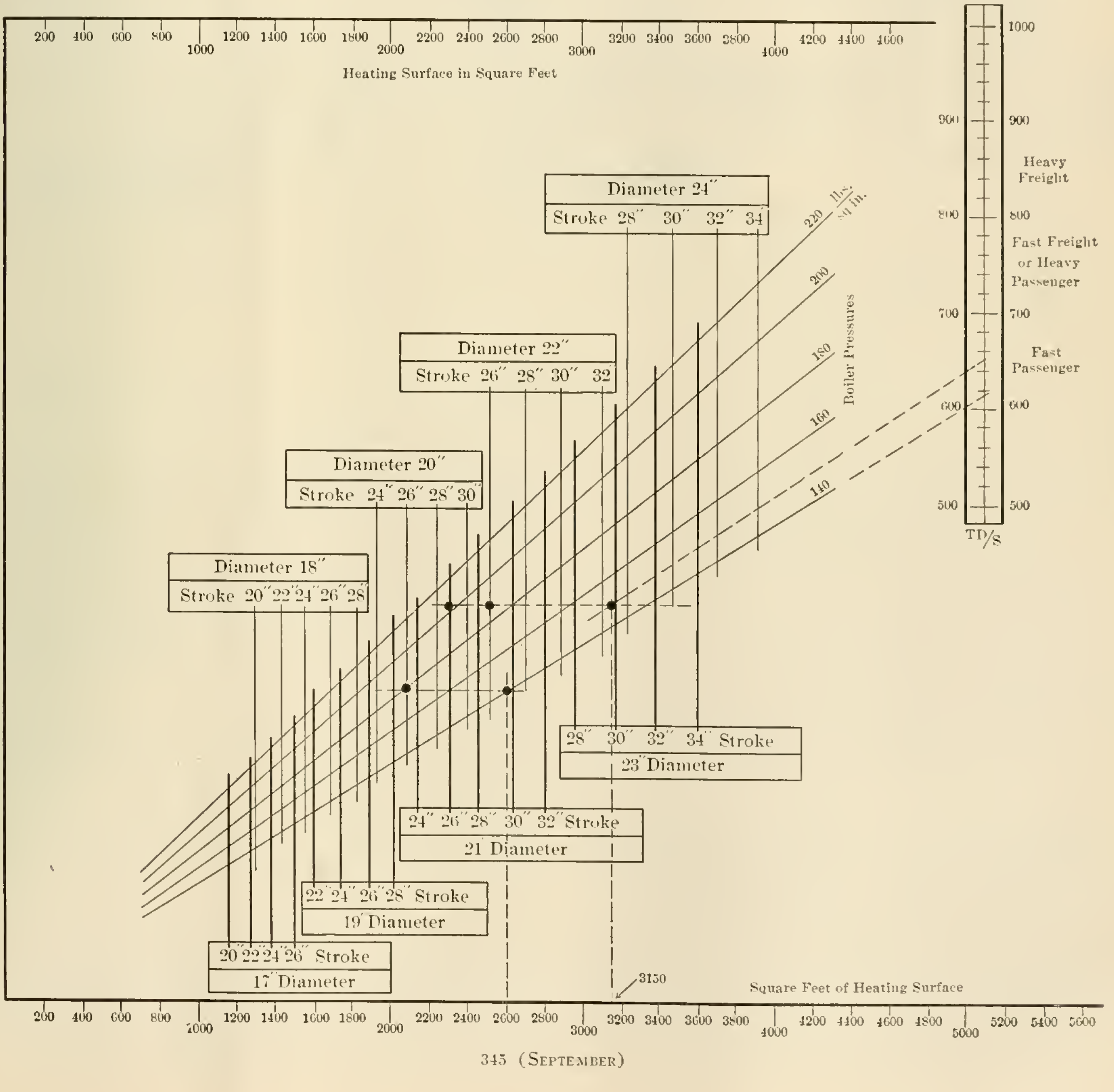
# A DIAGRAM FOR DETERMINING THE RELATION BETWEEN CYLINDER POWER AND HEATING SURFACE.

Lawford H. Fry.

In any study of locomotive proportions it is necessary to have some method of measuring the relation between the cylinder dimensions and the boiler heating surface, that is, between the dimension which governs the steam consumption and the dimension which governs the steam production. The present writer has pointed out on several occasions in the American Engineer that a simple and efficacious method of measuring this relation is to determine the value of the factor TD ÷ S, that is, the Maximum Tractive Effort (T) multiplied by the Driving Wheel Diameter (D) and divided by the Total Heating Surface (S), the dimensions being respectively in pounds, inches and square feet. It has been shown (American Engineer, October, 1907) that this factor is proportional to the number of foot-pounds of work developed per square foot of heating surface during each revolution when the engine is working at maximum power.

The diagram herewith has been designed to afford a simple means of determining the value of the factor TD ÷ S for any combination of cylinder dimension and heating surface. It will be seen that there are a number of vertical lines grouped to represent cylinders of various diameters and strokes, and across these run diagonal lines corresponding to various boiler pressures. The first operation is to find the intersection of the vertical and diagonal corresponding to the cylinder and boiler pressure under consideration. A circle indicates, for example, the point corresponding to cylinders 20 x 26 with 180 pounds per square inch pressure. Through the point thus found a horizontal line is drawn, and its intersection with the vertical corresponding to the heating surface is noted. Through this second intersection point a diagonal is drawn from the origin. This diagonal will show, on the scale at the upper right hand corner of the figure, the value of the factor TD ÷ S.

It is found from a study of American practice that the usual values of the factor TD ÷ S run from about 620 to 850, the lower values corresponding to locomotives for high speed service, and the high values to heavy slow speed engines. This enables the diagram to be used to determine the cylinder dimensions suitable for a given service. Suppose, for example, that in high speed service an engine is to develop 1,400 horse-power



and that we can count on about 0.46 horse-power per square foot of heating surface. The total heating surface required will be about 3,150 square feet, and a value of 650 may be assumed for the factor TD ÷ S. A vertical is drawn to correspond to 3,150 square feet and a diagonal from the origin through 650 on the TD ÷ S scale, and a horizontal drawn through the intersection. This horizontal will indicate the cylinder dimensions which fulfil the conditions, and in the case chosen we have a choice between 21 x 26 cylinders with 200 pounds pressure or 22 x 26 cylinders with 190 pounds pressure. Of course, large cylinders and lower pressures will give the same proportions, but would hardly be likely to be chosen in practice.

If the diagram is to be used frequently it should be mounted with a thread attached at the center so that it can be used to draw the diagonal to the TD ÷ S scale; or an even better plan is to mount a transparent celluloid arm to pivot about the origin, drawing a line along the arm from the origin.

## WEIGHING COAL FOR LOCOMOTIVES.

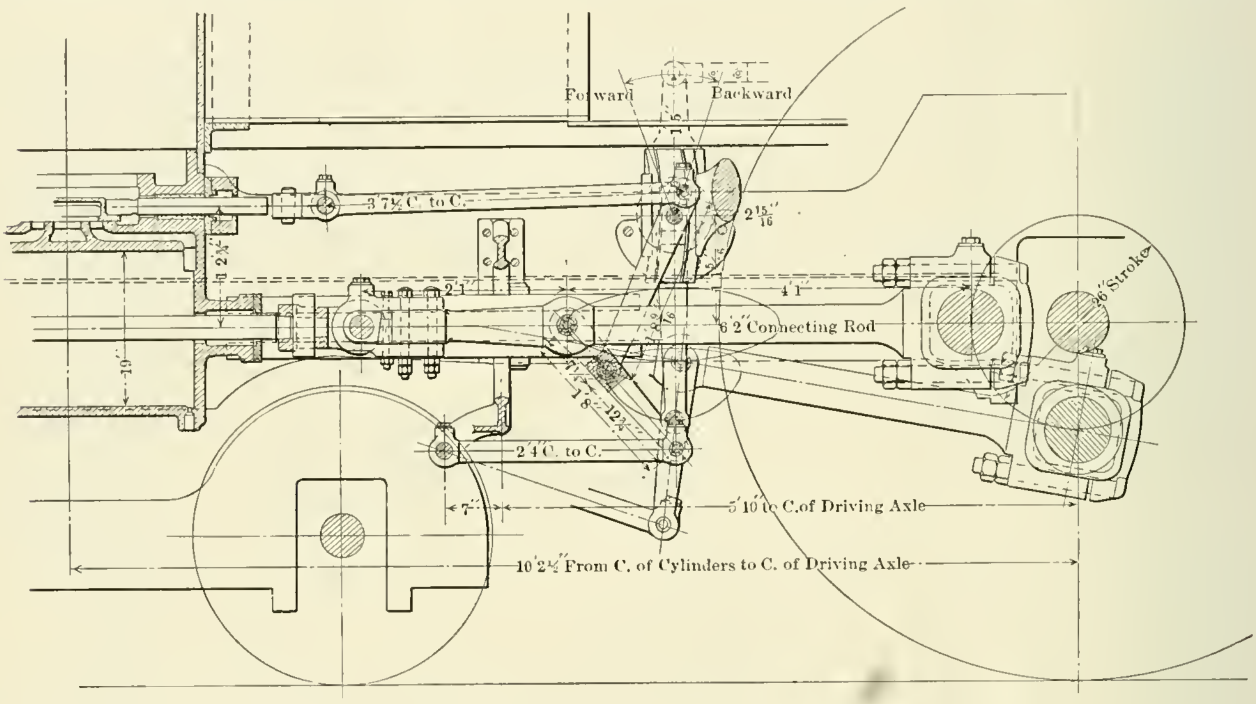
"It will be conceded that the most difficult side of the transactions is to obtain reports of the actual disbursements, as it is well known that this information is arrived at by most all roads on practically an estimated basis, on either the figured capacity of a coal bucket or other conveyance. It is found, however, from experience and actual test that the men in charge of coaling trestles become quite efficient in arriving at approximate actual figures of the number of tons of coal placed on each engine. From the number of engines that are coaled each day and from the fact that any discrepancies which exist at the close of the month are reported to him, he is receiving a training which fits him to be reasonably accurate in his daily records.

"Some roads have experimented with various devices for getting at the actual weight of coal placed on an engine. Such experimenting, it is believed, has been expensive and the results not permanent. It is a question, therefore, whether the expense involved in an endeavor to secure and use such a device would be in proportion to any better final results. It is thought, however, that the results which would be thus brought about could not vary from the results obtained from the system that has been outlined."—*From a Report on "Best Method of Accounting for Railway Fuel," to The International Ry. Fuel Assn.*

## JOY VALVE GEAR ON LOCOMOTIVES.

The Joy design of valve gear is of the radial type to which the Walschaert and Marshall designs belong, but differs from both of these in several important particulars. It has been used to some extent in marine practice both in this country and abroad, but has never met with much favor in locomotive practice except in England, where several companies have applied it to a number of locomotives, and one, the Lancashire & Yorkshire, to a very large proportion of its equipment. Practically its only use in this country on modern locomotive equipment has been in the case of a three-cylinder locomotive, where it is used for actuating the valve gear of the center cylinder.

This valve gear has all of the advantages of the Walschaert gear for locomotive use, and some features which make it more desirable than that type for this purpose. On the other hand, it has one primary fault, from a practical standpoint, that has been largely responsible for its non-adoption. This refers to the constant sliding of the block in the link, which presents an opportunity for rapid wear and lost motion at this important point, with a possible decided alteration in the valve events. The fact, however, that it has been for many years in successful operation on the Lancashire and Yorkshire Railway, being at present applied to over 1,000 locomotives, indicates that this difficulty can be overcome and the advantages of simplicity, constant lead, rapid opening and closing of the ports, which it offers can be taken advantage of.

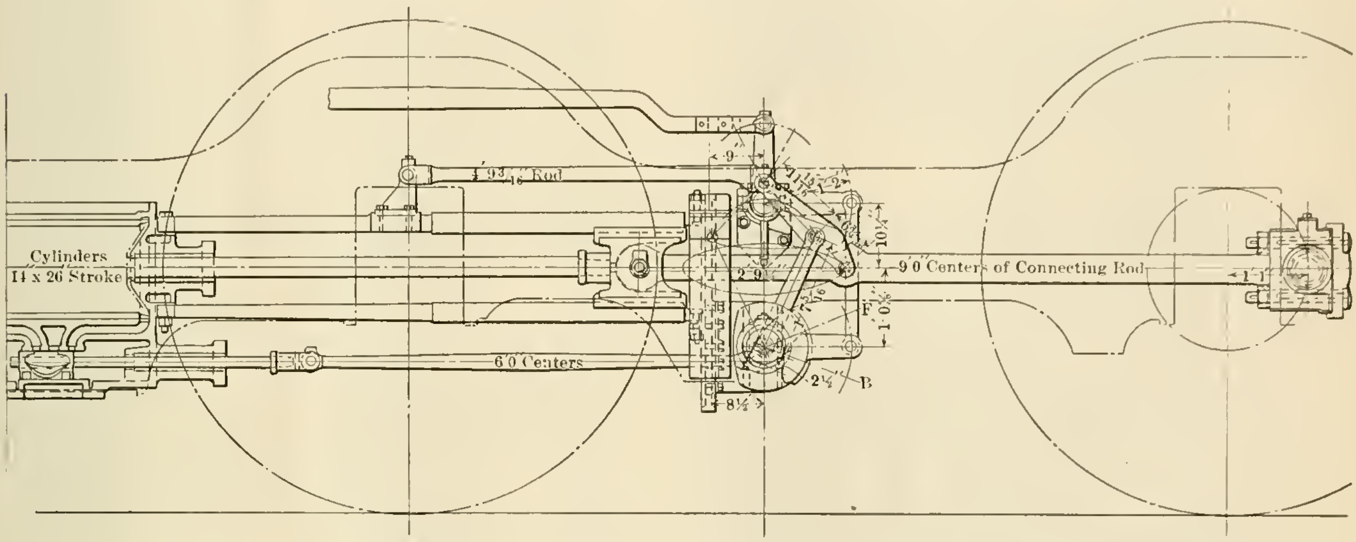



DESIGN OF JOY VALVE GEAR USED ON THE LANCASHIRE AND YORKSHIRE RAILWAY.

The illustrations show two arrangements of this valve gear in use on English railways, one being for a valve located below the cylinder and the other with the valve, in its customary American location, over the cylinder.

Referring to the Lancashire & Yorkshire design, it will be seen that the motion of the valve is all obtained from a connection on the main rod. A lever connected at this point has its lower end guided in a vertical arc by means of a link hinged to some stationary point, as the guide yoke. The upper end of this lever follows the path of an oval, symmetrical as regards the horizontal line, but slightly more pointed at the front end than the rear. The length of this oval is equal to the length of the piston stroke. Any point on this lever between the two connections will follow a distorted oval path and at a point, about one-third the distance from the main rod connection, is pinned a lever which extends upward and is connected at its upper end to a radius bar hinged to the valve stem. Just below this upper connection is a pin carrying a block which slides in a link, the radius of which is equal to the length of the radius bar. When this link is set in a vertical or mid position the travel of the valve is equal to twice the lap plus twice the lead, the same as in the Walschaert gear in the mid position. The inclination of the link from the vertical determines the amount of travel of the valve and the occurrence of the valve events, since the block must of necessity travel a vertical distance approximately equal to the vertical length of the oval followed by the lower end of the connecting lever the path of which is shown in the illustration and a slight inclination of the link will thus increase its horizontal travel very materially.

On the Lancashire & Yorkshire, where this type of valve gear has probably had its most extensive use on locomotives, it is found that with engines identical in every respect except the valve gear, the mileage between repairs was greater and the coal consumption was less on those having the Joy valve gear and it is now specified as the standard valve gear for all new locomotives. When the gear was first introduced on this road the locomotives had cylinders 17½ x 26 in. and a working pressure of 160 lbs. and the same design was maintained and has been used on engines with 21½ in. cylinders and a pressure of 180 lbs. On larger locomotives, however, it was found that it was necessary to strengthen the pins and levers, which has now been done, although the same centers of links, etc., are still maintained. That road now has 1,004 out of 1,517 locomotives equipped with the Joy valve gear.




JOY VALVE GEAR USED ON THE LONDON AND SOUTHWESTERN RAILWAY.

BUYING COAL ON A HEAT VALUE BASIS.—The United States Geological Survey has just published a bulletin (No. 378) containing a discussion by John Shober Burrows on the "Results of Purchasing Coal Under Government Specifications." Among other things it describes the general plan followed and its advantages; the form of the specifications for both anthracite and bituminous coal are reproduced and a list of the contracts for the present fiscal year are given. The method of reducing the proposals to one common basis for comparison is also carefully described. Results of buying coal under these specifications for the fiscal year of 1907-8 are shown in a series of tables. The latter part of the bulletin, prepared by D. T. Randall, considers the "Burning of Small Sizes of Anthracite for Heat and Power Purposes."

HIGH SPEED DRILLS.—It is my experience that the high speed drill situation comes down to the question of which one will last the longest. Speed does not enter to any extent, as they will all stand a reasonably high speed without burning, but if they break too easily we quickly lose more than the equivalent saved on the output of work from the machine.—*A Foreman.*

## BRIQUETS ON EUROPEAN RAILROADS.

Practically all of the European railroads use briquets and the quantity varies from 15 to 40 per cent. of the total coal consumed. The briquets for railway and steamship use are prismatic in shape. The French navy specifies 22-pound briquets. These briquets are broken before firing, and if well made will break into pieces without making dust. The railroads use briquets not to exceed 11 pounds in weight, which are fired one or more at a time by hand. Storage fuel is usually in the form of briquets; they are carried on the tanks along with coal and generally used to get up steam, to make up time, or over heavy grades during the run.

The specifications to contractors furnishing briquets to the state railroads on the continent are very rigid, particularly in France. These specifications vary somewhat in the different countries, but are covered generally by the following items:

1. Briquets shall be well made, sonorous, entire, with sharp edges, breaking with a clean cut, brilliant and homogeneous fracture.

2. Their cohesion shall be not less than 55 per cent. and they shall not soften at 50° C.

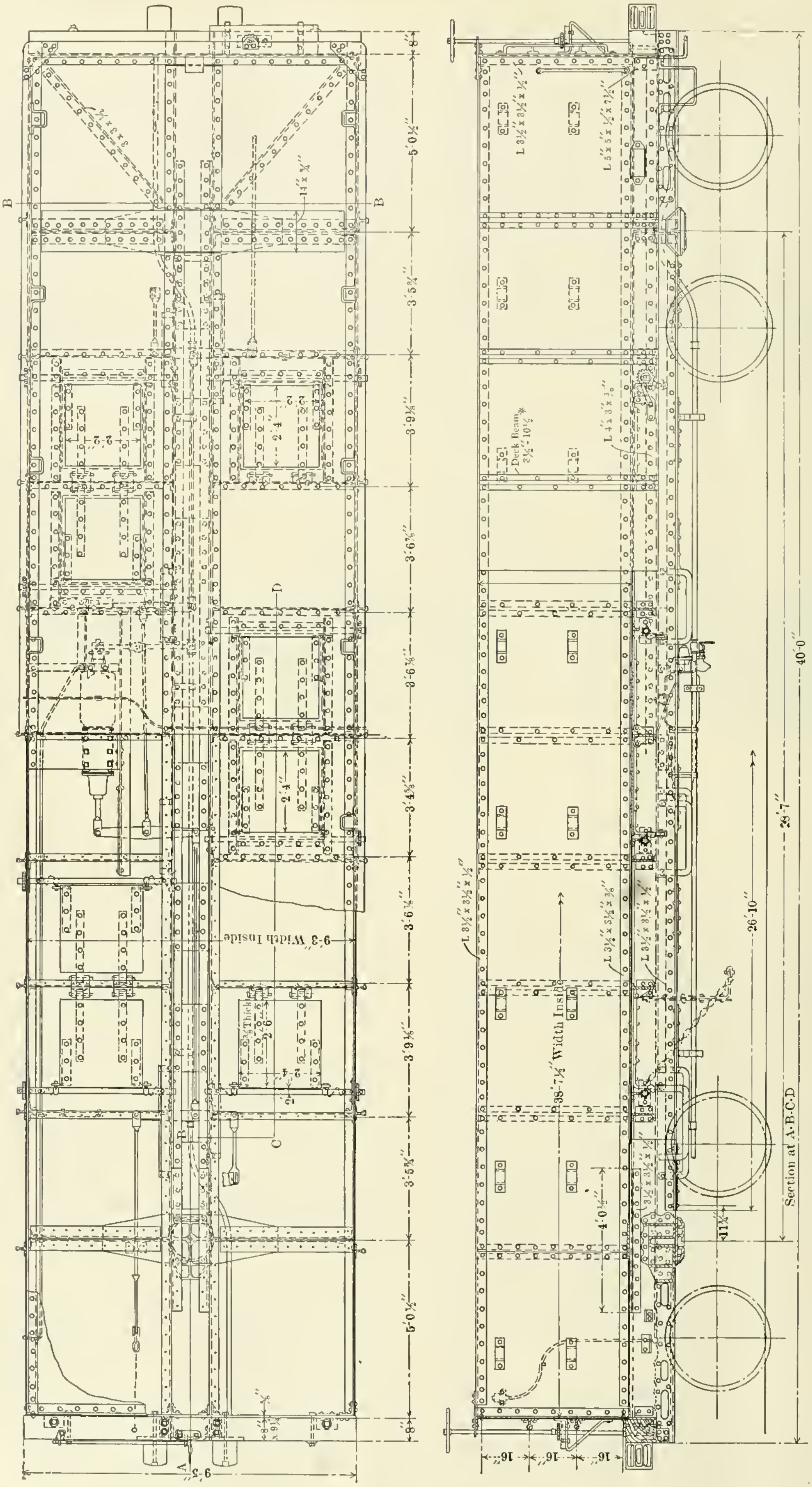
3. The briquets shall ignite easily without causing dense black smoke, shall burn with a quick bright flame and be consumed without disintegrating. The slag or clinker shall not adhere to the grates or tube sheets.

4. The briquets shall not be hygroscopic nor contain more than 4 per cent. moisture. They shall contain between 15 and 22 per cent. volatile combustible, and not more than 11 per cent. ash. The coal shall have been freshly mined and free from sulphur.

5. Coal tar pitch is the only binder specified; it must be practically odorless and limited to 10 per cent.

6. The briquets must be prismatic with a square base; when specified they are from 3 to 11 pounds in weight, according to kind of coal used, with a density of from 1.13 to 1.21.—*C. T. Malcolmson before The International Ry. Fuel Assn.*

FIRE LOSSES IN UNITED STATES.—In the last five years, the total fire losses in buildings in the United States amounted to a billion and a quarter dollars. This was due mainly to the combustibility of the timber construction employed and might have been largely prevented by the use of suitable chemical fire-proofing compounds. In 1906, we spent $650,000,000 in building operations and the total cost of our fires was $500,000,000 and 6,000 human lives. In all the United States there are about twelve million buildings, in only about 8,000 of which has any serious attempt been made at fire prevention.—*M. T. Bogert, Presidential Address, American Chemical Society.*

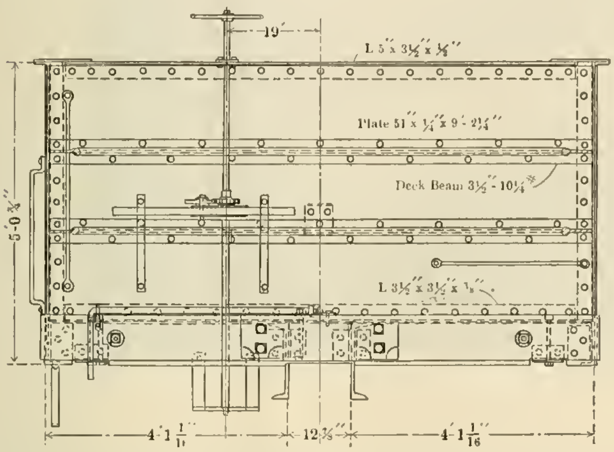



FIFTY-TON STEEL GONDOLA CAR WITH DROP DOORS—NORFOLK AND WESTERN RAILWAY.

# FIFTY TON STEEL GONDOLA CAR

NORFOLK & WESTERN RAILWAY.

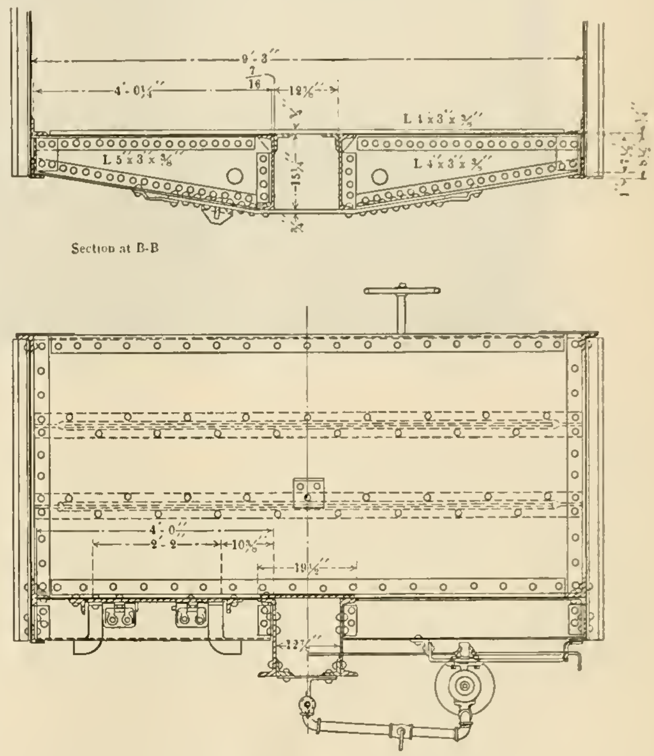
The Norfolk & Western Railway has recently designed a 50-ton steel gondola car, 300 of which are to be built at its Roanoke shops. Except for a few minor changes these cars will be similar to the sample car that has already been built, and which is shown in the accompanying drawings. While the sample car was under construction four drop doors were added, so as to allow for a greater discharge opening. To do this the location of the brake cylinder was changed slightly to admit of two doors being placed on that side of the car, while the additional doors on the other side were placed at the center of the car. This makes the floor of the car unsymmetrical as far as the drop doors are concerned. The car measures 40 ft. over the end sills and has the following inside dimensions: Length, 38 ft. 7½ in.; width, 9 ft. 3 in., and height, 4 ft. 4 in. One-quarter-inch plates are used for the sides, ends and bottom of the car.



END ELEVATION OF 50-TON GONDOLA.

The stakes on the sample car were made of Carnegie tee section, but on the remaining cars will be made of 3½ in. deck beams, as it is much easier to drive rivets in the deck beams. The sides are reinforced at the top with 3½ x 3½ x ½-in. angles and at the bottom on the inside by 4 x 3 x ⅜-in. angles. In addition 3½ x 3½ x ⅜-in. angles are used for connecting the floor to the sides. The ends are stiffened by 5 x 3½ x ½-in. angles at the top and by two deck beams, as shown.

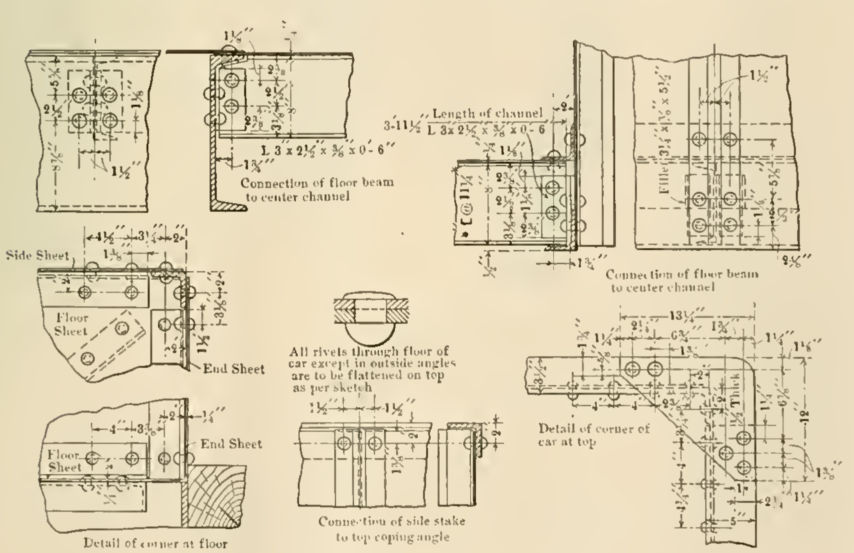
The center sills are 15-in., 33-lb., channels, with a top cover plate 5/16 in. thick. They are reinforced at the bottom between the bolsters by 3½ x 3½ x ½-in. angles. It will be seen that where the top cover plate is cut away at the bolster the sills are reinforced at the top by 3½ x 3½ x ⅜ in. angles. The body bolster is built up of plates and angles, with a heavy casting between the center sills. The cover plate of the bolster is ¾ of an inch thick by 14 in. wide; the bottom plate is of the same thickness, but only extends up about half-way between the center and the side sills. The bolsters have been made especially strong, as it is expected that the major portion of the load will be transmitted to them through the deep plate girders which form the sides of the car and which, owing to their stiffness, will probably carry the larger part of the load. The floor stiffeners between the center and side sills are channels, fastened to them by angle plates.




CROSS-SECTIONS AT BOLSTER AND CROSS-BEARERS.

In the cars that are to be built there will be some minor changes in the rivet spacing to more readily suit the multiple punches; also in the location of some of the handholds, brake staffs and stake pockets to facilitate handling the material in the course of manufacture.

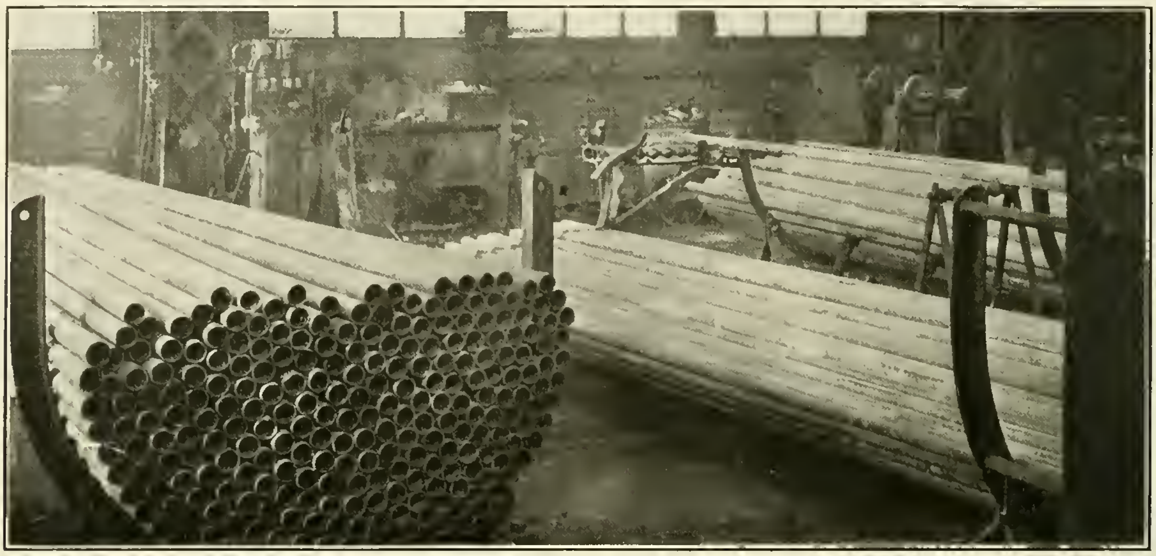
Among the specialties that will be used are Session's draft gears, Farlow draft attachments, Westinghouse air brakes; cast steel truck bolsters, Andrews cast steel side frames and Plastic bronze journal bearings. A portion of the cars will also be equipped with Kensington journal boxes. These cars will be known as class GJ and were designed by the railroad under the direction of W. H. Lewis, superintendent of motive power, and John A. Pilcher, mechanical engineer.




STRUCTURAL DETAILS—N. & W. GONDOLA.

## AN EFFICIENT FLUE PLANT.

The horning, safe-ending, welding and swaging of 500 flues is considered an ordinary 9 hour day's work for two men, using but one furnace, in the flue department of the Lake Shore & Michigan Southern Railway shops at Collinwood. The general arrangement of this department is shown on one of the drawings. The flues are rattled and cleaned just outside the door to the right. They are then brought in and piled on the flue horses and the fag ends are cut off by the abrasion saw shown in the background, at the right, in the photo.

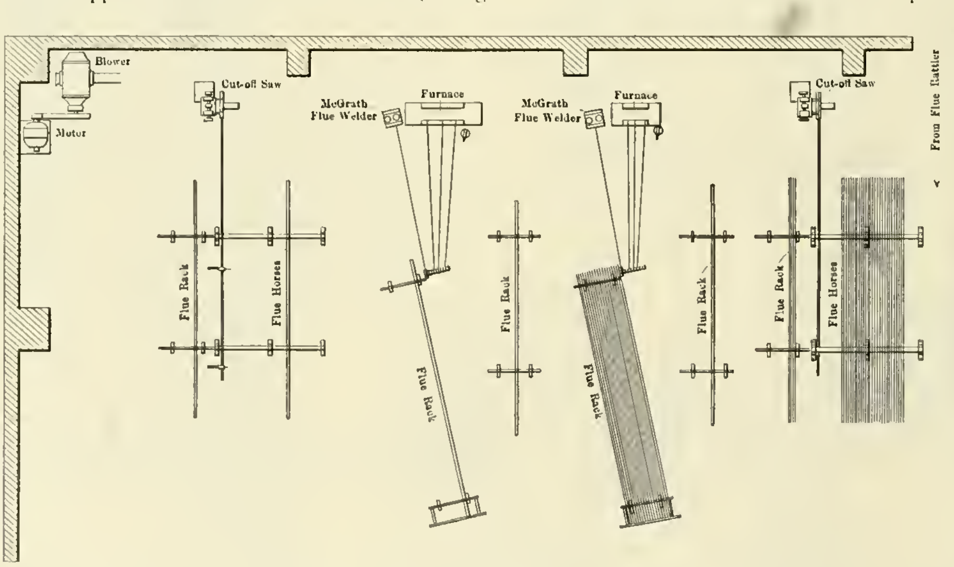


PARTIAL VIEW OF FLUE HANDLING PLANT AT COLLINWOOD SHOPS.

The construction of the abrasion cut-off saw is shown on one of the drawings. The cutting wheel is of tank steel 3/32 in. thick and 18½ in. in diameter. It is driven by a 10 h.p. motor through gearing and a belt drive, as shown, and revolves at the rate of 4,280 revolutions per minute. It cuts the flue by abrasion, doing it quickly and satisfactorily. The end of the flue is placed on the rest to the left of the wheel and revolves on the two rollers. The framework which supports the rest is forced inward, bringing the flue in contact with the cutting wheel, by admitting air into the cylinder which is made of a piece of 3¼ in. seamless brass tubing, No. 11, B.W.G., 12½ in. long. The air is controlled by the ½ in. cock. When pressure is removed from the lever which operates this cock it is brought back to its initial position, closing the cock and releasing the air, by the 9 in. coil spring attached to the frame of the machine and by the coil spring in the air cylinder.

As the fag ends are cut off the flues are piled in a rack from which they are transported by a traveling crane to the rack nearer the welding machine. The assistant welder picks the flue from this pile, heats it in the furnace, bells it on the horn and applies a safe-end. It is then placed in the center hole of the furnace, retaining the heat left in it after horning. The welder places it in the extreme left hole—the one nearest the hammer—and after bringing it to a welding heat, welds it in a McGrath welder, and while still hot swages it to the proper size. The flue is rolled backward and slides into a rack. The details of the front of this rack with the rollers which support the ends of the flues while they are being worked is shown on one of the drawings; also the roller and the guide at the edge of the rack which guide the flues to place when they are finished. The rear end of the flue rack is similar to the front part, except that there are no rollers and it is backed up by a ¼ in. plate to keep the flues from sliding too far backward.

The duplicate set of machines and apparatus at the left is used at times when an increased output is necessary. It is also used for 2¼ in. flues and for stationary boiler flues for outside points.




PLAN OF FLUE HANDLING PLANT AT COLLINWOOD SHOPS.

LEAKY GASOLENE TANKS.—These can be temporarily repaired by the use of common yellow soap. Gasolene will not affect soap and if the latter is merely pressed into a leak the opening will be effectually closed. In the absence of shellac, soap is good to use in making up gasolene-pipe joints.—*Nautical Gazette.*

## HOW TO SUCCESSFULLY BURN COAL IN A LOCOMOTIVE.

T. E. Adams, superintendent motive power of the St. Louis & Southwestern Railway (Cotton Belt) presented a paper on this subject before The International Railway Fuel Association, from which the following extracts are taken:

"It has been my privilege in the past twenty-five years, during a scientific and practical investigation of the coal question, to use coal from the following States: Pennsylvania, Ohio, Indiana, Illinois, Kentucky, Tennessee, Arkansas, Oklahoma, Iowa, Montana and Washington; and notwithstanding the wide territory from which the coal was taken, the different grades used and the variance of opinions to the contrary, *it has been demonstrated beyond a doubt that the impurities in coal do not necessarily fill up the firebox with an accumulation of ash, or produce clinkers, if the coal is properly fired,* although it is true some coals take more careful handling than others to bring about the required results. These principles will apply to any of the fuel coals now in use.

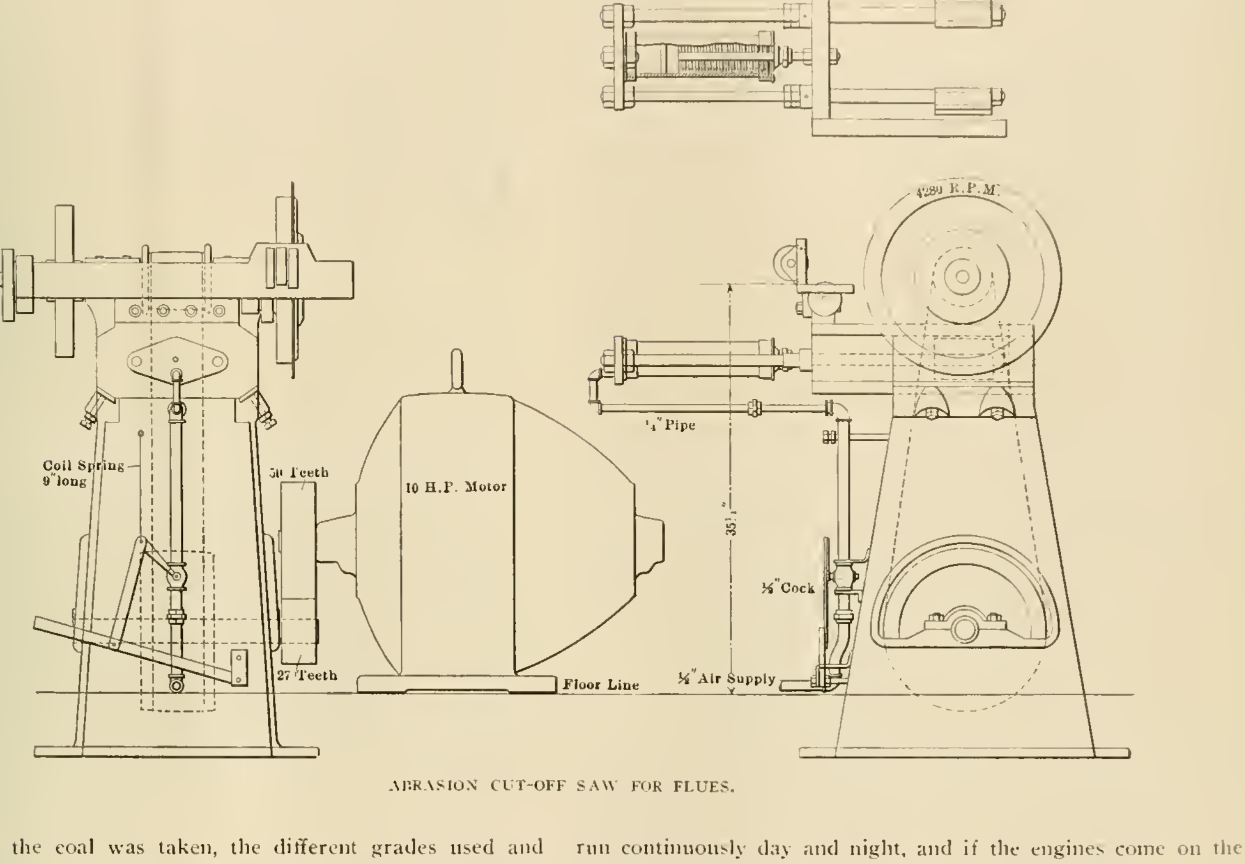
It may be of interest to the members of this association to have me in a few words outline our policy. The first important step that was taken in my own experience as a locomotive engineer was to eliminate under all conditions the excuse of "poor coal," the character of the coal not being considered. I consider this the first step in the line of progress, and this, with other important methods, has been followed up to the present time and it is unnecessary for me to say that the improvements made on the line with which I am associated are a great source of satisfaction not only to the management but to the enginemen in general.

The clinkering of coal is due to the manner in which it is handled and not to the quality of the coal. It therefore must be understood by foremen in charge of engineers, hostlers, etc., that they must understand the principles upon which the desired results may be obtained. At the several different places where switch engines are in use the business requires that they run continuously day and night, and if the engines come on the cinder pit with badly clinkered fires it causes serious delay to have them cleaned. In order to avoid this, it is necessary for engineers and firemen to understand that if the proper depth of fire is established on the grate when the fire is new, it will not be clinkered from this cause. Enginemen should be instructed that fires must not be shaken, when the fire is light, to prevent clinkering.

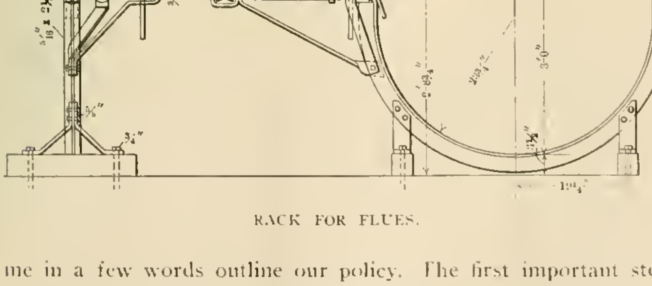
Engineers, hostlers, firemen, etc., should all understand that when an engine has run an unusual length of time without the fire being cleaned and the idea of not shaking grates has been carried out and the firebox has become filled with ashes and more or less unburned coal, it does not necessarily demonstrate that the fire is in bad condition and should be cleaned, but on the other hand it should be shaken down to a depth of eight or ten inches, ash pan cleaned and the engine continued in service; and if the matter is handled in this way the condition of the fire on the grates will be much better than if it had all been cleaned out and a new fire established.

If the weather is at freezing point or colder, and the train is an unusually heavy one in freight or passenger service, they should understand the necessity of building the fire on the grate surface so that the required steam pressure will be maintained.

In case after leaving the terminal, when the fire has been prepared in the manner suggested, the engine does not steam freely, grates should not be shaken for the reason that there is more liability of fire on grates not being heavy enough to main-




ABRASION CUT-OFF SAW FOR FLUES.



RACK FOR FLUES.

tain the required steam pressure, or possibly not being spread over the entire grate surface, such as front corners and under flue sheets, etc. If the grates were shaken it would have the effect of rather increasing the difficulties instead of overcoming them.

Enginemen should understand the importance of these instructions, as they are the fundamental principles of the art of firing, which have been demonstrated beyond a doubt: that where an engine lags for steam it is due to the condition of the fire in the box and in almost every case the fire is either not distributed properly over the grate surface or it is entirely too light to suit the condition under which the engine is to be worked. The principal thing to be understood in developing steam in a boiler freely is that the fire on grate surface must be maintained so that the air passing through it will be heated to a proper temperature.

## THE HANDLING OF LUMBER IN THE YARD.

The following notes are taken from a paper on the treatment and handling of lumber presented by Hermann Von Schrenk before the Railway Storekeepers' Association: "Knowing that lumber is liable to check, warp, twist and rot, the question is how should it be handled in order to prevent these changes and to get it into the best possible condition for storage. The most important item is to dry the lumber evenly and as quickly as possible. This is done generally in the yard, and I now propose to devote a few minutes to the establishing of a yard and the manner in which lumber should be piled in order to dry it to the best advantage.

"Before placing lumber in a yard, as level a tract of ground as can be found should be selected. This should be well drained, and wherever possible, should be covered with some inert ballasting substance, preferably cinders, so that the growth of grass and weeds may be prevented as far as possible. All rubbish in the shape of old sticks, etc., should be carefully removed and kept removed. The ideal yard is the clean yard, and it is in such a yard that the best and least defective lumber is found. In laying out the yard a series of alleys should be planned, and wherever possible, these should be so constructed that the alleys run in the direction of the prevailing winds, and not at right angles to the prevailing winds, as is frequently the case. The yard should then be divided into a portion for piling, another for ties, stringers, caps, sills, etc., and another for building lumber, etc. In other words, the different classes of material should be kept separate as far as possible. Not only is this important because of the different kinds of woods used, and the different kinds of material, but it also facilitates counting and keeps the yard in a better condition.

"All material should be piled on permanent foundations. These foundations should, as far as possible, be decay-proof. In all of the tie and lumber yards recently constructed on the Rock Island and Frisco, we use nothing but creosoted stringers. We used for this purpose culled ties or culled bridge material, which was not fit for track use or for bridge construction. We treat these cull ties in the treating plants and lay them on the ground. This keeps the new material off the ground and renders any infection impossible. We put some of these creosoted stringers on the ground and then one pile across these stringers. The important part is that no untreated material is in contact with the ground. Instead of using creosoted stringers, one can make use of pecky cypress, which in the Southern States has been found to be one of the most valuable and essential timbers for this purpose.

"In laying out the yard attention should be given to the matter of fire protection. In addition to the longitudinal alleys, frequent alleys at right angles should be left, and these likewise should be permanent. It is far better not only from the standpoint of fire protection, but also for drying purposes to build small individual piles of all classes of material, than to bunch it in large piles where the fire danger would be greater and the drying more uneven. In our tie yards we are now building small piles both of ties and piling and also lumber. Between each pile we are leaving a space of at least four feet, and these spaces extend clear across the yard. We mark the rails of the standard and narrow gauge tracks, which extend up the longitudinal alleys, with paint, so that we know where the center of each pile is located and where the alleys are. When one pile of material has been used, the stringers are left on the ground, and when new material comes in, it is placed on the old stringers in exactly the same position in the yard. This insures permanency in the construction of the yard, and I can assure you that we are finding it of the utmost advantage. After the yard has been laid out, we are ready to pile the material. Certain general principles will apply to all classes of material; that is, ties, lumber, stringers, piling, etc. Remembering that we wish to get rapid and even drying, and remembering furthermore that where two timbers touch a weak place will be created where the fungi will flourish, it will readily be seen that the first principle in piling is to construct piles which are as open to air circulation as possible, and where the individual pieces will be in contact with one another to the minimum degree. The subject is too large a one for me to give specific directions as to the piling of the different kinds of material, because slight variations are necessary, depending upon the kind of timber and the climatic conditions involved.

"In spite of the most careful planning, however, some pieces of the timber will split and check. I have for years been recommending the use of S-irons for all classes of material. These are extensively used abroad and to some extent in this country. They consist of bevel strips of iron bent in the shape of the letter S. These are driven in at right angles to the check which is just beginning to form. As these S-irons are very cheap they ought to be used much more extensively.

"A well run yard is one in which great care and attention is paid, not only to keeping the material properly piled, but where all defective material is removed and destroyed. Pieces of wood lying around on the ground are constant sources of serious infection for the good material. Any expense incurred in keeping the yard clean is the cheapest kind of investment. I always insist that inspectors in lumber yards must have microscopic vision, that is, they must realize constantly that fungus spores are everywhere present in the atmosphere in countless millions, and are ever ready to pounce upon material at every favorable opportunity. We try to train our inspectors to recognize their greatest enemy in a punk or toadstool on a piece of material, and I think most of them realize by this time that the rubbing off of such punk or toadstool by no means lessens the danger, because new fungus will grow out from the same spot in short order, and the only way to get rid of the infection is to remove the diseased stick.

"Summing up the foregoing, please to note that lumber is liable to decay, warp, check, etc., that the object of putting lumber into a yard is to dry it so as to get it into fit condition for use, and at the same time to get it into a condition where it can be kept. In order to do so you must build a yard where all the conditions are such that the lumber can dry out evenly and quickly and remain free from infection. This means care in the construction of the yard, drainage, ballasting, and above all, cleanliness."

RAILROAD Y. M. C. A.—There are now 245 associations, which own 178 buildings worth $3,569,200. These figures are constantly increasing. In 1907 and 1908 there were twenty-six new buildings erected at a cost of over $750,000. On the New York Central Lines there are forty associations. On the Pennsylvania Lines, East and West, there are thirty-six. The Grand Trunk Railroad has fourteen; the Boston and Maine, ten; the Chesapeake and Ohio, nine; the Norfolk and Western, eight; the Gould lines count twenty-seven among its valuable items of successful operating features. One or more branches are on as many as sixty-three different railroad lines throughout the United States and Canada.—*H. O. Williams before the Richmond Railroad Club.*

# HEAT AND WATER CONSERVING SYSTEMS FOR CLEANING AND WASHING OUT BOILERS

J. E. Epler.

Water in a locomotive boiler becomes foul or dirty as continued evaporation concentrates the impurities fed in with the feed water. As a result boiler washing and refilling is necessary at intervals varying with the amount of impurities in the feed water.

Cold water may be used for washing and filling though a liberal supply of hot water is much better, as by its use boilers can be emptied, washed and filled without causing destructive cooling and expanding strains. Terminal delays are reduced 2½ to 3 hours when washing out and washouts are materially less in number, as frequent water changes take their place. Changing water in a locomotive boiler may be accomplished in less than two hours and engines can always leave the house with clean water in them, thus reducing delays on the road due to foaming.

A thorough and careful washing with cold water proceeds about as follows:

Boiler is cooled down by feeding cold water into it, requiring, 15,000 gal. water, 1½ hr.
Boiler is emptied.......................................................½ hr.
Boiler washing gang removes plugs, washes boiler and replaces plugs, 2,000 gal. water, 2 hr.
Boiler is filled with cold water.......................3,000 gal. water, ¼ hr.
Fire is built and steam pressure raised to working point....2 tons coal, 2hr.

Total ..........................20,000 gal. water, 6¼ hr. 2 tons coal

The possible savings by using hot water for washing and filling are:

No cooling necessary, thus saving................15,000 gal. water, 1½ hr.
Actual operation of washing can be accomplished with less water in less time, saving...............................1,000 gal. water, 1 hr.
Coal for firing up and time required reduced by..........1 ton coal, 1½ hr.

Total...........................16,000 gal. water, 3½ hr., 1 ton coal

The value of hot feed and wash water is sufficient to warrant the burning of fresh coal to produce it. If, however, the heat, ordinarily thrown away when an engine is cooled down and emptied, is saved, it will be sufficient to heat the water used for refilling, and the dirty water, after imparting a part of its heat to the fresh feed water, is itself available and satisfactory for washing out purposes.

### Methods of Saving Heat.

The methods in common use for saving the heat in the boilers of incoming engines so that it may be used in the boilers of outgoing engines are as follows:

*First*—Discharging the contents of the boilers of incoming engines into a hot well.

*Second*—Condensing the steam rising from the foul water blown off from incoming engines by bringing it in direct contact with sheets of fresh water flowing over the trays or baffle plates of an open heater.

*Third*—Transferring the heat through the tubes or coils of a heater, the steam and water from incoming engines being blown through the heater on one side of the tubes and the fresh water to be heated passing through the heater on the other side.

### Hot Well Receiving Steam and Water.

The simplest method is to blow the entire contents of the boiler into a hot well. This is not very satisfactory, as the same foul water, partially diluted, will be pumped back into the engine when re-filling. The water lost in leakage and that used for washing must, of course, be replaced by fresh water in the well.

When this method is used connection must be made to the blow-off cock and the boiler's contents are discharged into a pipe, encircling the roundhouse, which empties into the hot well.

*Heat Available.*—The saving of heat is the amount of heat in the water discharged when cooled down to 212 degrees. All of the heat above 212 degrees passes off from the hot well in the steam rising from its surface. This method would furnish the supply of wash and feed water at 212 degrees if it was not for radiation losses.

### Hot Well Receiving Steam Only.

As the hot well receiving the entire contents of the boiler is not satisfactory because of using the same foul water over again the practice is sometimes followed of blowing the steam only into the hot well. When this is done it is customary to pipe the roundhouse so that connection is made at the dome of the engines to an overhead pipe which circles the house and discharges under the surface of the water in the hot well. This is inconvenient, as it it necessitates climbing up to the engine dome to connect and disconnect. After the engine has been blown down the water in it runs into the pit and thence to the sewer, a process which fills the roundhouse with steam, making it damp and unpleasant and also preventing the mechanics and others from getting at the machinery and running gear while the water is being emptied out.

*Heat Available.*—Most of the heat carried off in the steam is saved. The amount of this depends upon the boiler pressure, or the temperature of the boiler when blown off. If the engine commences to blow off at 100 lbs. pressure the temperature of the water in it is 337.8 degrees. Steam will pass off until the temperature of the water in the boiler reaches 212 degrees. A fair-sized locomotive boiler contains 3,000 gallons, or 25,000 lbs. of water. The heat saved by the above method would then be 25,000 multiplied by 125.8, or 3,145,000 B.T.U. With the initial temperature of the feed water at 65 degrees, this heat will raise 3,000 gallons, or one boiler full, to 190.8 degrees.

### Open Heater With Tank Separator.

Another method of obtaining hot water for filling and washing is to discharge the entire contents of incoming engines into a tank or separator from which the steam rises and goes to an open heater and the water in the separator is saved for washing purposes. This system is more desirable in the roundhouse than the system of blowing steam into the well, as the connection to the engine is made at the blow-off cock, a much more accessible point than the dome. The entire contents of the boiler are discharged through this connection into a pipe encircling the house which leads to the tank in which the steam separates from the water.

*Heat Available.*—This method is better than the simpler method of blowing the steam only into the hot well, as the hot water left in the separator is available for washing. The heat saving, however, is not as great as in the method where both steam and water are discharged into a well so constructed that radiation losses are small.

### Closed Heater.

With the closed heater the heat in the foul water is saved by transferring it through tubes or coils in which the foul water is on one side of the tubes and the fresh water to be heated is on the other side. In this system one connection is made to the engine at the blow-off cock by means of a flexible hose and the entire contents discharge into a pipe encircling the house and emptying into the heater. This method possesses all the advantages of the others, such as accessibility to the engine, dry roundhouses, etc. It also has a further advantage in that a greater amount of heat may be saved than with an open heater.

Any system using only the steam for heating can only use the heat given in cooling down to 212 degrees. A closed heater system can carry this cooling of the hot foul water to a much lower degree. In fact with a suitable design of heater, the transfer of heat can be carried on until the foul water is cooled down to the temperature of the incoming feed water. The desirable point to stop, however, is at 130 degrees, about the maximum temperature the washout men can handle. After cooling down to 130 degrees by the transfer of the heat to the incoming feed the foul water is drained into a storage tank and is available for washout water without the necessity of adding cooling water to temper it to a point where the washout gang can handle it, as must be done with open heater systems which discharge the foul water into the washout storage tank at a temperature of 212 degrees.

*Heat Available.*—The amount of heat available for heating feed water with this system, assuming as before that the engine is blown off at 100 lbs. steam, or 337.8 degrees Fahr., and that the water blown off is cooled in the heater to 130 degrees is 207.8 B.T.U. per pound of water blown off. This will amount to 207.8 times 25,000, or 5,195,000 B.T.U., or more than enough to raise 3,000 gallons of feed water from 32 degrees to 212 degrees.

*Tempering Water to Cool Wash Water.*—With the open method the foul water goes to the wash storage tank at 212 degrees, necessitating cooling this 82 degrees by the introduction of cold water before it is at a temperature such that the boiler washers can handle it. This is an item of expense not necessary with a closed heater system which cools the foul water to wash water temperature in passing through the heater.

RESULTS AND COST OF INSTALLATION.

As to the cost of installation of these three methods. The first hot well is without doubt the cheapest to install. The last or closed heater is the most expensive and gives the best results, as it possesses all of the desirable features of the other two, and in addition is more economical as a heat conserving device.

At a roundhouse where 400 engines were handled per month a closed heater method showed $11.45 per day as the value of coal and water saved. This is $343.50 per month, or $5,322 per year. At this rate it is evident the saving will soon pay for the plant.

The other savings, such as quicker turning of power, increased life of fireboxes, reduced boilermaker wages, cleaner roundhouses, etc., are much greater than the saving in coal and water These savings, though very real, are not easily reduced to dollars and cents.

## WELDING BOILER TUBES TO THE TUBE SHEET.

TO THE EDITOR:—

Probably the most important factor in causing the bridge walls of the tube sheet to crack is the use of the flue expander or roller. In order to keep the joint tight, even with the use of copper ferrules, the metal of the flue sheet must be strained beyond its elastic limit next to the tube, and this process repeated many times causes incipient cracks, which under the stresses due to the heat of the furnace, ultimately results in the entire disruption of the metal between the tubes. The use of the expanding tools is rendered necessary because of leakage of the flues, and therefore if we are able to secure and maintain tight joints without the use of the expander, and without straining the metal at this point, it would seem that the life of the sheet would be increased, and the troubles due to leaking tubes obviated.

Since the oxy-acetylene process of welding has entered the railroad field, I have looked in vain for a description of the method of using this process to weld the tubes to the tube sheet. While radical, this seems to me to be entirely feasible, and I understand is being used at least experimentally at some points. In studying the subject I have evolved the following method of welding the tubes and propose a means of removing them when necessary on account of scale, which would leave the hole the exact size for the insertion of the new tube, and also prepared for the welding-in process, all in one operation.

Referring to the sketches, Fig. 1 shows the tube sheet with the hole drilled and the fire side counterbored at the desired angle (say 45 degrees) for about one-half the thickness of the plate, to allow clearance for the welding process. Fig. 2 shows the tube inserted, with the end flush with the fire side of the sheet. Fig. 3 represents the tube welded into the sheet, the dotted portion being the filled-in part of the weld. If properly done this should give a homogeneous structure throughout the welded portion, the surface of the tube and of the sheet being fused. This should prohibit all leakage at this point. It will be noted that there are no projections to be burned off by the furnace fire.

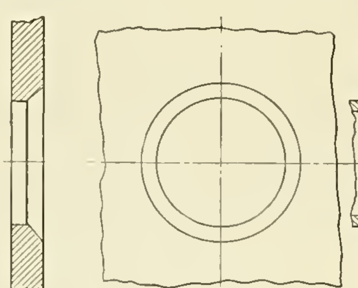


Fig. 1

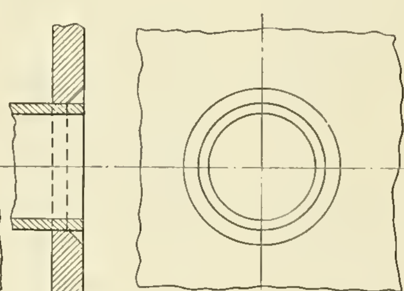


Fig. 2

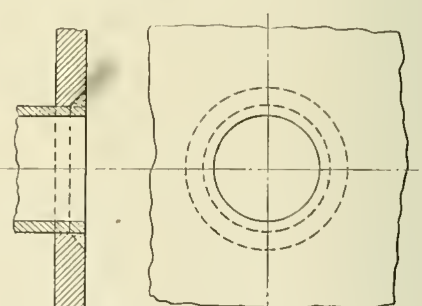


Fig. 3

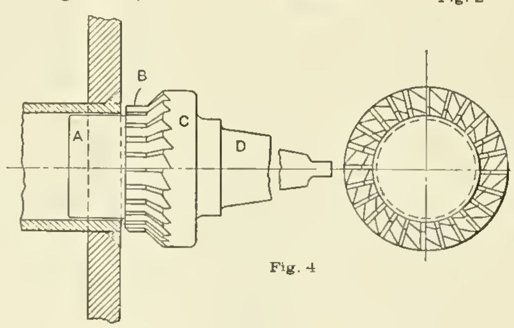


Fig. 4

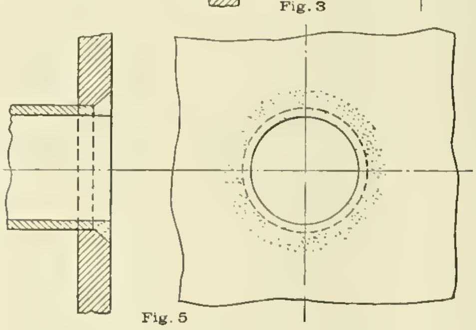


Fig. 5

TESTS OF BRIQUETS.—The most representative tests, and therefore the most accurate expression of what may be accomplished with well made briquets, are the tests made on the Rock Island and Missouri Pacific Railroads with Oklahoma and Kansas coals. The Rock Island tests show an increased equivalent evaporation of 8 per cent. and increased boiler efficiency of about 15 per cent., while the Kansas briquets show 25 per cent. increased evaporation and boiler efficiency over lump coal.—*C. T. Malcolmson before The International Ry. Fuel Assn.*

In order to remove the tubes for cleaning, the tool shown in Fig. 4 is suggested. This is intended to be driven by either an electric or pneumatic motor, through the shank "D." Part "A" is a guide, slightly less in diameter than the internal diameter of the tube; "B" is an end reamer, the outside diameter of which is the same as the outside diameter of the tube, the difference in the diameters of "A" and "B" representing twice the thickness of the tube wall. The length of part "B" can be more than one-half the thickness of the tube sheet. Part "C" is a reamer having a bevel that gives the desired counterbore to the tube sheet. A shank "D" provides means of driving the reamer. This tool can be made out of one piece if desired, or the sheet may be counterbored later by a separate tool.

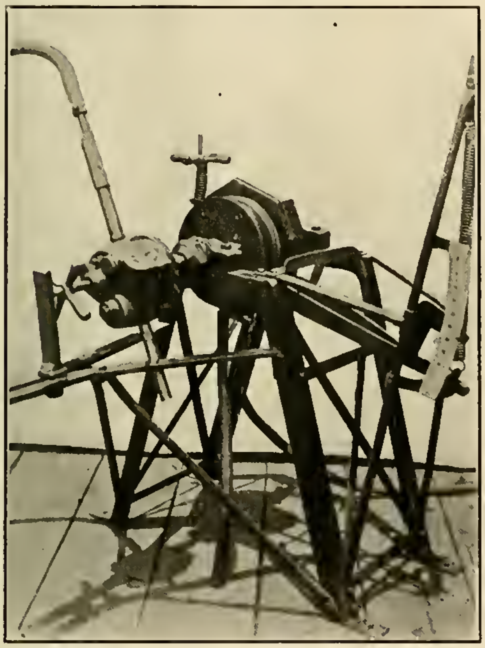
Should difficulty be experienced in getting a good weld on the under side of the tube, as shown in Fig. 2, the method indicated in Fig. 5 may be used, where the tube is inserted only one-half way through the sheet, and metal added to complete the weld as indicated by the dotted portion. The same tool would be used to cut out this tube as though the previous method were used.

The writer would be glad to hear criticisms of the above method, or to learn of any case where the tubes have been welded-in.

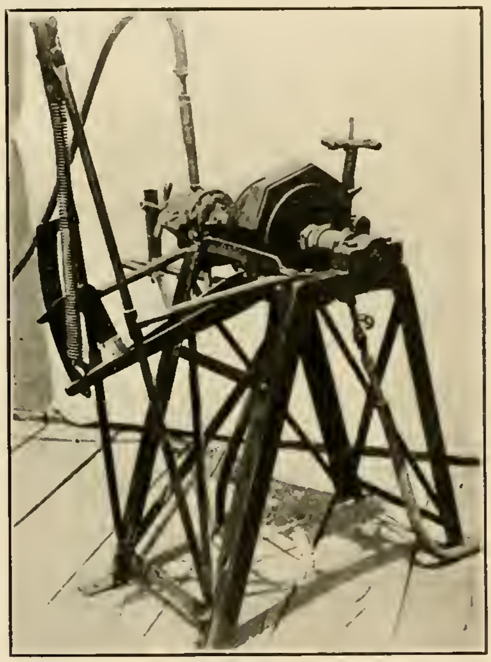
J. W. Rupert.

## PORTABLE AIR MOTOR TESTING MACHINE.

A machine for testing pneumatic and small electric motors has been in use for about a year at the Mt. Clare shops of the Baltimore and Ohio Railroad and has proven to be of decided value in determining the capacity and economy of new motors as well as the condition of older equipment. By the courtesy of R. C. Powell, foreman of shop tools, we are able to give a photograph that shows the general arrangement and principle of the machine very clearly.



AIR MOTOR TESTING MACHINE—FRONT.



AIR MOTOR TESTING MACHINE—REAR.

It consists of a substantial framework supporting a shaft which carries a hollow cast iron wheel around which is fitted a prony brake. The movement of the brake arm is resisted by a long coiled spring and a scale, graduated in pounds and ounces, is provided for showing the tension on the spring. The revolutions are taken by a counter on the end of the shaft and the horse-power is thus easily obtained. The volume and pressure of air are accurately measured and the economy of the motors at different speeds are then derived. The brake wheel is arranged for water circulation to carry off the heat generated. The machine is so arranged as to be capable of testing any sized air drill which can be very quickly and easily put into place. It can be moved to different shops as desired or stowed where it will be out of the way when not in use.

*New York Railroad Club.*—At the September meeting Frederick C. Syze, of the Staten Island Rapid Transit Railway Company, will present a paper on "Surprise and Efficiency Tests of Employees Charged with the Operation of Trains."

## POWER REQUIRED FOR TAPPING.

The accompanying table gives the results of experiments on the power required for tapping, covering nominal pipe tap sizes from 2 to 8 inches. The holes tapped were reamed with standard pipe tap reamers before tapping. The tests were made by the American Tool Works Company, of Cincinnati, on one of its radial drills.

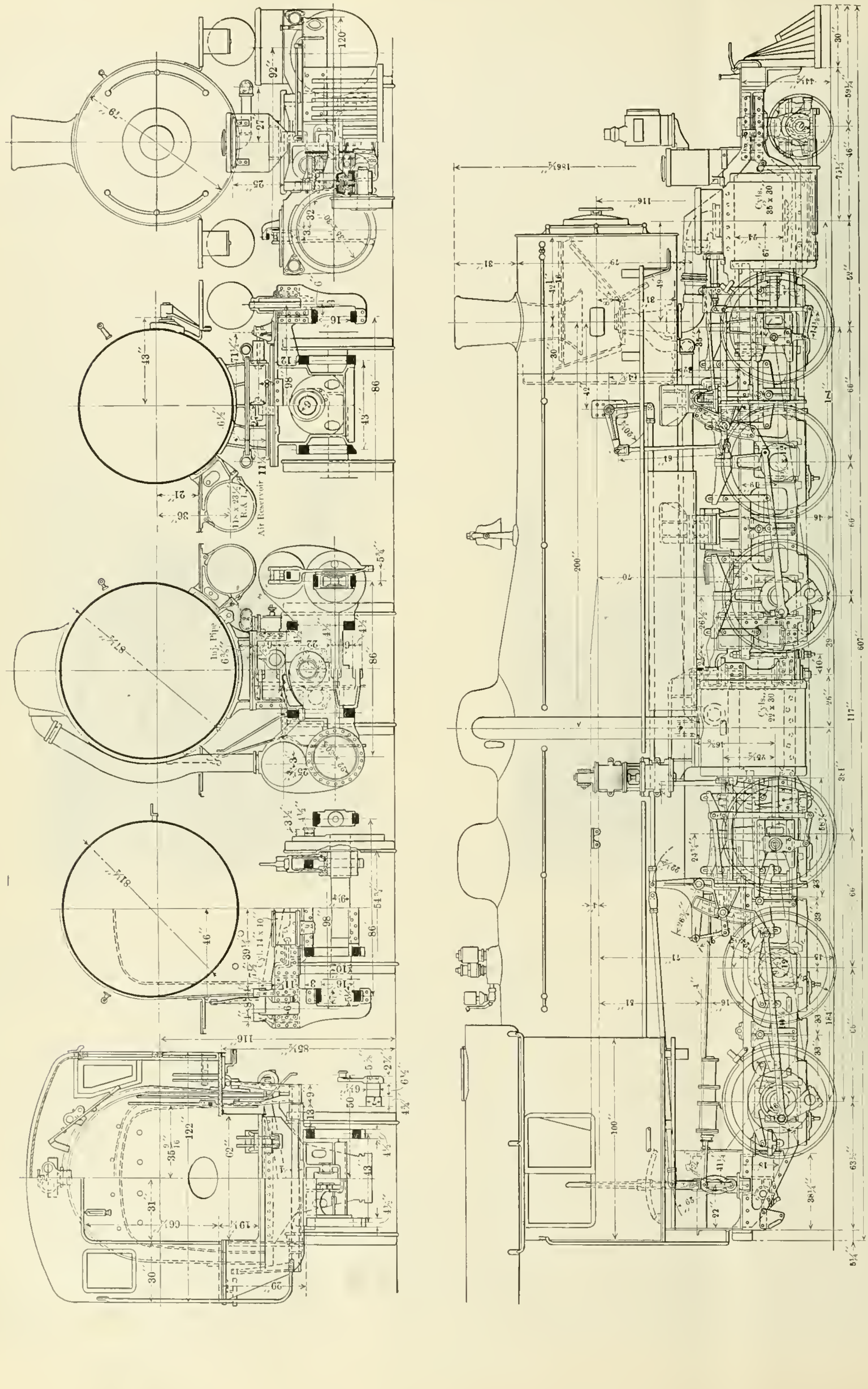
POWER REQUIRED FOR TAPPING

| Nominal Size of Pipe Tap, inches | Revolutions per Minute | Net Horse-power | Thickness of Metal, Inches |
|---|---|---|---|
| 2 | 40 | 4.24 | 1½ |
| 2½ | 40 | 5.15 | 1½ |
| *2½ | 38.5 | 9.14 | 1½ |
| 3 | 40 | 5.75 | 1½ |
| *3 | 38.5 | 9.70 | 1½ |
| 3½ | 25.6 | 7.20 | 1¾ |
| 4 | 18 | 6.60 | 2 |
| 5 | 18 | 7.70 | 2 |
| 6 | 17.8 | 8.80 | 2 |
| 8 | 14 | 7.96 | 2½ |

* Tapping steel casting; other tests in cast iron.

The horse-power recorded was read off just before the tap was reversed. In the table, however, is given the net horse-power, deductions being made for the power required to run the drill without a load. The material tapped was cast iron, except in two instances, where a steel casting was tapped. It will be seen that nearly double the power is required for tapping the steel casting. The taps used were of the inserted blade type, the blades being made of high-speed steel.

Smoke and Cinders from Briquets.—The reduction in cinders and sparks by briquetting depends on the quality of the coal as well as the density of the briquets. Certain coals, like the Loydell coal, produce a fine scale of coke in burning which is often loosened from the surface of the briquet by the action of the draft and carried partially burnt through the stack. With Hartshorne and Arkansas coals the coking is much different in character, probably due to the higher ash content, and these coke scales are scarcely noticeable. The same difference was noticed in burning briquets made from Pocahontas coal and "bone coal" picked from the mine-run coal. The latter was high in ash and the scales were greatly reduced. The results at Altoona testing plant show no appreciable reduction in the weight of cinders from briquets, but a decided reduction in their calorific value.—*C. T. Malcolmson before The International Ry. Fuel Assn.*




ELEVATION AND SECTIONS OF MALLET ARTICULATED COMPOUND LOCOMOTIVE—2-6-6-0 TYPE—VIRGINIAN RAILWAY.

# MALLET ARTICULATED COMPOUND LOCOMOTIVES, 2-6-6-0 TYPE, AND SWITCHING LOCOMOTIVES 0-8-0 TYPE.

VIRGINIAN RAILWAY.

On page 261 of the June issue of this journal appeared a brief general description, with outline elevation, of a design of Mallet compound locomotive, four of which are being delivered by the American Locomotive Company to the Virginian Railway. These locomotives were designed under the direction of R. P. C. Sanderson, superintendent of motive power of the railway, and are the first of this wheel arrangement to be used in this country, although not the first to be constructed by the builders, who last year delivered an order to the Eastern Railway of France of the same type, although smaller in size.

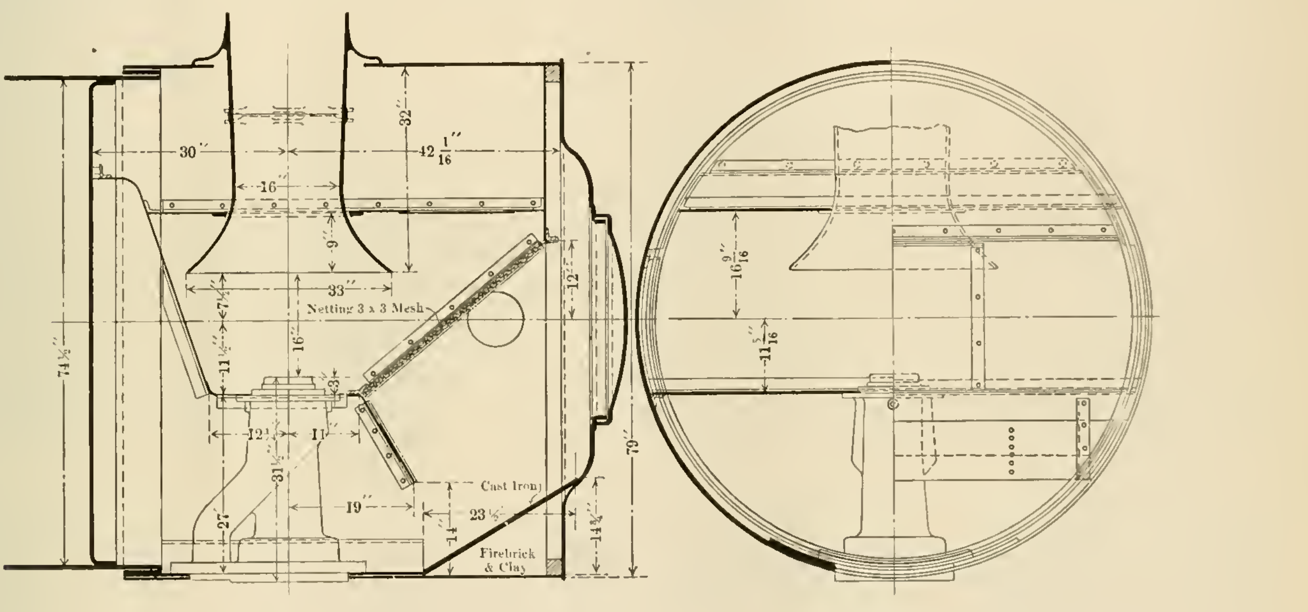
With the exception of the climb over the Allegheny Mountains, the ruling grade of the Virginian Railway, against the east-bound or loaded traffic, was placed at .2 per cent. compensated. There are places in the mountains where the grade rises to .6 per cent. and there are also other short stretches where it is slightly in excess of .2 per cent. For the purpose of handling traffic over sections in excess of .2 per cent. grade, the Mallet compound locomotives have been purchased.

stays at the front end of the crown and has liberal spaces in the water leg. There is but one fire door.

The arrangement of the diaphragm, deflector plates and netting at the front end is shown in one of the illustrations. It will be noticed that the smokestack has an unusually long extension inside of the front end.

Directly above the high pressure cylinders on the dome course, measuring 87½ in. outside diameter, is located the cast steel dome, which is very similar in design to that used on other Mallet articulated locomotives built by this company. It has an annular cavity extending around the front half of its circumference, which leads from the throttle pipe connection to the steam pipes extending down on either side to the top of the valve chambers of the high pressure cylinders. The throttle, which also acts as a steam separator, is very similar in design to that applied to the Erie Mallet.*

Differing from the usual practice, the throttle valve is operated through a system of levers by a crank arm on a horizontal shaft, passing out through a stuffing box in the side of the dome. The throttle lever is pivoted above the top of the backhead of the boiler.




SECTION THROUGH FRONT END—VIRGINIAN MALLET.

In working order the locomotive will have a total weight of 330,000 lbs., of which 312,000 lbs. is carried on drivers. The calculated tractive effort working compound is 70,800, which, however, can be increased about 20 per cent. by working the engine simple, giving a maximum tractive effort of nearly 85,000 lbs. The design includes the Mellin intercepting valve, which permits live steam to be admitted to the low pressure cylinders while at the same time diverting the exhaust in the high pressure cylinders through a separate pipe to the exhaust pipe in the smoke box, which is specially designed, as is shown in the illustration, to prevent the exhaust from the two points interfering with each other.

The general elevation shows the designs of the large extended wagon top type of boiler and the heating surface, etc., will be found in the table of general dimensions. This boiler contains no particular novelties, differing from customary practice principally in having a double check valve on the top center line of the front barrel sheet, which arrangement is used on other locomotives on this road, and in having the firebox crown and side sheets in one piece, as are also the outside and roof sheets. The fire box is radially stayed, with two rows of sling

The arrangement of steam pipes to the high-pressure cylinders and the design of the cylinders follows the usual practice for this type of engine. The high pressure cylinders, which are 22 inches in diameter by 30 inches in stroke, are cast in pairs with saddles and are separated at a point to the right of the center in order to provide room for the connection to the receiver pipe which extends along the center line of the engine.

As before stated, the Mellin system of compounding is used. the intercepting valve being located in the left high pressure cylinder casting. The emergency exhaust valve is contained in a separate chamber attached to the side of the left cylinder casting and communicating with the intercepting valve. From the emergency exhaust valve, a 4½″ pipe, with universal joints, leads to the exhaust pipe in the smoke box. Exhaust steam from the right high pressure cylinder passes back through the casting into an outside U-shaped pipe connecting to a passage in the left cylinder casting, which leads up to the intercepting valve chamber into which steam from the left cylinder also exhausts. From the intercepting valve, it passes to the receiver pipe, leading to the low-pressure cylinders.

* See AMERICAN ENGINEER, 1907, page 340.

The receiver pipe has a ball joint connection with the high pressure cylinders and a slip joint at the front end where it connects to a Y-pipe, the branches of which connect to the cored passages in the low pressure cylinders.

Owing to the application of the leading truck and the consequent moving forward of the boiler, it was necessary to use a different arrangement of flexible connections between the low pressure cylinders and the exhaust nozzle from that employed by the builders in other engines of this type without a truck. The two exhaust passages from the cylinders come together in the center of the cylinder saddle, and fitted to the single opening in the top of the saddle is a cast iron flange which forms a stuffing box for the ball joint connection. The back end of the elbow screws into the front section of the connecting pipe leading to the exhaust pipe in the smoke box. The two sections of this pipe have a slip joint connection between them and the rear section is provided with an elbow which has a ball joint connection with the exhaust pipe in the smoke box. This combination of ball joints and slip joint thus permits the connecting pipe to adjust itself to any lateral or vertical movement of the low pressure cylinders relative to the smoke box.

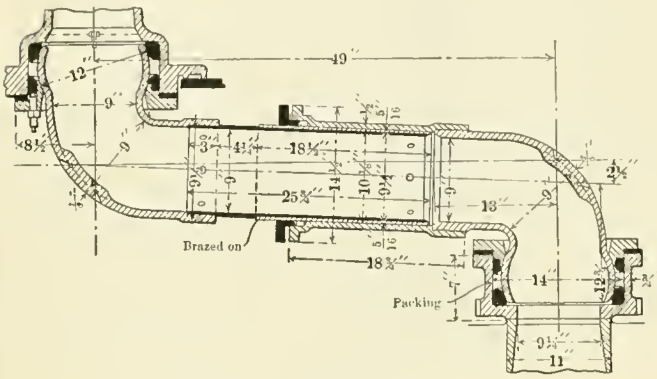
Piston valves, having internal admission, are used on the high pressure cylinders, while the low pressure cylinders are provided with Allen-ported slide valves, having external admission. Both valves have a maximum travel of 6 inches and are set for 3/16″ lead. The high pressure valves are designed with 1¼″ steam lap and 5/16″ exhaust clearance, while the low pressure valves have the same exhaust clearance, but 3/16″ less steam lap. The valves in each case are actuated by the Walschaert valve gear, and the two sets of gears are so arranged that the high pressure link block is raised while the low pressure one is lowered, when being thrown into forward gear and the two gears consequently counterbalance each other. As the high pressure valve has inside admission, and the low pressure outside admission, the eccentric crank thus leads the pin in each case. Reversing is effected by means of a hydropneumatic reversing device, the same as that used on the Mallet articulated compound built by this company for the Baltimore and Ohio R. R. The construction of the frames, which are of cast steel, and the arrangement of the articulated connection between the front and rear engines are also practically the same as in the Baltimore and Ohio engine.

The front truck is of the radial swinging bolster type, being suspended by three point or stable equilibrium hangers and the load is transmitted to the journal box by means of coiled springs seated on top of the box. This arrangement is shown in one of the illustrations. Because of the application of the truck, it was necessary in this design to use two self-adjusting sliding bearings to support the boiler on the front frames, both of which carry load under normal conditions. Each of these bearings is provided, as usual, with safety straps to prevent the frames from dropping away from the boiler in case of derailment, and the front bearing is provided with the builder's usual design of spring centering device.

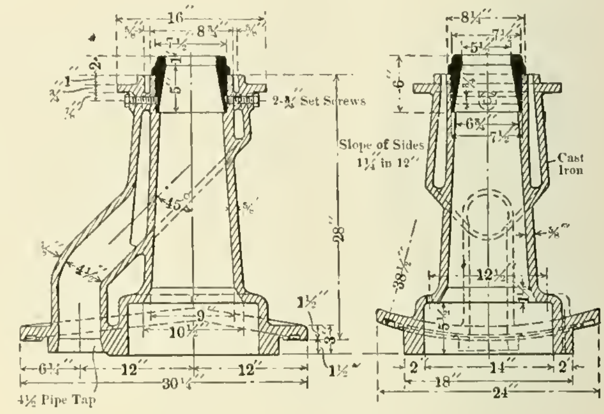
Vertical bolts, connecting the upper rail of the front frame with the lower rail of the rear frame, are used to equalize the front and rear systems. But in this design the load on the bolt is supported by a coil spring, through which the lower end of the bolt passes and which bears up against the bottom of the rear frame rail, the spring cap having a ball joint with the frame.

A flexible support at this point was necessary in order that each of the three boiler supports, namely, the two sliding bearings and the equalizing bolt, might bear its proportion of the load in any variation in alignment of the three.

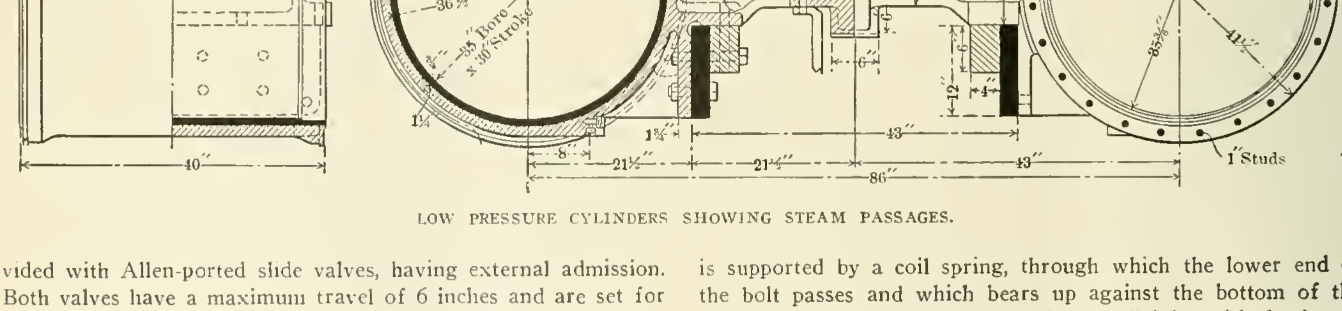
In order to obviate the necessity of flexible connections in the sand pipes leading to the driving wheels of the front engine, sand is supplied to these wheels from a sand box supported on the front deck plate. The headlight is carried on a bracket




FLEXIBLE EXHAUST CONNECTION.




EXHAUST PIPE AND NOZZLE.




LOW PRESSURE CYLINDERS SHOWING STEAM PASSAGES.

bolted to the front of this sand box.

Another interesting detail of the design is the arrangement of the draw gear between the engine and tender, in which the draw bar pin is horizontal and is inserted through the side walls of the foot plate instead of being vertical and put in through the top of the foot plate as is the usual practice. This arrangement facilitates the extraction of the draw bar pin when it is necessary to disconnect the engine from the tender. The construction is clearly shown in the accompanying illustration which needs no further explanation.

The tender is of the railroad company's design throughout, and is provided with a water bottom tank having a water capacity of 9,500 gallons. The tender frame is of steel, the center sills being constructed of 15" channels and the side sills of 10" channels. The tender trucks are of the four-wheel equalized type.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Service | Freight |
| Fuel | Bit. Coal |
| Tractive effort | 70,800 lbs. |
| Weight in working order | 330,000 lbs. |
| Weight on drivers | 312,000 lbs. |
| Weight on leading truck | 18,000 lbs. |
| Weight of engine and tender in working order | 492,300 lbs. |
| Wheel base, driving | 31 ft. 9 in. |
| Wheel base, total | 39 ft. 11 in. |
| Wheel base, engine and tender | 73 ft. 2 11/16 in. |

RATIOS.

| | |
|---|---|
| Weight on drivers ÷ tractive effort | 4.41 |
| Total weight ÷ tractive effort | 4.67 |
| Tractive effort × diam. drivers ÷ heating surface | 753.00 |
| Total heating surface ÷ grate area | 88.50 |
| Firebox heating surface ÷ total heating surface, per cent | 4.42 |
| Weight on drivers ÷ total heating surface | 61.90 |
| Total weight ÷ total heating surface | 65.10 |
| Volume equiv. simple cylinders, cu. ft | 20.46 |
| Total heating surface ÷ vol. cylinders | 247.00 |
| Grate area ÷ vol. cylinders | 2.79 |

CYLINDERS.

| | |
|---|---|
| Kind | Mellin Compound |
| Diameter and stroke | 22 & 35 × 30 |

VALVES.

| | |
|---|---|
| Kind | H. P. Piston, L. P. Slide |
| Greatest travel | 6 in. |
| Outside lap | 1¼ & 1 1/16 in. |
| Inside clearance | 5/16 in. |
| Lead, constant | 3/16 in. |

WHEELS.

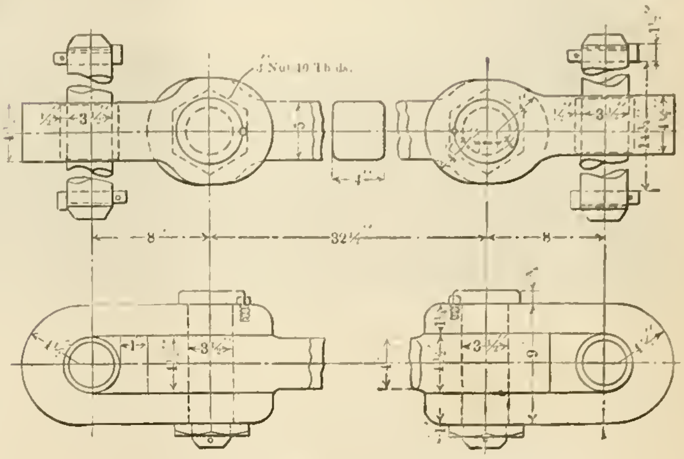
| | |
|---|---|
| Driving, diameter over tires | 54 in. |
| Driving, thickness of tires | 3½ in. |
| Driving journals, diameter and length | 9½ x 12 in. |
| Engine truck wheels, diameter | 30 in. |
| Engine truck, journals | 5½ x 12 in. |

BOILER.

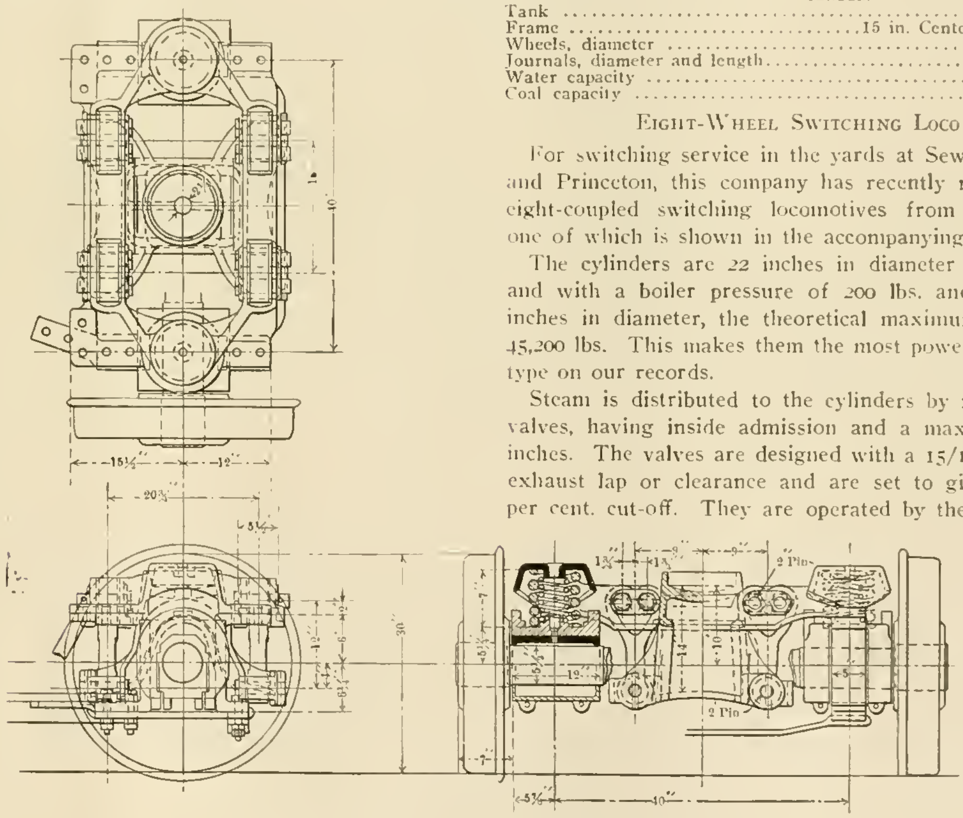
| | |
|---|---|
| Style | E. W. T. |
| Working pressure | 200 lbs. |
| Outside diameter of first ring | 70 in. |
| Firebox, length and width | 114 & 72 in. |
| Firebox plates, thickness | ⅜ & 9/16 in. |
| Firebox, water space | F.—6, S. & B.—5 in |
| Tubes, number and outside diameter | 390—2¼ in |
| Tubes, length | 21 ft |
| Heating surface, tubes | 4,812 sq. ft |
| Heating surface, firebox | 223.9 sq. ft |
| Heating surface, total | 5,065.9 sq. ft |
| Grate area | 57 sq. ft. |
| Smokestack, diameter | 16 in. |
| Smokestack, height above rail | 186½ in. |
| Center of boiler above rail | 116 in. |

TENDER.

| | |
|---|---|
| Tank | Water Bottom |
| Frame | 15 in. Center Sills, 10 in. Side Sills |
| Wheels, diameter | 33 in. |
| Journals, diameter and length | 5½ x 10 in |
| Water capacity | 9,500 gals. |
| Coal capacity | 14 tons |



DRAW BAR BETWEEN ENGINE AND TENDER.



FRONT ENGINE TRUCK—VIRGINIAN MALLET.

### Eight-Wheel Switching Locomotives.

For switching service in the yards at Sewell's Point, Roanoke and Princeton, this company has recently received three heavy eight-coupled switching locomotives from the same builders, one of which is shown in the accompanying illustration.

The cylinders are 22 inches in diameter by 28 inches stroke and with a boiler pressure of 200 lbs. and driving wheels 51 inches in diameter, the theoretical maximum tractive power is 45,200 lbs. This makes them the most powerful engines of their type on our records.

Steam is distributed to the cylinders by means of 12" piston valves, having inside admission and a maximum travel of 5½ inches. The valves are designed with a 15/16" steam lap and no exhaust lap or clearance and are set to give a ¼" lead at 50 per cent. cut-off. They are operated by the Stephenson's shifting link gear arranged with a transmission bar. The valve chests are equipped with by pass valves of the P. R. R. standard type.

The frames which are of cast steel with single front rail are 4½ inches wide. Following the ordinary practice in this type of engine, the first and second driving wheels on either side are equalized together and the first pair are cross equalized; while the third and fourth driving wheels are equalized together, but the cross equalization is omitted. This gives a three point suspended engine.


POWERFUL EIGHT-WHEEL SWITCHING LOCOMOTIVE—VIRGINIAN RAILWAY.

Lubricators for oiling the driving wheel flanges are provided on the front and back driving wheels. The device consists of a 2" wrought iron pipe, filled with oiled waste, the bottom end of the pipe being cut out to fit over the flange of the tire. This pipe is held in position by a wrought iron bracket, which is loosely pivoted on its point of support so as to allow the pipe to accommodate itself to the movement of the wheel relative to the frame.

The boiler is of the radial stayed, straight top type with sloping back head and vertical throat sheet. The barrel, which is made in two courses, measures 74 inches in diameter outside at the first course. It contains 354 tubes, 2 inches in diameter and 15 feet long. The total heating surface of the boiler is 2,940 square feet, of which the tubes provide 2,763 square feet and the fire box the remainder. The fire box is narrow and is placed between the driving wheels and over the frames. It is 108 inches long and 42 inches wide and provides a grate area of 31.5 square feet.

The water spaces around the fire box are 4 inches wide at the mud ring on the front and 3½ inches wide on the back and sides, increasing in width at the crown sheet to 4½ inches in the back and about 6½ inches on the sides.

A limited number of flexible staybolts are used in the back head and throat sheet. In the back head they are located in the outside row all around and also around the fire box door; while in the throat sheet, the first three rows down from the waist are flexible stays.

The fire box is supported by a buckle plate at the back end and by sliding bearings on either side, ahead of the center of the fire box and just back of the rear driving wheels.

Between the fire box and the cylinders, the boiler is supported by two waist sheets, one just back of the main driving wheels and the other at the guide yoke. The rear one of these sheets extends down to the bottom rails of the frames and is secured to a cross tie between them as well as to a cross tie spanning the upper rails of the frames. A similar arrangement is employed at the guide yoke, though the waist sheet is not in one continuous piece.

The tender is equipped with a sloping back tank, having a water capacity of 5,000 gallons and space for ten tons of coal. The tender frame is built of steel, with center sills of 15-inch channels and side sills of 10-inch channels. The tender trucks are of the arch-bar type with cast steel bolsters. The arrangement of the draw-gear between engine and tender is similar to that employed in the Mallet locomotives described above.

The general dimensions, weights and ratios of these locomotives are as follows:

| | |
|---|---|
| **GENERAL DATA.** | |
| Gauge | 4 ft. 8½ in. |
| Service | Switching |
| Fuel | Bit. Coal |
| Tractive effort | 45,200 lbs. |
| Weight in working order | 182,300 lbs. |
| Weight on drivers | 182,300 lbs. |
| Weight of engine and tender in working order | 293,700 lbs. |
| Wheel base, driving | 14 ft. |
| Wheel base, engine and tender | 49 ft. 6 11/16 in. |
| **RATIOS.** | |
| Weight on drivers ÷ tractive effort | 4.03 |
| Tractive effort × diam. drivers ÷ heating surface | 785.00 |
| Total heating surface ÷ grate area | 93.20 |
| Firebox heating surface ÷ total heating surface, per cent | 6.04 |
| Weight on drivers ÷ total heating surface | 62.00 |
| Volume both cylinders, cu. ft. | 12.35 |
| Total heating surface ÷ vol. cylinders | 239.00 |
| Grate area ÷ vol. cylinders | 2.55 |
| **CYLINDERS.** | |
| Kind | Simple |
| Diameter and stroke | 22 x 28 in. |
| **VALVES.** | |
| Kind | Piston |
| Kind of gear | Stephenson |
| Greatest travel | 5½ in. |
| Outside lap | 15/16 in. |
| Inside clearance | 0 in. |
| Lead at 50% C. O. | ¼ in. |
| **WHEELS.** | |
| Driving, diameter over tires | 51 in. |
| Driving, thickness of tires | 3½ in. |
| Driving journals, main, diameter and length | 9½ x 12 in. |
| Driving journals, others, diameter and length | 9 x 12 in. |
| **BOILER.** | |
| Style | Straight |
| Working pressure | 200 lbs. |
| Outside diameter of first ring | 74 in. |
| Firebox, length and width | 108 x 42 in. |
| Firebox plates, thickness | ⅜ & 9/16 in. |
| Firebox, water space | 4 & 3½ in. |
| Tubes, number and outside diameter | 564—2 in. |
| Tubes, length | 15 ft. |
| Heating surface, tubes | 2,763 sq. ft. |
| Heating surface, firebox | 177 sq. ft. |
| Heating surface, total | 2,940 sq. ft. |
| Grate area | 31.5 sq. ft. |
| Smokestack, diameter | 17 in. |
| Smokestack, height above rail | 175½ in. |
| Center of boiler above rail | 109 in. |
| **TENDER.** | |
| Tank | Sloping Back |
| Frame | 15 in. Center & 10 in. Side Sills |
| Wheels, diameter | 33 in. |
| Journals, diameter and length | 5 x 9 in. |
| Water capacity | 5,000 gals. |
| Coal capacity | 10 tons |

---

RAILROAD CO-OPERATES WITH FOREST SERVICE.—For the purpose of reducing the number of fires along the right of way in the Arkansas national forest, the Forest Service has recently entered into a co-operative agreement with the Kansas City Southern Railroad which provides that the railroad shall clear its right of way of all inflammable material for a distance of fifty feet on each side of the track and burn over an additional 100 feet wherever necessary. A provision is made for the use of efficient spark arresters, and that fires shall be reported to the nearest station agent, who will notify Forest officers and section crews. The maintenance of a Forest Service telephone line along the right of way will also be allowed. On its side, the Forest Service will patrol and supervise the clearing of the right of way, supply tools, and maintain and operate sufficient telephones as well as grant the railroad the timber free of charge, where it is necessary to clear the right of way. This agreement is for a period of ten years and has already been put into effect. Six telephones have been established along the line and excellent results are being obtained. Inasmuch as a great majority of the fires on the Arkansas national forest can be laid to this source, it is thought that a great reduction in the area of burned over land will be made during the coming season. The Forest Service will be glad to have similar co-operation with other railroads traversing national forests.

# WEIGHTS OF ROUND IRON IN LBS.

LENGTH IN FEET

DIAMETER

| SIZE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/4" | .167 | .334 | .501 | .668 | .835 | 1.00 | 1.17 | 1.34 | 1.50 | 1.67 | 1.84 | 2.00 | 2.17 | 2.34 | 2.51 | 2.67 | 2.84 | 3.01 | 3.17 | 3.34 |
| 3/8" | .370 | .740 | 1.11 | 1.48 | 1.85 | 2.22 | 2.59 | 2.96 | 3.33 | 3.70 | 4.07 | 4.44 | 4.81 | 5.18 | 5.55 | 5.92 | 6.29 | 6.66 | 7.03 | 7.40 |
| 1/2" | .660 | 1.32 | 1.98 | 2.64 | 3.30 | 3.96 | 4.62 | 5.28 | 5.94 | 6.60 | 7.26 | 7.92 | 8.58 | 9.24 | 9.90 | 1056 | 11.22 | 11.88 | 12.54 | 13.20 |
| 5/8" | 1.04 | 2.08 | 3.12 | 4.16 | 5.20 | 6.24 | 7.28 | 8.32 | 9.36 | 10.40 | 11.44 | 1248 | 13.52 | 14.56 | 15.60 | 16.64 | 17.68 | 18.72 | 19.76 | 20.80 |
| 3/4" | 1.50 | 3.00 | 4.50 | 6.00 | 7.50 | 9.00 | 10.50 | 12.00 | 13.50 | 15.00 | 16.50 | 18.00 | 19.50 | 21.00 | 22.50 | 24.00 | 25.50 | 2700 | 2850 | 3000 |
| 7/8" | 2.03 | 4.06 | 6.09 | 8.12 | 10.15 | 12.18 | 14.21 | 16.24 | 18.27 | 20.30 | 22.33 | 24.36 | 26.39 | 28.42 | 3045 | 32.48 | 3451 | 36.54 | 38.57 | 40.60 |
| 1" | 2.62 | 5.24 | 7.86 | 10.48 | 13.10 | 15.72 | 18.34 | 20.96 | 23.58 | 26.20 | 2882 | 31.44 | 34.06 | 36.68 | 39.30 | 41.92 | 44.54 | 47.16 | 49.78 | 52.40 |
| 1 1/8" | 3.31 | 6.62 | 9.93 | 13.24 | 16.55 | 1986 | 23.17 | 26.48 | 29.79 | 33.10 | 36.41 | 39.72 | 43.02 | 46.34 | 49.65 | 52.96 | 56.27 | 59.58 | 62.89 | 66.20 |
| 1 1/4" | 4.09 | 8.18 | 12.27 | 16.36 | 20.45 | 24.54 | 28.63 | 32.72 | 36.81 | 40.90 | 44.99 | 49.08 | 53.17 | 57.26 | 61.35 | 65.44 | 69.53 | 73.62 | 77.71 | 81.80 |
| 1 3/8" | 4.95 | 9.90 | 14.85 | 19.80 | 24.75 | 29.70 | 34.65 | 39.60 | 44.55 | 49.50 | 54.45 | 59.40 | 64.35 | 69.30 | 74.25 | 79.20 | 84.15 | 89.10 | 94.05 | 99.00 |
| 1 1/2" | 5.89 | 11.78 | 17.67 | 23.56 | 29.45 | 35.34 | 41.23 | 47.12 | 53.01 | 58.90 | 64.79 | 70.68 | 76.57 | 82.46 | 88.35 | 94.24 | 100.1 | 106.0 | 111.9 | 117.8 |
| 1 5/8" | 6.91 | 13.82 | 20.73 | 27.64 | 34.55 | 41.46 | 48.37 | 55.28 | 62.19 | 69.10 | 76.01 | 82.92 | 89.83 | 96.74 | 103.7 | 110.6 | 117.5 | 124.4 | 131.3 | 138.2 |
| 1 3/4" | 8.02 | 16.04 | 24.06 | 32.08 | 40.10 | 48.12 | 56.14 | 64.16 | 72.18 | 80.20 | 88.22 | 96.24 | 104.3 | 112.3 | 120.3 | 128.3 | 136.3 | 144.4 | 152.4 | 160.4 |
| 1 7/8" | 9.20 | 18.40 | 27.60 | 36.80 | 46.00 | 55.20 | 64.40 | 73.60 | 82.80 | 92.00 | 101.2 | 110.4 | 119.6 | 128.8 | 138.0 | 147.2 | 156.4 | 165.6 | 174.8 | 184.0 |
| 2" | 10.47 | 20.94 | 31.41 | 41.88 | 52.35 | 62.82 | 73.29 | 83.76 | 94.23 | 104.7 | 115.2 | 125.7 | 136.1 | 146.6 | 157.1 | 167.5 | 178.0 | 188.5 | 198.9 | 209.4 |
| 2 1/4" | 13.25 | 26.50 | 39.75 | 53.00 | 66.25 | 79.50 | 92.75 | 106.0 | 119.3 | 132.5 | 145.8 | 159.0 | 172.3 | 185.5 | 198.8 | 212.0 | 225.3 | 238.5 | 251.8 | 265.0 |
| 2 1/2" | 16.36 | 32.72 | 49.08 | 65.44 | 81.80 | 98.16 | 114.5 | 130.9 | 147.2 | 163.6 | 180.0 | 196.3 | 212.7 | 229.0 | 245.4 | 261.8 | 278.1 | 294.5 | 310.8 | 327.2 |
| 2 3/4" | 19.80 | 39.60 | 59.40 | 79.20 | 99.00 | 118.8 | 138.6 | 158.4 | 178.2 | 198.0 | 217.8 | 237.6 | 257.4 | 277.2 | 297.0 | 316.8 | 336.6 | 356.4 | 376.2 | 396.0 |
| 3 | 23.56 | 47.12 | 70.68 | 94.24 | 117.8 | 141.4 | 164.9 | 188.5 | 212.0 | 235.6 | 259.2 | 282.7 | 306.3 | 329.8 | 353.4 | 377.0 | 400.5 | 424.1 | 447.6 | 471.2 |

LENGTH IN INCHES — LENGTH IN FRACTIONS OF ONE INCH.

DIAMETER

| SIZE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | SIZE | 1/8 | 1/4 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/4" | .014 | .028 | .042 | .056 | .070 | .084 | .097 | .111 | .125 | .139 | .153 | .167 | 1/4" | .002 | .004 | .005 | .007 | .009 | .011 | .012 |
| 3/8" | .031 | .062 | .093 | .123 | .154 | .185 | .216 | .247 | .278 | .308 | .339 | .370 | 3/8" | .004 | .008 | .012 | .016 | .019 | .023 | .027 |
| 1/2" | .055 | .110 | .165 | .220 | .275 | .330 | .385 | .440 | .495 | .550 | .605 | .660 | 1/2" | .007 | .014 | .021 | .028 | .034 | .041 | .048 |
| 5/8" | .087 | .173 | .260 | .347 | .433 | .520 | .607 | .693 | .780 | .867 | .953 | 1.04 | 5/8" | .011 | .022 | .033 | .044 | .054 | .065 | .076 |
| 3/4" | .125 | .250 | .375 | .500 | .625 | .750 | .875 | 1.00 | 1.13 | 1.25 | 1.38 | 1.50 | 3/4" | .016 | .031 | .047 | .063 | .078 | .094 | .109 |
| 7/8" | .169 | .338 | .508 | .677 | .846 | 1.02 | 1.18 | 1.35 | 1.52 | 1.69 | 1.86 | 2.03 | 7/8" | .021 | .042 | .063 | .085 | .106 | .127 | .148 |
| 1" | .218 | .437 | .655 | .873 | 1.09 | 1.31 | 1.53 | 1.75 | 1.97 | 2.18 | 2.40 | 2.62 | 1" | .027 | .055 | .082 | .109 | .136 | .164 | .191 |
| 1 1/8" | .276 | .552 | .828 | 1.10 | 1.38 | 1.66 | 1.93 | 2.21 | 2.48 | 2.76 | 3.03 | 3.31 | 1 1/8" | .035 | .069 | .104 | .138 | .173 | .207 | .242 |
| 1 1/4" | .341 | .682 | 1.02 | 1.36 | 1.70 | 2.05 | 2.39 | 2.73 | 3.07 | 3.41 | 3.75 | 4.09 | 1 1/4" | .043 | .085 | .128 | .171 | .213 | .256 | .298 |
| 1 3/8" | .413 | .825 | 1.24 | 1.65 | 2.06 | 2.48 | 2.89 | 3.30 | 3.71 | 4.13 | 4.54 | 4.95 | 1 3/8" | .052 | .103 | .155 | .207 | .258 | .310 | .361 |
| 1 1/2" | .490 | .982 | 1.47 | 1.96 | 2.45 | 2.95 | 3.44 | 3.93 | 4.42 | 4.90 | 5.40 | 5.89 | 1 1/2" | .061 | .123 | .184 | .245 | .306 | .368 | .429 |
| 1 5/8" | .576 | 1.15 | 1.73 | 2.30 | 2.88 | 3.46 | 4.03 | 4.61 | 5.18 | 5.76 | 6.33 | 6.91 | 1 5/8" | .072 | .144 | .216 | .288 | .360 | .432 | .504 |
| 1 3/4" | .668 | 1.34 | 2.01 | 2.67 | 3.34 | 4.01 | 4.68 | 5.35 | 6.02 | 6.68 | 7.35 | 8.02 | 1 3/4" | .084 | .167 | .251 | .334 | .418 | .501 | .585 |
| 1 7/8" | .767 | 1.53 | 2.30 | 3.07 | 3.83 | 4.60 | 5.37 | 6.13 | 6.90 | 7.67 | 8.43 | 9.20 | 1 7/8" | .096 | .192 | .288 | .384 | .479 | .575 | .671 |
| 2" | .873 | 1.75 | 2.62 | 3.49 | 4.36 | 5.24 | 6.11 | 6.98 | 7.85 | 8.73 | 9.60 | 10.47 | 2" | .109 | .218 | .327 | .437 | .546 | .655 | .764 |
| 2 1/4" | 1.10 | 2.21 | 3.31 | 4.42 | 5.52 | 6.63 | 7.73 | 8.83 | 9.94 | 11.04 | 12.15 | 13.25 | 2 1/4" | .138 | .275 | .413 | .550 | .688 | .825 | .963 |
| 2 1/2" | 1.36 | 2.73 | 4.09 | 5.45 | 6.82 | 8.18 | 9.54 | 10.90 | 12.27 | 13.63 | 15.00 | 16.36 | 2 1/2" | .170 | .340 | .510 | .680 | .850 | 1.02 | 1.19 |
| 2 3/4" | 1.65 | 3.30 | 4.95 | 6.60 | 8.25 | 9.90 | 11.55 | 13.20 | 14.85 | 16.50 | 18.15 | 19.80 | 2 3/4" | .206 | .413 | .619 | .825 | 1.03 | 1.24 | 1.44 |
| 3" | 1.96 | 3.93 | 5.89 | 7.85 | 9.82 | 11.78 | 13.83 | 15.71 | 17.67 | 19.63 | 21.60 | 23.56 | 3" | .245 | .490 | .735 | .980 | 1.23 | 1.47 | 1.72 |

COMPUTED BY S. HUNTER MICHAELS

EXAMPLE: *Find the weight of a piece of round iron 1⅝ in. in diameter and 17 ft. 7¾ in. long:—From the upper part of the table the weight for a piece of iron of this diameter 17 ft. long is 117.5 lbs.; the weight of a piece 7 in. long is 4.03 lbs., as shown by the part of the table in the lower left hand corner; the weight of a piece ¾ of an inch long is .432 lbs., as shown by the part of the table in the lower right hand corner; therefore the total weight of the rod would be 117.5 + 4.03 + .432, or 121.962 lbs.*

EXAMPLE: *Find the weight of a piece of 1 in. iron 31 ft. long:—From the upper part of the table a piece 3 ft. long weighs 7.86 lbs. Moving the decimal point one place to the right makes the weight of a piece 30 ft. long 78.6 lbs. From the same part of the table the weight of a piece 1 ft. long equals 2.62; therefore the weight of the entire rod is 78.6 + 2.62, or 81.22 lbs.*

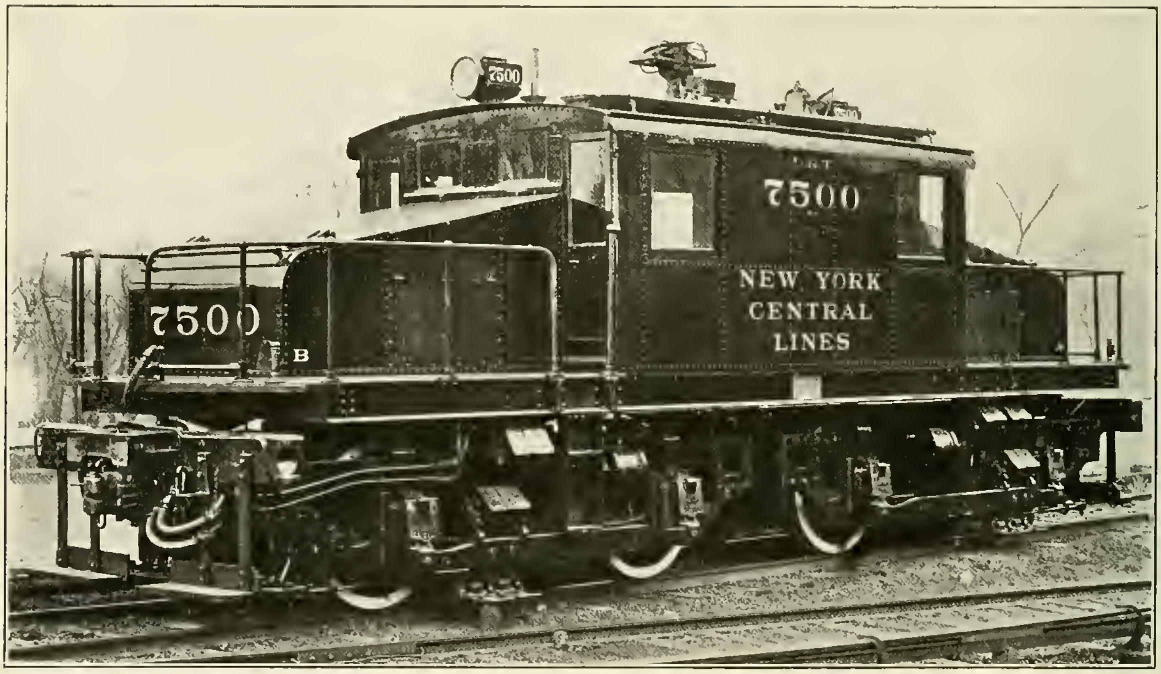
## ARTICULATED ELECTRIC LOCOMOTIVE FOR THE DETROIT RIVER TUNNEL.

A series of acceptance tests has been completed recently by the General Electric Company and the Detroit River Tunnel Company, jointly, upon electric locomotive No. 7500, the first of six locomotives for the Michigan Central Railroad, one of the New York Central lines, and to be operated in the tunnel under the Detroit River now under construction The electrical equipment of this locomotive, which is the most powerful in point of tractive effort ever designed for operation by direct current, was built and installed by the General Electric Company. The mechanical details, including the trucks and cab structure, are the product of the Schenectady works of the American Locomotive Company.

The Detroit River tunnel will connect the West Detroit yards of the Michigan Central Railroad with the new Windsor yards in Windsor, Ont. The electrified zone, embracing the tunnel with its approaches, terminal tracks and sidings, will cover a distance of approximately 33,000 ft. Maximum grades are encountered on the approaches, where a 2 per cent. grade extends for approximately 2,000 ft. at each end of the tunnel.

The locomotives are designed for hauling both freight and passenger trains through this tunnel, and also for switching service at the terminals. The specifications under which they were built demand a maximum service, consisting of hauling an 1,800-ton trailing train up the 2 per cent. grades at a speed of not less than 10 m. p. h., with two locomotives operating as multiple units. Their capacity is such that they are capable of repeating trips with this weight of train continuously with a lay-over of 15 minutes at each end without undue heating of the motors.

The articulated running gear may be considered as consisting of two four-wheel trucks coupled together; but the method of coupling and the relation of the equalizing systems on the two trucks make it necessary to consider the two trucks together. The truck side frames are heavy steel castings of a truss pattern. In order to obtain the necessary weight on drivers the members of this frame are made heavier than actually required for strength, the top member having a section 5 in. x 7 in., while the other members are proportionally heavy. This gives a peculiarly massive and substantial appearance to the whole running gear. The truck end frames and bolsters are castings of heavy box girder type, rigidly bolted to the side frames and fitted in such a manner as to relieve the bolts of shear. Draft gear buffers and all truck frame members are calculated for buffing stresses of 500,000 lb. and pulling stresses in proportion.




ARTICULATED ELECTRIC LOCOMOTIVE—DETROIT RIVER TUNNEL.

The system of spring suspension is of the locomotive type, the weight being carried on semi-elliptic springs resting on the journal box saddles. The system of equalization by which these springs are connected together is ingenious and interesting. The *A* end of the running gear—or what may be called the forward truck—is side equalized, the two springs on each side being connected together through an equalizer beam. This equalizes the distribution of weight between the two wheels on one side, giving to this truck a two-point support, and consequently leaving it in a condition of unstable equilibrium as regards tilting stresses—that is, stresses tending to tip the truck forward or backward. The *B* end of the running gear, or what may be called the rear truck of the locomotive, is cross-equalized, the two springs on the rear axle being connected together through an equalizer beam. The other two springs on this truck are independent and are connected directly to the truck frame. This results in a three-point suspension on the rear truck, leaving it in a condition of stable equilibrium, capable of resisting stresses in any direction, whether rolling or tilting. The two trucks are coupled together by a massive hinge, so designed as to enable the rear truck to resist any tilting tendency of the forward truck. This hinge combines the two trucks into a single articulated running gear, having lateral flexibility with vertical rigidity. It will be noted from the above description that the running gear has what may be called a compound three-point suspension. The rear truck has in itself a three-point suspension, while the forward and rear trucks together form an articulated frame having a three-point suspension, consisting of the two-point support of the forward truck and the independent equalization of the rear truck.

The draft rigging is mounted upon the outer end frames of the trucks which insures that all pulling and buffing stresses are transmitted on the same horizontal line through the draft rigging, side frames and connecting hinge pin of the trucks. The center pins and cab platform framing are entirely relieved of all longitudinal stresses except those due to the weight of the cab, platform and equipment.

Center pins and side bearings are provided on the running gear for the support of the cab. The center pin on the *A* end is a swivel pin, having a turning motion only, while that one on the *B* end has a turning and sliding motion. This construction allows the longitudinal motion necessary to take care of the variation in distance between the truck center pins occurring as the locomotive passes around curves. The side bearings on the *A* end have a clearance of about 1/8 in. when the cab is level, while those on the *B* end have a clearance of about 1/2 in. The result of this arrangement is that under ordinary circumstances the cab is carried on a three-point suspension, since the side bearings on the *A* end support all normal rolling action of the cab, the side bearings on the *B* end coming into play under abnormal conditions only.

The cab platform is built of four 10-in. longitudinal channels running the whole length of the locomotive, which are tied together by the end channels and bolster plates. Such ballast as is necessary to bring the weight of the locomotive up to the required amount is bolted to the two center sills. A floor plate, consisting of two sheets of 3/8-in. steel, is riveted to the platform sills, and serves to stiffen and square the platform framing. In the operating cab a 7/8-in. wood flooring is placed over this steel floor. The sides and ends of the cab are built of 1/8-in. steel plate, supported by a framework of small angles, while the roof is of No. 8 gauge steel. The main operating cab occupies the central portion of the locomotive and covers a floor space of 15 ft. 6 in. x 10 ft. It is fitted with windows on each side and two windows and two glazed doors in each end, allowing a practically unobstructed view in every direction. The cab contains the engineer's seat, and such apparatus as is required in the operating compartment of the locomotive. Auxiliary cabs extend from the main cab to the ends of the locomotive, and occupy a floor space of 9 ft. x 6 ft. each. These cabs house the air tank, sand boxes, rheostats and contactors. Hinged perforated doors in the sides of the auxiliary cabs give access to the rheostats and the connections back of the contactors, while folding doors between the auxiliary and main cabs allow access for inspection of the contactors. The edges of the auxiliary cabs are bolted to the platform and main cab, so that they can be readily removed when it is necessary to make heavy repairs.

The difference in width of the auxiliary and main cabs allows room for a narrow platform or running board, extending from the main cab along the sides of the auxiliary cabs to the ends of the locomotive. This running board is protected by hand rails running around the outside of the locomotive from one side of the main cab to the other. The doors of the main cab open to this platform, and the steps reaching the ground are located near the doors. One marked advantage of this construction is the unobstructed view given the engineer, both ahead and to the rear.

A type C-79 controller and the operating handles for the air brakes are located in the cab within easy reach of the engineer's seat. Sander valves are located beside the engineer, and over his head are switches for the headlight and control circuits. Directly in front are illuminated air gauges, ammeter and a foot-operated trolley valve for raising and lowering the overhead trolley. Sanders are arranged to sand the rails in front of the leading wheels on either truck.

A two-stage, four-cylinder compressor, geared to a 600-volt, direct-current series motor, is located in the center of the main cab. It has a capacity of 100 cu. ft. piston displacement per minute when pumping against a tank pressure of 135 lb. Ample circulating pipes are provided for cooling the air between stages and between pumps and tanks, in order that a moderate temperature may be maintained. The compressor is controlled by a governor, consisting of a pneumatically operated piston controlling the contact of the motor circuit switch, and so arranged as to close or open this circuit at any predetermined limits of pressure.

The motor equipment consists of four GE-209 motors having a rating of approximately 300 h.p. each. At its one-hour rating the motor will develop a torque of 4,050 lb. at 1-ft. radius. The gearing between motor and axle has a 4.37 reduction, and the driving wheels are 48 in. in diameter. With this reduction, each motor will develop a tractive effort of 9,000 lb. at the rail head, which gives a total tractive effort for the four motors of 36,000 lb. at 12 m. p. h. The motors have an overload capacity sufficient to slip the driving wheels, and the locomotive can develop at the slipping point of the wheels an instantaneous tractive effort of 50,000 lb. to 60,000 lb. The maximum speed of the locomotive, running light upon a level track, is about 35 m. p. h. There are two gears and pinions per motor, one at either end of the armature shaft.

The motors are designed for forced ventilation. Air is delivered into the motor frames at the end farthest from the commutator, passes between the field coils and around the armature, and finally escapes through suitable discharge openings over the commutator. The blower used for this purpose has a capacity of 2,000 cu. ft. of air per minute at 2 1/4 in. of water pressure, and is driven by a direct-current series motor. This blower delivers air to the passage between the two center sills, from which the ventilating ducts are tapped off to the motors at appropriate points.

The control system used is the Sprague-General Electric multiple unit type, with two master controllers in the main cab and the contactors in the auxiliary cab. Multiple unit connections have been supplied, so that three locomotives may be operated in unison, if necessary. The problem of starting and accelerating a train of from 1,000 to 1,500 tons weight, which may consist of 40 or 50 cars, is a rather delicate one. Consequently, the control for these locomotives was designed especially to produce a uniform increase of speed and torque during the period of acceleration. The control combinations are arranged so that the motors may be operated four in series, two in series and two in parallel, or four in parallel. There are nine resistance steps in series, eight in series-parallel and seven in the parallel position. In a test run with a train of 1,578 tons weight, consisting of one locomotive and 26 freight cars, the acceleration from a standstill to 10 m. p. h. was accomplished with marked smoothness. The maximum increase of drawbar pull was about 6,500 lb. on the first few steps, after which the maximum throughout the remainder of the acceleration was from 2,000 to 3,000 lb. To an observer standing in the caboose of such a train the rear end of the train is started so gradually that the beginning of the motion is almost imperceptible. The contrast with the results obtained with a steam locomotive is very striking.

The locomotive is equipped with third-rail shoes to take current from an inverted third-rail. It is also fitted with an overhead trolley, which, as stated previously, can be raised or lowered by a foot-operated valve in front of the motorman.

General data of the locomotive are given in the following table:

| | |
|---|---|
| Number of motors | 4 |
| Gear ratio | 4.37 |
| Number of driving wheels | 8 |
| Diameter of driving wheels | 48 in. |
| Total wheel base | 27 ft. 6 in |
| Rigid wheel base | 9 ft. 6 in. |
| Length inside coupler knuckles | 39 ft. 6 in. |
| Length of main cab | 15 ft. 6 in. |
| Height of cab | 12 ft. 6 in. |
| Maximum height, trolley up | 15 ft. 6 in. |
| Maximum height, trolley retracted | 14 ft. 10 1/8 in. |
| Maximum width | 10 ft. 2 5/8 in. |
| Width of cab | 10 ft. 1 15/16 in. |
| Total weight | 199,000 lb. |

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HIGH SPEED STEEL CUTTERS FOR WOODWORKING.—In the January issue, page 78, we described the high speed steel cutters for planing and surfacing, as made by Samuel J. Shimer & Sons, of Milton, Pa. The cost of high speed steel makes it necessary to use thin blades which fit in carefully designed holders. These thin knives have been found to be far more efficient than the old type, and the above mentioned company has decided to designate them as Bedee knives.

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WIRELESS TELEGRAPHY.—It is proposed to build at Washington a concrete tower, in connection with a wireless telegraph system, which will rise 600 ft., overtopping the Washington monument by 45 ft. Installations will also be made on board the various vessels of the fleet, so that it will be possible to telegraph 3,000 miles seaward and from vessels to land a distance of 1,000 miles.

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## CONTENTS



## THE FUEL QUESTION.

The fuel question is beginning to be given the attention, by some of the larger railway companies, that its importance warrants. The reports and very active discussion at the convention of the International Railway Fuel Association last June clearly show how much can be accomplished, even at the beginning of the campaign along these lines. The results which have been achieved by some of these fuel experts, even after efforts covering from six months to a year, are most decidedly encouraging and are but an indication of what may be expected after a carefully studied system has been thoroughly established. This is the youngest of the national railway associations and bids fair to become one of the most important and valuable.

## SLIPPING OF BOILER TUBE JOINTS.

The experiments of Prof. O. P. Hood and Prof. G. C. Christensen on the slipping point of rolled boiler tube joints, which were reported in a paper before the American Society of Mechanical Engineers last December, are most interesting. An abstract of this paper will be found on page 370 of this issue. It is known that the expansion of a long boiler tube in a locomotive boiler, opposed to the expansion of the side sheets, places a very large stress on the joints in the back tube sheet, which, taken in connection with the temperature differences between the ends of the tubes and the tube sheet, is very largely responsible for leaky tubes. The experiments reported in this paper indicate that the strength of these joints can be very decidedly increased with practically no expense and very little trouble by simply corrugating the hole in the tube sheet. This sounds very sensible and the result of the experiments indicates that it is most practical.

A correspondent, whose communication is also given in this issue, suggests the welding of the tubes to the sheet by the oxy-acetylene process. This plan is also feasible and has been employed at least in the case of a front end superheater. The chief objection, of course, is in the removing of the tubes and a special cutter is suggested for overcoming this.

Another article in this issue shows a fire box designed by Wm. H. Wood in which the side and crown sheets are corrugated and the front and back tube sheets have a flexible connection at their flanges, all of which works toward the same end, *i. e.*, of reducing the stresses at the joint of the tube in the sheet, although in this latter case other advantages are also indicated.

It would seem that with three methods available, leaky boiler tubes could be conquered.

## MECHANICAL STOKERS.

One of the most encouraging features of the last Master Mechanics' convention was the evidence of the present state of the development of the mechanical stoker. The report of the committee, and more especially the discussion by members, indicated that there were at that time at least two different types of stokers in practical every-day operation, each on a number of locomotives, and that they were performing satisfactory service in the hands of the regular engine crews, without any great amount of tinkering or repairs. This is most encouraging news, coming as it does after four of five years of constant expectation and continual false alarms that a successful stoker had finally been designed. The accuracy of the report was fully vouched for by a number of so-called "disinterested" men (of course, as a matter of fact they were very much interested in the operation), who had ridden the locomotive and watched the stoker work for at least one trip. These gentlemen all spoke enthusiastically of what they had seen.

It appears from the discussion that the stoker as at present in use cannot be expected to save very much coal, nor will it reduce smoke to any noticeable extent under the conditions in which it is now operated, but it will fire a locomotive and keep up a full head of steam under difficult conditions and that is really the prime requisite. The demand for a stoker comes from the same source as the demand for other improvements on locomotives, *i. e.*, increase of capacity. There are large numbers of locomotives now in more or less successful operation on which the average fireman can keep up full boiler pressure at the beginning of his run with comparative ease, but often has great difficulty in doing so toward the end of the division when he becomes physically tired and the fire gets into a bad condition. Possibly the tubes begin to leak and other things are to his disadvantage. On such runs as this a reliable stoker will be greatly welcomed. On the monstrous Mallets, however, where it is practically impossible for one fireman to handle enough coal to keep up a full head of steam for more than an hour or so, the use of a stoker is imperative.

While it is hardly safe to say that the stoker is beyond the experimental stage it certainly looks as if it was rapidly developing and that probably within the next year the experience will be sufficient to prove its entire reliability under ordinary conditions.

## JOY VALVE GEAR.

The Joy type of valve gear is and has been for a long time the standard type on the Lancashire & Yorkshire Railroad in England and is now in operation on over 1,000 locomotives. It is also used to a much smaller extent on some other English roads and has been tried on the continent. With the exception of the Lancashire & Yorkshire it seems that other roads have found, after trial, that its disadvantages are sufficient to at least not make it as popular as the Stephenson or Walschaert. For locomotives with inside cylinders having independent valve gears however, it would seem that the Joy gear was particularly adaptable, inasmuch as it requires no connection and obtains no motion directly from the crank or axle. It has been adopted by Mr. Taylor for use on the inside cylinder of his three-cylinder Atlantic type locomotive and is evidently well suited for that design. It has also been adopted for use on the engine of the White steam automobile, where it is reported to be very successful.

The Joy gear is of the radial type to which the Walschaert and Baker-Pilliod designs belong and like them it gives a constant lead. It gives a very rapid motion to the valve when opening and closing and considerable less compression at short cut-off than does the link motion. Its greatest disadvantage is probably in the opportunity for wear between the block and the link and these parts have to be made with great care and with ample surface. We give elsewhere in this issue a descriptive article of two designs which are now in successful service on English locomotives.

## A DIAGRAM OF LOCOMOTIVE CHARACTERISTICS.

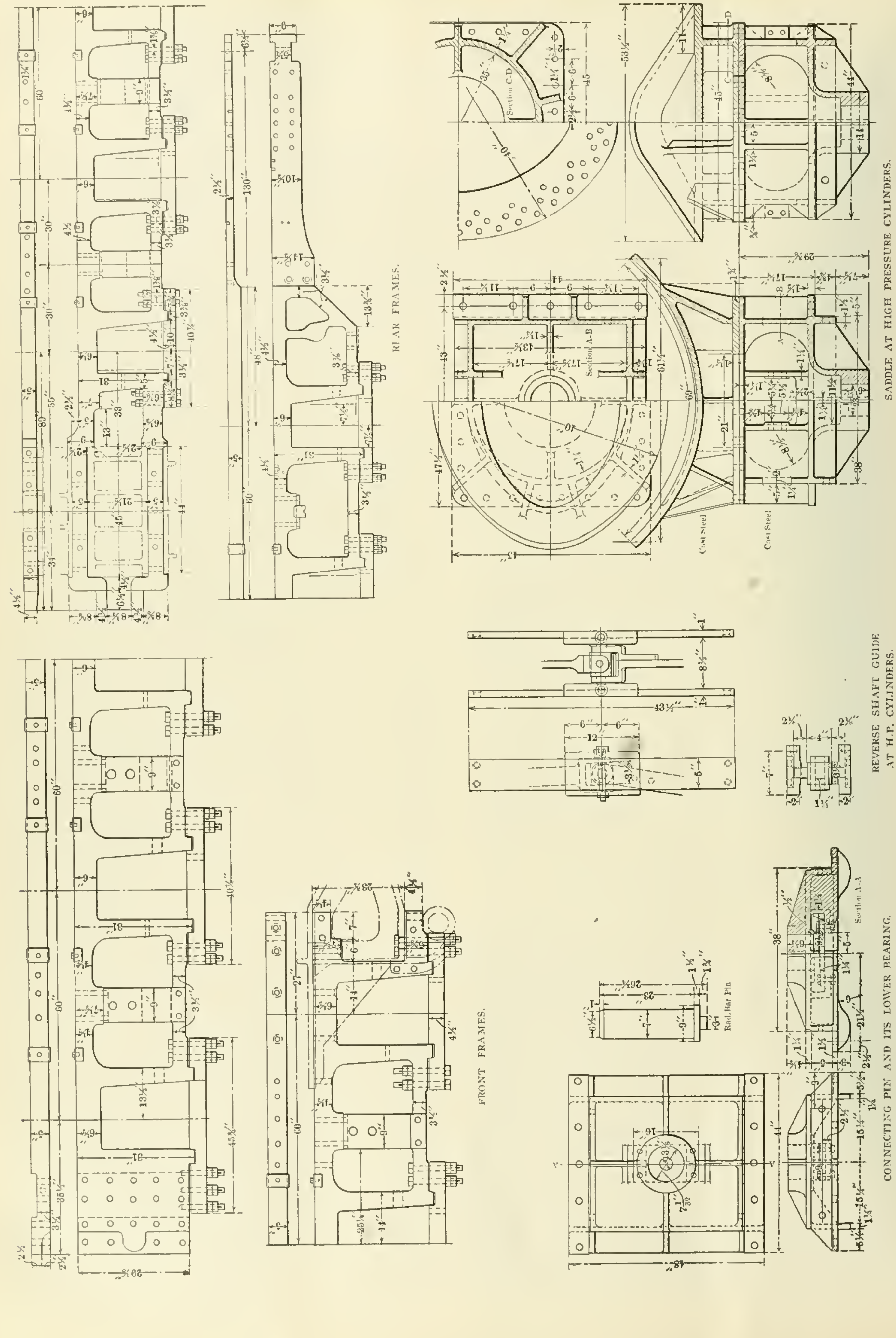
In the October, 1907, issue of this journal, page 389, there was presented an article by Lawford H. Fry giving a most interesting and valuable diagram consisting of a series of characteristic curves covering the whole range of operation of a high speed balanced compound locomotive, by means of which a most thorough and accurate investigation could be made of the proportions of any locomotive of this type. In the November, 1908, issue, page 417, a similar series of curves were given for single expansion locomotives. By means of these characteristics a rapid determination can be made of almost any desired feature in connection with the operation of the locomotive under any assumed condition. These curves show that the B. D. factor (tractive effort multiplied by diameter of drivers divided by total heating surface) is proportional to the number of foot-pounds of work developed per square foot of heating surface during each revolution when the engine is working at full power, and in this issue is given another article by Mr. Fry in which is included a diagram for determining this factor with any combination of heating surface, cylinder dimensions and boiler pressure. This chart, we believe, will be found to be of considerable value in developing a new design or in investigating a present one and we are arranging to furnish copies of the diagram, printed on heavy paper, to any one wishing them, for ten cents a copy.

## RAILROAD CLUBS.

It is pretty generally admitted that the railroad clubs as a rule are not accomplishing the results which they should and of which they are easily capable. The cause of this condition of affairs cannot be laid at the door of any one in particular, nor can it be corrected by any one acting alone. The secretaries of most clubs are given practically full control of the conduct of affairs and are expected to accomplish impossible results unaided. In their efforts to keep up the interest and increase the activities of the club they find a most decided disinclination of members to furnish papers and a most disheartening ignorance of the contents of the paper by the few who get up in the meeting to discuss it. The latter condition is, however, oftentime not the fault of a member wishing to speak, who has received his copy of the paper but a day or so before, nor is it the fault of the secretary, who at the last moment was thrown down on the paper that he had arranged for and had to get something on short notice to fill in with. The position of secretary of a railroad club is by no means an easy one and they are deserving of all credit for accomplishing as much as they have, although it is really, in the final analysis, but a small part of what should be gained. If the full benefit possible from the railroad club is to be gained by the members and incidentally their employers, it will be necessary for every one to do his share. The secretaries can accomplish the result if they are actively backed by the members, individually, and only then.

President Vaughan in his address before the M. M. Association this year suggested that the railroad clubs should perform a large part of the detail work which the large association now attempts to do and finds impossible because of shortness of the time. He suggested that the subjects which will come before the association in June be submitted to the different clubs, and that a full and general discussion, taking into consideration the local conditions in each part of the country, can thus be obtained. When the subject is then taken up by the M. M. Association it will be possible to rapidly come to a sensible conclusion. Somewhat of the same idea was expressed about a year ago in these columns by L. H. Turner in a letter in which he said: "I have had a hobby for some years, but so far have been unsuccessful in getting any one to ride it but myself, to the effect that the railroad clubs of the United States should appoint a joint committee on subjects, and that each club should discuss the same subject the same month that the other clubs are handling it; if you can get five or six of the best clubs discussing the same subject at the same time, with a membership of anywhere from four to six thousand, and the members as a class taking an active interest, it is safe to assume that there will be very little left of the subject which would not be thoroughly threshed out by the time the reports were all in, and I believe that were five or six of the best clubs to take up any particular subject, that the findings of the whole would be very valuable to any railroad interested in that particular subject."

It is certainly to be hoped that some action along this line will be taken and that it be started as soon as possible. The railroad club secretaries already have an association which would seem to be the natural place for a movement of this kind to be developed. There are enough subjects coming up for discussion at the next June conventions to keep the railroad clubs busy all the winter and if the secretaries of the different clubs will get together and see that each of them cover as much as possible of this list of subjects there is no doubt but what their work will be appreciated by the M. M. and M. C. B. Associations as well as by their members. The secretaries, however, can't write the papers and do all of the discussing. The members must each do his share.




DETAILS OF SOUTHERN PACIFIC MALLET.

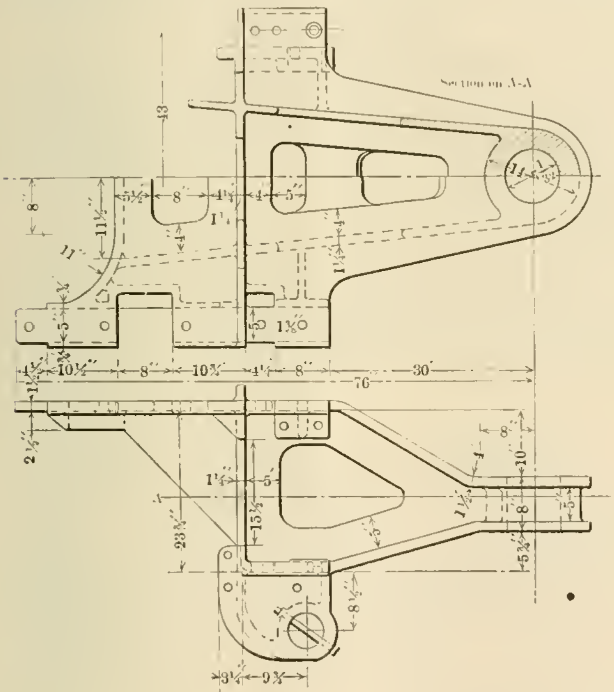
## MALLET ARTICULATED COMPOUND LOCOMOTIVE

Southern Pacific Company.

(*Continued from page 181, May issue.*)

In the former article was given a general description and a number of illustrations of this locomotive and of its very interesting boiler, which includes a feed water heater and re-heater. In this section there will be described a few of the more interesting details and reference should be made to the former article for a general description.

*Cylinders.*—The high pressure cylinders, with their valve chambers, are cast separately and without a saddle, being supported entirely by the frames of the rear group, which have two front rails. They are secured by keys in front and are bolted to the frame rails both vertically and horizontally through flanges on the casting. Since in this design the steam at boiler pressure is brought to the top of the valve chamber through an outside pipe and the exhaust from the high pressure cylinders is carried forward on either side by pipes secured to the boiler shell, there are no steam passages leading between the frames. The high pressure cylinders are 26 in. in diameter and are not provided with bushings. The walls are 1½ in. thick and the heads are of cast steel. Fifteen inch piston valves with inside admission are used, the valve chamber bushing being ⅝ of an inch thick. The admission ports are 1½ in. wide and the exhaust ports 3 in. in width. The exhaust steam is carried through a passage in the steam chest




CONNECTING HINGE CASTING, ATTACHED TO FRONT FRAMES.

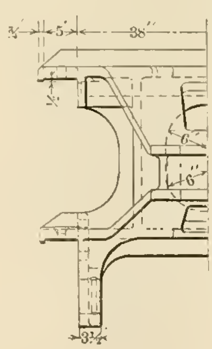
back of the valve chamber to a 6 in. opening in the center at the top, to which the pipes leading forward are connected by ball joints. The walls of the steam chest are normally 1¼ in. thick and the center of the valve is set 4½ in. outside of the center of the cylinder. The relief or drifting valves of the Sheedy type consist very simply of a 5 in. passage cored in the casting back of and between the valve chamber and cylinder, having a connection at either end to the cylinder steam port. At either end of this passage is a valve held open by a spring, which is easily compressed and the valve closed when steam is admitted to the cylinder. It remains open when the steam is shut off and gives a free passage from one end of the cylinder to the other.

Eight-inch exhaust pipes are carried forward along the boiler shell from the H. P. cylinder to the front end of the reheater in the smoke box. These pipes are fitted with a slip joint near their connection to the cylinder, which will allow for expansion and also give a disconnecting joint when the front section of boiler with the front group of wheels is to be removed, a joint in the boiler shell being provided at the combustion chamber for this purpose.

The low pressure cylinders, 40 in. in diameter, are also cast separate and are bolted to a box casting, which is secured to the forward end of the frames. They are of the same general design as the high pressure and have 15 in. piston valves with inside admission. The walls of the cylinder are 1⅝ in. thick at the thinnest part. The ports in the valve bushing are of the same width as in the high pressure. The heads are cast steel deeply dished and ribbed, as are also the piston heads which have a cast iron bull ring forming the bearing surface and seat for the packing rings.

The box casting between the low pressure cylinders is of cast steel and massive in design. It has a bearing of 21½ in. in length and 29⅛ in. in depth on the slab section of the front set of frames, to which it is secured by 20 1½ in. bolts and held in line by a recess 1½ in. deep and 8¾ in. wide in the frames. The cylinders are set into a recess in this casting 2 in. in depth and are locked in place by a wedge at the front end and secured by 22 1½ in. bolts. A steam passage is cored in the casting, the connection from the re-heater being brought to it by a flexible pipe which will be mentioned later, connecting on the back face at about the center line. From this point a 9 in. diameter passage is carried forward and dividing at the center line of the cylinder emerges at the top on either side and is continued by a short elbow pipe with ground joints to the steam passage of the low pressure valve chamber. A massive cast steel bumper plate is secured ahead of this box casting, the connection being similar to that at the frames.

The exhaust from these cylinders is discharged into a double return pipe or tee connecting on the front side of each cylinder just inside of the valve chest and joined on the center line to a short pipe having a full ball joint on the forward end, a slip joint in the center and a flexible ground joint at its connection to the smoke box and exhaust pipe. The slip joint in this pipe is held tight by means of snap rings and leakage grooves. The ball joint in the forward end is the same type as those on the steam type, shown in one of the illustrations. The flexible joint at the smoke box is of the ball and socket type and is held to its seat by a coil spring.



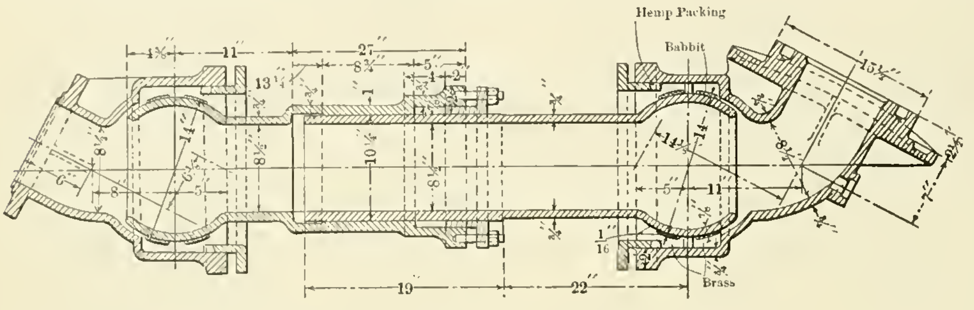
The design of the steam pipes for conveying the steam from the re-heater to the steam passage in the box casting, is clearly shown in the illustration. It has a full ball joint at either end and a slip joint in the center, the latter being packed with hemp packing.

The valve gear is of the Walschaert type, being arranged so that one gear will balance the other, *i. e.*, for go-ahead motion the radius bar is down on the forward valve gear and at the top of the link for the rear gear. The general arrangement of the valve gear is shown in the illustration on page 182 (May issue).

*Articulated Connection.*—The connection between the two groups of wheels is made by one bar, which is hinged on a 7 in. pin located between the high pressure cylinders, 57 in. back of the center of the rear axle of the front group of wheels and 55 in. ahead of the front axle of the rear group. The steel castings forming the hinged joint are shown in the illustrations. The one attached to the front group of frames is most substantial and has a bearing of 46 in. in length on the top rail and 13½ in. on the bottom rail, to which it is secured by 1⅜ in. bolts. It is cored out and made as light as consistent with the desired strength and stiffness. The connection to the rear set of frames is made by a saddle casting riveted to the boiler shell and bolted to the top rails of the frames between the high pressure cylinders. Below this and forming the lower bearing for the pin is a frame cross tie secured to the bottom frame rails.

The pin is inserted from below and is held in position by a plate below it setting into a recess in the bottom casting. The design of this is clearly shown in the illustration.

*Frames.*—The frames are of the usual bar type 5 in. in width and 6 in. deep over the pedestal, except the front pedestal of each group, which is 6½ in. in depth and the rear pedestal of the forward group which has the same dimensions. The pedestal binders are of the usual type held in place by bolts passing through the bottom rail. The front frames terminate in a slab section, which is secured to the box casting as mentioned above. The rear group of frames terminate in a 2½ x 10½ in. slab section, which




FLEXIBLE STEAM CONNECTION TO LOW PRESSURE CYLINDERS.

forms a trailer truck frame, but is integral with the main frames. The frames on one of these locomotives were made of vanadium steel to the same dimensions as those shown in the illustrations.

*Centering Device.*—The weight coming on the front group of wheels is transferred to them at two points, one being located under the center of the combustion chamber 87 in. ahead of the center of the fulcrum pin and the other 61 in. in front of this or 148 in. ahead of the articulated connection. Both of these supports are, of course, of the sliding type, permitting the front group of wheels to move horizontally in relation to the boiler. The support at the combustion chamber consists of a cast steel saddle bolted to the shell and a steel box casting secured on top of the frame. Between these is a renewable cast iron bearing plate. The forward support is of the same general type, its saddle, however, being riveted to the boiler shell and it contains a spring centering device to bring the front group of wheels into alignment after passing through a curve. This arrangement is practically the same as was applied by these builders to the Great Northern locomotives of this type. The frame cross tie or bottom bearing is extended out on either side and carries two brackets at its outer end. These brackets carry a 1⅝ in. rod which passes through cored passages in the saddle casting and has four large washers, the inner two being secured to the rod and the outer two being free to move inward but prevented from outward movement. These outer washers take a bearing on the inside of the outer walls of the saddle casting. Between the two washers is a heavy coiled spring put in under slight tension. The operation of the device is as follows: When the front frames move sidewise relative to the boiler in taking a curve, they carry with them the rod and the spring on the inside of the curve is compressed, the outer washer bearing against the saddle wall and remaining stationary while the rod slips through it and the washer on the opposite end of the spring secured to the rod compresses the spring. The spring on the other side is simply carried inward between its washers without compression.

The extension of this frame cross tie is also used to support the ends of the longitudinal casting which extends outside the wheels between it and the guide yoke and carries the reverse shaft and link bearings.

Side pieces lipping over the saddle and secured to the frame casting prevent the frames from falling away from the boiler in case of derailment.

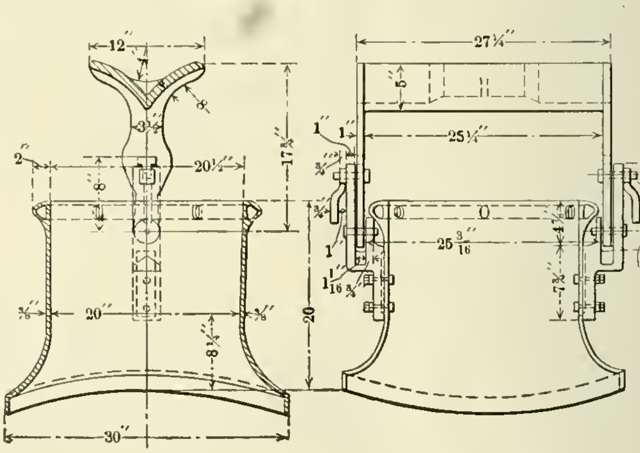
*Reversing Gear.*—As mentioned above, the two sets of valve gear are opposed for balancing each other, but even under these conditions the weight is too great to be handled conveniently by the ordinary reversing lever and the Raggonet power reversing gear, which was fully described on page 260 of the July, 1908, issue, is used. This gear is very similar to that used in marine practice and is operated by compressed air. It is self-locking and has proven to be most satisfactory in practice. From the reverse shaft on the rear engine the connection to the front reverse shaft is carried forward in the center of the locomotive, just above the frames, each shaft having a downwardly extending arm in the center. In order to prevent any derangement of the front valve adjustment when the locomotive is on a curve, a universal joint and bearing is provided in the reach rod where it passes through the high pressure saddle. This, as can be seen in the illustration, will permit free movement in both directions without any change in the length of the rod, and hence without movement to the front reversing shaft, when the forward group of wheels is swung out of line.

The stack is provided with a smoke deflector, arranged as the accompanying illustration shows. This is provided for use in tunnels in order to prevent the smoke from the stack mushrooming against the top of the tunnel and immediately coming down, thus cutting off the engineer's view. This deflector throws the smoke horizontally both ways and it is found that it will cling to the top of the tunnel and give the engineer a comparatively clear sight ahead.

## ADVANTAGES OF BRIQUETTED OVER RAW COAL.

In general the following advantages may be claimed for briquets made from bituminous coal over the same coal not briquetted:

Comparative absence of smoke.
Uniformity of size and quality.
Less loss of fuel in ash.
Increased furnace and boiler efficiency.
Reduced consumption of fuel per ton-mile.
More fuel can be burned per square foot of heating surface, hence greater capacity.



SMOKESTACK AND DEFLECTOR—S. P. MALLET.

Less slack in handling fuel.
Less clinker and cinders.
Longer life of grates.
Fires can be kept up for longer periods without cleaning.
Less cleaning of tubes.
Less labor in firing, hence greater efficiency of fireman.
Less draft needed.
More uniform steam pressure.
Steam pressure can be increased more rapidly.
No liability to spontaneous combustion.
Availability for storage without deterioration.—*C. T. Malcolmson before The International Ry. Fuel Assn.*

## AIR OPERATED DROP DOORS ON SUMMERS' ORE CARS

As stated in the August issue, page 338, in connection with the account of the results that the Summers' ore cars are giving in service on the Duluth & Iron Range Railroad, a part of these cars have been equipped with a device for operating the drop doors by air. Although the Summers' cars, when the doors are operated by hand, may be unloaded in very much less time and with fewer laborers than required for either the special ore cars or the ordinary type hopper car, the cars with the Summers' air operated doors may be unloaded in a fraction of the time required for those operated by hand.

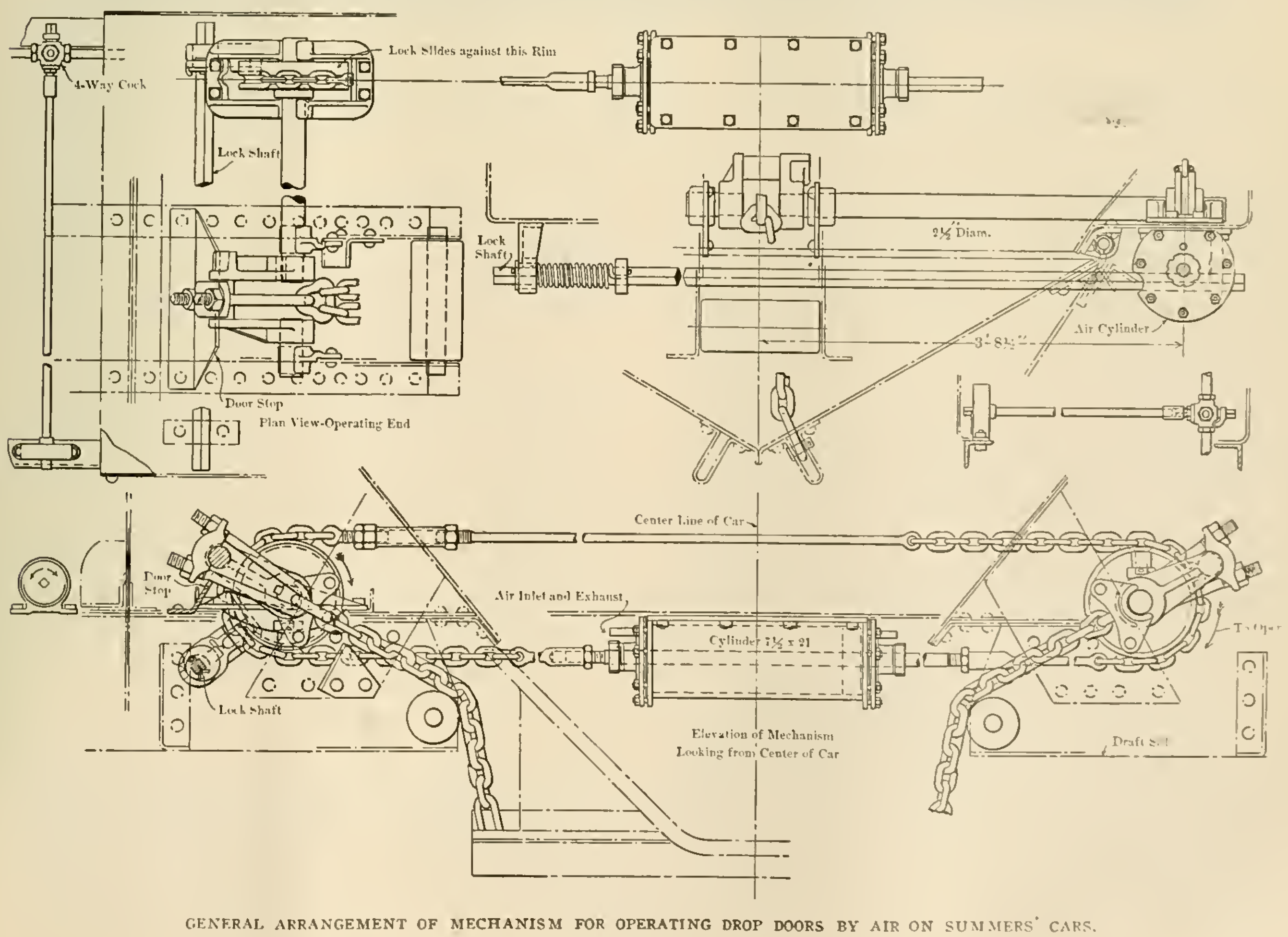
The Duluth, Missabe & Northern Railway Company recently borrowed a couple of Summers' cars from the lot of 800 furnished by the Summers Steel Car Company to the Duluth & Iron Range Railroad, in order to make some comparative tests of unloading a number of special ore cars. The results of these tests are shown in the following table. It will be seen that the Summers' cars required only one man for unloading as against four and eight on the other cars; also that the total time required for unloading was very much less, especially on the car equipped with the air operated doors, the performance of which was remarkable.

The general arrangement of the mechanism for operating the doors by air is shown on the drawing. The cylinder with the extended piston rod is bolted underneath the car at the side. The piston rod and the chain form a continuous belt over the sheaves at the outer end of the shafts which operate the cranks connected to the door chains. When the cranks are on the dead center at the upper end of the stroke, as shown, the doors are in a closed position. When in this position a lock, which slides against the rim of the sheave at the outer end of the operating shaft, engages a notch, thus locking the door closed. This lock is automatically operated by a spiral spring at the other end of the lock shaft.

To open the doors the lock shaft is given a quarter of a turn, thus unlocking the sheave; the four way valve which controls the air supply to the cylinder is then operated, causing the cranks to move in the direction indicated by the arrows on the drawing. Both the four-way valve and the lock-shaft may be operated from either side of the car. The valve is returned to its central or closed position by a spring in a case at the opposite end of the shaft, as shown. When the doors are wide open the cranks to which the door chains are attached are on the dead centers in the lower position. When the doors are closed there is a stop for the crank at the left just beyond the dead center, as shown. This device, which is patented, is simple and effective and should not easily get out of order.

| Number of Cars | Light Weight | Weight of Ore in Long Tons | Per Cent. Pay Load | Sq. Ft. Door Opening | Time Commence to Open Doors | Time Doors Closed | Total Time Consumed Min. Sec. | Number Men Working on Car: Winding Doors | Punching Ore | Cleaners and Bumpers |
|---|---|---|---|---|---|---|---|---|---|---|
| D. M. & N., 11,591 | 32,400 | 40-1,400 | 73.74 | 23.33 | 4: 18-50 | 4: 21-41 | 2-51 | 2 | 4 | 2 |
| D. M. & N., 8,930 | 32,200 | 38-2,140 | 73.54 | 20.85 | 4: 16-15 | 4: 18-29 | 2-14 | 2 | 4 | 2 |
| Summers, Hand Operated 9,985 | 31,000 | 38- 880 | 73.50 | 44.90 | 4: 10-51 | 4: 12-15 | 1-24 | 1 | 0 | 0 |
| Summers, Air Operated, 10,384 | 31,300 | 38- 780 | 73.29 | 44.90 | 4: 03-00 | 4: 03-14 | 0-14 | 1 | 0 | 0 |
| Clark, 170 | 32,000 | 37-1,920 | 72.60 | 35.50 | 4: 06-42 | 4: 10-00 | 3-18 | 2 | 0 | 2 |
| C. & N. W., 27,345 | 31,000 | 39- 440 | 73.90 | 43.00 | 4: 12-37 | 4: 15-51 | 3-14 | 2 | 4 | 2 |

NOTE.—D. M. & N., 11,591, had original doors re-arranged at Proctor. D. M. & N., 8,930, had standard style of doors used on steel cars. Weather Fair.

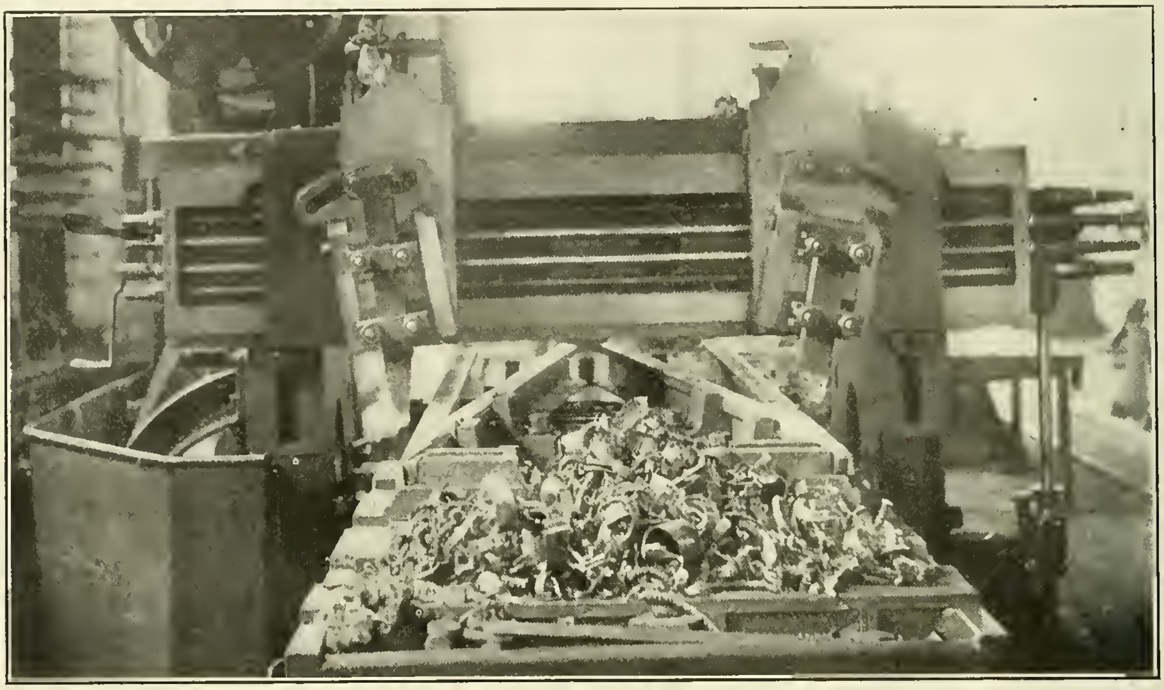



GENERAL ARRANGEMENT OF MECHANISM FOR OPERATING DROP DOORS BY AIR ON SUMMERS' CARS.

## GOOD PLANER RECORDS.

Splendid work is being done at the Toronto shops of the Grand Trunk Railway on some frog and switch planers, built by The John Bertram & Sons Co., Ltd., Dundas, Ontario. These planers are identical with the Niles-Bement-Pond planers, specially designed for this class of work.

An important feature in connection with the work on these machines is the fixtures for setting and holding the rails rigidly. These were designed by the foreman of the shop, Mr. Garden. The frog planer has a table 16 ft. long and in nine hours finished 32 frog points, removing 576 lbs. of metal. A view of part of this machine is shown in the illustration. The switch planer, with a table 23 ft. long, finished six pairs of 100-lb. rails in ten hours, removing 1,140 lbs. of material.



FROG PLANER AT THE TORONTO SHOPS—GRAND TRUNK RAILWAY.

It should be understood that these are not "break-neck" records with men clustered around the machine and every one keyed to the highest pitch, but are tests of what the machine is capable of doing under ordinary service conditions. Both of the machines are belt driven, but are arranged so that they may be changed to a motor drive in the future. The following data gives the time required for some of the different operations on 80-lb. rails, the men working on piece work. This is the time required for the average performance and is quite close to what was accomplished in the above mentioned tests. Cutting the side of the head on one rail required 15 strokes varying in length from short ones up to about 8 ft. The other rail was considerably harder and took 13 additional short strokes, the total time required being 12 minutes. Twelve strokes were required for planing the top of the rail, requiring seven minutes. Cutting off the flange, running back 11 or 12 ft., and cutting down to the web at the point required seven minutes.

"PENNSYLVANIA SPECIAL."—The Pennsylvania Railroad's eighteen-hour train between New York and Chicago has just completed a continuous record of four years' service. From June 12, 1905, when the train was started, to June 12, 1909, a total of 2,922 trips were made—1,461 in each direction—and upon 2,483, or 85 per cent. of these trips, the train was on time or within five minutes of its schedule at destination. The actual running time from Jersey City to Chicago is 17 hours and 41 minutes. The scheduled time is 57.2 miles per hour, or 1,061 minutes to cover 912 miles.

## THE SLIPPING POINT OF ROLLED BOILER TUBE JOINTS.*

When a boiler tube has started from its original seat the fit may be no longer continuous at all points and a leak may result, although the ultimate holding power of the tube may not be impaired. A small movement of the tube under stress is then the preliminary to a possible leak and it becomes of interest to know at what stress this slipping begins. A knowledge of the slipping point of a tube in its relation to the ultimate holding power is somewhat analogous to a knowledge of the elastic limit of materials in relation to their ultimate strength, in that working stresses should be kept within the smaller values.

The analogy is further warranted by the appearance of the load-slip diagram from such a joint, which has a general resemblance to stress-deformation diagrams of tension tests of steel.

Figure 1 is a typical diagram of the action of a 3-in. twelve-gage, Shelby cold drawn tube expanded into a straight machined hole in a 1-in. plate, the tube end projecting ½ in. and not flared

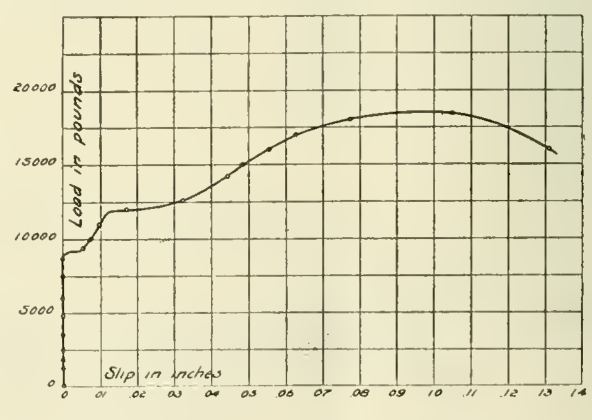



FIG. 1.

The figures to the left give the total force applied to pull the tube from its seat; the figures below, the total slip or movement of the tube through the hole. The curve shows the relation between the load applied and the corresponding slip

The tube in this joint began to move at 9,000 lbs. and shows a

* Abstract of a paper by Prof. O. P. Hood and Prof. G. L. Christensen presented at the December meeting of the American Society of Mechanical Engineers.

decided slip at 12,000 lbs, reaching an ultimate holding strength of 18,000 lbs.

There is a considerable probability that this joint would leak after the tube had slipped and be condemned because of its leakiness. This slip occurs at 50 per cent. of the ultimate holding strength of the joint and at 29 per cent. of the elastic limit of the material in the tube.

There is then a considerable field for improvement in which to raise the slipping point to a higher per cent. of the ultimate stength of the joint or of the elastic limit of the tube. The usual design seems sufficient for most cases, but where high pressures are used or where the stresses due to temperature variations are large, a joint with a higher initial slipping point seems necessary.

In many boiler designs a certain few of the tubes seem to be more highly stressed in service than others and for such designs a joint of high initial slip would be an advantage. As an illustration, a 3-in. tube under 225 lb. boiler pressure would be urged from its seat by a force of about 1,600 lbs. due to pressure alone. In many tests the initial slip comes at about 6,000 lbs. This gives a factor of safety of 3.75 within the slipping point to take care of the unknown temperature stresses. If the design calls on the tube to act as a stay and support the pressure of but 16 sq. in. this factor of safety within the slipping point is reduced to about 1.7.

In attempting to strengthen the usual joint it might appear that harder rolling of the tube would raise this slipping point, but experiment does not show this. Harder rolling within certain limits will raise the ultimate holding power but has little effect on the initial slip.

The recommendation to flare the projecting end of the tube has high authority and is of value, but while this raises the ultimate holding power it does not alter the original slipping point. It seems evident that this flared portion would have to be moved into the hole before its metal could come into play and this initial movement might be the cause of leakage.

If the holes into which the tubes are rolled are tapered 1-10 in. in diameter per inch in thickness of the plate the first slipping point is hardly affected, but the joint is more rigid after a slip of 1-100 in. and the ultimate strength is increased. In Figure 2 curves 12 and 35 represent the results from straight holes; while curves 6 and 38 are typical of those having tapered holes. These curves show the slipping points as agreeing in general, but those

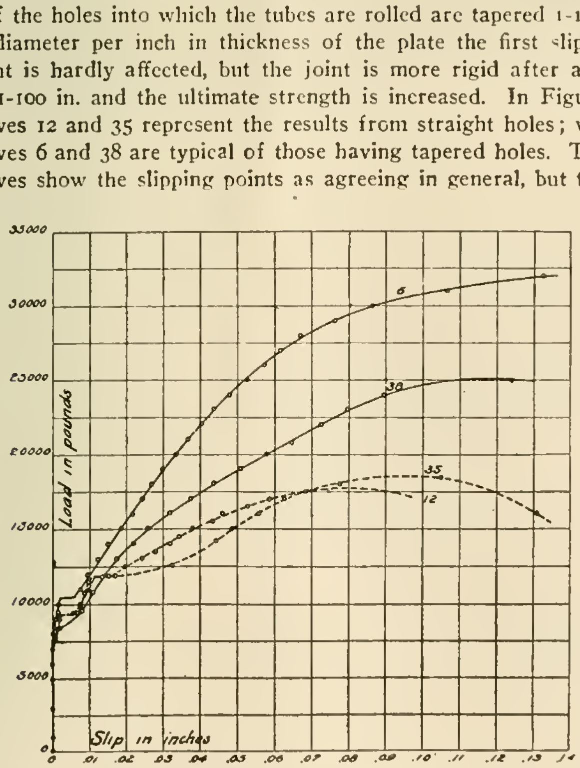



FIG. 2.

from tapered holes rise more rapidly and are thus more rigid.

During the progress of these experiments a form seemed wanted, to put the rolled metal under an initial stress in the direction of the axis of the tube, thus reinforcing the frictional resistance to the first slip. A tapered hole in the sheet was therefore given a reverse taper also, so that its smallest diameter was ⅛ in. from the tube side of the sheet.

This amounted to a slight chamfering of the inner side of the tube sheet. Rolling the tube against the two tapers would develop such stresses along the tube as should help to resist movement. In Figure 4 numbers 36, 44, 26, 25, 38 and 37 had double taper. Compared with the straight holes the general effect was to lower the slipping point somewhat but increase the rigidity.

A study of the several tests made shows that in the usual ma-

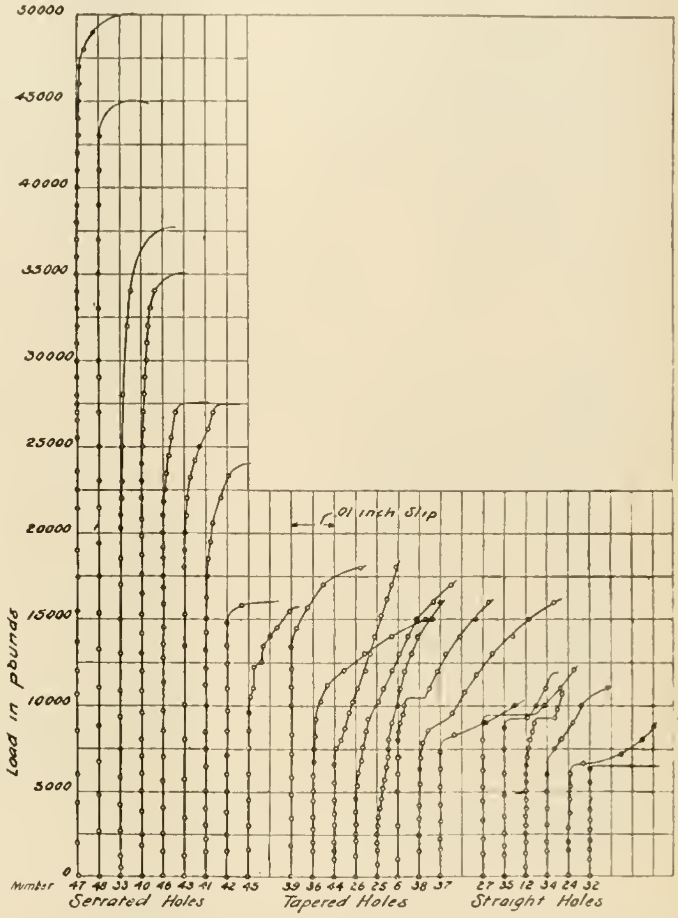



FIG. 4.

chined joint the resistance to the first slipping comes from friction only. The friction is dependent on the normal pressure of the expanded tube against the sheet and this will be a maximum when the rolled metal of the tube is stressed to its elastic limit. The rolling of the metal elevates the elastic limit, but it takes a small amount of rolling to reach this maximum value. Further rolling reduces the thickness of the metal in play as fast as the elastic limit is exalted.

Assuming the elastic limit of the rolled metal at from 30,000 to 40,000 lbs., the observed slipping point shows that the coefficient of friction must have been 35 to 26 per cent. The total friction per square inch of tube bearing area seems to be about 750 lbs. in tube plates ⅝ and 1 inch thick. It was observed that in straight and tapered holes wherever a high final strength was attained the metal of the tube was in some way abraded. Sometimes the sharp edge of the tube plate would shear a small ring from the metal of the tube and in other cases patches of the metal had apparently seized and sheared. Computing the probable frictional resistance of these joints and adding the resistance of the sheared area shown on the tube gave a result agreeing closely with the observed ultimate strength of the joint as tested.

Most of these joints also showed a relatively high slipping point, suggesting the necessity of providing shearing resistance in addition to frictional resistance in order to obtain a high resistance to initial slip. Several forms were therefore made which provided square shoulders in the tube sheet for the tube to be rolled against, with the object of making these several edges abrade the tube when it started to move. This serrating of the holes amounts to but little more than a "rough cut" in machining

| Form of Joint | Taper per inch | Test No. | Load in pounds at point of: Initial Slip | Slip = 1/100 inch | Ultimate Load | Slip in inches at point of Ult. Load |
|---|---|---|---|---|---|---|
| Tube Sheet 1" thick | | | | | | |
| Straight and Tapered | | 1 | 7800 | 8000 | 8400 | .02 |
| | | 2 | 7800 | 9500 | 11400 | .05 |
| | .06 | 7 | | | 17200 | .12 |
| Flared, Straight, and Tapered | .06 | 4 | 6000 | 10300 | 11500 | .07 |
| Flared, Chamfered, Straight, and Tapered | .06 | 5 | 4000 | 7600 | 15000 | 06 |
| Tapered and Straight | .06 | 3 | 7000 | 7800 | 26000 | .112 |
| Double Taper | | 8 | 15000 | 17500 | 30000 | .04 |
| | .10 | 9 | 14500 | 15500 | 21000 | |
| Tube Sheet 5/8" thick | | | | | | |
| Straight | | 11. | 5000 | 6100 | 6400 | .03 |
| | | 15 | 4500 | 7000 | 9500 | .04 |
| | | 16 | 3700 | 5900 | 17000 | .088 |
| Punched | | 18 | 8000 | 14700 | 17000 | .044 |
| Double Taper | .10 | 23 | 6500 | 12000 | 16000 | .04 |
| Tube Sheet 1/2" thick | | | | | | |
| Straight | | 10 | 2000 | 5600 | 7400 | .03 |
| | | 14 | 2000 | 6800 | 9500 | .035 |
| | | 17 | 3000 | 6000 | 20000 | .06 |
| Punched | | 19 | 10000 | 17200 | 17500 | .022 |
| | | 20 | 3500 | 17000 | 23000 | .036 |
| Double Taper | .10 | 22 | 7000 | 15000 | 27000 | .048 |
| Tube Sheet 3/8" thick | | | | | | |
| Straight | | 13 | 1300 | 7000 | 18000 | .045 |
| Punched | | 21 | 8000 | 15200 | 16500 | .027 |

| Form of Joint | Serrations: Number per inch | Serrations: Depth in inches | Test No | Load in pounds at point of: Initial Slip | Slip = 1/100 inch | Ultimate Load | Slip in inches at point of Ult. Load |
|---|---|---|---|---|---|---|---|
| Tube Sheet 1" thick | | | | | | | |
| Straight Machined Hole | | | 12 | 7000 | 11500 | 17700 | .085 |
| | | | 24 | 6000 | 7000 | 20000 | .12 |
| | | | 27 | 9000 | 9500 | 21000 | .10 |
| | | | 32 | 6400 | 6000 | 6400 | – |
| | | | 34 | 6800 | 10500 | 11500 | .035 |
| | | | 35 | 8800 | 11200 | 18400 | .105 |
| Average | | | | 7333 | 9283 | 15833 | .089 |
| Double Taper (Taper 1/16" in diam. per inch) | | | 25 | 3500 | 14000 | 23000 | .08 |
| | | | 26 | 5500 | 12800 | 19700 | .047 |
| | | | 36 | 8200 | 12600 | 16500 | .042 |
| | | | 37 | 7500 | 8900 | 23000 | .178 |
| | | | 38 | 7000 | 10300 | 25000 | .124 |
| | | | 44 | 7500 | 14400 | 33000 | .069 |
| Single Taper | | | 6 | 8500 | 12200 | 32000 | .133 |
| | | | 39 | 13500 | 17500 | 22600 | .354 |
| Average | | | | 7650 | 12837 | 24350 | .128 |
| Serrated | 10 | 005 | 45 | 10000 | 15500 | 15800 | .015 |
| | 10 | 010 | 46 | 22000 | 27500 | 27500 | .008 |
| | 10 | 015 | 47 | 45000 | 50000 | 50000 | .012 |
| | 10 | 020 | 48 | 43000 | 45000 | 45000 | .003 |
| Serrated | 10 | 015 | 33 | 23000 | 37500 | 37700 | .012 |
| | 10 | 015 | 40 | 25000 | 35000 | 35000 | .01 |
| | 10 | 007 | 41 | 16500 | 23800 | 24200 | .015 |
| | 16 | 007 | 43 | 21000 | 27200 | 27200 | .006 |
| | 64 | 002 | 42 | 15000 | 16000 | 16000 | .010 |

FIG. 3.

Figure 3 gives the significant results obtained in several series of tests and Figure 4 shows them graphically up to the slipping point.

To discover how much roughening was desirable a series of tests were made with straight holes, in which a shallow square thread was cut with a pitch of ten threads to the inch and from 0.005 to 0.020 in. deep. The tube ends were not flared. No. 45, 46, 47, 48 show the results from these serrated holes, in which it appears that the slipping point may be very greatly elevated by this means.

With serrations 0.005 in. deep the surface is barely roughened and the slipping occurs at 10,000 lbs. This is increased successively to 16,000, 22,000 and 45,000 lbs. by increasing the depth of the grooves to 0.007, 0.010, and 0.015 in., respectively. The elastic limit of the tube is reached in tension at about 34,000 lbs. and this load was exceeded by a number of the tubes before there was any slip.

In test 41 the hole in the tube sheet was serrated by rolling with an ordinary flue expander, the rolls of which were grooved 0.007 deep and 10 grooves to the inch. This method of serrating is easy and can be recommended where tubes are giving trouble from slipping and are required to carry an unusual load.

This tube has the slipping point raised to three or four times the usual value. It appears that with serrations about 0.015 inches deep giving an abutting area of about 1.4 sq. in. in a seat one inch wide that the maximum strength is reached as shown in tube 47.

SUMMARY.

*a* The slipping point of a 3-in. twelve-gage Shelby cold drawn tube rolled into a straight smooth machined hole in a 1-in. sheet occurs with a pull of about 7,000 lbs.

*b* Various degrees of rolling do not greatly affect the point of initial slip.

*c* The frictional resistance of such tubes is about 750 lbs. per square inch of tube-bearing area in sheets 5/8 inch and 1 inch thick.

*d* For a higher resistance to initial slip other resistance than friction must be depended upon

*e* Serrating the tube seat in a straight machined hole by rolling or cutting square edged grooves about 0.01 in. deep and ten pitch will raise the slipping point to three or four times that in a smooth hole.

*f* It is possible to make a rolled joint that will offer a resistance beyond the elastic limit of the tube and remain tight.

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Central Railway Club.—The next regular meeting will be held at Buffalo on Friday, September 10. The annual fall outing will be held at this time, the boat leaving the foot of Main street at 10 A. M., the trip being down the north channel of the Niagara River, around Grand Island and thence to Electric Beach on the American side, where a fish and chicken dinner will be served. There will be music and refreshments on board. Tickets for the dinner will be 50 cents for members and $1.00 for guests. The evening meeting will be held at the Hotel Iroquois at eight o'clock, the paper being an illustrated lecture on "The Safe Transportation of Explosives and Other Dangerous Articles" by Col. B. W. Dunn.

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During 1908 the New York street cars killed 444 persons and injured 35,060 others.

## WOOD'S FIREBOX AND TUBE PLATES FOR HEAVY CONSOLIDATION LOCOMOTIVE.

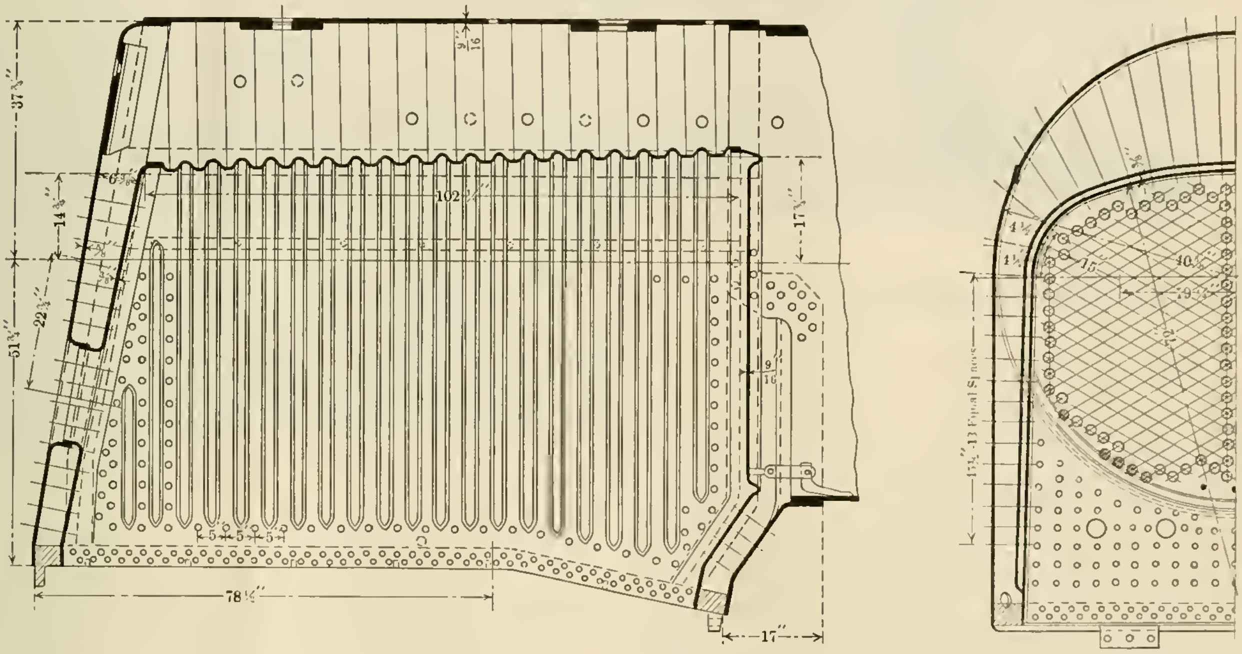
CHICAGO, BURLINGTON & QUINCY RAILROAD.

The accompanying illustrations show the details of the firebox and tube plates which are being applied to the boiler of a heavy consolidation locomotive on the Chicago, Burlington and Quincy Railroad by the William H. Wood Locomotive Firebox and Tube Plate Company, of Media, Pa.

This locomotive is known as Class D4, and was fully described on page 48 of the February, 1903, issue of this journal. It has 22x28-inch cylinders, 57-inch drivers, and 210 pounds steam pressure giving a tractive effort of 42,500 pounds. The weight is 202,600 pounds, of which 179,200 pounds is on drivers.

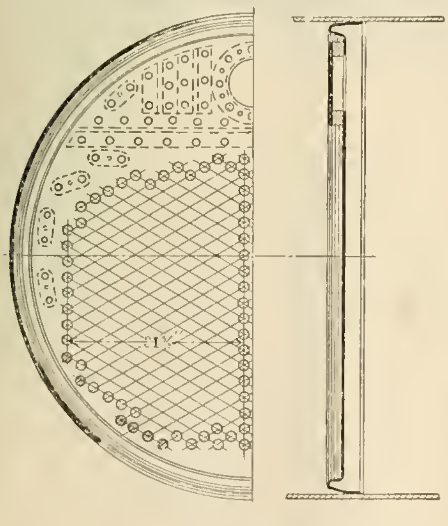
The firebox is of the flexible type, permitting longitudinal expansion of the side and crown sheets to be taken up by the corrugations between the staybolts, in addition to flexible tube plates, front and back, which take care of the expansion of the tubes as well as the firebox plates, and prevent the concentrating of the expansion stresses at any one point, which, no doubt, in the ordinary boiler, is responsible for much of the trouble with leaky tubes and stays and cracked side sheets.

RAILROAD Y. M. C. A.—We believe that the Railroad Y. M. C. A. has been and is doing a very necessary work for the social, mental and physical improvement of our employees, and because of this opinion the Grand Trunk Railway Company has contributed to December 31, 1907, the sum of $72,758 toward the construction, enlargement and improvement of the fourteen associations located at division points on our system of railways. The company is also contributing a large sum per annum towards the expenses of operating and maintaining these associations, with the belief that the indirect benefit in a financial way is in excess of the amount expended, because of the better condition of our men, both mentally and physically, to perform their duties in connection with the operation of our trains, the maintenance of our road and the service generally.—*Chas. M. Hays, Second Vice-President and General Manager.*

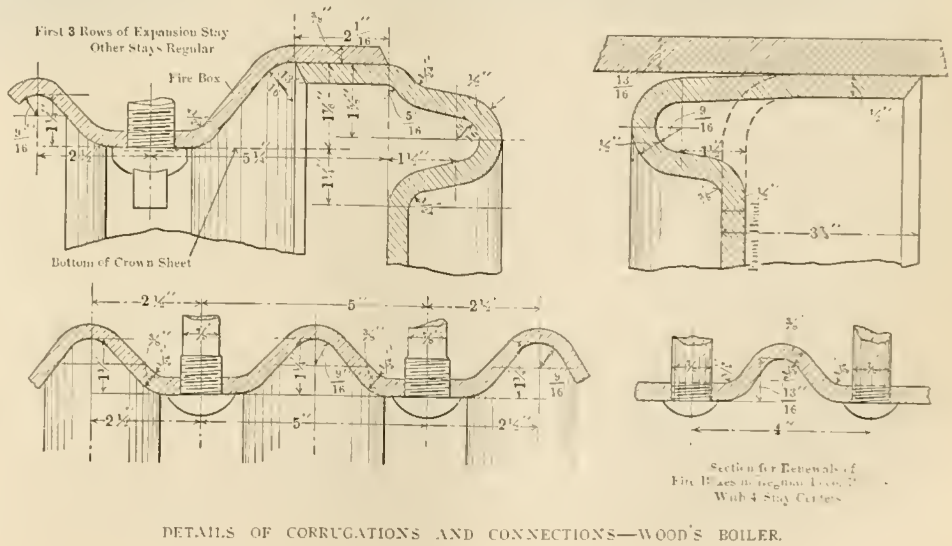


WOOD'S FLEXIBLE FIREBOX AND TUBE PLATES APPLIED TO C. B. & Q. LOCOMOTIVE.

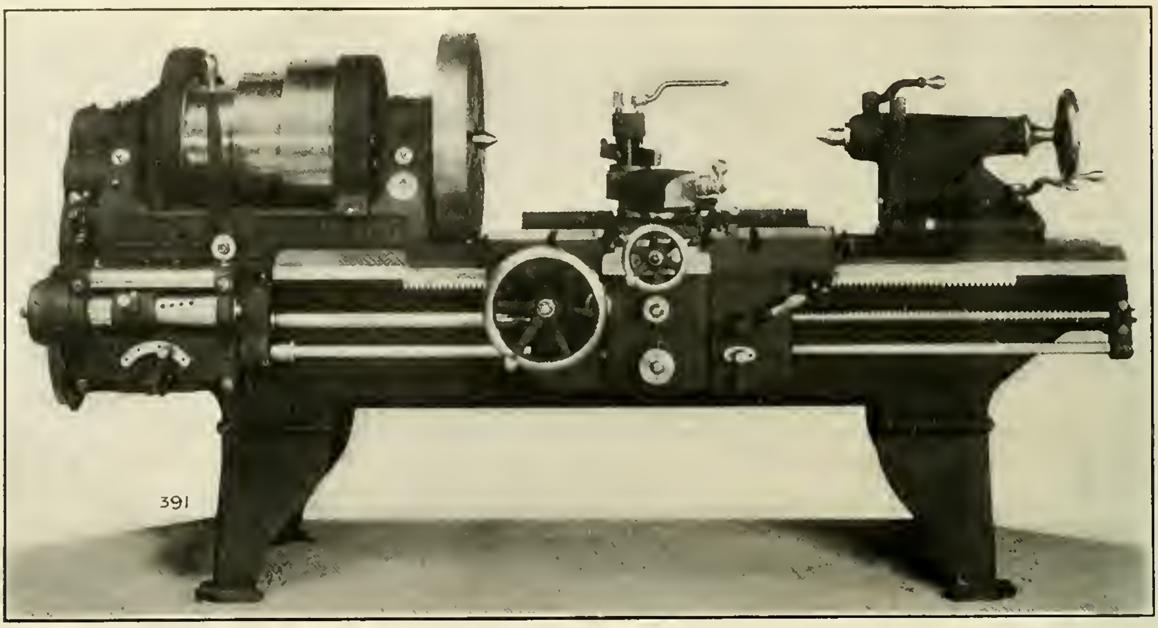
HIGH SPEED TWIST DRILLS.—The cutting angles and clearances of high speed twist drills are most important features. Should the points of a drill be unevenly ground (and it does not break in work), it will be found to bore an eccentric hole, one lip having done all the duty. The lips must be of equal length and at the same angle. The angle of the cutting point should be 59 degrees for steel, but for cast iron it may be much more pointed. At Clyde Works an angle of 45 degrees has been adopted for experimental work on cast iron.—*Fred M. Osborn before the Leeds Assn. of Engineers.*



FRONT TUBE SHEET.




DETAILS OF CORRUGATIONS AND CONNECTIONS—WOOD'S BOILER.



TWENTY-INCH HEAVY DUTY ENGINE LATHE.

## HEAVY DUTY ENGINE LATHES.

The R. K. LeBlond Machine Tool Co.*

A given number of cubic inches of metal removed per minute is the basis of a design of a new line of heavy duty engine lathes, which have recently been perfected by the R. K. LeBlond Machine Tool Co. The lathe shown in the illustration is the 20-inch size, and is capable of taking a cut ¼-inch deep with $1/_{6}$-inch feed at the rate of 65 feet per minute on a piece of 50-point spindle steel, which gives it a capacity of removing 32 cubic inches of this very tough material per minute. In addition to the 20-inch size the same machine is also made in 16, 24 and 30-inch sizes.

Although there are a large number of new ideas presented in the construction of this lathe there is nothing which might be called a radical departure from previous practice, and it has been the aim of the manufacturers to produce a tool without complications, easy to manipulate, of great rigidity and capable of transmitting a large amount of power.

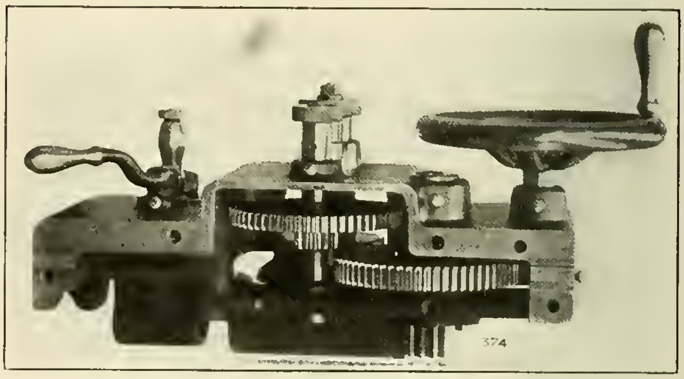
Considering some of the details separately, the head stock is of the drop-braced pattern, of great rigidity and is securely fastened to the bed with bolts of large diameter. A three-step cone used in connection with friction back gears and a two-speed countershaft, which gives 18 changes of spindle speed covering a carefully selected range.

The hollow spindle, which is made of high carbon hammered steel, has hardened and ground front and rear journals. These journals are carried in special cast-iron boxes, carefully scraped to a bearing. This type of bearing does not require intricate oiling devices with continual attention from the operator, but the lubrication is, nevertheless, well taken care of. The bearing pedestals are cored out to form large oil chambers, filled from the front of the lathe, from which the oil is fed to the bearings by means of felt pads. This construction precludes all possibility of grit entering the bearing and reduces the attention required to a weekly filling of the oil receptacles.

The tail stock slides on a V of the usual proportions on the rear way, and on a flat surface in front. The carriage travels on a flat surface on the back and is held down at that point by a flat gib. The front of the carriage slides on a guide, however, of different shape than that usually found on engine lathes. This guide, or V, as is shown in one of the illustrations, is machined at an angle of 15 degrees on the front side and 70 degrees back angle. It is well known that the force exerted downward on the carriage of an engine lathe is many times the outward pressure, and in designing this bed the wearing surfaces have been proportioned accordingly.

The bed, in addition to having an unusually deep section, is reinforced and braced by a transverse rib of I-beam section, directly under the front bearing; this extends up to the extreme top of the bed. In addition the metal around the holding-down bolts has been reinforced to about three times the thickness usually found at this point.

The carriage is extremely rigid and is carefully scraped to a bearing for its entire length on the bed. It is held in perfect alignment by taper gibs on either end bearing on a scraped surface at the front of the bed, which, together with the 70-degree



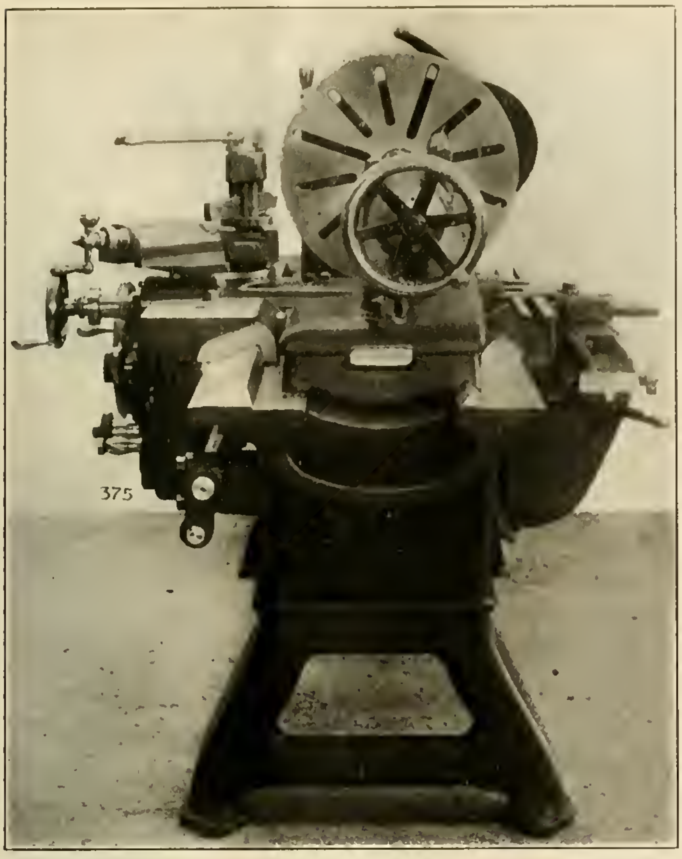
TOP VIEW OF APRON.

back angle on the V, overcomes any tendency to climb the ways when engaged on heavy work. These gibs are tongued in position on the carriage and they, together with the form of V, form a construction that automatically compensates for wear and makes it unnecessary to give any attention to the adjustment of the gibs. Carefully designed wipers are provided, fitted with felt pads, which in addition to wiping off any grit also automatically oil the sliding surfaces.

The spindle, as will be seen, is set back some distance from the center of the shears, which not only gives an increased swing over the carriage, but at the same time permits the machine to be used at full swing without the tool overhanging the bed. This gives great rigidity on work of large diameters.

The apron is a one-piece box section casting, with all gears and studs supported at either end. The top view clearly shows

* Cincinnati, Ohio.



VIEW SHOWING OFFSET OF SPINDLE AND SHAPE OF GUIDES.

the wide bearing by which it is attached to the carriage. The tongue is accurately fitted to the carriage and the apron is rigidly held in position by four bolts of large diameter. This single box section form of apron does away with the necessity of an auxiliary support at the lower end and overcomes the difficulty of uneven wear between such lower slides and the V on the top of the bed.

The longitudinal and cross feeds are operated by a single friction, which, in addition to being of large diameter, is so placed in regard to the gearing, that it has but a slight duty to perform. The feeds are engaged in the apron by an in and out movement of the knob shown on the front. This moving member has a central position, which disconnects all the gearing when a lathe is used for screw cutting. The apron is further provided with a device which makes it impossible to engage the feed rod and lead screw at the same time.

The tail stock is of massive design with bearing of ample length on the bed and rigidly clamped by two clamping bolts of large diameter, centrally located between the shears. The tail spindle barrel is designed in such manner to give the maximum length of bearing and long travel. Suitable screws are provided for setting over for taper work, the base being graduated so that this setting can be easily accomplished.

The quick change gear box supplied with these lathes is said to be the only device of this kind on the market in which the entire mechanism is contained in one unit. Nine changes of speed are obtained by means of a cone of gears and the tumbler. It will be seen that this tumbler gear is supported on a large cylindrical bearing and is securely locked in position by the plunger in the change handle. This construction has been used on the lathes manufactured by this company for some time. The nine changes mentioned above are quadrupled by the addition of the sliding gear transmission, which is well illustrated in one of the cuts. This construction permits the use of a direct reading index plate, from which the operator can read the position of the levers instantly. The 36 changes of threads, ranging from 2 to 30, are all made while the lathe is running under the heaviest cut. The gears in this box, as well as all other feed gears, are made from drop-forged steel. The feed rod is driven by the same mechanism, suitable gears connecting it with the lead screw, giving a feed range from 8 to 120.

The feed box is connected to the spindle by means of gears, the intermediate one of which is mounted on a quadrant, which permits the use of special or compound gearing at this point to cut special threads or metric threads with the U. S. S. standard lead screw or vice versa.

## THE TENDENCY OF LOCOMOTIVE BOILER DESIGN IN EUROPE.

The conclusions of subject VI, sections A and C, on the question of improvements in locomotive boilers covering Belgium, Spain, France, Italy and Portugal, and printed in the bulletin of the International Railway Congress, are as follows:

Section A—

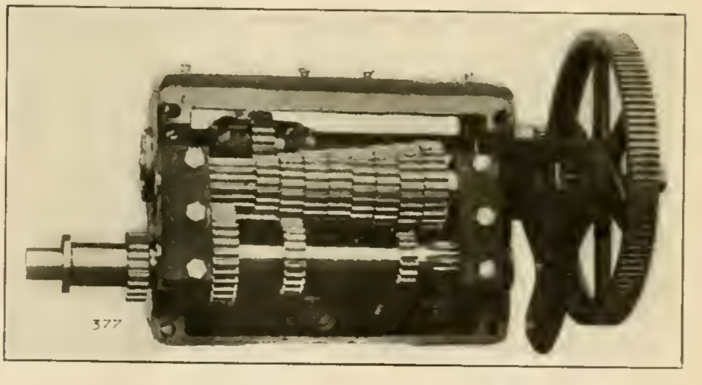
The actual tendencies as regard the construction of fire-tube boilers are: The retention of copper fire-boxes; the use of stays in the fire-boxes; the introduction of rocking grates; the adoption of steel tubes, except where the water is bad; a fall in the favor with which ribbed tubes have been regarded during the last ten years or so; the application of means for reducing leakage at the tubes and damage to the tube-plates without any definitely successful results having yet been obtained in this direction.

Section C—

The principal damage to boilers due to: Cracks in the fire-box tube-plate, in the bends and in between the tubes; the wear of the lower part of the fire-box plates around the heads of the stays; cracks and grooves in the front and back plates of the fire-box and in the tube-plate of the smoke-box; pitting and general surface corrosion in the lower part of the barrel and along the seams.

Water of bad quality accelerates the production of these defects.

Consequently, the purification of feed water of medium quality is to be recommended; it becomes indispensable when the water contains a large proportion of alkaline earth salts. But in order to prevent priming, the purified water should contain as little sodium salts as possible.

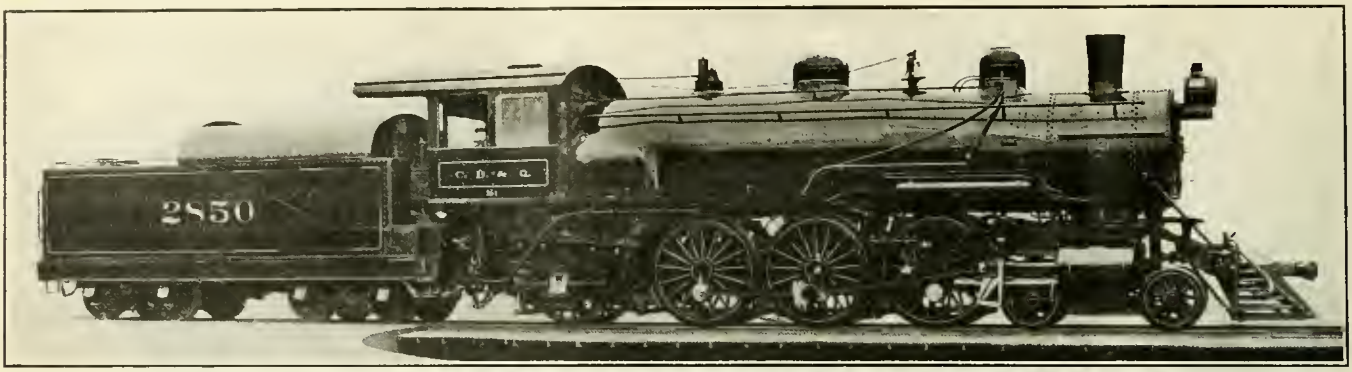


QUICK CHANGE GEAR BOX.

The use of disincrustants is also to be recommended, although they do not do away with the formation of scale and are only a palliative.

Washing out the boilers with hot water and blowing off under pressure help to keep the boilers in good condition.

Organization.—Organization presupposes an organizer. Upon him, then, depends success. The call is for industrial leaders able to see broadly over the needs of a business, to subdivide and plan its work into departments, to understand men and study their personalities, to train them and to select the right man specialized and qualified for each place.—*Prof. H. Wade Hibbard before the St. Louis Railway Club.*



PACIFIC TYPE LOCOMOTIVE—CHICAGO, BURLINGTON AND QUINCY RAILROAD.

## PACIFIC TYPE LOCOMOTIVE.

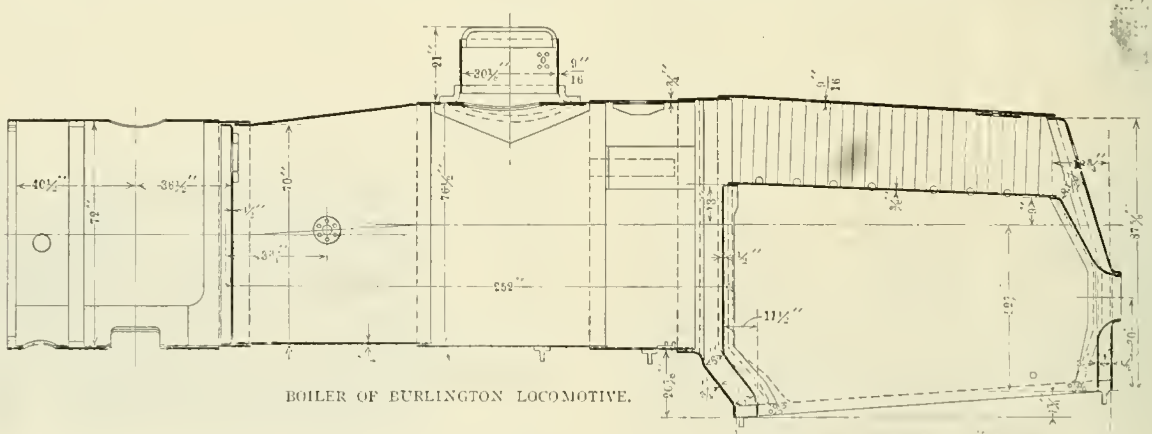
Chicago, Burlington & Quincy Railroad.

About three years ago the Chicago, Burlington & Quincy Railroad received thirty large Pacific type locomotives from the Baldwin Locomotive Works, which were illustrated and described on page 300 of the August, 1906, issue of this journal. These engines were built to specifications furnished by the railroad company and were a direct development from the Prairie type locomotive which has been in most successful use on that road for a number of years. The satisfactory performance of the new type is evidenced by the fact that the same builder has recently delivered an order of 25 more of practically the same weight and size. The chief changes made in the new design are in the use of the Walschaert valve gear in place of the Stephenson and in minor boiler alterations.

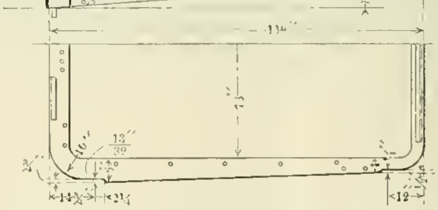
Since the same cylinder pattern was used as on the former order with Stephenson valve gear, which locates the 12 in. piston valve inside the cylinder and between the top and bottom frame rails, it was necessary to incorporate a rocker in the valve gear. One of the illustrations shows the design of this rocker, which is made of cast steel in webbed section of unusual rigid and strong design. It is swung from a steel shaft carried by bearings secured to the guide yoke and resting on top of the frame. The inner arm is slightly longer than the outer and connects to the valve stem by a link. This arrangement makes an admirable support for the weight of the gear and eliminates all possibility of the valve rod getting out of line because of the weight carried by it. The valve gear links are carried outside of the front driving wheel, being supported by longitudinal bearers connecting the guide yoke with the frame cross-tie between the first and second drivers, this being the same general arrangement that is commonly used on Pacific type locomotives.

The boiler, while very similar and of practically the same size as was used before, contains a novelty in the shape of a side water leg, which is 4 in. wide at the mud ring at the back end of the firebox and 6 in. wide at the forward end of the firebox, the mud ring being tapered, as is shown in the illustration. The number of flues has been reduced by ten to 293, the same diameter and length, however, being maintained. This reduces the total heating surface slightly, but not sufficient to affect the ratios materially. The grate area and size of firebox remains the same as before. The crown sheet has four rows of expansion links at the front end and the throat sheet completely encircles the barrel, being flanged out of a single plate. The safety valves and whistle are mounted on an auxiliary dome just ahead of the firebox. The smoke box has a short extension and is fitted with a spark hopper and low single exhaust nozzle.

The design of the frames is shown in the illustration. They are of cast steel, the front rail of the main frame extending to the front of the cylinders only. The cast steel bumper plate is braced by supplementary lower frames set at 23 in. centers, being secured below the cylinders and extending to the bumper beams. The rear frames, as has been the practice of this company from the beginning, are placed outside the trailer wheels and are connected to the main frames by a substantial steel casting. The trailer wheels are allowed a limited amount of side play and the boxes are braced transversely by tie rods. The load is transferred to the box through cast iron plates having inclined sliding surfaces.



BOILER OF BURLINGTON LOCOMOTIVE.



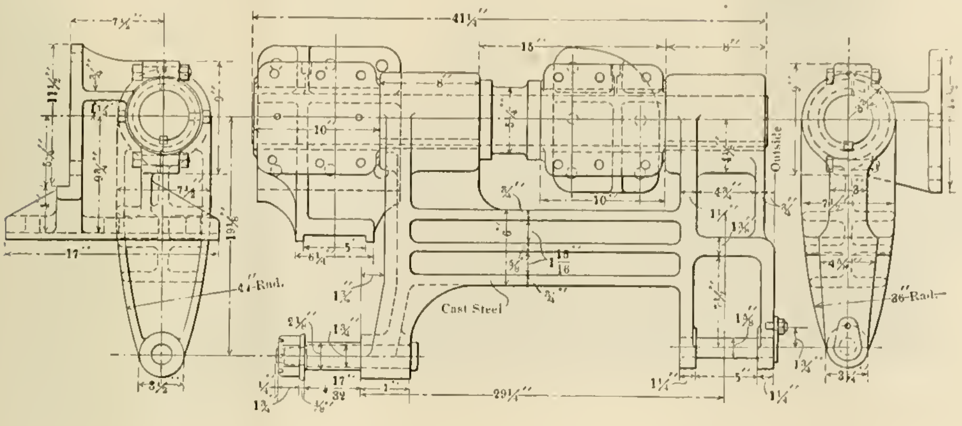
The general dimensions, weights and ratios of these locomotives are as follows:

GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Service | Passenger |
| Fuel | Bit. Coal |
| Tractive effort | 31,100 lbs. |
| Weight in working order | 234,900 lbs. |
| Weight on drivers | 160,150 lbs. |
| Weight on leading truck | 37,400 lbs. |
| Weight on trailing truck | 37,350 lbs. |
| Weight of engine and tender in working order | 390,000 lbs. |
| Wheel base, driving | 12 ft. 10 in. |
| Wheel base, total | 32 ft. 9 in. |

| | |
|---|---|
| Wheel base, engine and tender | 64 ft. 3¼ in. |
| **RATIOS.** | |
| Weight on drivers ÷ tractive effort | 5.17 |
| Total weight ÷ tractive effort | 7.55 |
| Tractive effort × diam. drivers ÷ heating surface | 605.00 |
| Total heating surface ÷ grate area | 69.20 |
| Firebox heating surface ÷ total heating surface, per cent | 5.10 |
| Weight on drivers ÷ total heating surface | 42.40 |
| Total weight ÷ total heating surface | 61.30 |
| Volume both cylinders, cu. ft | 12.30 |
| Total heating surface ÷ vol. cylinders | 310.00 |
| Grate area ÷ vol. cylinders | 4.48 |
| **CYLINDERS.** | |
| Kind | Simple |

| | |
|---|---|
| Tubes, length | 21 ft. |
| Heating surface, tubes | 3,610 sq. ft. |
| Heating surface, firebox | 194 sq. ft. |
| Heating surface, total | 3,804 sq. ft. |
| Grate area | 55 sq. ft. |
| Smokestack, height above rail | 182 in. |
| Center of boiler above rail | 109⅞ in. |
| **TENDER.** | |
| Tank | Water Bottom |
| Wheels, diameter | 37¼ in. |
| Journals, diameter and length | 5½ × 10 in. |
| Water capacity | 8,200 gals. |
| Coal capacity | 13 tons |

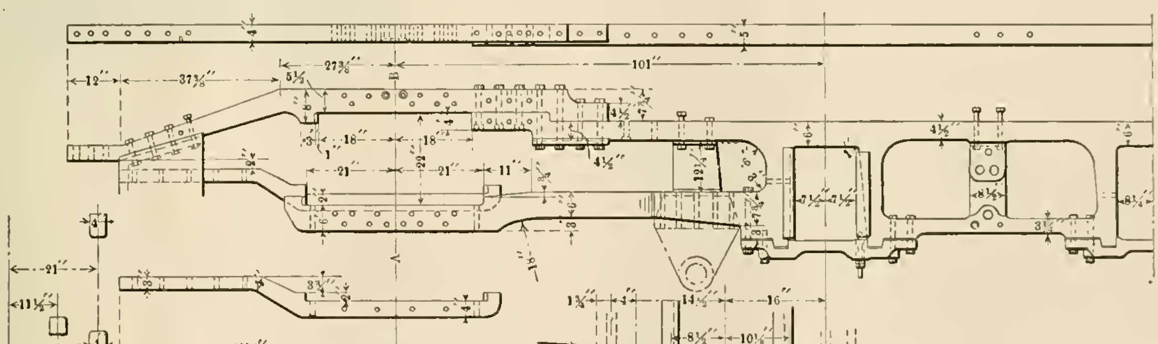


ROCKER ARM AND SUPPORT—BURLINGTON LOCOMOTIVE.

| | |
|---|---|
| Diameter and stroke | 22 × 28 in. |
| **VALVES.** | |
| Kind | Piston |
| Diameter | 12 in. |
| Greatest travel | 5¾ in. |
| Outside lap | 1⅛ in. |
| Inside clearance | ⅛ in. |
| Lead, constant | ¼ in. |
| **WHEELS.** | |
| Driving, diameter over tires | 74 in. |
| Driving, thickness of tires | 4 in. |
| Driving journals, diameter and length | 10 × 12 in. |
| Engine truck wheels, diameter | 37¼ in. |
| Engine truck, journals | 6 × 12 in. |
| Trailing truck wheels, diameter | 48¼ in. |
| Trailing truck, journals | 8 × 12 in. |
| **BOILER.** | |
| Style | W. T. |

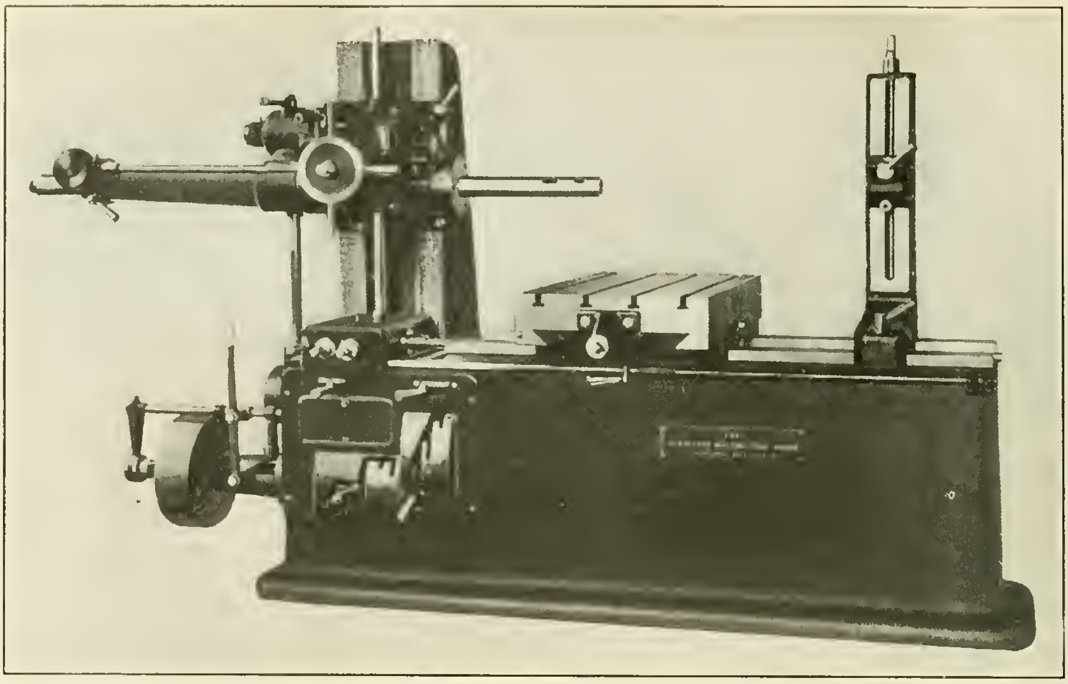
THE EXTENT OF THE HARRIMAN LINES.—One can leave New York on a Southern Pacific Company steamship, transfer to the Sunset Lines at New Orleans, board a Pacific Mail steamer at San Francisco and land at Hong Kong, a total journey of 9,902 miles, without leaving Harriman Lines. On the completion of the lines now under construction between Seattle and Portland, and between Culiacan and Guadalajara, Mexico, a traveler will be able to make a continuous trip on Harriman rails from Seattle, in latitude 47° 30", to Guadalajara, in latitude 22°, a distance of 3,169.4 miles; or from Seattle to New Orleans, a distance of 3,441.4 miles.—*J. Kruttschnitt before the New York Railroad Club.*

FRICTION METAL SAWS.—An explanation of the manner in which a soft steel disk, revolving at high velocity, cuts hard steel has been sought with the aid of a microscopic inspection. The result corroborates the theory that the material acted upon is heated at the place of contact to the fusing point and then brushed away. The high temperature appears to be confined very narrowly to the point of contact, so that a thin gash is cut. The temperature of the revolving disk does not rise so high because of the large surface area of the disk. The part of the disk in contact is continually changing, while the frictional energy is concentrated on a very small area of the material subjected to its action.—*The Practical Engineer.*



FRAMES—BURLINGTON PACIFIC TYPE LOCOMOTIVE.

| | |
|---|---|
| Working pressure | 200 lbs. |
| Outside diameter of first ring | 70 in. |
| Firebox, length and width | 108⅛ × 72¼ in. |
| Firebox plates, thickness | ⅜ & ½ in. |
| Firebox, water space | F.-6, S.-6 to 4, B.-4 in. |
| Tubes, number and outside diameter | 293—2¼ in. |



CLEVELAND HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

## HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

In designing this machine, manufactured by the Cleveland Machine Tool Works, Cleveland, O., ease and convenience of operation have been carefully studied. The spindle runs in solid taper bearings with adjustment for wear and has a face plate to receive large milling cutters for heavy work. It revolves in either the right or left hand direction and may be started, stopped or reversed instantly, this feature being convenient for facing, tapping, milling and other operations. The spindle and back gear drive is located between the spindle bearings. The levers for operating the back gear and for reversing the spindle are located on the head and can be engaged or disengaged while the machine is in operation.

The spindle bar has a traverse of 22 inches and may be fed by power in either direction. It is operated by a pilot wheel on the head for both the hand feed and the quick traverse; when used for face milling purposes it may be securely clamped in position. The platen has a working surface of 20 x 36 in., with a traverse of 24 in. Both the platen and the carriage have micrometer dials on the adjusting screws. The outer support for the boring bar may be easily removed for overhanging work; provision is made for aligning it accurately with the spindle head.

Twelve spindle speeds are provided in geometrical progression, the gear ratio from the spindle to the driving shaft being 7 to 4 in single gears. Sixteen positive feeds are provided, ranging from .005 to .3 in. per revolution of the spindle. The deep box construction of the bed, together with internal ribs, makes a foundation unnecessary. Two chutes are provided which carry away the chips. The machine weighs about 6,000 lbs., occupies a floor space of 11½ x 6 ft. and has a maximum distance from the face plate to the out-board support of 4 ft. 6 in.

## OXY-ACETYLENE WELDING OF FIRE-BOXES.

At the recent convention of the International Boiler Makers' Association, M. S. Courtney, general boiler inspector of the Great Northern Railway, St. Paul, Minn., described the process of oxy-acetylene welding in use on the Great Northern Railroad. Patches are now welded into the side sheets of fire-boxes by the oxy-acetylene process in comparatively short time with gratifying results, and thus far the work has been absolutely satisfactory, with no sign of leakage. The oxygen is generated from chloride of potash and dioxide of manganese. The acetylene generator is one which was designed by Mr. Emerson, who also developed the blow torch which is used. By means of this process fire-boxes are now cut out 50 per cent. faster than by the former method of cutting out rivets, stay-bolts, etc.

In welding patches in fire-box sheets, the defective part is first cut out with the torch, and the edge of the side sheet is beveled to an angle of 60 degrees. The edge of the patch is also beveled to an angle of 60 degrees, and then the patch is placed in position so that the two beveled edges form a V-groove, into which the additional metal is allowed to flow during the welding process.

Much of the success of this process depends upon the kind of metal used in welding. At first, spring steel about 3/16 inch diameter was used, but this was found to be too hard. Then vanadium steel was tried and gave promise of good results, but was finally found to be too hard after being heated to a welding heat. Finally Swedish iron was used with good results. This iron is fibrous and tough; it is also ductile, and in order to use it in welding it is unnecessary to heat the adjacent plate at a great distance either side of the joint. This is an important point, as heating an excessive area of the joint causes local expansion, which interferes with the placing of the patch.

It is now the intention to equip all of the Great Northern boiler shops with oxy-acetylene welding apparatus, and to use it, not only for boiler work, but also for repairing castings and other machined parts. Up to date there are from twenty-five to thirty engines on this road which have welded patches in the fire-box, some of them as large as 30 by 36 inches, and those engines have given no trouble. In some engines which gave trouble by leakage at the longitudinal seam in the fire-box, a strip about 9½ inches wide the whole length of the seam was cut out by means of the torch and another sheet welded in, thus doing away with the riveted joint. This job, too, has proved entirely satisfactory and has given no trouble.—*The Boiler Maker.*

The belt speed for maximum economy is between 4,000 to 4,500 feet per minute, but for main-drive belts it can be considerably higher.

## SHOP TELEPHONE SYSTEM.

Most of the large modern railway shop plants are very thoroughly equipped with a local telephone service and a very short experience with it is sufficient to show that the value of the different foremen and superintendents is very decidedly increased as a direct result of the telephone service. In large shops each foreman now has but few reasons for leaving his office or its immediate vicinity, or for holding any piece of work because of the lack of full and explicit instructions as to what is to be done with it. The results of the telephone service are noticeable not only in much less spoiled work, but also in the work of each gang being better directed and moving more smoothly and at a higher rate of speed than was the case in the older shop. In fact, the telephones quickly become so much a part of the shop system that the whole organization and scheme of work would have to be altered if they were to be removed, and beyond doubt the efficiency of the shops as a whole would be lowered very decidedly in such an event.

Very few of the older and smaller shops have been equipped with a telephone system which puts each and every foreman in direct communication with the shop superintendent or master mechanic, as well as with each other, although these men, because of the diversified duties falling upon them in a small shop, really have a greater need of a telephone than do highly specialized departments of a big shop. There have been very good

reasons for this condition at places where there are not a sufficient number of connections to make a central switchboard advisable, in that there has not been, until within the last few years an entirely satisfactory intercommunicating system of telephone. The demand for local telephone service of this kind has been so great that the efforts of some of the largest electrical companies and telephone experts have been directed along these lines so that at present it is possible to obtain at a very reasonable expense an entirely automatic local telephone service for a shop plant or division headquarters which can have, as desired, any number of communications, up to 31. The illustration shows one of these telephones on a circuit equipped with twelve connections, which is manufactured by the Western Electric Company, 463 West street, New York. The operation of the system is entirely automatic and to make a call all that is necessary is to simply push the button opposite the name of the station desired and remove the receiver from the hook and place to the ear.

Systems of this kind are manufactured by this company in a number of different styles, which include desk phones in several arrangements, as well as wall phones. An extra equipment is sometimes included, consisting of a general superintendents' call by means of which a special bell can be rung at all offices throughout the system for the superintendent or master mechanic, who is somewhere about the plant and is wanted immediately. Full descriptive matter of the features of this type of telephone and prices of equipment of various sizes can be obtained from the manufacturers.

## DECAY OF LUMBER.

Decay is caused by a number of species of fungi. These are low plants which grow in the wood fiber, just as weed plants grow in the soil. The spore of these fungi are produced in punks or toadstools, which grow on boards or old sticks. These spores germinate in season checks or on the surface and grow into the timber. The fungus extracts certain elements from the wood fibers, and when it has extracted a sufficient quantity, a new punk or toadstool grows out from the outer surface of the timber. After the fungus has grown in the wood, we say the wood has decayed. I wish to call particular attention to the fact that in many of the woods which we are now using, particularly the so called inferior woods, the sap wood decays with great rapidity. The decay takes place apparently inside of the stick, that is, it is rarely visible on the outside. This is due to the fact that the fungus, in order to grow, requires a certain amount of water, heat, oxygen and food supply. The outer surface of the stick dries out rapidly, and very shortly after it is cut, there is not enough water in the outer portion to sustain life. The fungus spores thereupon find their way to the bottom of season checks, where they find enough water and produce decay in the inner portion of the stick. This is getting to be an extremely serious problem, the gravity of which should be realized by those responsible for the lumber and timber in railroad operations. The appearance of a punk or toadstool on a piece of wood may always be taken as an indication that the inside is decayed. There are, to be sure, certain forms which grow on sugars, and on the outside of boards, which are harmless, but these are few in number. The chief point which I wish to emphasize in mentioning the decay is the fact that these fungi cannot grow in wood without a certain amount of water.—*Hermann Von Schrenk before the Railway Storekeepers' Association.*

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The Pennsylvania Tunnels at New York.—The Pennsylvania Railroad has completed the construction of its tunnels under Bergen Hill and the Hudson River into its station at Seventh avenue and Thirty-third street, New York City. The work of electrification, signals and track laying will be pushed forward as vigorously as possible. This culminates the construction work on the first two tunnels to be built for trunk line service under the Hudson River. The first excavation was begun May 12, 1905. The north tunnel was joined on September 12, 1906, and the south tunnel on October 9, 1906. The tunnels under Bergen Hill were connected on May 7, 1908, and April 11, 1908, respectively. These two tunnels, which are 23 feet in exterior diameter, are lined with 2 feet of concrete. They extend from the Hackensack portal under Bergen Hill to the Weehawken shaft, a distance of 1.2 miles, and from the latter shaft to Ninth avenue, New York, 1.4 miles. In the course of their construction, 501,995 cubic yards of material have been excavated. For blasting, 1,201,000 lbs. of powder have been used.

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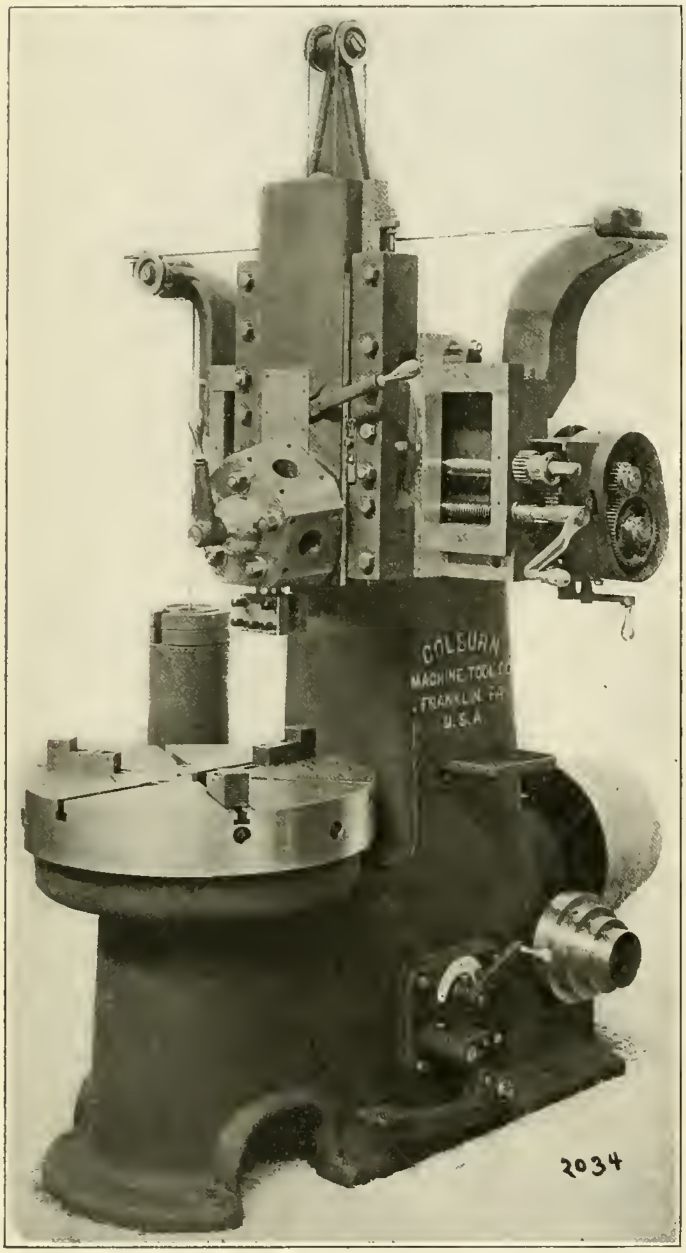
Conservation of Coal.—There is not much consistency in exploiting the conservation of coal when operators at certain seasons are compelled to dump hundreds of thousands of tons of screenings or fine coal on the ground, because the trade at that season does not want that particular grade of coal. I believe that we should confer very closely with the coal producer, to the end that in some instances a compromise grade, possibly, somewhere between lump and mine run may be purchased, and burned on our locomotives, preventing the necessity for the operator dumping fine coal on the ground, which in the majority of cases is practically lost, or, in other words, the revenue that he derives from the sale of that subsequently picked up barely offsets the expense of throwing it down and picking it up. You all know that coal stored on the ground deteriorates very rapidly. A further advantageous disposition of fine coal can be made by the extension of the briquetting industry.—*President Eugene McAuliffe, The International Railway Fuel Assn.*

## A NEW 30-INCH VERTICAL BORING MILL.

THE COLBURN MACHINE TOOL CO.*

A number of valuable improvements are incorporated in the vertical boring mill shown in the accompanying illustration. The most noticeable new feature is in the design of the head stock, or main drive, which is all enclosed in a separate box or frame and can be quickly detached from the main frame or housing. This construction makes it most convenient for repairs and also presents an opportunity for building the machine with greater accuracy and better workmanship, as the fitting up of this most




THIRTY-INCH VERTICAL BORING MILL.

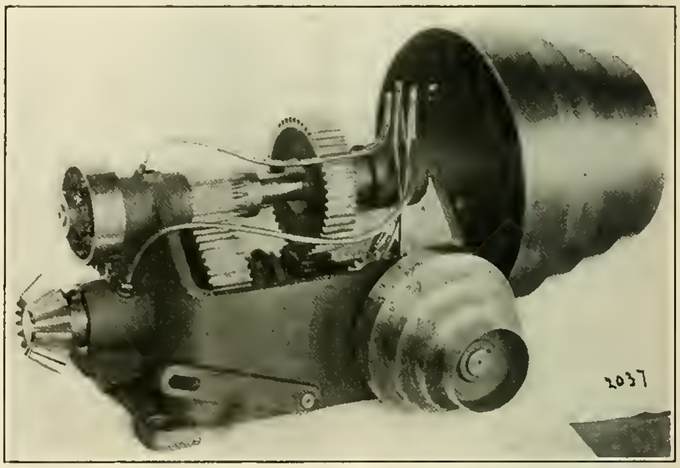
important part of the boring mill can be done entirely separate from the massive sections of the machine. Another new feature is seen in the foot-brake, for quickly stopping the table at any desired position.

The turret head on the cross bar is five sided and set at an angle of 8 degrees, which gives it plenty of clearance for large tools. The turret slide can be swiveled at any angle up to 30 degrees either side of the center, and a graduated scale with a pointer is provided for accurately indicating the depth of cut. The main spindle has 16 changes of speeds and there are eight different rates of feeds, vertically and horizontally. The head stock is driven by a four-step cone pulley belted to a two-speed counter-shaft. On the shaft to which the cone pulley is keyed are keyed a gear and pinion which mesh with gears below, revolving loosely on the second shaft. Between these two gears is a tooth clutch splined to the shaft, which can be interlocked with either gear. This gives two speeds from the gearing, and with a four-step cone gives eight speeds in the head stock, the two-speed counter-shaft increasing this to sixteen.

Lubrication has been given special attention, and in the head stock all bearings are lubricated from one oil box by means of brass tubing leading to the journals. The vertical driving shaft is lubricated by a large oil pocket filled with oil, from which a wick carries the oil to the top of the bushing, where it makes the lubrication of this important bearing entirely positive. A storage reservoir, connected to the smaller one around the bushing, is provided, and thus assurance is almost positive, that the bearing will never become dry.

* Franklin, Pa.

FAILURES.—Few fields of study are more fruitful of results and lead to more genuine progress than a study of the causes of failures. Such studies may be unpleasant and disagreeable, they may at times be even disheartening, but the man who would make substantial advances must heed the lessons which his failures teach. Faraday, who spent his life in experiment, used to say that he learned more from his failures than he did from



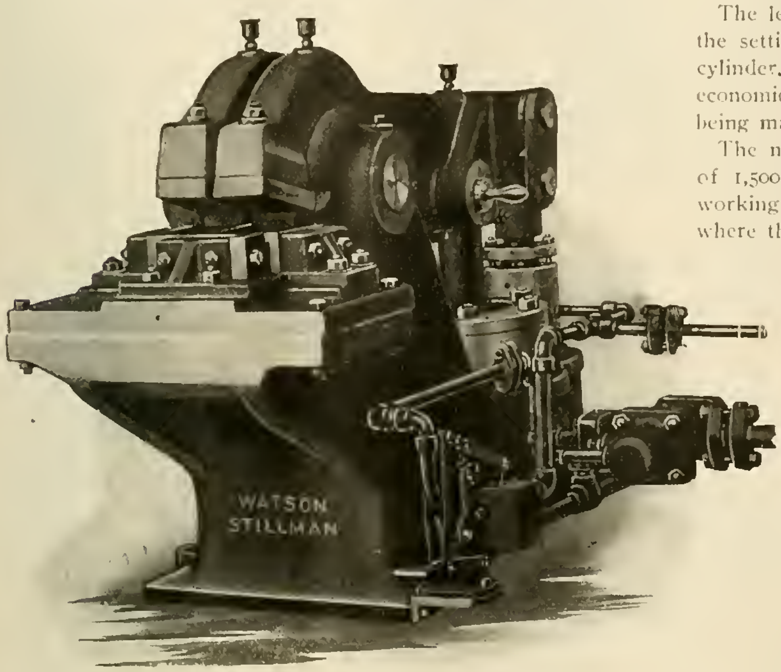

SEPARATE MAIN DRIVE—OIL BOX REMOVED.

his successes. And it is not difficult to see why this should be so. When an experiment or a construction has proved successful we are naturally most interested in the result, and do not usually spend time and thought and study over the details which have led to our success. On the other hand, if our experiment or construction is a failure, the cause of the failure is immediately sought for, every detail is questioned, and it is this study of the details which broadens our knowledge. Quite in line with Faraday's statement is the rather more homely phrase, with which you all are doubtless familiar, and which we remember to have seen somewhere in engineering literature, that "the scrap heap is the place to learn."—*Dr. Chas. B. Dudley, American Society for Testing Materials.*

BUILDING UP THE EFFICIENCY OF A SHOP.—Every bit as great care should be taken in getting new men and apprentices as in getting new machines, and they should not only be started right, but their development provided for. Machines inevitably depreciate, even 10 per cent. per year, and more as improved machines are invented which render existing machines out of date; but men, if properly cared for, may appreciate in value many hundred per cent. An organization can never become strong unless it has some well thought out plan for recruiting and raising the level of the men in the ranks.—*Prof. H. Wade Hibbard before the St. Louis Railway Club.*

## HYDRAULIC COPING MACHINE.

The machine shown in the illustrations is manufactured by the Watson-Stillman Co., 50 Church street, New York, and has been successful in greatly reducing the time, labor and power consumption in trimming structural shapes, small pieces of plate metal, bar iron, etc. It has shown itself eminently fitted for use in car building or repair, boiler and locomotive shops or wherever splices, connections or cuts similar to those shown in the illustrations must be made.




HYDRAULIC COPING MACHINE.

It consists essentially of a heavy steel beam hydraulically operated from the rear to concentrate extreme power upon shearing knives in front. The forward end of this lever is so divided and constructed that by the removal of a pin the half containing the upper right hand knife may be thrown out of action and the knife left standing at its upper limit. The divided upper knife also permits the insertion of a web or flange when it is desired to shear close to those parts, and is very handy in certain types of cuts, smaller than the combined area of both knives. The lower or stationary knives are bolted to the plates in such a manner that those on any side may be removed without disturbing the others.

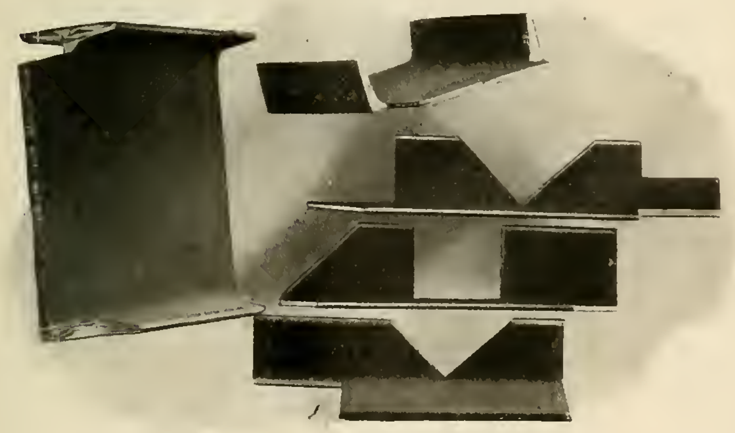
This construction offers a large number of cutting combinations, and as the change can be made from any one combination to another in less than one minute's time the machine will be found very convenient in making cuts at odd angles.

The machine is operated by a simple foot lever. All that is necessary to make a clean smooth cut is to hold the section in proper position and press down on the foot lever until the upper knives descend to the bottom of their stroke. The knives rise the minute the foot pressure is removed and the machine is ready for the next cut. Reference to the sectional illustration will show the arrangement of the parts.

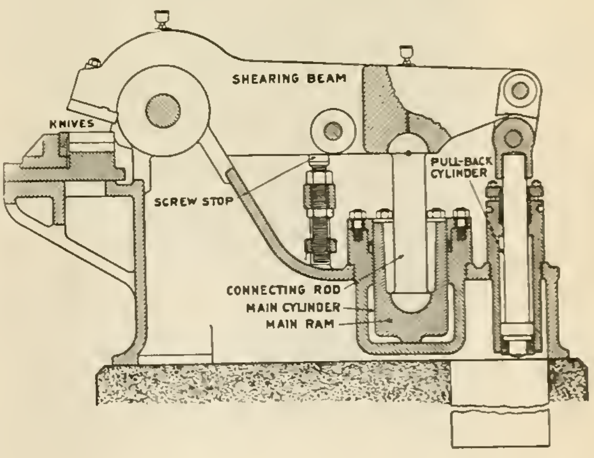
The length of lever stroke is adjustable, being determined by the setting of a screw stop between the main bearing and the cylinder. It is thus possible to reduce the stroke to be most economical of power while a large number of similar cuts are being made.

The main cylinder is ordinarily built for a working pressure of 1,500 pounds per square inch, but can be obtained for any working pressure between 1,000 and 3,000 pounds. In shops where the line pressure is below these figures an intensifier may be employed to produce a suitable operating pressure.

The machine weighs 4,700 pounds and has a 9 in. diameter ram.



SAMPLES OF WORK PERFORMED BY THE HYDRAULIC COPING MACHINE.

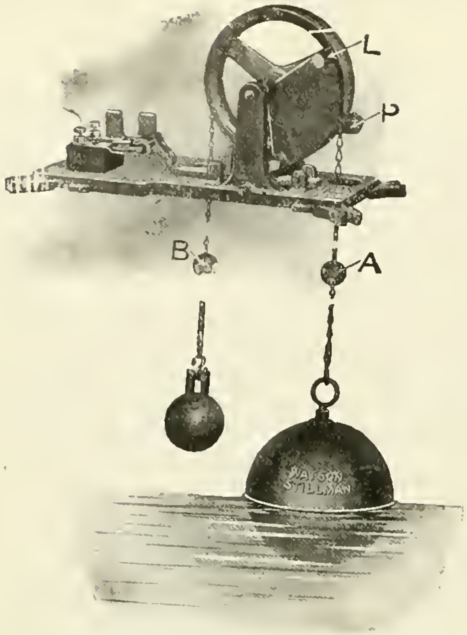



SECTION OF HYDRAULIC COPING MACHINE.

## A NEW AUTOMATIC TANK SWITCH.

This device is claimed to be a decided improvement over previous devices for automatically maintaining the water level between desired limits in open tank or sump systems. The construction permits it to be placed on top of the tank or sump cover, and allows any desired variation in water level to be carried without relocating the electrical apparatus. When the switch is placed on top of the tank there is no necessity for boring a hole into the side of the tank and there is no danger of the switch flooding and becoming short-circuited.

The operation of the Watson-Stillman switch in starting and stopping the motor is dependent upon the movement of a falling hammer, the movement of which in turn is governed by a freely suspended copper float nearly counterbalanced by a cast iron ball. Referring to the illustration of the interior mechanism, which is shown arranged for tank service, the two small wooden balls on the chain are adjustable and their position determines the variation of water level between operations of the pump. The switch is shown as when the pump is in operation. As the float rises, the ball A comes into contact with the projection P on the hammer and carries it past the center. The hammer then falls to the other side of the pulley shaft by gravity, and in doing so, the lug L strikes a projection on the switch and disengages the knife, thus stopping the motor and pump. The switch movement is quick. There is no chance for arcing, and as the hammer remains in contact with the switch arm,




NEW AUTOMATIC TANK SWITCH.

there can be no rebound. The hammer holds the switch arm in this position until the falling of the water level brings the other wooden ball B into contact with the hammer lug, which reverses the hammer, throws the knife into contact and starts the pump again. The wheel acts merely as a carrier for the copper chain. It plays no other part in the operation of the switch.

As arranged for draining sumps, the copper float and iron ball are reversed. This reverses the switch action to start the pump when the water level gets too high. Dampness will not affect the working qualities of the switch when it is placed in the pit.

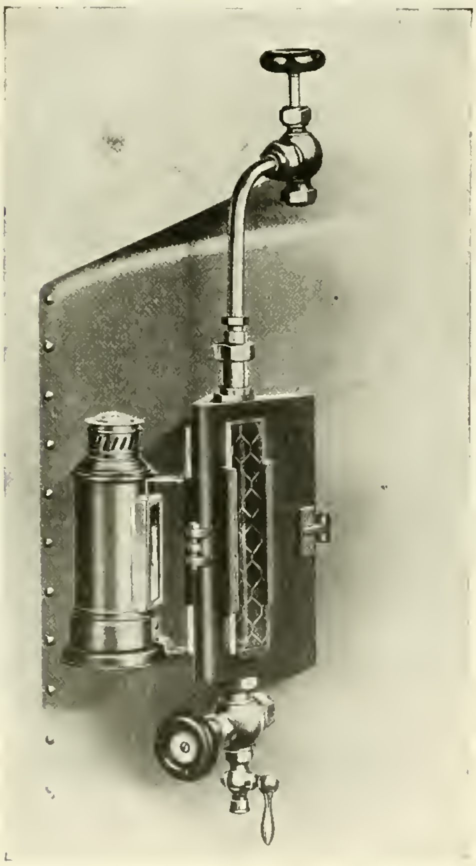
The knife arm is thoroughly insulated from every other part of the switch and the two contact points are mounted upon a slate block. A suitable opening is provided in the body for inserting the tube and making the connection to the binding posts. No parts of the switch need oiling or other attention. The shaft is bronze to prevent corrosion and all parts are extra strong. All working parts are enclosed in a heavy cast iron case which protects them from the weather and from external injury.

This switch may be had single or double pole and for all ordinary currents and voltages. It is made by the Watson-Stillman Co., 50 Church street, New York.

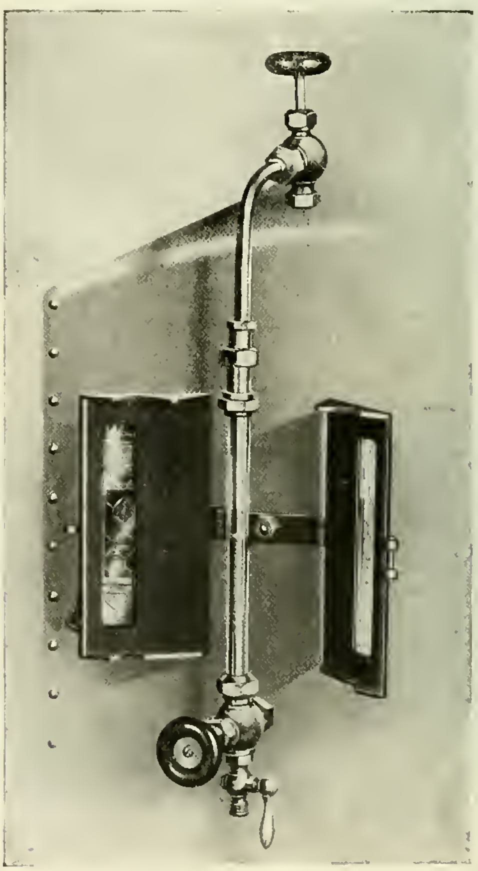
## "POSITIVE" WATER GLASS GUARD

The water glass guard, shown in the illustrations in both a closed and open position, is known as the "Positive" and is manufactured by the American Steam Gauge & Valve Manufacturing Company, of Boston. It consists of two frames, or doors, of malleable iron swinging on hinges, attached to a bracket secured to the boilerhead by studs. The doors completely cover the water glass and stand at such an angle with the boilerhead that the light is reflected through the sight glasses. These glasses are made of heavy plate glass with woven wire insert, and placed in slots in each door directly in front of the water glass, giving a view of the water level at all times.

The following claims are made for this guard: It will protect the enginemen in case the water glass breaks, thus eliminating claims for injuries received from this cause and the accompanying law suits. The guard is practically a permanent fixture on the boilerhead and cannot be lost or thrown away. It lasts as long as the boilerhead and costs nothing for renewals. Train delays caused by inability of enginemen to locate and shut off



"POSITIVE" WATER GLASS GUARD—CLOSED.



"POSITIVE" WATER GLASS GUARD—OPENED.

cocks are done away with as the cocks can be found immediately and closed with the bare hand with the new guard. Time is saved when renewing water glasses, as there are no parts to remove or lose. After the glass is applied cocks may be opened quickly with no danger to workman. The guard does not necessitate a change in water glass fixtures and may be applied at a very small cost.

Firing Briquets.—The work of the fireman is reduced by the use of briquets. Their uniform size makes the handling easier; it is easier to keep up steam and only necessary to fill up the holes in the fire without leveling. No slicing is necessary as is usual with eastern coals. The comparative absence of clinker, when briquets are properly fired, is a big advantage in forcing the boiler for heavy grades or higher speed.—*C. T. Malcolmson before The International Ry. Fuel Assn.*

## PERSONALS.

Charles J. McNulty has been appointed master mechanic of the Salt Lake & Ogden Ry.

J. G. Neuffer has resigned as superintendent of machinery of the Illinois Central R. R.

John Tonge, master mechanic of the Minneapolis & St. Louis Ry., at Minneapolis, Minn., has resigned.

Frank Lane has been appointed the electrical engineer of the Wabash R. R., succeeding W. A. Hopkins, resigned.

H. P. Latta, general foreman of the International & Great Northern Railway shops at Palestine, Tex., has resigned.

J. B. Buker has been appointed superintendent of the car department of the Illinois Central R. R., with office at Chicago.

J. E. O'Brien has been appointed mechanical engineer of the Northern Pacific Railway, succeeding W. L. Kinsell, resigned.

R. W. Bell has been appointed superintendent of machinery in charge of the locomotive department of the Illinois Central R. R., with office at Chicago.

William Smith, of the Pittsburgh & Lake Erie Railroad, has been promoted to general foreman of the machine shops at McKees Rocks, Pa.

E. B. Van Akin has been appointed the road foreman of equipment, St. Louis division of the Chicago, Rock Island & Pacific Ry., with office at Eldon, Mo.

James Hoflich, roundhouse foreman, of the Illinois Central R. R., at East St. Louis, has been appointed general foreman, succeeding Mr. Walker, promoted.

W. L. Kinsell, mechanical engineer of the Northern Pacific Ry., has resigned to accept a position with the Westinghouse Machine Company at East Pittsburgh.

D. J. Redding, master mechanic of the Pittsburgh & Lake Erie R. R., has been appointed assistant superintendent of motive power and his former office has been abolished.

F. J. Barry has been appointed the general inspector in charge of air brakes, steam heat and lighting of the New York, Ontario & Western R. R., with office at Middletown, N. Y.

G. S. Turner, general equipment inspector of the Southern Railway, has resigned to become the southern representative for the American Locomotive Sander Co., Philadelphia, Pa.

Joseph Walker, general foreman of the East St. Louis shops of the Illinois Central R. R., has been appointed to succeed Mr. McIntosh as master mechanic, with office at East St. Louis.

Robert F. McKenna, master car builder of the Delaware, Lackawanna & Western R. R., at Scranton, Pa., has resigned, and will retire entirely from railroad life.

J. R. Radcliffe, who has had charge of the apprentice work at the McKees Rocks shops of the Pittsburgh & Lake Erie R. R., has been made foreman of the machine shop, succeeding Mr. Smith.

W. L. Allison, mechanical engineer of the Atchison, Topeka & Santa Fe Railway, with office at Chicago, has resigned to accept a position with the Franklin Railway Supply Company, New York City.

H. W. Burkheimer has been appointed the master machanic of the New Orleans Great Northern R. R., with office at Bogalusa, La., succeeding F. Schledorn, acting master mechanic, resigned.

C. L. Dougherty has been appointed the acting mechanical engineer of the Cleveland, Cincinnati, Chicago & St. Louis R. R., with office at Indianapolis, Ind., succeeding B. D. Lockwood, resigned.

W. A. Hopkins, electrical engineer of the Wabash R. R., at Decatur, Ill., has resigned to accept a position as electrical engineer of the Safety Car Heating & Lighting Co., with headquarters at St. Louis, Mo.

W. B. Embury, master mechanic of the Oklahoma and Pan Handle divisions of the Chicago, Rock Island & Pacific Ry., with headquarters at Chickasha, Okla., has had his jurisdiction extended to include Sayre Station.

J. J. Burns, general foreman of the Chicago & Alton Railroad at Chicago, has been appointed general foreman of cars with authority over the entire Alton system, with headquarters at Bloomington, Ill. Mr. Burns succeeds, with extended jurisdiction, J. H. Milton, resigned.

## CATALOGS.

Ventilators.—The Globe Ventilator Company, Troy, N. Y., is issuing a new catalog illustrating its ventilators as applied to buildings of all classes and showing a number of different styles and sizes.

Ash Pan Cleaner.—The Talmage Mfg. Co., Cleveland, Ohio, is issuing a small leaflet devoted to illustrations of the Talmage system ash pan cleaner, which can be applied to any locomotive ash pan and make it entirely self-clearing.

A-B-C-Engineering.—The Hill Clutch Company, Cleveland, Ohio, is issuing the first of a series of booklets under the above title. This is devoted to line shaft bearings in general and contains some very interesting matter on this subject.

Nut and Bolt Fasteners.—A booklet has been received from The American Nut and Bolt Fastener Company, P. O. Box 996, Pittsburgh, Pa., explaining the advantages of the Bartley fasteners and illustrating various types suitable for use on cars, locomotives and track.

No. 930.—The Cleveland Twist Drill Company is issuing a leaflet descriptive of the new high speed "flatwist" drill with a "Paragon" flat taper shank, which was illustrated on page 343 of the August issue of this journal. The leaflet contains a brief description and full price list.

Commutating Pole Motor.—Bulletin 4679, from the General Electric Company describes a new line of commutating pole constant speed motors. They are made in both slow and moderate speed types, in capacities of from 20 to 250 horse power in the former, and 30 to 350 in the latter. They may be operated entirely open, semi-enclosed, or totally enclosed, and may be installed on the floor, wall or ceiling.

Bullseye Locomotive Lubricators.—The Detroit Lubricator Company, Detroit, Mich., is issuing a very attractive booklet containing a full description of the various types and sizes of the bullseye locomotive lubricator, together with valuable information relative to installation, operation, care.

etc. The book is thoroughly illustrated and will prove to be of much interest and value to all locomotive men, particularly engineers and roundhouse men.

Log Log Duplex Slide Rule.—Keuffel & Esser Company, 127 Fulton street, New York, is issuing a leaflet describing a new slide rule which has been designed to furnish solution of many problems beyond the range of the ordinary slide rule. It will do the same work that the usual rule performs and in addition will extract any root or raise to any power, integral or fractional. Hyperbolic logarithms are read direct, sines, tangents and co-tangents are given from one second to 90 degrees.

Belting.—The New York Leather Belting Company, 51 Beckman street, New York, issues a monthly publication known as *The Phoenix*. This magazine contains technical discussions, with illustrated descriptions of transmission problems. It shows comparative tests of the efficiency of various types of belting for different classes of machinery. The proposition of reducing replacement costs in the railroad shops was treated in a recent issue of this publication. Copies may be obtained without charge on application.

Brushes.—The Wolfe Brush Company, Pittsburgh, Pa., is issuing catalog No. 58, which contains 126 pages devoted to illustrations, brief description and price lists of the very large variety of brushes manufactured by it. These include scrubbing brushes, dusters, vacuum cleaning brushes, etc., as well as paint brushes of all kinds. Many brushes are shown which are designed specially for railroad use and this catalog should be available in the car cleaning as well as the paint department. A very complete index is included.

Fire Proof Siding.—The H. W. Johns-Manville Co., 100 William street, New York, is issuing a little booklet which draws attention to the many valuable qualities of "Asbestoside," which is a fire proof, weather proof siding that never needs painting. It is claimed to be the most durable, weather resisting material known, and will last as long as the building stands. It is not affected by acids, gases or fumes and is an excellent non-conductor of heat and cold. The booklet shows some most interesting tests that have been made with this material.

Ballata Belting.—A very interesting pamphlet entitled "From Forest to Factory," is being issued by the New York Leather Belting Co., 51 Beekman street, New York. It contains a full description of the manufacture of the Victor-Ballata belting, explaining how the valuable qualities of Ballata for belting purposes were discovered and how this gum is gathered in the jungles of the tropics and the processes it passes through in being prepared for use. This type of belting has a number of ideal qualities and is being successfully used under some of the most trying conditions.

Articulated Compound Locomotives.—At the December, 1908, meeting of the American Society of Mechanical Engineers, C. J. Mellin, consulting engineer of the American Locomotive Company, read an extensive paper on "Articulated Compound Locomotives." An abstract of this paper appeared on our January issue, page 14. The paper in full, completely illustrated, has just been published in pamphlet form by the American Locomotive Company, 30 Church street, New York City. It includes also extracts from the discussion as well as half-tone illustrations and data concerning a number of important locomotives of this type.

Electrical Machinery.—Among the bulletins recently issued by the General Electric Company is No. 4675, which describes and illustrates a new single phase induction motor designated as type RI. The bulletin shows various applications to this motor; illustrates and describes controllers for use in connection with it and contains other data, including diagrams of connections. Bulletin No. 4668 describes the latest railway motor being built by this company, which is of the box form type and is equipped with commutating poles, mica insulated brush holders and removable armature shaft. These motors are 50 h. p. capacity and are designed for operating on a 600 volt circuit. The bulletin contains lists of gear ratios and gives characteristic curves, as well as dimension diagrams of the motors.

Chain Belts.—The Chain Belt Co., Park street and 11th avenue, Milwaukee, Wis., is issuing its general catalog No. 37, a cloth bound book containing 302 pages, and provided with a comprehensive index. This company manufacture elevating, conveying, and concrete machinery of all kinds and the catalog is very largely given up to most excellent illustrations of its products, both in operation and in their detailed construction. Chain belts of practically every conceivable design and size are shown, price lists being included. The catalog also contains an extensive section on sprocket wheels, clutches, gearing, etc. Many special attachments for hoisting and conveying machinery are also included. The catalog is most complete and is very attractive in its make-up.

Silent Running Flexible Gearing.—Under this title the Morse Chain Company, of Ithaca, N. Y., is sending out its machine tool bulletin No. 8. The Morse silent-running high-speed chains are briefly described and a large number of half-tone illustrations are presented showing various applications of it to machine tool drives. In connection with each illustration the following data is given: Horse power of motor, r. p. m of motor and driven shafts, distance between centers, size of sprockets and chain, and speed in feet per minute. The illustrations include applications to lathes, boring mills, shapers, gear cutters, cold saws, punch and shear, rack cutting machine, grinding machines, screw machine, horizontal cylinder boring machine, blower, bending rolls, milling machine, angle shear, forging machine and bolt and pipe threader.

## NOTES

American Steam Gauge & Valve Mfg. Co.—The address of the Chicago office of this company has been changed to 130 North Jefferson street from No. 7 South Jefferson St.

The Asbestos Protected Metal Company has just completed plans for an addition to its manufacturing plant at Canton, Mass., and also for the extension of its head office building at the same place.

Crocker-Wheeler Co.—A new branch office of the above company will be opened in the Ford Building, Detroit, Mich., about September 10, and will be in charge of Chas. W. Cross as manager.

Westinghouse Machine Company.—F. C. Armstead, supervising engineer of the stoker department of the above company, who for a number of years has been located at East Pittsburgh, has removed his headquarters to Attica, N. Y., where the stokers are manufactured.

Grip Nut Company.—The Chicago offices of this company have been removed from 1590 Old Colony Bldg. to 575 Old Colony Bldg., where much larger quarters are occupied. It is announced that the universal window fixtures and universal deck sash ratchets are to be used on the fifty new passenger cars now being built for the Baltimore & Ohio Railroad.

Colburn Machine Tool Co.—After September 1 the above company will be represented in the Chicago territory by The E. L. Essley Machine Co., 62 West Washington St., Chicago. Charles L. Robinson, formerly superintendent of the plant of this company at Franklin, Pa., will be associated with The Essley Company as special representative and expert. A representative line of boring mills will be carried in stock in Chicago and will be exhibited in operation.

Manufacturers Publicity Corporation.—Benjamin R. Western and W. Hull Western, respectively proprietor and manager of the Manufacturers Advertising Bureau, New York, associated with Walter Mueller and W. H. Denney, respectively president and manager of the Banning Company, New York, have organized the Manufacturers Publicity Corporation, with offices at 30 Church street, New York, and the advertising interests of clients heretofore directed by the above mentioned companies will be in charge of the Manufacturers Publicity Corporation.

B. F. Sturtevant Co.—The above company, having a capital of $500,000, has been reorganized and recapitalized. The new corporation is organized under Massachusetts laws with $1,250,000 6% cumulative preferred stock and $1,250,000 common stock. The stock has all been taken by a few of the large owners. John Carr is president, Eugene N. Foss is treasurer, and E. B. Freeman has been elected general manager. The increased capitalization represents capital expenditures during the past year, largely in the erection of a new plant in Hyde Park which cost over $1,500,000.

Curtis & Curtis Co.—Roderick Perry Curtis, president of the above company, died on August 9 at Southport, Conn., as the result of an automobile accident which occurred several weeks before. Mr. Curtis formed the firm of Forbes and Curtis in 1882 to manufacture the Forbes patent die stock. This company existed until 1887, when Mr. Forbes' interests were taken by Lewis B. Curtis, and the firm of Curtis & Curtis continued the business. In 1900 the firm was incorporated under its present name. Mr. Curtis was president and secretary at the time of his death. He was very prominently connected with many social, literary and athletic associations in New York and Connecticut.

McGraw-Hill Book Company.—The book departments of the McGraw Publishing Company and the Hill Publishing Company have consolidated under the corporate name of the McGraw-Hill Book Company, with offices at 239 West 39th street, New York. This consolidation brings together two of the most active publishers of technical books in the country. The new company takes over the book departments of both houses with a list of about 250 titles, both industrial and college text books, covering all lines of engineering. It will continue as well the retail, importing and jobbing business of the two houses. The officers of the new company are: President, John A. Hill; Vice-President, James H. McGraw; Treasurer, Edward Caldwell; Secretary, Martin M. Foss.

Dodge Mfg. Co.—The 20th anniversary of the Dodge Mutual Relief Association, made up of the employees of the above company, at Mishawaka, Ind., was celebrated on July 31. This association is a voluntary one and the dues are exceptionally small, being but five cents a week for employees whose earnings exceed $6.00 per week, and half of this amount for those whose earnings are less than $6.00. The benefits in the first case are eighty cents a day and in the second forty cents, and cover a period of thirteen weeks in any year. Death benefits of $50 and $25 are paid. All dues are suspended when the funds on hand amount to $500, and are resumed when they get as low as $300. All of the 2,000 employees of this company are members of this association, and during its twenty years' existence, over $15,000 has been distributed.

# THIRD ANNUAL CONFERENCE OF THE APPRENTICE INSTRUCTORS.

NEW YORK CENTRAL LINES.

The apprentice instructors of the New York Central Lines held their third annual conference* at the Beech Grove shops of the Big Four System on Friday, September 3rd. In addition to C. W. Cross, superintendent of apprentices, and his assistant, Henry Gardner, all of the drawing and shop instructors were present with the exception of Mr. Middleton, of St. Thomas. Following are the names of the instructors at the various shops:

| Drawing Instructor. | Shop Instructor. | Shop. | Number of Apprentices |
|---|---|---|---|
| A. L. Devine | G. Kuch, Jr. | West Albany (N. Y. C.) | 104 |
| H. S. Rauch | W. F. Black | Oswego (N. Y. C.) | 24 |
| G. Kuch, Sr. | E. Kennedy | Depew (N. Y. C.) | 75 |
| F. Deyot, Jr. | F. Deyot, Sr. | East Buffalo (N. Y. C.) | 13 |
| C. A. Towsley | M. T. Nichols | Elkhart (L. S. & M. S.) | 64 |
| R. M. Brown | H. J. Cooley | Collinwood (L. S. & M. S.) | 121 |
| Benjamin Frey | R. W. Middleton | St. Thomas (Mich. Cen.) | 34 |
| C. P. Wilkinson | C. T. Phelan | Jackson (Mich. Cen.) | 46 |
| A. W. Martin | John Buehler | Beech Grove (Big Four) | 47 |
| V. J. Burry | Frank E. Cooper | McKees Rocks (P. & L. E.) | 36 |
| | | Total....... | 564 |

Appropriate resolutions were drawn up concerning the death of Claude M. Davis, formerly instructor of apprentices at the Beech Grove shops and later connected with the apprentice department of the Santa Fe system.

*Address of Welcome.*—In the absence of Mr. Garstang, superintendent motive power, M. J. McCarthy, superintendent of the Beech Grove shops, addressed the conference and welcomed them to Beech Grove. In speaking of the work of the apprentice department Mr. McCarthy said: "It is hardly necessary for me to dwell on the importance of your methods of apprentice instruction, and the benefits we are obtaining from them, as it is apparent on every side. I feel satisfied that within a very short time, or at the present time, if you please, all that it will be necessary for any young man to say who has taken our instruction courses, and desires employment, is that he has served his apprenticeship on the New York Central Lines."

Following Mr. McCarthy's address a number of letters were read from which the following extracts are taken:

*J. F. Deems, General Superintendent of Motive Power.*—"This is an important meeting and it will be a memorable one, for, judging from the reports and such observation as I have been able to make, no one connected with the work can fail to feel encouraged at the progress that has been made, and though the period has been short, I believe all can report substantial benefits that have accrued, both to the companies and to the apprentices."

*G. M. Bosford, Assistant to the President, American Locomotive Company.*—"I am watching the progress of your department with the keenest interest and great satisfaction, because of having hoped for so many years to see a large railroad inaugurate an apprentice plan such as you have adopted. To know that this work, which was started March 1st, 1906, now provides for over 550 apprentices in all the branches of the motive power department, gives assurance of a work well founded; the fact that these boys are receiving training in the shop and co-ordinate education in the classroom promises soon to make an impression on the organization which everyone will appreciate.

"It seems clear that the success of the work now depends upon the instructors and upon the future development of the plan. To my notion the word 'training' seems to represent that which is most vital. All large industrial organizations require training of recruits, and nearly all are suffering from lack of it. In the old days, when the boy came into an organization he was placed in the hands of some one who had time to see that he learned that which the owner of the business desired he should know. However, he really learned only as much as the individual with whom he worked desired him to know. The instruction was given grudgingly; it was given by men not accustomed to teaching; it was given to each new recruit differently in accordance with the personal characteristics of the workman who gave the instruction, and the knowledge was imparted as if it was a secret and only for the initiated. Now all this is changed, and the boys may be really trained in accordance with a system, which will develop each individual as far as he can go and prepare the boys to become expert workmen in the shortest possible time. Furthermore, your organization renders it possible to give a training which is not only systematic but enlightened and scientific, free from the effect of possible conflicting ideas of individual workmen; in short, your department is in position to give a New York Central training rather than the unsystematic training of the old days when apprentices received the 'hit and miss' instruction in the shop.

"There was, however, an element in the apprenticeship of the old days, going back to that which was given by the owner of the business direct to the apprentices, which must not be forgotten. *I refer to the personal influence of the master over the apprentices, and the responsibility which the master is supposed to have held in developing the moral side of the boy, his manhood and his citizenship. In this I believe lies the greatest responsibility of your corps of instructors, both in the shop and in the class room. If the boys are trained as are the recruits in the army, you will attain only one part of the success desired. It is not only necessary to produce thinking mechanics, but to produce thinking mechanics who are also good citizens, appreciative of the responsibilities and opportunities of life.*

"I believe that in such movements as this there is a danger to be avoided. It can be avoided if the instructors will bend their efforts to the production of workmen interested in their work and inspired by the desire to be good workmen, leaving the development of leadership to, in a broad sense, take care of itself. Of course, such work would undoubtedly develop leadership. The danger is that the boys would be allowed to believe that the completion of apprenticeship is a guarantee of immediate official position. I firmly believe that the training of leaders is not so much what is wanted to-day as the training of men in the ranks from among whom the strongest leaders are sure to spring."

*John Howard, Supt. Motive Power, N. Y. C.*—"The results produced by our instructors are indeed quite gratifying. I find that our young men are accomplishing nearly as much in one year's work as they formerly accomplished in two years, which means a great deal to the young men, especially at this time of their lives, and as a result of the work being done by our instructors the young men are able to absorb what would be equivalent under our old methods to two years of knowledge in twelve months."

*F. W. Brazier, Supt. of Rolling Stock, N. Y. C.*—"In present-day railroading the necessity of reduced cost of operation and

* The proceedings of the first annual conference will be found in the November, 1907, issue of this journal, and those for the second annual meeting in the October, 1908, issue. The organization of the apprentice department and the methods and equipment used by it were described in detail in the June, July, September and October numbers, 1907.

maintenance is of vital importance, together with the necessity for increased efficiency, and the work requires men of more than ordinary experience to handle it to those ends. My one regret is that when I learned my trade as a car builder I was not privileged to have the help of such efficient instructors."

*LeGrand Parish, Supt. Motive Power, L. S. & M. S. Ry.*—"The object of your work is one well worthy of any man's time. The need for the apprentice school was thoroughly appreciated long before the work was taken in hand and thoroughly systematized. The results so far have been very satisfactory to me personally, and I feel that you are working along the right lines.

"Speaking broadly on the subject, I feel that we should increase our efforts to select as high a class of young men as possible for apprentices in the various trades. The educational benefits which the boys receive at this time are of a very high class, and as we will naturally increase our efficiency in handling the apprentice schools we should increase our efforts to improve the young man who is thoroughly worthy.

"As you are aware, we have tightened up somewhat in our discipline, and I feel that it is necessary. We ought not, under any circumstances, to permit boys to remain in our service as apprentices who do not apply themselves, both in the drawing room and shop, as the boys' success, as well as our own, depends upon individual effort.

"The apprentice instructors, in both the shop and school room, occupy a very important position in relation to the shop organization, on account of the fact that they have the boys directly under their charge. Whenever the mechanical engineer, shop superintendent, or other official, desires to place an apprentice in a position of responsibility, the apprentice instructor should be able to advise him thoroughly as to the boy's qualifications and have a fair idea of what may be expected in his future development in any line of work to which he may be assigned."

*L. H. Turner, Supt. Motive Power, P. & L. E. R. R.*—"I want to take this opportunity of saying that while I have always felt that much good would be obtained by a systematic education of our apprentices, that I did not realize we would derive such a decided benefit, and there is no reason why the shops of the New York Central Lines, as a whole, should not, in the course of a few years, be filled with the best lot of mechanics there are in any shops in the country.

"It is probable that all apprentices trained under the system will not be able to secure positions above that of journeyman, but they will certainly make themselves valuable as mechanics, and be able to retain their positions when poorer ones are dismissed."

*William Garstang, Supt. Motive Power, C. C. C. & St. L. Ry.*—"The apprentice system of instruction is a most important one. It has a far-reaching effect and will have a great bearing on the future mechanics. You have my heartfelt wishes for a successful and instructive meeting."

*E. D. Bronner, Supt. Motive Power, Michigan Central.*—"I have watched the apprenticeship work with a great deal of interest and pleasure, and the methods which are being employed I know are bringing about splendid results. The work you are carrying on is such as cannot help but lay a splendid foundation for a class of men suitable for any position in the mechanical department of any railroad organization. We do not necessarily expect that they will all become experts, but there is no question whatever but that those who enter into the true spirit of the work will be better mechanics by having had an opportunity of acquiring the training that is being put in their way. The working out of the theoretical with the practical certainly will have to produce good results, and the only suggestion I have to offer for consideration at this time is possibly one in the way of a caution that we do not go too deep into the theoretical part with the boys at first, but rather that the idea not to be lost sight of is the development of a better class of men throughout the shop with a view of placing the ambitious, capable and bright ones in line for advanced positions."

*R. T. Shea, Inspector of Piece Work, N. Y. C.*—"In reading over your annual report regarding the progress of the apprenticeship department, I notice that you refer to the apprenticeship training working in harmony with the piece-work system. Our

MEMBERS PRESENT AT NEW YORK CENTRAL LINES APPRENTICE INSTRUCTORS' CONFERENCE.

M. J. McCarthy, Supt. Shops—Beech Grove (standing).
First row (top), reading left to right: H. S. Rauch, W. F. Black, A. W. Martin, G. Kuch, Sr., Frank Cooper, John Buehler, C. A. Towsley, C. T. Phelan, C. P. Wilkinson, and F. Deyot, Sr. (Second row): R. M. Brown, H. J. Cooley, Benj. Frey, V. T. Burry and F. Deyot, Jr. (Third row): M. T. Nichols, E. Kennedy, C. W. Cross, H. Gardner, G. Kuch, Jr., and A. L. Devine.

observations are that the apprentices are being instructed along the right lines in regard to the working of piece work and the piece-work organization; in many cases we are using them temporarily to help the piece-work inspectors, giving them an opportunity to know that side of the work, in addition to giving them an opportunity to work piece work on a percentage basis whenever possible, and educating them to our plan of paying for work done rather than for time put in. We feel sure that this will be far-reaching in its effect."

## MR. CROSS' ADDRESS.

In his address Mr. Cross spoke in part as follows:

*Extension of the Work.*—"During the past year, since the second annual conference at the Depew shops, the apprenticeship work on the New York Central Lines has continued to occupy an important place in the affairs of the associated companies and has also been inaugurated on the Erie, Lehigh Valley, and Canadian Pacific Railroads. There is now no hesitation in saying it has gone safely beyond the experimental period and has become a regular department of the railroad business. All the heads of departments, subordinate officers, workmen and apprentices are showing a very agreeable spirit of co-operation. Within the past year a number of apprentices and graduate apprentices have been promoted to positions of responsibility, such as draftsmen, apprentice instructors, inspectors, assistant foremen and foremen.

*Graduate Apprentices.*—"Particular attention is called to properly taking care of graduate apprentices in a manner to make them useful to the company as well as to properly recognize the ability and faithfulness of the employee. To train an apprentice and not to make use of him when out of his time is to lose the best results of the effort, and yet some of our organizations at the present time are not prepared to make intelligent use of graduate apprentices. The bright boy is blamed for leaving at or before the completion of his term, but the fault is largely due to the failure of his employers to appreciate his true value and to make further progress possible. It is not economy to spend three or four years training a boy and then let him go, and a continuance of such policy will ultimately kill the best apprenticeship system. Nothing less than a complete and radical change of policy is needed in some organizations to fit them both to attract and to hold apprentices.

*The Shop Instructor.*—"The most noticeable result from the installation of the new apprenticeship system has been the increased efficiency of the working force which must result from the number of workmen, developed through apprenticeship schools and shop instruction, who have been promoted to workmen and positions above that of workmen. This is largely due to the work of the shop instructor, supplemented by the classroom instruction. Under the old system the foreman was expected to see that the boys received proper instruction concerning their work and that they performed it properly. Ordinarily the foreman is too busy to give the boys anything like the proper amount of attention. With the addition of the shop instructor, who has the duty of looking after the boys, the efficiency of the apprentice has been very greatly increased, with a resulting improvement both in the amount and quality of shop work done. There is no question but that the work accomplished by the shop instructors has more than paid for their salaries. The shop foreman, relieved of the care of the boys, can give his time to the administrative features of his department.

*Benefits from the Drawing Room Work.*—"Another important feature is that the apprentice after he has had a few months of classroom instruction can read simple working drawings, and the third and fourth year apprentices become adept in reading the most difficult drawings. When we consider the comparatively small number of so-called mechanics in the average shop who can read drawings readily, and the necessity for being able to do this, its importance can be realized. Not only this, but the boys are able to make sketches or drawings of shop devices or of parts of the equipment, which it is often advisable to have for record at the local shop, or for transmission to the office of the mechanical engineer. During the past year 2,121 drawings and tracings have been made by apprentices in addition to those made in the regular class work. The boys are thus drilled in New York Central Lines standard practice.

*Easier to Obtain Apprentices.*—"At several shops it was formerly difficult to obtain a sufficient number of suitable apprentices, but now it is possible to obtain all we require of a much better class of boys as they are assured of being given a thorough training in the trades, which combined with the educational advantages, gives them greater opportunities for advancement than formerly. The men in the shops are in thorough sympathy with the apprentice system; the workmen who have sons taking the apprenticeship course realize that their sons are being given better opportunities than they had themselves.

*General Benefits.*—"Some of the benefits derived by the associated companies due to apprentice training during the past year, 1908-9, are shown in the annual report prepared by Mr. Gardner, and indicate a substantial growth of the ideas of apprenticeship training and demonstrate the co-operation of subordinate officials in the work. Increased efficiency of the developed workmen and greater output of machine tools handled by them is noted as a direct result of the instruction the apprentices have received in the shops and schoolroom. The boys are used on important work much earlier in their course than is customary with other systems.

*Piece Work.*—"A unique feature of this plan of apprenticeship is that it is applicable to either a day-work or piece-work method of operation in shops, as it is successful under both systems of working.

*Labor Unions.*—"It is also worthy of note that there has been no criticism of the apprenticeship system by the labor unions, but quite the opposite, as they have endorsed this plan of training the young men as recruits to the trades.

*Loyalty to the Company*—"The subject of loyalty to the company and co-operation between departments is one that the instructors should earnestly study and instill thoroughly into the minds of the apprentices. The following extract from the card on this subject issued April 15th, 1909, by W. C. Brown, president, should be especially emphasized:

"In order to secure the most effective results for the company and likewise for every individual in the service, it is of the utmost importance that the entire staff of the New York Central Lines should work together as one harmonious family, and it is the earnest request of the management that this spirit shall prevail in all departments."

## SOME RESULTS FROM IMPROVED APPRENTICESHIP METHODS.

Mr. Gardner, the assistant superintendent of apprentices, presented a detailed report of the various machines which apprentices have operated during the past year at the various shops. This includes practically every type of machine used in the locomotive machine and erecting shops, car shops, smith shop, boiler shop and tin shop. The list of jobs upon which some of the boys have been employed at various shops also indicates that they are being used on all classes of work in the locomotive machine and erecting shops, boiler shop, smith shop, foundry, car shops, tin and copper shop, and general repair work in roundhouses.

The following statistics concerning the year's work are of interest:

| | |
|---|---|
| Number of boys who have attended high schools.................... | [illegible]3 |
| Number of boys who have attended technical schools................ | 8 |
| Number who have studied in outside evening or correspondence schools .................................................. | 73 |
| Number of graduate apprentices made journeymen.................. | 58 |
| Number who left the service voluntarily.......................... | 77 |
| Number discharged ............................................... | 26 |
| Number who have worked on tests with the mechanical engineer's force. (These include engine indicating, coal tests, dynamometer car tests, etc.)............................................. | 27 |
| Number of boys who have been given experience in the company's (mechanical engineer's) drafting rooms......................... | 16 |
| Number who have been given experience in shop drafting rooms.... | 40 |
| Number who have had experience in round-houses.................. | 44 |

Six boys have worked in a shop foreman's office, three in a shop superintendent's office, one in a storekeeper's office and one in an air brake instruction car.

The following 15 boys have been promoted to permanent positions of responsibility:

W. F. Black, shop instructor of apprentices, Oswego, N. Y.
E. Kennedy, shop instructor of apprentices, Depew, N. Y.
B. Frey, drawing instructor of apprentices, St. Thomas, Ont.
F. E. Cooper, resident material inspector, Pittsburgh, Pa.
H. E. Russell, asst. foreman, car machine shop, Collinwood, O
J. Busdiecker, asst. foreman, rod and motion gang, Collinwood, Ohio.
Paul Kiefer, shop order foreman, Collinwood, O.
J. H. Collins, in charge of engine house machine shop, Oswego, N. Y.
O. G. Milkey, foreman locomotive jobbers, Elkhart, Ind.
R. Barhydt, draftsman, West Albany, N. Y.
J. Latt, draftsman, Depew, N. Y.
S. Bock, draftsman, Cleveland, O.
F. A. Troxel, draftsman, Cleveland, O.
A. A. Shafer, draftsman, Elkhart, Ind.
F. H. Conners, draftsman, Pittsburgh, Pa.

| | |
|---|---|
| Apprentice boys who have been used as assistant instructors in the classroom during school hours | 32 |
| Number of drawings made by boys which were added to the N. Y. C. Lines files | 149 |
| Number of tracings made by boys which were added to the N. Y. C. Lines files | 582 |
| Number of drawings added to local drawing room files | 578 |
| Tracings added to local drawing room files | 812 |
| Total | 2121 |

Note.—(The total reported for 1907-8 was 1344, showing an increase of 777.)

| | |
|---|---|
| Number of apprentice clubs | 3 |
| Number of dances given by apprentice clubs | 2 |
| Number of socials given by apprentice clubs | 3 |
| Number of individual papers read by apprentices at club meetings | 10 |

Injectors, W. G. Ringland.
The Future of the Apprentice, J. H. Donovan.
Metallic Packing, W. G. Ringland.
The Driver Brake, W. L. Degner.
The Apprentice Club, E. T. Phelan.
Walschaert Valve Gear, J. H. Roden
Lining Up Guides, W. McGrath.
Balancing Driving Wheels, J. W. Hugill.
Types of Boilers, G. H. Font
Travels in the Philippines, H. Van Etten

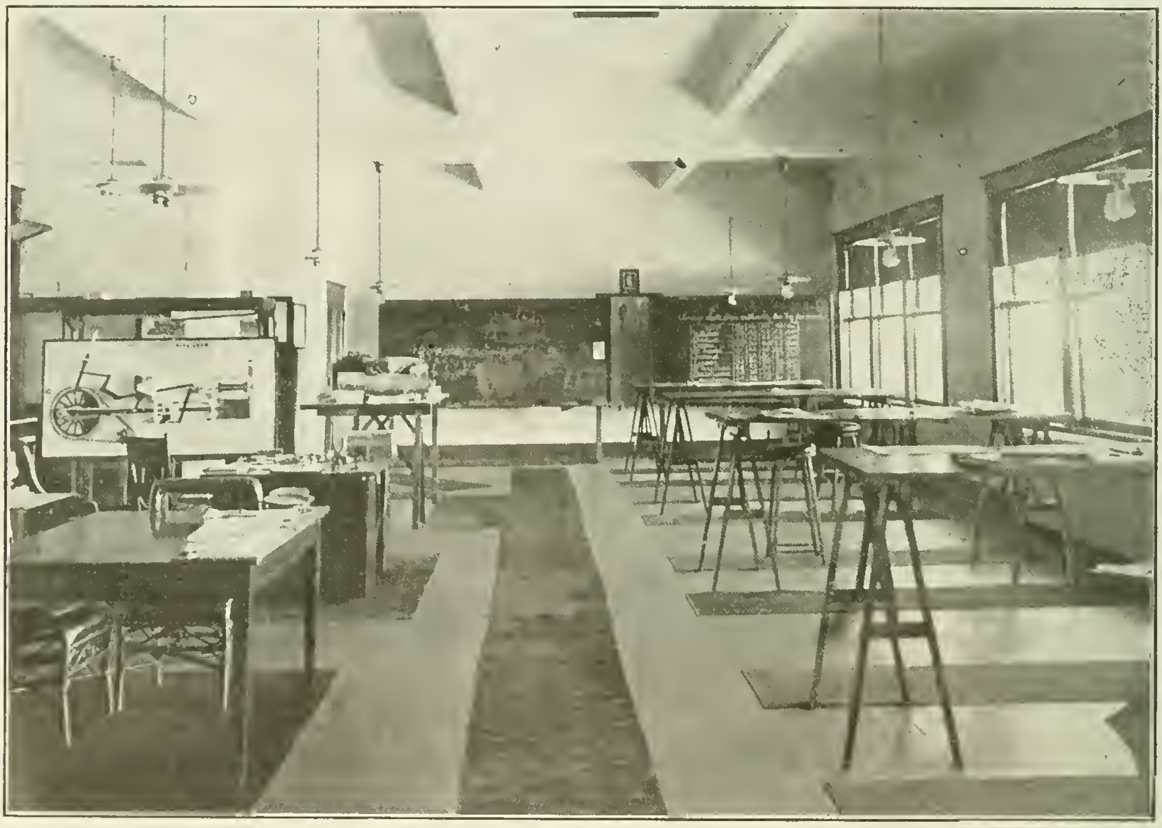
| | |
|---|---|
| Number of papers read before apprentice clubs by other than apprentices | 18 |

Following are a number of important jobs* done by apprentice boys while working in the shops or roundhouses. Some of these were piece-work and were performed in remarkably short time. All of the work was excellent and worthy of special mention and in many cases the output equaled that of the regular journeyman:

*West Albany.*—A second year apprentice laid out a locomotive frame for outside equalized brake from blue print. Two second year apprentices laid out a new locomotive boiler for all holes, including boiler mountings, running boards, expansion pads, etc.

*Oswego.*—A second year apprentice in the tool room is cutting gears, grooving taps and reamers and repairing pneumatic tools. A third year apprentice lays out driving wheel keyways, equalizers and brake rigging from blue print, working piece work. A fourth year apprentice makes cabs, cab doors, sashes, etc., working from blue print.

*Depew.*—A second year apprentice working in the roundhouse overhauled an air compressor and made a gear rack for large lathes. Two fourth year apprentices are in the tool room making dies and tools, gear cutting, etc. They have built a flue testing machine and a hydraulic press from blue print. A third year apprentice in the millwright gang puts up countershafts and sets machines. A fourth year apprentice acted as foreman in the boiler shop for two weeks during the absence of the regular foreman.



APPRENTICE SCHOOL-ROOM, BEECH GROVE SHOPS—BIG FOUR SYSTEM.

*Collinwood.*—A third and fourth year apprentice have each set valves in the roundhouse. A third year apprentice has charge of all piston and valve rod packing and grinds all relief valves.

*Elkhart.*—A second year apprentice with some assistance made a pattern for a 72-inch driving wheel, also for a car truck bolster column with brake hanger bracket. A first year apprentice fitted together 25 cast iron flasks for molding journal boxes. He bolted these up for planing and drilled all holes. He also finished up a set of metal patterns for journal boxes. A second year apprentice bored two cylinders and two piston valve chambers in nine hours, including setting up the machine, working piece work.

*St. Thomas.*—A fourth year apprentice took charge of the valve setting job during absence of the regular man. A second year apprentice has laid out and put patches on boilers.

*Jackson.*—A third year apprentice fits pistons, piston valves, crossheads and intercepting valves, working to blue print. A third year apprentice can lay out and plane up a cylinder casting to blue print without assistance.

*McKees Rocks.*—A second year apprentice squared the frames and lined up cylinders and guides for a new engine, working to blue print. A third year apprentice laid off a reverse lever complete and transmission bar, using blue prints.

*Beech Grove.*—A third year apprentice laid out holes on a new boiler for gage cocks, gage, water column, fountain, throttle, bell, checks, handrails,

* Editor's Note.—Because of lack of space only a few of the many examples cited by Mr. Gardner are reproduced here.

etc., from blue prints. A first year boy overhauled and repaired a 9½-inch pump, working piece work. A second year boy in the smith shop does eccentric rod and link work, piece work. Has also designed formers for bending clamps and fire door latches. A third year apprentice laid out all the patterns for 13 new boilers, including dome, dome ring, roof sheet, gusset sheet, waist sheet, throat and smoke box sheets, fire door sheet and front and back tube sheets. He also laid out all patterns for two new 8000 gallon tanks; also assembled, riveted and calked one of the new boilers.

Following are listed good responsible jobs * done by apprentice boys while working in the mechanical engineer's office or shop drafting room. This is all excellent work and worthy of special mention:

*West Albony.*—A second year apprentice made drawings for an 8½-inch improved compound air pump; one is to be built for trial. A third year apprentice made a book of 433 tracings from sketches of parts for smith shop piece work schedule. A fourth year apprentice made tracings for three layouts of machine location in new machine and smith shops.

*Oswego.*—A third year apprentice designed and made drawings and tracings for link motion for classroom engine. A second year apprentice made drawings and tracings for a 3-inch tube roller, pneumatic cylinder cock, tool post slide, punch and die and hard grease lubricator.

*Collinwood.*—A fourth year apprentice made 60 drawings and tracings of them for small tools used in the boiler shop. A third year apprentice made a list of all air tools in use, obtaining all information regarding them.

*Elkhart.*—A third year apprentice has for nine months been designing and making drawings and supervising the installation of pipe clamps for all classes of locomotives. A second year apprentice has been making comparative tests of material applied to 50 locomotives.

*St. Thomas.*—A first year apprentice made an assembled drawing of a turret head, together with sketches of all the necessary attachments for making patch bolts and later made working drawings of them. A fourth year apprentice designed details for a grate arrangement and a dump rigging for a pile driver boiler.

*McKees Rocks.*—A third year apprentice made a complete set of sketches, drawings and tracings for valve stem and piston packing. A third year apprentice made sketches of front end arrangement and completed a general drawing of it.

*Beech Grove.*—A fourth year apprentice made elevation sketches, drawings and tracings for rebuilding a class F-62 locomotive. First and second year apprentices made sketches, drawings and tracings for the cross-sections of above locomotive.

*Depew.*—A fourth year apprentice scaled down and traced a locomotive boiler complete. A third year apprentice made a drawing of a brush holder for an electric crane.

*Jackson.*—A third year apprentice made drawings and tracings for the redesigning of a flue rattler; sketches, drawing and tracing of screw press for the shop; complete drawings and details for flue welding furnace; also tracing of elevation and sections for three types of cylinders. Another third year apprentice made drawings and tracing for a pneumatic staybolt breaker.

## A NEW DRAWING COURSE FOR CAR SHOP APPRENTICES.

*R. M. Brown.*—After consultation with heads of departments and mechanics we find a wide variation in regard to which parts of cars are most important for a drawing course for apprentices. We have arranged the following course to be given the car apprentice after he has finished the general drawing course. On the first sheet are seven drawings showing joints, splices and bracing. On the second sheet are shown partial drawings of the following body and framing details: Post pocket, truss rod bearing, ⅞" brace rod washer, sill step, push pole pocket, stake pocket, truss rod anchor, needle beam bearer.

On the third sheet are wood details as follows: Sheathing section, 2½" flooring, ⅞" flooring, sheathing (outside), floor fillet, end sill, vestibule step, crosstie beams.

On sheets 4 and 5 are partial drawings of truck details, taking the six-wheel Pullman truck as a representative type; on sheets 6 and 7 are partial drawings of the draft gear and platform details of a standard passenger coach. The remainder of the course should give practice in drawing steel and wood underframing, floor plans and general drawings. Care should be taken to choose standard cast and wrought iron details which are in use on all the N. Y. C. Lines in order that the models may be easily obtained.

*Discussion.*—Mr. Brown's suggestions seemed to meet with the approval of the conference.

## THE FREIGHT CAR SHOP APPRENTICE.

*(Editor's Note: This course is intended largely for young men who have started in in the freight car repair department and who seem to be capable of developing into good inspectors or foremen.)*

*F. Deyot, Jr.*—The schedule for freight car apprentices exclusively should give the apprentice a thorough knowledge of the manufacture and construction of freight car equipment in general. Our present apprenticeship system in this department includes only the machinist, blacksmith, carpenter and tinsmith trades, and since the variety of work required for freight car work in these trades is limited and only a small amount of skill required, we cannot expect to turn out very high class mechanics. However, with models and a proper course of lectures, the apprentice will acquire a fair elementary knowledge of work which he may not be called upon to do in the shop.

The schedule as outlined below would result in more thoroughly educating apprentices who are able to fill a foreman's position than if they had simply worked at any one trade for the entire term:

| | |
|---|---|
| Blacksmith Shop | 6 months |
| Machine Shop | 6 " |
| Tin Shop | 6 " |
| Planing Mill | 6 " |
| Carpenter Shop | 6 " |
| Erecting Shop | 6 " |

This schedule allows the boy a year for general car construction work and for work in any departments other than those mentioned above.

## STIMULATING HOME WORK.

*H. S. Rauch.*—This can be done to a certain extent by giving data sheets* as a reward, but we cannot rely on it entirely as it takes the average apprentice about two years before he begins to realize the value of such information. I would suggest as a further stimulus that the average number of problem sheets worked out per capita at each point be sent to the New York office on the first of each month. These averages should then be arranged in bulletin form and sent out to all schools, and be posted on the bulletin board in the classroom. I think all instructors and apprentices would look forward with interest to the arrival of these bulletins.

*A. L. Devine.*—Since a majority of apprentices consider home work drudgery, it is quite difficult to stimulate it to any great extent without giving the boys some inducement; something attractive which will hold their interest. I believe this can be remedied by giving each apprentice a data sheet with each home problem sheet. We have tried this during the year and found the results very satisfactory; it was appreciated by the boys and caused no extra labor for the instructor as the data sheet prints were made by the apprentices during school hours. No trouble will be experienced in getting good material for at the present writing 28 data sheets have been furnished and 24 more are under way, making a total of 52. It will be an easy matter to increase this number to accommodate the total number of home problem sheets for there are many useful tables and other interesting information which may be adapted to our conditions. I would suggest that an additional binder be furnished each apprentice to file his data sheets. This will be of more value during and after his apprenticeship than the problem sheets and it is impossible to make one binder do for both, especially after a boy has served his second year.

*(To be continued next month.)*

Flexible Staybolts.—Let us consider the flexible staybolt at a cost of 50 per cent. more for application to a locomotive boiler. We shopped one of our engines for overhauling. The boiler was sent to the boiler shop for a new firebox, with instructions to make a full installation of flexible staybolts; that is, back head, throat sheet, and both side sheets up to the seams of the wagon top. This engine has been in service now for over two years and has not had one broken staybolt removed. This looks pretty good for the flexible staybolts, as engines of this same type only run from 60 to 90 days before more or less of the solid staybolts have to be renewed.—*C. J. Murray, Erie Railroad, before Int. Master Boiler Makers' Assn.*

* See p. 138, April, 1909, issue of this journal.

# SUB-BITUMINOUS OR LIGNITE COAL AS FUEL FOR LOCOMOTIVES.

E. W. Fitt.*

The enormous deposits of sub-bituminous, or as it is more commonly called, lignite, coal in the state of Wyoming and northern parts of Colorado, makes the question of using it as a fuel for locomotives of great importance, not only to these states, but also to the railroad companies whose lines pass through or near the lignite districts. The deposits cover without question one-half the area of Wyoming and probably one-third that of Colorado. In the former state there are some ten or more veins of coal which run from a few inches to forty feet in thickness. The quality of the coal, however, is not uniform, and a different appearing coal will be mined in one hill to that in one not half a mile distant. Many shafts have been sunk, but this method of mining is not entirely satisfactory because of the quantity of water which percolates through the coal, the most successful mines being those driven into the hillside. This coal is very bright and shiny and almost entirely free of impurities; the fracture is sharp and irregular.

In the northern Colorado coal field several veins are recognized which vary in thickness from seven to fourteen feet, and it is not difficult to trace them, chiefly because each variety has a different appearance. The surface of the ground is rolling prairie, some parts being depressed, forming small valleys, where faults exist, which affect somewhat the depth of the coal from the surface. The principal mines operating, are shafts of various depths, ranging from 185 to 254 feet. The coal is bright and shiny, the fracture is regular and in some cases vertical, the layers of stratification being well defined. Some samples from the few mines driven into the hillsides are dull black and fracture is irregular. It is not considered, however, that this latter coal is any better quality than the grades from lower levels. Analysis of the different grades from both states show only slight variations, but experience has shown that a laboratory test does not give sufficient information to determine accurately whether one grade is superior to another, for practical use, and reliance should, therefore, be placed upon service tests made on a locomotive.

The following analyses are the average of many samples from fields in Colorado and Wyoming and are representative of the different mines now in operation in those states. The B. T. U. is calculated and is not to be considered entirely accurate.

| State | Moisture | Volatile Matter | Fixed Carbon | Ash | Sulphur | Heat Units B. T. U. |
|---|---|---|---|---|---|---|
| Colorado. ....... | 15.95 | 32.65 | 46.29 | 4·03 | 0.98 | 11458 |
| Colorado. .. | 13.08 | 36.22 | 45.67 | 5.01 | 2.12 | 12181 |
| Wyoming......... | 20.13 | 33.06 | 42 39 | 3.50 | 0.91 | 11072 |
| Wyoming... .... | 9.44 | 40.47 | 45.74 | 3.83 | 0.54 | 11564 |

There are very few impurities in this coal, the percentage of ash and sulphur being small. The percentage of moisture is, of course, very high, some coals having as much as twenty-five per cent. This affects the storage qualities and it is necessary to protect it from the weather if stored at all. When stored under cover and properly protected by floor or platform from the moisture coming from the ground, it will keep in good condition for a long time without slacking to any extent or being in danger of spontaneous combustion. Experiments have shown that coal stored in open cars from one week to ten days loses from 5 to 8 per cent. of its moisture to an average depth of four inches, and will show signs of slacking. Below this depth the coal does not show so great deterioration, the total loss per car load not exceeding 2 per cent. As a general rule, the coal is used within ten days from the mine, when the best results are obtained; under these conditions it has very few equals as a steam producer.

There is a wide difference in the Wyoming coal, the samples analyzed having been taken from the extreme eastern and western fields. It will be noticed that the ash is about the same, and the greatest difference is in moisture and volatile matter, the sample with the least moisture being a very fair storage coal. There is not such a noticeable difference between the Colorado samples, except in the amount of sulphur, and it is considered that the percentage is higher than it would have been if more care had been taken in the selection of samples.

Both these coals are good steam producers, not only for stationary boilers, but also for locomotives, and are now used with success on some of the largest engines in the United States, very few failures occurring from lack of steam, leaking flues or crown stays; in fact, it is preferred to semi-bituminous or bituminous coal by the men using it, especially in bad water districts. The results obtained show it to be an economical fuel, though a slightly larger quantity is used per 100-ton mile than bituminous coal, still, the difference in first cost and maintenance of power more than covers the cost of increased consumption. It is not so hard on flues, crown stays, staybolts, grates or ashpans as bituminous coal, there being so little ash there is no clinker when properly fired, with practically no shaking of grates.

Notwithstanding these good features, there are some serious objections to its use on locomotives, which may be outlined as follows:

1. Danger of setting fire to property on or near the right of way.

2. The necessity of special spark arresting devices, grates and ashpan.

3. Poor storage qualities.

Objections 1 and 2 are so closely allied, they will be considered under one heading.

Sparks from lignite being light and wood-like, have the peculiarity of remaining alive until almost entirely consumed, in this respect differing from those from bituminous coal. Consequently, greater care has to be taken of the spark arresting devices for lignite coal, and the successful use of this coal on locomotives as at present designed practically depends on three things, namely:

(a). Proper construction of spark arresting devices.

(b). Inspection and maintenance at terminals.

(c). Firing of the locomotive.

By proper construction is meant that in the front end the nettings, or other devices applied to the engine must be as nearly spark-proof as it is possible to make them. It will not do to have any openings around the edges of the netting, especially along the sides or where the steam and exhaust pipes pass through; these places should be covered with tight-fitting strips of sheet iron bolted down, and, if desired, iron cement can be used, but this is not recommended because then an opportunity is given for covering up careless workmanship. The netting used must be the smallest possible mesh consistent with proper drafting of the engine. Doors in the netting should have iron frames, one fastened to the netting of the door and the other to the netting of the front end. Iron should be placed against iron, and fastened with studs and taper split keys; this method ensures a tight joint.

The ashpan is also a very important feature. It requires to be tightly constructed, all air openings must be covered with double

* Consulting Engineer, 516 Bee Building, Omaha, Neb.

netting to prevent escape of sparks and doors should close tight to their frames; these precautions are necessary because high winds will blow the ashes out of the ashpan if it is loosely put together, causing trouble on the right of way.

*Inspection and Maintenance.*—Too much attention cannot be given this work; on it depends success or failure with regard to throwing fire from the stack or dropping from the ashpan. It is

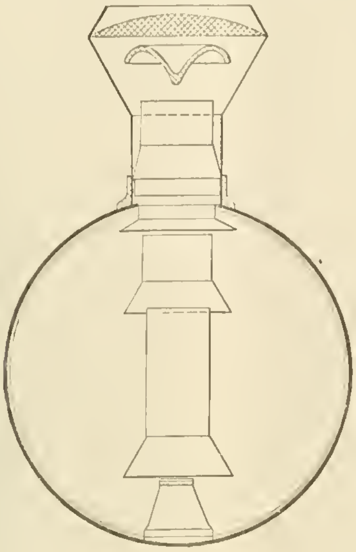


FIG. 1.

possible when careful inspection and prompt repairs are made, to run engines for months without complaint, still, although inspection be carefully made, if repairs are not promptly done, it may happen that there is a good chance of damage to property on the right of way occurring on the next trip, which often amounts to more than the loss of time by holding the engine and cost of repairs.

*Firing.*—A good fireman can fire this coal without throwing fire from the stack and have plenty of steam, by firing light and often; but the one who throws in fifteen to twenty scoopsful at one fire, generally waits too long between fires, which results in coal burning down, and when next fire is thrown in, the light sparks are stirred up and ejected from the stack. While these may not be large enough to cause any damage, still they make an alarming illumination which frightens the property owners along the road.

3. The poor storage qualities of this coal are a serious drawback in some respects, but the facility with which it can be obtained more than offsets this objection. As before stated, if it is desired to store this coal for any length of time, say six months, it is then absolutely necessary to keep it under cover and protect it from the moisture of the ground. That it can be stored for that length of time under those conditions without serious deterioration has been proved. The coal loses only a slight portion of its moisture, and the volatile gases remain about the same. This shows that when the coal is fresh the larger part of the moisture is mechanically combined, and is, therefore, in better condition to mix with the heated volatile gases than if it were in chemical combination in the coal. However, it may be accepted that up to the present time the situation does not require the storing of the coal, and practice has proved that the fresher it is used the better the results.

When the foregoing arguments are considered there should be no greater liability to cause fires on buildings and other property near railroad right of way, with lignite than with bituminous coal, for the prevention of throwing fire depends almost entirely on the spark arresting devices and the fireman. Thus if the spark arresters are properly constructed, inspected and maintained, and the engine properly fired, the use of lignite coal as locomotive fuel is entirely feasible.

A short description of some of the front-end arrangements which have been used, and are now in use on locomotives on various roads burning this coal are illustrated, and show the extent to which experiments along this line have been carried in efforts to make a perfect spark arrester. The illustrations show only those which have been known to be successful in actual practice and are in service to-day.

Diamond Stack.—The diamond stack, with all its faults, is the oldest and safest spark arrester in service to-day. Though more expensive to maintain and more costly in the consumption of fuel than the straight stack with extended front end, it is without doubt, the most effective. Figure 1 illustrates an ordinary type of diamond stack used on some roads in preference to the extended front end, especially in timber country. Several years ago experiments were made to determine the comparative loss from back pressure between the diamond stack with cone and netting, and the straight stack with extended front and spark arrester, which resulted in showing a loss of over 20 per cent., due to the back pressure in the diamond stack. These experiments showed that the diamond stack was not an economical factor, and efforts were directed to perfecting a straight stack and extended front end that would be a spark arrester and at the same time make a good steaming engine, without increasing the consumption of fuel. It is not the intention to follow up the various designs which were tried and found wanting, and three designs are shown which illustrate different practice and ideas.

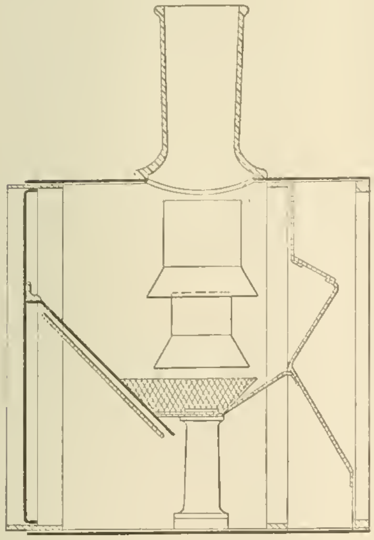


FIG. 2.

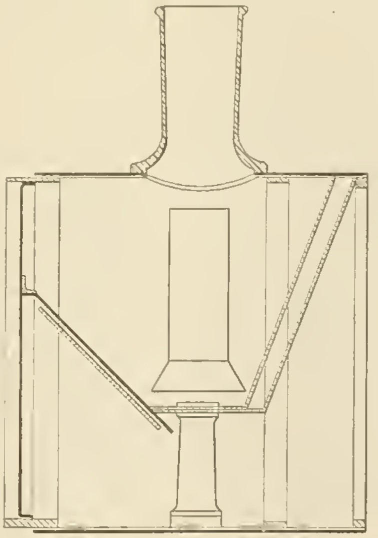


FIG. 3.

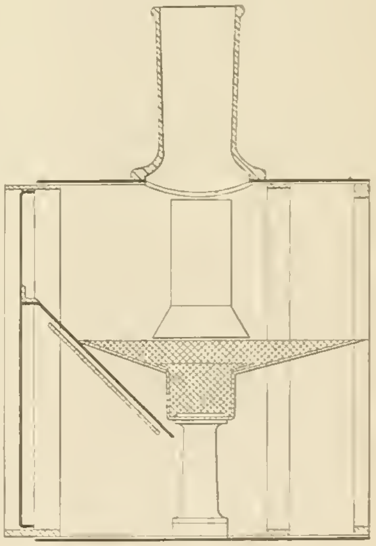


FIG. 4.

Extension Front End.—Figures 2, 3 and 4 show the most successful arrangements in service. The first design has been very successful as a spark arrester, but some trouble was experienced from filling up and consequent burning out of the lower nettings. This occurred more frequently on the small engines than on the larger ones, and was overcome by substituting a plate for the lower course of netting. The main feature in this plan is the double nettings, the sparks having to pass through two courses before reaching the stack. The repairs with this design are not excessive.

The design shown in Fig. 3 has not been very extensively used, but is far less complicated and uses a larger nozzle tip than Fig. 2. It is practically a self-cleaning front end, depending on the pulverizing of the sparks before they pass through both nettings to the stack. The repairs are light. Objections have been raised to this plan on account of the double doors in the netting, to get at the exhaust tip, which leaves a loop-hole for carelessness in making repairs.

The design shown in Fig. 4 is extensively used on several roads and gives very good satisfaction. It is simpler in construction than either of the others, but has the objection that there is only one course of netting used. This compels the application of a much finer mesh netting than that used in the other types, neither can so large an exhaust tip be used. More sparks are retained in the front end and have frequently to be let out through the cinder hopper, the netting stops up and decreases the draft, and together with the smaller exhaust causes increased consumption of fuel; therefore, notwithstanding the cheaper construction and repairs, it is not as favorably looked on for general economy as Fig. 2, which is considered the most effective of the three designs.

In connection with this subject it might be stated that with all these extended front end plans, it has been found necessary to use an extremely long fire brick arch, which assists in retaining the lighter parts of the coal in the fire box and also helps materially in consuming the volatile gases and excess carbon which otherwise pass off as smoke. The fire-brick arch is built up solid against the flue sheet, thus preventing any direct draft through the flues and protecting them from cold air.

The most suitable ashpan for lignite coal is of the hopper type, with openings at the sides for air. These openings require to be well protected with double netting. The doors require to be made with a tight joint and the levers must be arranged so they can't possibly become unlatched on the road.

Lignite coal breaks up so very easily in the fire box that ordinary grates cannot be used, but special designs with $^9/_{16}$-inch openings between the bars have proved successful. The fingers are short, as it was found that long-fingered grates broke up the fire too much when shaken. Box grates with bars ½-inch wide with $^9/_{16}$-inch openings work quite satisfactorily.

Lignite coal is most efficient on long-flued engines of large boiler capacity, in fact any large consolidation or prairie type engine of modern design will give perfect satisfaction with this coal. It is not necessary to provide for such an extremely large grate surface as the quality of the fuel would lead one to suppose, fifty to fifty-four square feet being ample for a seventy-eight to an eighty-four inch boiler, and is within the limit of endurance of the fireman.

It seems, however, that the proper solution of the problem would be to build a boiler after a new design that would not require special spark arresting devices, and which would have a large heating surface, long flues and grate area in proportion.

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Broadening the Viewpoint of an Official.—As a further means of education, division officials are sent, a few at a time and usually in a business car, on a fifteen-day trip once a year over other railways to observe methods and appliances. The semi-annual meetings of general officials are held in different cities on the Associated Lines in order that the participants may gain an idea of conditions on all parts of the system. The Chicago office endeavors to spread among all the properties or to cause them to send to each other from every available source all possible information that may have an educational value.—*J. Kruttschnitt before the New York Railroad Club.*

## A GOOD OPPORTUNITY FOR AMBITIOUS MEN.

What is designated as an educational bureau of information was established on the Union Pacific Railroad, September 1st. The objects of this bureau, as stated in the circular making the preliminary announcement, are to assist employes to assume greater responsibilities, to increase the knowledge and efficiency of employes, and to prepare prospective employes for the service. It is the policy of the road to, as far possible, fit its own employes for promotion, and the new bureau is intended to assist such of the employes as indicate a desire, to qualify, by means of courses of instruction, which will be specially prepared for them, in addition to the reading and study of such published works as bear in a practical manner on their work.

The privilege of using this bureau is open to all departments and employes free of any charge, the company maintaining it for the benefit of the entire service. The work of the bureau will be controlled by a board of supervisors, consisting of the following officers of the company: Vice-president and general manager, freight traffic manager, general superintendent, chief engineer, superintendent motive power and machinery.

An advisory board, consisting of responsible officials selected from the various departments, (*i. e.*, operating, traffic, engineering, mechanical, signal, legal, auditing, etc.), will act with the chief of the bureau in handling all questions relating to their respective departments. This board passes on all applications for courses and assigns such work as it deems best suited to the man. It also passes on the answers to all questions sent in, so that there will be no danger of interference with the general organization's instructions or ideas.

The following outline of the work of the new department is taken from one of the circulars issued from the office of the general superintendent.

"*Assisting Employes to Assume Greater Responsibilities.*—The bureau will offer any employe desiring to qualify himself to assume greater responsibilities, a course of reading and study along the line which he may indicate. This course will be conducted somewhat on the method of now existing correspondence schools, and will be prepared with special reference to the needs of the particular case. This course need not necessarily be confined to the particular work of the department with which the employe is connected, but may embrace any subject, the knowledge of which may be of value to the employe in the position now occupied or which would help to qualify the employe to change positions to a line of work which would be more nearly suited to his ambition or desire.

"An employe taking up a special line of work of this kind must show his interest in it by doing a reasonable amount of reading or studying. Otherwise the company will not be justified in continuing the expense of maintaining the employe on its student rolls.

"Those selected for advancement to minor official positions will be afforded an opportunity, before formal appointment is made, of acquiring a knowledge of the practical workings of such departments as they have not been intimately connected with, through a temporary connection therewith under the direction of the heads of such departments, and at a salary fixed by the board of supervisors.

"*Increasing the Knowledge and Efficiency of Employes Now in the Service.*—This bureau offers to all employes the opportunity to increase their knowledge, thereby increasing their efficiency, by means of the information department feature. Employes desiring information on any problem or proposition connected with their work, or on railroad matters in general, can, without any formality, address this bureau, stating the information desired. Name and address, position or occupation, division, district, office or shop where employed should also be stated. This information will be furnished promptly and in as simple and practical a manner as possible.

"All inquiries should be addressed to the Chief of the Bureau of Information, but any inquiry requiring special departmental information will be referred to the member of the advisory board best qualified to give the information desired, it being the intention to have all inquiries answered in such a manner that they will in nowise conflict with the instructions, ideas or precedents of the department to which they relate. Questions referred to members of the advisory board will not carry the names of the employes desiring the information, although a record will be kept available to the heads of departments wishing to know whom of their employes are seeking to increase their knowledge of railroad matters.

"It is the intention to further this work by means of lectures on live railway subjects, to be given from time to time at various district headquarters. Pamphlets and reports will be distributed periodically, containing information on subjects of interest. Classes will be organized at various points to teach important subjects, and a representative of this bureau will be continually on the road to handle matters which cannot be properly explained or demonstrated by correspondence.

"*Preparing Prospective Employes for the Service.*—This bureau will be glad to register the names of dependents or relatives of employes who wish to enter the service of the company, and will also keep in touch with various universities, colleges, high schools and technical schools for the purpose of having at all times material on hand to supply help desired by any of the departments. Persons registering with this bureau may indicate the particular line of work which they desire to follow. They will be given every opportunity for learning the elementary methods and requirements of the department they wish to enter, and while it is not promised that positions will be given to all applicants, it is, however, expected that the various departments will avail themselves of this opportunity for filling vacancies in their ranks from individuals registered with this bureau, who have taken advantage of the opportunity to qualify themselves for the positions desired."

From the last paragraph, quoted above, it would appear that young men about to enter the railroad service will have exceptional opportunities offered to them for gaining a thorough and complete knowledge of the branch of work which they wish to take up.

The headquarters of the bureau is at the Pacific Express Building, Omaha, Neb. D. C. Buell, who, in addition to his railroad training, has had considerable experience in educational work along correspondence lines, has been appointed chief of the bureau; his assistant is G. W. Seiver.

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Tempering High-Speed Steel Tools.—The following data as to tempering tools are accurate for practically all makes of good high-speed steel, and cover in a general way the range of these tools. The temper of high-speed tools is in general drawn (when they are tempered at all) somewhat farther than is done with carbon-steel tools. Roughing lathe tools, and all tools for heavy rough cutting, are left untempered. Large reamers and drills with heavy stocks are drawn at 440° F., which is equivalent to a light straw surface color. Ordinary drills, small reamers, and other tools having rather light stocks or bodies, and subject to considerable torsional strains, are drawn at 460° F., or a full straw color. Threading dies and taps, 490° F., very dark straw or brown yellow. Ordinary milling cutters and the like, 400° F., or faint yellow. Punches, stamping or cutting dies, and shear blades, 530° F., purple. Chisels, snaps, and like tools subjected to sudden shocks, 570° F., or polish blue. Wood-working tools of nearly all sorts, 525° to 625° F., which is from light purple to greenish blue, according to shape and kind of wood to be cut. Brassworking should be drawn from 20° to 30° lower than iron or steel cutting tools of the same kind.—*O. M. Becker in the American Machinist.*

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Flux for Oxy-acetylene Welding.—After numerous experiments F. C. Sanborn, of Bridgeport, Conn., has discovered that common salt is as good a flux as any of the more expensive compounds.—*American Machinist.*

## THE USE OF TWO AIR PUMPS ON THE LOCOMOTIVE.

The advisability of using two medium size air pumps on a locomotive, in place of one large one, was discussed in a committee report at the General Foremen's Convention as follows:

"In applying one air pump to a locomotive there is always a liability of its breaking down at a very unexpected time. With the application of two pumps it is assumed that we must always have one for service in case the other breaks down.

"While the double unit proposition has some very desirable features, we should not overlook the fact that its adoption will, if extra precautions are not taken, lead us into some very undesirable conditions. Therefore, while we are considering the merits of this arrangement as a source of air supply, we should also consider it from a train-handling standpoint. That the number of delays at terminals, so common on account of the inability of the single pump to pump sufficient pressure to properly test the brakes and insure the safe handling of the train, and that the number of air pump failures and slid flat wheels will be materially reduced, can not be questioned. And by reason of the fact that as high temperatures will not be developed during compression with this arrangement as with the single unit, we can expect less trouble with frozen brake pipes. However, it is likely to encourage carelessness on the part of the trainmen and car inspectors in looking after brake pipe leakage, which must be kept within certain limits if we are to expect smooth handling of long trains and to keep the maintenance of freight equipment within a reasonable figure; an excessive brake pipe leakage takes the control of the brakes out of the hands of the engineer, and incites undesired quick action of the brakes, both of which are sure to result in much train parting and damage to equipment and lading.

"At present most of the large freight engines and a number of passenger engines are equipped with 11-inch pumps, these pumps having sufficient capacity to supply most of the big trains when in good condition; in applying two pumps, it would be unnecessary to go to the expense of putting on two 11-inch ones. The following data have been secured from the Big Four, which has three engines in service, with two 9½-inch pumps each, one of which has been in the heaviest freight service for the last year, making 145 miles daily; the present condition of these pumps indicates that they will continue to give satisfactory service for several months.

"Up to the present time the maintenance cost on the two pumps has been less than $1.00, and should it become necessary at the end of 18 months to remove the pumps, they can be overhauled for about $30.00 ($15.00 each), which means a yearly cost of $20.00 for both pumps.

"The average life of the 11-inch pump in heavy freight service is from five to seven months, and the average maintenance cost is about $32.00 a pump per year. The maximum capacity of the 11-inch pump, pumping against 100 pounds pressure, with 200 pounds steam, is about 57 cubic feet of free air per minute. Under the same conditions two 9½-inch pumps will pump 70 cubic feet per minute. The steam consumption per cubic foot of air pumped is practically the same in both cases. The location of the two pumps is only a matter of choice, but it is more desirable and economical in every way to apply both pumps with one bracket on the left side of the shell of the boiler."

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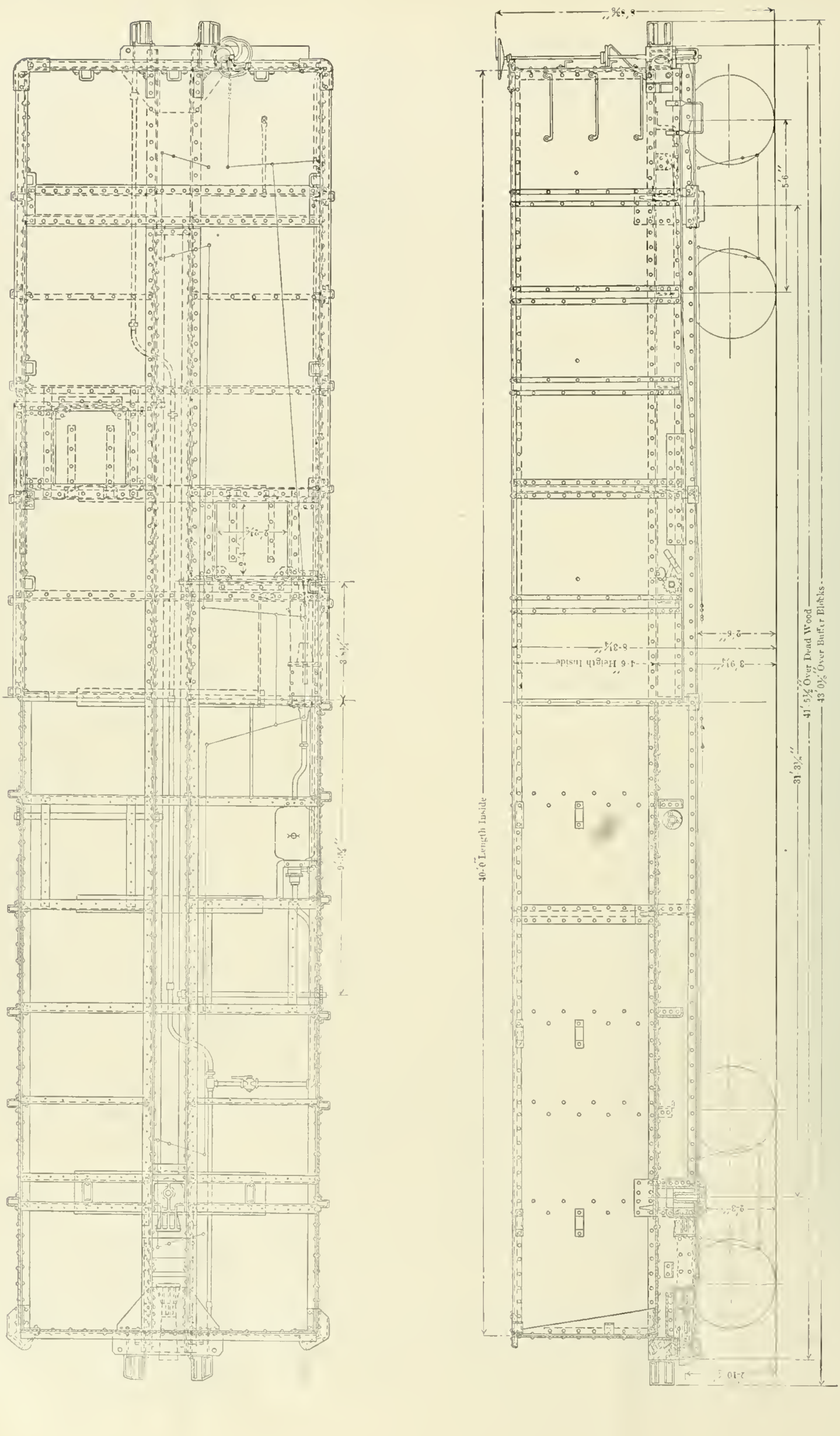
Inspection of Coal.—As far as possible, the inspection of coal by purchasers should be made at the mine, in order to know the conditions existing when the coal is loaded. The top of a car can easily be picked carefully, and especially when drop-bottom cars are used it would be difficult to detect the impurities contained below the surface. Sizes used for locomotive purposes cannot always be disposed of commercially, and rejections at points far distant from the mines may work a serious hardship on the producer and the railroad as well.—*From Committee Report before Int. Ry. Fuel Assn.*



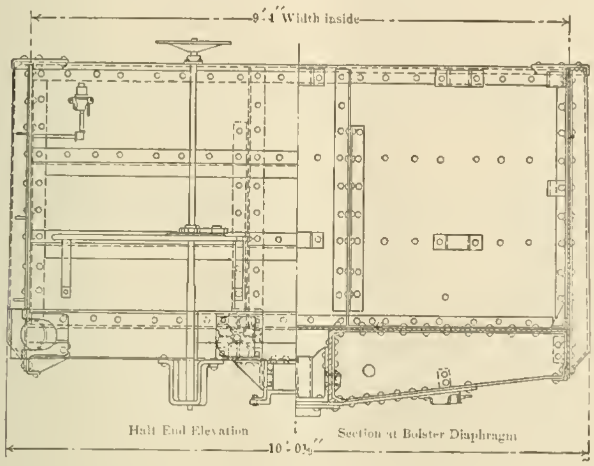

FIFTY-TON STEEL GONDOLA CAR—VIRGINIAN RAILWAY.

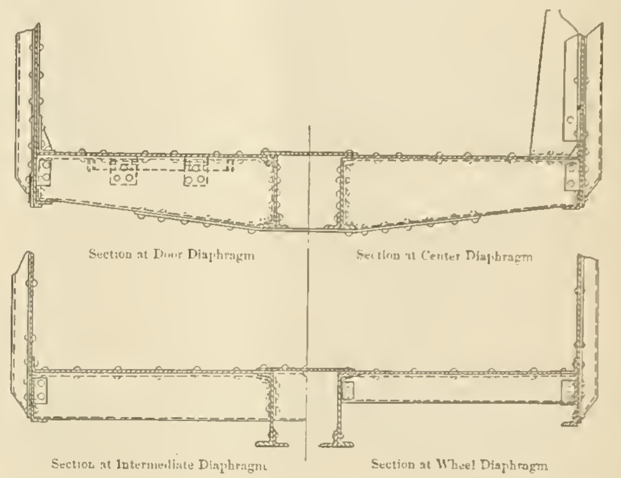
# FIFTY-TON STEEL GONDOLA CAR.

Virginian Railway Company.

The Virginian Railway Company has recently received an order of 1,500 all-steel gondola cars from the Pressed Steel Car Company. These cars are 40 feet long inside and have four small drop doors. Practically all of the coal cars on this road are unloaded by machine; it is therefore not necessary to arrange them for self-unloading and only enough drop doors are provided to facilitate the unloading through the bottom at points where the unloaders are not in use, or in case other classes of material are transported.

In order to keep down the stock of material for car repairs and to reduce the cost of making repairs all pressed steel members and plates are designed to be used interchangeably on all designs of freight cars, cabooses and tender frames.




The general dimensions of these cars are as follows:

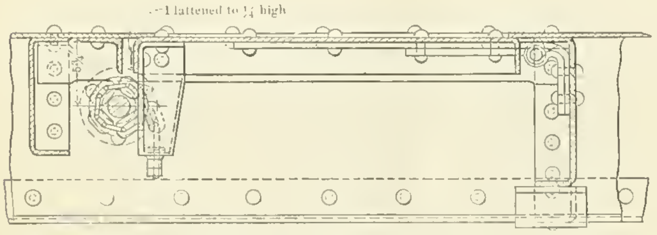
| | |
|---|---|
| Length inside | 40 ft. |
| Length over buffer blocks | 43 ft. ⅛ in. |
| Width inside | 9 ft. 4 in. |
| Width over side stakes | 10 ft. ½ in. |
| Height inside | 4 ft. 6 in. |
| Height from rail to top of sides | 8 ft. 3¼ in. |
| Center to center of trucks | 31 ft. 3⅛ in. |
| Number of drop doors | 4 |
| Size of drop doors | 2 ft. 4 in. by 2 ft. 2½ in. |
| Weight of car | 43,500 lbs. |

The center sills are 15 in., 40 lb., channels. They are covered between the bolsters with a 5/16 in. cover plate 20 in. wide and tied together by the top cover plate 7/16 in. thick, 16 in. wide, extending practically the full width of the car and with a bottom cover plate ½ in. thick, 16 in. wide, extending beyond the side bearings. The ¼ in. floor plate at the end of the car is in one piece and its rear end is riveted between the bolster cover plate and the diaphragms. The floor plates, between the bolsters, are ¼ in. thick and are bent upwards at the sides and riveted to the side sheets as shown.

There are four drop doors with openings 2 ft. 4 in. long and 2 ft. 2½ in. wide. These doors are operated by a simple mechanism—a chain winding on a shaft—as shown in one of the illustrations. At the center of the car the center sills and sides are tied together by pressed steel diaphragms, similar to those used in the bolsters, and with a plate 6 in. wide extending across the bottom about two-thirds the width of the car. Between each pair of doors a similar construction is used. On the other side of the doors are what are known as intermediate diaphragms. These consist of a pressed steel diaphragm between the center sills, as well as between the center sills and the sides; these diaphragms are of a uniform depth of 9-11/16 in. The cross tie between the intermediate tie and the bolster is an 8 in. channel, a greater depth not being allowable because of its being over the


wheels. These channels only extend between the center sills and the sides, the center sills not being tied at these points.

The sides and ends of the car are constructed of ¼ in. plate. The sides are stiffened at intervals, varying from 2 ft. 10½ in. to about 3 ft. 11 in., by U-shaped pressed steel side stakes, 4 in. are reinforced at the bottom, on the inside between the bolsters, with 3 x 3½ x 5/16 in. angles. Westinghouse friction draft gear is used with Farlow attachments. The bolster consists of pressed steel diaphragms between the center sills and the sides and a steel casting between the center sills. These parts are securely deep at the point of greatest depth. The side sheet is reinforced at the bottom on the inside by 3½ x 3 x 5/16 in. angles and at the top on the outside by 4 x 3½ x ½ in. bulb angles. The ends of the car are stiffened on the outside by two 5 in. Z bars placed horizontally and by two vertical gusset plates on the inside just over the center sills. They are also reinforced at the top by bulb angles, in the same manner as the sides. The buffers are bolted to wooden buffing blocks reinforced at the back by a channel.



CROSS SECTION THROUGH DROP DOOR.

The trucks are of the diamond arch bar type with pressed steel bolsters. The general design of these cars was prepared under the direction of R. P. C. Sanderson, superintendent of motive power, the details being worked out by the Pressed Steel Car Company.

## INCREASING THE LIFE OF LOCOMOTIVE CRANK AXLES.

The extensive adoption of 4-cylinder 4-crank locomotives in France has shown the necessity of improving the design of the crank axles. Their cost is very high, and cracks in the webs or cheeks began to appear after a relatively short period of service. Under these conditions, the railway engineers have been compelled to investigate the best design of crank axle in order to increase its life and to reduce the maintenance expenses of the locomotives. On the Western Railway of France the following observations have been made on crank axles of the oblique type (as shown in Fig. 1) used on fast passenger engines:—

(1) Of 13 ordinary axles of annealed open-hearth steel on locomotives of the 4-4-0 class, 10 were found to have cracks after runs of from 105,000 to 158,000 miles; (2) of 26 hollow axles from similar locomotives, three were found to have cracks after making runs of from 291,400 to 339,760 miles; (3) other things being equal, the crank axles of engines of the 4-4-2 class gave less service than those on engines of the 4-4-0 class, and on the former engines axles of annealed open-hearth steel have developed cracks after runs of from 45,880 to 124,000 miles.

The axles crack always in the filleted angles A or B, Fig. 1, under the influences of the violent shocks in service, the dynamic effects of the shocks being concentrated at these points, where they cannot be absorbed by the elasticity of the metal. Permanent deformation is set up, and in time a crack appears; its development is often facilitated by defects in the metal, resulting from the segregation of metal in the ingot.

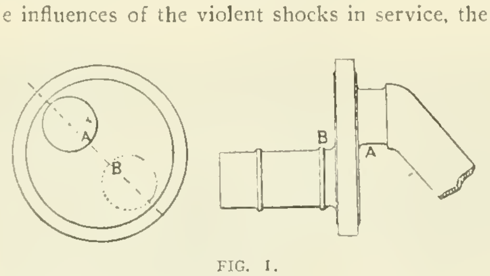



FIG. 1.

In order to avoid the formation of these cracks, Mr. Frémont, Chief of Works at the School of Mines, has devised the plan of cutting away the crank web in the part between the journal and the crank pin, as shown in Fig. 2. With this arrangement, the dynamic effects are not concentrated at a point, but are distributed around C and D, over the largest possible amount of metal, and the elasticity of which can absorb them. This method also removes the defective metal that may occur in the axis of the ingot. Fig. 2 shows the arrangement for double-web cranks on straight axles, as well as for single-web cranks on bent or oblique axles.

Five axles of the oblique type, which showed cracks after runs of 106,480 to 213,195 miles (on engines of the 4-4-0 class) had the webs slotted out in the Frémont plan so as to remove all traces of the cracks. Since then (and up to October, 1908) they had run for from 29,080 to 92,253 miles, and had shown no signs of cracks.

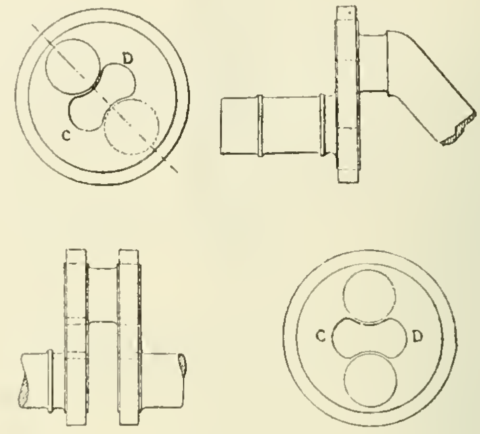



FIG. 2.

Four new crank axles with slotted webs were put in service on engines of the 4-4-2 class (with which cracks are most likely to occur), and have run from 81,230 to 110,193 miles without showing any cracks. Axles made of the same metal, but with solid webs, were applied at the same time to similar engines in the same service; these showed cracks after running less than 62,000 miles.—*E. Hallard, Asst. M. E. Southern Ry. of France in the Revue Generale des Chemins de Fer.*

## TESTING LOCOMOTIVE FUEL.

A committee of the International Railway Fuel Association recommended in its report that fuel contracts should be based on a stipulated amount of ash, with penalties for excess and premiums for reductions, as is the practice of the United States Government. While the members generally seemed to favor this principle, there is more or less uncertainty as to just how the ash content should be determined.

R. Emerson, of the Lehigh Valley, in speaking on this phase of the question, said: "The farther my experience has extended in these matters, the less confidence I have in the methods of sampling fuel. Suppose a consumer receives a carload of coal and wishes to determine roughly the average per cent. of ash in that carload. He attempts to pick a sample. Let him pick two or three pieces of coal at one end of the car, two or three pieces of coal at the other end of the car, two or three at the middle; he gathers up a few impurities that he sees lying around, bone or slate. The quality may fluctuate through the car, and he takes more samples, finally getting quite a little pile of coal. He then quarters it, dividing it into four parts so as to get what he calls an average sample. He breaks the lumps up more, quarters that again and finally when he gets done with all, he has a very small pulverized sample that is supposed to be an average sample of the fuel. He contents himself with not only one sample, but he may take a dozen of such supposedly average samples and then proceed to analyze his fuel in the laboratory to determine its calorific value, and its chemical constituents. Now he takes all his results and averages them together and gets (to his satisfaction at least) the average determination of the quality of the coal furnished by that car.

"But it seems to me that, notwithstanding the care of his method of analyzing and his mathematical averages, his first selection of a sample is unscientific and crude in the extreme. It is a question in my mind if, owing to the crudeness of selecting the sample, however conscientious a man may be, however many witnesses he may have representing the mine or somebody else, to see that the sample is a fair one, that you are not getting good results which you know really represent the calorific content of the car. Mr. Crawford, of the Burlington Lines, has gone rather to the method of testing the fuel in actual service on the locomotives, and that method, while a more rough-and-ready one, it seems to me is really much more nearly in the right direction. (See American Engineer, April, 1908, page 124.)

"On the Lehigh Valley, we have not gone into this question of regularly testing the quality of the coal received. I have been asked to take that matter up and do something in connection with it, but I have been so dissatisfied with the ordinary "scientific" method that I have not been willing to put our company to that expense. Mr. Crawford's results have been more satisfactory, and I have been seriously considering using his method.

"There has lately occurred to me, however, the possibility of using a much more wholesale and perhaps generally more practical and satisfactory method, and that would be to weigh the ash from each locomotive, just the same as we weigh the coal issued to each locomotive. Of course, there will be certain difficulties in connection with that. The ashes will often be scattered and dropped along the line, fires will be cleaned at odd stations and a certain amount of the ash content will be lost in that way, but perhaps, taking certain runs, you might get at some fairly satisfactory result by weighing all of the ashes that were produced from all the coal issued to those locomotives, and in that way arrive roughly at a per cent. of ash content of the coal that was consumed, and determine the basis on which you would pay your mine for the quality of coal delivered."

Geo. M. Carpenter, of the N. C. & St. L., agreed with Mr. Emerson, and spoke as follows: "The usual custom is for the party who is to make the analysis to go to the face of the vein and make a series of clippings from the top or roof, taking anything that may come in the path and take a sample, perhaps, two or three times on the same face; take it then into his laboratory, and then he will come out, and tell you of the high per cent. of carbon that this coal shows, the low per cent. of sulphur, ash and volatile matter. While he is doing that, some miner drills a hole into that same vein and makes a shot, and if that same man were to come back and take another sample and analyze it, his results would be altogether different. There are very few mines in this country that the analysis will prevail or follow itself up throughout the entire vein. The consequence is that buying coal on the fuel analysis of the fixed carbon in the coal, has never yet been found to be uniform or satisfactory. I agree with Mr. Emerson when he says that to determine the most economical grade of coal is to put it into service and get its value from a practical standpoint, and not a theoretical one."

Eugene McAuliffe, president of the association, at the close of the discussion said:

"I appreciate that laboratory work is scientific and generally accurate, but Mr. Emerson struck the keynote when he said it all rested with the fellow that took the sample. * * * I believe that the B. T. U. discussion which has been exploited a great deal in the last four or five years is rather on the wane. I do not believe that it is practical to apply it to railroads at all. In the first place, you have to measure up the results you get from railroad coal after it is placed on the engine tender, and you know sometimes we take an operator's coal and keep it on hand a couple of months before putting it on the engine tender, and the result is, you have to take your sample off the coal chute, and we have not the facilities at the average coaling station to take samples and to get, as Mr. Emerson says, a thoroughly representative sample. I would say, for a fair sample, I would want two or three tons of coal to mix, reduce, quarter, grind, and work down; it would probably increase the supervision incident to the purchase, handling, distribution and economical use of coal four or five per cent. How clearly out of the question it would be to get the force necessary to properly sample railroad coal and get reasonably accurate results on the B. T. U. basis!

"I think there is only one way to determine the relative efficiency of coal. In the first place, I believe a coal that will get a heavy train over the road in a reasonable time with a reasonable quantity of fuel is probably the most economical coal for a railroad to buy. If you can do that with mine run, I say, buy mine run; if you cannot do it with mine run, buy screened coal. If you can get a successful grade of coal by screening out a percentage of the slack, buy that. If you have to have it all taken out, have it taken out and pay for it. There is only one way to test locomotive coal, and that is to take an engine of average character and condition, with an average crew—I am speaking of an average crew from the standpoint of intelligence and experience—and give them a full tonnage train that will keep the engine busy over the division, put competent, honest observers on the engine, and, after weighing the coal and calibrating the tank, determine the exact amount of coal and water used, compute at the end of probably a three round-trip period the evaporative efficiency of the coal; make note of weather conditions, delays, time used in cleaning fires, ash pans, etc., and keep that work up. It should be kept up for about six months during the summer season. I do not believe in conducting evaporative tests, or locomotive tests in the winter time, when the weather conditions are so shifting as to practically nullify the results. The losses from radiation are abnormal in cold weather, therefore we should have an average temperature. I do not think the man in charge of the tests should work on one grade of coal an undue length of time—they become careless—but shift the thing around, keep moving, and at the end of a couple of years you will know fairly well where you are at.

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Available Water Power.—M. O. Leighton, of the United States Geological Survey, estimates that "were all practicable storage sites utilized and the water properly applied, there might be established eventually in the country a total power installation of at least 200,000,000 horse-power and probably much more." The significance of this is more readily apparent when it is recalled that the total estimated horse-power now used in this country, including the railroads, is only about 30,000,000. Thus far only about 5,356,000 h.p. of water power has been developed. The United States Geological Survey has recently issued a bulletin designated as "Water-Supply Paper 234," containing a number of papers on conservation of water resources which were presented before the National Conservation Commission. Among these are "Distribution of Rainfall," by Henry Gannett; "Floods," by M. O. Leighton; "Developed Water Powers," compiled under the direction of W. M. Stewart, with discussion by M. O. Leighton; "Undeveloped Water Powers," by M. O. Leighton; "Irrigation," by F. H. Newell; "Underground Waters," by W. C. Mendenhall; "Denudation," by R. B. Dole and H. Stabler, and "Control of Catchment Areas," by H. N. Parker.

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The Value of Good Lighting.—As a mere matter of industrial economy, there is no item of such importance as the efficiency of workmen and workwomen. The "cost of raw materials," "interest and depreciation," "office expense," or any item that you will, is wholly overshadowed by the cost of labor; and there is no single utility that has a greater influence upon the actual efficiency of the laborer than the light by which he works. At least 99 per cent. of the results of labor are accomplished under the direction of the sense of vision. Imperfect or defective vision makes labor difficult, and the results imperfect. Of all things let the workman have a good light. As human labor has become less a matter of mere physical strength, and more a matter of intelligence, the mental attitude of the worker has come to be of greater importance. The discontented worker will never equal in efficiency the contented worker, and the worker who is compelled to use poor tools, the most important of which is light, is bound to be discontented.—*E. L. Elliott in the Illuminating Engineer.*

# LOCOMOTIVE COUNTERBALANCING.*

H. H. Vaughan.

The counterbalancing of locomotive engines is one of the few problems in connection with that apparently simple yet exceedingly complex machine, which is capable of an exact theoretical determination. When the weights, locations and movements of the various parts of an engine are known, it is possible to calculate accurately the forces which they cause at any speed of rotation, and apart from some practical considerations, such as the engine being constricted in its lateral movements by the wheels which support and guide it on the rails, and the fact that it is connected in a more or less imperfect way with a tender, the movements which result from the action of these forces can also be exactly ascertained; this subject has consequently been very thoroughly treated by a number of writers, and I shall therefore endeavor to discuss, as shortly as possible, the theoretical principles which underlie it.

The disturbing forces which necessitate the counterbalancing of any reciprocating engine are those required to start and stop the mass of the reciprocating parts at each end of the stroke;

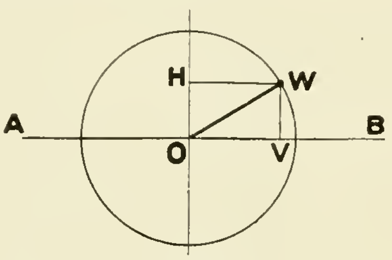


FIG. 1.

neglecting the disturbance caused by the obliquity of the connecting rod, which is unnecessary to consider in any existing type of locomotive, these forces are identical with that caused by a corresponding mass at the crank pin, with the exception that they have no vertical effect.

In Fig. 1 let the weight W be rotating around the center O, at a velocity of V feet per second; then what is known as the centrifugal force, which is really the force that is required to make W move in a curved line instead of in a straight line, as it would do if left to itself, acts along the line W O, and equals $\frac{W V^2}{32.2r}$ when r is the radius in feet.

This force W O can be resolved into two components W H and W V, the first acting entirely in a horizontal, and the other in a vertical direction; it will be seen that when W is on the vertical diameter W H is nothing, while W V equals W O, and when it is on the horizontal diameter W H equals W O while W V is nothing. Now, if the weight W moved backwards and forwards along the horizontal line A B in such a way that its position on that line was always vertically under or over the position of W when rotating uniformly around the center O, the force necessary to accelerate or retard it is always W H, or, in other words, equals the horizontal component of the centrifugal force due to an equal weight rotating in a circle.

This is what happens in the case of a weight such as a piston and crosshead actuated in a horizontal line by a connecting rod, as in Fig. 2; here the distance of the weight P from the center of the stroke corresponds with the horizontal distance of the crank pin C from the center O, and the force accelerating or retarding it is equal to C H when C O equals the centrifugal force which P would exert if moving on the path of C.

Since P in this case is moving entirely in a horizontal plane, it gives rise to no vertical forces whatever, and it is this fact that introduces all the difficulties in connection with balancing an engine; before, however, discussing that question, the connecting rod must be referred to. It is evident that this has at one end a circular, and at the other a reciprocating movement, while between the ends, the motion of any part is of an intermediate nature; the result is the same as though part of its weight were concentrated at the crank pins and had a circular motion, while the remainder was concentrated at the crosshead and had reciprocating motion.

In a paper read before the Northwest Railway Club, in 1893, I suggested that four-fifths of the weight of the back end should be taken at the crank pin, and the weight of the front end and one-fifth of the back end at the cross-head, figures that were obtained by calculations from two or three types of rod; this question was, however, treated in an exceedingly ingenious and scientific way in a paper read before the New York Railway Club by R. A. Parke. He developed an accurate method for obtaining the exact division of weights for any rod, and his results showed for modern types of rod that five-sixths of the weight of the back end of the rod should be considered as concentrated at the crank pin with reasonable accuracy. I would refer anyone interested in this subject to his paper, as it is a most interesting example of the application of a really difficult methematical analysis, by which an absolutely simple method is deduced for obtaining correct results. I consider, however, for practical purposes, that five-sixths of the weight of the back end is sufficiently accurate, and that figure is used on the Canadian Pacific.

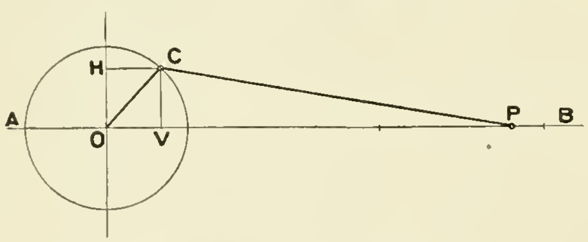


FIG. 2.

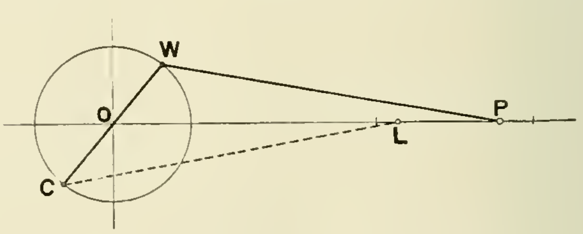


FIG. 3.

There is one more elementary statement to make, namely, that a weight of W pounds at a radius 2r has the same effect as a weight of 2W pounds at a radius r; this follows immediately from the value of the centrifugal force $\frac{M V^2}{32.2r}$, for with the same number of revolutions V is proportional to r, so that for equal forces Mr must be a constant. For simplicity, therefore, all balance weights will be assumed to be placed at the same distance from the center as the crank pin.

With these facts in mind, let Fig. 3 represent an ordinary engine, and let all the rotating weights be concentrated at the

* Presented before the September meeting of the Canadian Railway Club.

crank pin W, say 1000 lbs.; let the reciprocating weights be concentrated at the crosshead at P, say 1500 lbs. The rotating weight can be balanced by a weight of 1000 pounds placed at C, diametrically opposite W on the other side of the center; evidently, whatever be the position of the crank, the forces caused by the two weights are equal and opposite, and there is no resulting force to disturb the axle at O.

When, however, attempting to balance the 1500 lbs. at P, by placing 1500 lbs. at C, the condition is entirely different; the horizontal forces caused by the movement of P are exactly equal and opposite to those caused by the 1500 lbs. at C, but as no vertical forces are caused by P's movement, the vertical forces caused by the movement of the 1500 lbs. at C are left entirely unbalanced, and the effect is the same as though a weight of 1500 lbs. at C were entirely unbalanced vertically. Whatever weight then is introduced at C to balance the horizontal forces caused by P, causes vertical forces equal in amount to the extent by which those due to P are reduced; there is no possible combination by which this can be avoided, except by using crank pins that are not at right angles to each other.

For instance, if there was a crank pin at C and a connecting rod as shown by the dotted line CL, then if the weights at L and P were in substantially the same plane and equal, they would practically balance each other, as is the case with four-cylinder engines, which can be almost perfectly balanced without introducing any vertical forces, while three-cylinder engines can be balanced longitudinally, but are, with respect to nosing, almost in the same class as two-cylinder engines. The latter are the engines now under consideration, and in their case the question of counterbalancing is a compromise. If P is left unbalanced the engine is said to be badly balanced, if P is completely balanced the engine is said to be well balanced, but vertical forces are introduced which certainly may be injurious to track or bridges.

The extent of the force due to any unbalanced weight may be calculated at any speed, but is usually taken at 40 times the weight when the speed in miles per hour is equal to the diameter of drivers in inches; it really varies with the stroke, and the exact figures are 38.5 for a 24" stroke, 41.7 for a 26", and 44.9 for a 28"; taking 40 for an approximate figure, 500 lbs. at C above that required to balance the rotating weights, or, as it is termed, "as overbalance," means a force of 20,000 lbs. acting upwards and downwards at each revolution, and while this seems a high figure, it is occasionally found.

The speed of 69 miles per hour is high for a 69" wheel, but it represents a possible condition, and it must be remembered that while the factor of 40 is not reached until that speed for that size of wheel, that it increases with the square of the speed, so that it is not advisable to consider a lower speed. Evidently, then, it is desirable to keep the overbalance as small as possible, and yet on the other hand the reciprocating parts must be partially balanced for the comfort of the men, and the various rules of counterbalancing have really indicated the nature of the compromise.

The rule most commonly used in America has been that recommended by the committee on the subject at the M.M. Convention in 1882, in which two-thirds of the reciprocating parts are balanced; this compromise has, on the whole, given very satisfactory results, and constituted a great advance on one of the methods given as an answer to the inquiry made by the committee, which was "to figure a little and then guess at it." The two-thirds rule, however, is not necessarily satisfactory; it proves so in the majority of cases, because the relations between the weight on drivers, weight of engine, and reciprocating parts do not vary greatly in engines of ordinary types, but the first great advance was made when G. R. Henderson, in a report made to the Norfolk and Western Railway, in 1895, pointed out that the allowable weight of unbalanced reciprocating parts was a factor of the weight of the engine.

Assuming only, that the maximum speed is proportional to the diameter of the drivers, and that it is desired to construct engines that will be reasonably comfortable for the men at that speed; in other words, that will vibrate to the same amount, then evidently the disturbing forces, or the weights of the unbalanced parts, may vary in direct proportion to the weight of the engine. Mr. Henderson showed that engines in which 1/400 of the weight of the engine was unbalanced rode satisfactorily, and that 1/360 can be left unbalanced without objectionable vibration; we have then in this rule a scientific method of determining the weight of reciprocating parts that may be left unbalanced, and yet allow the engine to ride reasonably well, which is applicable to engines of widely varying types; for instance, if two engines were of the same weight, but one had reciprocating parts weighing twice as much as those on the other, this rule would allow the same weight to remain unbalanced; in other words, both engines would ride equally well, whereas with the old two-thirds rule one engine would have twice as much unbalanced weight as the other.

So far as the action of the engine is concerned, there is, I consider, no criticism possible that can be made of this rule; in other words, an engine balanced by it is certain to ride satisfactorily, but in balancing an engine there is another and very important aspect of the matter which it ignores, namely, the effect of the overbalance on the track. This side of the question has often been referred to, and its effect discussed in a general way, but so far as I am aware, locomotive builders have never really established any rule limiting its amount, although they have recommended balanced compound engines or the utilization of the weight of the tender, which I shall refer to later. On the other hand, no maintenance of way engineer has, I believe, defined the limit of overbalance which he considers permissible, although he will cheerfully advocate none being used; neither is he able, except in extreme cases, to show any definite evidence of damage from this cause. Taking, however, the maximum speed before referred to, an overbalance of 500 lbs. in a wheel carrying 20,000 lbs. causes the pressure between that wheel and the rail to vary from 40,000 lbs. when its overbalance is down, to nothing, when it is up, and any greater overbalance would tend to lift the wheel from the rail.

Testing plant experiments show that when the calculated effect of the overbalance exceeds the weight on the wheel that it does actually leave the rail, and that there is a definite blow when it strikes it again. I have analyzed this action (see AMERICAN ENGINEER AND RAILROAD JOURNAL for February, 1909), and have shown that this blow may, in extreme cases, be severe and sufficient to account for the damage that is occasionally met with; on the other hand, I do not believe that any case of repeated bending of rails has occurred in which the vertical effect of the overbalance did not considerably exceed the weight on the wheel. It is, however, only reasonable to acknowledge that a wheel that presses alternately nothing, and 40,000 lbs. on the rail, is going to affect the track more than one which presses down continuously with 20,000 lbs.

It will damage more defective rails, cause more injury to tracks, and may, in weather when the rail is unevenly supported, be the cause of rail breakages. From the track point of view, therefore, the less the overbalance the better, and the problem of the locomotive engineer is to determine to what extent it can possibly be reduced. To discuss this I must refer more in detail to the action of the unbalanced weights on the engine. In Fig. 4 let $P_1$, $P_2$, be the right and left crossheads respectively, $C_1$, $C_2$, the crank pins, and $O_1$, $O_2$, the overbalances; as $C_2$ and $O_2$ are in the middle of the stroke they have no horizontal effect, and there is a longitudinal force equal to $P_1 - O_1$ tending to drive the right side of the engine backward; as $P_2$ comes to the end of its backward stroke there is a similar force tending to draw the left side of the engine backward, and at that time the effect of $P_1$ and $O_1$ is nothing. This action is repeated at the other end of the stroke, so that the action of the unbalanced weight is to drive the engine backwards and forwards as a whole, and also to cause the ends of it to vibrate transversely; or, as it is usually called, "make it nose."

There are then two distinct actions of the unbalanced weight in an engine, which I will call the longitudinal and transverse movements: the latter you will agree, I believe, is not generally very noticeable, but on small 8-wheel engines it is objectionable when running at a high rate of speed. Some years ago, when working on this subject, I noticed, as I dare say you have, that on the longer, heavier engines, the nosing from unbalanced weights was not noticeable, and in a paper before the Northwest Railway Club, in 1896, I advocated a rule in which the unbalanced weight was increased in proportion to the length of the engine as well as to its weight. This rule was defective, as it increased the longitudinal vibrations on a long engine as compared to a shorter one of equal weight, and as the longitudinal vibrations are those which render an engine rough riding, it could not, and no rule could increase the unbalanced weight beyond a certain amount without being objectionable. It is true

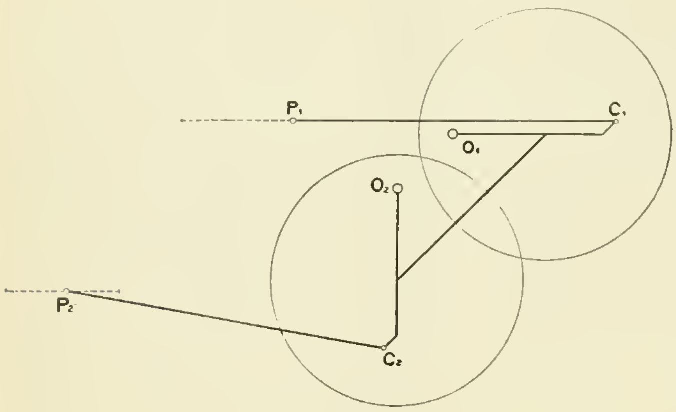


FIG. 4

that engines balanced by it rode satisfactorily, but that was because it started with a short engine with 1/400 of the weight unbalanced, and on the longest engines it was applied to, did not increase the unbalanced weight beyond 1/360, which is an amount that does not, as a rule, lead to criticism by the men.

Although this rule was not of much practical value, it recognized one point, namely, that the nosing motion was not as important as the longitudinal, and when investigating the counterbalancing of some engines on the Canadian Pacific, in which the counterbalances were offset so as to increase the longitudinal and decrease the nosing movement, it occurred to me that by allowing an increase in the nosing movement, a decrease in the amount of overbalance could be obtained without increasing the longitudinal movements.

This can be done by means of offset counterbalance weights, but as they have a serious objection, the same result can be obtained by means of supplementary counterbalance weights placed at right angles to the cranks. This arrangement is shown on Fig. 5, $S_1$, $S_2$, indicating the supplementary counterbalances and the arrows the direction of the forces.

Neglecting the difference in the distances, center to center, of the balance weights and the pistons, which it is not necessary to consider here, it will be seen that the forces at $O_2$ and $S_1$ both tend to drive the engine forwards as against that of $P_2$ driving it backwards; in place of a force $P_2 - O_2$ driving it backward as in Fig. 4, the force is, therefore, reduced to $P_2 - (O_2 + S_1)$, on the other hand, the force $P_2 - O_2$ still tends to throw the front of the engine to the right, and it is assisted by $S_1$.

The net result therefore is, an engine that is balanced longitudinally as an engine would be with an overbalance $O_2 + S_1$, and balanced transversely as though its overbalance were $O_2 - S_1$. To put this into figures, suppose the engine weighs 160,000 lbs., and the reciprocating parts weigh 1300 lbs. a side; the permissible unbalanced weight at 1/400 of the weight is 400 lbs., leaving 900 lbs. to be balanced, or 300 lbs. per wheel, if the engine has six drivers; if the weight per wheel is 20,000 lbs., this overbalance is 1.5% of the weight on the wheel, and the variation in pressure at the maximum speed is 12,000 lbs., or 60%.

This would not be an unusual case, in fact it would be an ordinarily well-balanced engine. Now, if we place a supplementary balance weight of 100 lbs. on the opposite wheel, and reduce the overbalance to 200 lbs., this 200 lbs., and the 100 lbs. from the other wheel, make up the 300 lbs. to balance the engine longitudinally, but for transverse balance the 100 lbs. has to be deducted from the 200 lbs. overbalance, so that only 100 lbs. is balanced in each wheel, or 300 lbs. altogether.

Taking 300 from 1300, leaves 1000 lbs. unbalanced transversely, or 1/160 of the weight, and we, therefore, have an engine that longitudinally has 1/400 of its weight unbalanced, but transversely 1/160 unbalanced. The overbalance has been reduced from 300 to 200, but the reduction in the effect on the track is not quite as great as this; the greatest effect of $S_2$ and $O_2$ is not when $O_2$ is vertical, but it equals $\sqrt[2]{O_2^2 + S_2^2}$ or, for the two weights in question 222 lbs., a reduction of 78 lbs., or 3120 lbs. at the maximum speed.

I am not entirely prepared to say how far this system can be carried, but from the experiments so far, it would appear that an engine having 1/400 of its weight unbalanced longitudinally, and entirely unbalanced transversely, is entirely satisfactory as far as its riding qualities are concerned. This would mean that the supplementary balance was equal to the overbalance, and in that case the effect on the track would be 71% of that of an ordinary overbalance giving the same longitudinal effect, and this reduction can be accomplished without detriment to the ordinary qualities of the engine, or without introducing any objectionable troubles.

It is true that the nosing must be prevented by the pressure on the hubs of the wheels, but against this, it must be remembered, that when balance weights are distributed amongst three or four wheels that the effect of the overbalance on the boxes of all except the main wheels is just the same as it is on the track, and that the steadying effect on the engine is obtained at the expense of wear in the boxes. The wheel base on an engine is so long, compared to the distance from the center of the engine to the center of the cylinder, that a very small pressure on the hub is able to overcome a nosing motion much better than a balance weight, and probably with less wear.

We are not, however, leaving engines entirely unbalanced

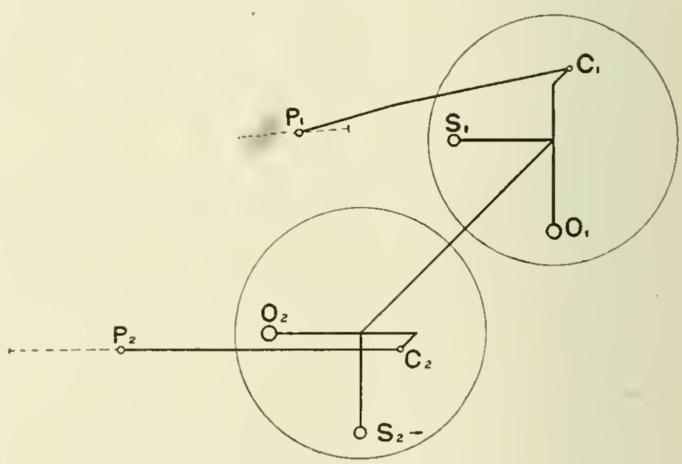


FIG. 5.

transversely except as an experiment, but are leaving from 1/100 to 1/150 of the weight unbalanced transversely, and 1/400 unbalanced longitudinally with extremely satisfactory results; one passenger engine has been entirely balanced longitudinally and entirely unbalanced transversely. It is reported to be a "perfect riding engine," and its balance is exactly the same as a 3-cylinder engine having two outside cranks each at right angles to the inside crank, and otherwise unbalanced, so that it has been shown that an engine of this kind would be entirely satisfactory as far as the balancing is concerned.

We are, however, using the system of balancing to reduce the action of the overbalance on the rail, and have adopted a rule to balance the engine so that the overbalance in any one wheel shall not, if possible, exceed 1% of the weight on that wheel, and is limited to 1¼%.

The latter figure causes a variation of 50% of the weight on the wheel at the maximum speed, and while I have, of course, no accurate information to show that this is the proper limit, it is so much better than on many existing engines, that I feel that it is a sound limit to work to, and we are certain that under no conditions can any hammer blow occur from wheels balanced in this way. So far, no engine has been met with in which it is not possible, by using supplementary balances, to obtain satisfactory results, without increasing the overbalance above this amount.

There are also one or two practical advantages in the system of allowing a greater unbalanced weight transversely. It is possible to properly counterbalance consolidations, as the supplementary weights can be placed in the wheels at right angles to the crank, thus overcoming the difficulty experienced of not being able to get sufficient balance opposite the crank without an excessive overbalance in the leaders and trailers.

It makes the adjustment of the balance very easy. It is only necessary to cast the main balances 75 or 100 lbs. light, and then place 75, 100 or 125 lbs. in the supplementary balance, as is necessary to keep the longitudinal unbalanced weight down to 1/400 of the weight of the engine. Extreme accuracy is entirely unnecessary, any engine that has less than 1/400 unbalanced longitudinally will ride well, and apparently, the transverse balancing is very unimportant.

The weights should be checked up to see that the effect of the

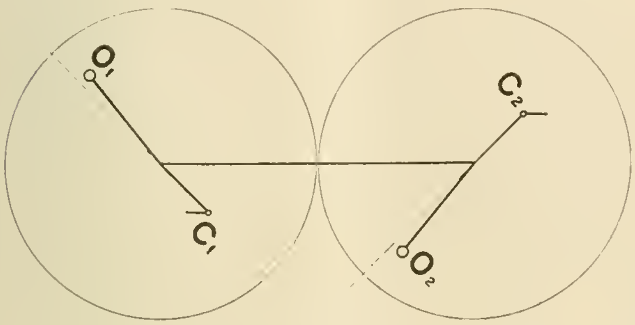

FIG. 6.

overbalance and supplementary balance is less than 1¼% of the weight on the wheel, but this is fairly well known from corresponding engines, and in the types so far gone into, there has been no case where this figure had to be exceeded.

These advantages are, of course, incidental, the chief interest is, I consider, the fact that an engine may be unbalanced transversely to a far greater extent than longitudinally without causing its riding qualities to be objectionable, consequently, the overbalance can be reduced, and its effect on the track maintained within reasonable limits.

I have referred to the utilization of the weight of the tender. This has been done on the Prussian State Railways by coupling the engine with tender so firmly that the weight of the tender assisted in absorbing the longitudinal vibrations. If this could be done the factor of 1/400 could, of course, be applied to the total weight of the engine and tender, and I understand that engines have run with the reciprocating parts entirely unbalanced with satisfactory results.

We have always found here that when less than 1/360 was unbalanced, trouble has developed in keeping up the connection between engine and tender, and lost motion has occurred very quickly. I feel that, with our heavy reciprocating parts and hard service, this method is hardly practicable, and it does not afford any hope of being able to avoid some system of balancing for two-cylinder engines.

Before closing, I wish to refer to offset counterbalances, as it is obvious that the combination of main and supplementary balances I have described is the same as an offset balance weight; the trouble with the latter is that it cannot be weighed, and must be calculated.

Some very serious errors have been introduced by depending on weighing it, especially where it is offset, to reduce the nosing movement; in Fig. 6 let $C_1$, $C_2$, be the crank pins, $O_1$, $O_2$, the counterbalances (not only the overbalances); when weights are placed on the crank pins at $C_1$, they do not show the weight of the overbalances at $O_1$, as is the case with an ordinary balance opposite the crank; suppose the crank pin radius be 12" and the counterbalance $O_2$ is set 4" off the center line; evidently the weight at $C_1$ acting at 12" is helped by that at $O_2$ acting at 4", and the mistake has been made of thinking this weighed the counterbalance at $O_1$; it does not begin to.

$O_1$ in addition to balancing the weights at $C_1$, is balancing the entire weight of the crank pin and hub, and a numerical example will show what happens. Suppose $O_1$ is also 12" from the center, and that the weight of the crank pin and hub at $C_1$ is 500 lbs., and that the counterbalance desired is 400 lbs. Neglecting the fact that $O_1$ is not quite 12" from the vertical line, it would require 900 lbs. at $O_1$ to give a counterbalance of 400 lbs. in addition to balancing the weight of the hub; this 900 lbs. would also act at $O_2$ at a distance of 4" from the center line, and consequently the weight required at $C_1$ to balance would be $\frac{900 \times 12 - 900 \times 4}{12}$ or 600 lbs., of which 500 lbs. is supplied by the crank pins and hub, leaving only 100 lbs. actually necessary to balance an overbalance of 400 lbs.

Evidently, this might easily be very misleading, and the difficulty is that, from the weight on the crank pin the actual overbalance cannot be calculated except by estimating the weight of the crank pin and hub, and knowing the exact offset of the center of gravity of the counterbalance.

For this reason the arrangement of counterbalance weights directly opposite the pin is far better, as they can accurately be weighed and the supplementary balances of known weight afterwards added.

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FUEL ECONOMY.—The greatest waste of our coal supply is in our imperfect processes for rendering available its latent energy. In the average power plant not over ten per cent. of the potential energy of the coal is utilized. About one-quarter of our total coal consumption is in locomotives, and the loss due to boiler scale is probably at least 15,000,000 tons. The advent of the gas engine and producer gas has marked a long step in advance, for not only can the percentage of coal energy utilized be raised to 18 or more, but, what is even more important, low-grade coals, such as lignites and some peats, become available. On the other hand, gas producers do not work very satisfactorily with bituminous coals, particularly those of the coking variety. Using small anthracite, producers will consume from one to one and a half pounds of coal per horse-power hour, while steam boiler plants require 2 to 3 pounds for large plants, and 4 to 8 pounds in very small plants. In plants of 300 h.p. or less, the same coal will generally give about 2½ times as much power in a gas engine as when burned under a boiler. In large plants (20,000 h.p. and over), the saving in fuel by the gas engine is largely offset by its greater cost of installation and maintenance.—*M. T. Bogert, Presidential Address, American Chemical Society.*

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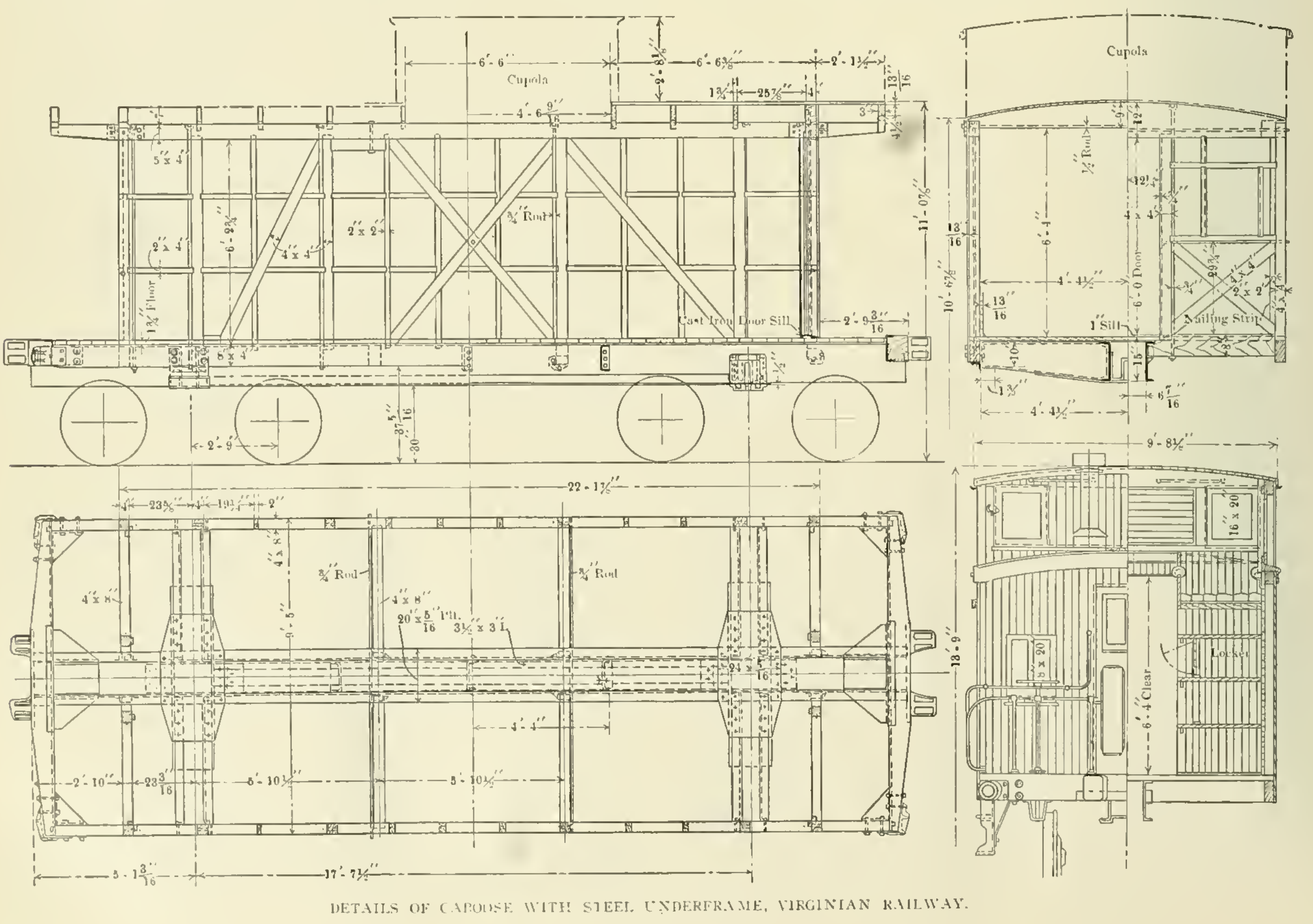
AMERICAN EXPOSITION IN BERLIN.—An American Exposition will be held in the city of Berlin, Germany, during the months of April, May and June, 1910, in the Exposition Palace, located in the best and most frequented part of the city. It is intended to educate the European, especially the German population, to the importance and excellence of American manufactured products, and thus to strengthen the existing cordial relations and to stimulate trade between the two countries. The exhibits will be limited to articles of proven merit, and in order to make the exposition of the greatest possible permanent benefit to both nations, the American advisory committee is desirous of having prominent American firms represented in every line. To encourage prospective exhibitors to this end, exceptional facilities will be offered them. Information may be obtained by addressing Max Vieweger, American manager, at the Hudson Terminal Buildings, 50 Church street, New York City.


## CABOOSE.

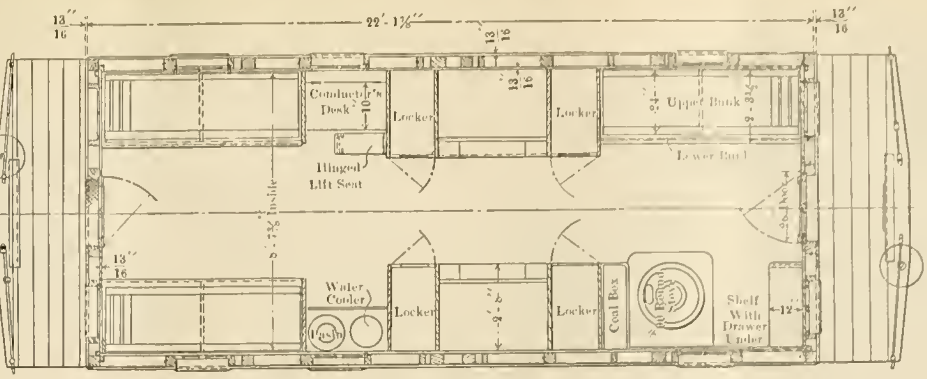
VIRGINIAN RAILWAY.

The Virginian Railway has recently placed in service a number of cabooses that were designed for use on the mountain divisions where Mallet compound locomotives, having a tractive force of 80,000 lbs., are used for pushing. The underframe is made unusually strong, the center sills and draft gear being the same, as far as conditions will permit, as those on the steel coal cars on that road. In a rear end collision one of these cabooses was not damaged although an ordinary caboose under the same conditions would have been completely wrecked. The center sills are 15-in., 40-lb., channels; they are covered with a 5/16-in. plate 20 in. wide and are reinforced at the bottom, between the bolsters, by 3½ x 3-in. angles. They are tied together, between the bolsters, by three pressed steel diaphragms and are connected to the wooden side sills by ¾-in. rods and 4 x 8-in. timbers, as shown.

The bolsters are built up of pressed steel members between




DETAILS OF CABOOSE WITH STEEL UNDERFRAME, VIRGINIAN RAILWAY.




FLOOR PLAN OF CABOOSE—VIRGINIAN RAILWAY.

the center and the side sills and a steel casting between the center sills. These are tied together by top and bottom cover plates. Westinghouse friction draft gear is used with Farlow attachments. The upper framing and the arrangement of the floor plan are clearly shown by the drawings. These cabooses were designed under the direction of R. P. C. Sanderson, superintendent of motive power, and were built by the American Car & Foundry Company at Wilmington, Del.

## COST OF OPERATING COALING STATIONS.

A committee on "Standard Types of Coaling Stations," in presenting its report to the International Railway Fuel Association, gave some figures showing the comparative cost of operating different types of coaling stations. The statement includes several examples of eight different types, located on various roads in different parts of the United States, suggesting variable climatic conditions and labor costs. In order to secure a more representative comparison, the average of a number of stations of the same type is given rather than items showing individual station figures, the results covering a twelve months' period. The figures do not include the items of general supervision, insurance, taxes or charge for locomotive service in placing cars for unloading.

| TYPE | COST OF INSTALLATION | INTEREST ON PLANT AT 5% | DEPRECIATION ON PLANT AT 5% | MAINTAINANCE | SUPPLIES | LABOR | TOTAL COST | TONS HANDLED | AVERAGE COST PER TON |
|---|---|---|---|---|---|---|---|---|---|
| 1 | $136,848.38 | $6,842.27 | $6,842.27 | $1,633.92 | $420.55 | $59,756.93 | $78,495.94 | 710,735 | $.1062 |
| 2 | 150,556.12 | 7,527.77 | 7,527.77 | 2,404.62 | 1,652.84 | 17,724.86 | 36,837.86 | 610,041 | .0604 |
| 3 | 91,777.45 | 4,588.86 | 4,588.86 | 2,114.98 | 135.22 | 13,128.42 | 25,556.31 | 471,103 | .0542 |
| 4 | 94,000.00 | 4,700.00 | 4,700.00 | 720.00 | 289.16 | 21,595.44 | 32,004.60 | 296,232 | .1080 |
| 5 | 4,686.42 | 234.31 | 234.31 | 239.71 | 72.68 | 8,236.15 | 6,017.16 | 33,505 | .1798 |
| 6 | 114,552.90 | 5,727.60 | 5,727.60 | 5,026.41 | 3,502.99 | 17,359.18 | 37,343.78 | 698,988 | .0534 |
| 7 | 66,364.06 | 3,318.20 | 3,318.20 | 200.40 | 1,077.64 | 10,970.49 | 18,884.91 | 267,226 | .0706 |
| 8 | 30,500.00 | 1,525.00 | 1,525.00 | 480.00 | 2,068.08 | 9,903.24 | 15,501.32 | 250,992 | .0617 |

Type 1.—Twenty-five Chutes—Shoveling chutes, inclined trestle served by locomotives; chutes located in Mo., Texas, Ala., Miss., Minn., Ia., Kas., Okla., Ark., Ind., Ky., Tenn., on lines of M. K. & T., Frisco., Rock Island, C. & E. I., Penn. R. R., and Queen and Crescent System.

Type 2.—Fourteen Chutes—Gravity chutes, timber construction, using self-clearing cars. Served by locomotives and gasoline or electric cable hoist. Chutes located in Kas., Tex., Okla., Mo., Miss., Ala., Ark., Ill., Ia., on lines of the M. K. & T., Rock Island, Frisco., and C. & E. I. R. R.

Type 3.—Nine Chutes—Holman type, using one to four balanced buckets with capacity of one to three tons each. Chutes located in Ill., Ia., Mo., Ark., Okla. and Pa., on M. K. & T., Frisco. Rock Island, Penna. R. R. and C. & E. I. R. R.

Type 4.—Eight Chutes—Trestle platform, one ton or more capacity buggies. Gondola and covered cars placed by locomotives. Chutes located in Ky., Tenn. and Ala., on Queen and Crescent System.

Type 5.—Six Chutes—Air hoist, crane and buckets, air pressure furnished by locomotive taking coal. Located in Tex., Kas., Ia., Minn. and Ind., on lines of Penna. R. R., M. K. & T. and Rock Island.

Type 6.—Seven Chutes—Bucket conveyor type, using gasoline, steam and electric power. Self-clearing cars employed. Located in Ia., Kas., Ind., Mo., Ohio and Tenn., on lines of M. K. & T., Penna. and Rock Island.

Type 7.—Three Chutes—Inclined conveyor, rubber or canvas belt, gasoline, electric and steam power. Self-clearing cars used.

Type 8.—Four Stations—Locomotive crane and clamshell, gondola cars used. Located in Ill., Mo., Okla. and Tenn., on lines of Frisco and Queen and Crescent System.

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Pulleys should be 25 per cent. wider than the belts running on them.

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Basing Fuel Contracts on Amount of Ash.—It is believed that fuel contracts should be based on a stipulated amount of ash, with penalties for an excess and premiums for reductions. This system would have the effect of encouraging operators to provide better facilities and employ the best means of preparation. The railroads would profit by reducing the haulage of inert material and the cost of handling the coal and ashes. While the expense of analysis may seem excessive, it would give the assurance that fuel inspectors are not discriminating against or favoring certain operators, and with this information at hand the officials in charge of locomotives could insist upon definite results. Enginemen will often resort to the excuse that poor coal was responsible for a delay, believing that it is the simplest method of preventing trouble for themselves, or shielding other parties. Engine troubles occur more frequently during the busy period, because they are of more importance at that time, and are, therefore, noted more carefully.—*From Committee Report on "Difficulties Encountered in Producing Clean Coal for Locomotive Use" before The International Ry. Fuel Assn.*

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Railroad Y. M. C. A.—The work of the railroad branches of the association located on our lines, the influence they exert, the accommodations they afford our employees, have, in my opinion, been of very distinct benefit in improving the character and morale of the service; and the contributions of the railroad company to these associations have been among the most profitable investments the roads have made.—*W. C. Brown, President, New York Central Lines.*

(Established 1832).

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## CONTENTS



## EDWARD H. HARRIMAN

A man of Mr. Harriman's energy and achievements must necessarily have made enemies and been subjected to much abuse. Leaving out of consideration his methods, which to some have appeared questionable, there is no question of the value of his work in upbuilding railroads which were in a precarious state when he took hold of them, and the resulting benefit to the communities through which they operated. An accurate estimate of the man himself can best be secured from one who was intimately acquainted with him. Col. E. L. Russell, a personal friend and railway associate, has this to say: "Mr. Harriman was a great genius. If he excelled in any one talent it was the talent of co-operation. He conceived gigantic plans, then proceeded to acquire the control of great forces, and brought them together with the same rapidity with which the thunderbolt collects the rain-clouds. He so arranged these forces that each held relative position to the others. This produced a harmonious co-operation which resulted in accomplishing possibilities that startled the world. Another faculty Mr. Harriman possessed in the highest degree was selecting able lieutenants and then giving them his confidence and authority to carry into effect his wisely conceived plans."

An editorial in *The Commercial and Financial Chronicle*, on Mr. Harriman as a constructive force, ends with these words: "Indeed, it may be truthfully said with respect to Mr. Harriman that in his whole lifework—in all the various undertakings and enterprises with which he was connected—he was never a wrecker. He always sought to build up, never to destroy. He devoted himself chiefly to restoring moribund properties to life and making them fulfil their functions. In this way he was able to acquire much money for himself, but he also made money for others. It has been declared that no one ever lost anything by investing in Mr. Harriman's undertakings. Most important of all, through his reconstructive process he helped to advance the welfare of the whole community."

Few men can have the ability of financing and building up a railroad property and at the same time concern themselves with the details of its organization. One cannot but be impressed by the work of Mr. Harriman and his lieutenants in unifying into a great system and perfecting an organization such as was described by Mr. Kruttschnitt in his paper on "The Organization and Operation of the Union and Southern Pacific Systems" before the New York Railroad Club last spring, and by Mr. Thorne's paper on "The Purchasing Department and Common Standards," presented at the February, 1908, meeting of the same club.

The following extracts, taken from an editorial on Mr. Harriman in *The Outlook*, are deserving of thoughtful consideration: "Even those who, like *The Outlook*, differ radically from Mr. Harriman's political, industrial and financial principles must admire the great qualities of mind which he possessed. * * * * Mr. Harriman has said more than once that the railways of the country should be consolidated and administered, if possible, by one man. * * * * In our judgment, however, his theory was wrong. Autocracy in industry is doomed in this country as was autocracy in politics in France at the time of Napoleon."

## ANOTHER IMPORTANT DEVELOPMENT IN INDUSTRIAL EDUCATION.

The opening of what is known as the "continuation schools," as a part of the Cincinnati public school system, in September of this year, marks another important mile-stone in the progress of industrial education, and is worthy of the most careful consideration by those who are interested in this question and apprenticeship problems. The continuation schools are another development of the co-operative system as exemplified in the co-operative engineering courses* at the University of

* AMERICAN ENGINEER AND RAILROAD JOURNAL, May, 1909, page 199.

† Extracts from this paper will be found on page 312 of the August issue of this journal.

Cincinnati. As was clearly shown by Prof. Hermann Schneider, of the University of Cincinnati, in a paper † presented before a recent meeting of the American Institute of Electrical Engineers, it is practically impossible to teach the trades in trade schools, because of the large number of young people to be trained and the great diversity of interests for which they must be prepared. Prof. Schneider's idea is that the problem will have to be solved by taking the school to the boy at his job, or, in other words, by devising a scheme of co-operation between the schools and the shops whereby the boy who is already employed will be made more efficient by mental training. This is exactly what the Cincinnati continuation schools are doing. When it came to the proposition of training five hundred or more apprentices in the machine shops, the question was merely one of detail, namely, how to take the public schools to these five hundred apprentices. The boys are sent to school one-half day per week for four years. They are rotated in such a way that the school has always the same number of students; that is to say,—a certain manufacturing company has six apprentices; one apprentice will go to school on Monday morning, the second one on Monday afternoon, the third one on Tuesday morning, the fourth on Tuesday afternoon, etc. About 250 apprentices are at present enrolled, and assuming ten half days of instruction per week, there will be twenty-five students at school every morning and every afternoon. The boys are paid for their time in school just as if they were working at their machines. Each half-day session has four hours of solid work.

Criticism may be made on the basis that the one-half day per week for four years is not very much schooling. If you consider, however, that the average public school pupil has about four hours of instruction per day, five days per week, you will see that this school gives to the boy already at work, almost one extra year of schooling. Furthermore, the instruction is such as to make him more efficient at his daily work and will also give him some fundamental training in good citizenship.

The half day per week arrangement is purely experimental and if it is found that it does not solve the problem, a re-arrangement will be made, holding, however, to the fundamental idea that the boy must receive his practical training in the shop, and his mental training in the public schools, under selected teachers.

While the present school is contemplated for machinist apprentices, it is expected to broaden it to cover all the industrial and commercial interests of the city. The details, of course, are not to be the same for the school of a department store, as for the machinist apprentices. In the department store the school will operate every morning *in the store* from eight to ten o'clock, when all the clerks are not needed for the work of the store. Each particular trade will be studied to find the most feasible means of obtaining training for efficiency, and in all cases the school will be taken to the boy who is on the job. A committee of manufacturers meet with a committee of the school board and the superintendent of schools, when necessity arises, to discuss and settle any questions which may come up.

## COUNTERBALANCING LOCOMOTIVES.

Probably no American railroad officer is able to speak on the subject of locomotive counterbalance with greater authority than Mr. Vaughan. Readers who recall his paper on that subject before the North-West Railway Club fifteen or sixteen years ago will remember that it was far in advance of anything written on the subject up to that time.

The paper presented by him before the Canadian Railway Club last month is therefore of unusual interest since it not only measures the progress in our knowledge of this matter since 1893, but it directs attention to the valuable contributions made by such men as G. R. Henderson and R. A. Parke toward the solution of this problem. Mr. Vaughan's conclusions, as embodied in the practice on the Canadian Pacific and the experiments that are being made on that road, cannot fail to be of value to those interested in this subject.

## APPRENTICESHIP.

Those who prophesied a few years ago that the new apprenticeship system that was being established on the New York Central Lines would deteriorate and die a natural death as soon as the first excitement passed off must be glad to learn that they were badly mistaken, and that after more than three years those who have followed its progress closely are more than ever convinced of the correctness of the principles upon which it is established. Many serious problems have arisen which could not have been foreseen, but these have been patiently and gradually solved; there is still much to be accomplished and in order to direct certain tendencies it is possible that some changes in the methods of instruction may be necessary, but these are largely questions of detail and may easily be solved as soon as the need becomes apparent. That any weakness will not remain long undiscovered is evident when one becomes acquainted with the instructors and those in charge of the department, and also the fact that the motive power department officers over the entire system are watching the progress of the work keenly.

A most important factor in its success is the loyalty and the interest that has been shown by both the drawing and the shop instructors. When it is remembered that these men were not specially trained for the work, but were selected from the various shop organizations, their success seems remarkable. With a very few exceptions it has not been found necessary to make changes from those originally selected. It simply demonstrates the fact that usually it is not only not necessary, but is foolish to go outside of an organization to find men for carrying on a special work. The trouble is not that there are not men capable of doing the work, but rather that those in charge are not big enough to find and direct them.

* * * * * * * * *

A number of the smaller roads are holding back in the matter of installing an up-to-date apprenticeship system, along the lines recommended in the report before the Master Mechanics' Association two years ago, because they do not see how it can be applied to a small shop, or a small road. If a road has several small shops it would seem that it could afford to have a man look after the drawing and mathematical end of the work, arranging the necessary courses and seeing that they are adapted to the men on the road in question. The drawing and problem work could easily be handled by this man, who could make regular trips to the shops and hold classes, or he could secure, and direct by correspondence and occasional visits, some one at each shop to give a few hours to it each week. If a road is small and feels that it can not employ a man as drawing instructor to arrange the courses and direct the work, why not combine with other roads in the same district and have some one at each shop give a short time to seeing that the drawing and problem work as laid out is taught?

As concerns the shop instructor, who is a most important and necessary factor in the system, it may be said that in a small shop with only a few apprentices it is not necessary for a man to give his entire time to this work. For instance, at the Jackson shops of the Michigan Central, Mr. Phelan, the shop instructor, for quite a period during the early development of the work gave only a portion of his time to it, and was regularly employed in operating a large planer. At the McKees Rocks shops, of the Pittsburgh & Lake Erie Railroad, the work for a considerable time and until recently was looked after by the assistant machine shop foreman.

* * * * * * * * *

It was not the purpose of the editors to make this issue an educational number, but the fact could not be overlooked that the first week in September marked the establishment of the educational bureau on the Union Pacific, the opening of the continuation schools at Cincinnati and the holding of the third annual conference of the New York Central Lines apprentice instructors. The remainder of the abstract of the instructors' conference will appear in the November number.

# LOCOMOTIVES DESIGNED AND BUILT AT THE HORWICH SHOPS*

LANCASHIRE AND YORKSHIRE RAILWAY.

GEORGE HUGHES.†

[This excellent paper by Mr. Hughes is altogether too extensive to be completely reprinted in these columns and there is given below only a few extracts of possibly the most valuable and interesting of his observations to an American reader. The paper opens with a brief description with illustrations of the different steps in the locomotive development on this road from 1889, and clearly shows the excellent work of Mr. Aspinall now being ably continued by Mr. Hughes. Following this general section, a number of the more important details are considered, and it is from this section and the appendices that the following extracts have been chosen.—ED.]

*Boilers.*—In the first boilers with round top fire-boxes, experience proved that the tubes were placed too near the bottom and sides of the barrels, as pitting soon developed, especially in the neighborhood of the smoke-box tube-plate. Subsequent boilers were built with a fewer number of tubes, so as to give greater distance between the tube and barrel, and more recently the distance between the tubes has been increased from 9/16-inch to 11/16-inch. In 1896 the Belpaire type of fire-box was introduced into a number of shunting tank-engines. This type of box had advantages in the way of increased steam and water-space, additional surface on the back plate for mountings, and direct staying of the crown. A similar design, of suitable proportions, was adopted for the large engines. With these boilers it was impossible to introduce the inside box from the bottom, and Mr. Aspinall decided to pass it in from the back, and flange the back plate outward, for convenience of riveting up by machine. This method of flanging cured more than one evil, but resulted in setting up severe stresses in the crown-shell along the line of rivet-holes which join the back plate to the wrapper. There has also been much grooving down each side of the plate along the waist. To relieve the crown-plate of these stresses some engines have been fitted with a row of flexible stays at the back end. The later boilers are now being made with the back plate flanged inwards, the final operation of riveting up this plate to the wrapper being done by hand. All new fire-boxes of the larger classes since January, 1904, have had wider water-spaces, which have resulted in increased mileage and fewer repairs, particularly in the renewal of stays. The reduction of grate surface, caused by increasing the spaces, has not interfered with the steaming qualities of the engines.

In the 10-wheeled passenger and coal engines the original boilers had 239 tubes, 2 inches diameter, and the more recent boilers with wide water-spaces have only 225 tubes. In each top corner, a group of tubes, 15 in number, are reduced in diameter at the fire-box end to minimize the fracturing between the tube-holes at these corners.

Copper and steel tubes are used, and their life, as in the case of boilers, is influenced by several circumstances, but over a period of 8 years the average mileage works out as under:—.

| | | | |
|---|---|---|---|
| Copper, | 1st period | (new) | 110,000 miles. |
| " | 2nd " | (stretched) | 80,000 " |
| " | 3rd " | (pieced) | 50,000 " |
| | Total | | 240,000 " |

and subsequently 30 to 40 per cent. of those pieced are treated so again.

| No. of Boilers cut up. | Average Age. | Maximum Age. | Miles. | | Remarks. |
|---|---|---|---|---|---|
| | | | Average. | Maximum. | |
| 336 | 18 | 38 | 485,480 | 1,207,191 | For 10½ years ending December, 1897. |
| 181 | 11¾ | 30½ | 326,187 | 739,798 | 27 months ending May 1902, and personally examined by the author. |
| 206 | 14⅜ | 29¾ | 356,268 | 959,944 | For 3 years ending December, 1908. |

| | | | |
|---|---|---|---|
| Steel, | 1st period | (new) | 70,000 to 80,000 miles. |
| " | 2nd " | (pieced) | 30,000 to 40,000 " |

*Life of Boilers.*—It is difficult to make just comparisons. This factor is influenced by many contingencies, such as pressure, constant employment, severity of use, etc. The table at the foot of the first column may be of interest.

*Boiler Pressure:*—

Previous to year 1888 the Boiler Pressures did not exceed 140 lb. per sq. in.
" " 1899 " " " " 160 " "
" " 1901 " " " " 175 " "
Present practice 180 lb. per sq. in.

Copper fire-boxes run from 150,000 to 275,000 miles, and copper tube-plates last 3¾ to 7 years.

In all cases the life of the boiler is dependent upon the amount of patching and renewals of wrapper and mouthpiece plates, and restoring of tube, throat, and barrel plates.

*Life of Cylinders.*—Over a period of 20 years it is found that the life of cylinders varies from 8 to 14 years. If they escape accident their life is dependent upon the wear of the valve faces.

The following table gives the average results of chemical analysis of cylinder metal:

*Chemical Analysis:*—

| | Per cent. |
|---|---|
| Combined Carbon | 0.3 |
| Graphitic Carbon | 3.0 to 3.5 |
| Silicon | 1.25 to 1.6 |
| Sulphur | Under 0.10 |
| Phosphorus | " 1.0 |
| Manganese | " 0.8 |

In regard to the tensile tests, sometimes these reach 14 tons per square inch, but generally, good cylinder-metal would be about 12 tons per square inch. Transverse tests are taken on bars 3 feet between centers, 2 inches deep and 1 inch wide, and give 28 cwt. before fracture.

*Crank-Axles.*—The crank-axles used on all engines built by this company up to 1901 were of the solid type without hoops. The material was Siemens-Martin open hearth steel, having an ultimate tensile breaking load of 28 to 32 tons, with an elongation of 25 per cent. on three inches, and the usual bend test. Nearly all the flaws on these axles occurred on the inside of the connecting-rod journal at the bottom of the radius, where it joins the crank-web, due to the constant opening and closing of the throws. The following diagram, Figs. 91, 92, and 93, and table below give the position and percentage of flaws:—

These axles did very good service, averaging 250,000 miles

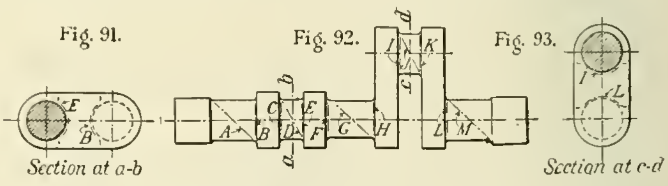



*Diagram of Position of Flaws and Table of Percentage of Failures of Solid Crank Axles, from 1892 to 1909.*

| Class of Engine | A | B | C | D | E | F | G | H | I | J | K | L | M | Average Mileage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard Goods, Wheels 5-1 dia., Cylinders 17½ x 26. | | 6 | 6 | | 27 | 12 | 3 | 6 | 21 | | 3 | 15 | | 243,932 |
| Standard Goods, Wheels 5-1 dia., Cylinders 18 x 26. | | 9 | 9 | | 14 | 15 | 2 | 11 | 31 | | 3 | 3 | | 232,932 |
| Radial Tanks, Wheels 5-8 dia., Cylinders 17½ x 26. | 2 | 5 | 9 | | 18 | 20 | 3 | 13 | 15 | 2 | 5 | 4 | 2 | 285,674 |
| Radial Tanks, Wheels 5-8 dia., Cylinders 18 x 26. | | 11 | 5 | | 33 | 17 | 3 | 5 | 17 | | | 3 | | 276,932 |
| Bogie Passengers, Wheels 7-3 dia., Cylinders 18 x 26. | | 15 | 16 | | 20 | 16 | 3 | 10 | 10 | | 3 | 4 | | 247,031 |

* From a paper presented before the Institution of Mechanical Engineers at the July meeting.
† Chief Mechanical Engineer, L. & Y. Ry.

before being condemned. Having passed this mileage, axles frequently attain a life of 600,000 to 700,000 miles. Standardization and interchangeability caused the same type to be introduced in the design of the 10-wheeled bogie passenger engines, the 10-wheeled radial tank-engines, and the 8-wheeled coal-engines, but the larger diameter cylinders, increased boiler pressures, demand for higher speeds and heavier hauling capacity, soon proved that this axle was inadequate to meet the stress; the built-up pattern therefore was introduced in 1901, having the same dimensions in the bearings as the solid type. This type has now been adopted as the standard practice of the Lancashire and Yorkshire Company.

The author thinks it will be interesting to give his experience in detail in regard to the design and manufacture of built-up cranks; it may save some useless experimenting by members and others. The first design, Fig. 88, was made entirely of mild steel, solid crank quality; the sweeps were made of figure 8 shape shrunk on the connecting-rod journals, bearings, and middle part, being further secured to the middle part and end portions by keys (1½ inch by 1 inch), rectangular section, and to the connecting-rod journals by screwed plugs (1½ inch diameter, 6 threads per inch). The shrinkage allowance was 0.009 inch, and the diameter of the holes in the webs 8⅝ inches. In a considerable number of cases the results were not satisfactory, as the tensile strength of the webs was unequal to the strains placed upon them, and consequently they worked loose. At the end of 1903 it was decided to make the crank webs of 0.35 carbon steel, and straight, instead of the figure 8 shape. The shrinkage was altered to 0.014 inch, and the holes in the webs reduced to 8¼ inches, thus giving a greater strength to the webs round the crank-pin, Fig. 89. These changes effected a decided improvement in one respect, as there was a considerable reduction in the number of cranks working loose at the webs. But a new difficulty developed: fractures were found commencing at the keyways, and in several cases they had extended a considerable length before being noticed. The first attempt to prevent these fractures, towards the end of 1904, was to increase the radius at the center of the axle from ¾ inch to 4½ inches, and also to put a small radius at the bottom of the key-bed, the result being that there were no more fractures in the center; but as it was not thought advisable to reduce the surface of the center bearing by extending the radius, the trouble was still likely to occur at that particular part. The only solution appeared to be the total elimination of the rectangular section keys. The first built-up crank-axle secured entirely with screwed plugs was made in March, 1905, and at the same time the shrinkage was increased to 0.018 inch. A short time previous to this change taking place, a series of tests, to determine the tensile limits of the crank-webs, was commenced; several webs were prepared with special pieces having a shrinkage allowance of from 0.010 inch to 0.016 inch. They were afterwards removed and records taken, which demonstrated that the shop practice of allowing 0.016 inch was well within the tensile limits of the webs. The next test, taken in October, 1905, was an attempt to fracture the webs by an absurdly high shrinkage allowance. The webs prepared had a shrinkage of 0.030 inch and 0.040 inch, and after being shrunk together, the one with 0.040 inch was drilled and tapped at the usual position. A special plug was driven in with extreme pressure and the web struck with a large hammer. As no fracture occurred, the plug was withdrawn, and the pieces pressed out. The records taken proved that the elastic limit of the webs had now been exceeded, as the webs with 0.030 inch allowance required 318 tons each to move the pieces, and those with 0.040 inch allowance took 298 tons. 230 cranks have been built by the present method, and sent into service, and of these only two have been condemned. Briefly, it may be stated that the mild-steel cranks were succeeded by those made of 0.35 carbon-steel, the shape being altered from figure 8 shape to straight webs. Cranks with screwed plugs were introduced in March, 1905. The shrinkage has increased from 0.009 inch to 0.018 inch, and the diameter of the hole in the standard crank-webs reduced from 8⅝ inches to 8¼ inches. This shrinkage amounts to 1/458 part of the diameter. The author does not propose to give the life of condemned built-up cranks during the experimental stage, but the subjoined table shows the average and maximum mileage of these cranks in use on the heavier and more powerful engines at the present time.

| Class of Engine | Diam of Cylinders. | Diam. of Wheels. | Boiler Press. | 7½-in diam Journal. | | 8-in. diam. Journal. | |
|---|---|---|---|---|---|---|---|
| | | | | Average. | Maximum. | Average. | Maximum. |
| | in. | ft. in. | lb. | | | | |
| 10-wheeled bogie | 19 | 7 3 | 180 | — | — | 96,400 | 112,947 |
| 10-wheeled radial tank | 19 | 5 8 | 180 | 106,568 | 117,736 | — | — |
| 4 ft. 6 in. coal engine | 20 | 4 6 | 180 | 86,780 | 98,750 | — | — |

MILEAGE OF CRANK AXLES ON HEAVY POWER.

The heavier loads upon the axle-box journals of the 4-cylinder passenger-engine have necessitated the adoption of a stronger crank-axle, but the same method of manufacture has been adhered to. The webs, Fig. 90, are extended to form balance-weights. Heating of journals or crank-pins must be specially avoided in built-up cranks.

*Wear of Cranks.*—The axle-box journals wear oval at right angles to the near web. This wear has never been found to exceed 1/32 inch, and is not always on the same side. They also sometimes wear taper, but this is rare, and not allowed to exceed 1/16 inch. Connecting-rod journals also wear oval, but never more than 1/64 inch.

*Renewal of Tires.*—In the case of wheels up to 5 feet 8 inches diameter, providing the tires will turn up to 1½-inch thickness

Fig. 88

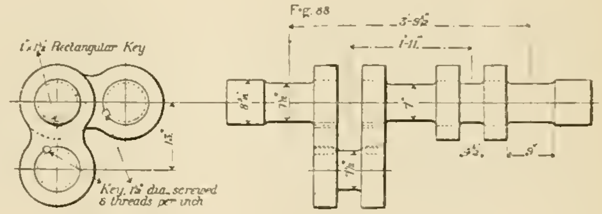



Fig. 89

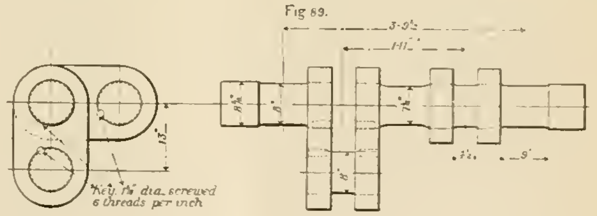
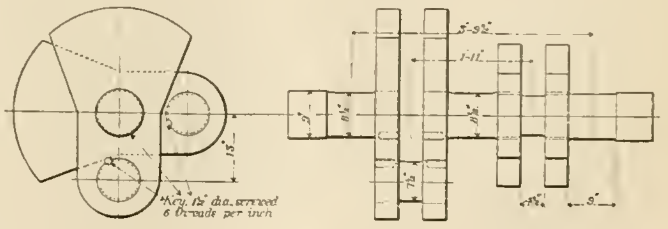



Fig. 90




and are in sound condition, they are retained. For wheels over this diameter the limit is 1¾ inches. For the half-year ending the 31st of December, 1908, out of 917 scrapped tires, 674, or

73½ per cent., were worn to the limit; 123, or 13 per cent., scrapped on account of slackness; and 8 or 9 per cent. for thin flanges; the remainder for flaws, blow-holes, or wheel defects. Some three or four years ago, with wheels of the larger diameter, the minimum tire thickness allowed had to be increased, because a considerable number of large tires showed signs of slackness, thereby increasing liability to fracture, hence the 1¾-inch minimum. At that time, tire material was generally 38 to 42 tons tensile, which has gradually been raised from 42 to 48. This hardening of the material, and in some cases strengthening of the rims, where new centers have been supplied, has been the chief step taken to prevent tires becoming slack. In the 10-wheeled bogie passenger class, which has the largest proportion of slack tires, the main cause of this tendency must be attributed to the comparatively weak wheel-center.

*Practice Regarding Shrinking.*—Previous to November, 1908, the practice with regard to shrinkage was not quite proportionate to the diameter. Too much shrinkage was allowed in the case of small tires, and probably not enough with large tires. After some consideration, the shrinkage was revised and now stands at 1/750th of the wheel center diameter for all sizes.

*Smoke-Boxes, Brick Arches, and Ashpans.*—The success of an engine entirely depends upon the boiler, and the excellence of the latter turns on these subjects.

The primary function of the smoke-box and its equipment is the production of draught, to economically burn the fuel at a proper rate, and at the same time, to maintain satisfactory steaming when working under all conditions of service. These qualifications are dependent largely upon proper proportions; the location and diameter of blast-pipe nozzle; its relation to chimney and tubes, and height and diameter of chimney. Blast pipes require to have an orifice sufficiently large to prevent back pressure in cylinders, and at the same time small enough to produce efficient draught. A proper disposition of the blast-pipe orifice, in its relation vertically to the chimney top, together with its right height from the boiler center line and a correctly proportioned chimney, will enable the orifice to be increased in diameter.

It must be remembered that an enormous amount of air enters the fire-box, and is immediately expanded six to eight times by rise of temperature, and upon arrival at the smoke-box and exit from the chimney, it is two or three times its original volume; and as the office of the smoke-box equipment is to deal effectually with this air, which is a variable quantity, a combination must be discovered for each class of engine, which will produce the best all-round efficiency. With a view of arriving at some conclusions on this question, the author has from time to time carried out experiments on certain classes of engines, with the following results:—

*Long versus Short Smoke-Boxes.*—To ascertain the value of long and short smoke-boxes observations were taken on two passenger tank engines. Particulars are given in table 9.

TABLE 9.

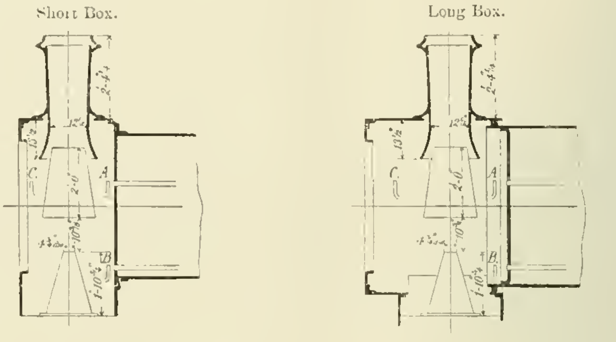
| Length of smoke-box. | Cubical Capacity of smoke-box. | No. of tubes | Length between tube-plates | Area through tubes | Grate area. | Air-space through grate. | Per cent. of air-space. | Area through ashpan door opening |
|---|---|---|---|---|---|---|---|---|
| | cub. ins. | | | sq. ins | sq. ft | sq. in. | | sq. in. |
| 32⅛ | 100,190 | 220 | 11-0 | 388.7 | 18.75 | 865.25 | 32 | 274.95 |
| 46½ | 111,390 | 220 | 10-9⅜ | 388.7 | 18.75 | 919.6 | 34 | 215.87 |

Both engines were equipped with identically the same blast-pipe, chimney and hood, but the smoke-box of second engine had a capacity 11 per cent. greater than that of the first. The smoke-box arrangements of the two engines are shown by the following diagram.

Vacuum readings were observed at points A, B, C, through pipes projecting into the smoke-box to the vertical center line of the engine; the outer end of each pipe was connected by rubber tubing with one leg of a manometer, or "U"-shaped glass tube, partially filled with colored water, and the table underneath gives a summary of the results.

In perusing this table it will be noticed that the vacua are even, all over the tube-plate, indicating that the position of blast-nozzle, hood, and chimney, appeared to be about right.

Short Box. Long Box.



| Test | Between Manchester and Bolton. | | | | | Between Bolton and Entwistle. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Vacuum in Inches Water Gauge. | | | Boiler Pressure, lbs. per sq. inch. | Cut-off, per cent of Stroke. | Vacuum in Inches Water Gauge. | | | Boiler Pressure, lbs. per sq. inch. | Cut-off, per cent of Stroke |
| Type of Smoke Box. | Top row of Tubes. A | Bottom row of Tubes. B | In front of Blast Pipe C | | | Top row of Tubes. A | Bottom row of Tubes. B | In front of Blast Pipe C | | |
| Short Type. | 3" | 3" | 3" | 157 | 39.2 | 3" | 3" | 3" | 157 | 39.2 |
| Long Type | 3" | 3" | 4 | 175 | 39.2 | 4.4" | 4.4" | 5.2" | 174 | 51.7 |

With the extended smoke-box, a higher vacuum is recorded at C than at A and B, which tends to prove that the long box serves as a reservoir, thus assisting the maintenance of draught between each exhaust, and so modifying the intermittent character of the blast. This is verified by the action in the glass tubes. With the extended smoke-box the water remains quite steady, and only moves when the steam discharge up the chimney is altered; whereas with the short box the water is in a constant state of agitation, rising and falling with each exhaust. The vacuum in both smoke-boxes was about normal for the cut-offs of 39 and 51 per cent. respectively, but steam pressure was better maintained in the extended smoke-box engine.

A series of experiments were conducted on one of the passenger tank engines with extended smoke-box. Five different arrangements were tested as follows:—

A. Blast pipe 1' 2¼" below horizontal center line of boiler; hood 1' 11½" long.
B. Blast pipe 1' 2¼" below horizontal center line of boiler; hood 1' 5½" long.
C. Blast pipe 1' 2¼" below horizontal center line of boiler; without hood.
D. Blast pipe 0' 2¼" below horizontal center line of boiler; without hood.
E. Blast pipe 0' 9¼" below horizontal center line of boiler; hood 1' 5½" long.

On the first four tests the loads were the same, namely, 160 tons behind the drawbar, but on test E the train hauled was 200 tons. The same chimney was used on all trials, namely, 12½ inches diameter choke, tapered, and increasing 1.4 inch per foot towards the top, length 2 feet 4¼ inches. The blast-nozzle was 4¾ inches diameter in all cases. The following table gives the summary of results. The best conditions were obtained from test E arrangement, as regards the highest vacuum, and least

Summary of Results.

| Test | Average Speed, miles per hour. | Average Cut-Off, per cent of stroke | Average Steam Press. lbs. per sq inch | Average Vacuum – Inches, Water Gauge. Readings taken at top row of Tubes. | Average Vacuum – Inches, Water Gauge. Readings taken at bottom row of Tubes. |
|---|---|---|---|---|---|
| A | 34.4 | 26.2 | 168.5 | 2.3" | 3.5" |
| B. | 37.6 | 31.37 | 175.4 | 2.75" | 3.75" |
| C | 38.4 | 25.6 | 176.5 | 1.66" | 3.166" |
| D. | 40.2 | 36.2 | 164.6 | 2.5" | 3.5" |
| E. | 38.6 | 30.1 | 174.3 | 3.875" | 4.375" |

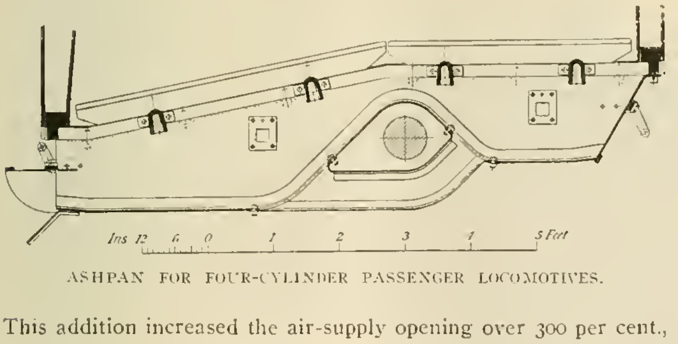
RESULTS OF TESTS ON FRONT ENDS.

variation in the intensity of draught at the top and bottom row of tubes. Test C was also very satisfactory, considering the low vacuum maintained. This, however, is accounted for by the fact of the weather being calm on that occasion, enabling the engine to be operated at an earlier cut-off, and with less demand on the boiler.

*Results of Experiments on 4-Cylinder Passenger Engine.*—This engine when first put into service had a 5-inch diameter blast-nozzle standing 8 inches below the center line of boiler. The chimney was only 12½ inches diameter at the choke, and had an extension in the smoke-box of 15 inches. This extension carried a hood 1 foot 6 inches long. Further particulars are given below:—

| | |
|---|---|
| Length of smoke-box | 68 in. |
| Capacity of smoke-box | 249,000 cu. in. |
| Number of tubes | 235 |
| Length of tubes | 15 ft. |
| Area through tubes | 564.0 sq. in. |
| Grate area | 27.0 sq. ft. |
| Air-space through grate | 9.47 sq. ft. |
| Percentage of air space | 35 |
| Area through ashpan, door open | 394.0 sq. in. |
| Minimum area of ashpan opening | 63.0 sq. in. |

On the first trial it was evident that the nozzle was too small, and it was decided to open it out to 5½ inches. This step, however, at first had a detrimental effect on the steaming, until the author tried a chimney of a different design. He retained the same pattern, but cut down the extension portion, to penetrate into the smoke-box 2 inches only, which increased the choke to 13½ inches diameter. He also belled out the entrance to 18 inches diameter. It was apparent at once that this form of chimney, although not quite satisfactory, improved the steaming; therefore further investigations were conducted on the best height of nozzle, and eventually it was found to be about 4 inches below center line of boiler. During these experiments, complaints were frequent that the fire burnt dead at the back end of the fire-box, and conclusions were drawn that this was due to the restricted air-space opening in the ashpan, where it is narrowed down in depth to clear the trailing axle. The author next decided to give additional air-supply to the back end of grate. He therefore connected the front and back portions of the ashpan by an air-duct shown in the accompanying illustration.




ASHPAN FOR FOUR-CYLINDER PASSENGER LOCOMOTIVES.

This addition increased the air-supply opening over 300 per cent., and has proved very beneficial in promoting combustion.

A further experiment has recently been made with a larger blast-pipe and chimney. The blast-pipe is cast with a bridge, so that the exhaust from the inside and outside cylinders is led away independently, and does not meet until near the top of the nozzle. The nozzle is 6 inches diameter, and the chimney choke 16 inches, the same design of chimney with short extension being adhered to. At first this combination was not successful, but after several trials with varied heights of blast-pipes, a position was discovered (viz., 6 inches below center line of boiler) which produce an excellent steaming engine.

These experiments go to prove the importance of ascertaining the correct positions and proportions of blast-pipes and chimneys; for here is a case of an engine which would not steam with a 5½-inch blast-pipe, but which eventually, after numerous experiments, steamed well with a 6-inch nozzle. Attempts have been made in America to standardize front ends, with some amount of success; but it appears to the author that each new design of locomotive demands some experimental work, in order to arrive at the best steaming position of blast-pipe, diameter of chimney, etc.

*Smoke-Box Doors.*—These are much larger than ten years ago. They cannot be kept perfectly tight by the single crossbar and central bolt arrangement, and a number of dogs pitched equally round the periphery of the door is essential. The wear and tear of smoke-boxes has increased of late years, particularly that class with the sides fastened to the main frames of the engine. The round smoke-box, supported on a cast-iron saddle, has much to recommend it. The author has adopted this design on several tank engines, and also on the 4-cylinder passenger engine. This latter smoke-box has been clothed with asbestos and a thin clothing sheet, for the purpose of reducing cost of maintenance.

*Brick Arches.*—All engines are fitted with brick arches. These extend from the tube-plate to about half the length of the fire-box. The rake of the arch is governed to some extent by the position of the fire-hole above the grate. When this distance is small and the fire-box long it is necessary to incline the arch, so that there is no chance of throwing the fuel upon it. With the fire-boxes which have horizontal grates the arch slopes upwards, pointing to the top side of the fire-hole. In the 4-cylinder engine the slope points to the top corner of the back plate. The function of the arch is to assist combustion by maintaining a high temperature, and to direct the gases round the fire-box, especially so that they impinge against the top and back plates. The fire-hole deflector is used to prevent the air passing direct to the tubes.

*Ashpans.*—All ashpans are made of ample dimensions, so that the accumulated ashes do not hinder air-supply. The damper doors open as wide as possible to allow a maximum air-supply, and for convenience of raking. The bottom is made to retain water for quenching the ashes, a small pipe being connected to the injector feed-pipe, and led to the ashpan for that purpose. The damper door-handles are fixed on the fireman's side of the engine, and have a screw arrangement for adjusting the amount of air, and for closing the door practically air-tight.

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Smoke Prevention in Locomotive Operation.—It has been well said, "The man behind the scoop, when properly educated, is the most efficient fuel saver and smoke arrester in existence," and this is true of the operating conditions of every locomotive on every railroad burning soft coal. The matter lies largely in the hands of the engineer and fireman, and the engineer as well as the fireman. Better results can be accomplished by the properly instructed and rightly-dispositioned crew, without any contrivance to prevent smoke, than can be obtained by the most elaborate mechanical provisions without the exercise of brains and interest by the men in the cab; and it is probable that the larger proportion of good results obtained, during tests of various devices to save fuel and prevent smoke, really result from the awakened interest and harmonious coöperation of the engineer and fireman. Fuel saving and smoke prevention on railroads is mostly a matter of *agitation* and *education*. One of these is as necessary as the other, but the best results follow the proper employment of both means of improvement.—*George H. Baker before the New England Railroad Club.*

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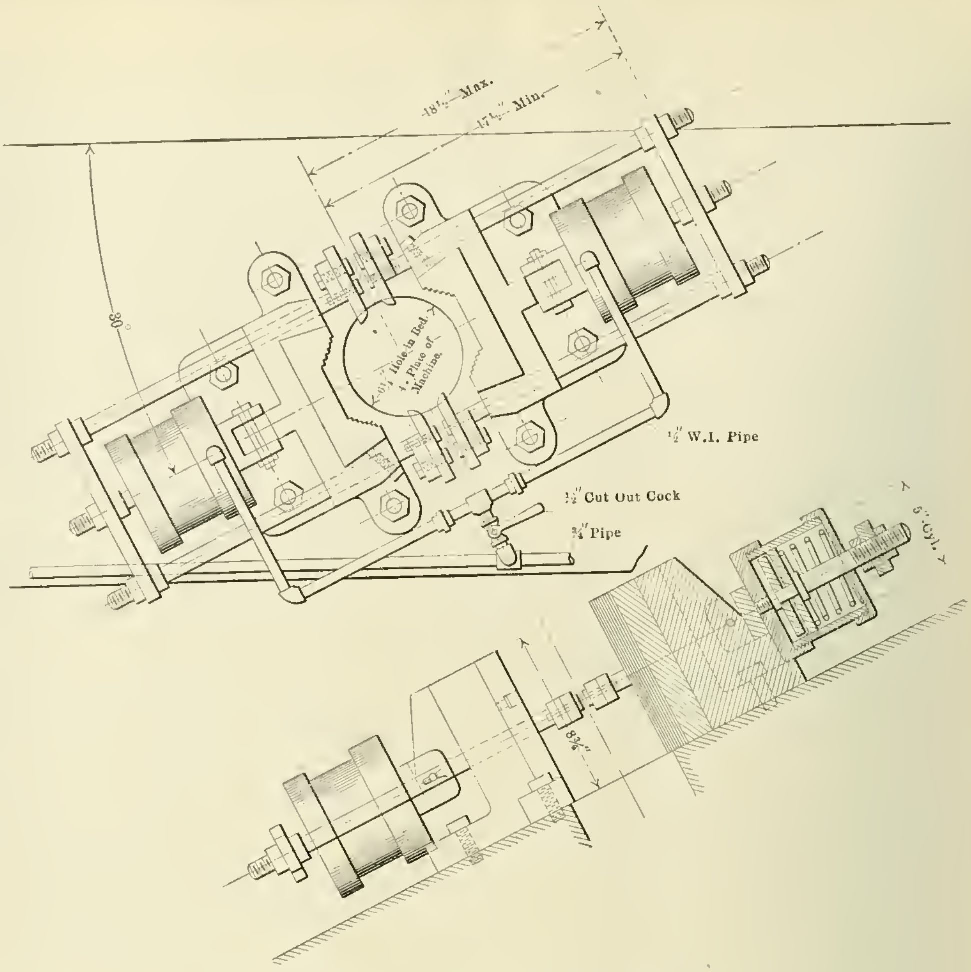
Gas versus Steam Engines.—I am fully aware of the possibilities claimed for the gas engine, but my experience thus far, and the practical results with which I am conversant, do not indicate an early fulfilment of the claims. From present indications, the best steam and the best gas engine plants appear to be about on a par with regard to coal economy. The producer plant and the boiler plant are practically equal so far as the first step in converting the coal into power is concerned. The average gas engine is more efficient than the average steam engine, but the best gas engines and the best steam engines are about equally efficient.—*From President M. L. Holman's address before A. S. M. E.*

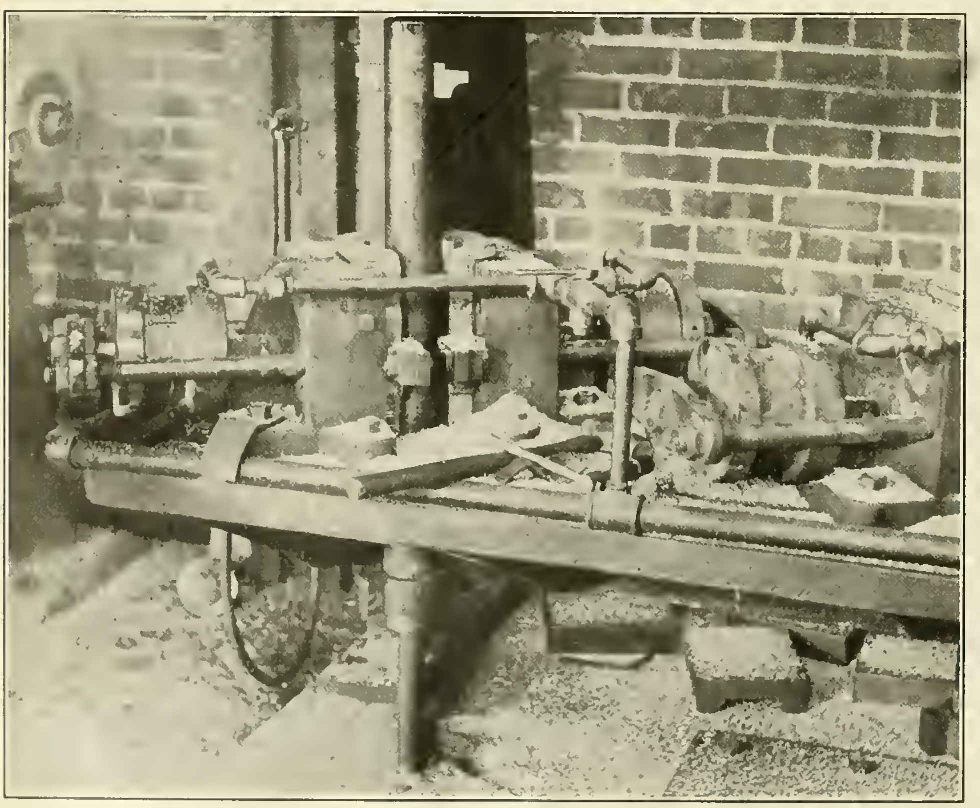
## BORING CAR JOURNAL BEARINGS.

A four-spindle drill press has recently been converted into a machine for boring car journal bearings at the Collinwood shops of the Lake Shore & Michigan Southern Railway. A home-made chuck for each spindle clamps two bearings at one time. Each bearing is held in place in the chuck by two clamps which are fastened to the rods attached to the crosshead on the end of the air piston, clearly shown in the photograph. When air is applied back of the piston it forces the piston and crosshead outward, drawing the rods and clamps with it, bringing the bearing up tight against the seat in the chuck. Both cylinders for each spindle are controlled by one stop cock.

The boring bar has a hole in its lower end in which the rod guiding it fits. This arrangement prevents the chips from getting into the guide and cutting. A filleting tool is provided at the top of the bar. Each spindle has an independent motion and a cut-out so that when the boring tool has passed through the bearing the spindle is stopped independently of the others. This adjustment is so close that it may be arranged to stop the spindle after the fillet is properly completed. The operator is thus enabled to give his entire attention to the removing and replacing of the bearings without reference to the operating spindles. The machine has proven very successful.




AIR OPERATED CLAMPS FOR HOLDING JOURNAL BEARINGS.



ONE SPINDLE OF MACHINE FOR BORING JOURNAL BEARINGS.

## LONG LOCOMOTIVE BOILER BARRELS.

[The following communication appeared in a recent issue of *The Engineer* (London).—Ed.]

Sir,—The saying that "necessity is the mother of invention" is clearly applicable to the 50-ft. long boiler of the new Mallet locomotive for the Southern Pacific Railway, shown on page 223 of your issue of August 27th, and the draughtsman who was confronted by the difficulty of finding thermal use for the immense length of barrel necessary for spanning so many axles, is to be congratulated upon his solution of the problem.

The point naturally arises as to how long a locomotive boiler barrel would have to be made in order to embrace a further series of questionable economies—what, indeed, is the limit of ingenuity, on the part of the draughtsman in vertically dividing up the surplus length to find justification for the same beyond that called for by the locomotive design?

Having regard for recent discussion upon the economical length of the locomotive boiler tube, one could commence by cutting off the useless last 5 feet of the tubes in the boiler under notice, so as to increase the space available for sections of naturally diminishing temperatures suited to a variety of purposes.

Allowing, then, boiler tubes of 16 feet in length, we might allow—

| | |
|---|---|
| For the combustion chamber | 4 ft. 0 in. |
| For the feed-water heater | 4 ft. 6 in. |
| For a sand drier | 2 ft. 3 in. |
| For a food-warming compartment | 2 ft. 0 in. |
| For a clothes-drying compartment | 2 ft. 0 in. |

There being little heat left for the superheater, this space could be utilized for other purposes; in fact, one may expect with still more immense locomotives of the Mallet system, that by the time the gases laboriously reach the smoke-box, the temperature may be a minus quantity, thus enabling the last section to serve as a refrigerator for preserving perishable articles of food for use in the dining car on a long journey.

ANTIPLEA.

MACHINE FOR BORING CAR JOURNAL BEARINGS.

## THE COST OF HIGH SPEED.

In commenting on the recent record run of the *Lusitania* when an average of 25.85 knots, or 29.75 miles, were made per hour, *Power* has this to say:

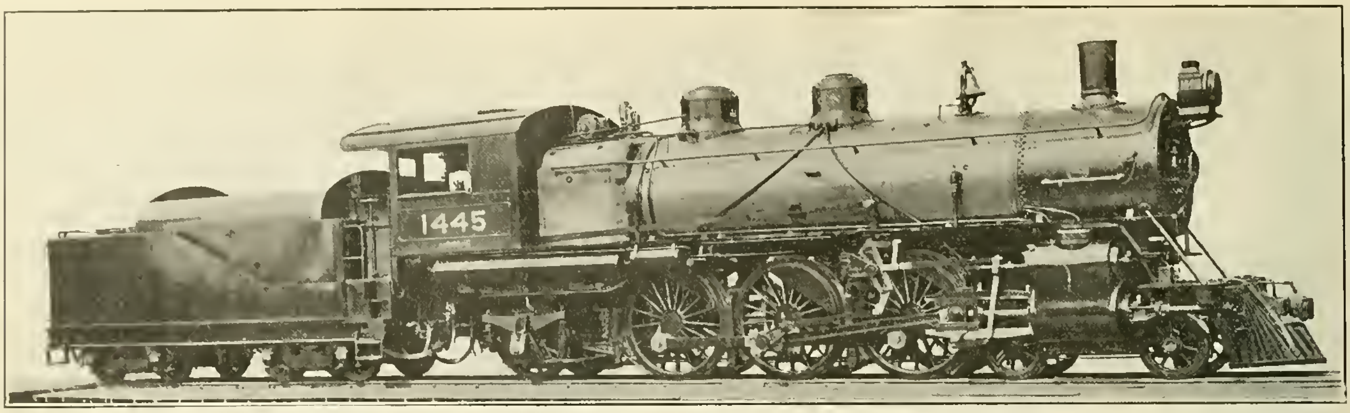
"To run a boat the size of the *Lusitania* at eighteen knots, or 20.7 miles, an hour, would require approximately 350 tons of coal a day. The time for a voyage would be six days and ten hours instead of four and one-half days, and the coal consumption 2.246 tons as compared to 4,725, and probably a much larger quantity when the coveted four days to complete the trip is a matter of history. The excess in speed already attained over the moderate figure of eighteen knots per hour costs nearly 2,500 tons of coal on each trip, or in other words, fuel enough to last five families throughout the natural lives of the household. This is but one trip and one vessel, and although no figures are available, a proportionate increase in railway speed would add largely to the coal consumption.

"It is, of course, apparent that the cost of provisions, labor, interest on investment, etc., will be less, and the greater charge for passage will in all probability make the faster boat and faster train paying investments, aside from the advertising the line receives. Four days to the other side or to the Pacific ocean from New York means much to men of business and is hailed with delight by the tourist, but when considered only from the standpoint of conservation of the fuel supply, high speed bears the ear marks of extravagant waste. More especially is this true when it is considered that the boat lays five days in port before starting on the return trip, and full advantage is not taken of the faster passage to reduce the number of ships in service From the standpoint of the business man and advancement in the field of navigation, the question must be viewed in an entirely different light, and here the motto would, and should be, the faster the better."

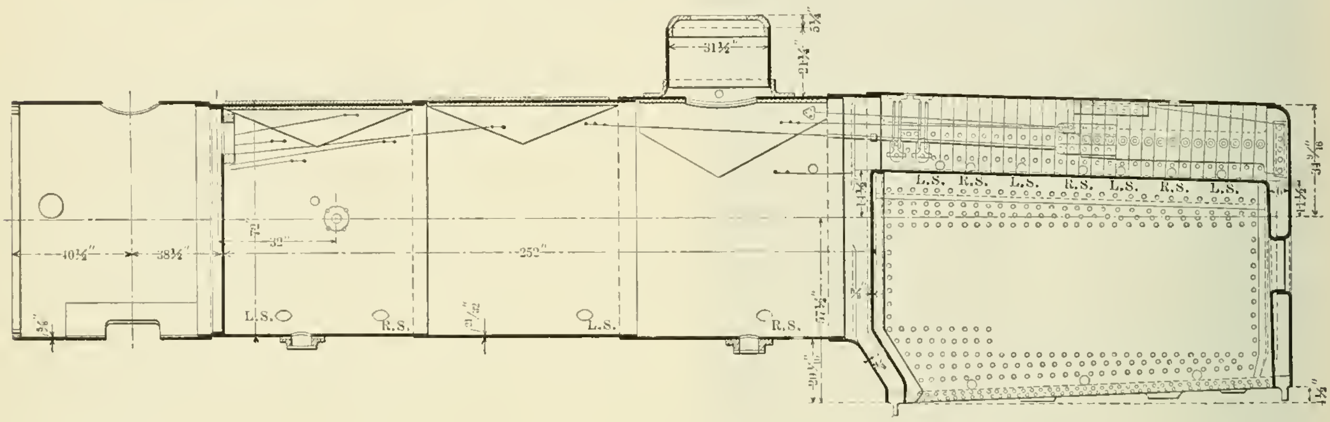
ECONOMIZERS, COST AND SAVING.—The unit costs of economizers and fixtures figure out as follows for machines of from 1,000 to 5,000 horse-power: Economizer, $2.75 per horse-power; brickwork, 60 cents; dampers, 2 cents; sectional covers, 13 cents; sheet iron, 8 cents; total, $3.58 per horse-power. A 5,000-horse-power economizer will figure complete about $18,000 and its saving may be estimated, with stack temperatures of 400 degrees and feed water at 200 degrees, as follows: Rise of feed temperature (70 degrees is the very best attainable), say 60 degrees. For each degree rise in feed water the evaporation gains 0.1 per cent., or 6 per cent. for 60 degrees. At 260 tons per day, 6 per cent. of the coal means 15 tons saved, which, at $3 per ton fired is $45 per day. As the actual boiler horse-power is seldom more than 75 per cent. of the total capacity of the boilers, however, the actual saving would be about $33. This amounts to $12,045 in a year and will pay for the economizer in about two years, allowing for all cleanings and repairs and maintenance charges. —*Warren H. Miller in Power and The Engineer.*

PATENT OFFICE.—Last year the patent office issued 33,514 patents, reissued 168 patents and registered 6029 trade-marks, labels and prints. There were 22,328 patents which expired during the year. The total receipts were $1.896,848 and the expenditures $1,712,303. On Jan. 1, 1909, the patent office had a balance to its credit with the United States treasury of $6,890,726. The work on that date was current, except in five examining divisions out of 49, and those five have caught up since then. Special attention is being directed to the classification of the 915,000 United States patents, the 2,000,000 foreign patents and the 85,000 volumes in the library, which is expected to reduce the expense of examining applications by one-third, and to improve the character of the work. Commissioner Moore has requested Congress to use a part of the surplus earned by the patent office for the erection of a building suitable for its needs.—*The Engineering Record.*

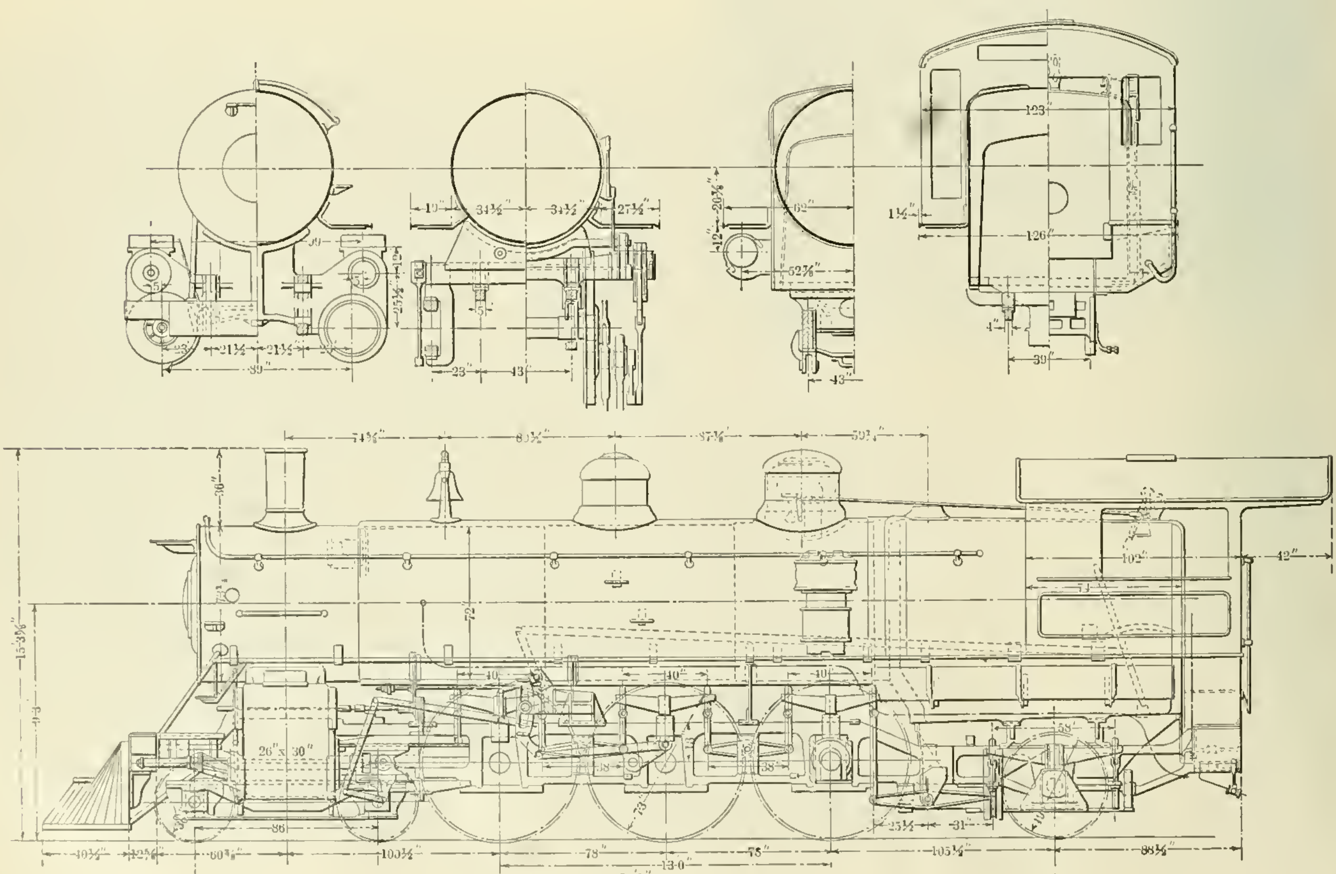
PRACTICAL BENEFITS OF STANDARDIZATION.—The practical benefits of standardization are apparent in many ways. The ability to order in large quantities standard articles, free from a capricious variety of details, makes possible a reduction ranging from perhaps 10 to 30 per cent. in the purchase price of many staple items of construction, maintenance and operation. Again, if a washout or other emergency occurs, a standard bridge, water tank, turntable, etc., can be ordered from the manufacturers in a ten-word telegram, and, pending delivery, a standard foundation can be built in full confidence that the structure will fit. Standard devices, signs, and equipment make it possible in emergencies to balance forces and resources by transferring men or material from one property to another with a minimum of inconvenience to the service and to individuals in orienting themselves to strange localities.—*J. Kruttschnitt, N. Y. R. R. Club.*



PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER—GREAT NORTHERN RAILWAY.



STRAIGHT TOP BOILER—GREAT NORTHERN RY. 4-6-2 TYPE LOCOMOTIVE.



ELEVATION AND SECTIONS OF GREAT NORTHERN PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER.

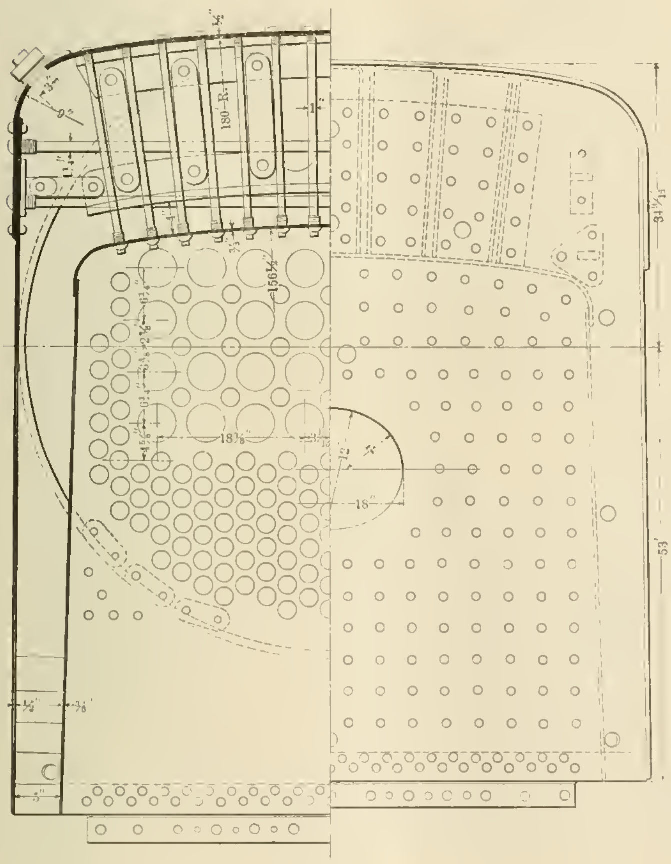
# PACIFIC TYPE LOCOMOTIVE WITH SUPERHEATER.

GREAT NORTHERN RAILWAY.

Twenty locomotives of the 4-6-2 type, using high degree superheated steam at 150 lbs. pressure, have recently been completed by the Baldwin Locomotive Works for the Great Northern Railway.

These locomotives are among the heaviest and most powerful ever built and weigh 248,970 lbs. total, being exceeded in this regard only by the engines of this type on the New York Central Lines, which were illustrated on page 164 of the May, 1908, issue of this journal and the two on the Pennsylvania Lines, which were shown on page 267 of the July, 1907, issue. The Great Northern engines, however, are more powerful than either of these heavier examples, having a tractive effort of 35,400 lbs. as compared with 29,200 and 30,700 lbs. respectively. This is the largest tractive effort for a Pacific type locomotive on our records. The factor of adhesion, however, indicates that it will be capable of attainment without difficulty whenever needed.

This order of locomotives follows a series of experiments with a high degree of superheat on both this type and the Prairie type



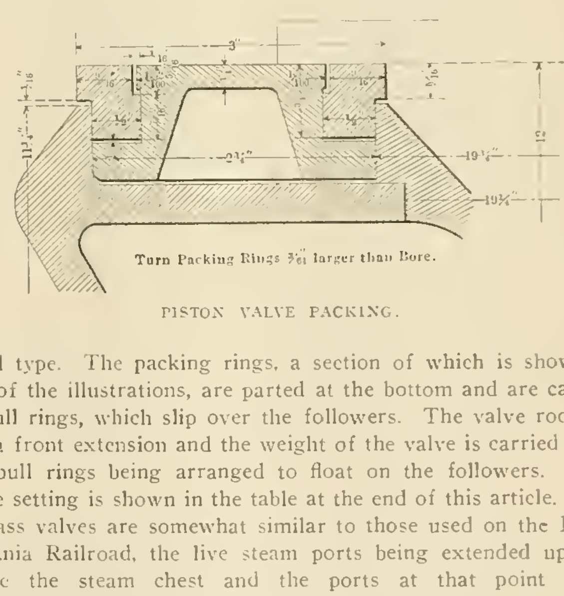
SECTION AND ELEVATION OF FIREBOX— PACIFIC TYPE LOCOMOTIVE.

passenger locomotives and hence indicates the successful service of low boiler pressure with high superheat for high speed passenger service. They have, however, shown themselves to be capable of very satisfactory performances in freight service as well, one of this order having recently hauled a train of 61 cars weighing 3050 tons, a distance of 98 miles in a net running time of five hours, the maximum grade being .6 per cent. for a distance of two miles, and the engine consuming seven tons of Illinois coal and two tanks of water.

In accordance with the general practice on the Great Northern Railway the boilers are of the Belpaire type and while a pressure of about 150 lbs. is used, they are designed for 210 lbs. pressure. The illustration shows the features of the boiler clearly and attention is directed to the staying of the back head, where plates are used which, in addition to being secured at the top to the roof sheet, are also secured to stays which run forward and fasten to the cylindrical part of the boiler shell, thus relieving the attachment of the roof sheet of a large part of its stress. The barrel is built up of three rings having butt seams on the top center line with diamond weld strips on the inside. Ample facilities have been provided for washing out, as a study of the boiler illustration will indicate. Wash out plugs are located quite close together on both sides of the fire box at the crown sheet and two 6-inch hand holes are located in the waist of the boiler in addition to the openings at the mud ring.

The superheater elements are contained in thirty-two 5½-inch boiler tubes. These tubes replace about 96 of the regular 2¼-inch tubes, but the total fire heating surface is reduced only about 220 square feet by this substitution. All tubes are 21 feet long and the superheater has a heating surface of 641 square feet.

Because of the reduced boiler pressure the cylinders are enlarged to 26 inches in diameter and are provided with walls sufficiently thick to enable them to be subsequently bored to 27 inches diameter if desired. The stroke is 30-inch. The pistons are of cast iron and provided with a front extension piston rod, which carries the greater weight of this part. The steam distribution is controlled by 12-inch piston valves, each valve being composed of a body casting with two heads, or followers, of the




PISTON VALVE PACKING.

usual type. The packing rings, a section of which is shown in one of the illustrations, are parted at the bottom and are carried in bull rings, which slip over the followers. The valve rod also has a front extension and the weight of the valve is carried by it, the bull rings being arranged to float on the followers. The valve setting is shown in the table at the end of this article. The by-pass valves are somewhat similar to those used on the Pennsylvania Railroad, the live steam ports being extended upward above the steam chest and the ports at that point being covered by a flat plate held down by steam pressure acting on its upper surface. This plate has a limited amount of rise and is guided by a central spindle and excess pressure within the cylinders will readily lift it from its seat. The steam chests are set out sufficiently to avoid the use of rockers in the valve gear and the width over the outside of the cylinders is 121 inches, making these the widest locomotives at this point of any passenger engines on our records. The links of the valve gear are supported on a cast steel bearer which spans the frames between the first and second pair of driving wheels and the valve rods are carried in brackets bolted to the guide yokes.

Cast steel frames, 5 in. in width, with separate rear sections of the same material, and double front rails of forged iron, were specified in this design. The trailer truck is of the radial swing type with outside journals similar to the ones used on the Mikado type locomotives for the Virginian Railway, the details of which were illustrated on page 228 of the June issue of this year. The truck wheels under these engines are steel tired with cast steel spokes and the tender wheels have cast steel plate centers. Other cast steel details include driving boxes, crossheads, crosshead shoes, cylinder heads, equalizing beams and deck plates.

A novelty is noticed in the location of the throttle rigging. The valve is operated by a shaft which passes through a stuffing box in the side of the dome and carries an upwardly extending lever from the end of which a rod connects to the throttle lever in the cab, which swings in a vertical plane.

The general dimensions, weights and ratios of these locomotives are given in the following table:

GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Service | Passenger |
| Fuel | Bit. Coal |
| Tractive effort | 35,400 lbs. |
| Weight in working order | 248,970 lbs. |
| Weight on drivers | 165,220 lbs. |
| Weight on leading truck | 39,900 lbs. |
| Weight on trailing truck | 43,850 lbs. |
| Weight of engine and tender in working order | 397,000 lbs. |
| Wheel base, driving | 13 ft. |
| Wheel base, total | 33 ft. 9 in. |
| Wheel base, engine and tender | 66 ft. 4 in. |

RATIOS.

| | |
|---|---|
| Weight on drivers ÷ tractive effort | 4.66 |
| Total weight ÷ tractive effort | 7.03 |
| Tractive effort × diam. drivers ÷ heating surface | 822.00 |
| Total heating surface ÷ grate area | 58.80 |
| Firebox heating surface ÷ total heating surface, per cent | 6.56 |
| Weight on drivers ÷ total heating surface | 52.80 |
| Total weight ÷ total heating surface | 79.20 |
| Volume both cylinders, cu. ft. | 18.50 |
| Total heating surface ÷ vol. cylinders | 170.00 |
| Grate area ÷ vol. cylinders | 2.90 |

CYLINDERS.

| | |
|---|---|
| Kind | Simple |
| Diameter and stroke | 26 x 30 in. |

VALVES.

| | |
|---|---|
| Kind | Piston |
| Diameter | 12 in. |
| Greatest travel | 5½ in. |
| Outside lap | 1 in. |
| Inside clearance | 0 in. |
| Lead, constant | 3/16 in. |

WHEELS.

| | |
|---|---|
| Driving, diameter over tires | 73 in. |
| Driving, thickness of tires | 3½ in. |
| Driving journals, main, diameter and length | 10½ x 12 in. |
| Driving journals, others, diameter and length | 9½ x 12 in. |
| Engine truck wheels, diameter | 36 in. |
| Engine truck, journals | 6 x 12 in. |
| Trailing truck wheels, diameter | 49 in. |
| Trailing truck, journals | 8 x 14 in. |

BOILER.

| | |
|---|---|
| Style | Belpaire |
| Working pressure | 150 lbs. |
| Outside diameter of first ring | 72 in. |
| Firebox, length and width | 116 x 66¼ in. |
| Firebox plates, thickness | ⅜ & ⅝ in. |
| Firebox, water space | 5 in. |
| Tubes, number and outside diameter | 160—2¼, 32—5½ in. |
| Tubes, length | 21 ft. |
| Heating surface, tubes | 2,931 sq. ft. |
| Heating surface, firebox | 206 sq. ft. |
| Heating surface, total | 3,137 sq. ft. |
| Superheater heating surface | 641 sq. ft. |
| Grate area | 53.3 sq. ft. |
| Smokestack, height above rail | 183⅝ in. |
| Center of boiler above rail | 111 in. |

TENDER.

| | |
|---|---|
| Frame | 12 in. Chan. |
| Wheels, diameter | 36 in. |
| Journals, diameter and length | 5½ x 10 in. |
| Water capacity | 8,000 gals. |
| Coal capacity | 13 tons |

## ENGINE FAILURES AND HOW THEY ARE OVERCOME.

In a paper on "The Locomotive Repair Shop and Its Proper Organization," presented before the Cleveland Engineering Society, M. D. Franey, superintendent of the Collinwood shops of the Lake Shore, gave some interesting facts concerning engine failures on that road and, also, how, when it is found desirable to change the design of a detail on a locomotive, records are kept insuring the change being made at the first opportunity.

"Before considering the shop organization, I wish to explain one of our record systems used in the Lake Shore main shops, which concerns the safety of the traveling public, as it checks and provides for prompt renewal of parts that may fail in service and cause delay to traffic, or cause accident. The mileage made by all locomotives per engine failure is recorded and a special effort is made by every member of the mechanical and operating departments to reduce these engine failures to a minimum. If a passenger train is delayed three minutes or a freight train ten minutes, on account of the failure of any part of the machinery on the locomotive, or the boiler not providing sufficient steam, or a failure of one of the many intricate parts of the safety appliances, it constitutes an engine failure. The following table shows the mileage made per engine failure in 1903, 1905, 1907 and 1908:

ENGINE FAILURES*—ALL DIVISIONS

| | PASSENGER | | | FREIGHT | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | No. Failures | Mileage | Miles per Failure | No. Failures | Mileage | Miles per Failure | No. Failures | Mileage | Miles per Failure |
| 1903 | 2,048 | 6,632,855 | 3,238 | 2,082 | 9,499,212 | 4,562 | 4,130 | 16,132,067 | 3,903 |
| 1905 | 1,521 | 7,587,790 | 4,987 | 2,079 | 10,531,247 | 5,065 | 3,600 | 18,119,037 | 5,033 |
| 1907 | 937 | 8,857,473 | 9,453 | 1,144 | 11,725,916 | 10,249 | 2,081 | 20,583,389 | 9,891 |
| 1908 | 439 | 8,491,650 | 19,343 | 852 | 9,702,851 | 11,388 | 1,291 | 18,194,501 | 14,094 |

"It will be observed that a marked increase of miles per engine failure has been made in the time specified.

"One of the means of reducing these engine failures is the constant study by motive power department members to improve the design of such locomotive parts as fail in service. Sketches of defective parts showing the defects marked in red are forwarded to the mechanical engineer and properly checked by each department head. Where the records show that these parts are breaking owing to weakness in design, the design is strengthened or changed to correct the defect and instructions for the application of improved parts are issued on manifests accompanied by necessary blue prints approved by the mechanical engineer. The manifests contain instructions as to when the parts are to be applied. The change of such details are termed 'change-in-progress,' and it is very necessary that a simple and comprehensive system be installed to insure the carrying out of these instructions on a railroad with over 1000 engines.

"Each engine is individualized by number; they are classified

| 4802 K2D | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 14 | | 27 | | 40 | | 53 | | 66 | | 79 | |
| 2 | 2-5-09 | 15 | | 28 | 2-12-09 | 41 | | 54 | | 67 | 2-2-09 | 80 | |
| 3 | | 16 | | 29 | | 42 | | 55 | | | | 81 | |
| 4 | | 17 | | 30 | | 43 | 2-2-09 | | | 69 | | 82 | |
| 5 | 2-2-09 | 18 | 2-2-09 | 31 | | 44 | | 57 | 2-11-09 | 70 | | | |
| 6 | 2-2-09 | 19 | | 32 | | 45 | | 58 | | 71 | 2-2-09 | 84 | |
| 7 | 2-2-09 | 20 | | 33 | | 46 | | 59 | | 72 | | 85 | |
| 8 | 2-11-09 | 21 | 2-2-09 | 34 | | 47 | | | | 73 | 2-11-09 | 86 | |
| 9 | | 22 | | 35 | | 48 | | | | 74 | | 87 | |
| 10 | | 23 | | 36 | | 49 | | 62 | | 75 | | | |
| 11 | | 24 | 2-5-09 | 37 | | | | 63 | 2-11-09 | 76 | | | |
| 12 | | 25 | | 38 | | | | 64 | | 77 | | | |
| 13 | | 26 | 2-5-09 | 39 | | 52 | | 65 | | 78 | | | |

FIG. 1.

by a letter to denote design, sub-divided by a numeral and at times a letter following the numeral to show some changes in detail of the same design. The 4800's, or the Lake Shore fast passenger Pacific engines, are known as class K-2; they are sub-divided into A, B, C, D or E. All of the 4800 engines are Pacific type. They are a class K-2 engine, but there are some slight differences in the detailed construction, which sub-divides them into class K-2A, K-2B, etc.

"We maintain in the general foreman's office a set of cards known as the 'change-in-progress' cards. A card, similar to Fig. 1, is provided for each engine on the division. You will note it has two columns, one on the left for consecutive numbers, 1, 2,

* See also pages 461 and 462 of the December, 1908, issue.

3, etc., and a column to the right of these numbers for the month, day and year. A master card, similar to Fig. 2, or several if necessary, is provided for each class of engine. The master card has numbers corresponding to the numbers on the individual card. It also has to the right, a space showing when the change is to be made. 'F.S.' indicates 'first shopping'; 'R' indicates 'renewals.' A space follows for a brief description of the change to be made or the item of work, and following that is a column for the authority or manifest number. You will readily see that No. 5 on the master card, Fig. 2, defines No. 5 on the individual card, Fig. 1, and saves and prevents the duplication of work. The card for the individual engine has merely the number of the item and to the right a space for the date when the repairs are made.

"We will follow a case of repairs to an engine coming to the

| NUMBER | CLASS OF REP'R. | K2 A, B, C, D | AUTHORITY |
|---|---|---|---|
| 1 | FS | INJECTOR RODS CHANGED FROM HEAD TO SIDE OF FIREMANS SEAT | ARA'S LETTER 5-20-08 |
| 2 | FS | CAB BRACES CHANGED TO BACK HEAD | MDF'S LETTER |
| 3 | FS | REVERSE LEVER QUADRANT ON BACK HEAD | T-41504 |
| 4 | FS | BABBITT IN MAIN ROD BRASSES | 14102 |
| 5 | FS | " " DRIVING BOX " | 13698 |
| 6 | FS | POUR DRIVING BOX HUB FACES BRASSES & SHIMS | |
| 7 | FS | CAST IRON HUB LINERS WITH BR. DR. BOX HUB FACES | |
| 8 | FS | TRAILER SPRING SEAT TURNED DOWN TO CLEAR GUIDE | T-40984 A |
| 9 | FS | TENDER TRUCK BRAKE RIGGING CHANGE LEVER BRAKE HEAD & HANGERS | V-41404 |
| 10 | FS | BRAKE HANGERS ON TENDER TRUCKS | RBK'S 12-27-07 |
| 11 | FS | FRAME FILLING PIECE SIZE OF PIN CHANGED | T-40327 B |

FIG. 2.

shop and select engine 4802, one of the Pacific type. When the engine arrives at the shop for repairs, its individual card is taken from the case; from this we find the engine to be class K-2A. Master cards for the class K-2A are taken from their case and all items to be changed at this shopping, and not dated on the individual card, are typewritten and each sub-foreman interested is given a copy of this report, which is termed the 'change-in-progress repair sheet.' The foreman immediately orders the necessary material to make these changes, and as each item is completed, he enters the date on the change-in-progress sheet. This change-in-progress sheet is returned to the general foreman's office when the repairs to the engine are completed and a clerk enters the date on the individual card to the right of the number indicating that the change has been made. This closes the item referred to for all time and provides a suitable and permanent record of changes in progress."

## LOCOMOTIVE CRANK PIN LUBRICATOR.

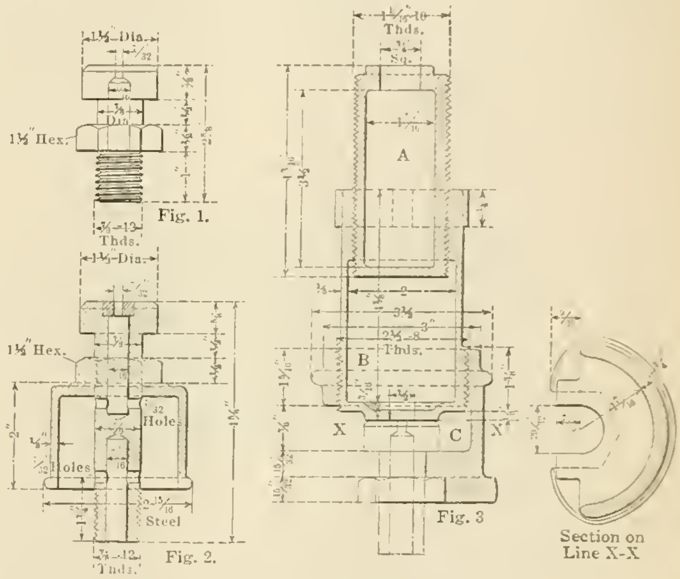
A radical departure from the usual grease cup for the lubrication of crank pins with hard grease is shown in the accompanying illustrations. This device has been invented and patented by a practical railroad man of many years experience and has been adopted by one large railway system with great success. It has not only shown a decided saving of grease, but it has eliminated all losses of grease cups and parts which formerly averaged nearly 1000 plugs and cups per month. In fact at one shop where the device is on every engine on the division, the services of a machinist who formerly put in his time entirely on grease cups has been dispensed with.

Figure 1 shows the receiving plug for side rods, containing a small reservoir and designed with a lip at the top for receiving the portable lubricator shown in Fig. 3. This small receiving plug will hold enough lubricant for a 500-mile trip. In Fig. 2 is shown a receiving plug for main crank pins, having a storage chamber holding a sufficient supply of grease for all requirements, even of abnormal conditions on main pins. The storage chamber is in the form of an inverted cup, held in place by the plug and makes a joint with the top surface of the rod. This is filled in the same manner as the other plug.

In Fig. 3 is shown the portable lubricator which is used for filling the receiving plugs; one of these is carried in a special standard in the locomotive cab to be used in emergencies and the roundhouse men, who fill the lubricators, are provided with others. It consists of three malleable iron castings, A—compressor screw; B—compressor barrel; C—lubricator stand. The stand is designed so that its base will slip into the grooves of the receiving plugs and interlock with the hexagonal top, so that when the compressor screw, turning with it the barrel, is forced down, a perfect joint is made with the upper part of the receiving plugs. The lubricant is then forced into the receiver and a turn with a spanner wrench, which goes with the lubricator, releases it. This portable lubricator holds eight ounces of hard grease.

It has been found necessary to fill the receiving plugs at the start of the trip only and this is done by the roundhouse men assigned for such duty. In cases of emergency where it is necessary for the engineer to lubricate, it has been found that he can do it with this type of lubricator in about one-quarter of the time required with the old style compression grease cup.

The design of receiving plugs is so light that there is no chance of them coming loose and there are no jam nuts to loosen up




NEW TYPE OF GREASE CUP.

and become lost. On the road where these cups are in use it has been found that not a plug has been lost or a hot pin occurred on an engine equipped in this manner.

This device was invented and has been patented by W. H. Dupree, Vicksburg, Miss.

Road Maintenance and Automobiles.—According to the report of the engineers in charge of the State roads of Massachusetts, a little over one-half the current year's estimate for resurfacing and treating the highways under their care is due to the additional burdens of automobile traffic. This figure amounts on the average to about $500 per mile of road 15 ft. in width. The figures given are, to a certain extent, cumulative for more than the past year, the total being, however, exclusive of the amount required for ordinary repairs and care. Of course, the damage is very unequally distributed. One stretch of wide macadam street resurfaced in the spring at a cost of about $5,000 per mile was entirely ruined in a year, almost wholly by motor cars, other traffic being rather light. While probably the additional charge of $500 per mile of upkeep would hold fairly well as an average were traffic uniformly distributed, the amount required on roads where motoring is common may be much larger.—*The Engineering Record.*

## HIGH DUTY BELTING.

The user of belting should familiarize himself with the properties of the various types of it in order to select the one best suited to the conditions with which he has to contend. For average railroad shop work a high-grade leather belting will prove most efficient and economical, but on certain classes of wood-working machinery, where the service is severe, a well-made balata belt will give better results. This belting is also waterproof and is less affected by the action of oils, acids, steam and alkalies than any other type of belting, thus being most suitable for application where these qualities are desirable. It may be used to special advantage where it is exposed to weather conditions, or for axle lighting drives on passenger trains. It is said that a belt of this type was used for driving the axle generator on a Rock Island passenger car which run 116,000 miles when the belt was lost, although still in good condition. The best records for other types were 70,000 miles for a chain belt and 40,000 miles for a rubber belt.

Balata is made from the sap of the boela tree, which is a native of Venezuela and Guiana. In some respects it is similar to rubber, although it does not have the same odor and has very little elasticity. It does not oxidize or deteriorate as does rubber. Cotton duck when impregnated with the balata is acid and waterproof. If there is a tendency for the belt to slip a slight heating softens the balata, increasing its adhesive properties, causing it to grip the pulley. As it thus becomes practically a positive drive it is not suitable for purposes where belt slippage is desirable, or necessary. It also makes it unsuitable for use in places where the temperatures are much above 100° F.

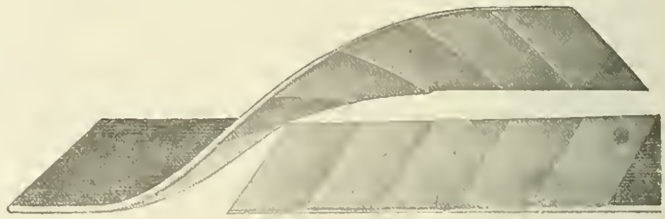
One of the best-known grades of this type of belting in use in this country is known as the Victor-Balata, manufactured by the New York Leather Belting Company. This company has spent a number of years in experimenting with it in order to determine the classes of work for which it is best suited. We are indebted to them for the following facts concerning its manufacture, characteristics and application. It is practically twice as strong as the best leather belting, having an average tensile strength of 8,800 pounds per square inch. In its manufacture a 37-ounce duck is used, which is woven from long staple cotton yarn, the threads being under high tension during the operation. Because of the special method of weaving, its tensile strength is considerably greater than is possible with the class of duck that it is necessary to use in the manufacture of rubber belting, and the percentage of stretch is very small. The balata is forced into the duck, which is thoroughly impregnated with it. The duck is then cut to width for the various sizes and plies, so that only one piece of fabric is used for a belt; there are thus no longitudinal seams running through it. The machinery for forming the folds is so designed as to eliminate any possibility of wrinkles or air cushions. Because of its greater tensile strength it may be used in lighter plies than other classes of belting. As the stretch amounts to only about two per cent. it is necessary to cut the belt more nearly to the exact length than is ordinarily done where users figure on a belt stretching from three to five per cent.; this also reduces the cost of maintenance. The construction of the belt is such that it operates with the least possible vibration, thus being of special value for use at high speeds.

### LACING TEXTILE BELTS.

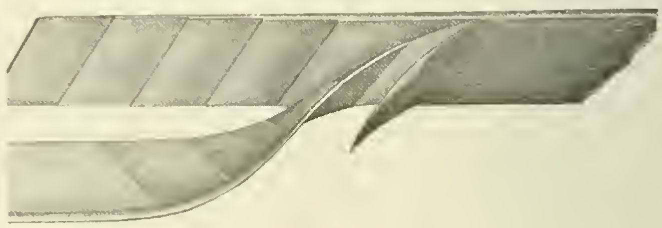
It is necessary to use greater care in lacing or fastening a textile belt of this kind than in the case of leather. Punching too large a hole or placing it too close to the ends of the belt is liable to result in tearing the fastener out. In place of punching the holes it is better to force an awl through the belt, so as to spread the strands apart and tear them as little as possible.

The following suggestions for lacing textile belts are furnished by the New York Leather Belting Company: In preparing the ends of a belt for lacing or fastening, invariably use a square so that they will be at right angles with the edges of the belt. It has often been found, where fasteners do not give entire satisfaction, that it is due to the fact that the ends have not been cut true; consequently, when joined together the strain is not evenly distributed across the width of the belt, falling more on some points than on others and resulting in the tearing out of the fasteners.

What is practically an endless belt sewed with raw-hide thong is shown in Fig. 1. In joining a Victor-Balata belt in this manner the ends are cut to form what is called a "step splice." The plies of the two ends are cut away as in A and B so that when the ends are overlapped the belt is of uniform thickness throughout its length. Balata cement is applied between these overlapped ends and the splice is reinforced with the raw hide. The number of stitches taken with the rawhide lace is dependent upon the width of the belt, as is also the number of rows. The holes should be from 1 inch to 1¼ inch apart and they should not



A



B

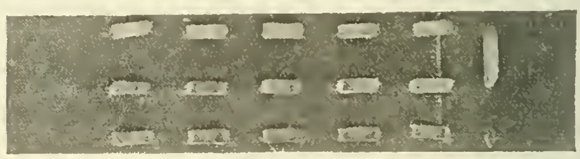


FIG. 1.

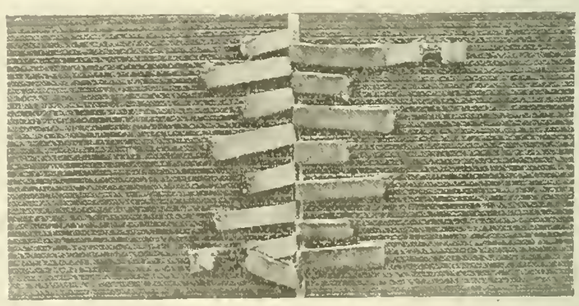


FIG. 2.

come closer to the edge than ½ inch in narrow belts; in wider belts this margin should be slightly increased. The rows of stitching running lengthwise with the belt should be from 1 inch to 1½ inch apart.

¼ in. lace should be used for belts 3 in. and under.
5/16 in. lace should be used for belts from 4 to 8 in.
⅜ in. lace should be used for belts of greater width.

In no case should a punch be used for the making of the holes. Use a sharp-pointed awl, spreading apart the fibers, making an opening sufficiently large for the lacing, severing as little of the duck as possible. It is very important that the points of the splice be over-stitched in the manner illustrated, otherwise they may work free and result in tearing the belt. This form of joint is not advocated for very small pulleys, as the stitches, to some extent, lessen the surface contact and if the load is heavy there is a possibility of slippage where the joint is formed.

The regular form of rawhide lacing is illustrated in Fig. 2. Little need be said of this method except to urge the greatest care in the proper spacing of the holes, so that the strain is evenly distributed, and the selection of a size of lacing in proportion to the width and thickness of the belt.

A hinge joint made with the alligator fastener is shown in

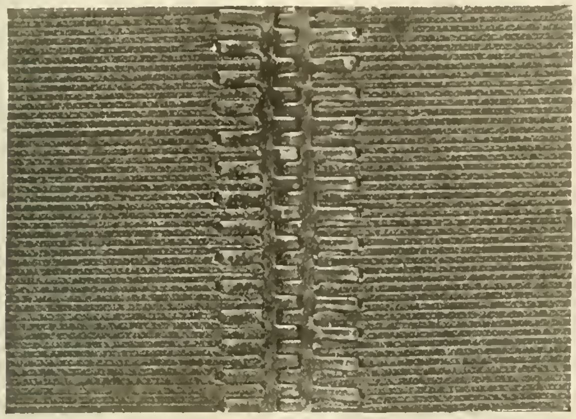


FIG. 3.

FIG. 4.

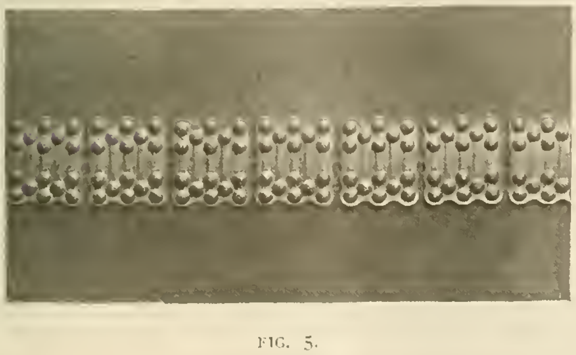


FIG. 5.

Fig. 3. The prongs are merely driven into the belt and clinched on the opposite side. This fastener is made in various sizes for belts of different thicknesses. The teeth of the fastener should be long enough to gain sufficient grip. The hinge is made by the insertion of a rawhide pin and when properly hammered down there is not much metal to come in contact with the pulley surface. This is a very efficient type of fastener to use and will be found satisfactory on belts of moderate width where the loads are not excessive. The rawhide pins will prove very durable, but should be examined from time to time and occasionally replaced.

A machine-made wire hinge joint, having the same advantage of flexibility, is shown in Fig. 4. This also works on a rawhide pin, and when the quality of the wire is right will stand greater strains than the alligator fastener, but its application requires a little more time. The machine used to make this form of joint is of inexpensive and simple construction.

The Crescent fastener (Fig. 5) is a fairly well known one, and this has been found extremely satisfactory where the upper side of the belt has no pulley contact. If the right size plate and rivet is used this fastener may be successfully operated on very small pulleys, and owing to the fact that the split copper rivet makes a small hole and spreads rather than cuts the fabric, the strength of the belt remains intact and will stand severe strains where joined.

The Jackson fastener (Fig. 6) is particularly desirable for heavy belts. The inside of the plate being slightly hollowed and the disc that goes on the pulley side being slightly convex, admits of this disc being drawn well up into the plate when the countersunk nut is tightly screwed down. This results in the belt being held in a vice-like grip and the strain is not to any great degree thrown on the bolt that passes through it. It is made in a number of sizes suitable for different widths and plies of belting, and is strongly advocated for use on heavy Victor-Balata belts. The hole for the belt should be made no larger than absolutely necessary to force it through. It is advisable to place between the upper surface of the belt and the plate what

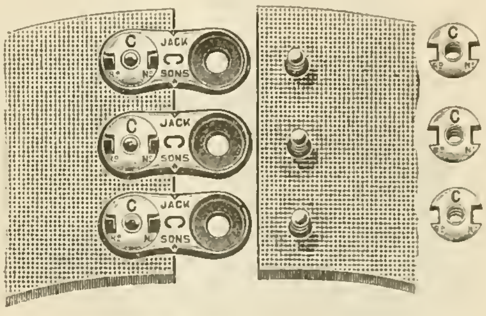



FIG. 6.

is termed a "safe," which should consist of two plies of balata belt, which is made in this form, or which may be cut from some remnant: this will prevent the plate breaking or cutting the belt's surface as it goes around the pulley.

Oil Houses.—The committee on buildings of the American Railway Engineering and Maintenance of Way Assn. made a study of the design of oil houses last year. Their conclusions as amended at the annual convention in March are as follows:

"(1) When practicable, oil houses should be isolated from the other buildings at a terminal.

"(2) Oil houses should be fireproof and the storage in large houses should preferably be either underground or in the basement.

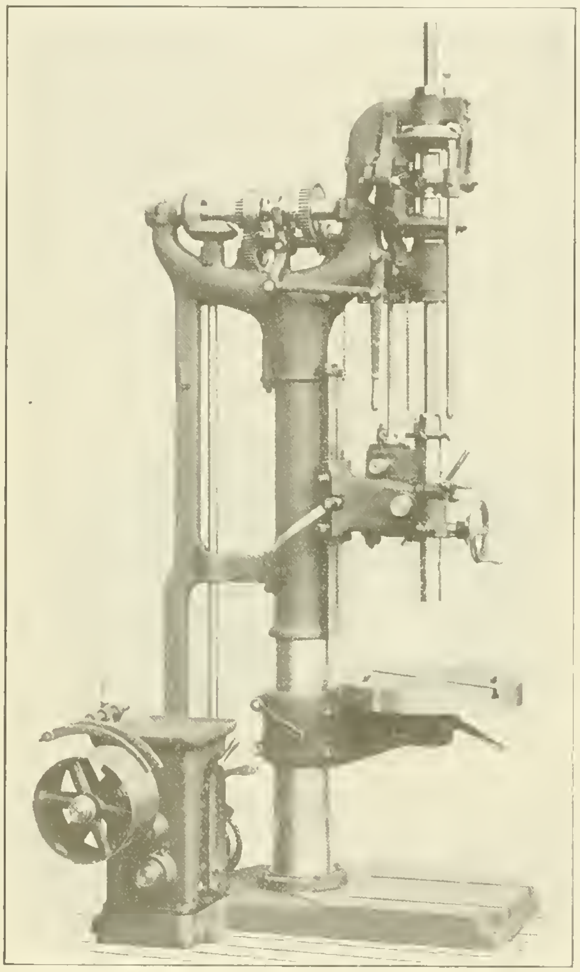
"(3) Oils that are stored in sufficient quantities should be delivered to the tanks in the house direct from tank cars. For oils that are stored only in small quantities provision should be made for delivery to storage tanks from barrels by pipes through the floor.

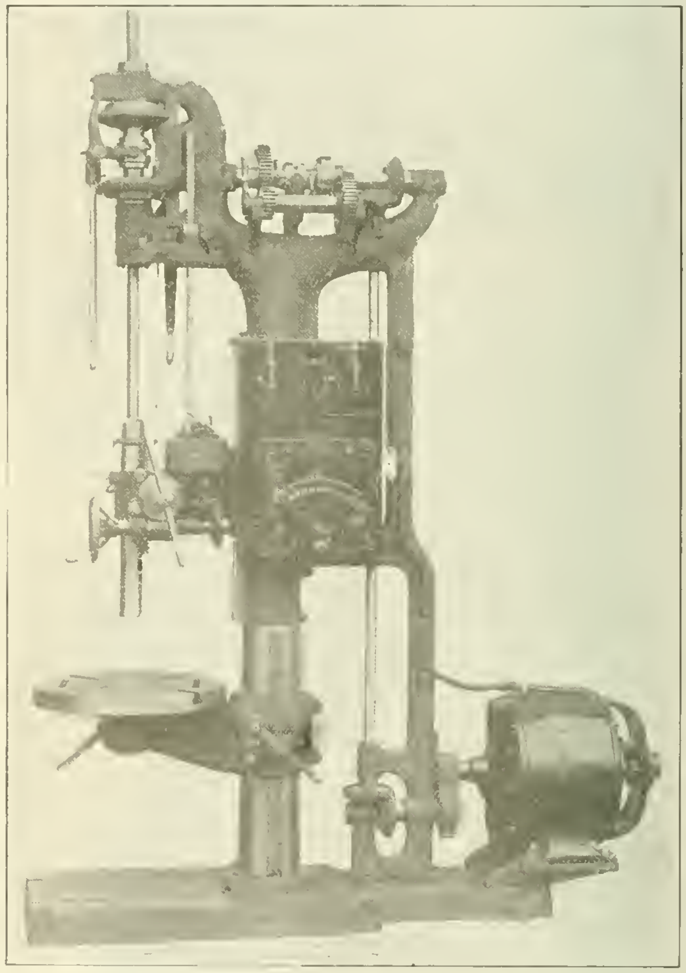
"(4) The delivery system from the storage tanks to the faucets should be such that the oil can be delivered quickly and measured. The delivery should also be such that there will be a minimum of dripping at the faucet and that the drippings be drained back to the storage tanks."

## HIGH SPEED UPRIGHT DRILL.

It has been a difficult task to improve the upright drill to make it powerful enough to use the high speed steel drills to advantage, in addition to providing other improvements which are desirable from the standpoint of increasing the output, as well as adding to the convenience in operation. A machine of this type has been developed during the past few years by The Cincinnati Bickford Tool Company, of Cincinnati, which fulfils these conditions to a remarkable extent, as may be seen from a study of the following description.

The column of large diameter is well braced and rests on an unusually heavy base, carefully designed to make it as rigid as possible. The base is also provided with T slots for holding the work. The head is counterbalanced and is vertically adjustable by means of a steel rack and pinion; it has a wide bearing on the column and may be quickly and securely clamped in any position. The table is of heavy construction, is well reinforced and has a large bearing on the arm which is hand-scraped, insuring perfect alignment. The table arm is raised and lowered by a rack and pinion and a worm and wormwheel; it is thus not possible for it to drop by accident.





CINCINNATI-BICKFORD IMPROVED HIGH SPEED UPRIGHT DRILL.—BELT AND MOTOR DRIVEN.

The spindle is provided with ball-bearing and jam nuts for adjustment, and has an automatic stop so that holes may be drilled to a fixed depth. A patent positive geared feed box is located on the sliding head, convenient to the operator, and provides six feeds. For the 24, 28 and 32-inch machines these feeds are 0.006, 0.009, 0.013, 0.018, 0.027, and 0.039 inch per revolution of the spindle. For the 36 and 42-inch machines they are greater.

The friction back gear at the top of the machine may be left in continuous engagement, although a handle is provided to disengage it when not in use. The lever for manipulating the back gear extends down near the front of the machine at the left, convenient to the operator; with it he may engage or disengage the back gear without stopping the machine, although the spindle may be stopped by bringing the lever to a neutral position; this feature has proved to be of great value. If desired, these machines may be furnished with a tapping arrangement, as shown, whereby the tap may be operated at a slow speed until it is reversed, when the speed is four times as great.

The belt driven machines are equipped with a gear box. It is placed at the left in order that the operator may change the speeds without leaving his position; eight speeds are obtained through it, thus making sixteen spindle speeds available in connection with the back gears. The time required for making any change of speed is not more than three or four seconds. The box contains no frictions and is of simple and substantial construction; its top furnishes a convenient tool tray.

With a motor drive the motor is mounted on a bracket at the rear; the switchboard containing the controller and switches is placed on the side of the column. The Triumph motor on the drill shown in the illustration, furnishes eighteen different speeds, which, in connection with the back gears, provides thirty-six spindle speeds. A 3 h.p. motor is recommended for the 24-inch machine; a 5 h.p. for the 28 and 32-inch; and a 7½ h.p. for the 36 and 42-inch. The drive for both belt and motor-driven machines is arranged to furnish a cutting speed of seventy feet per minute for the different size drills. An index plate indicates the

| | | | | | |
|---|---|---|---|---|---|
| Size of machine | 24″ | 28″ | 32″ | 36″ | 42″ |
| Height of drill, regular machine | 7′ 5½″ | 8′ 0″ | 8′ 5″ | 8′ 11½″ | 9′ 3″ |
| Height of drill, tapping machine | 8′ 3½″ | 8′ 11″ | 9′ 4½″ | 9′ 11½″ | 10′ 3½″ |
| Drills to center of | 25″ | 29″ | 33″ | 37″ | 43″ |
| Distance between base and spindle | 48″ | 52″ | 54″ | 57″ | 58″ |
| Distance between table and spindle | 35¼″ | 37¼″ | 38½″ | 39½″ | 38¾″ |
| Traverse of table on column | 19¼″ | 19¼″ | 18¾″ | 18½″ | 19″ |
| Traverse of head on column | 21¼″ | 22¾″ | 24¼″ | 26¾″ | 24¾″ |
| Diameter of table | 22″ | 25″ | 28″ | 32″ | 36″ |
| Horsepower required | 3 | 5 | 5 | 7½ | 7½ |
| Weight, pounds, about | 2 700 | 3,500 | 4,000 | 5,200 | 6,100 |

position of the levers for using the various size drills at a cutting speed of 70 ft. per min.

The table on the opposite page gives the general dimensions of the different sizes of this line of drills.

## TWO-SPEED PLANER DRIVE.

An ingenious arrangement has been contrived by The Cincinnati Planer Company, Cincinnati, Ohio, for providing two cutting speeds and a constant return speed on its smaller size belt-driven planers—22 to 36 inches. At the extreme right on the countershaft, shown in the illustration, is the large pulley for driving the return belt. Next to this, and not shown clearly, are three 16-inch pulleys set closely together. The one nearest the return pulley is narrow and keyed to the shaft; the other two are loose, the first one being quite wide and the other one narrow. Beyond these on the countershaft, are three pulleys—a small one for driving the elevating pulley, and two wide pulleys, one keyed to the shaft and the other one running loose. The tight pulley at the left is connected to the line shaft and drives the countershaft and thus the return pulley, and also furnishes the high cutting speed when the cutting belt is on the narrow pulley next to the return pulley. To change to a slower cutting speed the cutting belt is shifted to the wide loose pulley, which is driven at a slower speed by a belt from the line shaft, the pulley being wide enough to accommodate both belts. To stop the countershaft the two driving belts are shifted to the loose pulleys at the left of both sets of pulleys. The cutting speed may of course be changed while the machine is in operation, the belts being shifted by the lever at the side of the housing.

## "HIGHPOWER" DRILLS.

A high-speed twisted drill that does not require special chucks or sockets, has recently been placed on the market by The Pratt & Whitney Company, Hartford, Conn. The increased twist in the shank permits its use with the standard Morse or other taper sockets. The drill is ground on the shank and barrel so that it has the same accurate alignment as the standard milled drill. The twisted shank is claimed to provide an even more effective contact with the socket, thus making possible the use of greater driving power, than does the ordinary solid shank. The breaking of tangs and the slipping of drills is eliminated.

The first two tests described below were made to determine the efficiency of the drill in machinery steel and cast iron, no effort being made to find the limit of the tool. The third test was made to determine the effective contact between the shank and the socket and the general strength of the drill.

*Test No.* 1.

Diameter of drill, 1¼".
Material drilled, machinery steel, 3½" thick
Cutting speed per minute, 98 feet.
Feed per revolution of drill, .0115
Inches drilled per minute, 4.2.
Number of holes drilled, 100.

At this point the drill was removed and found to be in practically as good condition as when test commenced.

*Test No.* 2.

Diameter of drill, 1¼"
Material drilled, cast iron, 3" thick.
Cutting speed per minute, 127 feet
Feed per revolution of drill, .0426.
Inches drilled per minute, 11.9
Number of holes drilled, 211.

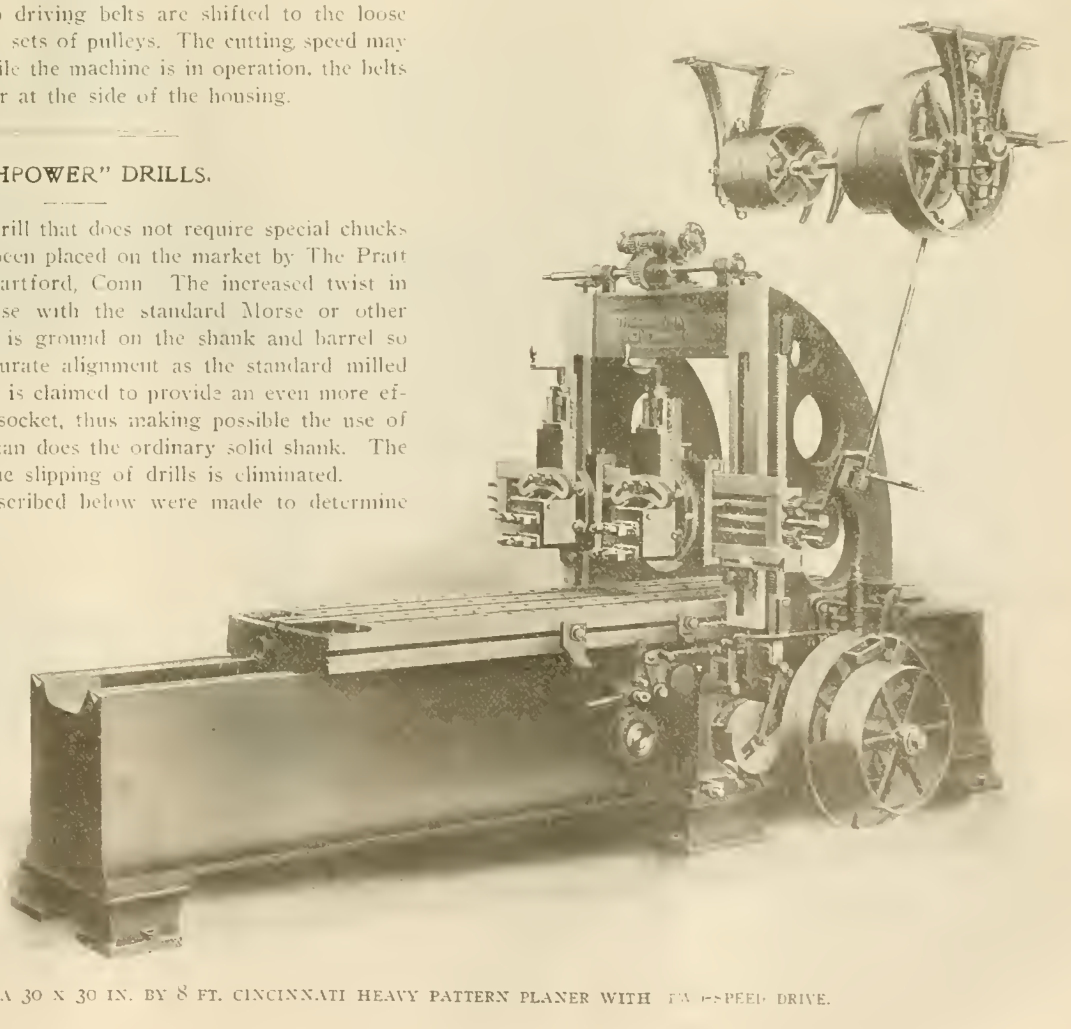
PRATT & WHITNEY "HIGHPOWER" DRILL.

At this point the drill was removed and found to be in practically as good condition as when test commenced.

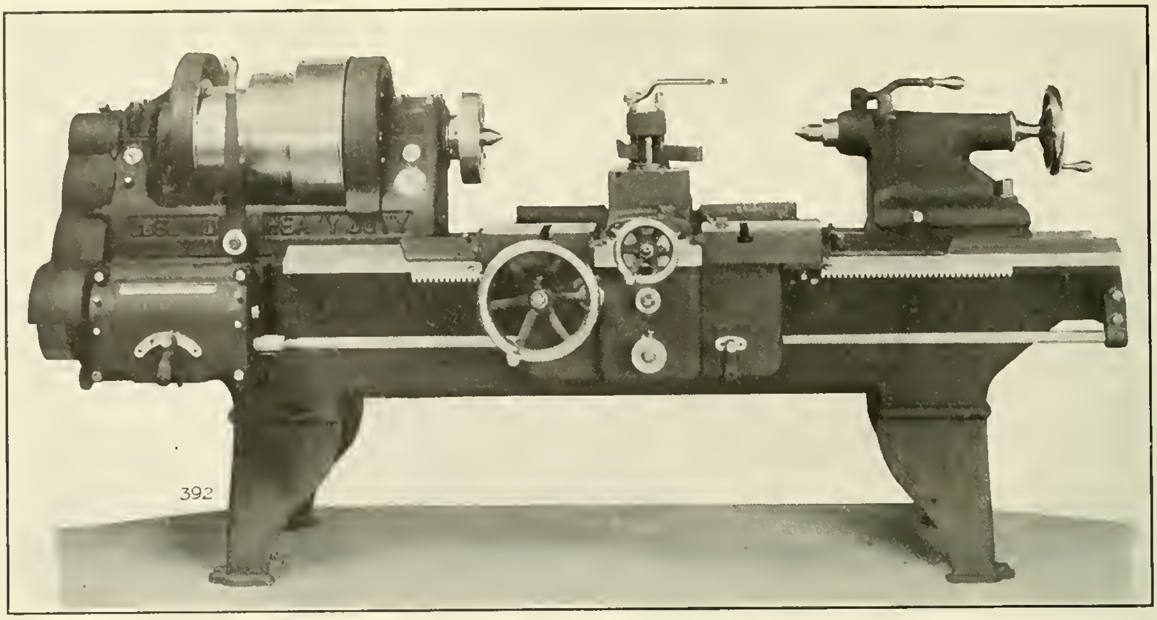
*Test No.* 3.

Diameter of drill, 1".
Material drilled, cast iron, 2¾" thick
Cutting speed per minute, 156 feet.
Feed per revolution of drill, .087
Inches drilled per minute, 51.9

The drill was removed after drilling one hole, without a sign of a flaw and cutting edges found to be in good condition.



A 30 X 30 IN. BY 8 FT. CINCINNATI HEAVY PATTERN PLANER WITH TWO-SPEED DRIVE.




LE BLOND HEAVY DUTY LATHE.

## HEAVY DUTY LATHE.

In the September number, page 374, we described a new line of heavy duty engine lathes that has recently been placed on the market by The R. K. Le Blond Machine Tool Co., of Cincinnati, Ohio. There is a considerable amount of work in railroad shops, especially on the smaller size lathes, where a simpler machine with fewer speed changes and special attachments may be used to just as good advantage as the more complicated and expensive ones. The lathe shown in the illustration, which is made in three sizes—16, 18 and 20-inch swing—has been designed to meet this need.

The headstock retains the same features as the one on the machine described in the September issue, with the exception of the back gearing. Instead of the double friction back gear with its quick changes, which are so essential in a general purpose tool, the double back gears are engaged with a sliding key operated by the hand lever directly in front of the driving cone. The usual quick-change box is replaced by a four-change feed box. The changes are obtained by sliding gears operated by the crank handle shown on the front of the box, and may be made while the machine is in operation under the heaviest cut. These four changes are doubled by a reversible compound gear on the end of the bed which gives the operator a choice of eight geared feeds, covering a carefully selected range.

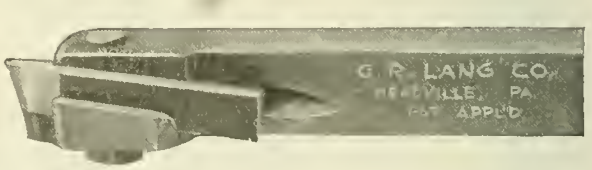
The apron is double-walled, of a single box section casting, as previously described. The lead screw and half nuts are stripped off. The manufacturers state that they are prepared to furnish this apron with automatic stops for the cross and longitudinal feed, of a construction similar to what they have been using on their high-speed roughing lathes for several years. In all other respects the lathe is similar to the one described last month.

## A NEW TOOL HOLDER.

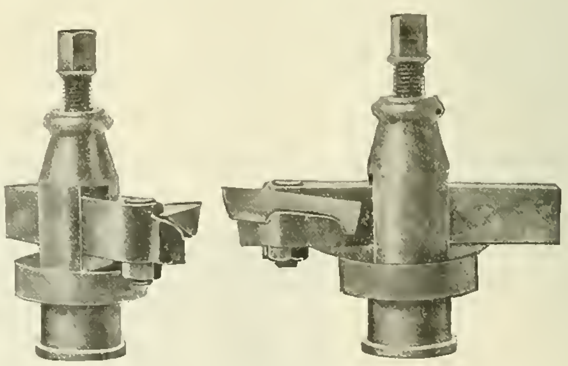
The tool holder shown in the accompanying illustrations is made by The G. R. Lang Company, of Meadville, Pa., and contains a number of features of merit, which makes it particularly well adapted for many of the most difficult railroad shop operations. It is designed to take the place of large solid forged tools on the class of work for which the ordinary tool holder has proven to be too light. It is intended primarily for heavy roughing work such as turning locomotive driving axles, but it has also been shown to be satisfactory for light and finishing cuts.

Special points of advantage of this tool holder are found in the large area of the cutting point, which gives a liberal radiating surface; the support underneath the cutter at a point directly opposite the thrust of the cutting edge; the use of triangular-shaped cutters, which permit a great saving in the cost of the steel; unusual rigidity, due to the use of the triangular cutter, which is seated in a V-shaped slot; the absence of set screws and tapped holes in the holder; the absence of obstruction in the way of the chip coming off of a heavy cut and the shape of the holder, which permits it to work up very close to a shoulder or face.

LANG TOOL HOLDER DISMANTLED.




LANG TOOL HOLDER WITH TRIANGULAR CUTTER.



LANG TOOL HOLDER IN TOOL POST.

The use of triangular steel for the cutters gives a liberal depth under the cutting edge, together with proper side and top clearances, without waste of steel in grinding. This makes a very economical cutter, which weighs but one half as much as it would in a square section. The triangular steel can be bought in bar lengths as readily as in other sections. The method of clamping and supporting the cutter practically eliminates the possibility of the point springing down or backing away from the work. The illustrations show the method of clamping the cutter to the holders which are made in rights and lefts, being set and used the same as a solid forged tool would be. Special shaped shanks are provided for use in a vertical boring mill.

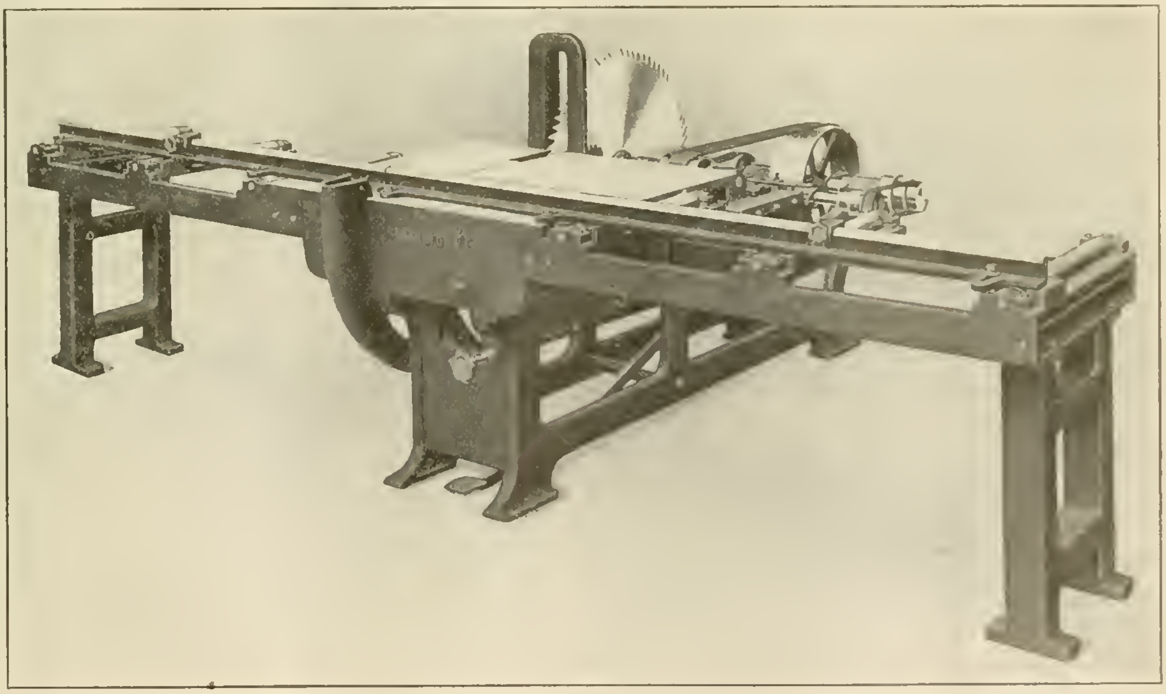
In railroad shops where these cutters have been tried it was found that in competition with solid forged tools the holder not only saved tool steel and the cost of forging, but also increased the output of the machine quite noticeably, largely on account of the small amount of time consumed in grinding the cutter point. The manufacturers of this holder fully guarantee that it will take as heavy cuts as a solid forged tool and the experience in shops that have been using them indicates that this can be done in practically all cases.

## HEAVY AUTOMATIC RAILWAY CUT-OFF SAW.

This saw is designed for medium and heavy work in car shops, shipyards and for heavy building material. It is ordinarily furnished with a thirty-inch saw, but will take saws up to thirty-six inches, which will cut off material up to 27 by 9 inches or 17 by 14 inches. The table is of extra large size, consisting of a central connected portion four feet in length and having long wing roller extensions, giving a total length to the table of thirteen feet. The roller table is thirty inches wide and will admit material twenty-seven inches wide.

The frame is of heavy construction, well braced throughout and is eight feet five inches long over-all from front to back. The table is thirteen feet long from end to end. The saw is driven by an improved drive consisting of an endless belt running over the various pulleys and idlers in such a manner as to maintain straight lines between the pulleys, thus maintaining equal tension on the belt at all times and doing away with swinging frames or idlers.

The saw housing travels on top of the frame in heavy dovetail slides and is provided with adjusting gibs for taking up wear and for lining up the saw. The housing is fed by means of a heavy lead screw driven by right and left friction gearing, which is controlled by a foot treadle at the front of the machine. There are three rates of forward feed and one return. The housing may be started or stopped at any point in its travel and may be returned to its starting point at the will of the operator. A stop rod is furnished by which the backward travel of the saw may be regulated, as it is not necessary to return it for the full stroke at every cut made. The countershaft is attached to the machine and has tight and loose pulleys, 14 inches in diameter with 8¼ inches face, which should make 250 revolutions per minute. The machine weighs about 3,000 pounds, requires from 15 to 25 horse-power and occupies floor space of 13 by 8½ feet. It is known as the Hamilton heavy automatic railway cut-off saw, No. 118, and is manufactured by The Bentel & Margedant Company, Hamilton, Ohio.



HAMILTON HEAVY AUTOMATIC RAILWAY CUT-OFF SAW.

## BELT DRESSING.

After a belt has been in use some time, its surface takes on a glaze. This results in losses due to slipping, always accompanied by heating, and draws the natural oils to the surface, causing them to evaporate. This condition further leads to the belt's getting stiff and hard, and lessens the angle of wrap (the angle between the extreme points touched and covered by the belt on the pulley). Without attention belts are almost sure to deteriorate in this way. To prevent the formation of surface glaze and the slipping accompanying it, it is the best practise to use a reliable belt dressing. This dressing should be of a nature that will not only offer temporary relief, but that will penetrate through the surface of the belt and replenish the natural oils. This will result in keeping the belt pliable and preserving the original efficiency.

Rosin is very frequently applied to prevent slipping, and this it will do, but at the same time it destroys the life of the belt itself. It furnishes temporary relief, but greatly shortens the life of the belt—the rosin dries out the belt and makes the leather fibers brittle.

A belt dressing is made by the Joseph Dixon Crucible Company, Jersey City, N. J., which it is claimed does not supply a surface stickiness, but is absorbed by the belt, thus keeping it in its natural condition, preventing the formation of surface glaze with the attendant slipping, and maintaining the angle of wrap at its widest points.

# RAILROAD CLUBS.

*Canadian Railway Club* (Montreal, Can.).—Tuesday evening, October 5th, C. Kyle, general master mechanic of the Canadian Pacific Railway at Montreal, will read a paper on "Locomotive Dispatching and Terminal Facilities."

Mr. Vaughan's paper on "Locomotive Counterbalancing," presented at the September meeting, is reproduced in another part of this issue.

Secretary, Jas. Powell, P. O. Box 7, St. Lambert, near Montreal.

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*Central Railway Club* (Buffalo, N. Y.).—At the meeting for November 12th, G. Herbert Condict, secretary of the International Lecture Institute, will read a paper on "The Application of Electricity to the Movement of Miscellaneous Terminal or Package Freight for Railway and Steamship Companies."

At the September meeting, Col. B. W. Dunn gave an illustrated talk on the "Railway Official's Responsibilities and Duties in Connection with the Transportation of Dangerous Articles."

Secretary, Harry D. Vought, 95 Liberty street, New York City.

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*Iowa Railway Club* (Des Moines, Ia.).—Next meeting, Friday, October 8th. Secretary, W. B. Harrison, Union Station, Des Moines, Ia.

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*New England Railroad Club* (Boston).—The next regular meeting will be held at Copley Square Hotel, October 12th. Dinner will be served at 6:30 o'clock, to be followed by the regular business session at 8:00 o'clock. William J. Cunningham, statistician of the Boston & Albany Railroad, will read a paper on "Railroad Operating Statistics."

Secretary, George H. Frazier, 10 Oliver street, Boston, Mass.

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*New York Railroad Club.*—Next meeting, Friday, October 15th. At the September meeting Frederick C. Syze, of the Staten Island Rapid Transit Company, presented a paper on "Surprise Efficiency Tests of Employees Charged with the Operation of Trains."

Secretary, H. D. Vought, 95 Liberty street, New York City.

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*Northern Railway Club* (Duluth, Minn.).—At the meeting for October 23d, W. A. Clark, general car foreman of the Duluth, Missabe & Northern Ry., at Proctor, Minn., will read a paper on "Steel vs. Wooden Freight and Passenger Cars; Their Relative Cost, Use and Repairs."

At the meeting of November 27th, W. H. Hoyt, assistant chief engineer of the D., M. & N. Ry., Duluth, Minn., will speak on "Steel vs. Wooden Ties."

December 18th, C. J. Whereat, traveling engineer of the Great Northern Railway at Superior, Wis., will present a paper on "Pooling of Locomotives."

At the January meeting the "Economical and Proper Handling of Material in a Storehouse" will be considered by J. E. Chandler, storekeeper of the Duluth & Iron Range Railway, at Two Harbors, Minn.

"Demurrage, Its Benefits, Necessity, etc.," was the subject of the paper presented at the September meeting by F. L. Flock, chairman of the Missabe Range Car Service Association.

Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

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*Railway Club of Pittsburgh.*—The subject to be considered at the meeting for October 22d, has not yet been decided upon.

At the September meeting A. D. Smith, superintendent of The Canfield Oil Company, Coraopolis, Pa., presented a paper on "The Technical Selection of Railroad Oils as Applied to Cost Reduction."

Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

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*Richmond Railroad Club.*—At the next meeting, October 11th, Capt. A. B. Guigon, assistant counsel for the Virginia Passenger & Power Company, will give an address on the relation to the public of officials and employes of public service corporations.

At the November meeting the annual election of officers will be held and an entertainment will be given to which the ladies will be invited.

At the December meeting it is expected that an illustrated lecture on block signals will be given by Chas. Stephens, signal engineer of the C. & O. Ry.

Col. B. W. Dunn, of the American Railway Association bureau for the safe transportation of explosives, gave an illustrated lecture at the September meeting.

Secretary, F. O. Robinson, C. & O. Ry., Richmond, Va.

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*St. Louis Railway Club.*—At the meeting for October 11th, H. McL. Harding, vice-president of the International Lecture Institute, of New York City, will give an illustrated address on "Terminal Handling of Freight by Electricity."

At the September meeting, C. F. Smith, road foreman of engines of the Terminal Railway Association, of St. Louis, read a paper on coal combustion and economy in the handling and firing of bituminous coal for locomotive use.

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

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*Southern & Southwestern* (Atlanta, Ga.).—Next meeting, Friday, November 18th. Secretary, A. J. Merrill, 218 Prudential Bldg., Atlanta, Ga.

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*Western Canada Railway Club* (Winnipeg, Man.).—Next meeting, Monday, October 11th. Secretary, W. H. Rosevear, 199 Chestnut street, Winnipeg, Man.

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*Western Railway Club* (Chicago).—The paper for the meeting of October 19th will be from the telegraph department.

At the September meeting George S. Payson, general counsel of the Western Railroad Association, gave an adddress on "The Relations of the Western Railroad Association to Railways and the Manufacturers of Railway Devices."

Secretary, Jos. W. Taylor, 390 Old Colony Building, Chicago, Ill.

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*Association of Car Lighting Engineers.*—The annual meeting of the association of car lighting engineers will be held at the new La Salle Hotel, Chicago, October 4 to 7, 1909. The question of changing the scope of the association will be considered at this meeting.

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*Monthly Meeting A. S. M. E.*—The first monthly meeting of The American Society of Mechanical Engineers for 1909-10 will be held in the Engineering Societies Building, New York, on Tuesday evening, October 12, at 8 P. M. A paper will be presented by Prof. R. C. Carpenter, of Cornell University, upon the High-Pressure Pumping System of New York City. There are two pumping stations comprised in this system which receive power transmitted electrically from several of the electric generating plants of the city. There are five pumping units in each station consisting of 5-stage centrifugal pumps driven by induction motors. Each pump has a capacity of 3,000 gal. per min. and delivers against a pressure of 300 lbs. per square in. in the mains. It is expected that the discussion following the paper will not only bring out information upon these systems, but will also lead to a general presentation of the subject of centrifugal pumps.

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## BOOKS.

The Protection of Railroads from Overhead Transmission Line Crossings. By Frank F. Fowle. 70 pages, 5x8 inches. Cloth. Illustrated. Published by D. Van Nostrand Company, 23 Murray street, New York City. Price $1.50.

One of the most troublesome problems caused by the advent of high tension power transmission is that of safeguarding persons and property from exposed transmission lines. In considering the specific case, indicated by the title of this work, the author has not attempted to consider such details as naturally pertain to individual crossings, but has considered the general principles involved and also the materials and the types of construction. The material was gathered and arranged for presentation before the Association of Railway Telegraph Superintendents at their 1908 meeting, but was not completed in time and arrangements were then made for publication in book form.

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Efficiency as a Basis for Operation and Wages. By Harrington Emerson. 171 pages, 5x7½-inch cloth. Published by *The Engineering Magazine*, 140 Nassau street, New York City. Price $2.

This is a book which should be, not in the the library, but on the desk of every man who has the efficiency and welfare of the company with which he is connected at heart. The fundamental principles advocated by Mr. Emerson—and they have demonstrated their correctness and great value wherever they have been tried out in practice—must appeal to anyone who studies them carefully. A man with a real message usually finds little trouble in convincing his hearers, if he can only get into personal touch with them, but usually the message loses greatly in force when reduced to writing. Mr. Emerson, however, seems to have forced his very personality into his book. With a wealth of illustration drawn from his broad experience and study, he clearly brings out and "forces home" each important truth, and as we read—and then stop for a moment and look up—we almost expect to see him sitting in the chair opposite.

The book has as its basis a series of articles which were published in the *Engineering Magazine*, but these have been so fully revised, rearranged and enlarged as to make it almost a new statement of Mr. Emerson's system. The *Engineering Magazine* is to be congratulated on adding it to its already valuble "Works Management Library." A rough idea of the scope of the book may be gained from the following list of chapter headings: Typical inefficiencies and their significance. National efficiencies; their tendencies and influence. The strength and weakness of existing systems of organization. Line and staff organization in industrial concerns. Standards; their relations to organization and to results. The realization of standards in practice. The modern theory of cost accounting. The location and elimination of wastes. The efficiency system in operation. Standard times and bonus. What the efficiency system may accomplish. The gospel of efficiency.

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The Drying of Lumber.—When lumber is freshly cut, it is full of water, and this water disappears with more or less rapidity. I may state, without fear of contradiction, that probably the most important item in the handling of lumber is to successfully dry it. As the water disappears, the wood fibers shrink in volume, and cause the outer layer to shrink faster than the inner portion; a series of tension forces are set up, which ultimately result in the formation of splits or cracks in the outer layer. The extent of this splitting or cracking will depend upon the rate of evaporation of the water from the outer and inner layers. Where the water dries out with great rapidity with approximately the same rate, practically no splitting will result. It is on this account that thin lumber will check and split less than thick lumber. Twisting or warping is due to similar causes, that is, one portion of a board will dry faster than another, the fibers will contract faster, resulting in a marked curving in one direction or another.—*Hermann Von Schrenk before the Railway Storekeepers' Association.*

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## PERSONALS.

F. E. Patton has been appointed road foreman of engines of the Mobile & Ohio Ry., with office at Mobile, Ala.

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J. F. Murphy, master mechanic of the Houston & Texas Central Ry. shops at Ennis, Texas, died on September 9.

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H. C. Eich, master mechanic of the Illinois Central R. R. at Memphis, Tenn., has been transferred to the Burnside shops, Chicago, Ill.

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Walter Hill has been appointed roundhouse foreman of the Delaware, Lackawanna & Western R. R. at Buffalo, N. Y., to succeed Thomas Horton.

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A. J. Devlin, bonus expert on the Coast Lines of the Santa Fe, has been appointed machine shop foreman of the Albuquerque shops.

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C. W. Lee has been appointed master mechanic of the Raleigh & Southport Ry., with office at Raleigh, N. C., succeeding George L. Womble.

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L. A. Larsen has been appointed assistant to Vice-President David Van Alstyne, of the American Locomotive Company, with office in the Hudson Terminal Bldg., New York City.

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John A. Lee, shop and engine-house foreman of the Western Allegheny Ry. at Kaylor, Pa., has been appointed master mechanic, with office at Kaylor, succeeding J. H. Marks.

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J. E. Weatherford, foreman of the car department of the Houston & Texas Central Ry. at Ennis, Tex., has been promoted to general foreman of the same department at Houston, Tex.

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James C. Fritts, foreman at the Hoboken, N. J., shops of the Delaware, Lackawanna & Western R. R., has been appointed master car builder, with office at Scranton, Pa., succeeding Robert F. McKenna, resigned.

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T. F. Quinn has been appointed division master mechanic of the Oregon Railroad & Navigation Company and the Oregon, Washington & Idaho Ry., with office at Starbuck, Wash., succeeding W. H. Dressel, resigned.

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The office of master car builder of the Chicago, Indianapolis & Louisville Ry., formerly held by C. Coller, having been abolished, the duties of this office will hereafter be performed by John Gill, superintendent of motive power.

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J. M. Barrowdale has been appointed assistant superintendent of the car department of the Illinois Central R. R., and A. J. McKillop has been appointed the assistant superintendent of machinery in charge of locomotives, both with office at Chicago.

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W. L. Kellogg, superintendent of motive power and car department of the Pere Marquette R. R. at Detroit, Mich., has been appointed superintendent of motive power of the Cincinnati, Hamilton & Dayton Ry., with office at Lima, Ohio, and will have charge of the locomotive and car department.

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Prof. H. B. MacFarland has been appointed engineer of tests for the Santa Fe System. He is a graduate of the Worcester Polytechnic Institute and was a graduate student in experimental engineering at Cornell University in 1903. From 1903 to 1908 he was associate professor of applied mechanics and thermodynamics at the Armour Institute of Technology. For the past few years he has been making mechanical and scientific investigations for private corporations and companies as consulting engineer, with office in Chicago.

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Capt. J. F. Divine, assistant general superintendent of the Atlantic Coast Line Railroad, died at his home in Wilmington on August 21. Capt. Divine was one of the oldest members of the Master Car Builders' Association and until the last few years had been a very regular attendant. He was born in Scotland in 1830, being brought to this country when a small boy. He started his railroad service in 1851 by superintending the erection of a number of locomotives for the old Wilmington &

Raleigh Railroad, and has been connected with the same line, it now being part of the Atlantic Coast Lines, for 58 years continuously, with the exception of four years during the Civil War. He was for a number of years general superintendent and was relieved of a greater portion of his duties and made assistant general superintendent on account of declining health. His loss will be keenly felt by the older members of the M. C. B. Association.

## CATALOGS.

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

Flexible Transmission.—Bulletin No. 22, from the Coates Clipper Mfg. Company, Worcester Mass., describes the flexible shaft made by that company and illustrates a great variety of devices in connection with which it is used.

Facts Worth Knowing About Grinding Wheels.—This is the title of a booklet received from the Norton Company, Worcester, Mass. It contains much valuable material concerning the selection of the proper grade of wheels for various purposes; also as to the application and care of grinding wheels.

Metallic Packing.—The Morris metallic packing for stationary and marine engines, gas engines, steam locomotives, steam pumps, air and gas compressors is described in a leaflet from the H. W. Johns-Manville Company, 100 William St., New York City.

Drill Grinding.—The Cleveland Twist Drill Company, of Cleveland, Ohio, is sending out with its compliments a leaflet containing a reprint of shop operation sheets, which were issued with the June number of *Machinery*, and which show in a concise form the proper methods of grinding both flat and twist drills.

Anti-Leak Stick.—H. W. Johns-Manville Co., 100 William St., New York, is issuing a leaflet pointing out the value of a new compound, which is put up in stick form and is designed for permanently repairing leaks in all kinds of receptacles, roofs, chimneys, etc. It is not affected by hot or cold weather and can be used on any material for permanent repairs.

Steel Ore Cars. An attractive folder, designated as "Bulletin No. 10," has been received from The Summers Steel Car Company, Farmers Bank Building, Pittsburgh, Pa. It describes and considers the advantages of the Summers center dump ore car. Drawings and photos are shown of one of a lot of eight hundred cars built for the Duluth & Iron Range Railroad a few months ago.

Portable Electric Tools.—The S. Obermayer Co., 641 Evans St., Cincinnati, O., is issuing a most attractive catalog fully illustrating and describing a complete line of electric drills, hammers, grinders, etc., the electrical part of which is manufactured by the Cincinnati Electrical Tool Co. These portable machines are very highly developed and are shown in many different sizes and forms; the grinders, in particular, being arranged for many special jobs. The descriptive matter is most interesting.

Railway Specialties.—The General Railway Supply Company, 531 Marquette Bldg., Chicago, is issuing a new catalog in which are illustrated in a most excellent manner a number of very high grade devices for use on passenger cars. These include metallic (steel) sheathing; National steel trap door and lifting device; Schroyer friction curtain roller; Garland ventilator; Flexolith composition flooring; roller deck sash ratchet; Imperial car window curtain; Perfection sash balance and National standard roofing. All of these devices are thoroughly practical and each has features of special advantage.

Electric Trucks.—The American Locomotive Company is issuing Bulletin No. 1 from its electric locomotive and truck department, which illustrates and describes the new type S short wheel base electric motor trucks with steel plate side frames. In this booklet are also shown two new adjustable swing link devices, which are applicable to any trucks built by this company with swinging bolsters. One of these devices is arranged for adjusting the height of the car body and the other permits of the same adjustment and also the changing of the angularity of the swing links to suit service conditions and give the easiest riding qualities to the car.

Valves.—The Nelson Valve Company, Wyndmoor, Philadelphia, Pa., is issuing its 1909 catalog in the form of a 220-page, cloth bound book, printed on heavy coated paper and arranged in a very attractive style. The catalog is confined exclusively to valves and accessories and covers the field very fully. For convenience in reference it is divided into three sections, the first being on bronze valves in all styles; the second on iron body and steel valves and the third on accessories and fittings. In each case the type of valve under discussion is shown by a full page illustration and a table is included giving complete general dimensions of the different sizes. All valves manufactured by this company are carefully tested and inspected and are fully guaranteed. Valves of all sizes and for all purposes will be found in this book which includes a complete index

Blue Print Papers.—Keuffel & Esser Co., Hoboken, N. J., is issuing a circular on the subject of blue print papers. This company manufactures a number of grades of blue print paper, each being specially adapted for certain printing conditions, and in this leaflet will be found details giving sizes and prices of each kind

Railroad Hydraulic Tools.—Catalog No. 73 bearing the above title, has just been issued by the Watson-Stillman Company, of New York. This is a 120-page book describing a most complete line of hydraulic tools for steam and electric railway service, and includes a number of entirely new devices and machines. Among these are several new types of jacks; a series of hydro-pneumatic wheel presses, which are much quicker in operation than the older types; a motor driven forcing press of wide range; a new hydraulic coping machine and a hydraulic beam shear, both of which effect a large saving on work of this character. Illustrations have been liberally used throughout and specifications and prices are included with each machine.

"Joxyl."—An explanatory treatise is being issued by the American Joxyl Company, 30 Church St., New York City, which points out the application of this process for passenger car, station and similar uses. In using this process the surface of the panel, for instance of wood, either hard or soft, is first chemically treated, so as to open the pores, following which the design or color is applied with the result that it does not remain a coating on the surface but is transfused into the wood itself. Following this a chemical treatment is applied with the result that the pores of the wood are instantly closed far more tightly than is done by nature. The colors and designs are thus made permanent and the surface is rendered unusually hard and durable and capable of receiving the most brilliant polish. In other materials than wood the same results can be obtained by a slightly different process.

## NOTES

Chicago Car Heating Co.—Roswell P. Cooley, mechanical inspector of the Pullman Company, has resigned to accept a position with the Chicago Car Heating Co.

Curtis & Curtis Co.—A decided improvement in business is reported by this company, which is now running its plant at Bridgeport, Conn., to full capacity in all departments. It is announced that export as well as domestic orders are very large.

The S. Obermayer Company.—The fire at the Cincinnati plant of this company Saturday night, September 11th, damaged the warehouse but did not damage the various manufacturing departments. There was no interruption to the business and orders are being filled with the usual promptness and dispatch.

Standard Coupler Co.—Charles R. Jenks has been appointed western sales manager of the above company with office at 1207 Fisher Bldg., Chicago. Mr. Jenks has been connected with the Pressed Steel Car Co. for the past seven years, and previous to that time was for eight years in the traffic department of the Pennsylvania Railroad Company.

Grip Nut Co.—L. H. Raymond, formerly master mechanic on the New York Central Lines, has accepted the position of eastern representative of the above company. It is also announced that the grip nuts manufactured by this company are ordered to be applied on 1,800 box cars recently ordered from the Pullman Company for the Northern Pacific Railroad.

Philadelphia Bourse.—With others the following concerns have recently placed exhibits and offices in the exhibition and selling department of the Philadelphia Bourse: Brown & Sharpe Mfg. Co., Tools; August Mietz, New York, Gas and Oil Engines; De La Vergne Machine Co., New York, Gas and Oil Engines, Refrigerating and Ice Making Machinery; and Trenton Engine Co., Trenton, N. J., Steam and Gas Engines. Some changes are being made in this department, which make it most attractive, and everything is being done to obtain the very best possible results for the exhibitors.

Western Electric Company.—The Philadelphia & Reading Railroad have followed the Pennsylvania and the Erie, as well as other large roads, in adopting a new device for the transmission of routine messages, which permits the use of the telegraph lines for telephone connection simultaneously with the use of the same lines for telegraph transmission. These devices and the apparatus have been furnished by the above company and seven telephone, as well as three intermediate telegraph stations have been equipped. The apparatus is not designed for the dispatching of trains but is entirely for the handling of local routine communications.

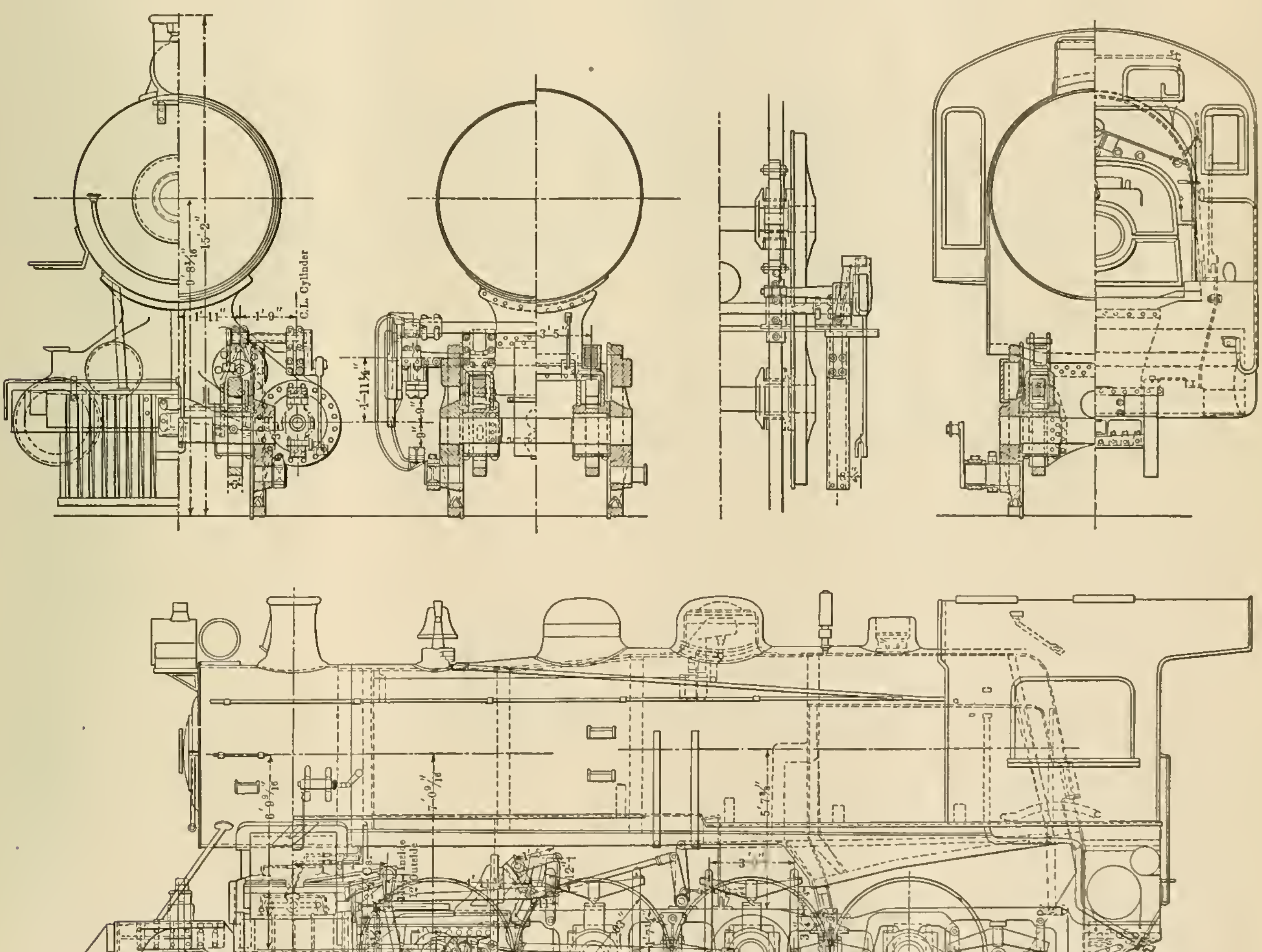
## WANTED.

# CONSOLIDATION LOCOMOTIVE WITH SUPERHEATER

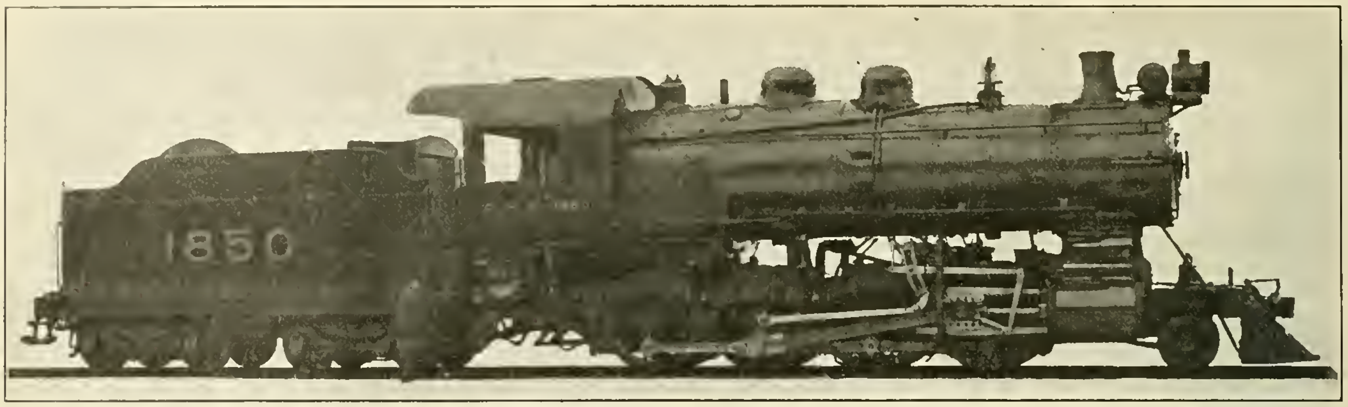
CANADIAN PACIFIC RAILWAY.

In the 1906 volume of this journal, more especially in the April and May numbers, will be found articles descriptive of the system of standardization of locomotive equipment, as well as a description of the standard locomotives and their parts, adopted by the Canadian Pacific Railway. In this classification the Class M4 is the standard consolidation locomotive and is, with a single exception, the most powerful class of locomotives on the road, being what is termed a 180 per cent. engine, the basis (100 per cent.) being 20,000 lbs. tractive effort at 80 per cent. of the boiler pressure. The locomotives of that class are 21 x 28 in. simple engines having 57 in. drivers and weighing 186,200 lbs., of which 163,700 lbs., or 87½ per cent., is on drivers. The boiler is of the extended wagon top type, 69 in. in diameter at the front end and carries a steam pressure of 200 lbs. All of these locomotives have superheaters and in some of the later ones the steam pressure is reduced to 180 lbs. and the cylinders enlarged to 22½ x 28 in.

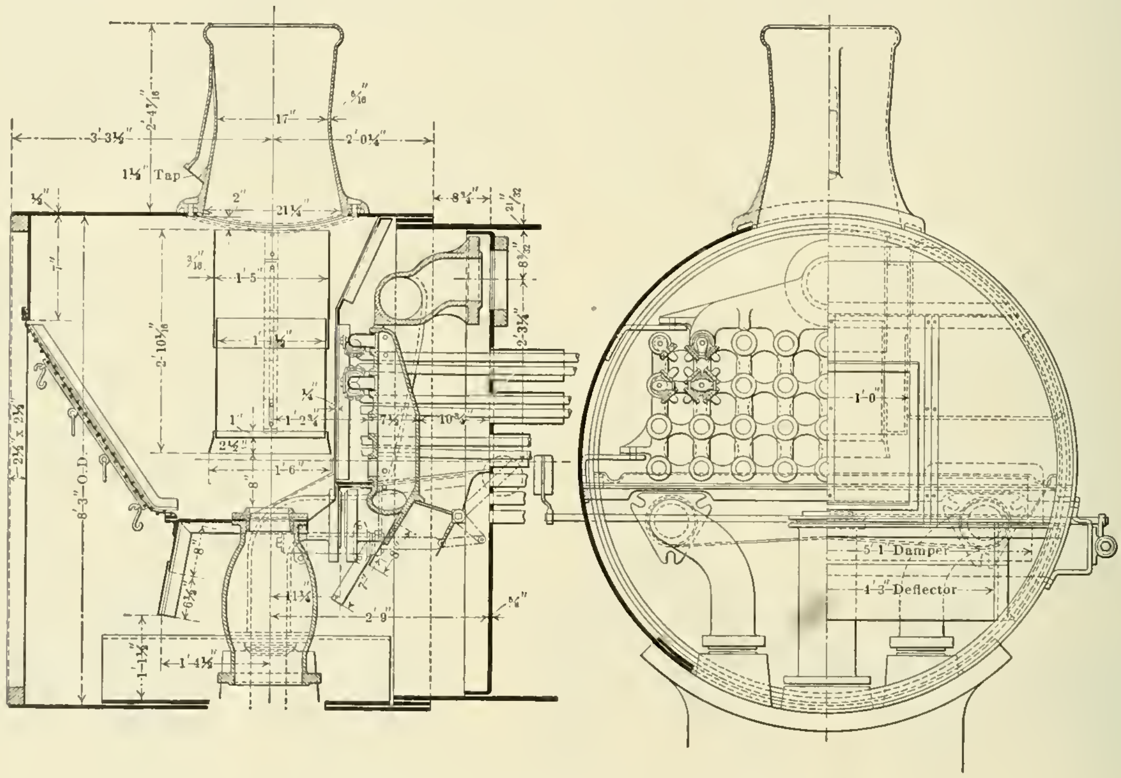
The traffic now demands a more powerful type of locomotive and an entirely new design of consolidation engine, which is known as class N3, has been developed. While, of course, a large number of the former standard parts are used in this design it is, in the main, an entirely new arrangement. It is a 210 per cent. engine and has a tractive effort of 42,500 lbs. The total weight is 220,000 lbs. and 195,000 lbs., or 88.6 per cent. is on drivers. The cylinders are very large, being 24 x 32 in., and a boiler pressure of 180 lbs. with a Vaughan-Horsey superheater, having 450 sq. ft. of heating surface, is employed. The drivers have been enlarged to 63 in. and the boiler has an evaporative heating surface of 2,811 sq. ft. as compared with 2,381 in the class M4. An examination of the ratios shows that while the



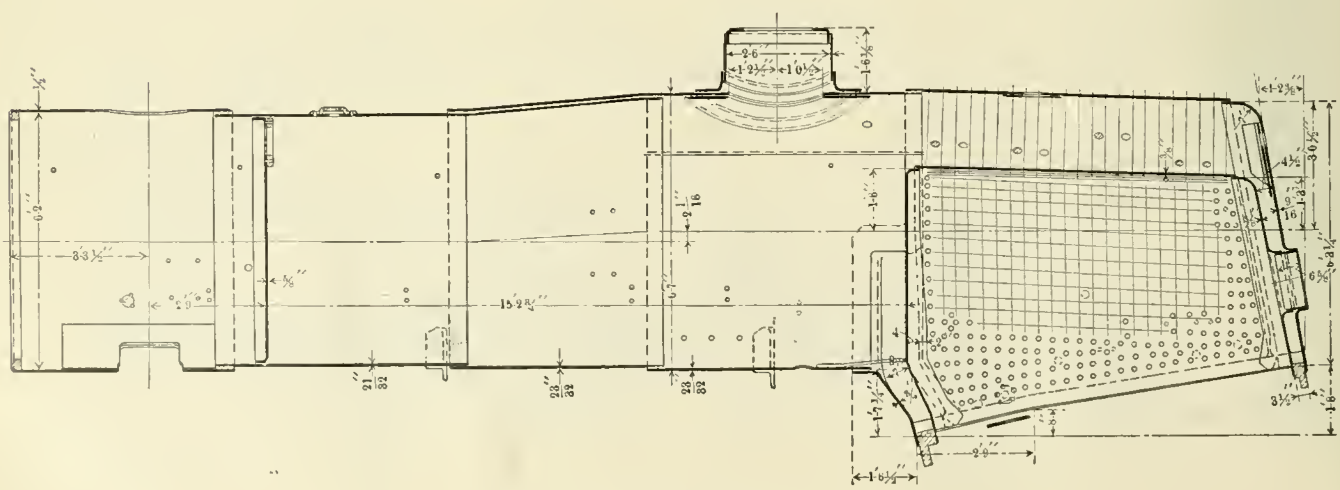

SIDE ELEVATION AND CROSS-SECTIONS OF CONSOLIDATION LOCOMOTIVE—CANADIAN PACIFIC RAILWAY.



CONSOLIDATION LOCOMOTIVE—CANADIAN PACIFIC RAILWAY.




SMOKE BOX AND SUPERHEATER ARRANGEMENT.



LONGITUDINAL SECTION THROUGH BOILER.

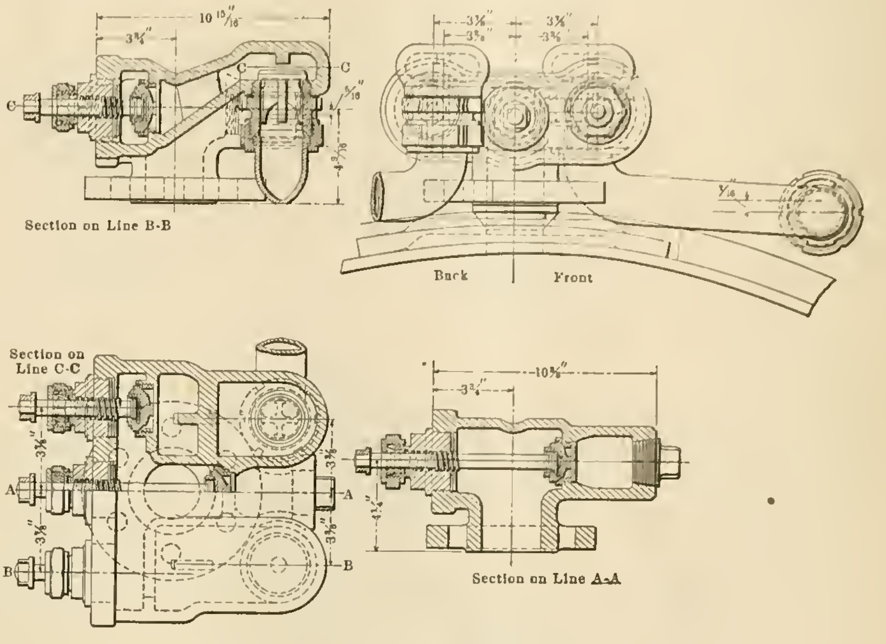
evaporative heating surface has kept pace with the increase in the weight of the locomotive, as compared with the class M4, the increase in the size of the drivers has affected the B D factor very materially, giving a figure of 1,003, as compared with 880. When the B D factor is determined by the use of an equivalent heating surface, the derivation of which will be explained later, it is found that it has a value of 815 as compared with 714 for the class M4.

In general the locomotive will be seen to be a normally conservative design arranged in many particulars to suit the special conditions under which it is to be operated. An electric headlight on a heavy freight locomotive is somewhat unusual, as is also the location of the air reservoir. The different parts of the locomotive will be considered separately, beginning with the boiler.

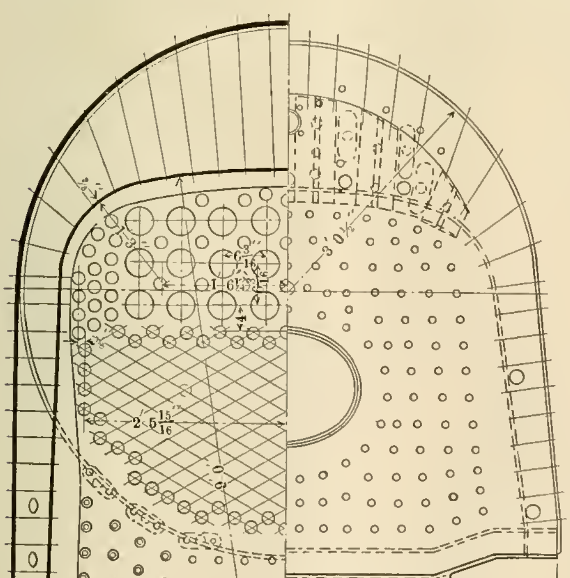
*Boiler.*—A radial stay, extended wagon top type of boiler having a firebox of large volume, with an inclined grate of 49 sq. ft. area, has been applied. Its largest diameter is 79 in. and the smallest 72 in. The throat is but 19¼ in. in depth and the level of the back mudring is slightly above the bottom of the barrel of the boiler, the grate inclining 20 in. in a length of 9 ft. 2¾ in.

One of the most noticeable features is found in the use of curves of very large radii at the corners of the mudring, which are gradually decreased toward the top portion of the firebox. The side sheets are both slightly inclined inward from the mud-ring, which is 4½ in. wide on the side; the distance between the side sheets is increased by 1 in. at the turn of the crown. Both the side and crown sheets and the roof are in one piece.

The location of the tubes, which includes 24 5-in. and 272 2-in., the former being arranged in three rows of eight each for the superheater elements, is shown in one of the illustrations. The heating surface of the fire tubes is 2,631 sq. ft., which, in connection with 180 sq. ft. in the firebox, gives 2,811 sq. ft. of evaporative heating surface. It has been found, however, that, in comparing a superheater engine with one using saturated steam, to get an equivalent heating surface in the latter it is necessary to multiply the superheating surface by 1.5, which should be added to the total heating surface of the engine as obtained in the ordinary manner. In this case this would show that a boiler of the same capacity as the one applied, if it was not fitted with a superheater, would require 3,486 sq. ft. of heating surface, or a ratio of one square foot to 55.9 lbs. on drivers, which is certainly a guarantee of ample steam capacity.




ARRANGEMENT OF CHECK VALVES AND SYPHON COCK.

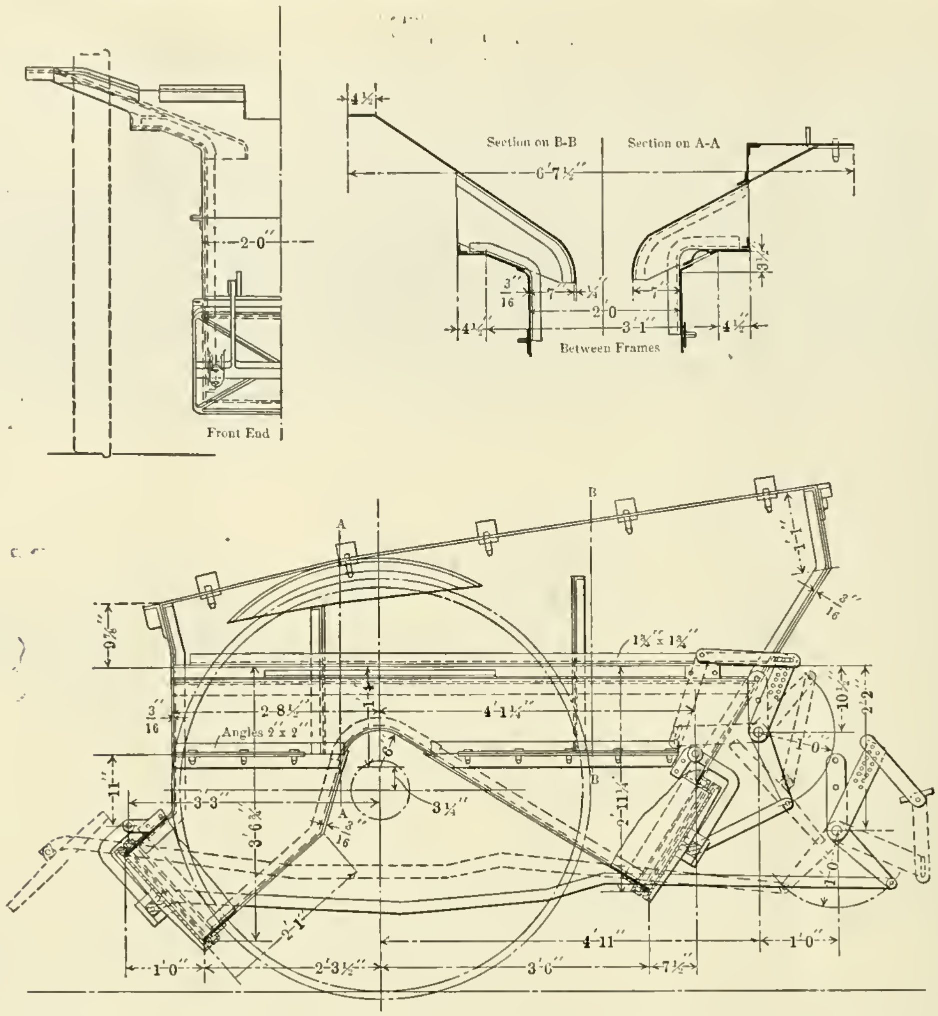



HALF SECTION THROUGH FIREBOX AND HALF END VIEW OF BOILER.

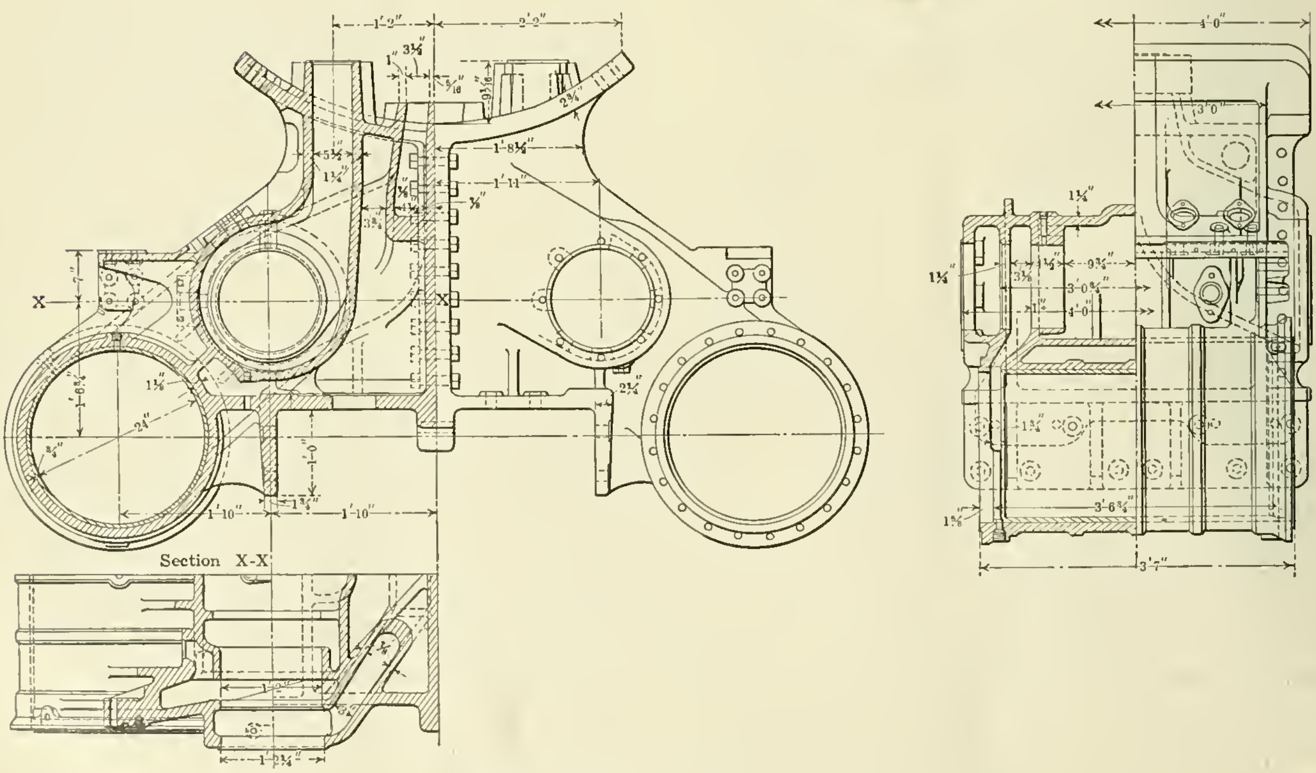
*Front End Arrangement.*—A section through the front end and superheater is given in one of the illustrations. This type of superheater was very fully described on page 41 of the February, 1906, issue of this journal, and has proven to be most satisfactory in every way, after a number of years of trial. It is now the standard type on the Canadian Pacific Railway, where a larger number of superheaters are in operation than on any American railroad. The introduction of the superheater requires the front tube sheet to be set back 2 ft. 9 in. from the center line of the stack and also the introduction of a special arrangement of diaphragm plates and a damper for cutting off the circulation to the large fire tubes when the engine is not using steam. The arrangement includes a comparatively low exhaust nozzle and long petticoat pipe in two sections. The stack has no internal extension. The presence of two adjustable deflectors admits of an accurate equalization of the draft. The petticoat pipe is arranged to be easily removed to permit access to the superheater elements behind it.

*Check Valve.*—The check valve is located on the top center line of the boiler, underneath the base of the bell stand. It consists of a double check arrangement, there being one check valve for either feed pipe, the passages from which are combined and enter the boiler through one opening. Each check valve passage is provided with a stop valve, which can be closed to permit the check to be reground when the boiler is under steam. A valve in the center of the casting closes the passage to a chamber in which there is a connection for a pipe or hose for either blowing down or filling up the boiler. All of these valves are provided with renewable seats. This arrangement of checks on top of the boiler gives a non-freezing discharge pipe from the injector to the checks and any leakage at the checks will drain back to the injector.

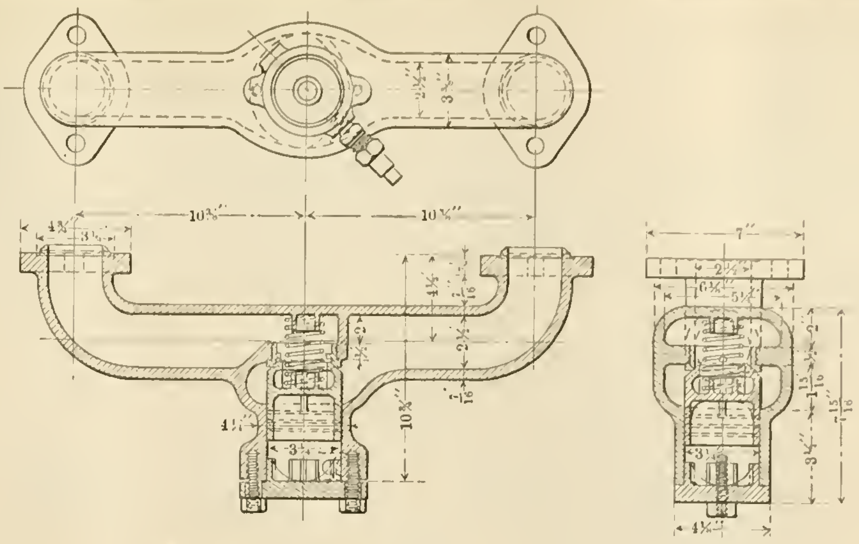
*Ash Pans.*—An exceptionally novel and interesting design of ash pan is used. It is of the self-clearing type, having two hoppers, and really consists of two separate parts, the hoppers and




UNIQUE DESIGN OF SELF-CLEANING ASH PAN.



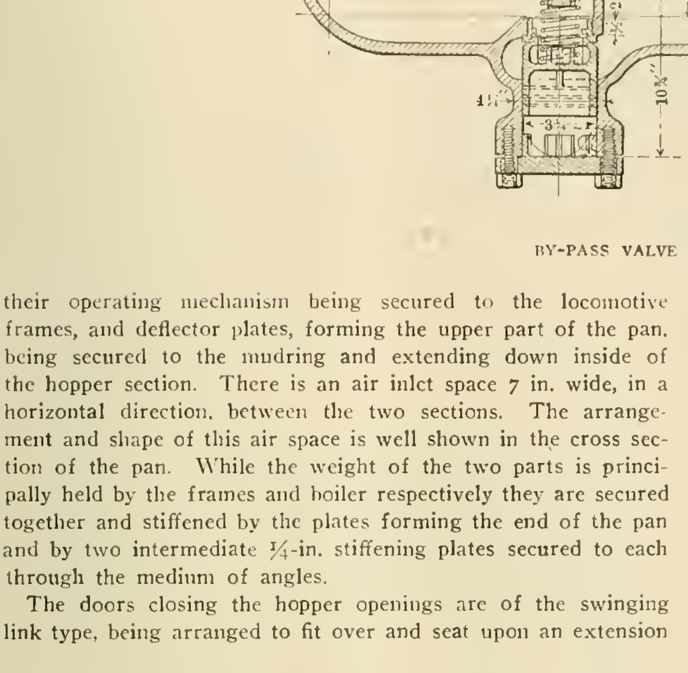

CYLINDERS OF THE CONSOLIDATION LOCOMOTIVE.



BY-PASS VALVE ARRANGEMENT.

their operating mechanism being secured to the locomotive frames, and deflector plates, forming the upper part of the pan, being secured to the mudring and extending down inside of the hopper section. There is an air inlet space 7 in. wide, in a horizontal direction, between the two sections. The arrangement and shape of this air space is well shown in the cross section of the pan. While the weight of the two parts is principally held by the frames and boiler respectively they are secured together and stiffened by the plates forming the end of the pan and by two intermediate ¼-in. stiffening plates secured to each through the medium of angles.

The doors closing the hopper openings are of the swinging link type, being arranged to fit over and seat upon an extension of the hopper frame. The swinging link is so designed that the first movement of the doors is directly outward to clear this flange and then swing upward, as is shown by the dotted lines in the illustration. The operating mechanism is arranged so that the doors may be securely locked or held open at any desired point. This design of pan gives unusually large openings for air, which is well diffused before reaching the grates, and at the same time it acts as a perfect protection against fire being blown out of the pan or otherwise escaping.



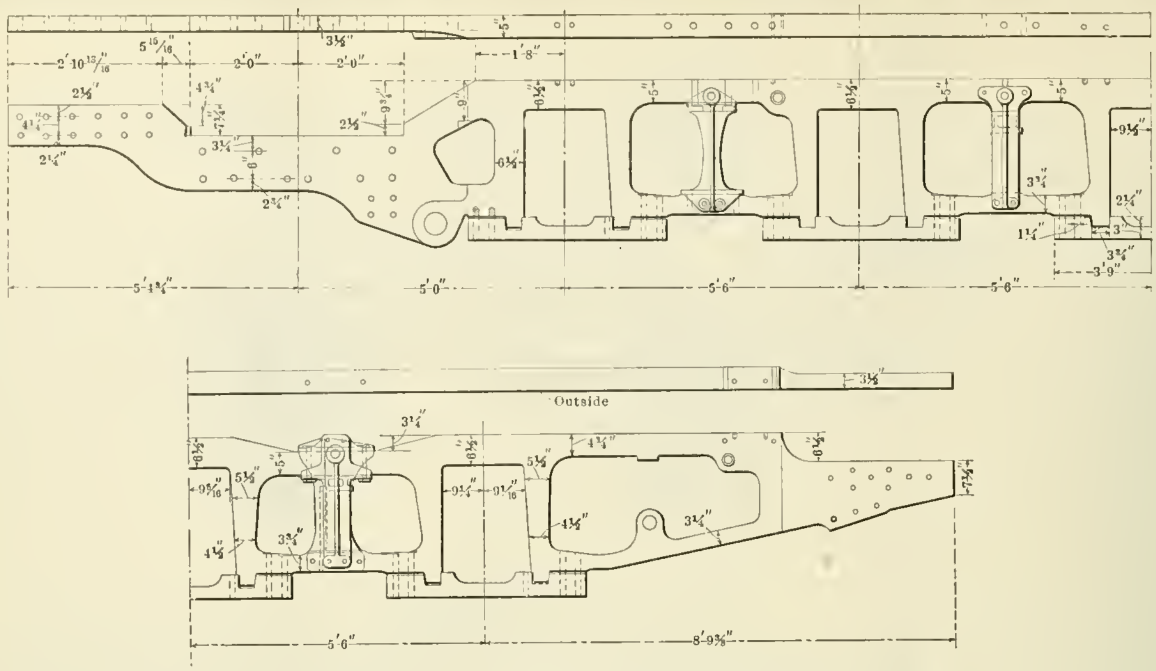
FRAME CROSS-TIE AT CYLINDERS.

*Cylinders.*—In the design of the cylinders every opportunity has been taken for the reduction of weight where it could be done without sacrificing strength or steam economy. The 12-in. valve chambers have been set inside of the cylinders almost directly over the frames and in the line of the steam passage to the cylinders. This location of the valve has made necessary an alteration of the design of Walschaert valve gear previously standard on this road, which will be mentioned later. The cylinders have a ¾-in. bushing, and ports for the application of a by-pass valve arrangement somewhat similar to the Sheedy type, which has been in use on this road for some years, are provided. An excellent arrangement is noticed in connection with the fastening of the cylinders to the frames, consisting of two steel castings secured underneath the cylinder proper and inside of the frames, forming between them the bearing for the fulcrum pin of the front truck equalizer. This makes a solid mass across from frame to frame beneath the cylinders and puts no strain on the bolts fastening the cylinder flanges together at the center. It also gives a fulcrum pin bearing of great strength, which is entirely independent of the cylinder casting. The design of these cross-ties is shown in one of the illustrations.

A by-pass valve arrangement, as shown in the illustration, is fitted to the cylinders and covered by the cylinder jacket. The two openings in the cylinder casting are the terminations of passages from the steam ports and connect to the by-pass valve casting with ground joints. In the center of this casting is a valve with a renewable seat, which is held open by a coiled spring. The valve is closed by the pressure of steam in the chamber behind it, in which it has a steam tight fit. This chamber is connected by a small pipe to the center steam passage in the valve chamber, so that when the throttle is open the by-pass valve is closed and communication between the two ends of the cylinder is prevented. When steam is shut off, however, the valve is held open by the spring and air is permitted to freely circulate from one end of the cylinder to the other.

*Valve Gear.*—Because of the difference in the location of the valve chamber in this design the valve gear differs somewhat from the one illustrated on page 16 of the January, 1908, issue of this journal, although it is designed on the same general principles. Reference to that description will show that, in that case, the valve was located directly over the cylinder, the whole weight of the forward part of the gear being supported by a bracket, forming part of the back steam chest cover, carrying a rocker to which is secured the combination lever and a block working vertically in a crosshead fastened to the valve stem, which sets in guides, also forming part of the steam chest head. The idea of this arrangement is to relieve the valve stem of all stresses from the weight of the other parts of the valve gear.

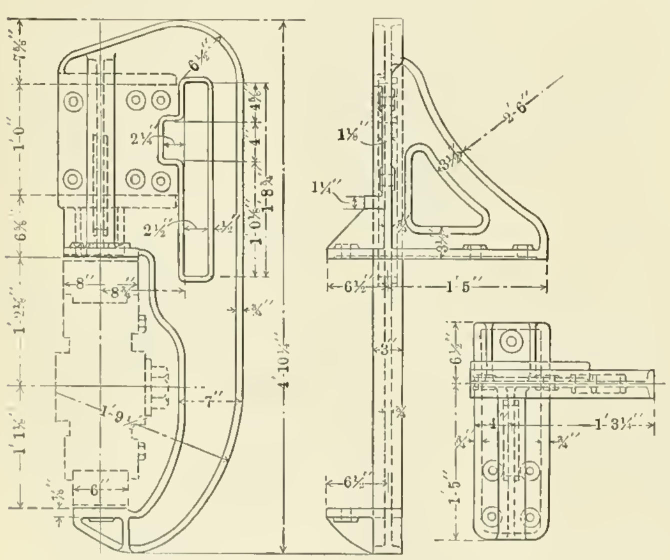
In the present design the same idea has been followed by connecting the combination lever to the outer arm of a rock shaft, the inner arm of which carries a small crosshead working in guides, forming part of the valve stem. The valve stem itself is extended backward and carried in a guide secured on top of the frames. The rock shaft is supported by most substantial bearings; the outer one, of very rigid design, is secured to the




FRAME OF CONSOLIDATION LOCOMOTIVE.

cylinder casting directly above the cylinder and the inner one is part of the valve chamber head. The bearings are both inside the arms of the rocker. In this manner the valve stem is relieved of the duty of carrying the weight of any part of the gear and is held in perfect alignment. The other features of the valve gear are practically the same as was shown in the article above mentioned. The design and method of supporting the link is of particular interest.

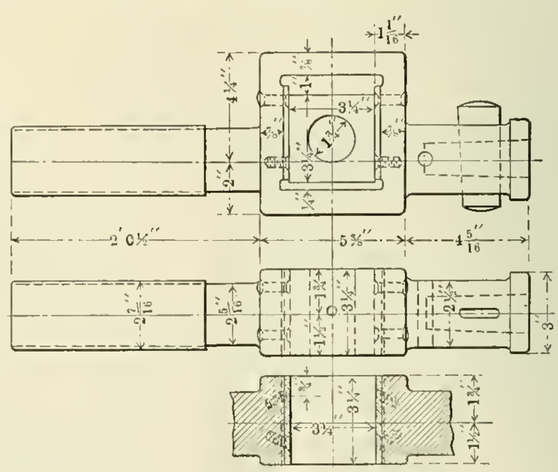
*Guide Yoke.*—The guide yoke is of the built-up type comprising a 1¾ x 12-in. wrought iron plate, supported across the frames by very substantial cast steel knees located in the rear of the yoke and including in the same casting the inner bearing for the link shaft. These knees are most securely bolted to the plate, having a lip over the top and a very liberal bearing and secure fastening to the top of the frames. At the outer end of the cross plate are secured large cast steel carriers for the guides, the details of which are shown in one of the drawings. These are of I-beam section throughout and include brackets for carrying the guides, the upper one being nearly 2 ft. in length and carrying the guide by three 1¼-in. bolts. These yokes were most carefully designed to obtain the required strength and rigidity with a minimum weight and are cut out for clearance of the radius bar. The plate is set in a recess in these castings and secured to each by six 1⅛-in. bolts



CAST STEEL CARRIERS FOR THE GUIDES.

From the guide yoke are also carried the outer bearing of the link shaft and the bearings for the lift shaft, these being separate castings of steel, which were specially designed to combine the maximum rigidity with minimum weight. They are carried on the back of the cross plate by four 1⅛-in. bolts. Each has a lip over the top of the plate and a bearing for the full depth of 12 in.

*Frames.*—One casting, 35 ft. 8⅛ in. long, forms each of the frames. The main section is 5 in. thick and has a depth of 6½ in. at the pedestal. The forward section passing below the cylinders, however, is but 3½ in. wide, the inside edge being in alignment with the main frame. The section below the cylinders is 12 in. in depth at the narrowest point. The pedestal binders are of the clip type, being held by two 1¼-in. bolts at either end. The design throughout is simple and straightforward, requiring comparatively few departures from straight line work on the slotter.

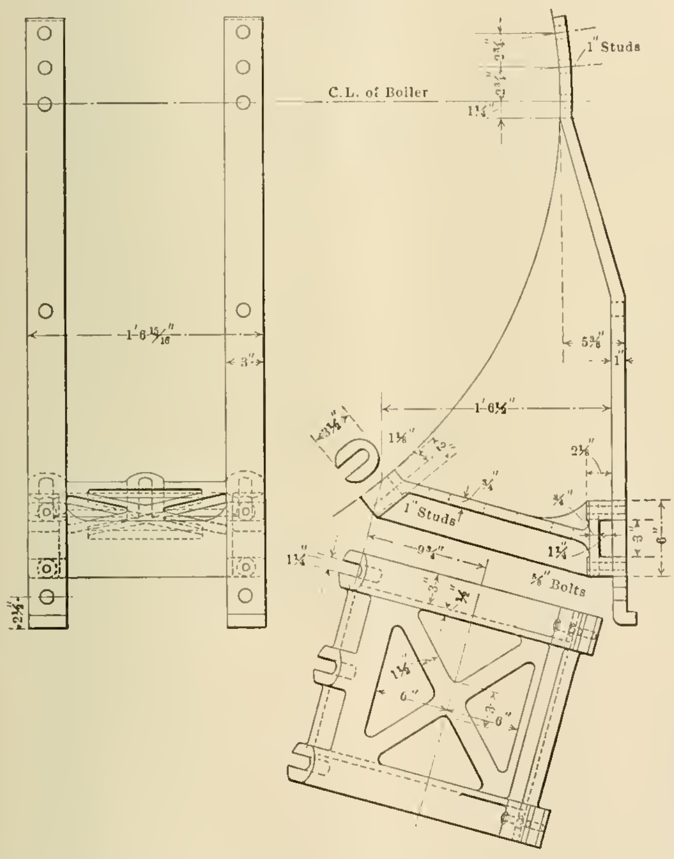


VALVE ROD EXTENSION.

*Bumper Beam.*—Three steel castings with a 15-in. channel form the bumper beam and center pin bearing. The casting between the frames, which forms the guide for the truck pin, is similar to that which was commonly used when cast iron was the only material available. It is deeply ribbed and securely fastened between the frames, but has no connection to the cylinder casting. In addition to this there are two castings on the outside of the frames, of deeply ribbed section, forming the wings of the bumper beam. These three castings are secured together by a 15-in., 40-lb., channel, which forms a tension member in case of any cornering strains on the end of the bumper beam. This makes a very strong arrangement, but also one which, in case of accident, permits part of the beam to be replaced without disturbing the remainder. The frames are terminated 10¾ in. from the face of the beam, the castings being lipped over the ends of the frames. The whole beam is covered with a ¼-in. plate, which is cut away where necessary and has a hinged section on each side to permit the removal of the pistons.

*Driving Boxes.*—The driving boxes have brasses 14 in. in length, the axles being 9½ in. in diameter except the main, which is 10 in. The boxes are set 1 in. out of line with the center of the frames, toward the inside, the spring rigging being arranged to be central over the box. This gives a longer bearing area than would otherwise be possible and introduces no particular complications.

The spring rigging is of the customary type, having the front pair of wheels equalized with the front truck




BRACKET FOR AIR PUMP.

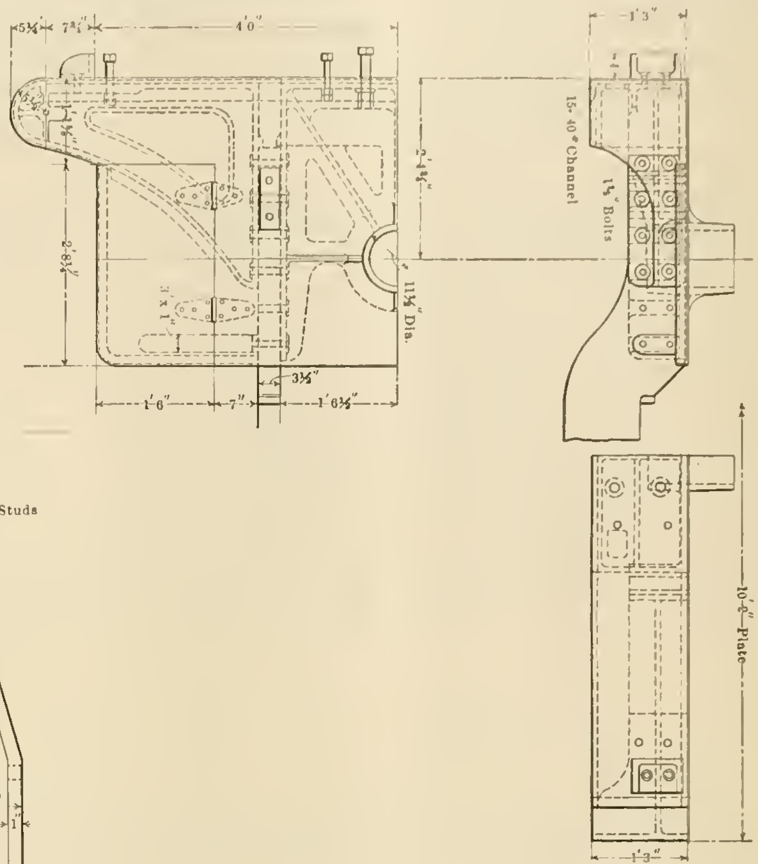
and the remaining three on either side being equalized together.

*Air Pump Bracket.*—A new design of air pump bracket is found on this locomotive, which is considerably lighter and fully equal in strength to the designs commonly in use. It consists of two 1 x 3-in. wrought iron straps, each secured by three 1-in. studs to the boiler shell at the top, and held in position at the bottom by a cast iron bracket extending out from the boiler and secured to each of the straps by two ⅝-in. bolts. The air pump is bolted directly to the vertical hangers, which are lipped over on the bottom. The illustration clearly shows the details of this bracket.

The general dimensions, weights and ratios of this locomotive, which was designed in the mechanical engineer's office under the supervision of H. H. Vaughan, assistant to the vice-president, are as follows:

GENERAL DATA.

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Service | Freight and Passenger |
| Fuel | Bit. Coal |
| Tractive effort | 44,760 lbs. |
| Weight in working order | 220,000 lbs. |
| Weight on drivers | 195,000 lbs. |




BUMPER BEAM.

| | |
|---|---|
| Weight on leading truck | 25,000 lbs. |
| Weight of engine and tender in working order | 354,000 lbs. |
| Wheel base, driving | 16 ft. 6 in |
| Wheel base, total | 25 ft. 5 in. |
| Wheel base, engine and tender | 55 ft. 7⅞ in. |

RATIOS.

| | |
|---|---|
| Weight on drivers ÷ tractive effort | 4.36 |
| Total weight ÷ tractive effort | 4.92 |
| Tractive effort × diam. drivers ÷ heating surface | 1003.00 |
| Total heating surface ÷ grate area | 57.35 |
| Firebox heating surface ÷ total heating surface | 6.40 |
| Weight on drivers ÷ total heating surface | 69.4 |
| Total weight ÷ total heating surface | 78.8 |
| Volume both cylinders, cu. ft | 16.75 |
| Total heating surface ÷ vol. cylinders | 168.00 |
| Grate area ÷ vol. cylinders | 2.98 |

CYLINDERS.

| | |
|---|---|
| Kind | Simple |
| Diameter and stroke | 24 x 32 |

VALVES.

| | |
|---|---|
| Kind | Piston |
| Diameter | 12 in. |
| Greatest travel | 6 in. |
| Outside lap | 1 in. |
| Inside clearance | Line and line |
| Lead in full gear | ¼ in. |

WHEELS.

| | |
|---|---|
| Driving, diameter over tires | 63 in. |
| Driving, thickness of tires | 3½ in. |
| Driving journals, main, diameter and length | 10 x 14 in. |
| Driving journals, others, diameter and length | 9½ x 14 in. |
| Engine truck wheels, diameter | 31 in. |
| Engine truck, journals | 6 x 10 in. |

BOILER.

| | |
|---|---|
| Style | E. W. T. |
| Working pressure | 180 lbs. |
| Outside diameter of first ring | 72 in. |
| Firebox, length and width | 101⅛ x 69¾ in. |
| Firebox plates, thickness, crown and sides | ⅜, Tube ½, and Back ⅜ in. |
| Firebox, water space | F. 6, S. 4½, B. 3½ in. |
| Tubes, number and outside diameter | 24—5 in. |
| Tubes, number and outside diameter | 272—2 in. |

| | |
|---|---|
| Tubes, length | 15 ft. 2¾ in. |
| Heating surface, tubes | 2,631 sq. ft. |
| Heating surface, firebox | 180 sq. ft. |
| Heating surface, total | 2,811 sq. ft. |
| Superheater heating surface | 450 sq. ft. |
| Grate area | 49 sq. ft. |
| Smokestack, diameter | 17 in. |
| Smokestack, height above rail | 15 ft. 2 in. |
| Center of boiler above rail | 9 ft. 8 1/16 in. |

TENDER.

| | |
|---|---|
| Weight | 134,000 lbs. |
| Wheels, diameter | 34 in. |
| Journals, diameter and length | 5½ x 10 in. |
| Water capacity | 5,000 gals. |
| Coal capacity | 10 tons |

## LOCOMOTIVE FIREBOX REPAIRS

Cecil Lightfoot.

Among the most recent developments in the application of the oxy-acetylene blowpipe is its use in repairs to locomotive fireboxes. As a substitute for chain riveting or stud patching in the repair of cracks, the oxy-acetylene welding process is admirably adapted and it is now being employed by a number of railway companies for work of this kind with the greatest success. In cases of a simple or isolated crack, the defective part is first cut or drilled out and the surrounding surface cleaned; the cavity is then filled with a mild steel wire, such as Norway iron. For work of this nature, it is necessary that the sides of the cavity be in a thoroughly molten condition at the point where the welding is being done.

Oxy-acetylene welding must be regarded as a trade which can only be mastered by intelligent work and gradual development from simple to difficult jobs. Much depends not only on the intelligence and ability of the workman, but also on the use of blowpipes and apparatus of the best quality and of established reputation. It should be borne in mind, moreover, that notwithstanding the excellent results which are being daily obtained with this method of welding the process has its limitations. This is more particularly the case with overworked steel in an old furnace. This, as is well known, becomes highly brittle and it cannot be welded unless carefully annealed first. A large number or nests of cracks indicate this condition of the plate or show it to have been originally of bad quality. In such cases, it is desirable not to undertake welding repairs of any kind.

As an example of what is now being done, the following description of some recent repairs may be of interest:

A patch was welded on the outside end sheet of a firebox (Fig. 1). The damaged part of the plate was removed by cutting out one line of staybolts (8 in number), and the bolts in the mudring. A new piece of plate was cut and fitted, the staybolts being replaced; only two of the bolts in the mudring were replaced or just enough to hold the plate in position while welding. The old and the new plates were then welded together in 2 hours and 3 minutes, with a consumption of 59 cubic feet of oxygen, the weld being 51 in. long and ⅜ in. thick. The plates were not preheated, but the two bolts in the mudring were removed as soon as the weld was finished so as to release the patch from any strain due to contraction in the cooling of the weld. Including labor the total cost of welding in this patch was about $3.50.

A patch was welded on the inside side plate of the same firebox. The dimensions of this patch are shown in Fig. 2. In this case the patch was removed by the cutting blowpipe in 12 minutes (The thickness of the plate was 5/16 inch and total length of cut 7 ft. 2 in.), with a consumption of 11 cubic feet of oxygen. The new patch was prepared and held in position by means of the staybolts marked with an X, the other staybolts being left out until after the weld was finished. To allow for contraction, the plate was dished to the extent of ⅝ in., so that as the weld cooled off and contracted the plate straightened itself out. This was helped a little by having three loose bolts placed through the patch and outer sheet where the staybolts had been removed, these bolts being tightened up as the weld cooled off. After the weld was completed, the plate was found to be quite flat. The remaining staybolts were then screwed into place. The time for this weld was 2 hours and 17 minutes—oxygen consumption 50 cubic feet. Including labor the total cost of making the patch was about $3.75, including the cost of cutting out.

A cast steel bolster, cracked across the top section, was repaired. This crack was ⅝ in. deep and 11½ in. long. The bolster was preheated to a dull red heat, after the crack had been chipped out to an angle of 90 degrees, and was then welded up in 23 minutes with a consumption of 25 cubic feet of oxygen. The position of this crack is shown in Fig. 3. Total cost about $1.00.

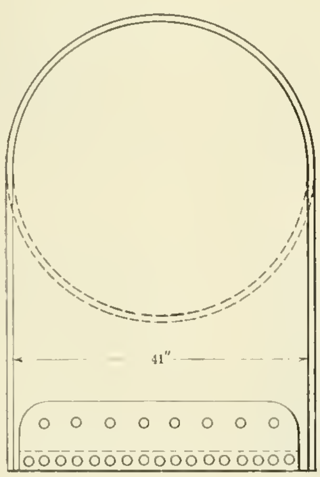



FIG. 1

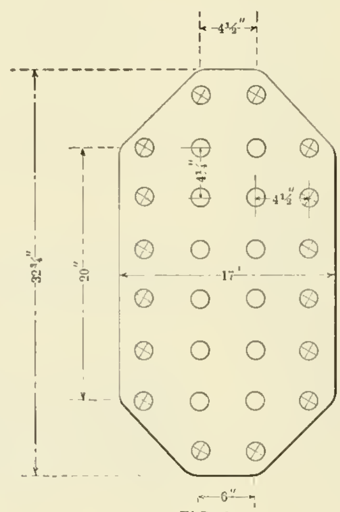



FIG. 2

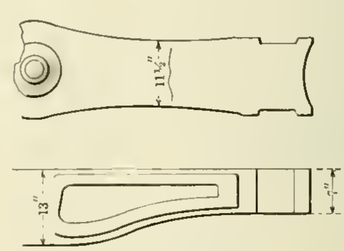


FIG. 3

The bottom half of a smokebox of an engine, which had been run into by some freight cars, was removed. The plate and the ring were doubled back towards the front flue sheet. The ring, 2¼ x 2¼ in., was first cut in two places in 4½ minutes, with a consumption of 5 cubic feet of oxygen. The rest of the damaged plate, ⅜ in. thick, was cut out in pieces, the total length of cut being 8 ft. 1 in., of which 12¼ in. was double plate. The actual cutting time was 32½ minutes with a consumption of 47 cubic feet of oxygen. Total cost about $2.25.

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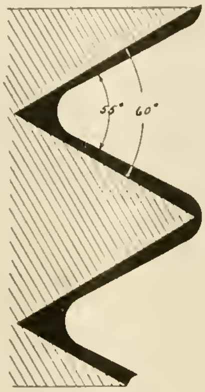
In 1908 there were 1,252 street railways in the United States owning 89,216 cars and with a capital stock of $2,444,892,057, or an increase of $193,466,175 over 1907. The mileage was 40,247 as compared to 38,812 for 1907.

## TEST OF STAYBOLT THREADS.

C. J. MORRISON.

The V thread was generally used on staybolts for many years, but recently the Whitworth thread has been attracting considerable attention. The difference between the Whitworth and the V threads is that with the former the threads at the root and the tap are finished to a slight radius, as is shown in the illustration, consequently the depth of the thread is less and the minimum diameter of the bolt is proportionately increased; also the angle of the Whitworth thread is 55 degrees, while that of the V thread is 60 degrees. The illustration shows a section




ILLUSTRATING DIFFERENCE BETWEEN V AND WHITWORTH THREADS.

through one side of a hole tapped out with Whitworth and V threads, the additional metal tapped out for the V thread being indicated by the heavy black portion.

In order to ascertain the relative strength and life of staybolts with the two types of threads careful tests were made, and the following results obtained:

BOILER STAYBOLT TEST.

| Thread. | Dia. of bolt. | Area in inches. | Breaking strain in lbs. | Strain per sq. in. | Original length. | Per cent. of elongation in length of section. |
|---|---|---|---|---|---|---|
| Sharp "V" | .880 | .608 | 32, 1 | 52,870 | 8" | 20.5 |
| | .881 | .610 | 32,910 | 53,960 | 8" | 15.7 |
| | .879 | .607 | 31,140 | 51,310 | 8" | 19. |
| Average..... | .............. | .............. | 32,063 | 52,713 | 8" | 18.4 |
| Whitworth | .882 | .611 | 33,060 | 54.120 | 8" | 27.5 |
| | .889 | .621 | 33,040 | 53.210 | 8" | 27.75 |
| | .887 | .618 | 33,080 | 53 540 | 8" | 27.25 |
| Average..... | .............. | .............. | 33,060 | 53,623 | 8" | 27.50 |

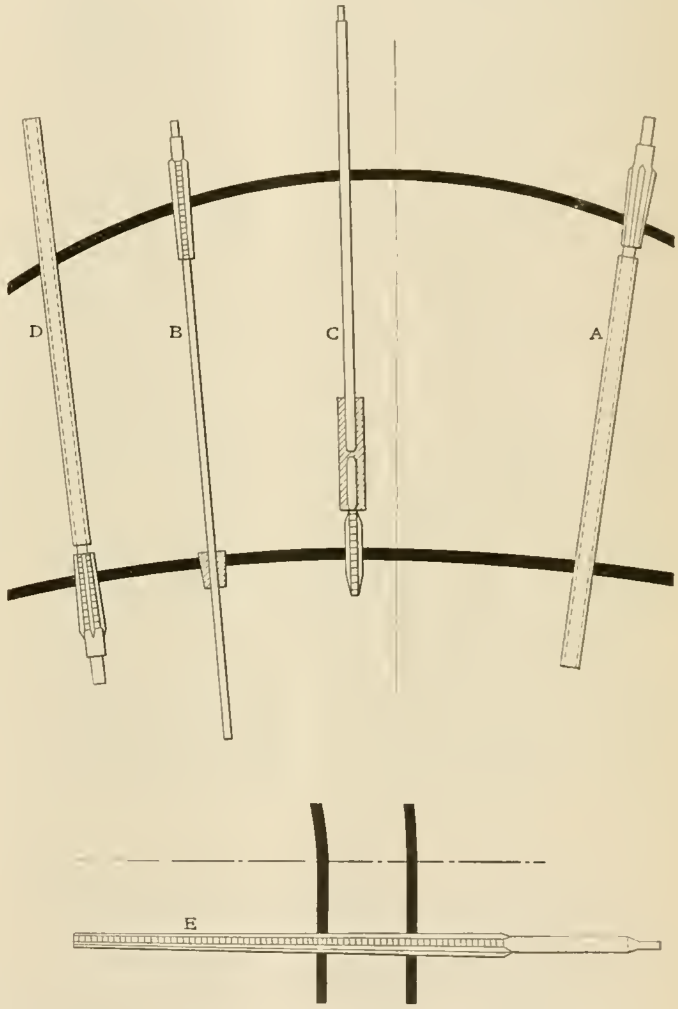
Vibration and bending tests were also conducted. In the vibration test, each bolt was screwed and riveted in a half-inch steel sheet in the same manner as staybolts are fastened in boilers. Each bolt was given a vibration of 3/8-inch; the average number of vibrations withstood by the V thread was 1485, while the average for the Whitworth was 3437. In the second series of tests each bolt was given 10,500 vibrations through 3/16 inch and then vibrated through 3/8 inch to destruction. The V threads averaged only 791 vibrations, while the Whitworth failed at 1932. One very noticeable feature of the tests was that the Whitworth thread bolts hold much tighter in the sheet than the V thread and also showed no tendency to cut into the sheet. Bending tests were also made, and in these the V thread failed when bent over a 3-inch circle, while the Whitworth withstood a bend over a 2-inch circle, but failed at 1⅞ inch.

These tests show the theoretical superiority of the Whitworth thread, while the practical superiority has been demonstrated by the great decrease in broken staybolts on several roads which have adopted the Whitworth thread as standard.

After the adoption of a standard thread, it became necessary to devise a cheap and accurate method of tapping. Many contend that taps and staybolts with continuous threads are necessary, but practical demonstrations have shown the weakness of their arguments. It is a very easy matter to get threads 1/24 out of being continuous, which is the worst they could possibly be when not continuous. It is also exceedingly difficult to get the taps for long radial staybolt work continuous. If the tap is out .008 inch in hardening, which often occurs in a tap of that length, and the lead screw on the lathe is out the same amount, it is readily seen that the threads in the wagon top and crown sheet, after the holes have been tapped and the stays screwed in, are no more liable to be in line than had the holes been tapped with separate taps. A simple, cheap and accurate method of tapping these holes is shown in the illustration, and explained as follows:

A shows the reamer which is used for reaming the outside sheet.

B is a spindle tap in position tapping outside hole. The practice is to provide the boilermaker with two sets of taps. One




TAPPING HOLES IN A LOCOMOTIVE BOILER.

tap is run through the hole, and while a boy inside the boiler passes the tap out, the boilermaker starts in another hole.

C shows the extension socket which runs the same tap through the crown sheet.

D is the taper tap with which the hole in the crown sheet is finished.

E is regular side sheet staybolt tap.

This method has been in use for several years and has proved to be very satisfactory.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, secretary of this association, advises that the annual convention will be held at the Planters' Hotel, St. Louis, Mo., on May 16, 17 and 18, 1910.

# DOUBLE OPEN DIAGONAL TRUSS FOR STEEL PASSENGER CARS.

## ON FOUR POINTS OF SUPPORT, AND WITH EQUAL OVERHANGING ENDS.

### ANALYTICAL AND GRAPHICAL ANALYSIS.

Arthur E. Heffelfinger.*

Believing that this detailed analysis will be found to be of greater value to the designer of steel passenger equipment, I have selected a common form of truss for a sixty-foot baggage car (having two doors in each side, and double body bolsters) as a good practical example.

It is obvious that the same solution is applicable to passenger cars with center doors, etc.; also that the principle involved is distinct from that employed in steel frame box car design where the bending moments in the top and bottom chords are resisted by some other continuous members, mainly the center sills, through cross-bearers.

The present designing of passenger equipment is so largely governed by the demand for a decreasing dead load per unit or passenger, also, greater facilities for exit, that, in the first place, increased length of structure is required, and secondly, larger and more openings in the side of car. The problem, then, becomes more involved, and with it there seems to come more or less conjecture as to the most economical method of distributing the stresses around the open panels or doors. Some engineers advocate side sills of uniform strength; others, a very complex system of bracing around the door, and still others remain loyal to the old truss-rod system. The last would seem rather superfluous when applied to a steel structure, except, perhaps, as a means to approximate a factor of safety against the uncertain stresses set up by oscillation.

Of course, these various systems depend more or less arbitrarily on the viewpoint, which is logical enough, when one considers how largely car construction is governed by practical considerations.

It is obvious, then, that the following analysis can only be of value as a demonstration of the solution of a simple, practical and economical system, of which all the process, except the several open panels, is past history. But, in order to enhance the value of this analysis to the busy designer each step of the process will be given, thereby understandingly facilitating its application to more complex systems, as well as simpler problems.

The conditions assumed in this case are: A sixty-foot baggage car, having two 6′—0″ door openings in each side, double body bolsters, and carrying a total load (dead and live) of 120,000 lbs., or 60,000 lbs. per truss.

Figure 1 shows approximate panel spacing and panel loads at apex points, which are symmetrical about the center of truss, and $R_1 + R_2 = \frac{60,000}{2} = 30,000$ lbs. But, since, resultant of $R_1$ and $R_1$ is half way between them, $R_2 = R_1 = \frac{30,000}{2} = 15,000$ lbs. This point is exceedingly important, and the truth of the assertion can be mathematically determined with ease.

#### ANALYTICAL SOLUTION.

Figure 1 shows truss and loads.

Natural tan of angle a $= \frac{7.54}{5} = 1.508$, ∴ a $= 56° 27' 0''$ nearly.

Natural sin. a = .8334 and natural cos. a = .5527.

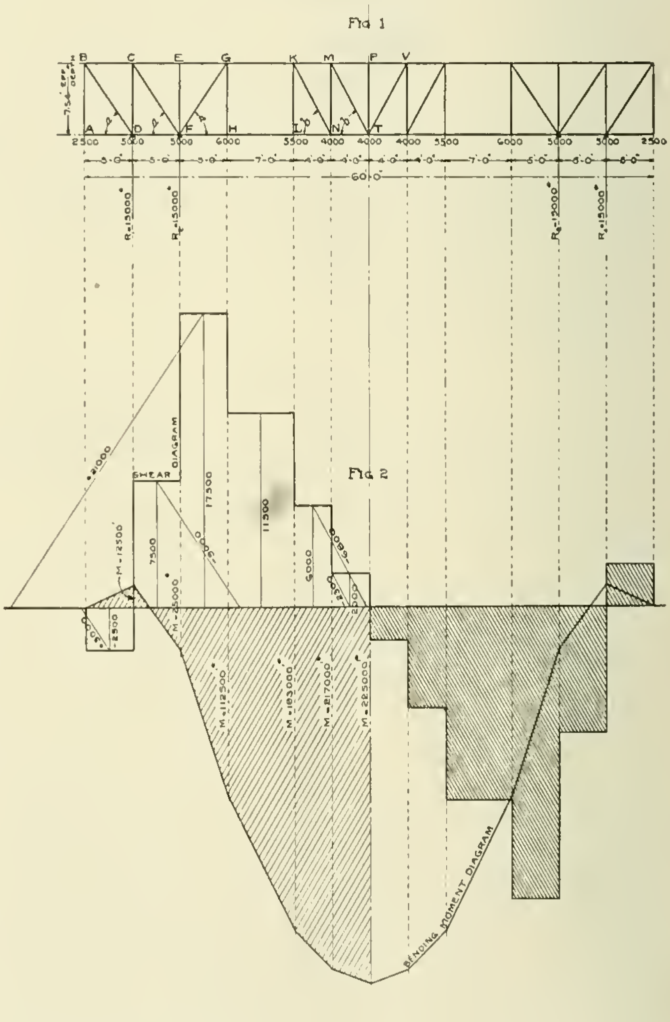
Natural tan. of angle b $= \frac{7.54}{4} = 1.885$, ∴ b $= 62° 3' 0''$ nearly.

Natural sin. b = .8834 and natural cos. b = .4687.

Stress in TP = zero, as MV must not be put in tension; ½ of the 4,000 lbs. at T passes up TM, and the other half up TV. ∴ tension in MT $= \frac{2,000}{\sin b} = \frac{2,000}{.8834} = 2,300$ lbs.

At M the tension in MT is resolved into 2,000 lbs. vertical component in MN, and a horizontal component in MP. ∴ compression in MN = 2,000 lbs., and compression in MP = 2,300 × cos b = 2,300 × .4687 = 1,100 lbs.

At N, 2,000 + 4,000 = 6,000 lbs. vertical load is resolved into tension in NK and tension in NT. ∴ tension in NK $= \frac{6,000}{\sin b}$




SHEAR DIAGRAM – SCALE 1″–6000#
MOMENT DIAGRAM – SCALE 1″–60000″#

$\frac{6,000}{.8834} = 6,800$ lbs., and tension in NT $= \frac{6,000}{\tan b} = \frac{6,000}{1.885} = 3,200$ lbs.

At K, the 6,800 lbs. tension in NK is resolved into a vertical and a horizontal component. The horizontal component produces compression in KMP. ∴ compression in KMP = 3,200 lbs., and vertical component at K = 6,000 lbs.

Now, this vertical component at K = 6.000 lbs., and the load

* Designing Engineer, 227 N. Broome St., Wilmington, Del.

at L = 5,500 lbs., or a total vertical load = 11,500 lbs. must be carried over to GH. Because there is no diagonal in this panel, this shear of 11,500 lbs. must be carried over as transverse shear in GK and HL.

Figuring from the center of the girder over to L, we find a downward shear at L = 11,500 lbs.

Figuring from the end A, of the girder, over to H, we find an upward shear at H = 11,500 lbs.

These upward and downward shears form a couple, which produces a bending moment = 11,500 lbs. × 7'—0" = 80,500' lbs. One-half of this moment = $\frac{80,500}{2}$ = 40,250' lbs., is carried by GK, and one-half by HL. No direct chord stresses result from this 11,500 lbs. shear passing over GK and HL; the stresses produced are a shearing and a bending stress only.

So far the chord stresses have been confined to KMP and NT.

Let GK and HL each carry ½ of 11,500 = 5,750 lbs., then 6,000 lbs., the vertical component at K, — 5,750 lbs., the amount carried as shear by GK, leaves 250 lbs., which passes from K, down KL to L as compression. Therefore 5,750 lbs. travels along KG to G as shear, and 250 + 5,500 at L = 5,750 lbs., travels along LH to H as shear. Therefore 5,750 + 6,000 at H = 11,750 lbs., travels from H up to G, producing tension in HG = 11,750 lbs.

At G, the 11,750 lbs. tension in GH and the 5,750 lbs. vertical shear brought over from K, or a total vertical load of 17,500 lbs., is resolved into compression in FG, and compression in GKMP. Therefore compression in GKMP = $\frac{17,500}{\tan a} = \frac{17,500}{1.508}$ = 11,600 lbs., and compression in FG = $\frac{17,500}{\sin a} = \frac{17,500}{.8334}$ = 21,000 lbs.

Since CG cannot take a transverse thrust or pull at E, the stress in FE = zero.

Therefore at F, the compression in FG is resolved into a vertical component acting downward at F, and a horizontal component producing tension in FHLNT.

∴ vertical pressure at F = 17,500 lbs. = vertical component of FG, and tension in FHLNT = 21,000 × cos a = 21,000 × .5527 = 11,600 lbs.

17,500 lbs. vertical pressure at F from FG, + 5,000 lbs. load at F = 22,500 lbs. total load at F. 22,500 lbs. — 15,000 lbs. upward reaction at F, = 7,500 lbs. excess downward pressure which must be carried up FC and down CD to D. Therefore at F, the vertical load of 7,500 lbs. is resolved into tension in CF and tension in FHLNT. ∴ tension in FC = $\frac{7,500}{\sin} = \frac{7,500}{.8334}$ = 9,000 lbs., and tension in FHLNT = $\frac{7,500}{\tan a} = \frac{7,500}{1.508}$ = 5,000 lbs. At C, the tension in FC is resolved into a horizontal component producing compression in CEGKMP, and a vertical component producing compression in DC.

∴ compression in CEGKMP = 9,000 × cos a = 9,000 × .5527 = 5,000 lbs., and compression in DC = 7,500 lbs. = vertical component of FC.

Load at A, 2,500 lbs., passes up AB as tension, and down BD as compression, to D.

∴ tension in AB = 2,500 lbs.

At B, tension in AB is resolved into tension in BCEGKMP, and compression in BD. ∴ tension in BCEGKMP = $\frac{2,500}{\tan a} = \frac{2,500}{1.508}$ = 1,700 lbs., and compression in BD = $\frac{2,500}{\sin a} = \frac{2,500}{.8334}$ = 3,000 lbs.

At D, the vertical component of BD = 2,500 lbs. = downward pressure at D, and the horizontal component of BD = 1,700 lbs. = compression in DFHLNT. No stress in AD.

Finally: 2,500 lbs. vertical pressure at D from BD, + 7,500 lbs. compression in DC at D, + 5,000 lbs. load at D, = 15,000 lbs. total downward vertical pressure at D; minus 15,000 lbs. upward reaction at D = zero, ∴ balances.

Total compression in MP = 1,100 + 3,200 + 11,600 + 5,000 — 1,700 = 19,200 lbs.

Total compression in KM = 3,200 + 11,600 + 5,000 — 1,700 = 18,100 lbs.

Total compression in GK = 11,600 + 5,000 — 1,700 = 14,900 lbs.

Total compression in CG = 5,000 — 1,700 = 3,300 lbs.

Total tension in BC = 1,700 lbs.

Total tension in NT = 3,200 + 11,600 + 5,000 — 1,700 = 18,100 lbs.

Total tension in FHLN = 11,600 + 5,000 — 1,700 = 14,900 lbs.

Total compression in DF = 1,700 lbs.

RECAPITULATION

| Member | Stress | Member | Stress |
|---|---|---|---|
| BC | —1700 | AB | —2500 |
| CE | +3300 | BD | +3000 |
| EG | +3300 | DC | +7500 |
| * GK | +14900 | CF | —9000 |
| KM | +18100 | FE | 0000 |
| MP=MV | +19200 | FG | +21000 |
| AD | 0000 | GH | —11750 |
| DF | +1700 | LK | +250 |
| FH | —14900 | KN | —6800 |
| * HL | —14900 | NM | +2000 |
| LN | —14900 | MT | —2300 |
| NT | —18100 | TP | 0000 |

* These two members also have each 5,750 lbs. shear, and 40,250 ft. lbs. bending moment.

These stresses can also be checked by constructing the shear and bending moment diagrams, as shown in Fig. 2.

In panel NT there is a shear = 2,000 lbs., which resolved in the direction TM, gives a tension = 2,300 lbs. in TM. Then the 2,000 lbs. shear travels down MN as compression.

In panel LN there is a shear = 6,000 lbs., which gives 6,800 lbs. tension in KN and 6,000 lbs. vertical component at K.

In panel HL there is a shear = 11,500 lbs. Because there is no diagonal, half of this shear = 5,750 lbs. will have to pass from K to G as transverse shear in GK, and half will have to pass from L to H as transverse shear in HL. ∴ 6,000 lbs. vertical component at K, minus 5,750 lbs. carried from K to G as shear, leaves 250 lbs. which passes down KL to L, producing 250 lbs. compression in KL.

Also, 250 + 5,500 = 5,750 lbs. at L, passes from L to H as transverse shear in HL, and 5,750 lbs. at H plus 6,000 lbs. load at H = 11,750 lbs., which passes up HG as tension. 11,750 lbs. tension in HG plus 5,750 lbs. shear in GK = 17,500 lbs. at G.

In panel FH, there is a shear = 17,500 lbs., which produces 21,000 lbs. compression in FG.

In panel DF, there is a shear = 7,500 lbs., which produces 9,000 lbs. tension in CF and 7,500 lbs. compression in CD.

In panel AD there is a shear = 2,500 lbs., which produces 3,000 lbs. compression in BD, and 2,500 lbs. tension in AB.

No stress in AD, EF, and PT.

At D, we have $\frac{12,500' \text{ lbs.}}{7.54'}$ = 1,700 lbs. tension in BC, and 1,700 lbs. compression in DF.

At F, we have $\frac{25,000' \text{ lb.}}{7.54'}$ = 3,300 lbs. compression in CE and EG.

At H, we have $\frac{112,500' \text{ lbs.}}{7.54'}$ = 14,900 lbs. compression in GK, and tension in FH, HL and LN.

Between H and L we have a bending moment = 11,500 lbs. × 7' = 80,500' lbs. Because there is no diagonal in panel HL, this bending moment cannot be carried by either the chords or web members of the truss as direct stress. It must therefore be carried by either HL or GK, or both, as a bending stress.

This means that from H to T, this amount of bending moment, 80,500' lbs., has no effect upon the direct stresses in the members of the truss between H and T. It must therefore be subtracted from the bending moments between H and T, to get the direct stresses in the members between H and T.

At L, we have $\frac{193,000' \text{ lbs.} - 80,500' \text{ lbs.}}{7.54'} = \frac{112,500' \text{ lbs.}}{7.54'}$ = 14,900 lbs. compression in GK and tension in LN, the same as was found by considering the bending moment at H.

At N, we have $\frac{217,000' \text{ lbs.} - 80,500' \text{ lbs.}}{7.54'} = \frac{136,500' \text{ lbs}}{7.54'}$ = 18,100 lbs. compression in KM and tension in NT.

At T, we have $\frac{225,000' \text{ lbs.} - 80,500' \text{ lbs}}{7.54'} = \frac{144,500' \text{ lbs.}}{7.54'}$ = 19,200 lbs. compression in MP.

We therefore see that the stresses, as found from the shear and bending moment diagrams, check those found in the analytical solution.

GRAPHICAL ANALYSIS.

The structure being symmetrical about the center, lay out half the truss, as shown in Fig. 3.

Then, at points of support, 15,000 lbs. upward reaction — 5,000 lbs. downward load = 10,000 lbs. net upward reaction.

$\frac{ST}{2}$ = 2,000 + RS = 4,000 + QR = 5,500 = 11,500 lbs. total vertical load to be carried across panel without a diagonal. This can be done by WG and GQ each carrying $\frac{11.500}{2}$ = 5,750 lbs. as a transverse shear.

This 5,750 lbs. downward shear at the right end of WG and GQ, and 5,750 lbs. upward shear at their left hand ends, form couples whose moments (5,750 lbs. × 7′ = 40.250′ lbs. each) tend to distort the panel with no diagonal.

This distortion is prevented by the moments of resistance of WG and GQ, which balance the moments of these couples.

We must therefore supply an imaginary downward force = 5,750 lbs. at left hand ends of WG and GQ, and an imaginary upward force = 5,750 lbs. at right hand ends of WG and GQ, to form couples equivalent to the moments of resistance of WG and GQ, because the moments of resistance cannot be represented in a graphical diagram of this kind.

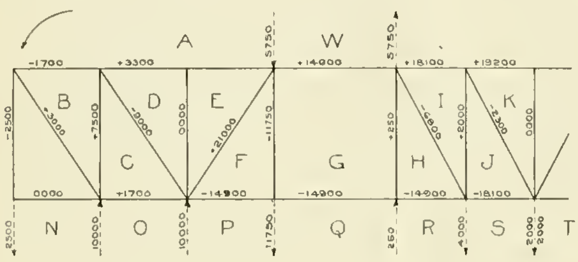



FIG. 3

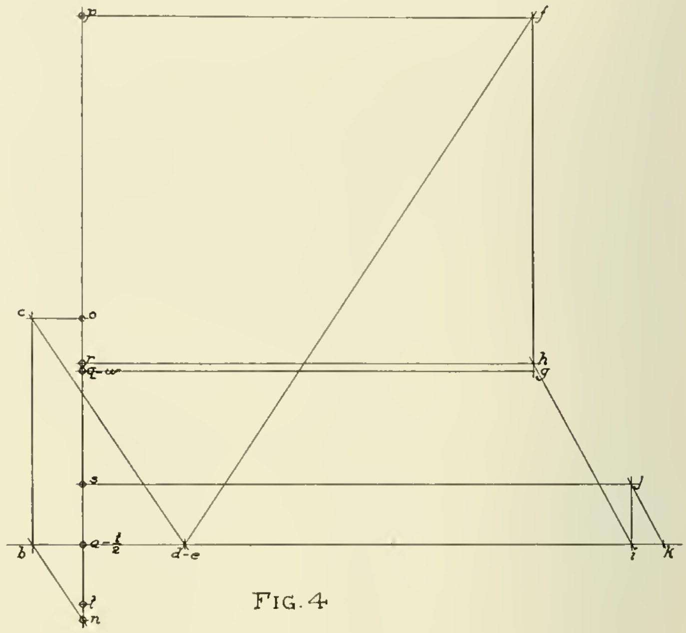


FIG. 4

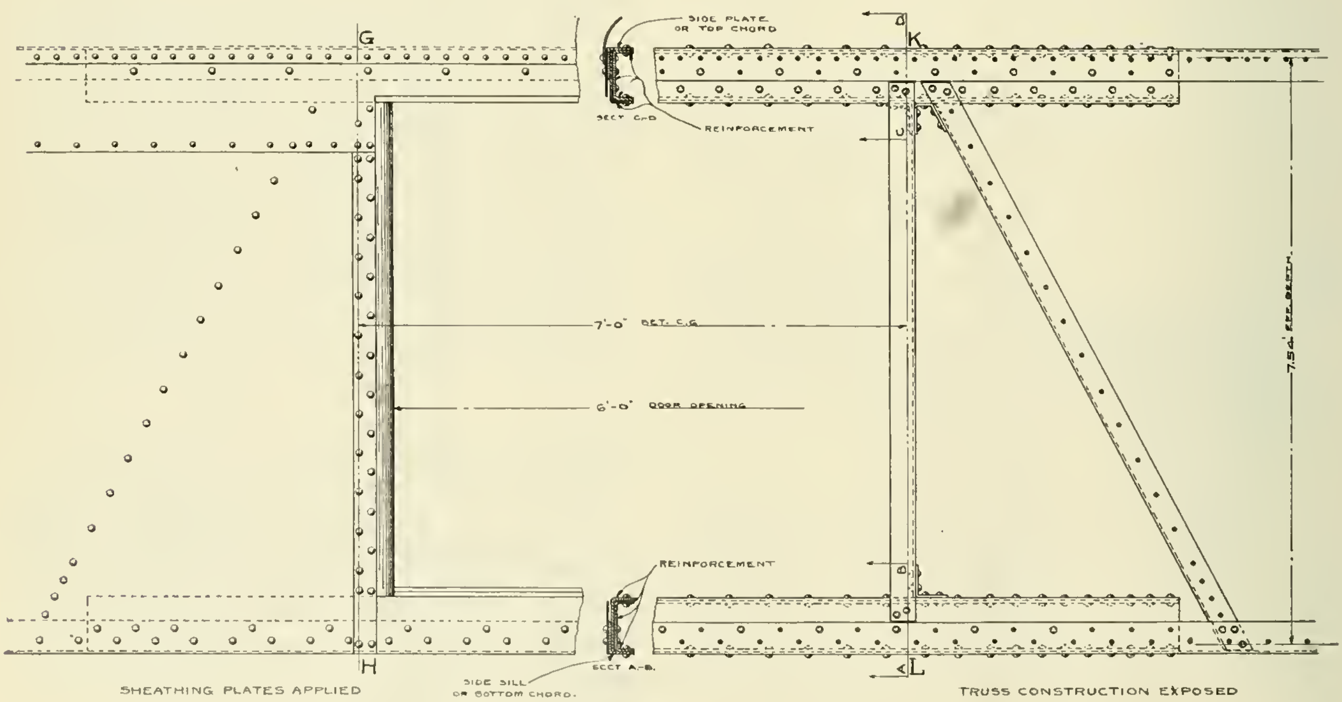



FIG. 5

This gives a total downward force PQ = 11,750 lbs. and a total upward force QR = 250 lbs.

The arrow in the upper left hand corner of diagram, Fig. 3, indicates the direction of rotation.

Construct the diagram as in Fig. 4, scale the stresses, which will be found to agree with the analytical solution.

Also, it will be seen that the diagram closes, which, of course, checks the analysis as a whole.

APPLICATION.

In designing a truss to meet these stresses, it is a simple matter to select the members and make their connections,—up to the open panels or doors.

Then, referring to Fig. 5, which shows a practical enough design of construction about the open panels, to meet the stresses here, which are, a bending moment = 40,250′ lbs. at G, K, H and L. Also, 5,750 lbs. shear from G to K and from H to L.

It will be seen that the moment of resistance or 40,250′ lbs. will require a section of large enough area to make the 5,750 lbs. shear negligible.

Then, section A-B and C-D must have a net moment of resistance of 40,250′ lbs., and, of course, this moment must be developed in the section at G, K, H and L, or the plane of stress; therefore, reinforcement must be of sufficient length beyond G, K, H and L to anchor and develop the moment of resistance required, by the time we reach G, K, H and L.

All of which requires no demonstration here.

# THIRD ANNUAL CONFERENCE OF THE APPRENTICE INSTRUCTORS

New York Central Lines.

(*Continued from the October Number, Page 389.*)

### WHAT CAN WE DO TO IMPROVE THE APPRENTICESHIP SYSTEM?

*H. S. Rauch.*—Let us add still another subject to our courses, a subject which may be difficult to teach and delicate to handle, but which will be equally productive of results and will encourage a high standard of morals, thrift and systematic saving. No man can give to any company the best that is in him unless he is contented and happy and to accomplish this he must be frugal, of clean mind and habits, and with a knowledge of something being laid by for the proverbial "rainy day."

For the purpose of applying these thoughts and principles I would first urge the promotion of apprentice railway clubs. Get the boys interested by making the meeting place attractive, let them be governed by officers elected from their ranks, let the combined clubs of the Lines have general officers who will be kept in touch with the work of all clubs and also keep the clubs in touch with one another. The apprentice instructors should make it their duty to take a deep interest personally in all papers read before the club, making suggestions based on their more mature judgment, and above all the instructor should not forget that his example will be followed and he should take care to govern himself with this fact in mind.

We should never let an opportunity slip by in which to promote friendly relations with the boys. Our influence would be greater with a friend than with one to whom we were indifferent and we should never let our interest lag after the boy has graduated, but use all honorable means to bring out the best there is in him. We should do all we can to keep him contented so that he will remain and give us the benefit of his training.

Let us teach through papers read before our apprentice clubs that the business of no department is of such importance that it can afford to reject co-operation with other departments and that success depends upon co-operation. It is indeed a narrow-minded man who conducts an enterprise solely from the viewpoint of that particular department with which he is connected.

We must remember that the future success of this apprenticeship system depends in a large measure upon the careful selection and retention of apprentices. Those in charge of this work should make a study of human nature and aim to place a boy in that vocation to which he may be particularly adapted. We should then watch him and if a mistake has been made, if nature has not fitted him for the work he is doing, the remedy should be an early transfer to a more congenial occupation.

### TO IMPRESS THE APPRENTICE WITH THE VALUE OF AN EDUCATION.

*C. A. Towsley.*—While the future career of an apprentice depends to a large extent upon himself, his possibilities are dependent to no small degree upon the influence of the instructors and it is our duty to see that the boys are continually made aware of the benefits resulting from constant application to their work and the solution of every problem that may come up in the regular routine of the shop and school.

The average apprentice is inclined to look upon the routine work as drudgery that should be passed over with as little effort as possible, little realizing that each operation is a stepping stone that is to gradually build the foundation upon which rests his future success. We should try to formulate some line of action that will appeal to them and awaken a realization of the benefits that may be derived from a close application to their various duties. We should stimulate a constant alertness for all of the little things which are usually passed by unnoticed and appear too trivial to be grasped and mastered and made available for future needs.

Many apprentices are prevented from advancing on account of timidity and fear of placing themselves in a position which might incur the jeers and taunts of their companions. If an apprentice is noticed by his fellow workmen to be more intent upon his work than usual, or working a few moments after the whistle blows, he is immediately set down by a certain class as a pet of the boss and it is noised about that he is working for a "stand in." Many boys through a foolish sensitiveness avoid doing any work that is commended by the foreman, or noticed by the management. If we can remedy this, if only to a small extent, we will have removed one of the worst stumbling blocks from their path.

A great many boys delude themselves with the idea that when the opportunity comes they can jump into a high place and swing it to perfection; that all it takes to reach the goal of their ambition is nerve. We should call our boys' attention to the fact that they must work their way up and expect everybody else who may be striving for the same position to pitch in and try to hold them down; that our industries and institutions would collapse if undeveloped, untried men were to lead them. We should teach them that success comes only through hard knocks and perseverance.

### CO-OPERATION—HOW TAUGHT.

*V. J. Burry.*—The old apprenticeship system lacked the spirit of co-operation. Before we had a shop instructor if the apprentice, when placed on a machine, asked a mechanic how to do a certain job he would get the reply: "You will have to learn that in the same way that I did." And if the boy went to the foreman for the information he would usually find him so loaded with other duties that he would not have any time to devote to apprentice education. The result was that the machine did not turn out the work and the boy finally became disgusted with his trade. With a shop instructor the apprentices are thoroughly instructed in the work on the different machines: this not only encourages them, but increases the amount and quality of the output.

In the classroom we have problems showing the boys how to cut plates so as not to waste the material, thus teaching them economy, the knowledge of which will save the company much in dollars and cents in the future. Since we now have courses in nearly all trades the bright, wide-awake apprentice boy who has finished the drawing and problem work in his own trade may take up that of another department, thereby widening his field of usefulness and broadening his ideas so that he will be in sympathy with all his fellow workmen.

Apprentice clubs and ball teams teach co-operation. Without team work the nine could not win: they must all play together for a common end. The debating club promotes good friend-

* The proceedings of the first annual conference will be found in the November, 1907, issue of this journal, and those for the second annual meeting in the October, 1908, issue. The organization of the apprentice department and the methods and equipment used by it were described in detail in the June, July, September and October numbers, 1907.

ship and the different subjects discussed awaken interest along new lines.

Co-operation and system eliminate friction and bad feeling. Among the apprentices every boy has an equal chance to make good and there can now be none of that jealousy which formerly existed when sons of employees and special apprentices were given every opportunity to advance and other boys were not noticed.

In conclusion I will repeat the first paragraph of the open letter written to all departments by President W. C. Brown. "*Co-operation between every department of this system is essential to its success. This means not only sincere, heart-felt interest in the welfare of the system as a whole, but personal friendship for the officers and employees of other departments, and an eagerness to assist all departments, so far as possible, in order that the best results for the entire system may be accomplished.*"

### AMOUNT OF HOME WORK.

*A. L. Devine.*—I believe it would be advisable to give each apprentice a month's supply of home problems at one time and the number of sheets given out should be determined by the number of class days for each month. If there are eight sessions for a certain month the boy should be furnished with eight problem sheets * at the first class he attends for the month in question, with the understanding that the entire lot must be worked out and returned correct before the first class of the following month. It should be optional with the boy whether he hand in all at one time or one at each class meeting. If a boy hands in the entire lot at the class following their receipt, it should be understood that no more sheets will be furnished him that month unless he requests them. This, of course, excludes all problem sheets returned for correction. We have tried this arrangement during the past two months with sixteen new apprentices and must admit that the results obtained far exceeded our expectations. Not one of these boys failed to live up to the requirements; on the contrary, four boys requested additional sheets before the end of the month and all expressed their approval of this innovation. This system reduces the clerical work in connection with the problem record sheet.

*H. S. Rauch.*—The number of problem sheets to be issued at one time depends largely upon the apprentice to whom they are issued; some boys do six or eight in a month while others will be able to do but three or four. One month's supply of problems is a sufficient amount to be given out at one time. We should require not less than three home problem sheets per month from each boy and care should be exercised not to let the boys know what the minimum is as we should require more than three sheets from those who are capable of doing it. My practice is to give each apprentice on the first of each month an amount of work which in my opinion is a reasonable requirement for that particular boy. I would then insist that he have this work all in and correct by the last day of the month for which it was issued. In this way I have been reasonably successful in getting my boys to do the home problem work.

*B. Frey.*—I think better results can be obtained by handing out ten sheets at a time than by handing out only four as called for by the spaces on the problem record sheet. In most cases it is harder for a boy to get started to work on the problems than it is to keep going after once making a beginning, and therefore if he had a larger number of problem sheets he would oftimes work out six or more at one time, instead of only one or two as at present. It is, of course, not necessary for him to hand in all of the sheets at once. The reason for suggesting ten problem sheets is that the record of problems given out can be more easily followed. Issuing sheets from 1 to 10, 11 to 20, 21 to 30, etc., affords a better means of determining just how many the boy has at home by simply looking at the last sheet handed in. This makes it easy to find out when the boy should be given a new set of problems without having to look at the problem record sheet.

* Each problem sheet contains a number of problems.

As to the minimum number of home problem sheets which should be required each month, I believe at least one sheet should be handed in each week. This will be necessary in order to properly get through the courses for each trade as outlined.

### PENALTIES FOR FAILURE TO DO HOME OR CLASSROOM WORK.

*A. L. Devine.*—We have no arrangement for imposing a penalty for failure to do home work other than notifying the general foreman resulting in the boy's receiving a mild "call down" from that officer. I would offer the suggestion that where boys fail to hand in the required number of problem sheets per month, that the delinquents be requested to report to the general foreman in a body. This could be handled very nicely by having them assemble in the classroom directly after lunch on or about the first day of each month. A boy reporting to the general foreman the second time for failure to do the required amount of work should be just cause for suspension, and the third time dismissal. If this rule was rigidly enforced and an example made of a few boys I believe we would have very little trouble from this source.

The time has certainly arrived when the instructor should have the encouragement and support of the local officers concerning this matter and the instructor's suggestions should be carried out in each case so that discipline can be maintained. I believe it would be unnecessary to provide a penalty for failure to do classroom work providing the problem sheets were distributed as soon as possible after the class opened. This would allow sufficient time to do all problems; if not, the sheets could be collected and returned to the apprentices at the next meeting of the class.

*H. S. Rauch.*—The penalty for refusing to do home problems should be dismissal. Inability to do this work, however, should be treated with the greatest consideration and every effort should be made to instruct the delinquent. Failure to do classroom problems should be dealt with on the same basis as home problems. If a boy is lazy and refuses to get into the game, and if reasonable methods prove futile, I would say send him to the employing officer with a request for his dismissal. But the instructor must use good judgment and not give the boy a greater amount of work than he is capable of doing, making the mistake of thinking him lazy because he does not keep up.

*B. Frey.*—We seldom have occasion to resort to penalties for failure to do home or classroom problems, as the apprentice usually understands that there is a fixed number of problems which must be handed in each month. If he falls a little behind one month, he is asked to hand in his back problems during the first two weeks of the following month. If he does not hand them in then, and has no good excuse, we resort to some sort of penalty, such as sending him back to work in the shop, which obliges him to explain to his foreman why he is not in the school.

A boy should not be reported to the foreman unless absolutely necessary. In an extreme case more stringent means may be used. For instance, an apprentice was sent home for not handing in the required number of home problems and was instructed that if he did not appear in the morning with them all worked, he would be discharged indefinitely. The result was satisfactory and we have had no other occasion to resort to such methods. Many penalties and methods of stimulating apprentices to do their best may be used, but I believe a systematic arrangement of the work will do more good than any punishment or other form of stimulation.

### STIMULATING INTEREST IN CLASSROOM WORK.

*V. J. Burry.*—First of all, we must know our boys, and must not forget that we are teaching boys. How can we know our boys? By honestly wanting to know them, by wanting to know them so much that we are willing to let our theories about them be destroyed and willing to give time at a sacrifice to get acquainted with them.

In the classroom laboratory we have the small engine, the lathe, the gear rack, the valve gear model, and many other simple models and devices, and by touching on their different mechanical points, we arouse the boys' curiosity, and curiosity is, broadly speaking, desire to know. We are familiar with its various forms and we all possess it to a greater or lesser degree. It acts as an appetite to the mind and is natural to a boy. It is an open door to the realm of knowledge, and an instructor should use it as a valuable aid in gaining interest, and interest does not mean to amuse, to entertain, but to arouse activity in a boy and make his mind work.

It is all very well to have books of mathematics and mechanics—we cannot get along without them—but seeing is believing, and the real way to stimulate knowledge is to show the boy the actual mechanism which illustrates the mechanical principle which we wish to teach him. We cannot expect the average boy to be interested in a problem or machine requiring much thought unless we are interested in it also. The boy gets inspiration and enthusiasm from the instructor, who should explain the problem or principle in a simple, conscientious way, repeating over and over again, if necessary, each step and always displaying that interest which is the secret of successful teaching.

A whole paper might be written about the moral side of apprentice instruction, gaining the confidence of the boy, knowing him at home and outside of working hours, and building up his character at the same time that we are building up his brain power and efficiency. All of this must be accomplished if the best that is in the boy is to be developed. Teaching is hard work and the love of it and the knowledge of the good we are doing is our stimulant. The pay is small in actual dollars, but the greatest reward is in our consciousness of the value we are, not only to the railroad company, but to the community. Our aim should be to train the boys in good citizenship, and raise the standard of honest and right living.

### DISCIPLINE IN THE CLASSROOM.

*Mr. Kuch, Sr.,* directed attention to the importance of exercising the same discipline in the apprentice schoolroom as is used in the classrooms of our schools and colleges. Promptness, neatness, cleanliness, obedience, politeness and strict attention to the work should be insisted upon.

drawing suitable for use in the erecting shop. After tracing the pencil drawing each boy, wherever possible, is allowed to take a blueprint of the tracing himself and this he may keep as his own.

### TEACHING OF SPELLING AND LETTER WRITING.

*Mr. Kuch, Sr.,* outlined an exercise in spelling such as is used at Depew, the object being to familiarize the boys with the correct or standard names for the different parts of locomotives, cars, etc., as well as the correct way in which to spell them. After the words have been given out and the papers collected different boys are sent to the board and asked to explain the different parts by sketch.

Letter writing is also taught in a very practical manner at Depew. No material is issued to boys in the drawing room unless the request is properly presented in writing in the form of a letter. In addition to this they are occasionally asked in class to write short letters in connection with their shop work. These are collected, corrected and returned at the next exercise.

*Discussion.*—After a thorough discussion it was decided to adopt Mr. Kuch's suggestions and put them into practice at all the schools.

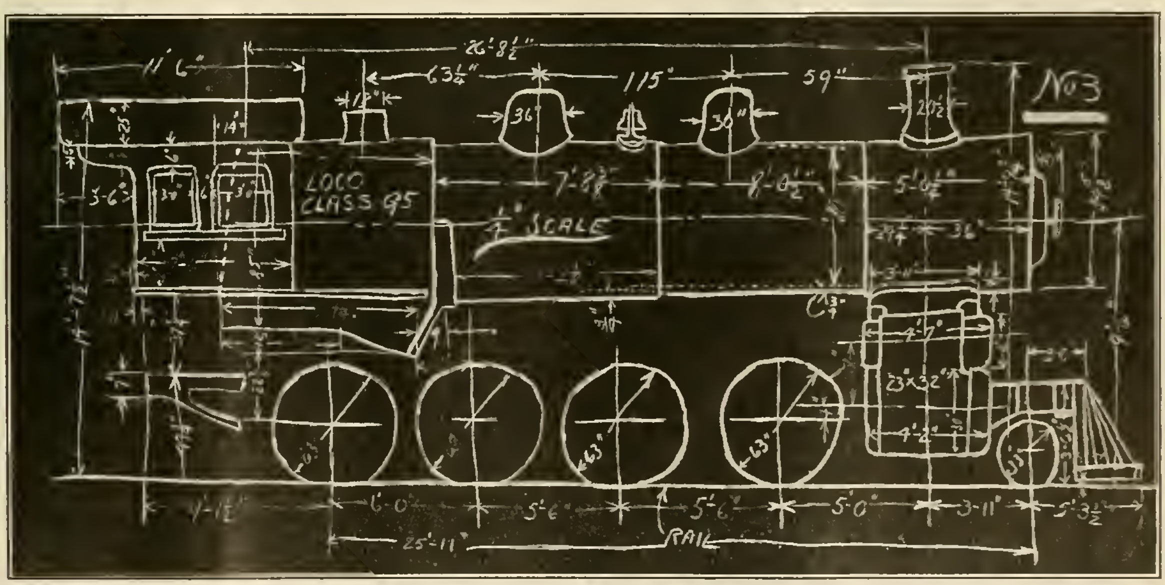
### CLASSROOM AND LABORATORY WORK.

*H. S. Rauch.*—Our practice at Oswego is to devote one hour and thirty minutes to drawing and thirty minutes to blackboard and laboratory work each day; this we find very satisfactory. For machinist apprentices I would recommend the following courses in blackboard and laboratory work in the order given.

1—Blackboard problems.
2—Gearing problems, including thread cutting on laboratory lathe using wooden mandrel and lead pencil.
3—Course in laying-out for drilling, slotting, boring, etc., using wooden models.
4—Lever problems with beam and weights.
5—Valve problems and valve setting on classroom engine.
6—Blue print reading.
7—Steam gage problems.
8 Course on strength of materials.

If these courses are followed up gradually, taking each part in detail, the apprentice will soon master the principles involved. This schedule will have to be varied somewhat for the other trades, cutting out valve setting and thread cutting and substituting courses applicable to the trade the boy is learning. Each of the courses, as listed above, should be so arranged that an average boy could cover the whole in four years, or in other words, no course should consume so much time that others would have to be omitted.

Once each month I would suggest suspending all work in the classroom and laboratory and giving the whole class a talk on




AN INTERESTING DRAWING EXERCISE.

### AN INTERESTING DRAWING EXERCISE.

At some of the schools advanced boys are given the outlines of an entire locomotive and tender to draw to scale and trace. The photo shows an engine drawn upon the blackboard, which is to be copied by the apprentice on drawing paper.

This work is stimulating and instructive—what boy, mechanically inclined, does not look with pride upon his first crude drawing of a locomotive. These boys go farther and make a some general subject of interest; taking up the air brake first, using charts and sectional models when available, or if charts cannot be procured a diagram on the blackboard answers very nicely.

*Discussion.*—Where the classes are large it is the practice to have a few boys work at a time on the special problems in laboratory work. By devoting the entire period of two hours to it, or as much time as is necessary, they can complete the experiments and do not need to overhaul and rearrange the apparatus again, as they would if they were allowed shorter periods in which they could not complete many of the experiments.

## WALSCHAERT VALVE GEAR—CLASSROOM INSTRUCTION.

*A. W. Martin.*—We have in the classroom at Beech Grove a wooden model of the Walschaert valve gear on our standard G-5 H A engines, made ¼ size and mounted on a pine board 72"x36"x1". This model was made by the patternmaker apprentice boys during their regular school hours and they did a job that would be creditable to any mechanic. The model is of value to machinists as well as apprentices. Men from the shop come to the school during the noon hour and study the motion by assuming certain conditions and then running the model over to get the different valve events. This interests the boys and they are all anxious to do the problems.

To start a boy on this work, we give all the adjustable parts, such as the valve, eccentric crank and eccentric rod, an improper setting. He is then given a set of instructions and told to square the valve, giving it equal lead in both forward and backing motions when the engine is on both centers. After doing this he is given a standard valve measurement sheet and required to fill in all the valve events at four positions of the gear. These valve events are preadmission, lead, port opening, cut-off, release and compression. Having gone through this work he is ready for the motion gang and should need very little shop instruction in order to do any work he may be given. If the model is carefully built a very close adjustment can be made which need not exceed a maximum variation of 1/64-inch for the four lead events.

### Instructions for Adjusting Walschaert Valve Gear.

(These instructions apply to the piston valve engine with inside admission, and combination lever fulcrum located above the valve stem; the link block is below the center of the link in the forward motion.)

Assuming all parts of the valve gear to be correctly proportioned we may proceed as follows:

1. With port lines marked on valve stem and main rod, valve and all parts of the valve gear connected, excepting the link end of the eccentric rod, adjust the link block so that there will be no movement of the valve when the link is oscillated on its center. In case both valves do not remain stationary with one position of the reverse lever, adjustment must be made in the lifting device of either side until they do.

2. With reverse lever in its central position, as found above, we next connect the link end of eccentric rod and find both dead centers of engine and with tram mark same on wheel from any rigid point; also mark the extreme travel points on the guides, at the same time checking the port lines for equal lead; square lead by adjusting valve stem as per Case 1 following.

3. With valves approximately set and ready to run over in order to get the different valve events, place engine in the forward motion and catch the front and back centers, at the same time noting the position of the port lines as in Case 1. Repeat this operation with engine in backward motion. With position of port marks noted, we may have readings similar to either of the four cases following. After adjustments are made the valves should be run over in their principal positions. Valves may be considered as practically correct when the cut off and release events in the forward motion, at the usual running position (say 25% cut off) do not vary over 1/32 of an inch, though of course closer adjustment is desired when possible.

### Rules for Making Adjustments on the Model.

1. The eccentric crank is correctly set when the sum of the leads in forward and backward motion are equal. Thus in Fig. 1 A + B = C + D.

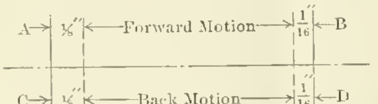


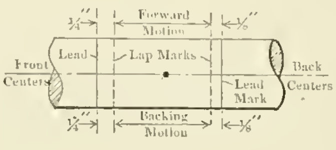

Fig. 1

2. Shortening the eccentric rod increases the lead at points C and B and decreases the lead at points A and D (Fig. 1), and vice versa. This may be done by means of liners in the strap end of the rod.

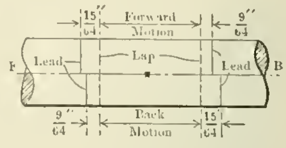
3. Decreasing the throw of the eccentric crank decreases the leads in forward motion and increases the leads in the backward motion, and vice versa.

### Following Are Four Cases of Valve Port Readings.

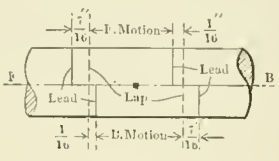
Case 1. When the two leads on the front centers in both motions, and the two leads on the back centers in both motions, are equal; but the front center leads not equal to the back center leads, as shown in the



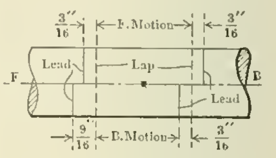

Case 1




Case 2




Case 3




Case 4

figure, we must make them all equal as follows: Adjust the valve stem an amount equal to ¼ the difference of the sums of the leads in both motions, thus:

$$\frac{\left(\frac{1}{4}+\frac{1}{4}\right)-\left(\frac{1}{8}+\frac{1}{8}\right)}{4}=\frac{1''}{16}$$

In this case the valve stem should be adjusted 1/16" to the right. This shows, according to Rule 1, that the eccentric crank is set correctly.

Case 2. When the leads come as shown, that is, the forward motion lead on the front centers is equal to the back motion lead on the back centers and the forward motion lead on the back centers equal to the back motion lead on the front centers, they must all be made equal by shortening the eccentric rod an amount equal to ¾ the difference of the sums of the leads, thus:

$$3\left[\frac{\left(\frac{15}{64}+\frac{15}{64}\right)-\left(\frac{9}{64}+\frac{9}{64}\right)}{4}\right]=\frac{9''}{64}.$$

When this is done we will have equal leads in both motions.

Case 3. Here we have 1/16" negative and 7/16" positive lead in both motions. In this case the valve may be squared by shortening the eccentric rod an amount equal to ¾ the total sum of the positive and negative leads, thus:

$$\left(\frac{7}{16}+\frac{7}{16}+\frac{1}{16}+\frac{1}{16}\right)\frac{3}{4}=\frac{3''}{4}.$$

If the leads came just the reverse of the above we would have to lengthen the eccentric rod to equalize them. (See Rule 2.)

Case 4. The figure shows 3/16" positive lead on both centers in the forward motion and 9/16" positive lead in the back motion on the front center, and 3/16" negative lead in the back motion on the back center. First move the valve stem 3/16" toward the back center. The next step is to equalize the lead as in Case 2. This may be done by lengthening the eccentric rod. (See Rule 2.)

## DRAWING COURSE FOR BOILERMAKER APPRENTICES.

[*Editor's Note.—The general drawing course of 65 sheets is followed by all apprentices; after completing these each trade has a course of its own.*]

*A. W. Martin.*—In order that an apprentice may become a first-class boilermaker and layer out he must be able to read and make a working drawing. To lay out a pattern it is not necessary to make a blue-print or scale drawing. A pencil sketch giving the principal dimensions is sufficient for drawing the elementary lines that are necessary for the development.

Every boilermaker apprentice should upon starting his apprenticeship be given the lessons in the new general drawing course. He should then take up sketching and the making of working drawings of all parts of the locomotive boiler, starting with simple details such as staybolts and stayrods and gradually advancing until he is able to sketch and draw the entire boiler. The average apprentice could accomplish this in from twelve to eighteen months, and would then have acquired the general principles of drawing as well as a thorough knowledge of boiler details and construction. This knowledge will not only be a great benefit to him in his daily work in the shop, but will prepare him for the sheet metal drawing course which should follow. This course starts in with the development of patterns for simple objects, such as square and round pipes, etc., gradually leading up to the more difficult jobs.

The three methods in general use for developing patterns should be taught the boys; these are, by radial lines, parallel lines and by triangulation. When the principles of these three methods are clearly understood a boy should have no trouble in developing the surface of any object. It has been two years since the boys in our shop started on the sheet metal course and our foreman boilermaker takes considerable pride in telling of some of the work that they have done.

We have found it good practice to have wooden models made for all the objects in the drawing course which are to be developed. The patterns may then be cut out and fitted on the models to prove that the work is correct. Some of the wooden models at Beech Grove are as follows: Square and round pipe, irregular and regular tapering pipe, Y branch pipe, transition pipe with rectangular to round opening as used over forge fires, etc. We have, also, a small model firebox of our K-2 engines that the boys use for trying on paper patterns of one-piece wrapper sheets that they have layed out. All these models are made one-quarter size.

We have under construction a one-quarter size class C boiler model to be made of No. 18 planished copper. All the patterns for this have been developed and the work of constructing the model is being done by the boys during their regular school hours. Since the use of models has been adopted the boys have been greatly stimulated in this work. They can try their patterns on the models and see how true are the principles which they have learned and applied when drawing and developing them.

It would be well to use part of the tinsmith course for the boilermakers as the early stages of development and laying out of patterns are practically the same for both.

*C. P. Wilkinson.*—Detailed sheets should be made of all plates in the various types of boilers, and showing all the lines necessary for their development and containing a full explanation with all necessary instructions. For example, the combining of the firebox side and crown sheets in one plate is a recent design, and for those not familiar with the work of laying out such sheets, there is much chance for error. A lesson sheet showing the details of how to lay out this plate would be beneficial.

It is not to be expected that many boys will care to put in the time and study necessary to make them experts, but there will be enough who will, if properly encouraged by the instructors. We should have as many models as possible made to a size as large as practical to test the accuracy of the drawing work after the patterns have been developed and cut out of brown paper or cardboard. While the tinsmith's course does not apply directly to boiler work, yet it contains problems that every sheet iron worker should know, and it should, therefore, be included in the boilermaker's course.

### A SIMPLE TESTING MACHINE FOR STUDYING THE STRENGTH OF MATERIALS.

*H. S. Rauch.*—The machine is constructed with four 1½-inch round posts, 30 inches long, connecting top and bottom plates, 1 inch thick and 12 inches square. From the center of the upper plate is hung the lever arm to which the upper end of the test piece is attached. The load is obtained through two 1½-inch square thread screws working in a threaded yoke. This yoke grips the lower end of the test piece. The lever arm is 4 feet 0 inches long, giving the machine a capacity of about 5000 pounds when using a 60-pound weight. This machine was designed for testing the tensile strength of ¼-inch round or square specimens. It can also be used for finding the compressive or shearing strength of specimens by means of an auxiliary yoke and plate extending from the lever arm or upper connection down to the under side of the threaded yoke. The piece to be tested is then placed between this plate and the threaded yoke. Turning up on the two large screws will put the test piece in compression.

In outlining a course of study on the strength of materials care should be exercised not to get the course too technical, and in the selection of terms and names which might confuse or discourage the average apprentice.

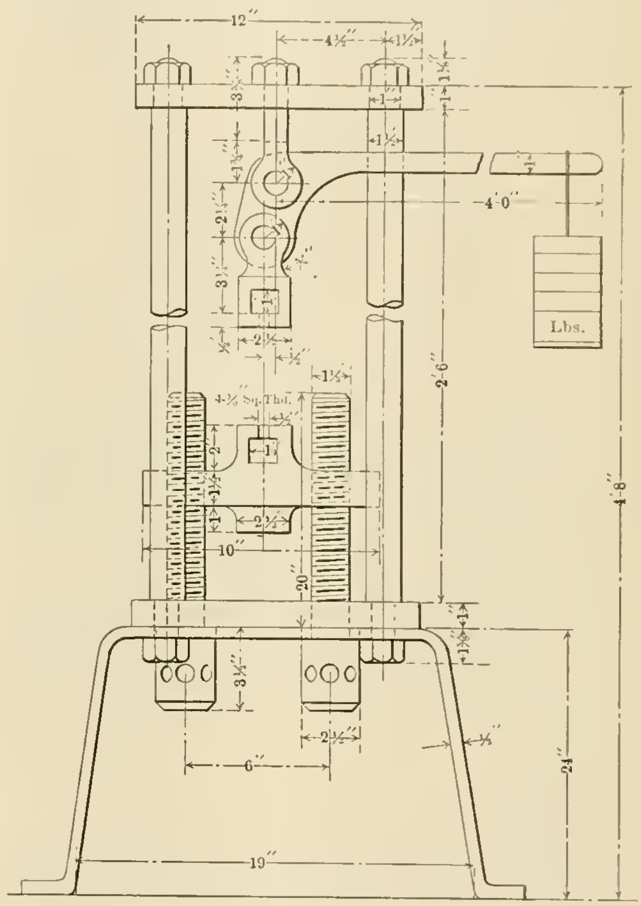
It is suggested that the first sheets of the course be instruction sheets as follows: Materials used for construction, giving a list of those in most common use and with a short description of the composition of each. Short definitions of live and dead loads, stresses, tension and compression, shearing, elastic limit, working strength, ultimate strength, etc. Simple rules for finding the above should be given as needed.

Take up next the study of stresses and strains, using the results obtained from actual tests of specimens. The following problems will illustrate this:

No. 1. What size bar would be required to raise 5 tons in a straight lift, allowing a factor of safety of 5?

No. 2. How may ¾" wrought iron studs would be required to hold a cylinder head having an area of 196 sq. in. with a mean effective pressure on the cylinder of 160 lbs.? Allow a factor of safety of 10.

A number of problems could be arranged for each material tested, each problem to illustrate in what practical way the material is used. For example, in testing staybolt iron all problems




MACHINE FOR STUDYING STRENGTH OF MATERIALS.

should deal with staying different parts of a boiler at different pressures and using different sizes of bolts.

After having gone through the list of materials usually subjected to a tensile stress, take up compression, treating it in a similar manner. It is important that in each case all problems should refer to practice with which the boy is familiar from his work in the shop. This may be illustrated by the following example:

No. 1. How much would a piece of steel used for pressing out crank pins be shortened if it is 4 in. in diameter and 10 in. long? The total pressure used was 100,000 lbs.

The next in order would be shearing stress: treating this in the same manner as tension and compression and always taking care to have the problems so closely related to the boys' work that the benefit to be derived will be easily recognized.

It is also suggested that tests be made on cement. Test pieces should be constructed by the boys in the laboratory and an accurate record kept of the quantities of the different materials.

used in their composition. The age of the test piece, effect of hardening under water, etc., should also be recorded.

To conclude the course about ten sheets of problems should be devoted to a general review working in the principles previously learned. In all the work it would be profitable to make blanks for recording the history and performance of each specimen, stating whether it is from new or second-hand material, to what specifications ordered, etc. From the information obtained through actual tests a set of tables should be made in data sheet form (these could be traced and printed by apprentices) giving the strength of different materials, under different loads and stresses. These sheets should be retained by the apprentices for future reference while working in the laboratory, and after graduation they would make a valuable addition to the boys' stock of useful information.

I believe the courses as outlined, properly worked out in detail and given to apprentices in all trades during the last year of the apprenticeship, would insure a more intelligent knowledge of the materials with which they work and a better idea of design and construction than could be obtained in any other way.

*Discussion.*—Mr. Rauch was asked to develop this course and report results later.

### NUMBER OF DRAWING EXERCISES TO ISSUE AT ONE TIME.

*H. S. Rauch.*—The drawing lesson sheets should be issued in lots of 25, neatly bound together with brass fasteners.

*B. Frey.*—I believe that giving the boy a booklet containing 8 sheets is proper since it gives him an opportunity to look ahead and become familiar with the next lesson while he may be waiting for assistance. These sub-divisions form a sort of goal to work for and have a tendency to stimulate the boy to get into the same book as his neighbor who may be a little ahead of him.

*A. L. Devine.*—I would suggest that they be put up in book form, 23 sheets in a book, and with a standard print cover and cardboard back. We have tried this with the new general drawing sheets and found it to work very satisfactorily. The boys are not allowed to take up their drawing sheet or proceed with the next drawing until the instructor checks the work and marks his initials on the title space of the sheet.

### SHOP COURSE FOR SPRING MAKERS' APPRENTICES.

*H. J. Cooley* suggested the following four-year course for spring makers' apprentices. He was asked to give it a trial and make a report later.

| | |
|---|---|
| Helping | 0 to 2 months. |
| Shearing | 3 to 4 " |
| Nibbing | 3 to 4 " |
| Rolling | 4 to 6 " |
| Punching | 4 to 6 " |
| Heating | 5 to 6 " |
| Tempering | 5 to 6 " |
| Bending | 3 to 4 " |
| Testing | 3 to 4 " |

This allows 6 months which may be used as the foreman thinks best in order to build up any branch of the work in which the boy may have shown a weakness.

### DUTIES OF THE SHOP INSTRUCTOR.

*W. F. Black.*—One of the first duties of a shop instructor is to create a feeling of friendship and trust, not only with the apprentices, but with the mechanics and shop foremen with whom he comes in contact. He should always strive to obtain the best results from the apprentices and for the company, and to do this he must be with the boys at all times. When a boy meets with a difficult job stay with him until he understands it thoroughly; oftentimes you can tell a boy how to go ahead and do it, but when you leave him to his own resources he is doubtful how to start the work and will lose time.

When in the shop I have often been asked this question, "How do you get so dirty?" and my answer is this: When a boy is working in the front end of a boiler or underneath an engine it is the shop instructor's duty to be with him and see that he is doing his work properly. If he needs instruction do not neglect him just because he is in a difficult and dirty place.

It seems to me it should be the duty of the shop instructor to spend one hour at each session in the classroom and laboratory and to keep in close touch with the apprentices in the drawing and problem work, assisting the drawing instructor to the best of his ability.

In regard to the shop instructor supervising apprentices in other trades with which he may not be familiar, would suggest that he use all means to gain the confidence and respect of the foremen and show them that his interest in their boys is bound to work to their advantage. Instruction given boys by the foremen is of great value and in some trades the foreman must be depended upon to give practically all the shop instruction which the boy receives. The shop instructor, if he is a graduate machinist, could only occupy a supervisory position in the smith or boiler shop. He should visit these shops once or twice a day and see that the boys are faithful in their work.

### SHOULD THE SHOP INSTRUCTOR NOTIFY THE FOREMAN OF THE BOY'S NEXT ADVANCE IN RATE?

*M. T. Nichols.*—I do not think it necessary for the shop instructor to notify the foreman directly of the apprentice's increase in rate. This should come from the shop superintendent's office. We are using the following method which covers the ground very satisfactorily. On the last day of the month I send a list of all the apprentices to the time-keeper, asking him to advise the number of days each apprentice worked during the month. I then add the days he gives me to the number of days credited in the record and whenever an apprentice is to receive an increase during the next month I send a notice to the assistant master mechanic which he forwards to the time-keeper.

*G. Kuch, Jr.*—It would be well to notify the general foreman when the time comes due for the boys' next advance in rate. The shop record shows the number of days credited for the month and the total days since beginning their apprenticeship; this will give the date of the boys' next advance in rate very closely.

*R. M. Brown.*—Most of you know that on the Lake Shore, we keep an efficiency record card* of all employees, including the apprentices. The clerk in the office of the superintendent of shops keeps the apprentices' time, which is furnished to him by the shop accountant. When a raise in rate comes due, the clerk and the shop instructor get together and notify the superintendent of shops of such boys as are due for a raise. They make up a regular form to be approved by the superintendent of shops and the superintendent of motive power, which finally comes back to the shop accountant. Before raising their rates we look up their efficiency record to see if they show up well. If they do not my attention is called to it and we find out why the boy hasn't a good grade.

*Discussion.*—It developed that the practice outlined by the first two speakers is in use at practically all of the shops.

### SHIFTING APPRENTICES.

*M. T. Nichols.*—We are trying a new method of shifting apprentices at the Elkhart shops which we feel sure is going to prove successful. It seems wise to keep a boy on some jobs longer than on others in order that he may become thoroughly familiar with the work, and for this reason we have decided to lengthen the time for all jobs from three to four months, but at the same time following as closely as possible the N. Y. C. Lines standard schedule.

The sequence or order of shifts sometimes makes a difference in the length of time a boy is left on a job before being shifted and a great deal also depends upon the boy's natural mechanical ability to learn quickly. A boy who has learned to run a planer will need but a short time to learn to run a shaper, and if he is put on the shaper right after the planer he may not need to remain there as long as if he had come from a lathe.

*G. Kuch, Jr.*—The shop instructor should carefully study the

* See December, 1908, issue of this journal, pages 459, 460 and 468.

shop record of apprentices near the last of the month and note any boys who have been on the same class of work for three or four months. He should then make a list of these boys, giving them shifts which will make their work most advantageous to the company and still as far as possible in accordance with the New York Central Lines schedule of courses. The instructor should show this "line-up" to the foreman for his approval. The list should be made a week or so ahead of the first day of the month so as not to delay the work when the shifts are made.

I would recommend that the boys be shifted in groups of from three to seven at a time, since by so doing they can be better handled and instructed in the work. When making shifts of groups of boys care must be taken not to have all of the boys from one department attend the same class in the schoolroom, since the department would be weakened by so many boys leaving it at one time.

The shop record and monthly report should be kept by the shop instructor as these two reports are the whole key to the apprentices' changes and without this record it would be impossible to check the time the boy is on a certain class of work. When the shop instructor keeps this record he can see the boys' marks relative to workmanship and personality and can in many cases shift a boy to that class of work to which he may be best adapted. By keeping in close touch with these records the shop instructor can see the total days credited on the record for each boy and how he is getting along in his time so that the proper shifts may be made as per schedule.

*Discussion.*—At Jackson all of the boys are shifted at the same time—the system of gang bosses is such that this may be done without disorganizing the work.

### OBSERVATION TRIPS FOR INSTRUCTORS.

*C. A. Towsley.*—We should be on hand before the school we visit is called to order to note the deportment of the boys in getting their outfits and taking their places. Make it a point to look over their work carefully and make mental comparisons with the work of your own boys and decide whether you are holding up your end. Look over all of the apparatus with a view of improving your own on your return. Whenever anything of interest is found, make a note and, if necessary, a sketch of it, to insure against the loss of any valuable information. A walk through the shops will be a fruitful source of information about many little kinks and tools that will undoubtedly be acceptable to your superiors upon your return.

There is nothing better for the general advancement of the instructor than a visit to one or more of the schools and shops. It works up a new store of enthusiasm—you feel that you are more than ever a factor in the great educational system and you go home more satisfied and better qualified to meet the emergencies that come up from day to day.

### TOPICAL DISCUSSIONS.

*Classroom Instruction in Shop Practice.*—It was decided to have the shop instructors look into the advisability of arranging a course of instruction on the proper names for tools, the best shapes for different purposes, proper ways of setting, the handling of special jobs, etc.

*How Far Should Instruction in Algebra, Geometry and Drawing Be Given?*—The sentiment seemed to be that only the simpler principles of algebra and geometry should be considered—just enough to solve the ordinary shop problems and make the principles of mechanical drawing clear. As a matter of fact the algebra and geometry that is taught is not designated as such, but the principles are introduced from time to time as they are needed in the problem course. The amount of mechanical drawing depends on the trade.

*The Assistant Classroom Instructor.*—At West Albany there are two assistant classroom instructors, one for blackboard and laboratory work and one for problem work. At Collinwood there are two assistants for each class, or six in all. These boys are shifted every three months. In the absence of the instructor they conduct the school.

*Should the Boys Be Discouraged from Becoming Draftsmen?*—Mr. Martin, of the Beech Grove shops, said: "During the past two years, among all the boys who have completed their apprenticeship courses, we have only had one who expressed a desire to become a draughtsman. He was out of his time two months ago and left the service. He was also the only boy to leave the service after completing the course. We have turned out many boys who would make very good men in the drawing room, but they all preferred to stay in the shop."

On the P. & L. E. R. R. the drafting room force for the past two or three years has been recruited from among the graduate apprentices. If a boy has a strongly developed tendency toward drafting room work he should not be discouraged from following it up.

*Should There Be a Separate Shop Instructor for Car Shop Apprentices?*—Mr. Cooley said that they had twenty-four car shop apprentices at Collinwood. The duty of seeing that they are properly instructed is alloted to the assistant foremen in the various departments. The only place where they feel they need a special instructor is in the freight car repair yard, where they have nine apprentices.

*Course in Lettering for Painter Apprentices.*—The discussion indicated that there is a need for such a course to be taken at the conclusion of the general drawing course.

*Difficulty in Obtaining Boilermaker and Blacksmith Apprentices.*—It has been overcome in some shops by increasing the rate. The instructors should secure the co-operation of the foremen in making conditions more attractive.

*Use of Stools in Drawing Room.*—It was the opinion of all that the drawing room should be so provided and that better work was done when the boys could either sit down or stand at their convenience.

*Should Square Root Be Taught?*—Mr. Towsley, of Elkhart, said: "We have been teaching it for about six months, and all of the boys with but a very few exceptions are now quite familiar with it and can use it whenever occasion requires. A number of the problems in arithmetic required its use, and rather than beat about the bush with approximations, we decided it would be better to give all an insight into the method of using it. We give all members of the class twenty minutes of arithmetic at the blackboard at the close of every session, and we devoted this entire time for several weeks to the study of square root and general problems requiring its use. From the results we feel that all are amply repaid for the time thus spent, and can heartily recommend its adoption and addition to the regular course." Mr. Gardner stated that a course in square root was in preparation.

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Travel Becoming Safer.—During the fiscal year that came to an end on June 30 last, the Chicago and Northwestern road carried a total of 27,000,000 people without a single fatality. This is the first road reporting such a remarkable record for the current fiscal year. Two roads, the Pennsylvania and the Burlington, accomplished a similar feat for the calendar year of 1908. The three records are taken by railway experts to indicate clearly that the science of railroad operation has made a substantial advance during the past two or three years. Better discipline has been inaugurated, block signal systems have been extended and, in the case of the Northwestern, double tracks have been completed between Chicago and the Missouri River.—*Railway World.*

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Surprise Tests.—Over 156,000 efficiency tests were made by the Pennsylvania Railroad in the first six months of this year, and practically a perfect record was made by the employees. The average number of tests made each day was 862, and of the total for the six months, 99.6 per cent. were perfect. In the .4 per cent. of failures are included the cases where enginemen passed signals by a few feet before stopping their trains, and similar cases which, though technical violations, were not such as would make possible an accident to a train.

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## CONTENTS



## EFFICIENCY NOTES.

Carefully studying the boiler repair question, which resulted in placing a man in general charge of the maintenance of boilers and the issuing of permanent instructions concerning the exact way in which the boilers should be cleaned and washed, and seeing that they were enforced, almost did away with the ordering of staybolt iron on one railroad. This result was only incidental—the money saved due to reduction of failures on the road, loss of time, etc., while it could not be estimated, was many times the additional expense involved.

* * * * * * *

The examination and study of broken and defective locomotive parts and provision for applying stronger ones, and the installation of a good system of roundhouse work reports and inspection was responsible for reducing engine failures on a large system from 8,000 to 30,000 miles per failure. It cost something to accomplish this, but it was only a small proportion of the total saving to the company.

* * * * * * *

In the discussion of a paper on "Fuel and Oil Consumption of Locomotives," presented before the Northern Railway Club, the statement was made that if a fireman will save one scoop of coal per mile, on a 133-mile run he will save one ton of coal. On this basis, a road making 10,000 train-miles per day would save 75 tons of coal, and at $3 per ton this would amount to $225 per day. This simply illustrates how little economies, if carried out, will reduce the operating expenses.

* * * * * * *

The cost of shop supplies at a certain manufacturing plant was calculated on the basis of the output in tons. It was believed that it could be very considerably reduced and an allowance, partly arbitrary, was made for each of the different departments with the understanding that if it was exceeded the matter must be taken up with the manager of the plant before additional supplies would be furnished. The result was a remarkable decrease in the expense of this item without in any way impairing the efficiency of the plant.

* * * * * * *

Frederick A. Geier, of Cincinnati, in speaking on industrial education at the October meeting of the National Machine Tool Builders' Association in New York, said: "Manufacturing processes are becoming more highly organized, and, while there is a greater subdivision of labor, I believe it is true that we need a working force to-day of greater general intelligence than in the days when simpler machines and simpler processes were employed in producing our work. A careful analysis of the conditions in any manufacturing plant will reveal a tremendous waste, because of the abuse of machinery and tools, a low standard of work, spoiled pieces, etc., a great part of which waste could be eliminated if there were a higher degree of intelligence on the part of the workmen."

* * * * * * *

Files are a comparatively small item of expense in a railroad shop, but judging from the investigation made by Edward G. Herbert, as described on page 454 of this number, there are great possibilities of increasing their efficiency. Surely the matter is worth while investigating when a difference of 3½ times as much work and 4 times as many strokes is possible on two sides of the same file.

* * * * * * *

The introduction of a type of car (which the leading car designers laughed at a few years ago and claimed would not stand up in service), in the ore traffic at the head of the lakes, made it possible to load a steamer a few days ago with 10,111 tons of ore in thirty-nine minutes as described in a note on another page of this number.

* * * * * * *

An investigation was made at a manufacturing plant, which seemed to be efficiently managed, to find out the cost of maintenance of the plant on a basis of tonnage output. The figure obtained appeared to be rather high and after investigating the matter in detail it was decided that it would be possible to reduce this cost 30 per cent. The various departments of the plant were given estimates as to their percentage of the total amount with the result that in a very short time a reduction of 21 per cent. had been made and it is expected that when business picks up it will not only be possible to make a 30 per cent. reduction, but go beyond it. This without in any way affecting the efficiency of the plant and with practically no increased expense for supervision.

* * * * * * *

The following is taken from Harrington Emerson's book on "Efficiency": "When each unit of locomotive repair is standardized, the sum of the units shows a cost between $0.03 and $0.06 a mile for maintenance. The actual average costs on the railroads are between $0.06 and $0.12—therefore twice what they ought to be. The standardized cost of maintaining freight cars is as low as $30 per annum. Actual average costs run from $45 on some roads to over $100 on others. Standards of maintenance of way vary, but innumerable assays of actual work show a maintenance-of-way labor efficiency of scarcely more than 30 per cent."

* * * * * * *

On a certain railroad a study of the cost of oil for freight car journal boxes indicated that it was entirely too high; at the same time there were too many hot boxes. Regulations were made for a more careful inspection and it was ordered that the boxes should be re-packed at regular intervals. To do this each division point was required to do a certain amount of this work each month. Each one of these points was also given a *reasonable* allowance of oil for doing the work. As a result the expenditure for oil was greatly decreased, and there was a remarkable reduction in the number of hot boxes. All of this was obtained by placing the oil on an allowance basis and issuing proper instructions, which it was plainly understood must be lived up to.

## UNIT SYSTEM OF ORGANIZATION ON THE HARRIMAN LINES.

The new system of organization being installed in the operating department of the Harriman Lines is a unit system. It is predicated upon the belief that true organization demands the preservation of the integrity of units; that overlapping jurisdictions must be avoided. For example, it denies the right of the chief engineer to have direct written communication with the division engineer or road master; or for the superintendent of motive power to deal in writing with any office but that of the division superintendent. A division is made a complete unit and duplication is avoided by a consolidation of all the files at the division headquarters. This in turn permits giving all the members of the division staff the uniform title and authority of "assistant superintendent." The result is to increase the supervision of the working forces and to augment the efficiency of service units. So tenuous is the line between the various so-called departments that this system pools the energies of the staff. It is left to the head of each unit, in case of the division, the superintendent, to co-ordinate the technical specialties of his staff for the best interest of the service.

Practical experience has shown already that this elasticity is far better than an attempt to define authority by rigid rules. Each assistant is held responsible for a particular branch of the work, such as track, equipment, train service, stores, etc. He is aided in the work of supervision by his fellow assistants of the staff. It has been found that the superintendent can be trusted to maintain a proper balance among his assistants, all of whom have been sufficiently long in the service to have a common-sense idea of propriety in any occasion that may arise. The system, like the English Constitution, is based on unwritten laws. It has a practical flexibility superior to standard charts of organization.

The underlying theory is that the service can only be improved by the broadening of the individual. Under the system each official transacts business in his own name and no person is allowed to sign the name or initials of another. Instead of ten or twenty dispatchers and clerks signing the name of the superintendent, each official or dispatcher signs for himself, the presumption being that in so doing he is properly delegated by the superintendent to the specific purpose in hand. The superintendent's name and initials cease to be cheap. The idea is to inculcate and locate responsibility and to give a communication weight in accordance with the actual signer rather than in accordance with the fancied importance of the sending office.

An essential feature of the system is a senior assistant for each unit who takes charge of the office and is relieved from traveling duties. Although the system reduces the volume of correspondence from 30 to 50 per cent., it is felt that the office end is of sufficient importance to hold the undivided attention of the second best official on the division or other unit. The superintendent, for example, and all the other assistants go out on the road, but the senior assistant remains at headquarters and preserves the continuity of the division activities. All communications received and sent are supposed to pass over the desk of this senior assistant, both for his information and for purposes of co-ordination. This scrutiny frequently results in cutting out useless correspondence. It should be borne in mind that much of this correspondence is already signed by some other assistant before reaching the senior assistant. In case, however, any assistant is out on the road, say the former division engineer, or one time master mechanic, the communication is not signed by a clerk for the absent official, but by the senior assistant himself in his own name, thus preserving individuality. The principle to guide subordinate officials and employees is the same as in train dispatching, to be governed by the latest instructions received.

Not only does this system facilitate administration, reduce correspondence and increase supervision, but it broadens the individual for future advancement. The division engineer must take some interest in motive power, the master mechanic cannot ignore track. As a consequence such division engineer or master mechanic has open to him an avenue of competition for the coveted position of superintendent and all possibilities beyond.

This system is now in successful operation on seventeen units of the Harriman Lines. It is estimated that its extension to the remaining units of the operating department will result in saving the writing of probably *300,000* unnecessary letters per year. It is explained that the cost of producing these unnecessary letters is a mere trifle in comparison with the magnitude of the operations involved. It is their retarding effect upon administration that is undesirable. They delay the game.

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The above organization, also known as "The Hine System of Organization," is being installed under the direction of Major Charles Hine, special representative on the staff of the director of maintenance and operation. He is a graduate of West Point Military Academy and studied law and was admitted to the bar while serving as a lieutenant in the army. After resigning his commission in 1895 he entered the service of the Big-4 as a brakeman and served in various positions, finally becoming general superintendent. In addition to this railroad experience he has been connected with several railways and corporations on special work and has made reports on different features of a number of railroads. During the Spanish-American war he served as a major of volunteers and was engaged in the siege of Santiago de Cuba. On returning from the war he was for a time inspector of safety appliances for the Interstate Commerce Commission. In 1907 he assisted in the revision of the business methods of the Department of the Interior at Washington and acted as a receiver of the Washington, Arlington & Falls Church Electric Railway. Many of our readers will recognize him as the author of "Letters from an Old Railway Official to His Son."

## CHAIN GRATES.

A study of chain grates in power plants was recently made by the United States Geological Survey. The following summary is taken from bulletin 373 containing the report of this investigation:

The chain-grate stoker was found in plants carrying uniform loads and in plants where loads were extremely variable. With a uniform load and a proper setting there should never be any smoke with this equipment, but when a variable load is carried a faulty method of operation may cause the emission of dense smoke. In a chain-grate plant having a variable load, with the fire carried up to the water back, a sudden release of load will require a reduction of draft. Too often the damper is nearly closed, so that the coal on the grate and the fresh coal fed to hold the fire are burned with a limited air supply, causing the stack to smoke badly.

Plants equipped with the chain grate can be made to carry a very variable load with good results by changing the thickness of the fire, the speed of the grate, and the position of the damper to suit the load. The draft should not be reduced below a certain value, which can be determined for each plant by gradually closing the damper and watching the stack. In a plant where the maximum variations of load are nearly the same, it might be necessary to vary only the speed of the grate and the position of the damper. The damper regulator is often the cause of a smoky stack, because it is usually set to choke off the entire draft, a condition which is never necessary.

Both the speed of a chain grate and the slope of the ignition arch are important. Too often the grate is run so fast that volatile matter is being driven from the coal as far back as the center of the grate; usually in this case there is not only a loss from incomplete combustion of the gases, but also losses from unconsumed carbon in the ash and from injury to the grate. Live coals in the ashpit will not only warp a grate, but gradually burn it up. The grate should not be run so fast that it will be hot when re-entering the furnace. In one plant where a high draft was carried, a sloping arch was removed, and an arch built parallel to the grate. With the sloping arch the stack smoked, but with the flat arch it was entirely clean.

With chain-grate equipment a plant may run very inefficiently if the fire is carried only on the front half of the grate, as sometimes happens. When coal is burned in this way with a proper setting, it is because the fireman finds it the easiest way to carry a variable load and have a clean stack, demanding less of his attention in operation.

At some plants the boiler is forced by firing considerable coal through the inspection door. Although the desired result is accomplished by this practice, the plant becomes the equivalent of a handfired plant and the stack will invariably smoke badly.

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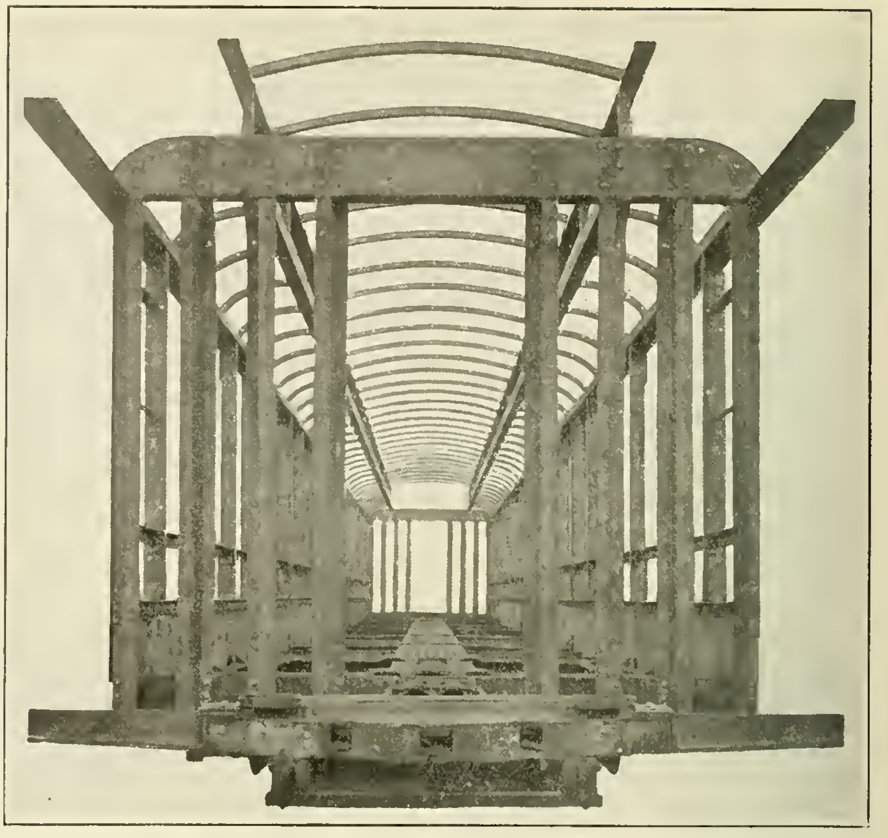
The Erie reports 125,000,000 passengers carried in the past 5 years without a fatality.



STEEL FRAME, BUFFET LIBRARY CAR.

INTERIOR OF STEEL FRAME, BUFFET LIBRARY CAR.

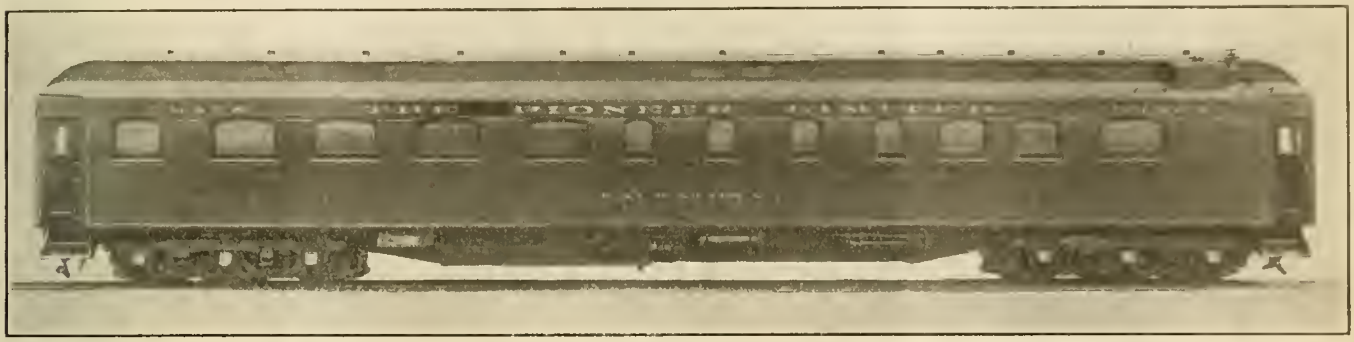
# BUFFET LIBRARY CARS.

CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY.

The Barney & Smith Car Company recently delivered to the Chicago, Milwaukee & St. Paul Railway some handsome passenger cars which embody a number of interesting features. This equipment consists of ten baggage, mail and express cars, fifteen day coaches and two buffet library cars.

An examination of these cars makes it apparent that the new Pacific Coast extension of the St. Paul is to be supplied with the very best possible accommodations for its passenger traffic. All of these cars are modern in every particular and the interior design and decorations are strikingly fine and original. In the structural features the three classes of cars are substantially the same, so that the description of the buffet library car will give a good general idea of all of them.

These cars are 72 ft. 6 in. long over end sills, 10 ft. wide over the frame and are constructed with complete self-supporting steel underframes and a steel framework for the superstructure. The underframes are composed of built up girder center sills and built-up side trusses in connection with the Commonwealth Steel Company's combined cast steel double body bolsters and platforms. The center construction consists of two 5/16-in. web plates 30 in. deep at the central portion between the cross-ties, tapering to 12 in. at the point of juncture with the bolsters, with four 3½x3½x⅝-in. angles at the bottom of the webs, two 3½x3½x⅜-in. angles at the top and one 24x⅜-in. top cover plate. The side trusses consist of 24x5/16-in. web plates with one 3x4x⅝-in. angle at the top, one 3x4x⅜-in. and one 3x3x5/16-in. angle at the bottom. The top angle is placed on the inside of the web plate forming a foot rest. The 5/16-in. angle is placed outside of the web plate and carries the wood nailing strip to which the side sheathing is secured. The center construction is designed to resist the pulling and buffing shocks and to carry a proportion of the load, while the side trusses take care of the balance of the load.



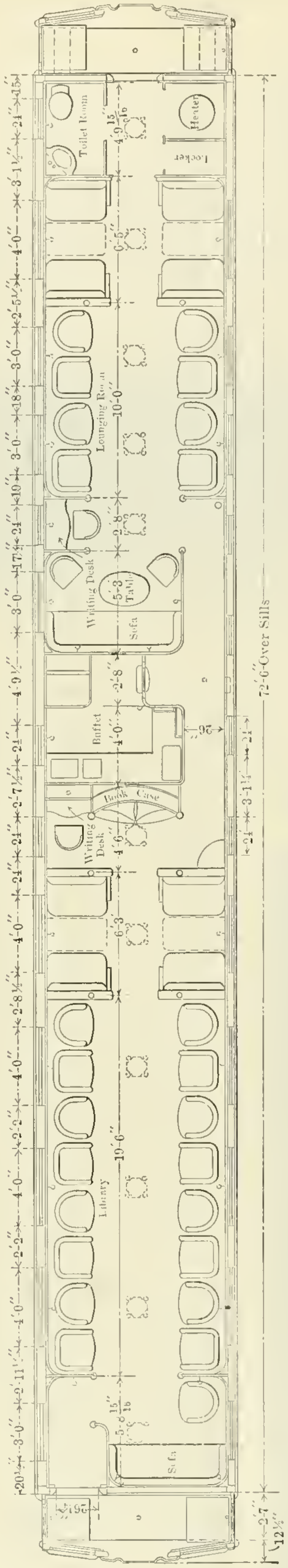
BUFFET LIBRARY CAR FOR THE "PIONEER LIMITED"—CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

There are four Commonwealth Steel Co.'s cast steel cross-ties and center filler castings per car, all being 30 in. deep, the object being to equalize and distribute the load between the center construction and the side trusses. The floor supports between the cross-ties are 4-in. channels.

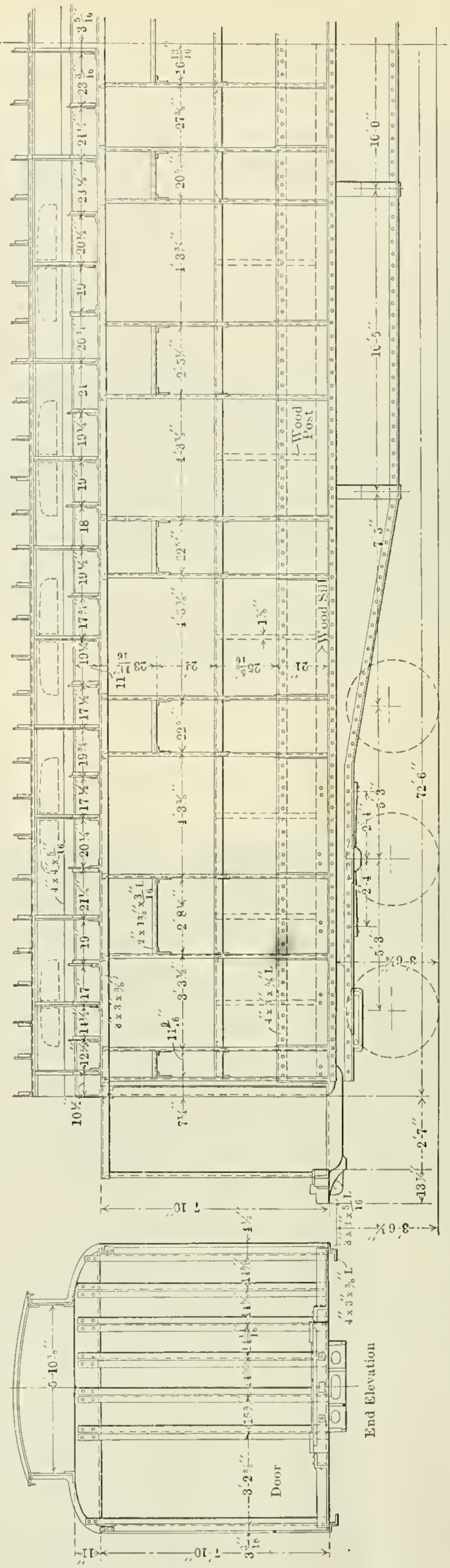
Eight 4-in. "Z" bars at each end of the car, the lower ends extending down into pockets cast in the steel platform and riveted to the end sill sections, form the end framing and anti-telescoping device. The upper end of each of these "Z" bars has the web cut out and the inner flange pressed back even with the outer flange, and both flanges are riveted to a pressed steel end plate, which in turn is securely connected to the side plates and roof framing of the car.

The side framing consists of 3/16-in. pressed steel channel-shaped posts running from the side plates to the bottom of the side trusses. Each of these posts extends the full depth of the side truss and has a large inner flange at this point, which provides an extremely large surface for securely riveting the post in po-

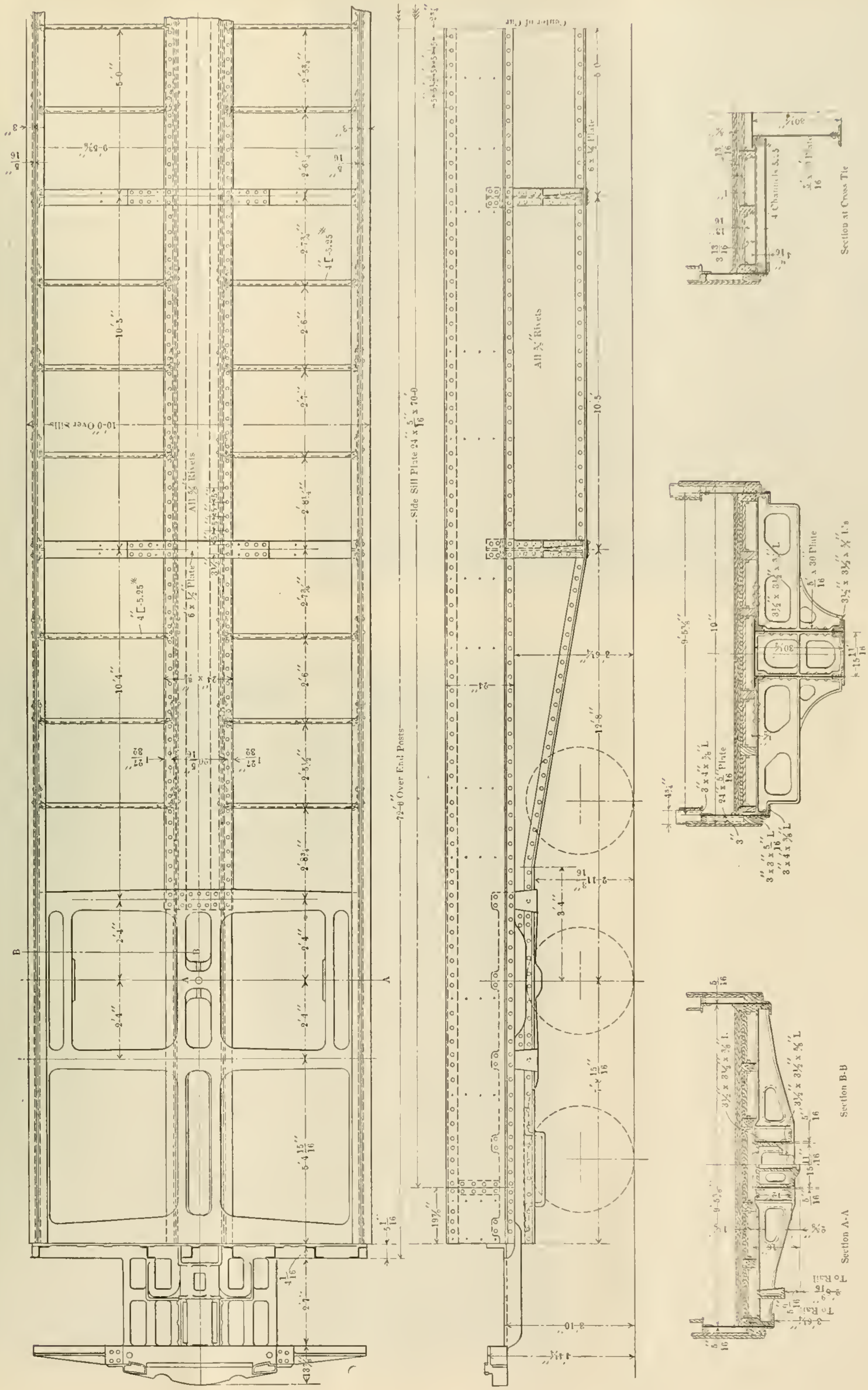
LIBRARY END OF CAR SHOWING SOFA.



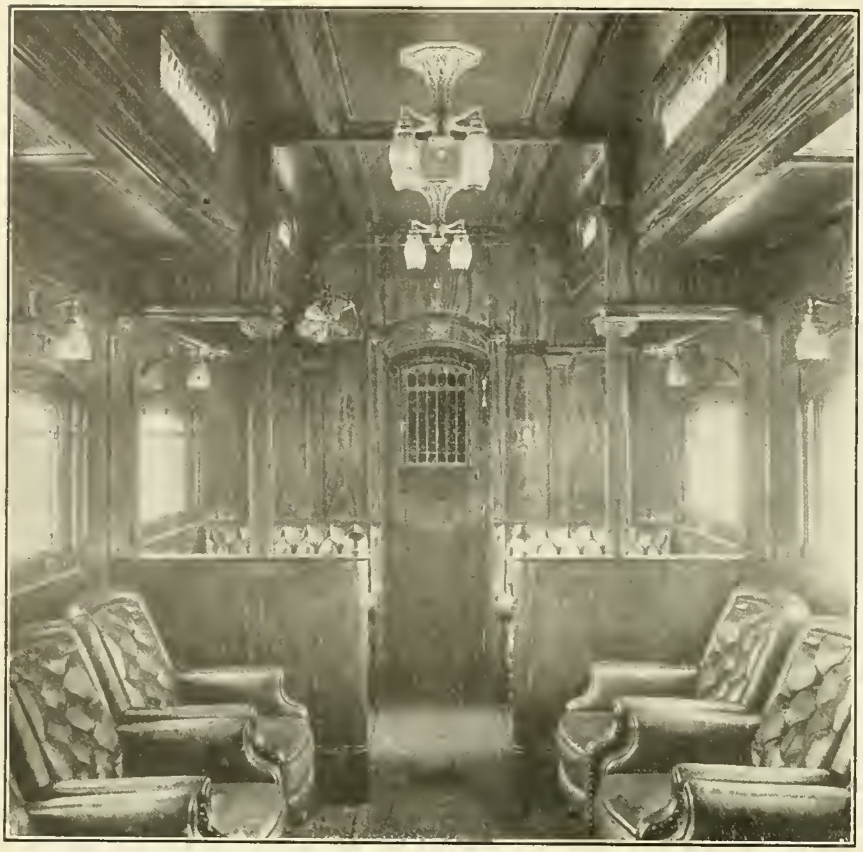

FLOOR PLAN OF BUFFET LIBRARY CAR.




END ELEVATION AND HALF SIDE ELEVATION OF FRAMING OF BUFFET LIBRARY CAR.




PLAN, SIDE ELEVATION AND SECTIONS OF STEEL UNDERFRAME, BUFFET LIBRARY CAR.



LOUNGING END, SHOWING STATIONARY SEAT SECTION.

the train or between sleeping cars, so that sleeping car passengers may enter it from either end, which was the feature that controlled the floor plan. This is likely to prove to be a most convenient and popular arrangement for passengers who want to use the car for reading or lounging.

The car is divided into two rooms with the buffet between them. The smaller of the two is the lounging room; the larger, the library or reading room. The former is finished in dark woods with subdued lighting and color effects; the latter in lighter tones with brilliant coloring. While both rooms suggest comfort and luxurious ease, the effect in the lounging room is toward relaxation, while the library reflects the well-ordered repose of a brightly lighted room for reading and social intercourse.

A dark wood, native to Peru, where it is known as "Quitacalcon," is used for the interior finish of the lounging room. The builders, who have used the wood for several years, have given it the name of "Peruvian Mahogany." It is finely figured and takes a perfect polish. The interior finish of the library end is in Cuban mahogany, beautifully marked. Delicately executed designs in marquetry of rare woods characterize the whole of the interior. All of the marquetry has had the special Barney & Smith treatment to preserve the natural colors of the woods.

sition. The side girths are composed of 3 x 5 x 5/16-in. angles fitted and riveted between the pressed steel posts. The side plates, which are continuous, are of 3 x 3 x 3/8-in. angles. The deck sills are continuous steel angles 4 x 4 x 5/16 in. The deck plates are of 3/16-in. pressed steel channel-shaped sections. The rafters, for both the upper and lower decks, are of angle section 2 x 1 1/8 x 3/16 in. bent to shape and riveted directly to the deck sills and the deck plates, and secured to the side plates by malleable iron castings riveted to the lower deck rafter and the side plates.

Nailing strips are bolted to the side posts and the rafters for securing the outside sheathing, the roof, the inside finish and the headlining. Wood nailing strips are placed in the bottom framing for securing the flooring, there being one deafening floor below the sills, and the two upper floors. The finished floor is of "Flexolith" composition material, manufactured by the General Railway Supply Company. This composition is laid over expanded metal, which is attached to the upper course of wood flooring. The lower floors are further insulated with a course of 1 1/2-inch hair felt placed between the floor nailing strips.

Extremely heavy draft and buffer attachments are provided, Miner friction draft rigging and Forsyth friction buffers being used. The trucks used under the buffet library cars are the Commonwealth cast steel six-wheel truck frame, equipped with Paige 38-inch wheels, Franklin journal boxes and Diamond special brake beams.

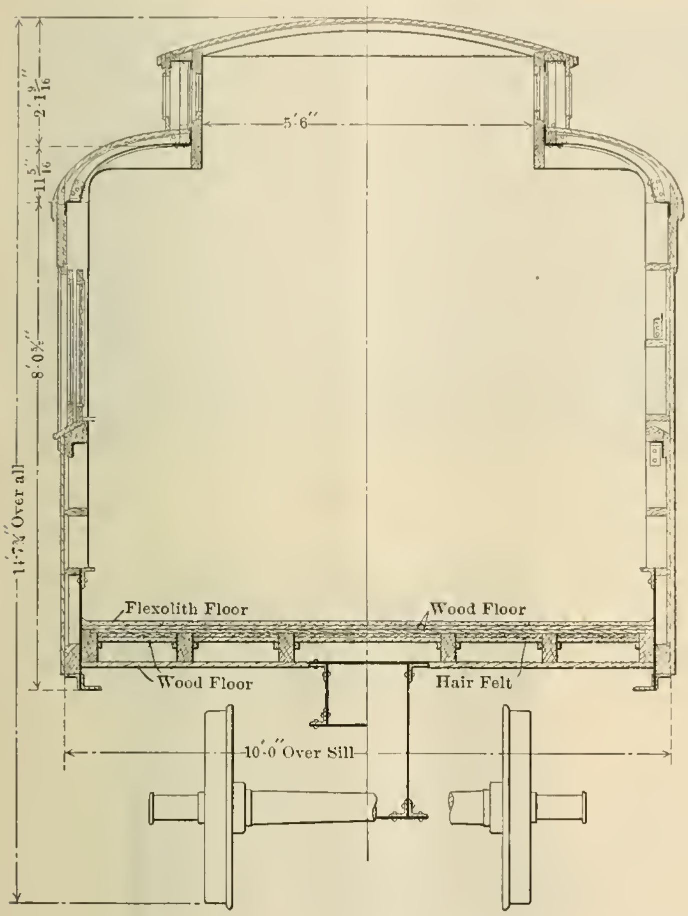
This car, instead of being placed at the forward end of the train, as is usual with buffet library cars, is to be placed in the middle of

SOFA IN LIBRARY.

This treatment consists in carefully coating the marquetry after it is placed in position with a composition, which is removed after the ground work has been filled. This treatment gives a clean-cut contrast and naturalness to the marquetry that is lacking in much of this sort of decoration to be found in passenger car ornamentation.

One of the noticeable features of the interior is the entire absence of square or angular corners in the library room. The bulkheads, side walls and partitions have round corners, forming a continuity of line which gives a pleasing relief from the usual box effect and thereby contributes to the general air of comfort and repose, which is the characteristic idea throughout.

The idea of the curved lines is carried into both the lower and upper deck in the library room and appears both in the ogee curve in the headlining and in the coloring, which gives an impression of height and roominess that is most attractive. This general effect of roominess is much enhanced by the height of




CROSS-SECTION OF FRAMING OF BUFFET LIBRARY CAR.

the windows. All of the windows stop at the chair rail line and the result is an impression of bulk and strength on the exterior and altitude and space on the interior.

Electroliers specially designed to suit the general theme and finished in statuary bronze are provided. Those in the lounging room have iridescent shades while those in the library end have Holophane shades. The inside windows are of leaded glass with a combination of polished French plate combined in designs of richly colored cathedral glass. The glass in the deck sash is of the same general character.

In the lounging room, the ceiling is finished in canvas and is paneled with massive beams and painted a rich red slightly relieved with gold line ornamentation. The carpets are of the best Wilton. The chairs, sofas and cozy corners are upholstered in Spanish leather in shades to match the color schemes of the several rooms.

The cars weigh about 153,000 lbs.

## CINCINNATI CONTINUATION SCHOOLS.

About three years ago, Houston, Stanwood & Gamble established a school in their own shop, giving instruction to their apprentices during shop hours. Their experience was so profitable that about a year later the Cincinnati Milling Machine Company established a similar school. We first attempted to operate this school at night, but, because of the difficulty in insuring an attendance on the part of the boys, we soon decided to also operate this school during working hours. These two schools were noticed by other manufacturers, and were also brought to the attention of the Board of Education. After a number of conferences between the manufacturers and the members of the Board of Education it was decided, beginning with September, to operate a continuation school under the auspices, and at the expense of the Board of Education. It was agreed by the manufacturers that they would send their apprentice boys and other young men to this school four hours per week, paying regular wages while the boys were in attendance.

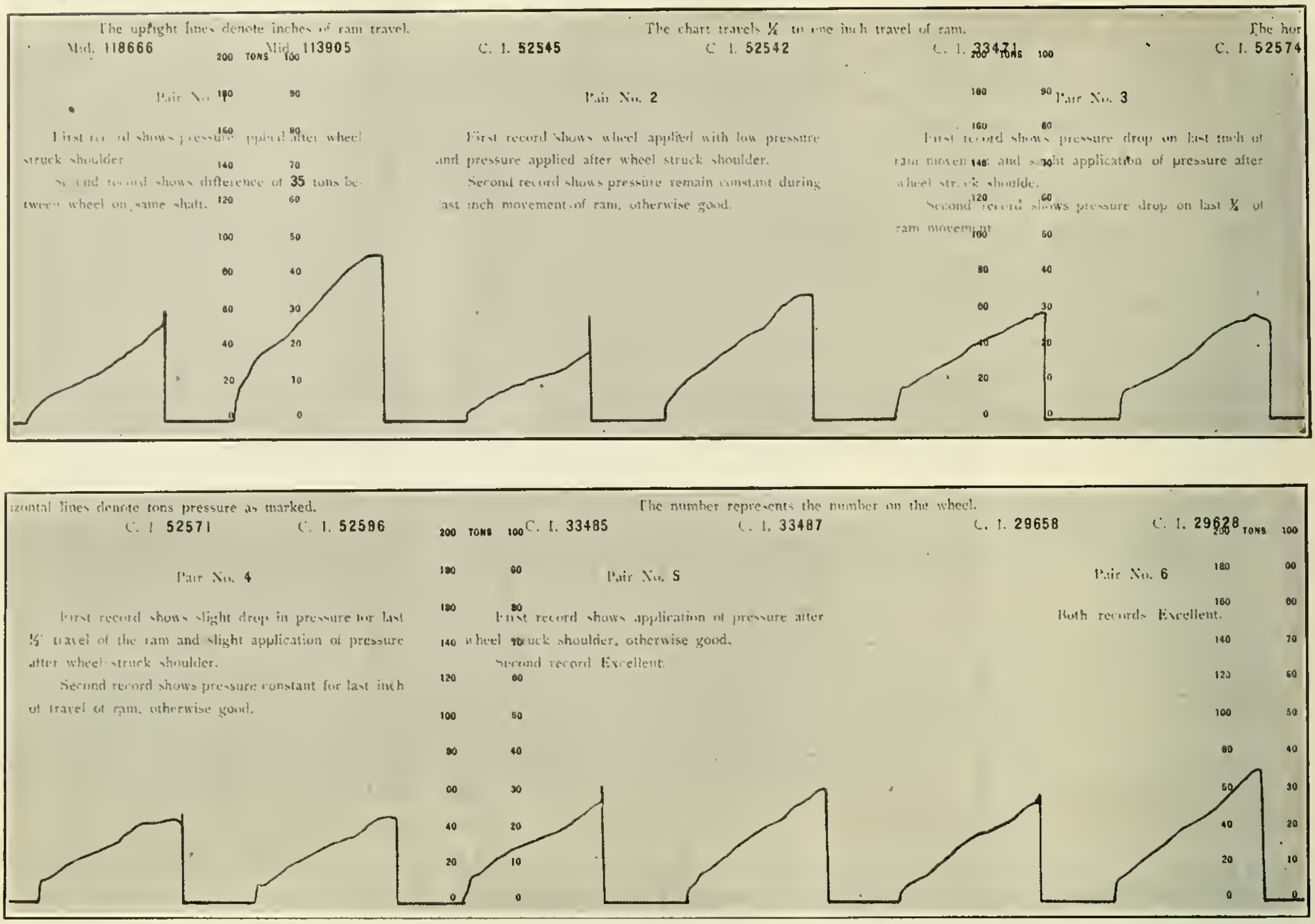
Over 200 boys are now enrolled, and, as fast as additional teachers can be provided, there is no doubt that this enrollment will be very greatly enlarged. You must remember that, at present, the boys that attend the continuation school are all employed in machine shops. The course has not yet been brought to embrace the other industries in Cincinnati. The classes of this continuation school are limited to about 20 boys. They are taught elementary and higher mathematics, including problems in geometry and trigonometry. The whole plan of the school is to teach directly the problems that the boy encounters in the shop. The catalogue and blue prints of the machine manufacturers of Cincinnati are the text books, and through the co-operation of the superintendents and the engineers employed in the shops of Cincinnati the work done at this school to-day is probably more practical and more effective than of any school in this country or in Europe. The efficiency of these boys in the shop is already showing substantial improvement, and will increase as the teaching force and courses at this continuation school are amplified.—*Frederick A. Geier, before the National Machine Tool Builders' Association.*

## TRESPASSING ON RAILROAD PROPERTY.

Trespassing on railroad property, in violation of the law, has been responsible for the deaths of 47,416 people in the United States in the last ten years. In the same period, more than 50,000 trespassers were injured. It is in view of these facts that many of the important railroads have determined to redouble their efforts to secure in this country that rigid enforcement of the law against trespassing, which, in England, has reduced the practice—and accidents to trespassers—to a minimum.

The number of people killed while trespassing on railroads has been increasing every year. In 1898, 4,063 trespassers lost their lives on American railroads; five years later the number was 5,000, and in 1907, the number killed was 5,612—more than 15 a day. These figures are taken from the annual reports of the Interstate Commerce Commission.

The alarming death roll from trespassing on railroad property, which from 1899 to 1909 was nearly four-fifths of that suffered by the entire Union Army in all of the battles of the Civil War, is every year charged up to the railroads, even though these people were killed while violating the law and under conditions over which the railroads have no control. The co-operation of state and county authorities has been solicited, but actual punishment of persons violating the laws forbidding trespassing on a railroad's private property has been infrequent. The cost of imprisonment has deterred the local courts from holding those arrested while trespassing on railroad property. The practice of walking on railroad tracks has been growing constantly, and the number of persons killed and injured increases with it.



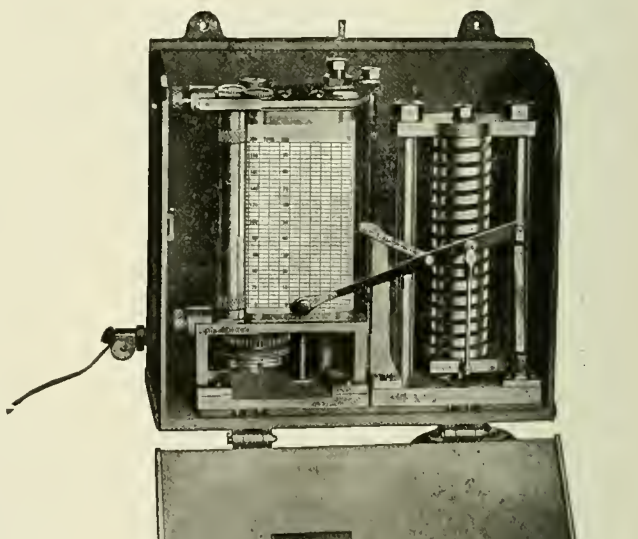

TYPICAL DIAGRAMS MADE BY THE HYDRAULAGRAPH IN PRESSING ON WHEELS. THE LARGER CAPACITY SCALE WAS USED. A LIGHTER SPRING MAY BE FURNISHED FOR WORK REQUIRING LESS THAN 100 TONS PRESSURE.

## THE HYDRAULAGRAPH.

In pressing wheels on axles in a hydraulic press it is customary to specify a certain maximum pressure which shall be attained, or not exceeded. This pressure will, under proper conditions, be reached just before the wheel strikes the shoulder on the axle, having increased in a constant ratio from the beginning of the operation. Because of the usual presence of the shoulder on the axle it is possible for a workman, either intentionally or accidentally, to obtain the required pressure on his gauge with a loose fit after the wheel has been completely pressed on and is against the shoulder and in this manner a wheel may be passed which is dangerously loose upon the axle.

To eliminate any possibility of this being done a new instrument has been designed by the American Steam Gauge & Valve Mfg. Co., of Boston, for application to hydraulic wheel presses, which has attracted much attention among railway mechanical men. By means of this instrument a diagram is obtained in a form very similar to the speed record from a Boyer speed recorder, which shows the exact pressure and movement of the wheel relative to the axle at all points in the operation. Such a record gives an exact graphic account of the conditions under which the fit was made and makes it possible to reject at once an unreliable pair of wheels, which might otherwise be placed in service and cause a bad accident.

The Hydraulagraph is built on the general design of a continuous steam engine indicator, but adapted to hydraulic work. It comprises a spring of great power of resistance and unerring accuracy, resisting the movement of a piston in a small cylinder connected to the chamber of the ram. By means of this and an air chamber for taking up the vibrations a diagram is obtained by a pencil point with a parallel motion, which gives as clear a line as a steam engine indicator. The card on which the diagram is drawn is arranged, as shown in one of the illustrations, so that



INTERIOR OF THE HYDRAULAGRAPH.

it obtains its movement from a connection to the ram of the press.

On this machine the moment the operator attempts to get the required maximum pressure on a loose fit the diagram shows a vertical line. There is no way of disguising this, neither can the operator by any means obtain access to the diagram or pen. In fact, any effort on his part to hold the pen would only result in breaking it. The only portion of the diagram accessible to the operator is a marginal space left purposely for him to record the wheel data.

One of the illustrations shows a section of a chart with diagrams obtained in actual practice which are self-explanatory. The chart is 100 ft. long, each one-quarter inch representing a one-inch movement of the ram, and a roll can thus easily record 400 complete movements or 200 pairs of wheels. The records shown contain comments pointing out the features of each operation.

In the rolling stock equipment of steam or electric railroads there is probably no part on which safety so much depends as upon the strength and reliability of the truck. In this the most unreliable factor and the one least capable of accurate inspection has been the security with which the wheels are held on the axle. It is believed that by means of the Hydraulagraph this difficulty will be removed and that, together with the usual tests for determining the safety of other parts of the truck, it will now be possible to turn out a completed truck with a very fair measure of dependability.

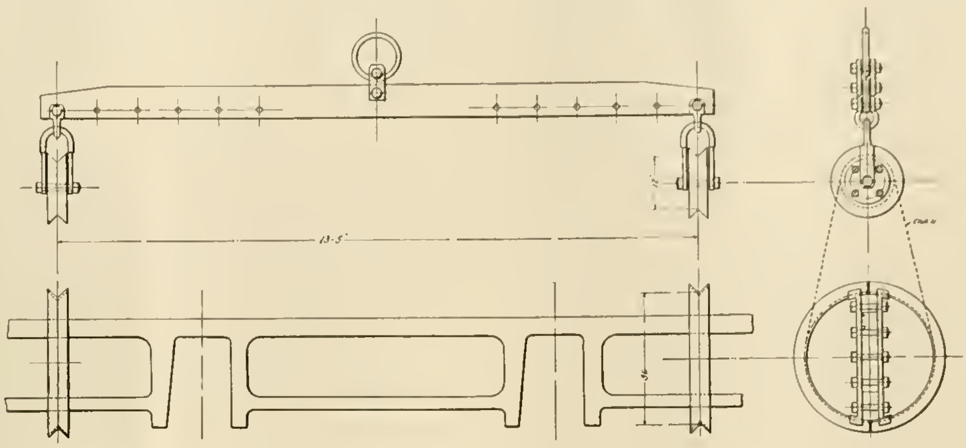
## WELDING LOCOMOTIVE FRAMES.

In making a report before the International Railroad Blacksmith's Association, J. E. Carrigan, master smith of the Rutland Railroad, directed attention to a new form of weld which they are using for locomotive frames.

"Instead of using the regulation V weld in making repairs, we have gone one better and adopted the plan of using one V and two binders, as shown by the sketches, being particular to select the best stock at hand for the V and the binders, and to have the grain in them run in the same direction with that of the section to be repaired. We are obliged to do this work with sledges, not having any steam hammer, and we contend that it is the best and strongest weld possible to be made with sledges, and think a man with a steam hammer might consider it profitable to himself and his company.

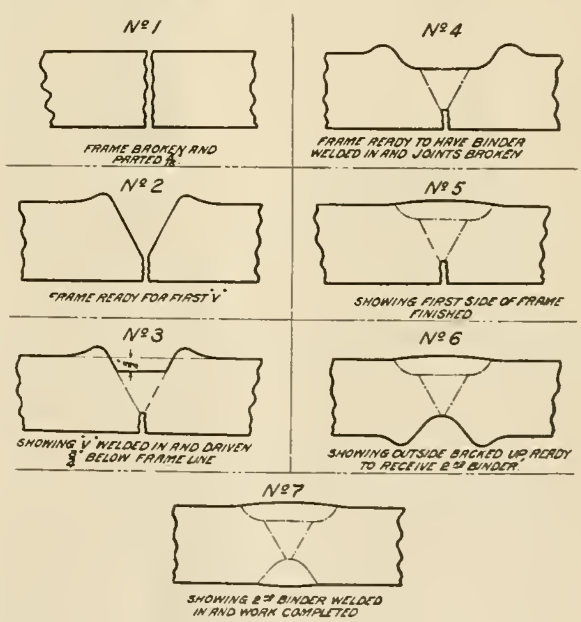
"We use an adjustable equalizer for handling the frames, suspended from a quick-acting chain-falls, which allows us to raise or lower it easily; the equalizer is made 1½"x8"x14' long, as shown by the drawing. We have no trouble in striking a balance on the length of any frame—with an equalizer made in this way. The frame wheels are thirty-six inches in diameter on the bearings, and it is an easy matter to get a balance crossways of the frame, by placing the heavy section of the frame nearest the center of the wheel. With a wheel of this size there is no need of using scrap iron for counterbalance, and it will take in and can turn over the lightest or heaviest of frames with very little trouble.

"We have a frame fire in the Rutland shop that I can recommend to anyone wanting the handiest thing possible in that respect, and that is a portable forge, connected to the blast pipe with a hose or to the compressed air. You can set it anywhere, on either side of your hammer; and when you come to do the work with sledges on a block—in a small shop—it is perfection. When the job is done all you have to do is to disconnect it and truck it out of the way until the next frame comes along."



ADJUSTABLE EQUALIZER FOR HANDLING LOCOMOTIVE FRAMES WITH A CRANE.

*A. S. M. E.*—At the New York November meeting of The American Society of Mechanical Engineers, to be held on the 9th in the Engineering Societies Building, 29 West 39th street, at 8:15 o'clock, there will be two papers presented, one by Prof. Gaetano Lanza and Lawrence S. Smith, of The Massachusetts Institute of Technology, on reinforced concrete beams, and the other by Prof. Walter Rautenstrauch, of Columbia University, on stresses in curved machine members.




NEW METHOD OF WELDING A LOCOMOTIVE FRAME.

Telephones on Freight Cabooses.—The Atchison, Topeka & Santa Fe Ry. will equip all of its freight cabooses with telephone instruments. When a freight is left on a siding some distance from a telegraph office or there is an accident on the main line that should be reported immediately, the trainmen will make connection with the telegraph wires by means of an extension pole that is carried in the caboose and arranged in joints.

## THE EFFICIENCY OF FILES.*

The following inquiry regarding files has been made not merely for the benefit of the file-maker, but quite as largely for the benefit of the buyer and user of files. The subject, therefore, is treated from the standpoint of a practical engineer without any special knowledge of file making.

The testing of files is accomplished by means of a special machine † which records the endurance and metal-removing qualities of the file on a piece of paper wound around a cylinder, thereby producing diagrams as shown in Figs. 1 and 2. In these diagrams the horizontal distances represent the number of strokes made by the file tested, and the vertical distances the number of cubic inches of metal removed during the life of the file. The curves drawn in Fig. 1 show the life history of two files from the time when they were new until they were completely worn out. It will thus be seen, for instance, that one file removed somewhat over eight cubic inches of steel in 108,000 strokes, after which the file was incapable of removing any more metal. The other file removed the same amount of material in the first 16,000 strokes, and was still in good condition, removing a total of 14 cubic inches in 42,000 strokes before being worn out. In Fig. 2 is shown even a more striking comparison, and here the great variation in the amount of work possible from files of different quality is exhibited. The two sides of one file removed which accomplished three and one-half times as much work and made four times as many strokes as the other. Such results are common. File-makers generally explain this difference as due to a variation in the sharpness of the chisel used in cutting the files. If a great variation is thus found between the sides of a file, it is likely that equally great variations will be found between individual files in the same lot, this being an evidence of lack of uniformity in the manufacturing process. One of the most important services, therefore, that is rendered by the file-testing machine to makers and users of files, is that of showing the great difference caused by minute variations in the shape of the file teeth, variations which can scarcely be detected by examination, and which can only be eliminated by extreme care in all the processes of manufacture.

It has been assumed that a file made of good steel is a good file. The teeth, of course, are expected to feel sharp, but beyond this very little attention has been paid to their shape. The file-testing machine has shown that the shape has a far greater influence than the quality of the steel, not only on the rate of cutting, but also on the amount of work that can be gotten out of the file. Fig. 5 shows the curves obtained from tests where five files were worn out at practically the same number of strokes (110,000). The amount of iron filed away varied very greatly. These variations in rate of cutting are more marked on cast iron than on steel. The best file in Fig. 5 cut when new at the rate

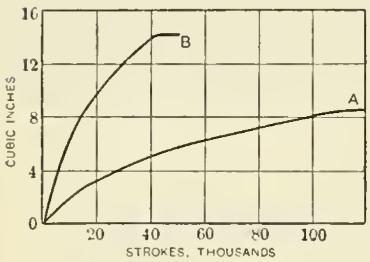



FIG. 1.—DIAGRAM RESULTING FROM FILE TESTS ON STEEL, MADE ON THE HERBERT FILE TESTING MACHINE.

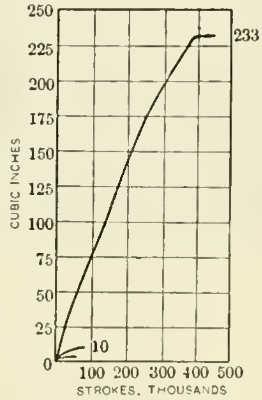



FIG. 2.—DIAGRAM RESULTING FROM FILE TESTS ON CAST IRON.

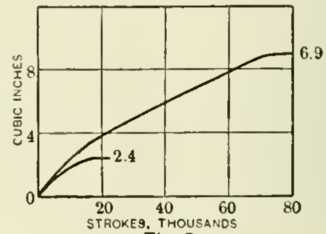



Fig. 3

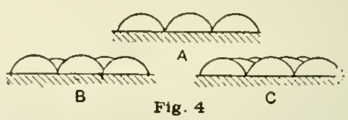



Fig. 4

FIG. 3.—CURVES RESULTING FROM TESTS OF TWO SIDES OF THE SAME FILE CUTTING THE SAME MATERIAL. FIG. 4.—ARRANGEMENT OF FILE TEETH, DUE TO VARIATION IN RATIO BETWEEN "UP-CUT" AND "OVER-CUT."

10 and 3 cubic inches, respectively, of cast iron before becoming too blunt to cut, while one side of another file reduced to filings nearly 20 feet of a cast iron bar one inch square before becoming unable to cut. These examples indicate that file testing is a matter of considerable importance in shop economy, particularly in the assembling department where a great deal of time may be wasted by using inferior files.

The files are tested until they slip over the surface of the test bar without cutting, this condition being shown by the curves taking a horizontal course. Tests which are stopped before this point is reached may give a false impression as to the relative merits of files. It may happen that two files cut equally well during the first 50,000 strokes, and if the tests were stopped at this point the files would be considered equal. If the tests were continued, one file might cease cutting at 60,000 strokes, and the other continue for 400,000 strokes, thus showing a great difference in their durability.

### Results and Conclusions of File Testing.

Among the results obtained by the file-testing machine, perhaps none is of more interest than the discovery that the two sides of a file are seldom equal in efficiency and durability. Fig. 3 shows the curves for the two sides of the same file, one of

* Abstract of paper by Edward G. Herbert, read before the Manchester Association of Engineers, March 27, 1909.

† For description of the machine for testing files see American Engineer and Railroad Journal, page 466, December, 1907.

of 14 cubic inches per 10,000 strokes, while the poorest file cut hardly more than ½ cubic inch during the same number of strokes, the material being cast iron. On steel a rate of 6 cubic inches per 10,000 strokes is rarely exceeded.

The rate of cutting is given by the slope of the curve and depends almost exclusively on the shape and sharpness of the teeth and on their relation to one another, and is not affected by the quality of the steel. As many files cut at a very slow rate when considerably worn, it is economical to reject files at a fairly early stage of bluntness.

### Factors Determining Efficiency of Files.

The chief factors by which the cutting efficiency of a file is determined are:

1. Sharpness of teeth.
2. Slope of the front face of the teeth, or rake.
3. Slope of the back face of the teeth, or clearance.

4 and 5. Angles of the two cuts relative to the axis of the file.

6. Pitch or coarseness of the cut.
7. Ratio between the pitch or number of cuts per inch in the "up-cut" and in the "over-cut."

At first sight it would seem that the sharpness of the teeth would be the most important factor in cutting efficiency, but the experiments indicate that this is not the case. Two files equally sharp, and thus cutting equally fast when new, do not show the same efficiency.

The slope of the front face of the teeth on commercial files as made at present is very rarely vertical, but in almost all cases there is a negative rake varying from 3 to 25 degrees. Experience with lathe and planer tools would lead one to expect that a tool with considerable negative rake would be exceedingly inefficient on almost all materials, and it is surprising that such a tool cuts at all under such light pressure as can be applied by hand on a file. Nevertheless it is a fact that files with considerable negative rake not only cut, but take off very satisfactory curled chips. The reason for this is probably that the file tooth is presented to its work at an angle, owing to the slope of the cut across the file. This gives a slicing cut, which probably accounts for this efficiency.

The slope of the back face of the tooth, or clearance, is very difficult to measure because it is not a plane surface, but the angle is very important in relation to the durability of the file. A file which is worn out has the tops of its teeth flattened or rounded. When the area of contact of the teeth with the work attains a certain value, great pressure is required to cause the teeth to "bite" the metal. The amount of work that can be obtained from a file, therefore, depends largely on the volume of teeth available for wear before this limiting area is obtained.

Examination of commercial files show that these angles are extremely variable, and it is certain that uniformly satisfactory results cannot be obtained unless correct angles are ascertained

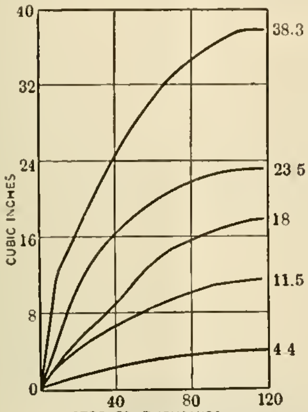



FIG. 5.—FIVE FILES OF EQUAL DURABILITY, BUT UNEQUAL CAPACITY, FOR REMOVING METAL.

and maintained, leaving nothing for the variation of judgment on the part of the workmen. The pitch or coarseness of the cut does not seem to influence the efficiency of files to any great extent. Very coarse files, however, are almost always inefficient, probably because of the difficulty of raising very large teeth, which are at the same time sufficiently thin and sharp. Very smooth files, on the other hand, cut slower and do less work than those of a somewhat coarser cut, but in some cases surprising results have been obtained from smooth files also.

It may not be generally known that the two cuts on a file differ in pitch. Suppose a file had 25 cuts in the chief or "up-cut." If it has also 25 cuts per inch in the secondary or "over-cut" a cross-section of the file would appear as at *A*, Fig. 4, each tooth standing immediately behind a tooth in the row in front, and all the teeth lying in straight rows parallel to the axis of the file. Such a file would leave on the surface of the work a series of furrows with ridges between them. Now suppose that there be 25 cuts per inch in the "up-cut," but the "over-cut" is made with 16¾ cuts per inch. Then the appearance of the cross-section would be as at *B*. Each tooth now lies opposite the space between the two teeth in the row in front. The teeth in the first row still make a series of furrows, and the teeth in the second row work on the ridges between these furrows, planing them off and leaving a fresh series of furrows, but the file would be inefficient because the ridge between any two teeth would be too large to be taken off at one cut by the teeth behind. If the number of teeth per inch in the "over-cut" is increased to 19, the effect will be as shown at *C*; the ridges between the teeth in the first row are divided between the teeth in the second and third rows behind. This subject of the ratio between the "up-cut" and "over-cut" is likely to be one of the most important factors in file efficiency, but it has not as yet been thoroughly investigated.

### Efficiency of Files on Various Metals.

It has generally been assumed that a good file is good for all classes of work, brass, cast iron or steel. Some difference of opinion on this subject has been expressed, and there has been a fairly general agreement that a file for brass should have the "up-cut" nearly at right angles to the axis, although this is by no means a general rule. In view of this a series of experiments was planned to ascertain whether there is one particular cut which is best for all metals, or whether each metal requires a special cut to produce the best results. For these tests a number of files were ordered from several makers who were asked to cut them in the manner which they considered most suitable for cast iron, steel, brass, and general work, respectively, each maker supplying a number of files for each purpose.

In the experiments each file was tested on brass, cast iron, mild steel, annealed tool steel and "normalized" tool steel, the last being subjected to heat treatment which would make it uniform in hardness throughout its length without actually annealing it. In one case a brass file gave the best result on brass, but this was the only instance where the best result on any metal was obtained by the file intended for that metal. In the test on cast iron, for instance, two files intended for steel cut more than three times as fast as the files intended for cast iron. On the "normalized" tool steel (not annealed) the cast iron file gave best results. The conclusions of these tests, therefore, showed:

1. The subject of files for specific purposes has practically received no thorough attention. As a rule, files cut for specific purposes gave poor results on the materials for which they were intended, and good results on materials for which they were not intended.
2. Files especially well adapted for any one metal did not give good results on other metals.
3. Files which showed average efficiency on all metals were rather inefficient on all.
4. The tests clearly show that the ductile metals, such as mild or annealed steel, are most easily worked with a sloping cut, which usually produces curled filings. Cast iron and hard brass require a much less sloping cut. Brass files, in fact, should have an "up-cut" almost at right angles to the axis of the file.
5. As a general conclusion, therefore, it appears that it would be advantageous to have files especially cut for various metals and keep them on the work for which they are intended. Most files intended to cut all metals are decidedly inefficient on them all.

It will rest with the user to make the first move in the matter. The file-maker is naturally reluctant to double or triple his stock and to make files for all the existing sizes, shapes and cuts in two or three distinct styles, suited to different metals. The difficulty may involve a slight increase in the price of files, but the increase in efficiency will be out of all proportion to the increase in cost.

Another evidence of the un-uniformity of files and the incomplete understanding of the subject, even by file-makers, is shown by the fact that sometimes files of two or three different qualities are sold by the same maker at different prices. In most, though not in all, cases where such files were tested, it was found that the cheapest grade gave the best result, and the most expensive the worst. This is probably explained by the fact that by a "good" file, the file-maker almost invariably means simply a file of expensive steel.

Most of the leading British file-makers are now investigating, with the aid of the testing machine, the various problems connected with file efficiency. This investigation is attended with special difficulty. Apart from the quality of the steel there are at least eleven important factors, all having an influence on efficiency: seven angles, the sharpness of the chisel, the force of the blow, the coarseness of the cut, and the ratio between the two cuts. It is possible to make an infinite number of combinations of these eleven variables, and an alteration in any one of them is likely to affect several of the others. The problem is, therefore, greatly simplified if a simple file tooth can be isolated and its cutting efficiency measured under constant conditions while progressive changes are made in its shape and in the angle of its presentation to the work.

### A Tool Steel Testing Machine.

The simplification of the problem mentioned is made possible by the use of a recently-designed tool steel testing machine. (This is described fully in Mr. Herbert's paper.)

By means of this machine it will be possible to ascertain what is the theoretically correct shape for a single file tooth for any particular metal. This information having been obtained, it will rest with the file-maker to ascertain by means of the file-testing machine what combination of theoretically correct file teeth gives the best maximum efficiency and durability to the file.

In relation to commercial file-making, the most important conclusion of the tests made with this machine appears to be that the least desirable results of all were obtained with the tooth which most closely resembled the commercial file tooth. The best results of all were obtained with a form of tooth which can probably be reproduced without great difficulty, but which appears never to have been adopted. This tooth would have a positive front rake of 15 degrees, and a clearance of 5 degrees. It was previously shown that the clearance angle is a most important factor in determining the total output and that the tool with no rake and only 5 degrees clearance will do only a very small amount of work, but it appears that a tool with the same clearance angle and with positive front rake will do an exceptionally large amount of work with great efficiency, and it is probable that by slightly increasing the clearance angle the output will be still further increased without undue weakening of the cutting edge.

Some caution will, of course, be necessary in applying the results just described to the art of file-making. These tests were made with what was practically a single isolated file tooth with a straight instead of a rounded cutting edge. The file is a series of round-nosed tools, lying very close together, and it may be found that a file with a positive rake will have a tendency to choke up with filings to such an extent as to neutralize its greater efficiency. The progress must be made by systematic experiments, confirmed at every step by the file-testing machine.

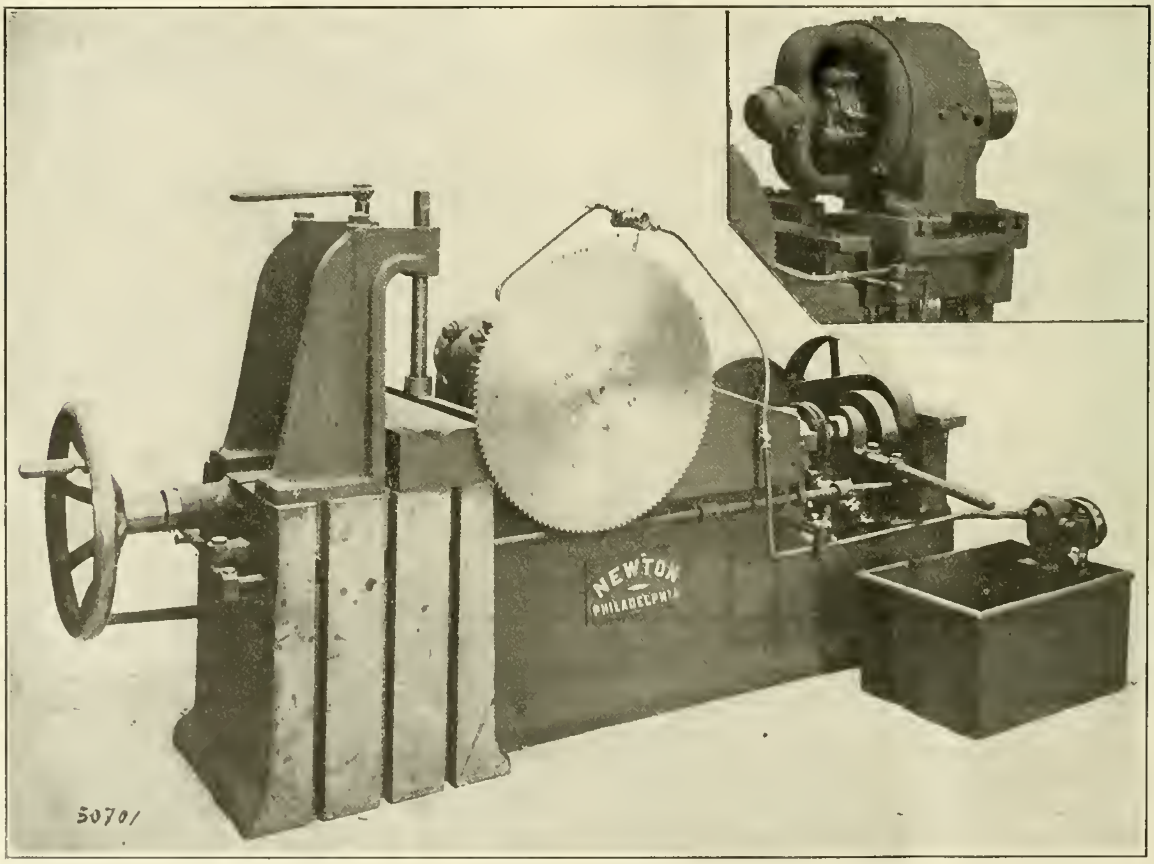
The results first described have a bearing on other cutting tools besides files. Of all the tool forms experimented with, among those that gave the smallest output of work was one having no front rake. This, however, is the usual form of tooth for milling cutters. There seems to be no reason for making milling cutters without front rake, except the well-known propensity of human beings to follow in their forefather's footsteps. Milling cutters with front rake have been made and tried, and have given good results, and yet it is impossible to buy such cutters without having them made to order.

## COLD SAW CUTTING-OFF MACHINE.

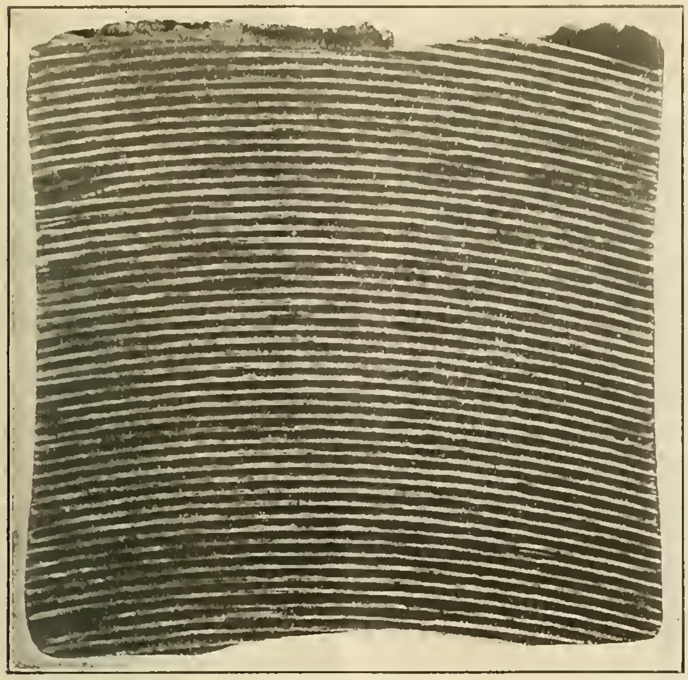
A 45 carbon steel bar, 8½ in. in diameter, was cut off in six minutes on the 28-in. cold saw cutting-off machine shown in the photo. One of the illustrations shows a section of a 10-in. square bar of 35 carbon steel that was cut off in six minutes on the same machine.

The table is arranged with both horizontal and vertical clamping surfaces adapting it for a wide variety of work, including the cutting off of gates and risers on castings. On some castings the risers may be clamped by the screws, leaving the body of the casting to overhang, while with others the casting may be clamped to the vertical surface, allowing the riser to drop after the cut has been made. These machines are made in sizes having capacities of 5, 7½, 9½, 11½ in., and larger, for special requirements.

The saw blade is 28 in. in diameter and is attached to the spindle by which it is driven by the flush bolts. The spindle is




COLD SAW CUTTING-OFF MACHINE. METHOD OF APPLYING ELECTRIC MOTOR SHOWN IN UPPER RIGHT-HAND CORNER.



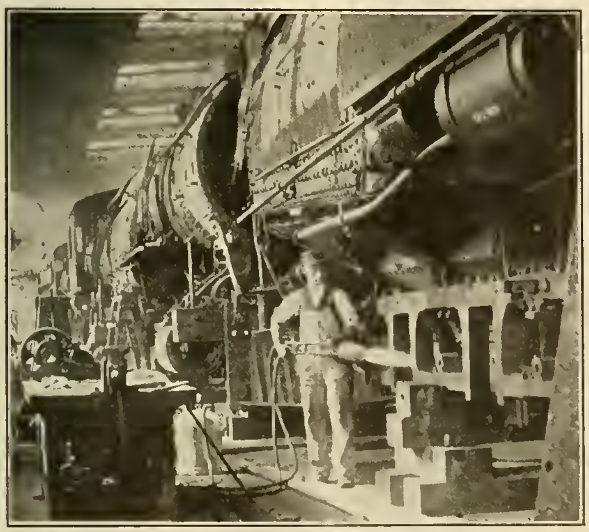
SHOWING SECTION OF 10-INCH BAR OF 35 CARBON STEEL CUT OFF IN 6 MINUTES.

supported at each end by bearings of large diameter, which are capped, and is driven by broad-face coarse-toothed hammered steel spur gearing and a worm and worm-wheel; the worm-wheel has a bronze ring with triple lead teeth, and the worm is of hardened steel with roller thrust bearings. The saddle is of heavy construction in proportion to the capacity of the machine and has wide bearings on the frame; it is arranged on the saw side with square lock gibs cast solid, adjustments being made by a taper shoe. The feed is transmitted from the roller on the driving shaft to the disk, which is held to the proper tension by a spring adjusted by lock nuts. Operation of the roller on the driving shaft by the hand lever, shown in front of the machine, controls the rate of the continuous feed, which is variable from ⅛ in. to 1½ in. per minute. The saddle carries an arm arranged to trip the adjustable automatic and positive safety release to the feed. The machine is also fitted with a power quick return. When arranged for a motor drive, using a double throw switch or reversing motor, the fast power traverse is available in both directions.

The hand wheel, which controls the operation of the hand motion, is fitted to the end of the squared shaft and is removable to permit of machining sections that will extend beyond the hand wheel when bolted to the work table. Both the vertical and the horizontal surfaces have machined "T" slots for clamping the work. The clamps and V-block are separate castings and are made removable. These machines are furnished with a pump, piping and attachments for cutter lubrication and have ample rigidity for driving the modern inserted high-speed saw blades to their maximum capacity. As evidence of the powerful drive and heavy construction of these machines, it may be stated that for crank shafts and similar work the spindles are extended to carry two saw blades at one time, the rate of feed being the same as when only one blade is used. These saws are manufactured by the Newton Machine Tool Works, of Philadelphia, Pa.

## A NEW BURNER USING HYDRO-CARBON AS FUEL.

The refuse from a Pintsch gas manufacturing plant is commercially known as hydro-carbon and will produce a very hot flame when burned under proper conditions. The Hauck Mfg. Co., 90 West street, New York City, has, by a slight alteration in the burner which they have manufactured for a long time with great success when using kerosene or crude oil, been able

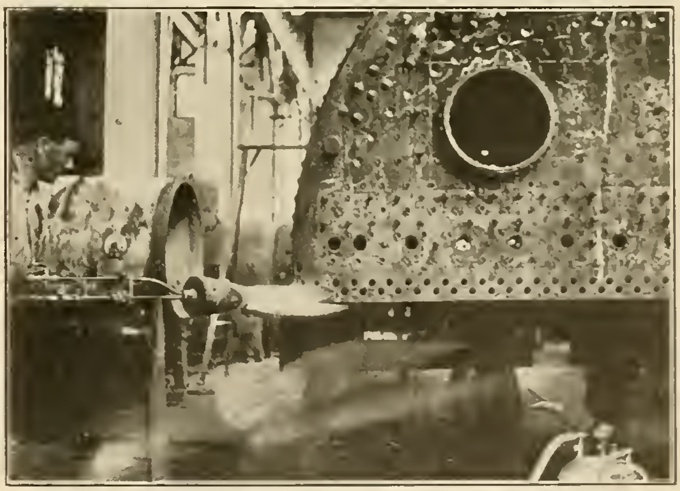


PRE-HEATING A LOCOMOTIVE FRAME.

to adapt it for use with hydro-carbon as fuel with a resulting flame of great intensity, which has proved to be particularly well adapted for railway shop uses at points where this refuse can be obtained. It has been found that this flame is excellent for use in the car yards for straightening bent parts of steel cars, in the boiler shop for laying up an obstinate corner or flange and in the frame shop for either straightening frames or for pre-heating preparatory to thermit welding. Frames can also be welded with this flame under proper conditions.

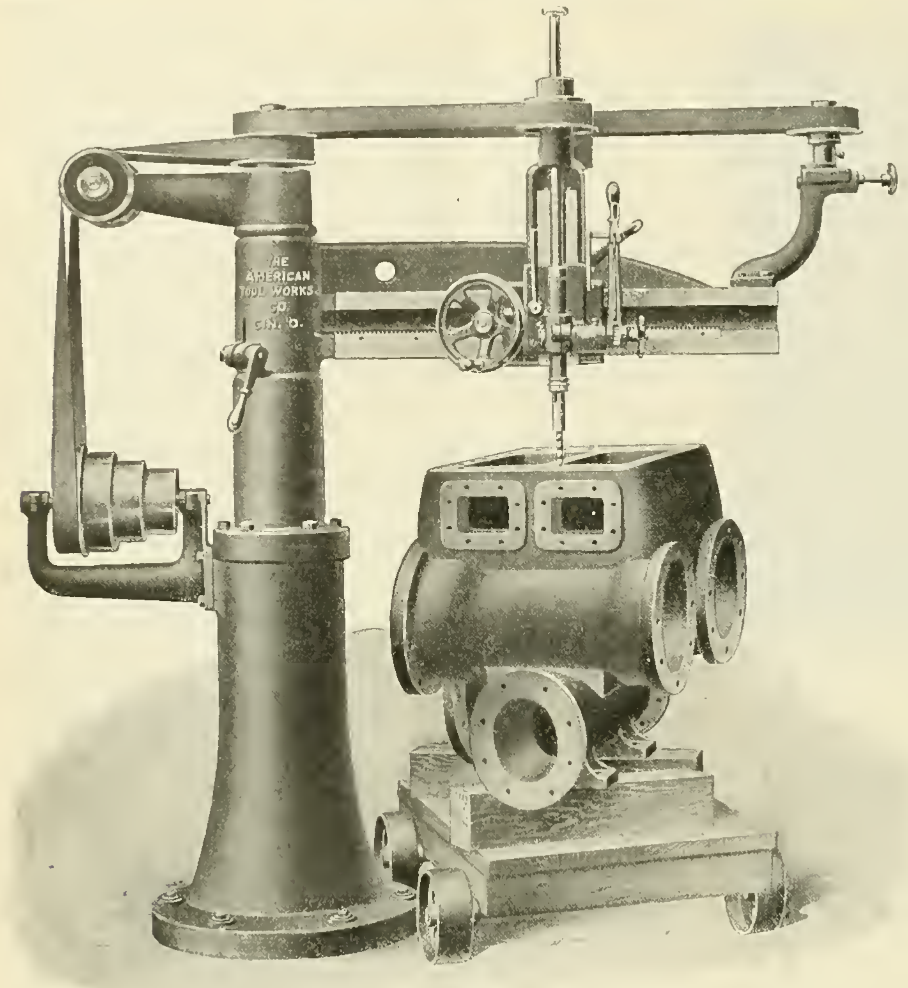
The burner used with hydro-carbon is but a slight alteration of the crude oil burner, which has made a reputation for economy and intensity. These burners are capable of use with an air pressure varying from five to 100 pounds, and in the largest size the burner weighs less than ten pounds.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.—This society will hold its annual convention at Milwaukee, Wis., December 1, 2 and 3. It is expected that some of the



USING HYDRO-CARBON BURNER IN BOILER SHOP.

most distinguished leaders in the industrial, legislative and educational world will be present and make addresses. An exhibition of trade school work from all over the United States will be one of the features of the convention. State branches of the society have increased in number during the past year; Massachusetts and New York alone have more than 200 members each. The society has just issued Bulletin No. 9, which contains all the addresses delivered at the last annual convention held in Atlanta.



UNIQUE ARRANGEMENT OF SENSITIVE RADIAL DRILL.

## HIGH SPEED SENSITIVE RADIAL DRILL.

In the May issue of this journal, page 210, was described what is believed to be the first sensitive radial drill made in this country. Since that time some tests and a couple of special applications have been made which are of interest.

One of the illustrations shows a machine of this type, with a 3-ft. arm, mounted on a pedestal base and not equipped with a

TEST OF AMERICAN HIGH SPEED SENSITIVE RADIAL DRILL.

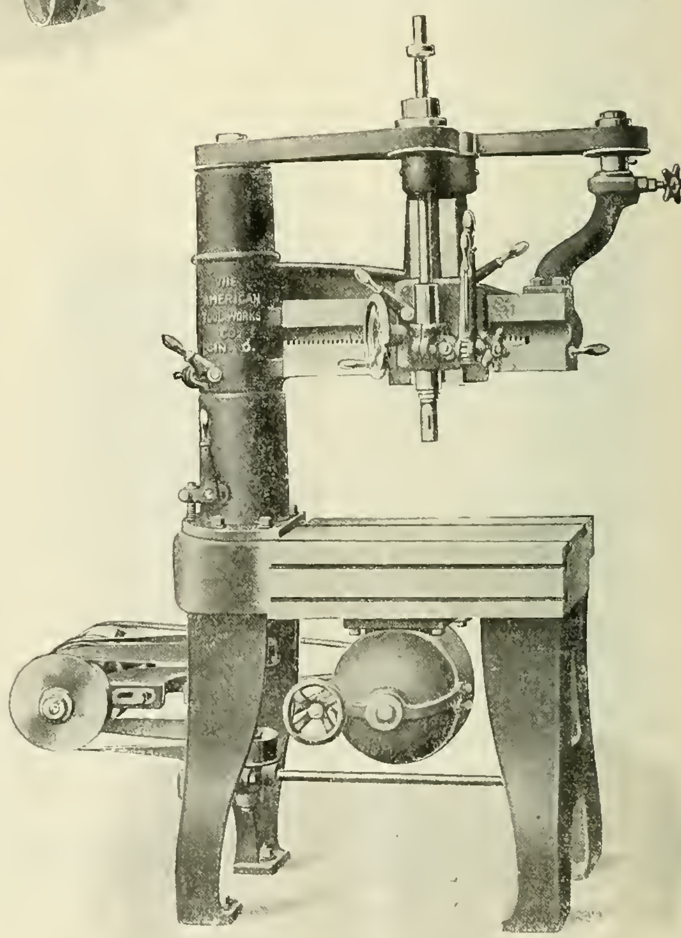
| Dia. of Drill. | Speeds. Rev. Per Min. | Speeds. Feet per Min. | Feeds. Aprx Per Rev. | Feeds. Inchs Per Min. | Net Horse Powr | Remarks. |
|---|---|---|---|---|---|---|
| ¼"* | 900 | 59 | | | 1.5 | Cast Iron 1" thick. |
| ½" | 900 | 137.2 | .022 | 20 | 1.50 | " " " " |
| ⅝" | 900 | 147.2 | .013 | 12 | 3.0 | " " " " |
| ¾" | 900 | 177 | 013 | 12 | 3.7 | " " " " |
| 1" | 455 | 119 | .0066 | 3 | 2 6 | " " " " |
| 1" | 785 | 207 | .0076 | 6 | 3.2 | " " " " |
| ½" | 900 | 137.2 | .037 | 16.8 | 1.2 | Aluminum Engine Frames. ½" thick. Drilled 14 holes in 25 seconds. |
| 1 19-64 | 745 | 248 | | | .9 | Aluminum case. Drilled from the solid. Bosses drilled and faced in 1 operation |

* Carbon steel drill; the others were all high speed steel.

box table. This machine is especially convenient in the drilling of holes in work which can be conveniently moved beneath the spindle of the machine on a truck, or otherwise. It does away with considerable handling of the work and permits of its being moved from the drilling department to the next one with the least possible delay. The arm is easily swung to the position desired and the head readily set at any point along the arm. Where drilling with a jig is practiced, the work is accomplished very rapidly. As will be noted from the test sheet a spindle speed of 900 r. p. m. is available, although this may be increased or diminished to suit special requirements. As all the bearings are of the ball bearing type, the drill will stand up to a speed of 2,000 r. p. m. without sign of distress, although, of course, no twist drill will hold an edge at such a speed.

The second illustration shows one of these machines, with a 2-ft. arm, equipped with a motor drive and a tapping attachment. The motor is mounted beneath the box table and is connected to the tapping attachment driving shaft by a belt. The motor is a Lincoln variable speed, 3 to 1, with speeds of from 525 to 1,575 r. p. m. These are controlled by the hand wheel on the motor. Many of the visitors at the Atlantic City convention, where one of these drills was exhibited, who operated the drill stated that it drilled into the metal as though it was wood, and as near as could be ascertained the ½-in. plate was drilled through with a ½-in. drill in two seconds.

The tapping attachment is perfectly controlled by the lever at the base of



MOTOR-DRIVEN SENSITIVE RADIAL DRILL.

THREE-CYLINDER SIMPLE LOCOMOTIVE, PHILADELPHIA & READING RAILWAY.

the column in spite of the high speed of the spindle. The frictions in the tapping attachment are of a patented type which cannot become disengaged of themselves, after once being thrown in. They are of such large proportions as to transmit the maximum power required.

Adjustment for regulating the tension of the belts is arranged for both of the overhead belts and for those of the tapping attachment and motor drive. This drill will handle high speed twist drills and standard taps up to 1 in. in diameter. When fitted with a tapping chuck, it is particularly well adapted for the tapping of small holes. These machines are manufactured by The American Tool Works Company, of Cincinnati, Ohio.

## HYDRO-PNEUMATIC PIT JACK.

The almost universal tendency to equip roundhouses and locomotive repair shops with air pressure pipe lines was recognized several years ago by the Watson-Stillman Company, of New York, when they introduced a new design of 15 and 30-ton pit jacks in which air pressure was utilized to accelerate the work of the jack. The favor with which this new operating principle was received has caused them to bring out a larger size to meet the increasing weight of modern rolling stock. The capacity of the new size is 45 tons. The jack illustrated, which was built for the St. Louis & Southwestern Railroad, runs on a 24-in. track, has a 4¾-in. ram with a 54-in. stroke, a clearance of 5⅜ in. from the rail to bottom of saddle, a height of 2 ft. 10 in. from rail to top of saddle when down, and extends down into the pit 3 ft. 7⅜ in. from the top of the rail.



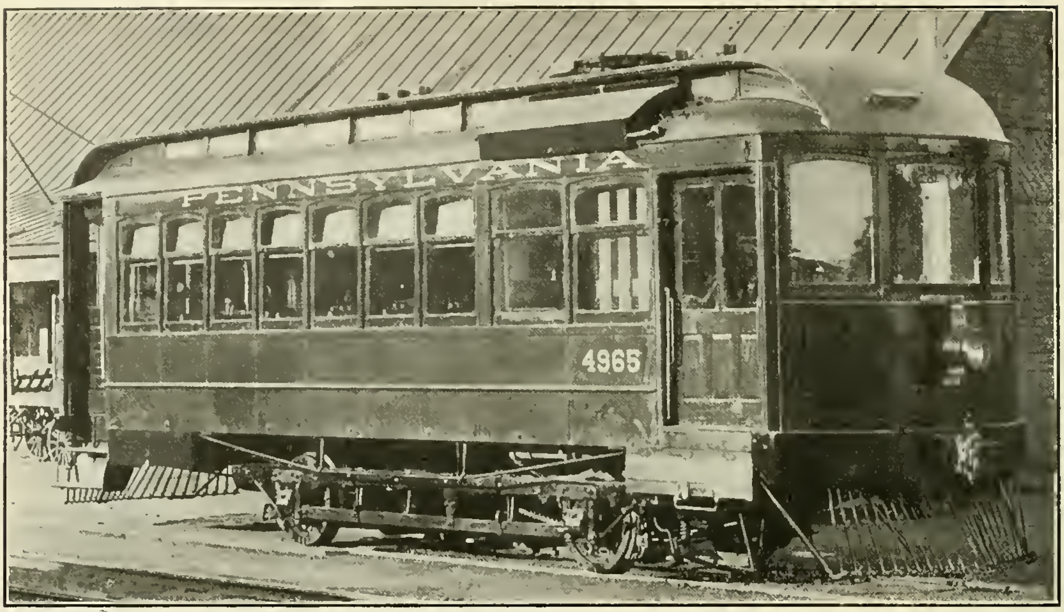
HYDRO-PNEUMATIC PIT JACK.

The hydro-pneumatic operating system gives the jack the quick motion of a pneumatic tool in moving the ram up to its work and thus effects a considerable time saving. After the jack has been placed in position, air pressure is admitted on top of the liquid in the cistern, thus forcing the water rapidly through the pump until the ram comes to a bearing under the load. A few strokes of the hydraulic pump will then raise the wheels sufficiently to remove the sections of track. The saddle is lowered in the usual way by the valve stem key.

## THREE-CYLINDER SIMPLE LOCOMOTIVE.

During the last convention of the Railway Mechanical Associations at Atlantic City, there was on exhibition a most interesting high-speed passenger locomotive of the Atlantic type, which was built at the Reading shops of the Philadelphia & Reading Railway from the design of H. D. Taylor, superintendent of motive power. This engine has three simple cylinders 18½ inches in diameter, with 24-inch stroke, two being in the usual position and one on the center-line of the locomotive. The driving wheels are 80 inches in diameter and the total weight of the engine is 207,000 pounds, of which 112,000 pounds is on drivers. Each cylinder is fitted with a piston valve, the two outer ones being actuated by the Walschaert valve gear, and the inner ones by a valve gear of the Joy type. The cranks are set at 120 degrees, the crank pin being on the back pair of drivers for the outside cylinders and on the front cranked axle for the inside cylinder. The boiler is fitted with a superheater arranged somewhat similar to the Pielock design and located adjacent to the front flue sheet, in fact the front flue sheet is arranged to form the wall of the superheater. This is expected to give about 125 degrees of superheat.

The finish of the locomotive was particularly noticeable, there being many more highly polished parts used than is customary in this country. It presented a most imposing appearance on exhibition, and was examined with much interest by the members in attendance.




MOTOR CAR FOR USE ON SMYRNA BRANCH OF PENNSYLVANIA RAILROAD.

## GASOLINE MOTOR CAR ON THE PENNSYLVANIA.

The Pennsylvania Railroad has inaugurated a gasoline motor car service on the Smyrna branch, between Smyrna and Clayton, Del. The car used was built by Fairbanks-Morse & Company and made the trip from their factory, Three Rivers, Mich., to Wilmington, Del., under its own power, in charge of J. Milliken, superintendent motive power of the Philadelphia, Baltimore & Wilmington. The distance of 780 miles was covered in 28 hrs. actual running time, or at the rate of 27.5 miles per hour.

The car is driven by a four-cylinder, four-cycle, water-cooled engine, heavy type, conservatively rated at 50-60 h.p. at 600 r. p. m. Under test it has developed 75 h.p. The power is transmitted through gearing, arranged to furnish three speeds in each direction. The gears are always in mesh, changes in speed being accomplished by sliding jaw clutches. The shafts run in roller bearings. Roller chain is used for transmitting the power to the axle.

As the car will be used on a short run, it is arranged with control at both ends. One small hand-wheel controls the different speeds and is arranged so that the clutch is released automatically whenever a change in speed is made; there is no possible way of damaging the transmission by throwing in more than one speed at the same time.

The body of the car is divided into two compartments. The forward one, 11 ft. long, contains the engine and has room for light baggage, express, etc. The rear compartment is 18 ft. long; it has reversible seats and a seating capacity for about 30 passengers. A gasoline tank of 50 gallons capacity is located underneath the body of the car and the gasoline is forced by air pressure to a small working tank in the engine compartment, which feeds to the engine by gravity.

The independent arrangement of the engine and the car body adds to the easy riding qualities; the body is carried on full elliptic springs on top of the truck frame, while the engine and transmission rest on the truck springs. The car is equipped with air brakes on four wheels, chime whistle and headlight.

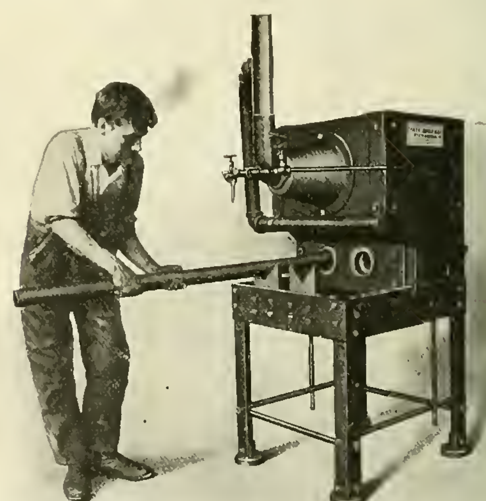
This is the fifth car of its kind built by Fairbanks, Morse & Co. Two are on the St. Joseph Valley R. R., LaGrange, Ind., one on Stanley, Merrill & Phillips Ry., Stanley, Wis., and one on St. Tammany, New Orleans Ry. & Ferry Co.'s line, Mandeville, La.

The September report of the Stanley, Merrill & Phillips car shows the following performance:

| | |
|---|---|
| Miles run | 3,234 |
| Passengers carried | 1,106 |
| Cost of operation— | |
| Wages of crew | $127.51 |
| Gasoline (515 gals.) | $46.35 |
| Lubricating oil | 8.97 |
| Total | $182.83 |
| Cost of operation per mile | .06 cts. |

## FLUE WELDING FURNACE.

A new type of flue welding furnace, known as the "Kirkwood Down Flame," has recently been designed by Tate, Jones & Co., Inc., of Pittsburgh, Pa. The burner is applied to an extension combustion chamber, thus providing sufficient room for the complete combustion of the mixed oil and air; the products of combustion are conducted downward past the flue ends. Where the combustion chamber is below the flues the slag falling from them cuts the brick lining of the chamber. This trouble is eliminated with the new furnace.



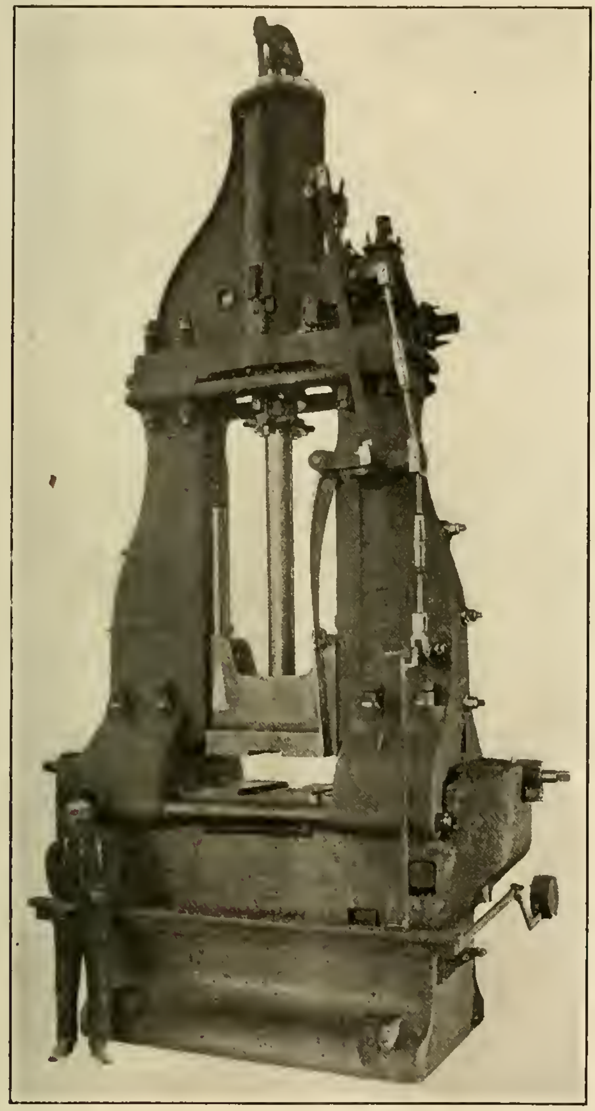
DOWN-FLAME FLUE WELDING FURNACE.

There is only one brick on each flue hole that ever requires renewing and it can be replaced by removing two bolts without disturbing the other parts of the furnace. The fire may be regulated by the operator without changing his position in front of the furnace. A cooling pipe is provided to blow the hot air away from him. Front guides and adjustable back stops are provided to suit the different lengths of tube.

## STEAM DROP HAMMER.

Several important improvements have been made in the steam drop hammer manufactured by the Erie Foundry Company, of Erie, Pa. These, as well as the important features of the standard machine, are shown in the accompanying photograph of a 3,500-lb. hammer built for the Thomas B. Jeffrey Mfg. Co., manufacturers of the Rambler automobile. These hammers are rated on the actual weight of the falling parts, although the force of the blow is greatly increased, due to the fact that steam is taken above, as well as below, the piston. The anvil block of the 3,500-lb. hammer weighs 70,000 lbs., the total weight of the hammer being 98,000 lbs.

The frames are of semi-steel and overhang the anvil block the full width of the frame instead of only half the width, as formerly. The steel tie plate between the top of the frames and the cylinder base laps over the frames both on the inside and the outside.



3,500-LB. STEAM DROP HAMMER.

Steel taper wedges having a bearing the full length of the guides make it possible to take up wear, preventing breakage of the piston rod. A warning mark is placed on the guides which shows when the piston is near the bottom of the cylinder. Before the corresponding mark on the ram reaches this warning mark the anvil must be raised or a higher die used The ram, crosshead and sow block are made of open hearth steel forgings. Adjusting screws at the sides make it possible to move the hammer sidewise, enabling the operator to line up the dies quickly.

The spring piston stop placed at the top of the cylinder protects the cylinder head against careless handling and against damage from the rods breaking or pulling loose from the crosshead. If, in operating by hand, the lower port be left open too long, or if the rod should break, the piston flying upward will not break the cylinder or cylinder head, because, before reaching the head, its force will be absorbed by striking the projecting pin, causing all shock to be transmitted through the yoke to the side rods shown. The lower ends of these rods are keyed to lugs projecting from either side of the cylinder. In most cases the buffer spring will wholly absorb the blow. If not, the worst that can happen is the breaking of two easily replaced side rods.

These hammers are made in a large number of sizes varying from 600 lbs. capacity upward. The builders advise that it requires approximately one horse-power per 100 lbs. falling weight to operate a hammer and recommend a steam pressure of 80 to 100 lbs. at the hammer.

## RAILWAY BUSINESS ASSOCIATION.

The Railway Business Association will hold its annual meeting at the Waldorf-Astoria Hotel, New York, on November 10, 1909. This will be a very important occasion, which it is proposed to conclude with a notable dinner having among the guests eminent leaders in the railroad, manufacturing, commercial and political worlds. If the association is to be made a permanent economic force, which many of those deeply interested in railway and allied interests have vigorously declared should be done, then there is need of a large representation of its membership and a full and careful consideration of the best means for enlarging its usefulness. The more people who are actively interested in its work, the greater will be its influence, and it is most desirable that if, in the opinion of any of its members, its plan and scope should be broadened or its methods changed, the annual meeting be made the place for consideration of all such matters, to the end that enthusiasm may prevail and all may feel that they are important factors in the movement.

The dinner will be attended by one of the most distinguished of gatherings, since the members of the Association, themselves an influential group of industrial captains, will have as their guests celebrated railroad officials, financiers, men of commerce and publicists. The dinner, moreover, will have a purpose—for the addresses of the national figures who are to speak will be a sort of symposium of assurances to the public that all concerned are earnestly seeking to promote permanent concord between the public and the railroads, and prosperity for both.

GOOD WORK OF SUMMERS' ORE CARS.—A new record was established in the loading of the steamer *Corey* at Two Harbors on Sunday, the 10th, when 10,111 gross tons of Pioneer ore from the Vermillion range was loaded in 39 minutes. Particulars of this record are not as yet at hand, but the time included all delays and probably embraced one shift of the steamer. The record in part was made possible by the use of the new Summers' steel ore cars, which dump their cargo in 45* seconds, as against 7½ minutes for the ordinary type of car. It is probable that all of the pockets were loaded and that the cars were standing on top of the pockets waiting to be dumped.—*Iron Trade Review.*

NEW YORK AND ST. LOUIS, 24 HOURS.—The Pennsylvania Railroad announces that beginning November 7 a 24-hour limited express train will be run between New York and St. Louis, leaving New York at 6:25 P. M., Eastern time, and St. Louis at 6 P. M., Central time. The apparent time will be 23 hours westward and 25 hours eastward. The distance from Jersey City to St. Louis by this line is about 1,052 miles which, after deducting the 15 minutes for crossing the river at New York, makes the rate through about 44.3 miles an hour. The best regular passenger time at present is 27½ hours.

* The drop doors on these cars were operated by hand. With the air operated doors, as described on page 369 of the October issue of the AMERICAN ENGINEER, the cars can be unloaded and the doors closed in about ten seconds on the average.

# RAILROAD CLUBS.

*Canadian Railway Club* (Montreal).—On Tuesday evening, November 2nd, R. W. Burnett, master car builder of the Canadian Pacific Ry. at Montreal, will present a paper on "Maintenance Regulation Cards." Secretary, James Powell, P. O. Box 7, St. Lambert, Nr. Montreal, Can.

*Central Railway Club* (Buffalo, N. Y.).—At the meeting for November 12th, G. Herbert Condict, secretary of the International Lecture Institute, will read a paper on "The Application of Electricity to the Movement of Miscellaneous Terminal or Package Freight for Railway and Steamship Companies."

Secretary, Harry D. Vought, 95 Liberty street, New York City.

*Iowa Railway Club* (Des Moines, Ia.).—Next meeting, Friday, November 12th.

Secretary, W. B. Harrison, Union Station, Des Moines, Ia. Moines, Ia.

*New England Railroad Club* (Boston).—The next regular meeting will be held at Copley Square Hotel, November 9th.

Secretary, George H. Frazier, 10 Oliver street, Boston, Mass.

*New York Railroad Club.*—At the next regular meeting, Friday evening, November 19, H. McL. Harding, vice-president of the International Lecture Institute, 20 Broad street, New York City, will present a paper on "The Handling of Freight at Terminals."

Secretary, Harry D. Vought, 95 Liberty street, New York City.

*Northern Railway Club* (Duluth, Minn.).—At the meeting for November 27th, W. H. Hoyt, assistant chief engineer of the D., M. & N. Ry., Duluth, Minn., will speak on "Steel vs. Wooden Ties."

Secretary, C. L. Kennedy, 401 West Superior street, Duluth.

*Railway Club of Pittsburgh.*—A. Stucki will read a paper on side bearings at the November meeting, Friday, the twenty-sixth.

Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

*Richmond Railroad Club.*—At the November meeting, which will be held on Monday, the 8th, the annual election of officers will take place and an entertainment be given for the ladies.

Secretary, F. O. Robinson, C. & O. Ry., Richmond, Va.

*St. Louis Railroad Club.*—At the meeting for Friday, November 12, T. E. Adams, superintendent of motive power of the St. Louis Southwestern Railway Co., will read a paper on "The Economical Consumption of Coal."

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

*Southern & Southwestern Railway Club* (Atlanta, Ga.).—The next regular meeting will be held November 18th at 10 A. M. The subjects to be discussed are "The Oil Lamp" and "Front End and Draft Arrangements." There will also be a general discussion on "How many million dollars per annum can American railroads save in damage to freight cars and contents by permitting switchmen to adopt passenger practice in handling equipment?"

Secretary, A. J. Merrill, 218 Prudential Building, Atlanta, Ga.

*Western Railway Club* (Chicago).—At the meeting of November 16th Col. B. W. Dunn, chief inspector of the Bureau for the Safe Transportation of Explosives, will read a paper on the "Transportation of Dangerous Articles."

Secretary, Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

*Western Canada Railway Club* (Winnipeg, Man.).—Next meeting, Monday, November 8th.

Secretary, W. H. Rosevear, 199 Chestnut street, Winnipeg, Man.

## NATIONAL MACHINE TOOL BUILDERS' CONVENTION

The eighth annual convention was held in New York City, October 12th and 13th. The committee on the standardization of machine tool motors presented a report of progress and was continued. The problem of the "creation of machinists" was discussed at length. Industrial education as embodied in the Cincinnati continuation school and the Fitchburg high school was also discussed.

The following officers were elected for the ensuing year: F. A. Geier, Cincinnati Milling Machine Company, Cincinnati, Ohio, was chosen president. Fred L. Eberhardt, Gould & Eberhardt, Newark, N. J., the retiring president, was elected first vice-president; P. E. Montanus, Springfield Machine Tool Company, Springfield, Ohio, the retiring secretary, was elected second vice-president. C. Hildreth, Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass., was chosen secretary, and George W. Fifield, Lowell, Mass., was elected treasurer.

The spring meeting will be held in Rochester, N. Y.

Technical Publicity Association.—The first of the monthly meetings for 1909-10 was held Thursday evening, October 14th, in the headquarters, 14 Gramercy Park, New York. There was a good attendance. All enjoyed the informal dinner and an interesting programme. The president of the association, Charles S. Redfield, advertising manager of the Yale and Towne Manufacturing Company, was toastmaster. The only extended address was that of George French, editor of *Advertising and Selling*. Preceding his remarks the attention of the members was occupied with reports of committees. The chairmen who were called upon outlined the work to be done during the winter months. Howard M. Post, advertising manager of the Western Electric Company, told of plans for a systematic, analytical study of effectually tracing results from trade paper advertising. The keying method has proved inadequate. There should be some way of determining the effect of such advertising. At the conclusion of a discussion of this subject in which every point of view was presented, Mr. Post was made chairman of a committee to outline this study work for the association.

International Railway Fuel Association.—D. B. Sebastian, secretary of the association, advises that the second annual meeting will be held in Chicago some time during the month of May, 1910. Mr. Sebastian may be addressed at 327 La Salle Station, Chicago, Ill.

Inter-State Commerce Commission Needs Examiners and Clerks.—The United States Civil Service Commission announces an examination on November 23-24, 1909, to secure eligibles from which to make certifications for the appointment of examiners and clerks in the Bureau of Statistics and Accounts, Inter-State Commerce Commission. The eligibles obtained from this examination will be classified in three general groups with salaries ranging as follows: Group A—Examiners, $2,220 to $3,000; Group B—Examiners, $1,860 to $2,100; Group C—Clerks, $1,200 to $1,620.

If a sufficient number of high-grade eligibles is obtained, it is expected that there will be appointed approximately five from Group A, fifty from Group B, and fifty from Group C. For positions in Groups A and B it is desired to obtain men having special qualifications for work in the following fields of railway and other common-carrier accounting: 1.—Steam roads: General Auditing, Disbursements, Freight, Passenger, Claims. 2—Electric Railways; 3—Express Service; 4—Steamship Service; 5—Other common-carrier service. Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for application Form 304.

## BOOK NOTE.

Lighting Engineers' Hand Book. Compiled by L. R. Pomeroy. 231 pages. 4 x 7 in. Leather bound. Price, $1.00. Published by the Safety Car Heating & Lighting Co., 2 Rector street, New York City.

While the book is a "lighting engineers' handbook," as designated by its title, it really covers a much broader field. In the April number of this journal was published a study of the number and kind of machine tools required in a railway locomotive machine and boiler shop, prepared by Mr. Pomeroy. The editors received a number of letters congratulating them upon presenting this study and the following extract is taken from one of them: "Hope you can draw still further on Mr. Pomeroy's remarkable store of information. I have felt for many years that I would like to be his stationer for his note book trade alone." The data for the handbook has been carefully selected by Mr. Pomeroy from his "valuable store of information" and, like all of his notes, is arranged in a compact form, so that it can conveniently be found and in a form for ready application. It is unique from the fact that most of the information contained in it does not appear in other handbooks, or if it does, is not arranged in nearly as convenient a form. The book is made up of eight sections as follows: General, 41 pages; electricity, 22 pages; lighting, 63 pages; steam, 19 pages, heat and heating, 15 pages; traction, 17 pages; pipes and tubes, 26 pages; hydraulics, 9 pages.

It is difficult to review a book of this kind and give the reader any adequate idea of what it contains, or of its scope. To give some idea of the value of the book, however, it might be said that the general section, instead of containing a lot of simple miscellaneous information, which the engineer always keeps within easy reach, contains only a very small amount of such material and this very compactly arranged. The greater part of this section is given over to such information as the strength of gear teeth; formula for coiled springs; emery wheel speeds; data concerning U. S. standard bolts and nuts; the loading of rope; belting; crane data; horse-power of shafting; power consumed by blowers; amortization; efficiency; geometrical progression for spindle speeds and a very extensive and complete discussion of the power requirements for railroad shop tools. The sections on lighting and heating are specially complete, going into the matter thoroughly. In connection with the chapter on lighting, passenger car lighting, including the axle lighting system, is fully considered, as is also the use of storage batteries in this connection. In addition to the general information contained in the chapter on heat and heating, a brief description is given of the Thermo Jet system of car heating. This book should be not only in the hands of all those who are specially interested in the subject of car lighting and heating, but will be found of great value for engineers generally, and particularly to those interested in railroad work.

## PERSONALS.

T. O. Moore has been appointed master car builder of the Texas State Railroad.

M. G. Brown has been appointed master mechanic of the Gulf & Ship Island, with office at Gulfport, Miss.

George H. Smeltzer has been appointed superintendent of the locomotive and car shops of the Philadelphia & Reading at Reading, Pa.

William Wibel has been appointed acting assistant purchasing agent of the National Railways of Mexico, with office at New York.

Ben Johnson has been appointed assistant locomotive superintendent of the United Railways of Havana, with office at Havana, Cuba.

C. J. Kennedy has been appointed master mechanic of the Denver, Boulder & Western, with office at Boulder, Colo.

T. J. McPherson has been appointed master mechanic of the Peoria & Pekin Union, with office at Peoria, Ill.

W. M. Perrine has been appointed master mechanic of the New Jersey Central and Lehigh & Susquehanna divisions of the Central Railroad of New Jersey.

E. E. Bashford, assistant purchasing agent of the National Railways of Mexico at New York, has resigned to accept promotion in another department.

J. J. Connor has been appointed acting general foreman of the Houston & Texas Central, with office at Ennis, Tex., succeeding J. F. Murphy, deceased.

W. J. O'Neill, formerly general foreman for the Chicago, Rock Island & Gulf, at Shawnee, Okla., has been appointed master mechanic at Fort Worth, Texas.

C. M. Bailey has been appointed master mechanic of the Chicago, Burlington & Quincy Railroad-Lines West of the Missouri River, with headquarters at Wymore, Neb.

H. H. Hale, formerly master mechanic of the Gulf & Ship Island R. R., has been appointed master mechanic of the Cincinnati, Hamilton & Dayton, with office at Lima, Ohio.

C. J. Cooper, master mechanic of the Toledo & Ohio Central has resigned. He will go to Japan to become American mechanical instructor in the Kumamota Higher College of Technology.

C. H. Kelly, for 10 years connected with the store department of the Delaware, Lackawanna & Western, has been appointed assistant to the general storekeeper of the Lehigh Valley at Packerton, Pa.

G. E. Johnson, formerly master mechanic of the Wymore division, has been appointed general master mechanic of the Chicago, Burlington & Quincy Railroad-Lines West of the Missouri River, with headquarters at Lincoln, Neb.

C. M. Hoffman, master mechanic for the St. Louis & Louisville division of the Southern Ry. at Princeton, Ind., has tendered his resignation to take effect October 1. He will take a position with a western railroad.

M. J. Collins, assistant general purchasing agent of the Atchison, Topeka & Santa Fe at Chicago, has been appointed general purchasing agent, with office at Chicago, succeeding W. E. Hodges, elected vice-president.

Daniel H. Deeter has been appointed general master mechanic of the Philadelphia & Reading, with headquarters at Reading, Pa. All division master mechanics and the general locomotive inspector and the general boiler inspector will report to him.

W. G. Jones, general car foreman of repairs of the St. Louis-Louisville lines of the Southern Railway at Princeton, Ind., has been appointed general foreman of the car department of the St. Louis, Brownsville & Mexico, with office at Kingsville, Tex.

G. N. Howson, master mechanic of the Southern Railway at Alexandria, Va., has been transferred to Princeton, Ind., succeeding C. M. Hoffman, resigned. E. C. Sasser, master mechanic at Charleston, S. C., succeeds Mr. Howson and C. H. Kadie succeeds Mr. Sasser.

P. Maher, superintendent of motive power and equipment of the Toledo, St. Louis & Western and the Chicago & Alton at Bloomington, Ill., has been appointed also superintendent of motive power and equipment of the Minneapolis & St. Louis and the Iowa Central.

William McIntosh, superintendent of motive power of the Central of New Jersey at Jersey City, N. J., having been granted leave of absence; his duties will be assumed by C. E. Chambers, general master mechanic at Jersey City, who is appointed acting superintendent of motive power, with office at Jersey City.

F. W. Mahl, general mechanical engineer and purchasing agent of the Colorado & Southern at Denver, Colo., has been appointed assistant to the director of maintenance and operation of the Harriman Lines, in particular charge of questions relating to shop practice, equipment and motive power, with office at Chicago.

Dr. Chas. P. Dudley, of Altoona, Pa., consulting chemist of the Pennsylvania Railroad, and president of the American Society for Testing Materials, was elected president of the International Society for Testing Materials at the congress held in Copenhagen, September 7 to 11. The next congress will be held in this country in 1912, in accordance with the invitation extended by the American Society.

P. J. Colligan, assistant master mechanic of the Chicago, Rock Island & Gulf at Fort Worth, Tex., has been promoted to division master mechanic at Dalhart, with jurisdiction over three branches of the Rock Island system. He will be in charge of the Mexico and Amarillo divisions of the Chicago, Rock Island & Pacific; the El Paso division of the Chicago, Rock Island & El Paso and the Amarillo division of the Chicago, Rock Island & Gulf.

H. H. Stoek, for many years editor of *Mines and Minerals*, has been appointed professor of mining engineering at the University of Illinois. Prof. Stoek has had a very wide and extensive experience which fits him admirably for his new work. This announcement is made under the authority of Dean Goss and it is to be accepted as evidence that the new department of mining engineering of the University of Illinois is to be as efficiently manned as are its other departments of engineering.

## CATALOGS

Panel Boards.—Bulletin No. 4681, recently issued by the General Electric Company, illustrates and lists all of the panel boards designed by them.

"What We Make."—The B. F. Sturtevant Company, Hyde Park, Mass., has ready for distribution a new general catalog, No. 165, showing its complete line of fans, blowers, dust collecting and conveying systems, fuel economizers, engines, motors, turbines, etc. Principal dimensions and other useful information are given.

Foundry Facings.—A twelve-page booklet of envelope size has been issued by the Joseph Dixon Crucible Company, Jersey City, N. J., describing their facings for various kinds of work. It contains some general information in brief on the proper use of facings, values of different kinds, and working conditions met in foundry practice.

Machine Tools.—The sixty or more bulletins issued by The Hamilton Machine Tool Company, Hamilton, Ohio, have been assembled and are being distributed in the form of a catalog. The different lines of tools including lathes, planers, shapers and upright and radial drills are illustrated and very fully described; the more important features and special attachments are considered in detail.

Electric Apparatus.—Among the recent bulletins issued by the General Electric Company, of Schenectady, N. Y., are the following: No. 4699, motor driven air compressors of the geared type for use in connection with the air brake on electric cars; No. 4687, direct current motor-starting rheostats; No. 4676, multiple enclosed arc lights; No. 4760, G. E. switchboard instruments, type R2; No. 4691, small polyphase motors for use in connection with motor drives on the smaller machine tools.

Gasoline Engines.—Catalog 80 D from Fairbanks, Morse & Co., Wabash avenue and Eldredge Place, Chicago, Ill., describes their small engines having a capacity of from 1 to 12 h. p. It opens with an illustrated description of these engines, considering the general construction and the operation, and also describes each part in detail. The remainder of the catalog considers the different types and applications, and presents much valuable information for those who have need of such power. The new 1 h. p. engine "Jack Junior" is also described for the first time. It is a practical, durable, 4-cycle engine, water-cooled, and made to meet the demand for a small reliable engine for running light machinery.

## NOTES

Ehret Magnesia Mfg. Co.—Henry L. Leach has become identified, as railroad representative, with this company, whose headquarters are in the Land Title Bldg., Philadelphia, Pa.

The Warner & Swasey Company.—This company, of Cleveland, Ohio, is building a large addition to its new plant to be completed by December 1st. The buildings are of single-story, steel and concrete construction, and equipped with electric cranes and other modern features.

Furnaces.—The furnaces for forging, heating and welding purposes, manufactured by the Rockwell Furnace Company, 26 Cortlandt street, New York, are illustrated and described in a 40-page catalog, 9 by 12 inches in size. Several pages are given over to a description of the attachments and apparatus used in connection with the furnaces.

Dearborn Drug & Chemical Works.—Edward C. Brown, manager of this company in the Hawaiian Islands and the Orient, has been elected president of the Commercial Club of Honolulu. Mr. and Mrs. Brown recently made a trip in the interests of the Dearborn Company to the Orient, spending several months in China, Japan, Korea, and the Philippines.

The B. F. Goodrich Company.—This company has just finished, in New York City, one of the most admirably equipped buildings for the handling of their rubber products, especially tires, that there is in America. It is at Broadway and West Fifty-seventh street and has twelve floors and a basement. The latter is used entirely for the storage of automobile tires. Throughout this building no mechanical device for the ready handling of the heavy stock has been omitted.

The General Electric Company reports that the sales of Tantalum lamps are more than double what they were a year ago and the lamp appears to be sharing with the demand for high efficiency lamps created by the introduction of Tungsten lamps. The Tantalum lamp, as at present supplied is giving most excellent life service. Contrary to general belief, these lamps will give good commercial life on alternating current of 60 cycles or less. Their life on this frequency will average well above 600 hours.

L. M. Booth Company.—W. R. Toppan, vice-president and general manager, has closed a contract with the Vandalia Railroad Company for a Booth water softener having a treating capacity of 40,000 gallons per hour, and a 350,000 gallon steel storage tank to be installed in connection with the new shops at Terre Haute, Indiana. The Booth water softener now under construction upon the C. R. I. & P. Ry., at Sayre, Okla., will be placed in operation shortly. The simplicity and convenience of operation of the Booth Company Type "F" softener called forth very favorable comment at the Master Mechanics' convention this year.

The Pilliod Company.—This company is erecting an additional factory, 180 x 50 ft., at Swanton, Ohio. It is expected that this will be completed and $20,000 worth of new machinery will be installed by December first. It will then be possible to turn out five complete gears per day. Within the past two weeks orders have been received for the Baker-Pilliod valve gear for four consolidation locomotives for the Mexican Railroad, two 10-wheel engines for the Missouri & North Arkansas Railroad, five Mallet for the Norfolk & Western Railroad, fifteen 10-wheel passenger engines for the Seaboard Air Line and six switch engines for the Central Railroad of New Jersey.

# ROBERT M. VAN ARSDALE

Robert Morris Van Arsdale, proprietor and sole owner of this journal, died very suddenly of apoplexy at his home, 276 W. 71st street, on the evening of November 23.

He was born in Titusville, Mercer Co., New Jersey, on July 1, 1848, and was connected with trade journalism from his twenty-fifth year, and at his death was one of the very few successful individual publishers. His first work was with a commercial paper in Chicago, which, however, did not prove congenial, and two years later, in 1875, he joined the staff of the *Railroad Gazette* as an advertising solicitor. His personal qualifications and business ability made him remarkably successful in this position.

He remained with the *Gazette* for about six years, and on January 1, 1880, purchased the *National Car Builder,* which was being published by Vose, Dinsmore & Co., New York. This paper was what would now be known as a house organ, and was immediately made independent and greatly broadened by its new owner and by James Gillet, who remained with it as editor. Its influence in car matters soon became national, and it was continued with marked success until January, 1896, when Mr. Van Arsdale purchased the *American Engineer & Railroad Journal* from M. N. Forney and combined the two papers under the title of AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL. This title was retained for two years, and was then changed to its present form, THE AMERICAN ENGINEER AND RAILROAD JOURNAL.

In purchasing this publication, Mr. Van Arsdale became the sole owner of the oldest railroad paper in the world, which had been founded in 1832 and published continuously since that date. Under Mr. Forney's ownership it had obtained a commanding position as a motive power authority and the combination of it with the *National Car Builder,* of equal reputation in the car department, made a remarkably powerful and influential publication. Mr. Van Arsdale, however, was not satisfied, and proceeded to develop, broaden and increase the influence of the combination along conservative lines, which policy was vigorously pursued up to the time of his death.

Upon the retirement of Mr. Forney at the end of 1896 George M. Basford was secured as the editor, and during the next nine years Mr. Van Arsdale's policy of publishing a paper which should not only be the champion of the motive power department and a leader in its development, but also of the greatest possible practical benefit to its individual subscribers, was fully developed and most successfully put into effect.

An illustration of his interest in the progress of the motive power department on American railways is shown in the elaborate series of tests on locomotive front end appliances, which were undertaken and most generously provided for by him. These tests were made at the locomotive laboratory at Purdue University under the direction of a committee of the Master Mechanics' Association, which was not then in a financial condition to undertake them itself, and the results obtained were of great importance. This action on the part of a publisher was widely commented upon and most generously praised throughout the country. The tests covered a period of two years.

Mr. Van Arsdale's success as a publisher was greatly assisted by his wide acquaintance and the esteem with which he was held by all who knew him. It was a valuable acquaintance, because it was special, being among railroad mechanical officials and manufacturers of railway supplies, and including nearly all of them. It has been commonly stated that Mr. Van Arsdale had no enemies, and this must have been very nearly true. He was equitable, contented and always serene. The use to which he put the first large sum of money which he was able to save through frugality and hard work was characteristic of his nature; he used it to buy a city house in Chicago for his mother, who had always wanted a house in the city.

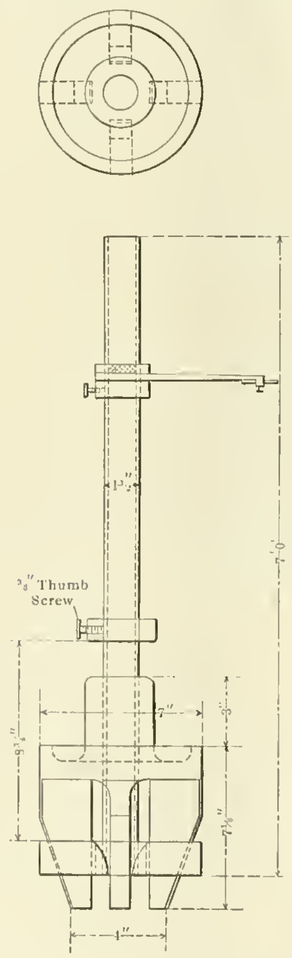
One of the most prominent impressions obtained of him by his business associates was his very high ideas of honor and his unusually strict business integrity. His honesty, both in word and action, was proverbial among his friends and associates. He was noted for his jovial nature and his manner of greeting his friends will always be remembered by those who knew him well. He was an excellent example of the finest type of good citizen who quietly does his work with few public appearances and nevertheless leaves a name which will be remembered by the very large number whom he helped along. His share of the public duty was always performed with pleasure, no matter what form it took. He sat on the Grand Jury in New York every year for many years.

His activity in organizing and assisting, both through the columns of his paper and by personal effort, any association which was designed to improve the work of the mechanical department of the railways was well known. He was a charter member of the New York Railroad Club and attended the conventions of the Master Mechanics' and Master Car Builders' Associations every year for over twenty years. He was a member of the American Trade Press Association of New York.

Mr. Van Arsdale was a very active member of the First Church of Christ, Scientist, in New York City, and of the Mother Church in Boston. He was formerly a member of the Manhattan and Colonial Clubs of New York. He is survived by his widow. Interment took place in Chicago on November 28.

## STACK CENTERING BAR.

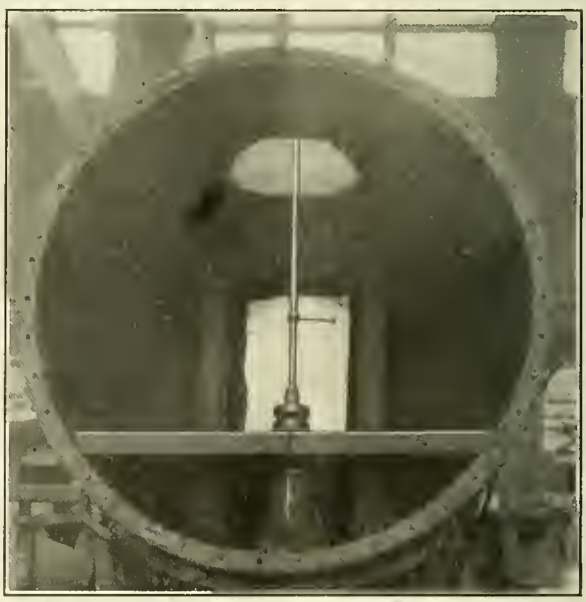
A very convenient apparatus for quickly and accurately centering the stack of a locomotive over the exhaust nozzle is shown in the accompanying illustrations. This device was designed and is in use at the Collinwood shops of the Lake Shore & Michigan




DETAILS OF CENTERING BAR.

Southern Railroad and consists of a long bar mounted on a base fitted with beveled jaws and a sliding ring so that it automatically centers itself in the exhaust nozzle tip and simply needs to be set into place to be assured of an accurate location. On the bar is a swinging arm, which can be located at any point, by means of which the stack, after being set into place, can be accurately centered, both at the choke and top.

New Steam-Electric Locomotive.—A locomotive of an entirely new type, the driving mechanism of which consists of a steam turbine coupled to an electric generator which supplies current to four motors on the driving axles, is under construction by the North British Locomotive Co., of Glasgow, Scotland. This new type of motive power, which is called the Reid-Ramsay system, was described by Hugh Reid, deputy chairman and chief managing director of the company above mentioned, in his inaugural address as honorary president of the Glasgow University Engineering Society, October 29. It was explained that this is not the first attempt to develop a self-contained



STACK CENTERING BAR IN PLACE.

steam-electric unit. The Heilmann steam-electric locomotive, built in 1894, was given wide publicity at that time; but the Reid-Ramsay locomotive, it is stated, develops the idea on a different and more practical basis. In the new engine, steam is generated in a boiler of the ordinary locomotive type, which is fitted with a superheater. The steam from the boiler is led to a turbine of the impulse type, running at a speed of 3,000 revolutions per minute, to which is directly coupled a direct-current, variable-voltage generator. The generator supplies electrical energy at from 200 to 600 volts to four series-wound railway motors, the armatures of which are built on the four main or driving axles of the locomotive. The exhaust steam from the turbine passes into an ejector condenser, and together with the circulating condensing water, is delivered eventually to the hot well.

# FOUR-CYLINDER SIMPLE LOCOMOTIVE WITH SUPERHEATER

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

Two locomotives, each with four 17½x26 inch cylinders and using highly superheated steam at 160 pounds' pressure, have recently been delivered to the Chicago, Rock Island & Pacific Railway by the American Locomotive Company. While these are not the first four-cylinder simple locomotives to be built in this country, they are the first of that arrangement to use superheated steam and the first to be built for regular service. In Great Britain, however, as our readers are aware, four simple cylinders have been employed for passenger locomotives using both saturated and superheated steam for several years.

Reduction of severe blows to the track at high speed, more constant turning moment with a higher average tractive effort, reduction of distorting strains in the engine frames, lighter rods, crossheads, pistons, etc., small and light piston valves, reduction of boiler troubles, and a steady even exhaust with larger nozzle, are some of the more prominent advantages of a design of this kind for passenger service. The most important disadvantages are:— The cranked axle, greater number of parts, difficulty of inspection, complex lubricating arrangement and expense of construction and maintenance.

It is interesting to note that the design has been taken up with the usual manner and the inside cylinders to the cranked axle. This axle is a solid forging and of an exceedingly strong construction to stand all the strains to which it is subjected. The bearings are 11 inches in diameter throughout, and the driving box journal and journal for the back end of the main rod of the inside cylinder are connected by a circular disk 4¼ inches wide. The crank pins are connected by a rectangular section 10½ inches by 13 inches, the whole forming a very durable arrangement likely to wear well in service.

Because of the connection being on the front axle it was necessary, in order to obtain a good length of main rod, to locate the cylinders about 3 feet further ahead than usual in this type of engine, the distance between the centre of the cylinders and that of the front driving axle being 11 feet. This permits the use of an 84-inch main rod.

Increasing the normal distance between the front drivers and the cylinder center 3 feet involved, of course, an increase of a like amount in the length of the boiler; though, in this instance, this was accomplished with an increase of only 2 feet in the length of the tubes.

A very simple valve motion, involving no complications in


BALANCED SIMPLE ATLANTIC TYPE LOCOMOTIVE WITH SUPERHEATER—CHICAGO, ROCK ISLAND AND PACIFIC RY.

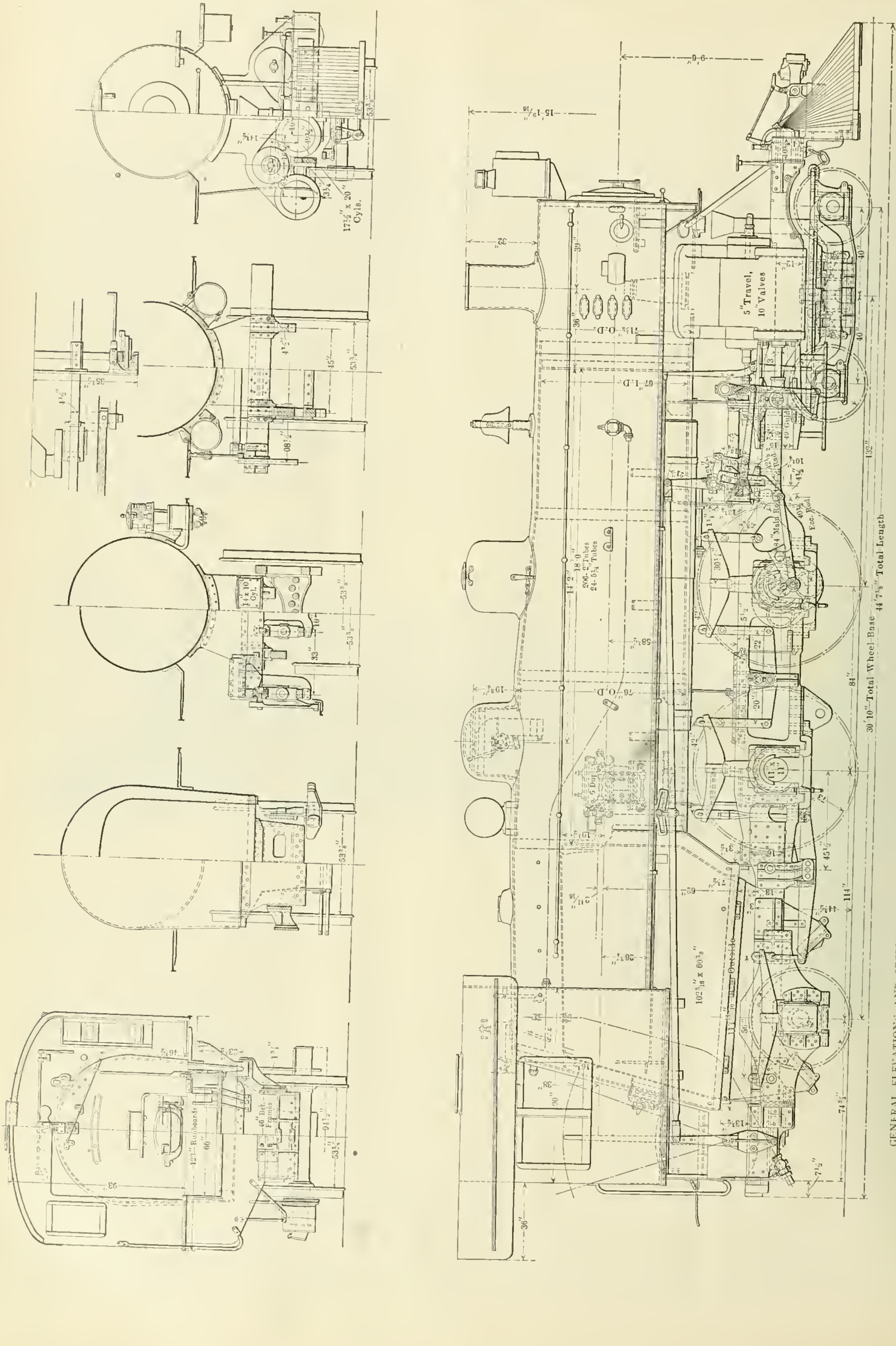
a view to experiment after an experience by this company, extending over four or five years, with balanced compound and simple two-cylinder Atlantic type locomotives of practically the same weight and power both with and without superheaters.

As will be seen from the accompanying illustration, the engines present a very attractive appearance, the lines of the design being symmetrical and pleasing. In working order they have a total weight of 202,000 pounds, of which 116,000 pounds is carried on the driving wheels. This is an increase of 14,000 pounds over the weight on driving wheels of the road's standard design of two-cylinder Atlantic type engine, this increase being permissible because of the balancing of the reciprocating parts and the elimination of the hammer blow.

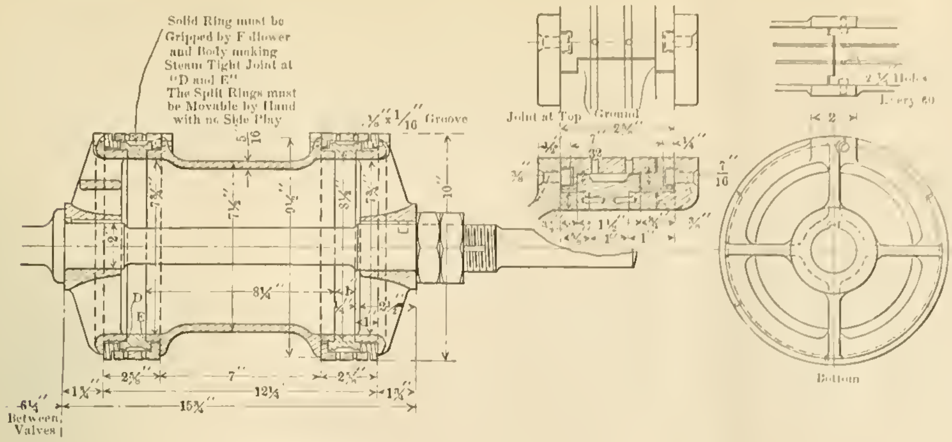
In the arrangement of cylinders, the design follows the Von Borries and Vauclain balanced compound locomotive, the four cylinders being set in the same transverse and horizontal planes.

The cylinder casting is made in two parts with half saddles, each part containing an inside and outside cylinder and a valve chamber placed above and between them. Each cylinder is 17½ inches in diameter by 26 inches in stroke. All four cylinders drive on the front pair of driving wheels, the main rods of the two outside cylinders being connected to crank pins on the wheels in the cylinder construction, has been employed. Superheated steam is distributed to the inside and outside cylinders on each side by two 10-inch hollow piston valves carried on a single stem and actuated by the Walschaert valve gear. Both valves have inside admission and outside exhaust. The live steam passage branches at a short distance down from its connection with the steam pipe and one part leads to the center of each valve. The front valve controls the admission of steam to the forward ports of the two cylinders, while the rear valve serves their back ports, the inside ends of the two valves operating the outside cylinder. This results in such an arrangement that while, as mentioned above each valve has inside admission, in combination they make what is the same as an outside admission valve for the outside cylinder and an inside admission valve for the inside cylinder. As the valve gear is connected to the cross-head of the outside cylinder, it is accordingly arranged for an outside admission valve. The piston valve, which is of special design for use with superheated steam, is shown in one of the accompanying illustrations.

The arrangement of the Walschaert valve gear is worthy of special notice as representing a very simple, compact and satisfactory design of this type of gear. The link is carried in a




GENERAL ELEVATIONS AND SECTIONS OF FOUR CYLINDER, BALANCED SIMPLE, ATLANTIC TYPE LOCOMOTIVE WITH COLE SIDEHEAD SUPERHEATER.—C., R. I. & P. RY.



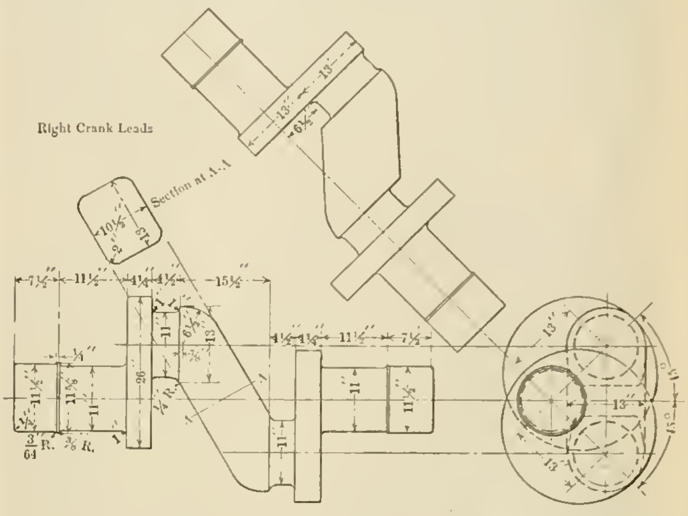

DETAILS OF ONE VALVE—TWO LIKE THIS ON EACH STEM.

cast steel bracket bolted to the front of a yoke or cross-tie located a little ahead of the front driving wheels. A longitudinal bearer extending between this cross-tie and the guide yoke furnishes support for the bearings of the reverse shaft, the forward extending arm of which is connected by means of a link to the radius bar 9¾ inches ahead of the link block. The front end of the radius bar has a pin connection to the combination lever, the upper end of which has a similar connection to the downward extending arm of the rocker which transmits the motion to the valve and is carried in a bearing secured to the guide yoke. The inside arm of the rocker transmits the motion to the valve rod by means of a block which works in a yoke in the rod arranged very similar to the Canadian Pacific design.* The rear end of the valve rod is extended and slides in a guide bolted to the back of the yoke. It will be noticed that the upper end of the combination lever is offset ⅝ of an inch. This was necessary in order to neutralize the effect on the valve events of the angularity of the main rods; and to give as nearly equal cut-offs as it is possible to obtain in two cylinders connected at 180 degrees to each other and operated by two valves deriving their motion from a single valve gear.

The frames consist of a main frame of cast steel 4½ inches wide with a single front rail 3¼ inches in width cast integral with it, and a slabbed rear section spliced to the main frame just back of the rear driving wheel. There is also an outside supplementary frame which carries the trailing journal box and is connected to the inside frame through the medium of heavy steel spacing castings.

An unusually strong and substantial system of frame bracing has been employed. This includes, in addition to the cast steel foot plate at the rear of the engine, a cross tie between the frames just ahead of the front of the firebox; another back of the rear pedestals; one, having a bearing of 41½ inches on the upper rails of the frames, between the front and rear driving wheels and one spanning the lower rails of the frames immediately back of the forward pedestals, all of these being of cast steel. The frames are further braced together by the cross-tie ahead of the front driving wheels, which furnished the support to the link bracket, and by the heavy guide yoke. The boiler is secured to the frames at all of these points by steel plates.

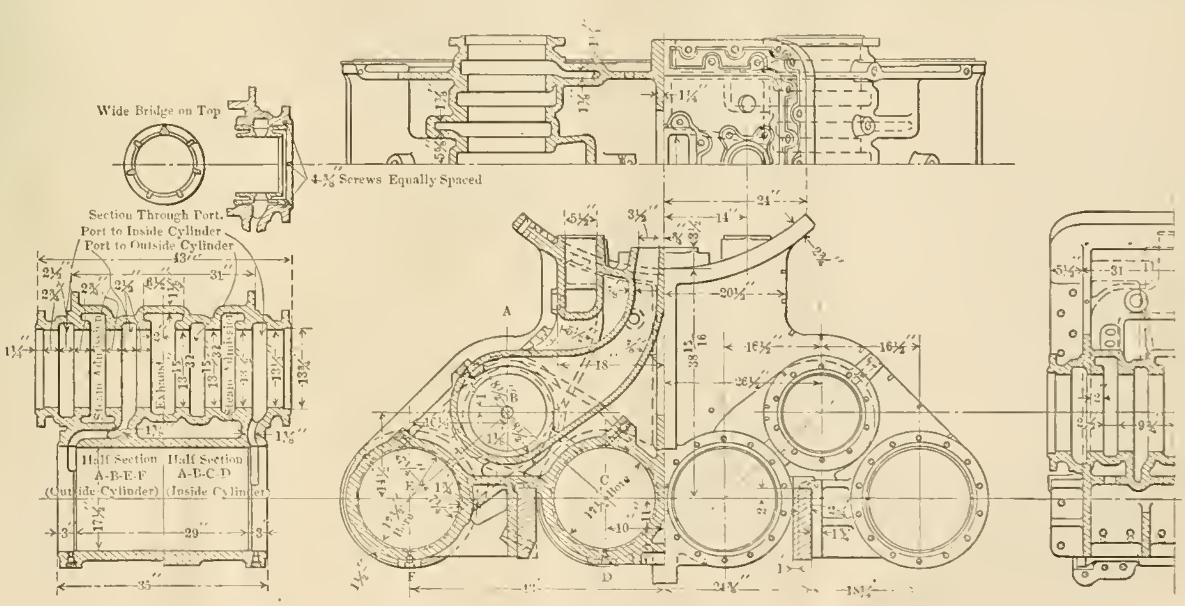
The boiler is of the radial stayed extended wagon top type




CRANK AXLE, ROCK ISLAND BALANCED SIMPLE LOCOMOTIVE.

with sloping back, head and throat sheet. The barrel measures 68⅛ inches outside diameter at the front ring. It contains 206 2-inch tubes and 24 tubes 5¼ inches ouside diameter, which contain the superheater pipes. The tubes are 18 feet long. The boiler has a total evaporative heating surface of 2726 square feet, of which the tubes contribute 2551 square feet and the fire-

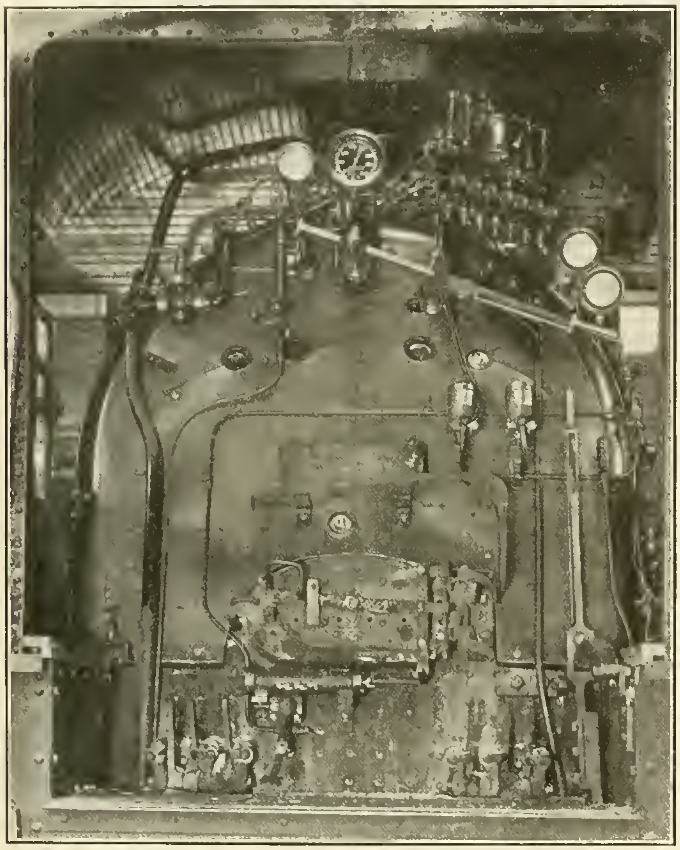
* See AMERICAN ENGINEER, January, 1908, page 16, and November, 1909, page 430.




DETAILS OF CYLINDER CASTING—ROCK ISLAND BALANCED SIMPLE LOCOMOTIVE.

box the remainder. The firebox is 102 3/16 inches long and 60⅜ inches wide and provides a grate area of 42.8 square feet.

Outside of the superheater, the boiler presents no unusual features of construction. The superheater is the builder's latest design of the fire tube type with side headers, similar to the arrangement applied to a consolidation engine built for the Wabash Pittsburgh Terminal Railway,* except that it is designed to give a higher degree of superheat. In the design here applied, each 5¼ inch tube contains four 1¼ inch superheating tubes arranged in double pairs and connected at the ends by return bends. The inside members of the two pairs are formed of a single tube which is looped at the front end, thus compelling the steam to traverse four times the length of the tubes in its passage from the dry pipe to the cylinders. This arrangement not only gives as high a degree of superheat as it is practicable to obtain, but also reduces the number of steam joints to inspect and maintain to a minimum. The ends of the



VIEW IN CAB—ROCK ISLAND BALANCED SIMPLE LOCOMOTIVE.

superheating pipes are bent around horizontally with a large radius to meet the side headers. In this way complete freedom for the expansion and contraction of the superheater tubes due to variations in temperature is provided. The inlet and outlet pipes of each four-tube superheater element are connected by a gland and secured to their connections with the header by a single bolt passing through the header with the nut and thread on the outside. Access is given to these bolts from the outside by means of covered openings in the side of the smoke box.

A damper automatically operated by a steam cylinder connected to the steam chest controls the passage of gases through the 5¼-inch tubes and around the superheating pipes.

The cylinders and valves are lubricated by a Nathan seven sight-feed lubricator and Campbell graphite cups are also provided for the cylinders.

Careful attention was given to the location of the various fittings on the boiler back head with the result that a very handy cab arrangement was effected, as will be seen from the illustration of the inside of the cab.

* For full drawing and description, see AMERICAN ENGINEER, June, 1909, page 256.

The tender is equipped with a water bottom tank, having a capacity of 7,500 gallons and space for 13 tons of coal. The tank is mounted on a solid cast steel tender frame manufactured by the Commonwealth Steel Company. The tender trucks are of the four-wheel equalized pedestal type with cast steel bolster.

The general dimensions, weights and ratios of these locomotives are as follows:—

| | |
|---|---|
| **GENERAL DATA.** | |
| Type | 4-4-2 |
| Gauge | 4 ft. 8½ in. |
| Service | Passenger |
| Fuel | Bit. Coal |
| Tractive effort | 29,600 lbs. |
| Weight in working order | 202,000 lbs. |
| Weight on drivers | 116,000 lbs. |
| Weight on leading truck | 49,000 lbs. |
| Weight on trailing truck | 37,000 lbs. |
| Weight of engine and tender in working order | 351,900 lbs. |
| Wheel base, driving | 7 ft. |
| Wheel base, total | 30 ft. 10 in. |
| Wheel base, engine and tender | 62 ft. 8½ in. |
| **RATIOS.** | |
| Weight on drivers ÷ tractive effort | 3.92 |
| Total weight ÷ tractive effort | 6.80 |
| Tractive effort × diam. drivers ÷ heating surface | 793.00 |
| Tractive effort × diam. drivers ÷ equiv. heating surface | 648.00 |
| Total heating surface ÷ grate area | 63.90 |
| Equiv. heating surface ÷ grate area | 78.00 |
| Firebox heating surface ÷ total heating surface, per cent | 6.42 |
| Weight on drivers ÷ total heating surface | 42.50 |
| Weight on drivers ÷ equiv. heating surface | 34.80 |
| Total weight ÷ total heating surface | 74.00 |
| Total weight ÷ equiv. heating surface | 60.80 |
| Volume, four cylinders, cu. ft | 13.00 |
| Total heating surface ÷ vol. cylinders | 210.00 |
| Superheater surface ÷ vol. cylinders | 31.3 |
| Equiv. heating surface ÷ vol. cylinders | 257.00 |
| Grate area ÷ vol. cylinders | 3.3 |
| **CYLINDERS.** | |
| Kind | Simple |
| Number | 4 |
| Diameter and stroke | 17½ x 26 |
| **VALVES.** | |
| Kind | Piston |
| Diameter | 10 in. |
| Greatest travel | 5 in. |
| Outside lap | 1 1/32 F.—31/32 B. |
| Inside clearance | ⅛ in. |
| Lead, constant | 7/32 F.—9/32 B. |
| **WHEELS.** | |
| Driving, diameter over tires | 73 in. |
| Driving, thickness of tires | 3½ in. |
| Driving journals, diameter and length | 11 x 11 in. |
| Engine truck wheels, diameter | 33 in. |
| Engine truck, journals | 6 x 12 in. |
| Trailing truck wheels, diameter | 45 in. |
| Trailing truck journals | 8 x 14 in. |
| **BOILER.** | |
| Style | E. W. T. |
| Working pressure | 160 lbs. |
| Superheater, type | Cole Sideheader |
| Outside diameter of first ring | 68⅛ in. |
| Firebox, length and width | 102 3/16 x 60⅜ in. |
| Firebox plates, thickness | 5/16 & ½ in. |
| Firebox, water space | F.—5, S. & B.—4½ in. |
| Tubes, number and outside diameter | 206—2 in. |
| Tuhes, superheater, number and diameter | 24—5¼ in. |
| Tubes, length | 18 ft. |
| Heating surface, tubes | 2,551 sq. ft. |
| Heating surface, firebox | 175 sq. ft. |
| Heating surface, total | 2,726 sq. ft. |
| Superheater heating surface | 406 sq. ft. |
| Equivalent heating surface* | 3,335 sq. ft. |
| Grate area | 42.8 sq. ft. |
| Smokestack, diameter | 18 in. |
| Smokestack, height above rail | 15 ft. 1 9/16 in. |
| Center of boiler above rail | 9 ft. 6 in. |
| **TENDER.** | |
| Tank | Waterbottom |
| Frame | Cast Steel |
| Wheels, diameter | 33 in. |
| Journals, diameter and length | 5½ x 10 in. |
| Water capacity | 7,500 gals. |
| Coal capacity | 13 tons |

* Equals evaporating heating surface (2,726 sq. ft.) + 1.5 times the superheater surface (406 sq. ft.).

LOCOMOTIVES EQUIPPED FOR FIGHTING FIRES.—In the realization that fires are liable to occur at any time at places which cannot be reached by ordinary extinguishing apparatus, the Pennsylvania has equipped 423 locomotives with fire fighting apparatus. These locomotives are used continually in yard service at various points on the company's lines and are available at all hours of the day and night. On a given signal, their crews, all of which have been trained in fire fighting, hurry their engines to the scene of the fire, and all tracks are cleared that no time be lost en route. So successful has this method of protecting property at out-of-the-way places proved that an additional number of yard engines are being similarly equipped.

# THE EQUIPMENT INDUSTRIES AND RAILROAD PROSPERITY.*

W. H. Marshall.

A year ago the mere statement of the subject assigned to me would have produced many rueful countenances among those I see before me to-night, for there was no prosperity in evidence for any one except the Western farmer, and he was keeping it pretty much to himself. Adversity was general and the members of this Association were fully informed by personal and painful experience of what railroad depression meant to industrial and commercial interests.

The public was familiar with statistics of railroad earnings showing a loss in gross of from ten to thirty per cent.; they knew great steel interests were running their plants at half of normal output, but they did not know the conditions in related lines of industry—manufacturing concerns dependent almost wholly upon the railroads as customers, whose individual interests may be smaller, but whose aggregate is enormous. Some of these shut down altogether and others ran from one-tenth to one-half of their capacity. Even after the worst was over statistics showed these concerns having 1,500,000 men on their pay-rolls in good times as employing barely one-half of that number, and not all of them had steady employment. Thus, the losses to employees and to capital engaged in furnishing material, equipment and supplies to railroads was even greater, in proportion at least, than that suffered by the railroads themselves.

But all this has passed into history and to-night we view with smiling faces the picture of railroad prosperity. It calls many to service whose families have suffered from their non-employment. In coal mines from Pennsylvania to Colorado, in the iron mines of the North, in the all but deserted lumber camps of the Northwest and the South and Southwest, all is activity. On the Great Lakes ships are again carrying forty million tons of ore per season to the lower lake ports, furnace fires are lighted in Pittsburg, in the valleys and in the lake cities from Buffalo to Chicago, and the wheels begin to turn in shops all over the land, bringing cheer and comfort to a million families whose bread winners do not work for the railroads, but whose employment is made possible by their activities. And in the background of this picture are merchants, great and small, benefiting by the resumption of buying by the railroads The transportation companies whose prosperity can and does make this picture are owned in a large measure by the people. The money paid for salaries and wages amounts to between 50 and 60 per cent. of the cost of operation, and possibly a larger percentage of what is paid for materials and equipment, whether charged to operation or capital account, goes to labor in the final analysis. Our prosperity, the prosperity of the railroads and of the people are inseparable.

If, therefore, anything is done to increase this prosperity, to lengthen its periods or to minimize the times of inactivity with which it is punctuated the entire people of the country are benefited and the capital and employees we represent come in for their full share.

Realizing that when the railroads were hurt we suffered more than they did, and believing that the attitude of the public and legislative bodies toward great corporations, particularly the railroads, was injurious and to some extent unjustifiable, this Association was formed one year ago. As the welfare of the public and the railroads is inseparable and as our welfare is bound up with that of the railroads, we have labored for our own well-being, confident that success meant a benefit to all and injury to none. We have championed the cause of the railroads for the reason that it was our cause, but we have done so only when we believed they were right. We have sought no favors or privileges, for them or for ourselves, but we have pleaded for calmness and good temper in the consideration of all differences between them and the public, and have endeavored to demonstrate how disastrous to us is injury to them. We are not obstructionists. We believe reasonable regulation of the railroads is right and will injure no one.

The efforts of ourselves and others working along similar lines have been attended with a measure of success, and right-thinking people have come to realize there was something wrong in the situation of a year ago. The agitation against railroads has diminished. The pendulum is swinging in the right direction. To do what we can to prevent its return is now the important problem to which we should apply ourselves.

During our one year of existence as an Association, we have had ample opportunity to study the situation. Two facts stand out prominently; first, that we are suffering from a great excess of legislation, and second, that for some reason the managements of railroads, in too many cases, do not reach the heart and sympathy of the people.

Few are aware of the total volume of legislation placed annually upon our statute books. In the last regular session of Congress there were introduced 28,440 bills, and in the 1909 session of thirty-nine state legislatures there were introduced 45,330 bills, or a total of 73,770. During that period Congress enacted 326 bills (exclusive of pension bills) and the thirty-nine state legislatures 12,508, or a total of 12,834 bills that became laws. In the session of the British Parliament, completed in 1908, 547 bills were introduced and 239 became laws. In the United States there was one bill introduced for approximately every 1,000 inhabitants and in Great Britain one for every 77,000. In the United States there was one bill enacted for every 6,000 inhabitants, while the British Parliament enacted one for every 175,000 inhabitants of the United Kingdom. Does not even a most charitable contemplation of this volume of legislation force the conclusion that it cannot all be deliberate or wise, or just or necessary? Is not the necessity of culling out over 60,000 proposals to legislate a most serious matter? And can any one doubt that the weeding out process should have been more complete and that we all would have been better off with much less than 12,834 new laws?

An illustration of the embarrassment of hasty legislation is the corporation tax law. In referring to this particular law there is no intent to assail its purpose as wrongful, but merely to cite it as the most recent example of important, far-reaching legislation entered upon precipitately. It was introduced towards the end of the last session of Congress and rushed through with every evidence of lack of study. It is an attempt to tax the profits of corporations, but apparently those who framed it were ignorant of modern methods of accounting At any rate, the law as passed will tax the net amount of cash added to assets during the year, whether that bears any relation to profit or not. Expert accountants say it is impossible to make the reports required by the law from accounts as now kept, and that accounts must be kept in two ways, involving needless expense and work. Furthermore, to add to the complexity of the situation, the railroads cannot keep their books in a way that will permit of reporting under the new law without violating the instructions of the Interstate Commerce Commission and being in danger of incurring penalties therefor. Did time permit, illustrations could be multiplied to

* Address at the annual dinner of the Railway Business Association, Waldorf-Astoria Hotel, New York, November 10, 1909.

show that even when the objects to be attained are worthy, much of our legislation is imperfect.

The great volume of legislation leads to much that is inconsistent. State laws conflict with Federal laws and are at variance with the laws of other states. A railroad finds it is compelled to do in one state something it is prohibited from doing in an adjoining state and must at times go to the courts to determine which of two laws it will obey, it being impossible to conform to both. This confusion will not disappear until the volume of new legislation is reduced to an amount that will permit of proper care in the preparation of each and every law. When this is accomplished we shall have fewer new laws and they will be the kind we need.

One great obstacle to the correct framing of proposed laws is the suspicion with which most attempts to enlighten are received. Perhaps it is unfortunate that expert knowledge of the subject with which it is intended to deal is generally found chiefly among those to be affected by the legislation, for the reason that information from such sources is considered to be prejudiced. But legislation to be right must be based upon knowledge, and if that knowledge can be made complete only by contributions from interested parties, it is the duty of our legislators to throw aside suspicion and consult those who will be affected by the legislation. To justify such a course their advances must be met by perfect frankness, and a cordial recognition of the rights of the public. Unreasoning opposition to legislation as such will not succeed. That which is unnecessarily restrictive or injurious in proposed legislation must be shown to be so with reasons that are true and convincing. Lack of frankness in the past and failure to freely concede to others their rights undoubtedly accounts for much of the antagonism of recent years, and it would seem as if the rapidity with which it is to be eradicated will be measured by the completeness of the change in attitude on the part of the railroads and other corporations.

It is also true that in the few instances in which railroads have been consulted on proposed legislation, no unanimity of opinion was to be found among them. There is some excuse for this, for the railroad managements represent interests located in various sections of the country, and what is best for one section may not fit any too well into the conditions found in another. The people have an example in the recent tariff law of the difficulties of reconciling interests in all parts of this great country, and what applies to general business is true of railroads. Nevertheless, railroads cannot expect to be of service in clarifying the situation, until they can agree among themselves as to the form legislation should take. If the layman consults the experts and they hopelessly disagree, what is he to do? He will get along without the experts.

It has been stated that the railroads do not reach the hearts and sympathies of the people. That the wrongs of past management are wholly responsible for the present feeling we do not believe. With the correction of many of these wrongs (at which every broadminded official rejoices) the feeling of resentment should disappear, and while we are glad to see conditions improving, the fact that the change is not as rapid as expected, points to something yet remaining to be done.

A railroad management should not lose sight of the fact that in its task of conciliation special attention must be given to the small shipper, to the passenger who travels but a few miles on its trains and to local communities. The big shipper can take care of himself, or can at least make a demonstration that will result in his grievances being duly considered. Not only is it difficult to do justice to the smaller interests through the instrumentality of minor employees in an organization as complex and extensive as that of a railroad, but the railroad is at a further disadvantage as compared with a commercial or manufacturing business. In a commercial house improper treatment of customers is quickly noticed, as it leads to loss of business, for the patron can go elsewhere, but if the local patron of a railroad is not treated right, revenues are not reduced. He must use the railroad company any way, but his exasperation is all the greater because he is helpless. It is not sufficient that those at or near the top of an organization should have the right spirit; that spirit should permeate the entire organization. It always does as a matter of fact, but unless determined effort is made it permeates too slowly. Whatever of effort is made in this direction has a twofold reward; it brings appreciation from the public and it improves the relations between employer and employee. Nothing adds more to the faith and loyalty of the kind of men all corporations wish to retain in their employ than daily evidences of strict justice to others. A full realization of all these conditions should lead to greater vigilance in the maintenance of correct relations with the public.

If some of these remarks are in the nature of criticism of our railroad friends, it should be borne in mind that they are uttered in the most friendly spirit. The justification for alluding to them lies in our belief that the better relations between the railroads and the people and the representatives of the latter sent to our legislatures, which we so ardently desire and for which we are working, cannot be advanced by ignoring any practical side of the situation.

And now in conclusion permit me to reiterate that railroad prosperity is everything to the interests represented in this Association. Knowing well the difficulties in the present situation we, nevertheless, are optimistic. That both sides may be now to some extent in the wrong does not shake our belief in the good sense of the public and wisdom on the part of railroad managements. We are confident the differences between the public and the railroads will finally be adjusted in a spirit of fairness and good temper on both sides, and with patience—not a patience that accomplishes nothing of reform, but a patience that while progressive is painstaking and thorough.

Does not our history justify such a faith? Important as are our present day problems, have not greater ones been solved already?

Surely a people that has by its energy, industry and intelligence accomplished so much in but little more than a century of national life is not going to fail when confronted with the task of correcting, with a minimum of injury to itself, evils brought about by its own growth. Nor is it conceivable that railroad men who have built and who are daily extending and operating these great transportation lines, men possessed of all the integrity, ability and application vital to such achievements, will be found wanting when weighed in the scales of public opinion.

## TRAIN RESISTANCE FORMULAS.

In two issues of *The Engineer* (March 26 and April 2, 1909), Lawford H. Fry brings together for comparison some of the more important formulas for train resistance which have appeared since the presentation of the elaborate paper of Mr. Aspinall to the Institution of Civil Engineers in 1901. He describes briefly the methods employed by Nadal and Conte in France, Sanzin in Austria, and by Frank and Von Borries in Germany to develop rational formulas to represent the results obtained experimentally; after which he proposes the following new formulas which give results agreeing fairly with the mean of the various experimental determinations:

Four-coupled Locomotives:—

$$R = 3.8 + 0.0435V + 0.0018V^2$$

Six-coupled Locomotives:—

$$R = 4.5 + 0.0563V + 0.0018V^2$$

Eight-coupled Locomotives:—

$$R = 6. + 0.21V + 0.0018V^2$$

(Locomotive and tender considered as a single unit.)

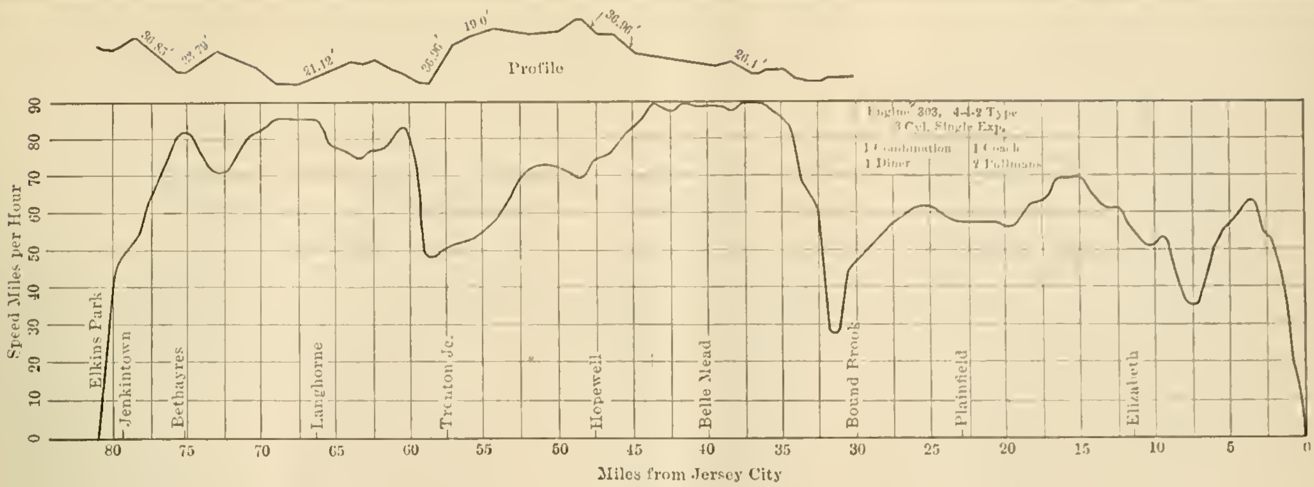
Four-wheeled Cars:—

$$R = 1.6 + 0.032V + 0.0012V^2$$

Bogie Coaches:—

$$R = 1.6 + 0.013V + 0.001V^2$$

In these formulas $V =$ speed in miles per hour, and $R =$ resistance in lbs. to move each 1000 lbs. of locomotive or car weight. They do not apply for speeds less than about ten miles per hour.




SPEED CURVE OF FIVE-CAR TRAIN DRAWN BY A THREE-CYLINDER LOCOMOTIVE—PHILADELPHIA & READING RAILWAY.

## A FAST RUN ON THE NEW YORK BRANCH OF THE PHILADELPHIA & READING RAILWAY.

By "Eagle Eye."

There are few, if any, cities in the United States, which can boast of an intercommunicative train service superior to that maintained by the Philadelphia & Reading Ry. and the Pennsylvania R. R. between New York and Philadelphia. The fastest trains on both roads make the run in two hours, and as this includes the time required to ferry passengers across the Hudson River, the distance of approximately 90 miles between Jersey City and Philadelphia must be covered in about one hour and forty-five minutes. Including stops, of which at least two are always made, the average speed is thus about 50 miles per hour.

The accompanying log represents a run recently made by train No. 602 on the Philadelphia & Reading Ry. This train leaves Philadelphia at 8:00 A. M., and is scheduled to stop at Columbia Ave., Wayne Junction, and Elkins Park, the last named a suburban station 9.2 miles from the Philadelphia terminal. The 81 miles from Elkins Park to Jersey City are scheduled to be run in 89 minutes, equivalent to 54½ miles per hour. In the present instance the train was composed of one combination baggage and smoker, one coach, one diner and two Pullmans, estimated to weigh between 275 and 300 tons. The engine was No. 303, a three cylinder single expansion Atlantic type with superheater. The cylinders are 18½ x 24 in. and the drivers 80 in. diameter. This locomotive was built in the company's shops at Reading in the spring of 1909, and was exhibited at the annual convention of the Master Mechanics' Association, where it attracted much attention because of the novelty of its design and the superior workmanship and finish of its various parts. It was illustrated and briefly described on page 459 of the November issue of the American Engineer.

The data for the log shown was secured by a passenger (myself) on the train, who, with the help of an ordinary watch, carefully noted the time in hours, minutes and seconds, of passing each mile post. In this way any cumulative error is impossible; the elapsed time between terminals absolutely correct, and I believe that the errors for the individual miles in no case exceed one second. Previous to its arrival at Elkins Park, the train was slowed several times, and it left the station at 8:24:00 instead of at 8:19:00 as per schedule. The locomotive accelerated rapidly, and Bethayres, six miles from Elkins Park, was passed at a speed of nearly 82 miles per hour. Between this point and the Delaware River there are a number of favorable stretches for high speed, and the maximum recorded was 42 seconds to the mile, equivalent to 85.7 miles per hour. At mile post 60 speed was reduced to scoop water, and the train started up the grade of 37 feet per mile, east of the Delaware River, at about 50 miles per hour. This grade is easier toward the summit, where the slope is 19 feet per mile; its total length is about five miles, and the summit was passed at a speed of nearly 60 miles per hour. On the favorable stretch east of Hopewell the speed increased rapidly, and at three points reached 90 miles per hour (40 seconds per mile). Near mile post 33 a sharp reduction took place, incident to crossing the Lehigh Valley tracks at grade, and running through the junction of the Reading's New York branch and the Central Railroad of New Jersey. Bound Brook was passed at moderate speed, and the remainder of the run calls for no special comment. Jersey City was reached, in advance of schedule time, at 9:43:18.

In this connection the following facts are worthy of note:—

The highest speed recorded was 90 miles per hour.

The 17 miles from mile-post 77 to mile-post 60 were run in 12 minutes 56 seconds, at an average speed of 79.0 miles per hour.

The 12 miles from mile-post 46 to mile-post 34 were run in 8 minutes 13 seconds, at an average speed of 87.6 miles per hour.

The 49 miles from Elkins Park to mile-post 32 were run in 41 minutes 34 seconds, at an average speed of 70.7 miles per hour..

The entire distance of 81 miles from Elkins Park to Jersey City were run in 79 minutes 18 seconds, at an average speed of 61.4 miles per hour.

If the average speed of 70.7 miles per hour had been maintained for the last 32 miles, the train would have reached Jersey City at 9:32:42. This fact certainly suggests the entire possibility if not the feasibility, of running from Philadelphia to New York in one hour forty-five minutes, including the ferry across the Hudson. Furthermore, it should be remembered that this run was made over the old road via Jenkintown. It is the usual practice to run the two hour trains over the new cut-off between Wayne Junction and Neshaminy Falls, which is a shorter and easier route than the one via Jenkintown. The stop at Elkins Park, however, makes it impossible for train 602 to use the cut-off.

This run was of course made without special preparation, and took place on a snowy morning with a consequently wet rail. It is of special interest in that it was performed by an experimental locomotive, possessing features new to American practice. The engine accelerated the train rapidly and appeared to handle it with great ease; and the performance throughout was highly creditable to the locomotive and all concerned.

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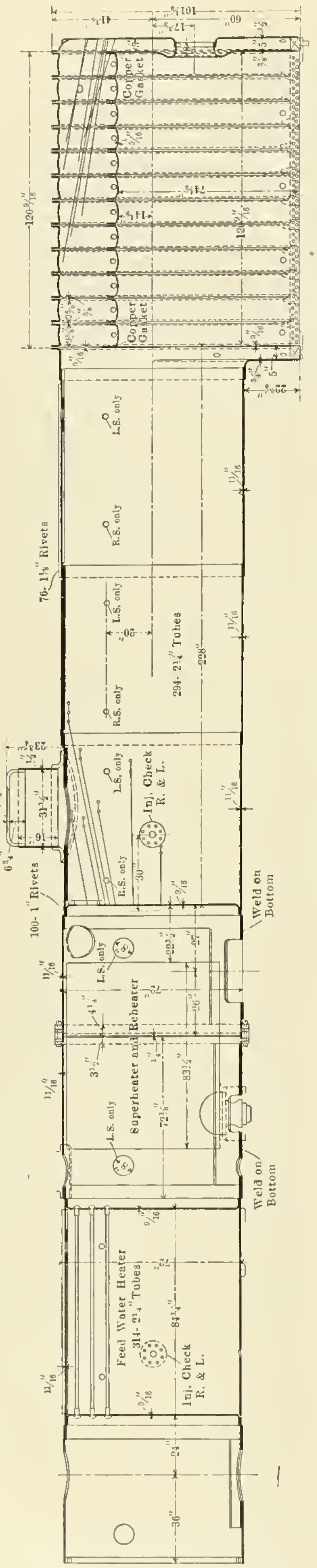
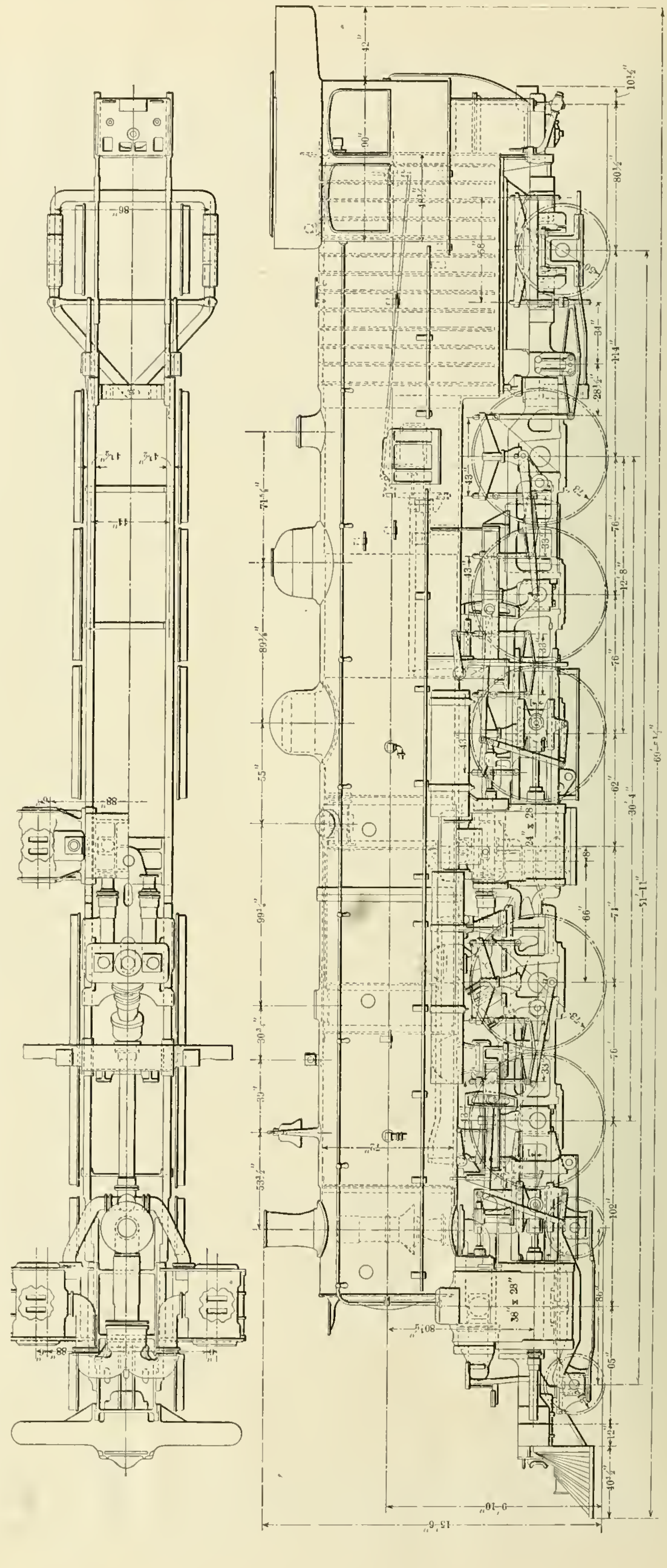
Telephone Train Dispatching.—The Atchison, Topeka and Santa Fe Railway has recently installed the telephone for train dispatching between Chicago and Newton, Kansas, a distance of 659 miles. This is but a small portion of what is being equipped, it being the intention of the railway company to extend this service over its entire system. At the present time there are eighteen different divisions upon which the trains are dispatched by telephone. In this way 380 stations are reached in a total distance of 1,925 miles. The telephone equipment being used was furnished by the Western Electric Company.




BOILER, INCLUDING SUPERHEATER, REHEATER AND FEEDWATER HEATER—MALLET ARTICULATED COMPOUND PASSENGER LOCOMOTIVE, 4-4-6-2 TYPE.



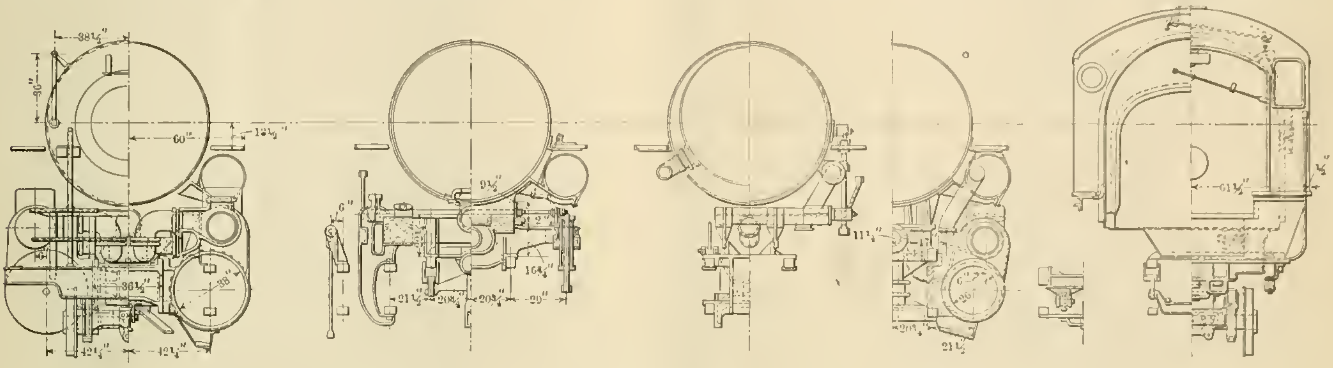
ELEVATION AND PLAN (BOILER REMOVED) OF MALLET PASSENGER LOCOMOTIVE, 4-4-6-2 TYPE—ATCHISON, TOPEKA AND SANTA FE RAILWAY.

# RECORD BREAKING FREIGHT AND PASSENGER LOCOMOTIVES FOR THE SANTA FE.

## ARTICULATED AND BALANCED COMPOUND ENGINES WITH SUPERHEATERS AND REHEATERS.

The Baldwin Locomotive Works are delivering to the Atchison, Topeka and Santa Fe Railway two passenger and two freight locomotives, both of which in their respective classes are the heaviest and most powerful ever built; these were illustrated in outline in the January number, page 16. Accompanying this order are also several of the balanced compound Atlantic type, which in general are similar to those which have been in very successful service on this road for a number of years, but differ from their predecessors in being equipped with a superheater, reheater and Walschaert valve gear.

The passenger locomotives are a complete and distinct departure from anything that has ever been built before for this service, being a Mallet articulated compound design of the



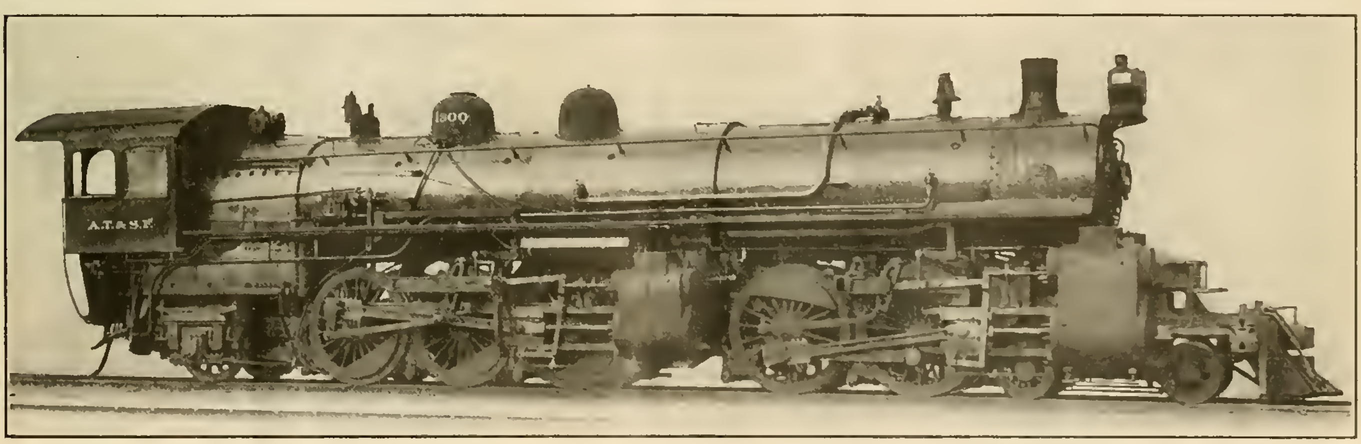
END ELEVATION AND SECTIONS OF MALLET PASSENGER LOCOMOTIVE.

4-4-6-2 type and weighing 376,450 lbs., of which 268,000 lbs. is on drivers. They have a tractive effort of about 53,000 lbs. The freight locomotives weigh 462,450 lbs., thus exceeding the Southern Pacific engines by 36,550 lbs. in total weight, and having 18,200 lbs. more weight on drivers. Both of these designs are arranged to traverse 16° curves. The Atlantic type engines weigh 222,150 lbs., of which 114,800 lbs. is on drivers, making them the heaviest of this type, in respect to total weight, on our records. These engines are the latest development of a very interesting series of locomotives, which have given most excellent results in high speed passenger service. They have been remarkable in the amount of mileage performed between repairs, according to records given in the *Santa Fe Employees' Magazine.* Of two engines which were received in October, 1904, one made 205,262 miles before general overhauling, with an average total repair cost up to that time of 4.8 cents per mile. The other made 184,399 miles at a cost of 4.3 cents per mile. One engine received in August, 1905, was not sent to the shop for general overhauling until July 21, 1909, and had made a mileage of 227,902 miles.

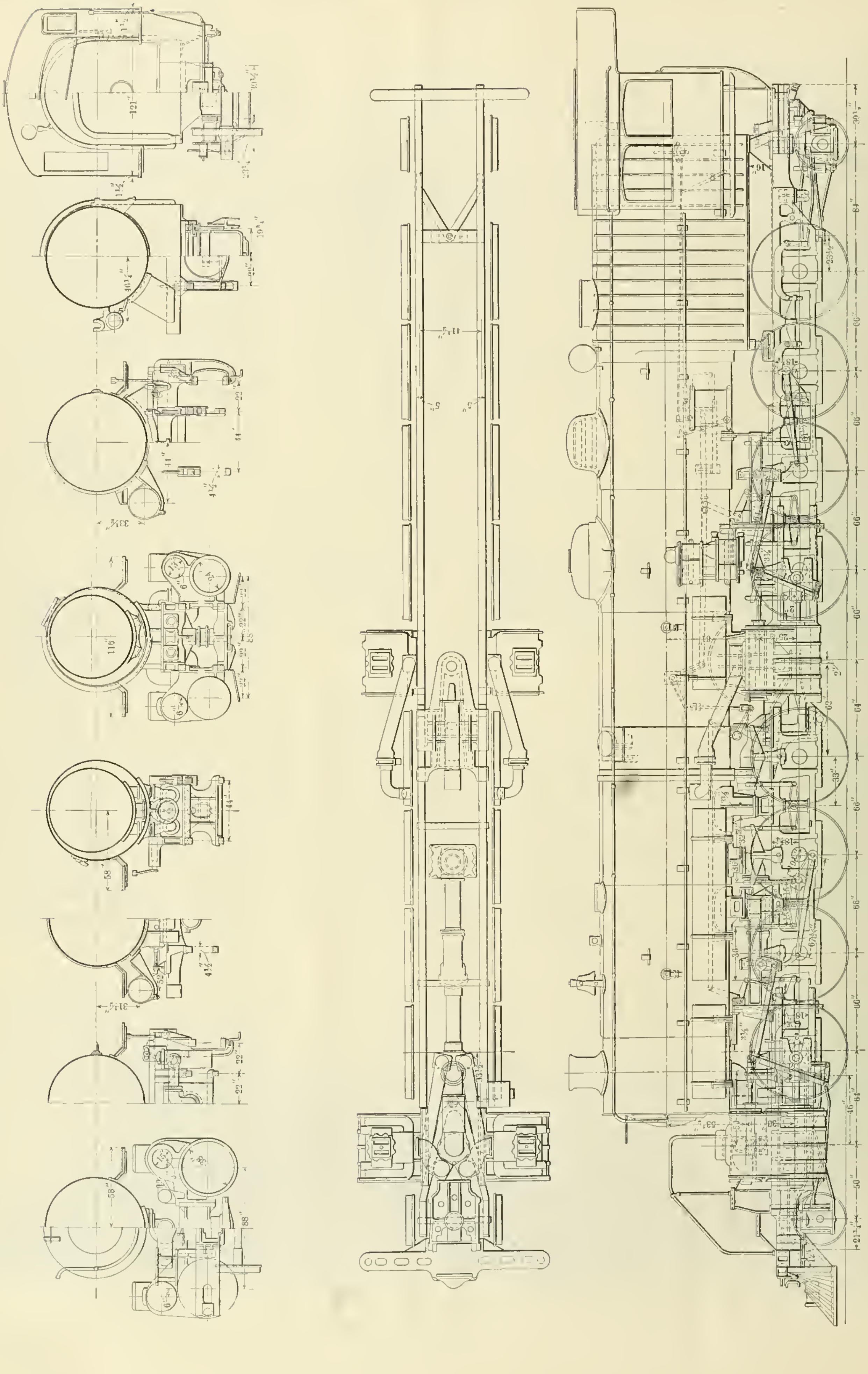
The different designs will be taken up and discussed separately.

### Mallet Articulated Passenger Locomotives.

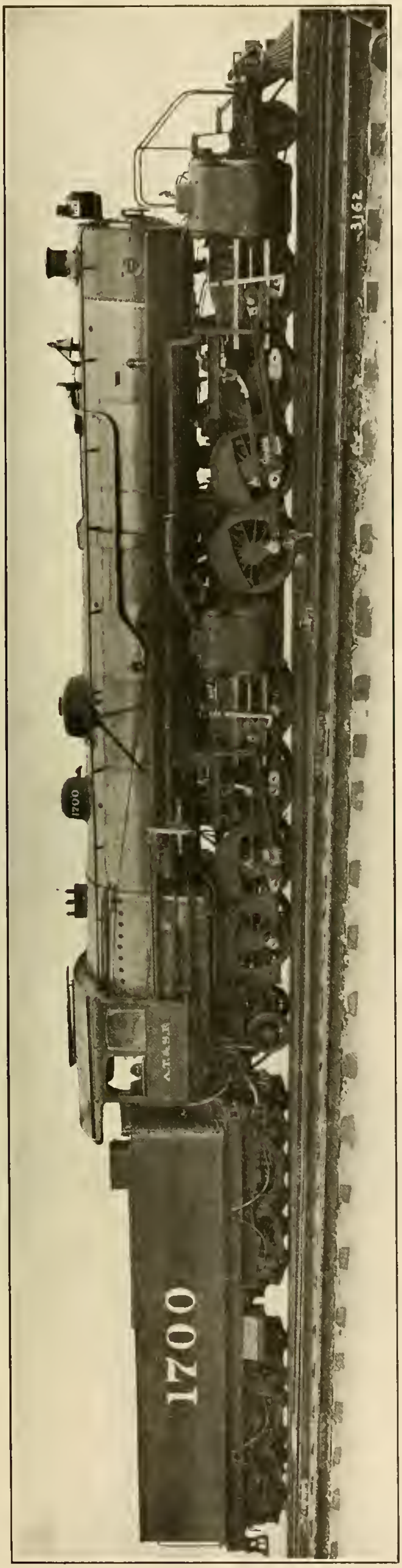
A passenger locomotive giving a theoretical tractive effort of 53,000 lbs. but a few years ago would have been considered a practical impossibility. This is about 50 per cent. more power than is given by the present most powerful engine having driving wheels over 70 inches in diameter. As regards total weight it is a jump of over 100,000 lbs. from the present record. In spite of this enormous increase in size and power the success of the machine, so far as general features are concerned, is practically guaranteed, since it does not differ from the articulated freight engines, that have proven to be an operating success in most cases, except in size of wheels and the application of the four-wheel truck. In effect it is a combination of the American type with a Pacific type, the equalizers and arrangement of spring rigging being the same as on those types.




MALLET ARTICULATED COMPOUND PASSENGER LOCOMOTIVE, 4-4-6-2 TYPE—A. T. & S. F. RY.



ELEVATIONS, SECTIONS AND PLAN (BOILER REMOVED) OF MALLET FREIGHT LOCOMOTIVE, 2-8-8-2 TYPE—A., T. & S. F. RY.



HEAVIEST AND MOST POWERFUL LOCOMOTIVE IN THE WORLD—ATCHISON, TOPEKA AND SANTA FE RAILWAY.

In many ways this design follows the scheme used on the Southern Pacific articulated compound engines built by the same company, which were illustrated on page 181 of the May and 367 of the September, 1909, issues of this journal. The articulated frame connection is very similar and reference to the September number will show its details. A distinct difference, however, is found in the supporting of the overhang of the boiler in the front group of frames, which in this case is done by a single support, located between the driving wheels, in which is contained the centering device. The construction of the low pressure cylinders and frame connections are practically the same as on the Southern Pacific design.

While the boiler of these locomotives contains a feed water heater and combustion chamber and has a separable joint just ahead of the high pressure cylinders, the same as is on the Southern Pacific design, it differs in having no reheater in the front end, but in employing both a superheater and a reheater which are located in the combustion chamber. It is also fitted with a Jacobs-Shupert fire box. This type of fire box has been very fully illustrated and described in these columns and needs no further description. The construction and arrangement of the superheater will be taken up later.

Oil fuel is used, the burner being placed at the front end of the fire box and the oil being fed through a heater, consisting simply of a long steam jacketed pipe, the details being arranged according to the railroad company's practice. The valve gear is of the Walschaert type, being controlled by a Ragonnet power reversing gear.* This construction is very similar to that on the Southern Pacific design, differing in detail, however, because of the location of the steam and exhaust pipes. The tender of these engines is the same as those on the freight locomotives and will be discussed later.

### ARTICULATED FREIGHT LOCOMOTIVES.

It would seem as if a locomotive giving a tractive effort of 108,300 lbs., and having the largest total weight of any engine ever built would deserve a very full description in these columns. Due to the fact, however, that the Mallet articulated compound designs have been very fully described and illustrated in previous numbers, and that this engine is practically a development from the Southern Pacific design, reference to the description of which is given above, there is comparatively little that can be said concerning it that is not clearly shown in the illustrations. Practically all of the new or especially interesting features of the design are contained in the boiler, which is an enlarged edition of the one applied to the passenger locomotives discussed above. The fire box is of the Jacobs-Shupert design, has a grate area of 70.8 sq. ft. The locomotives, however, are designed to burn oil, being arranged the same as the passenger engines. The barrel of the boiler is of the straight type, the circular sheet next to the fire box measuring 85⅞ in. internal diameter.

The evaporative section of the boiler contains 387 2¼-in. tubes, 21 ft. long, which terminate in a combustion chamber 10 ft. 9 in. long, containing a superheater and reheater. In front of this is the feed water heater having 417 2¼-in. tubes 6 ft., 8 in. long, giving a heating surface of 617 sq. ft. Then comes the ordinary front end, which is 55 in. in length from the tube sheet. This gives a boiler 54 ft. 4 1-16 in. in length over all, which is formed in two parts, having the separable joint located 36¼ in. ahead of the flue sheet in the combustion chamber. This joint, and the arrangement of pipes around it, is the same as in the passenger engines and the same as was used on the Southern Pacific design.

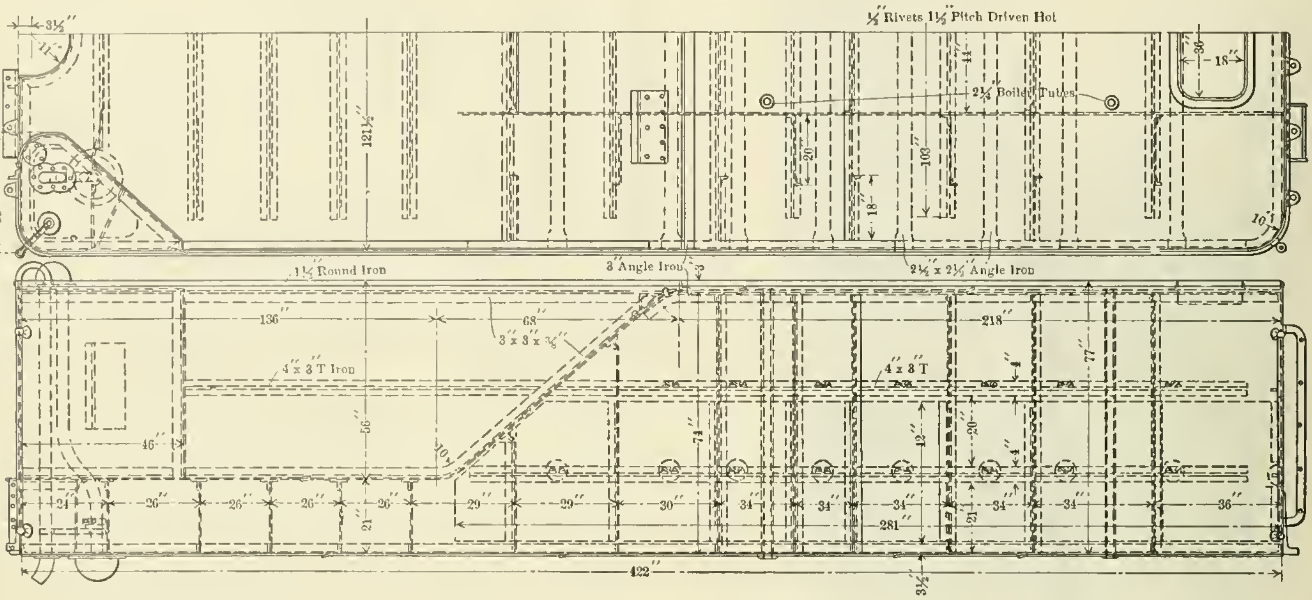
The general dimensions, weights, etc., of these locomotives are given at the end of this article.

### 12,000 GALLON TENDER.

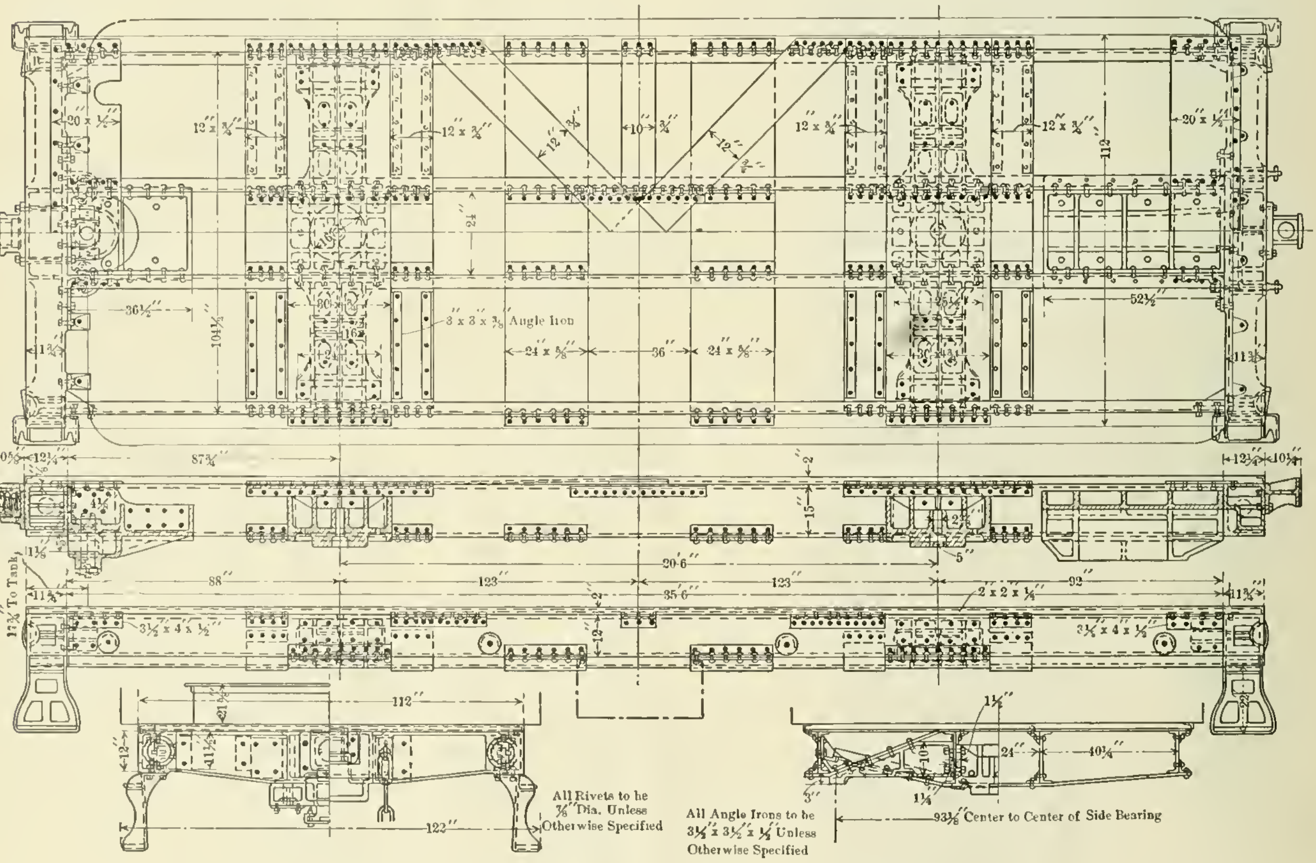
Some remakable tenders have been applied to these Mallet compound locomotives, being far in excess, both as respects capacity and weight, of anything that has ever been built for

* See AMERICAN ENGINEER, July, 1908, page 260.

locomotive use before. They have a capacity of 12,000 gallons of water and the coal space is taken up by a tank with a capacity of 4,000 gallons of oil. The very large weight of this amount of water and oil together with the great weight of the casting, which is seated on the bolsters and bridges the middle transoms. The latter are cast in one piece with the truck frame. The design of the tank has been carefully considered and splash plates have been intelligently distributed to prevent




12,000 GALLON TANK—A., T. & S. F. RY.




UNDERFRAME FOR 12,000 GALLON TENDER—A., T. & S. F. RY.

tender itself requires the use of two six-wheel trucks.

On the underframe, 15 in. channels are used as center sills and 12 in. channels as side sills; the front and back bumpers being of cast steel of very substantial design. The illustrations show the constructional details of the underframe as well as the tank and six-wheel trucks. The latter are practically the same as a passenger car truck and have the frames and pedestals of cast steel. The center plate is in one piece with a heavy steel both longitudinal and horizontal surging. The bracing is well designed and ample.

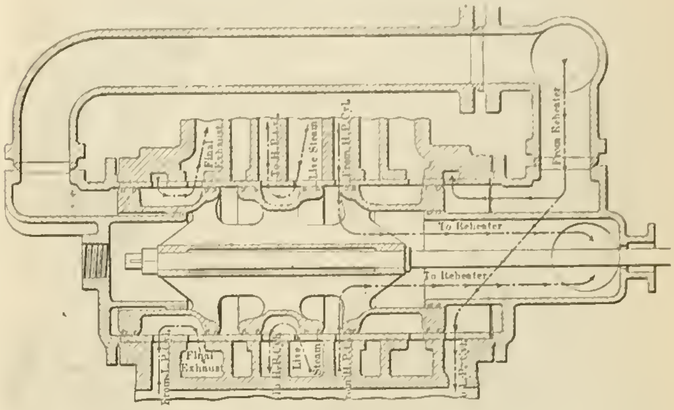
### Atlantic Type Balanced Compound Locomotives.

As mentioned before, these engines are a development of those which have been in service for a number of years. The later examples have 79 in. drivers instead of 73 in. as did the earlier ones. The most interesting features of difference in this later design are found in the application of the superheater and reheater in the front end of the boiler and in the Walschaert valve gear. The former will be discussed later.

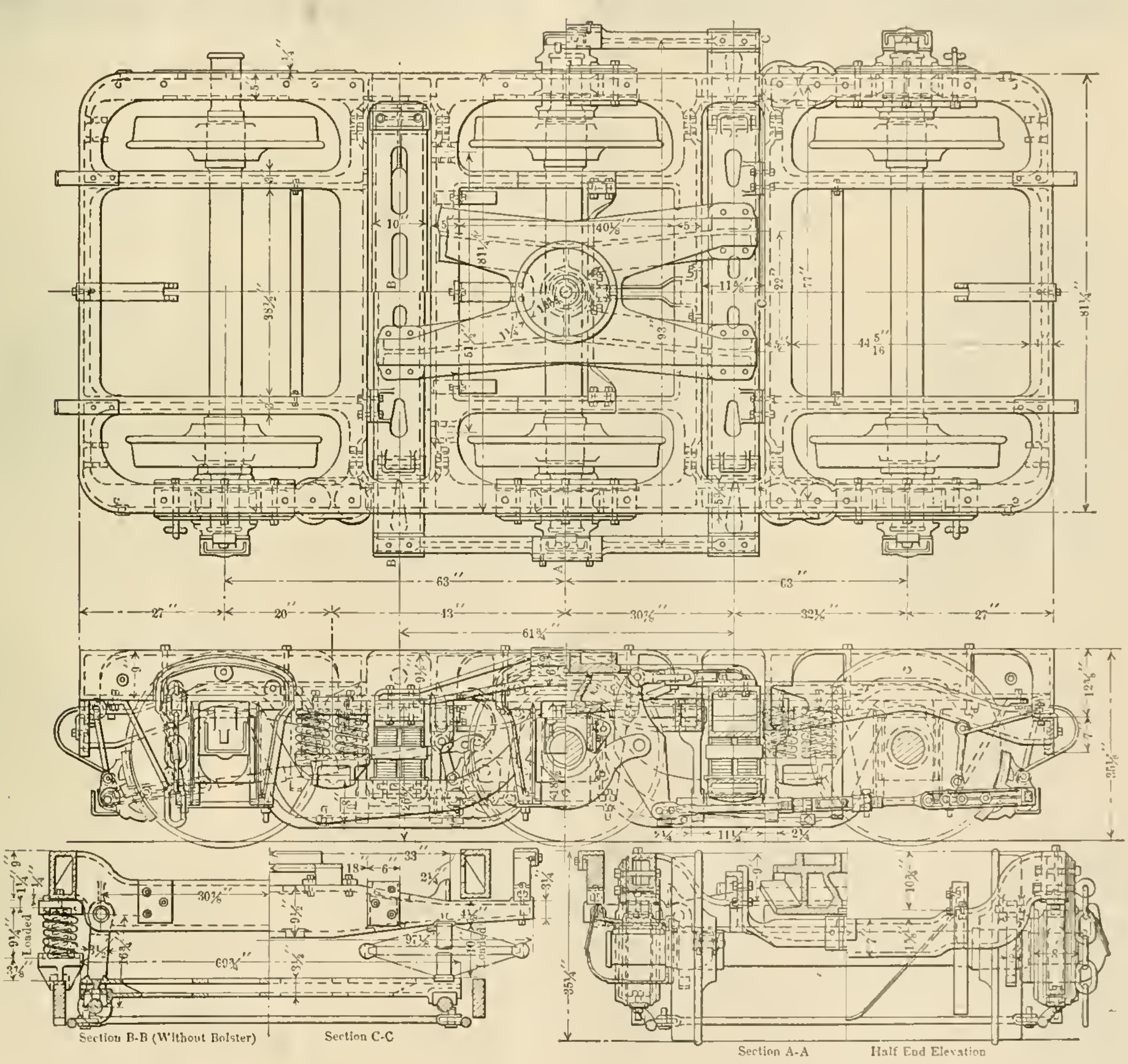
An interesting arrangement of valve gear has been applied in which the link is back of the main crank pin. All the main rods are connected to the leading pair of drivers, eccentric cranks being secured to the main pin. The link is supported by a cross bearer of cast steel, which spans the frame between the two pairs of drivers and is operated by an eccentric rod 48¾ in. long, the connection to the foot of the link being on a line with the center of the axles. The radius bar is 98 in. in length and connects to the combination lever, which is carried by a rocker resting in a bearing secured to the guide yoke. The inner arm of this rocker is connected to a long valve stem, which has no intermediate supports. The union link extends back from the cross head connection and is 38⅛ in. in length. The reversing is accomplished by a connection to the radius bar through a 19¾ in. link from the arm of the reverse shaft, which is supported on top of the frame cross bearer that carries the link bearing.

The crank axle is of the built-up type, with a cast steel center web, that has given satisfactory service on this type of power. The trailing wheels have outside journals, the box being bolted to the truck frame, which is clamped to the main frames, thus preventing any radial motion. The main frames are of cast steel with comparatively light, single front rails of forged iron.

One of the illustrations shows a section through the steam chest from which the passage of the steam to and from the valve, both to the superheater and reheater, are illustrated. After leaving the superheater the steam enters two connections which lead to the main admission ports in the valve chamber. The distribution at this point is practically the same as in former locomotives of the Vauclain balanced compound type. Internal admission is provided for each high pressure cylinder, from which the steam exhausts into the hollow interior of the valve. From this point the steam is carried through an extension having a steam tight

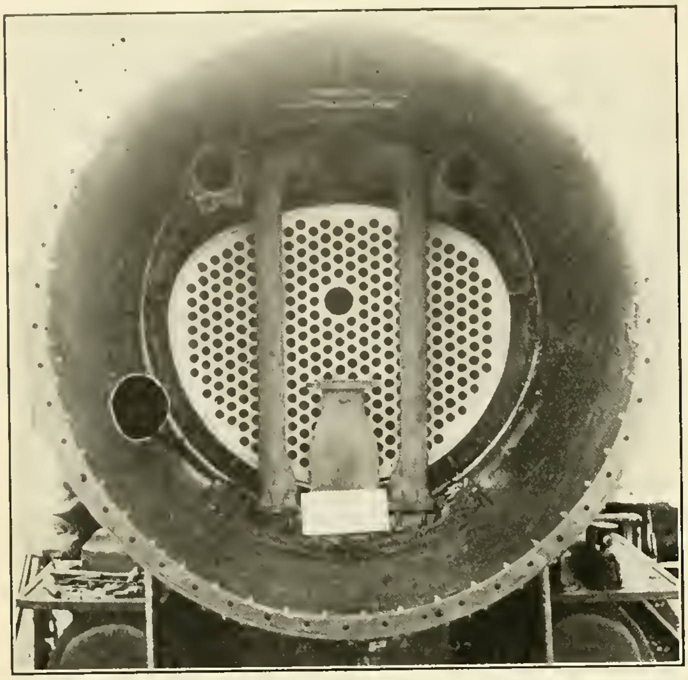



SECTION OF VALVE CHAMBER AND VALVE—ATLANTIC TYPE BALANCED COMPOUND WITH SUPERHEATER AND REHEATER.

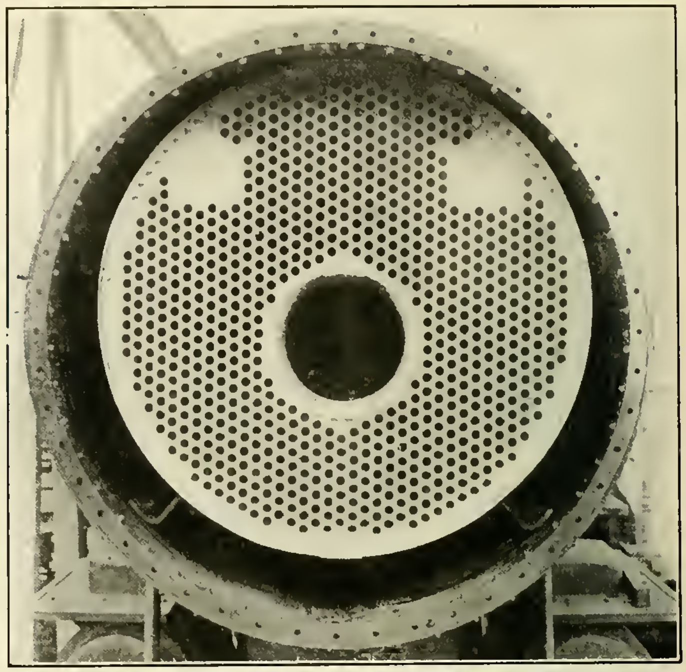



SIX WHEEL TRUCK FOR 12,000 GALLON TENDER—A., T. & S. F. RY.

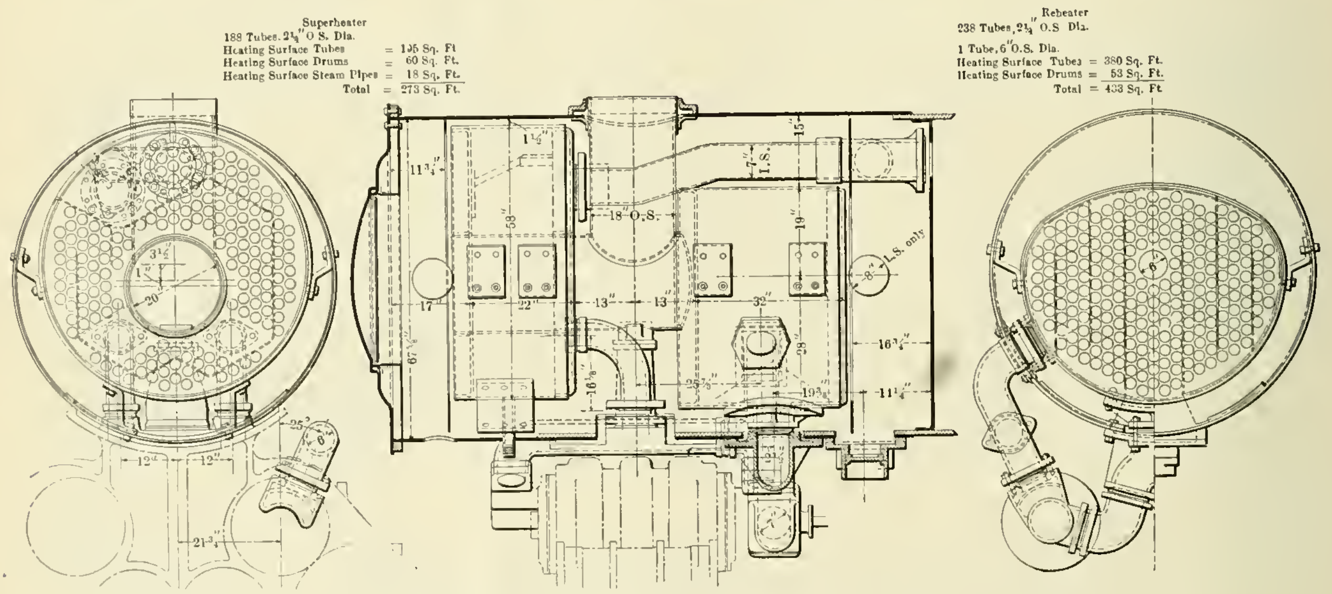
fit with the internal part of the valve to the reheater. This connection is only made at the back end of the valve. After leaving the reheater it is conveyed by suitable pipe connections back to the steam chest heads, in which it enters by means of openings which practically surround the exhaust passage just mentioned,



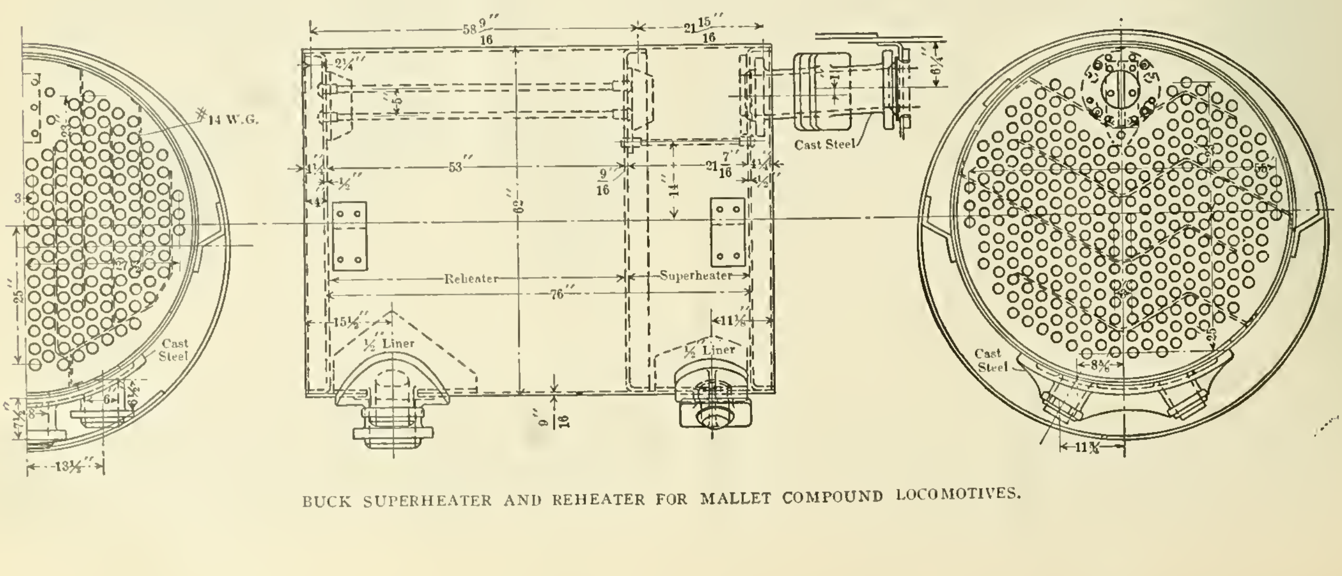
VIEW OF REAR DRUM OF JACOBS SUPERHEATER.



VIEW OF FRONT DRUM OF JACOBS SUPERHEATER.




ELEVATION AND ARRANGEMENT OF JACOBS SUPERHEATER FOR COMPOUND LOCOMOTIVE.




BUCK SUPERHEATER AND REHEATER FOR MALLET COMPOUND LOCOMOTIVES.

| | | | |
|---|---|---|---|
| **GENERAL DATA.** | | | |
| Type | 4-4-6-2 | 2-8-8-2 | 4-4-2 |
| Gauge | 4 ft. 8½ in. | 4 ft. 8½ in. | 4 ft. 8½ in. |
| Service | Pass. | Freight | Pass. |
| Fuel | Oil | Oil | Bit. Coal |
| Tractive effort | 53,000 lbs. | 108,300 lbs. | 22,150 lbs. |
| Weight in working order | 376,450 lbs. | 462,450 lbs. | 222,150 lbs. |
| Weight on drivers | 268,000 lbs. | 412,350 lbs. | 114,800 lbs. |
| Weight on leading truck | 58,050 lbs. | 24,050 lbs. | 58,550 lbs. |
| Weight on trailing truck | 50,400 lbs. | 26,050 lbs. | 48,800 lbs. |
| Weight of engine and tender in working order | 600,000 lbs. | 700,000 lbs. | 392,000 lbs. |
| Wheel base, rigid | F. 6 ft. 4 in., B. 12 ft. 8 in. | 16 ft. 6 in. | 15 ft. 9 in. |
| Wheel base, total | 51 ft. 11 in. | 50 ft. 10 in. | 30 ft. 3 in. |
| Wheel base, engine and tender | 94 ft. 5½ in. | 98 ft. 5⅛ in. | 62 ft. 4¾ in. |
| **RATIOS.** | | | |
| Weight on drivers ÷ tractive effort | 5.05 | 3.78 | 5.20 |
| Total weight ÷ tractive effort | 7.10 | 4.24 | 10.08 |
| Tractive effort × diam, drivers ÷ boiler heating surface | 1115.00 | 1375.00 | 650.00 |
| T. E. × D. D. ÷ boiler and feed heater H. S. | 812.00 | 1038.00 | .......... |
| Total boiler heating surface ÷ grate area | 66.00 | 70.70 | 54.30 |
| Total H. S. (boiler and feed heater) ÷ grate area | 90.5 | 93.7 | .......... |
| Firebox heating surface ÷ total boiler heating surface, per cent. | 5.80 | 4.72 | 8.00 |
| Weight on drivers ÷ total boiler heating surface | 77.10 | 82.40 | 42.70 |
| Total weight ÷ total boiler heating surface | 108.00 | 92.60 | 82.50 |
| Volume equiv. simple cylinders, cu. ft. | 20.60 | 33.10 | 8.30 |
| Total boiler heating surface ÷ vol. equiv. cylinders | 168.20 | 152.00 | 324 00 |
| Grate area ÷ vol. equiv. cylinders | 2.54 | 2.14 | 5.98 |
| **CYLINDERS.** | | | |
| Kind | Compound | Compound | Compound |
| Diameter and stroke | 24 & 38 x 28 in. | 26 & 38 x 34 in. | 15 & 25 x 26 in. |
| **VALVES.** | | | |
| Kind | Piston | Piston | Piston |
| Diameter H. P. | 13 in. | 13 in. | .......... |
| Diameter L. P. | 15 in. | 15 in. | .......... |
| **WHEELS.** | | | |
| Driving, diameter over tires | 73 in. | 63 in. | 79 in. |
| Driving, thickness of tires | 3½ in. | 3½ in. | 3½ in. |
| Driving journals, main, diameter and length | 11 x 12 in | 11½ x 12 in. | 10 x 10½ in. |
| Driving journals, others, diameter and length | 9 x 12 in. | 10 x 12 in. | 9 x 12 in. |
| Engine truck wheels, diameter | 31¼ in. | 34¼ in. | 34¼ in. |
| Engine truck, journals | 6 x 10 in. | 6½ x 10½ in. | 6 x 10 in. |
| Trailing truck wheels, diameter | 50 in. | 34¼ in. | 50 in. |
| Trailing truck, journals | 8 x 14 in. | 7 x 12 in. | 8 x 14 in. |
| **BOILER.** | | | |
| Style | Straight | Straight | Wagon Top |
| Working pressure | 200 lbs. | 220 lbs. | 220 lbs. |
| Outside diameter of first ring | 72 in. | 84 in. | 66 in. |
| Firebox, length and width | 119⅝ x 63¼ in. | 129⅝ x 78⅞ in. | 107 15/16 x 66 in. |
| Firebox plates, thickness | 5/16, ⅜ & 9/16 in. | 5/16, ⅜ & 9/16 in. | ⅜ & 9/16 in. |
| Firebox, water space | F. & B. 5, S. 5½ in. | F. & B. 5, S. 5½ in. | F. 4½, S. 5, B. 4 in. |
| Tubes, number and outside diameter | 294—2¼ in. | 387—2¼ in. | 273—2¼ in. |
| Tubes, length | 19 ft. | 21 ft. | 15 ft. 6 in. |
| Heating surface, tubes | 3,275 sq. ft. | 4,768 sq. ft. | 2,478 sq. ft. |
| Heating surface, firebox | 202 sq. ft. | 236 sq. ft. | 215 sq. ft. |
| Heating surface, total | 3,477 sq. ft. | 5,004 sq. ft. | 2,693 sq. ft. |
| Superheater heating surface | 323 sq. ft. | 544 sq. ft. | 273 sq. ft. |
| Reheater heating surface | 798 sq. ft. | 1,201 sq. ft. | 433 sq. ft. |
| Feed water heating surface | 1,279 sq. ft. | 1,617 sq. ft. | .......... |
| Feed water heater tubes, number and diam. | 314—2¼ in. | 417—2¼ in. | .......... |
| Feed water heater tubes, length | 7 ft. | 6 ft. 8 in. | .......... |
| Grate area | 52.5 sq. ft. | 70.8 sq. ft. | 49.5 sq. ft. |
| **TENDER.** | | | |
| Tank | Water bottom | | Water Bottom |
| Frame | 15 & 12 in. channels | | .......... |
| Trucks | 6 wheel | | 4 wheel |
| Wheels, diameter | 34¼ in. | | 34¼ in. |
| Journals, diameter and length | 5½ x 10 in. | | 5½ x 10 in. |
| Water capacity | 12,000 gals. | | 9,000 gal. |
| Fuel capacity | 4,000 gals. | | 12 tons |

and goes to the low pressure cylinder ports being controlled by the outer ends of the valve.

### Jacobs' Smokebox Superheater.

A new type of superheater has been in service on the Santa Fe Railroad for more than a year and the results have been such as to lead to its application to a very large number of locomotives, including those of the 4-4-2 type described above.

The superheater is of the smokebox type and consists of two drums, each containing a set of fire-tubes. The drums are located in the smokebox, where steam passing through the drums on its way from the boiler to the cylinders, is raised in temperature by heat from the flue gases that would otherwise go to waste. This superheater is equally applicable to both simple and compound locomotives. When applied to a simple engine the steam passes through both superheater drums before entering the cylinders. When applied to a compound engine steam passes through one drum before entering the high pressure cylinders and passes through the second drum on its way from the high to the low pressure cylinders.

The general arrangement of the superheater and connections is shown by the accompanying photographs which illustrate the parts assembled and also show each drum in the smokebox. The forward drum is cylindrical in shape, while the rear drum is flattened at the top to permit the location of the dry pipe extension above this drum. The drums are made of material as thin as safety will permit in order that all parts will serve as heating surfaces. Each drum contains as many fire-tubes as consistent with the volume of steam space required. In the rear drum the tube ends are welded to the tube sheets, while in the forward drum the tube ends are rolled and beaded. The drums are supported by brackets bolted to the smoke arch and are readily removable.

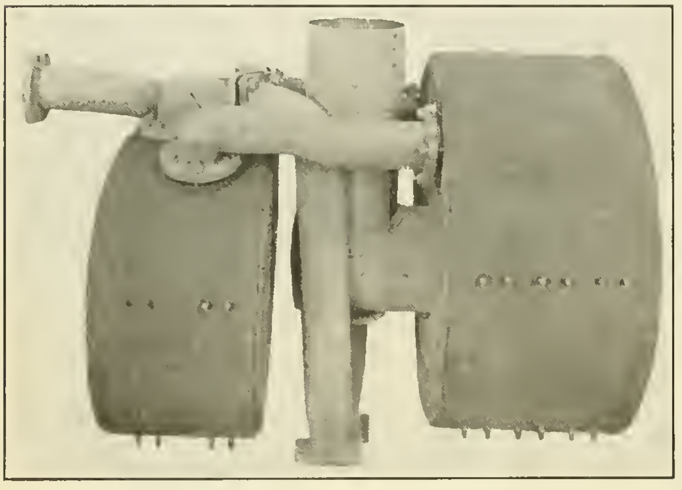
Between the exhaust pipe and the stack the exhaust is thoroughly enclosed in order that there may be no draft to induce gases direct from the boiler flues to the stack. The enclosed petticoat pipe is connected by an elbow with a large opening through the forward drum. The draft, therefore, is forward through the tubes of both drums and rearward through the large opening of the forward drum.

Flue gases pass straight through the tubes of the rear drum from the boiler tubes. Upon leaving the rear drum, the gases are deflected around the petticoat pipe and elbow and pass forward through the tubes of the forward drum to the front end of the smoke arch. Here they are reversed and drawn backward through the cylindrical opening in the forward drum and are swept upward through the petticoat pipe to the stack.

To aid in the direction of the greater portion of the gases through the flues of the superheater drums a deflecting plate is so located as to obstruct the rapid flow of gases around the drums. The shape of this plate conforms to the area between the forward drum and the smoke arch and the plate is located about one inch ahead of the forward drum. A wide opening at the bottom of the plate allows a rapid flow of gases through this section to sweep out any cinders that might fall to the bottom of the smoke arch. The shells of the drums are thus allowed to come in contact with hot gases, but the gases around these surfaces have little or no velocity.

The passage of gases through the tubes of the superheater drums so breaks up the cinders carried by the gases that the usual form of front end netting is unnecessary. The arrangement incident to the application of this type of superheater is a radical departure in the drafting of American locomotives, as it does away with the diaphragm and netting, the draft being very direct and also pulling on the fire much more evenly, thus obtaining more complete combustion and more efficient evaporation.

Steam is conducted from the dry pipe to the forward drum,



JACOBS' SUPERHEATER FOR SIMPLE LOCOMOTIVE.

where it is circulated around the tubes. When the superheater is applied to a simple engine, the steam is conducted from the forward to the rear drum, where it is again circulated around the hot tubes, and it is then carried to the steam chests. Baffle plates of thin sheet iron direct the circulation of steam in both drums.

When applied to a compound engine, steam is conducted from the forward drum to the high pressure cylinders. Exhaust from the high pressure cylinders is directed to the rear drum where the steam is again superheated before being passed on to the low pressure cylinders. The accompanying line engraving illustrates the superheater and its connections applied to the balanced compound locomotives of the Atlantic type described above.

It is reported that the first Jacobs' superheater placed in service has been in continuous operation for 13 months with absolutely no repairs to the superheater. One hundred and forty-six superheaters of this type are now in operation and under construction. The average superheat obtained is 90 degrees and a saving of 12 per cent. in fuel and 25 per cent. in water is said to have been attained.

This superheater was designed by H. W. Jacobs, assistant superintendent of motive power of the Santa Fe.

### Buck Superheater.

The locomotives of the Mallet type are equipped with a superheater consisting of a single drum. This superheater operates on the same principle as the two-drum superheater, being divided into two sections by an intermediate head. The tubes are 76 inches long and the intermediate head is 54 inches from the front head. The superheater is located in the combustion chamber and is shown in one of the illustrations.

Steam from the dome is carried to a connection at the top of the forward section and emerges through two steam pipes connected at the bottom, by which it is conveyed to the high pressure steam chests. Exhaust from the high pressure cylinder is brought together in one pipe at the center of the engine, by which it is conducted to the bottom of the rear superheater section. These steam pipes are provided with separable joints in order that the front section of the boiler may be removed from the rear section, the superheater being secured in the forward section.

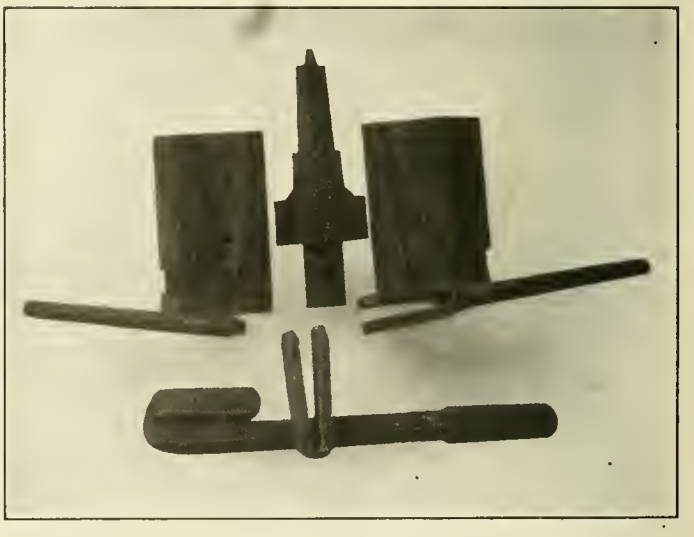
From the rear section of the superheater steam is conducted to the low pressure cylinders through a single pipe located centrally between the frames. This pipe is equipped with a slip joint and two ball joints, one of the ball joints being located immediately beneath the rear section of the superheater and the other just ahead of the second driving axle. Forward of this point the pipe is held in alignment with the frames and a short distance back of the low pressure cylinder it is divided into separate leads in order to convey steam to the two steam chests.

The superheater of the single-drum type was designed by W. F. Buck, superintendent of motive power of the Santa Fe.

## FORGING BRAKE ROD JAWS.

There has appeared in these columns a number of articles descriptive of the machine forging methods in use at the Collinwood shops of the Lake Shore & Michigan Southern Railway.* Among the latest developments along this line at that point are dies and formers for forming a brake rod jaw, which it is practically impossible to break at the connection. The accompanying illustrations show the dies as well as the parts before and after forging.

The jaw proper is previously formed in a bulldozer and the bend is heated in a furnace to a welding heat, as is also the end of the shank of round or square bar iron, and the two are forced together by hand on a special anvil and then placed in the forging machine, where a stream of air is kept playing over the point to be welded, keeping it at a very high welding heat. The side dies then come together, holding the bar securely, while the center die comes forward, forcing the jaw on to the shank and upsetting the section at the weld somewhat. The extension on the end of the center die forces a small hole through the jaw into the shank, all of this metal being at a full welding heat, so that the fibers of the iron of the two pieces are interlocked



DIES AND FORMER FOR FORGING BRAKE ROD JAWS.

and securely pressed together, both inside and outside. The work is then removed from the machine and placed over a former, which brings the legs of the jaw parallel and in proper alignment.

For making the lower brake rod, the same operation is gone through on the opposite end of the shank, which is cut to proper length.

* See April, 1906, page 142; June, 1906, page 234; May, 1907, page 192; September, 1907, page 344, and April, 1909, page 131.

Jaws forged in this manner have been put in the testing machine and have also been bent cold, both twisting and in other directions, without being able to separate the parts of the weld. A jaw which has been bent back upon itself at the weld without damage is shown at the bottom of the illustration.

## TIMBER DECAY COSTS MILLIONS.

Millions of feet of timber and finished lumber rot every year in railroad ties, bridges, trestles, piles, farm buildings, fences, poles, and mine props. The lumber consuming public of the United States pays perhaps thirty to forty million dollars a year to make good the losses from wood decay. These great drains are a source of more and more concern each year. Chemists and engineers who have to do with the uses of wood are working unceasingly on the problem. The United States Forest Service has men who devote their whole time to it. The importance of the problem can not be overestimated. Millions of dollars are annually saved by preservative treatment of timbers, but much yet remains to be learned.

Wood decay is caused by fungus, a vegetable growth sometimes so small that it can be seen only with the microscope. Its roots or branches, like minute hairs, force their way into the wood tissues and absorb or eat away the solid parts. The collapse which results is called decay. Timber is artificially preserved by forcing into its cells and pores certain substances which prevent the growth of fungi. As long as this substance is present in sufficient quantity, the germs of decay—the threads and spores of fungas—can not enter, and the wood is preserved. This often means doubling and sometimes trebling the life of the timber.

The United States government considers the investigations of the preservative treatment of timber of such importance that the business of one office of the United States Forest Service, that of Wood Preservation, with new headquarters at Madison, Wis., is given over entirely to the work of experiments in cooperation with railroad companies and other corporations and individuals in prolonging the life of railroad ties, mine props, bridge timbers, fence posts and transmission poles.

## RAILROAD FATALITIES SHOW MARKED DECREASE.

Particularly gratifying are the reports recently issued by several of this country's railroads, showing a large total of passengers carried without a single fatality. The Pennsylvania Railroad, for instance, was perhaps the first to make this favorable report, with a total of 142,676,779 passengers carried in 1908 with not a single fatal accident due to inefficient operation, exclusive of accidents at crossings or result of a passenger's own carelessness in getting on or off of moving trains.

This extremely favorable report has been followed by others showing that the Chicago & North Western carried 25,994,182 passengers in the year ending June 30, 1909, without a single fatal accident, the Rock Island 18,743,022 passengers, Burlington 20,000,000, Atchison 22,605,697, Lehigh 4,877,801, while the Erie reports 125,000,000 passengers carried in the past five years without a fatality.

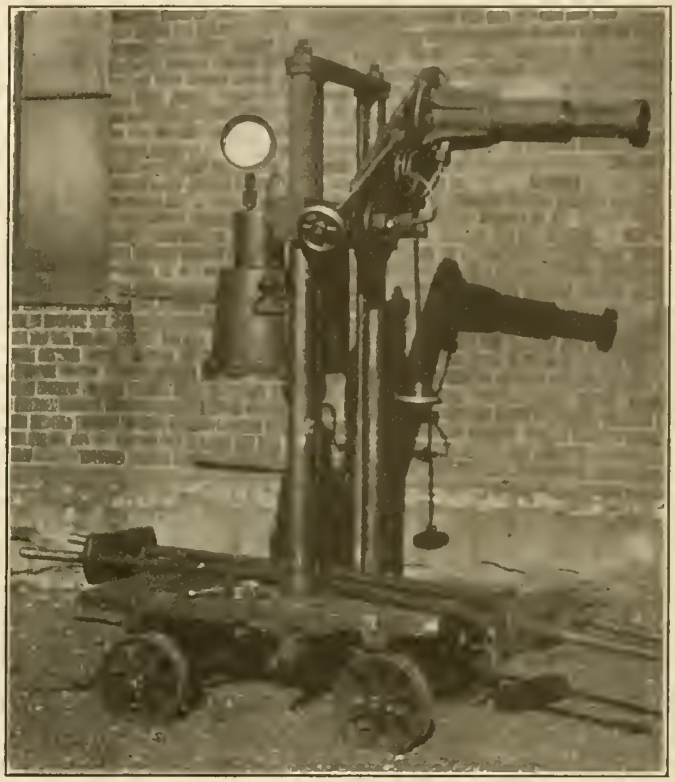
This aggregates a total of 330,000,000 passengers carried safely and presents a striking example for other roads. And not the least peculiar feature of these reports is the fact that with the exception of the Pennsylvania, Lehigh Valley and Erie, the roads reporting this absence of fatalities are in the West, where a large proportion of single track prevails, use of safety appliances is less general, and the roadbed is in most instances not up to the Eastern standards.—*Railway World.*

Motor Cars.—The motor car used by the Santa Fe in southern California has developed so much business that it has been taken off and a regular train put on instead.—*Santa Fe Employe's Magazine.*

## VALVE CHAMBER BUSHING PRESS.

The installation and removal of valve chamber bushings on piston valve engines with sufficient pressure to assure them remaining in place is usually accomplished with more or less expenditure of time and effort. For performing this operation there has been designed and constructed at the Collinwood shops of the Lake Shore & Michigan Southern Railroad a hydraulic press which is mounted on wheels, so as to be easily transferred to different parts of the shop, and has a ram conveniently adjustable in all directions, making it easy to apply to the valve chamber of any locomotive in the shop.

It is made up of two heavy upright columns, securely fastened to the body of a cart, on which a crosshead slides. Two long screws are located just inside of the columns, guided top and bottom, and operated by means of beveled gears from one shaft, the squared end of which is seen just below the bottom of the



HYDRAULIC PRESS FOR VALVE CHAMBER BUSHINGS.

cart. These screws are threaded in the crosshead and control its movement. On one side of this crosshead is secured an old hydraulic jack from which the ram has been removed and the top opening plugged. On the opposite side is a heavy arm constructed of boiler plate arranged to swing around its single substantial connection to the crosshead. The outer end of this plate, or arm, carries a hydraulic ram about 3 in. in diameter. This arm with the ram can be swung around its pivot as desired, its location being controlled by two threaded rods with hand wheels so constructed and placed as to securely hold it in any location.

The hydraulic pressure is carried from the chamber, where it is obtained by means of the same pump and handle that was previously used on the jack, to the ram by a heavy copper pipe, which passes through the center of the joint of the arm and is fitted with a swivel joint. A coil on the ram side gives it further flexibility. Pressures of 25 to 30 tons are easily obtainable with this arrangement. Both bushings are put in at once, and removed at once, if desired, by means of the rods and plates shown lying on the cart.

This device has not only proven to be very convenient and rapid, but it also permits the bushing to be put in under a pressure which will assure it remaining in place.

(Established 1832).

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**Contributions.**—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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## CONTENTS



## ROBERT M. VAN ARSDALE

Mr. Van Arsdale's death will be felt as keenly by a large majority of our readers as it was by the editors and others who were in constant contact with him. He was a man who made friends with practically every one with whom he dealt and it always pleased him to feel that the subscribers and readers of the paper and the advertisers were personal friends, as indeed a large number of them were. The AMERICAN ENGINEER AND RAILROAD JOURNAL represents his life achievement and those who have known it and watched its development under his direction realize how much he has accomplished.

The paper has always been published for the greatest good of its subscribers and Mr. Van Arsdale has never allowed its editorial pages to be influenced by profit from the advertising section. He always held, and truly, that the greatest value to the advertiser could be obtained by a paper which was of the greatest value to its subscribers, and many times during his career it has been necessary to resist the temptation of very large profits in order to maintain this standard. He has not allowed the income from the advertising section of the paper to influence the amount or quality of the editorial matter, as is customary with most publications.

His personality needs no comment to those who knew him and to others it is sufficient to say that his real friends include practically every one with whom he became acquainted. He had no enemies. One of his greatest pleasures was to attend the M. C. B. and M. M. conventions and talk over old times with all of the attendants of the early meetings, both railroad and supply men. "Van" was known by all of them and they never missed an opportunity of having a chat with him. He had attended the conventions for over twenty years consecutively.

## LOCOMOTIVE DESIGN

The locomotive designs illustrated in this issue mark a distinct departure from all previous standards. It has become so customary during the past year or so to publish descriptions of the largest locomotive in the world that a new champion attracts comparatively little attention, but the latest new leader in weight and power has one feature which distinguishes it from its predecessors. The same is also true of the balanced compound locomotive built for the same railroad. This consists in the application of both a superheater and reheater to a compound locomotive, a combination which is entirely new in locomotive practice in this country. This feature, taken in connection with the feed water heater and the compound cylinders on the Mallet locomotives, it is expected, will increase the efficiency, as compared with a simple saturated steam engine, by about 50 per cent. The articulated compound arrangement readily lends itself to the application of these appliances and if the locomotives of this great size are going to deliver their rated tractive effort when fired by hand it will surely be necessary to achieve an improvement fully equal to 50 per cent. as expected.

* * * * * * * *

A locomotive with four simple cylinders arranged on the balanced principle and supplied with highly superheated steam would seem to be an excellent combination and arrangement for high speed passenger service. The balanced locomotive in the form of a compound has been a very successful design and when arranged as a simple it should be capable of a greater refinement, as far as constructional details are concerned. Highly superheated steam will easily equal the economy of a compound and gives additional advantages for a four-cylinder engine having one valve to each pair of cylinders. The Chicago, Rock Island & Pacific Railway are to experiment with this arrangement. This company has had four or five years' experience with balanced compound Atlantic type locomotives and an equal experience with high degree superheated steam and so, to a certain extent, this new design can be considered as the outcome of previous experience, although, of course, it is an entirely new arrangement, the success of which can only be predicted.

# AN EPOCH MAKING DINNER.

Railway Business Association.

"An epoch making affair." Such was the enthusiastic expression of those who attended the annual dinner of the Railway Business Association at the Waldorf-Astoria Hotel on November 10th. And the men who expressed themselves thus were not carried away by the enthusiasm of the moment, but gave expression to these words after the affair was over and they had had time to calmly and deliberately study it. Among them were financiers of note, leaders in the manufacture of railway supplies, hard-headed business men and thoughtful and progressive railroad officials. What was it that had been done in one short year to bring this about and why such enthusiasm?

Briefly, two things: — First, it was demonstrated under the auspices of the Association that eminent railroad officials are anxious and studying to meet the public desires and that the railroad world generally, as well as the financial world, both elements being represented in large numbers and by their foremost leaders at the dinner, are ready and eager to acquiesce. Second, because the railway supply and equipment interests have for the first time come to a realization of their own economic and social importance when aligned as a common whole, and have become conscious of their dignity as a group of industries through the most convincing and satisfying process—namely, the complete realization of it by the railroads themselves.

*        *        *        *        *        *        *

As to the first point, listen to what W. C. Brown, president of the New York Central Lines, had to say in opening his address: "There was a time when the fundamental right of the nation and states to regulate and control its railroads was seriously discussed and questioned. Happily for all—the railroads as well as the public—this question is no longer open for debate. The question of the limitation of the right of regulation, the extent to which it should be exercised, is still open for discussion—not in a harsh or hostile spirit, not for the purpose of fixing by law an arbitrary point beyond which such regulation shall not go; but in a spirit of friendly co-operation to try and ascertain, in the interest alike of the public and the railroads, that happy mean which shall result in the maximum benefit to the patrons of the railroads and the minimum embarrassment in the way of restrictive regulation to the railroads of the nation."

Following is an extract from a letter of regret from Marvin Hughitt, president of the Chicago & Northwestern Railway: "If you succeed in convincing the public that the railroads desire to merit the good will and confidence of their patrons by honest, efficient service in the business of transportation, you will have accomplished much. I understand that especial emphasis will be laid upon that point at your dinner on November 10, and in your efforts in this direction you have my heartiest approval and endorsement."

President Ripley, of the Santa Fe, in his address on "The Railroads and Public Approval," emphasized the fact that the railroads stand ready to do their part in co-operating with the public to bring about the best results, in the following words: "Acknowledging as we must that the public is all-powerful, the question is, How may we satisfy our masters and thus mitigate our woes and preserve our properties?

"First. We must realize, as I think we all do (after a series of very hard knocks), that the railroads are not strictly private property, but subject to regulation by the public through its regularly constituted authorities—that the Government may reduce our earnings and increase our expenses has been sufficiently proved.

"Second. To meet this situation we must endeavor to get in touch with public opinion. Perhaps you will smile when I say that for years I have read every article on railroad matters in each of the papers published along our ten thousand miles of road—not an easy task for a busy man—but while I have waded through much chaff I am sure it has resulted in some reforms.

"Third. The avoidance of action seriously counter to public opinion except for compelling reasons.

"Fourth. The disposition to explain these reasons through officers and employees of all grades. Generally, the loudest criticisms come from those who are not anxious to know the truth.

"Fifth. Efforts to improve service in many cases without hope of reward and for the deliberate purpose of winning public approval, such as better stations, improved heating and lighting devices, better equipment, better terminal facilities, elimination of grades, etc.—all with due regard to the rights of those whose money we are spending."

*        *        *        *        *        *        *

As to the dignity and importance of the position of the railway supply man. One of the railway operating managers in attendance at the dinner said in a letter a day or two later:

"I believe thoroughly that the possibilities of the Association are but touched, and that the influences will be more far-reaching than any of us to-day can fully appreciate. I have always maintained that the railroads needed the supply man to precisely the same degree that supply men needed railroads. The former practically withdrew from the markets during the last two years, and railroad manufacturers felt it, but let the latter withdraw to the same degree, both as shipper and seller, for the same period of time, and a clamor would go up from the railroads which would result in forming an Association for fair play to the manufacturers because their absence would make their necessity appreciated.

"I am a railroad man and proud of that distinction, but I believe it is easier for some of us in the present generation to think straight on some of the present day problems than it is for men who have done most of their work under conditions which would often lead them to mistake the strength of the property which they were handling for their own individual strength, and while I do not believe that the Railway Business Association should ever be permitted to drift into an educational institution, it will be stronger with the public and will accomplish more good if it feels free to point out the errors of management and claims its proper proportion of the credit for invention which has brought about improvement in the railroad service and its right to participate in the financial benefits which should follow."

As President Post said in his address, "Sellers are as good as buyers, any day."

There can be no question that the relations, business and otherwise, between the railroad supply men and the railroad people have recently undergone a very healthful change. Nothing could better illustrate the attitude which the railroads are welcoming wherever it is manifested by the railway equipment business men than the address delivered at the dinner by W. H. Marshall, president of the American Locomotive Company. Mr. Marshall's address is reproduced in full in another part of this number.

Serving themselves by serving their customers in the fundamental matter of protecting their purchasing power, exerting themselves like business men in an economic effort to which as a body they have never before addressed themselves, the railway equipment and supply industries have entered upon a new phase and one which should be fraught with benefit to themselves, to the railroads and to the country.

# THE GOSPEL OF EFFICIENCY

Another dinner was given in New York at about the same time as that of the Railway Business Association, which may be considered as marking an important mile post in the progress of industrial efficiency. The guest of honor was Harrington Emerson, well known because of his success as an efficiency engineer and as a disciple of Fred W. Taylor, who is a couple of generations ahead of his time, and whose ideas Mr. Emerson has modified to more nearly suit the conditions of to-day. The gathering was made up largely of young men who are associated with Mr. Emerson and by friends who have had the good fortune of becoming acquainted with and studying his work. It was probably the largest gathering of efficiency engineers that has ever assembled.

* * * * * * *

What is this efficiency system? Primarily it is designed to cut out all waste or lost motion by better organization, by the establishment of standards for the maintenance and operation of equipment and seeing that they are lived up to, and by the fixing of standard times for all operations and encouraging the men to attain them by paying a bonus or by the introduction of the individual efficiency system, as it is otherwise known.

* * * * * * *

Three thoughts were brought out at the dinner which are of importance to those interested in improving the efficiency of their departments or plants. The first one was a suggestion as to the solution of the problem of how to perpetuate and insure the permanency of the efficiency work. The second showed why some of the elaborate systems of welfare work among the workmen have proven worthless, and the third was an explanation of the reason why the so-called betterment engineers, not previously acquainted with the details of operation in a plant, can tell the men who have spent years in the business how to improve its efficiency.

* * * * * * *

As to the question of how to perpetuate the efficiency system. In the first place, this system is eminently fair to the workman in that his wages are based on his output, the reward for reaching or approximating standard time adding considerable to the amount in his pay envelope at the end of the week. It emphasizes the fact that labor and capital are dependent upon each other and that any injury to one must surely react upon the other. If the employee and the employer can be brought to a realization of this, then instead of both standing on the defensive they will co-operate closely to secure the best mutual results. Under these conditions the employer must rejoice as the strength of the labor organization increases and its influence is widened, and the agreements and understandings that will then be reached will practically insure the perpetuation of the efficiency system even though a change in management may place men at the head of the organization who do not understand or appreciate its advantages.

* * * * * * *

It is good business policy to look after the comfort and convenience of the workmen in order that they may be able to do their best work, but beyond this the so-called welfare work is useless unless based on a square deal to the men. The important thing is that the man receive a fat pay envelope at the end of the week and that the working hours be shortened as much as possible.

* * * * * * *

Most of us have doubtless wondered why it could be that men who know nothing of the details of operating a railroad shop or a manufacturing plant could in the capacity of betterment engineers greatly increase the efficiency of the plant with resulting increased dividends to the stockholders. One of the speakers who had made an intimate study of this question gave the following logical reason for it. It is quite possible for improvements to come from within the plant, but ordinarily they will not be radical ones, since the man who has been raised in the plant and understands every detail of its working will in making a change study its effect upon each of the other dependent details and operations and will not make improvements involving radical changes which effect the relation of all of the operations to each other.

One who comes from the outside and has had experience in other lines of work will look at the problem from a broad standpoint rather than that of detail operation and by utilizing his experience in other fields will solve the problem in an entirely different manner. Men who have been at the head of great reforms or who have put into practical use the great discoveries or inventions that have changed the world's history were not men who were brought up and established in the work in which their great achievement lay, but came from other fields and were better able to appreciate the possibilities of the new idea with which they came in contact.

## RAILROAD CLUBS

*Canadian Railway Club* (Montreal).—W. S. Atwood, mechanical engineer of the Dominion Car and Foundry Company, Montreal, will read a paper on "Steel Freight Cars," at the meeting on December 7th. At the meeting for January 3rd, there will be a discussion on the Master Car Builder rules of interchange. Secretary, Jas. Powell, P. O. Box 7, St. Lambert, near Montreal.

*Iowa Railway Club* (Des Moines).—Next meeting Friday, December 10th. Secretary, W. B. Harrison, Union Station, Des Moines, Ia.

*New England Railroad Club* (Boston, Mass.).—Charles B. Edwards, of the Fore River Shipbuilding Company, Quincy, Mass., will read a paper on "The Curtis Turbine Applied to Marine Propulsion" at the meeting on December 14th. Dinner will be served at the Copley Square Hotel at 6:30, to be followed by the regular business session at 8 o'clock.

At the November meeting William J. Walsh, of the Galena Signal Oil Company, read a paper on "Lubrication of Railway Equipment."

Secretary, Geo. H. Frazier, 10 Oliver street, Boston, Mass.

*New York Railroad Club* (New York City).—The annual Christmas reunion and entertainment will be held in the Engineering Societies Building, Friday evening, December 17th. No technical paper will be presented. Secretary, Harry D. Vought, 95 Liberty street, New York City.

*Northern Railway Club* (Duluth, Minn.).—C. J. Whereat, traveling engineer of the Great Northern Railway at Superior, Wis., will present a paper on "Pooling Locomotives," at the next meeting, December 18th.

Secretary, C. L. Kennedy, 401 West Superior street, Duluth, Minn.

*Railway Club of Pittsburgh*.—The date of the December meeting has been changed to Wednesday, the twenty-second. R. B. Woodworth, engineer of the Carnegie Steel Company, will present a paper on "Tunnel Construction," principally of a subaqueous character. As the rapid transit problem is again coming to the front in Pittsburgh it is expected that there will be a lively discussion of the subway question. The meeting will be held at the Fort Pitt Hotel. Secretary, C. W. Alleman, P. & L. E. R. R., Pittsburgh, Pa.

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*Richmond Railroad Club.*—Chas. Stephens, signal engineer of the C. & O. Ry., will present a paper on "Block Signaling," at the next meeting, December 13th. He will be assisted by Mr. Johnson of the Union Switch & Signal Company. Secretary, F. O. Robinson, C. & O. Ry., Richmond, Va.

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*St. Louis Railway Club.*—At the meeting on Friday, December 10th, C. R. Gray, vice-president of the St. Louis & San Francisco Railroad, will make an address.

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

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*Western Railway Club* (Chicago).—Next meeting Tuesday, December 21. The subject has not yet been announced. At the November meeting in addition to Col. Dunn's paper on "The Transportation of Dangerous Articles," C. A. Seley, mechanical engineer of the Rock Island System, presented a paper on "Electrification of Chicago Railways." He showed the foolishness of the Chicago authorities in attempting to insist upon the electrification of the steam roads entering that city because of the effect upon the prevention of smoke; also that even if it would eventually pay the railroads to electrify, the local conditions are such that nothing should be done without the most careful and extended study and discussion.

Secretary, J. W. Taylor, 390 Old Colony Bldg., Chicago.

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*Western Canada Railway Club* (Winnipeg, Man.).—Next meeting Monday, December 13. Secretary, W. H. Rosevear, 199 Chestnut street, Winnipeg, Man.

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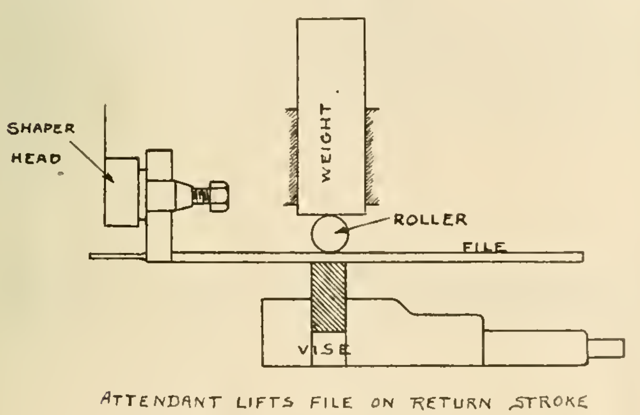
## EFFICIENCY OF FILES.

TO THE EDITOR:

Referring to the article on the efficiency of files, page 454 of your November issue. This is exceedingly interesting and instructive, but, like many other reports, it takes only the first step, namely, the making of records, and fails to take the second and more important step, the establishing of standards. It is interesting to know that a certain file when placed in the testing




APPARATUS FOR TESTING FILES.

machine produces a certain curve, lasts a given number of strokes and removes a certain weight of metal, while another file produces an entirely different record in all these respects. However, it is far more important to establish a standard upon which to base the purchase of files. Which is the most economical file for a shop both as to original cost of the files and as to the cost of labor for producing a given amount of work? Shall we select the file which lasts the greatest number of strokes or the file which lasts fewer strokes, but produces more work while it lasts? Where shall the line be drawn between the life of the file and the time in which a given amount of metal is removed?

No elaborate testing machine is needed to establish such a standard. A simple arrangement used several years ago for establishing this standard is shown in the illustration. Files were purchased according to the standard thus established and produced a considerable saving for the shop.

RECORD OF TESTS.

| No. | Time | Thickness of Test Piece. | Metal Removed. | Strokes Per Minute. | Length of Stroke. | Per cent. of Efficiency Compared with Standard. |
|---|---|---|---|---|---|---|
| 1 | 1 Hour | 15-16-in. | 12.25-oz. | 25 | 9-in. | 100 |
| 2 | " | " | 5.7 | " | " | 46.5 |
| 3 | " | " | 6.7 | " | " | 54.6 |
| 4 | " | " | 7.5 | " | " | 61 2 |
| 5 | " | " | 4.0 | " | " | 32.6 |
| 6 | " | " | 5.25 | " | " | 42.8 |
| 7 | " | " | 4.25 | " | " | 34.7 |
| 8 | " | " | 4.25 | " | " | 34.7 |
| 9 | " | " | 5.25 | " | " | 42.8 |
| 10 | " | " | 6.25 | " | " | 51.0 |
| 11 | " | " | 6.25 | " | " | 51.0 |

The life of file No. 1 was not as long as that of No. 4, but was longer than that of the other files tested. However, the introduction of the labor cost immediately established file No. 1 as the standard.

| | No. 1 | No. 4 | No. 5 | No. 6 & 9 |
|---|---|---|---|---|
| Price per dozen | $3.25 | $3.20 | $2.05 | $2.05 |
| No. of dozen used per year | 375 | 346 | 494 | 400 |
| Cost of files per day | $4.06 | $3.68 | $3.38 | $2.73 |
| No. of men required to produce same amount of work per day | 20 | 32.7 | 61.3 | 46.7 |

As the difference in efficiency is in the files and not in the workmen, we can consider the men as paid at the uniform rate of $3.00 per day.

The cost of producing the same amount of work then becomes:

| | No. 1 | No. 4 | No. 5 | No. 6 & 9 |
|---|---|---|---|---|
| Cost of files | $4.06 | $3.68 | $3.38 | $2.73 |
| Cost of labor | 60.00 | 98.10 | 183.90 | 140.10 |
| Burden as 40% on labor | 24.00 | 39.24 | 73.56 | 56.04 |
| Total cost | $88.06 | $141.02 | $260.84 | $198.87 |
| Excess cost by use of inefficient files | | 52.96 | 172.78 | 110.81 |

These tests therefore established a standard and determined that the most economical file to purchase was the one which would remove the most metal in the shortest length of time irrespective of the life of the file.

C. J. MORRISON.

30 Church street, New York City.

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ENGINEMEN AS PASSENGER AGENTS.—Enginemen may become traffic solicitors by adopting advanced methods of handling engines, so as not to jolt passengers in starting or stopping their trains, avoiding reckless running, and by firing lightly, so as to prevent black smoke.

Some exceptionally good fuel records, equal to the average European railways, have recently been made by our engines—and if the average consumption of coal could be reduced to these special records the electrification of railways would be indefinitely postponed, because there would be no smoke nuisance, and the cost of operation by steam would be so low that the advantages of the electric railway would be removed. * * * There is no trick in it. All that is necessary is to take full advantage of your knowledge of the district over which you are running, and of your engine.

First—Shut off steam when it is not required.

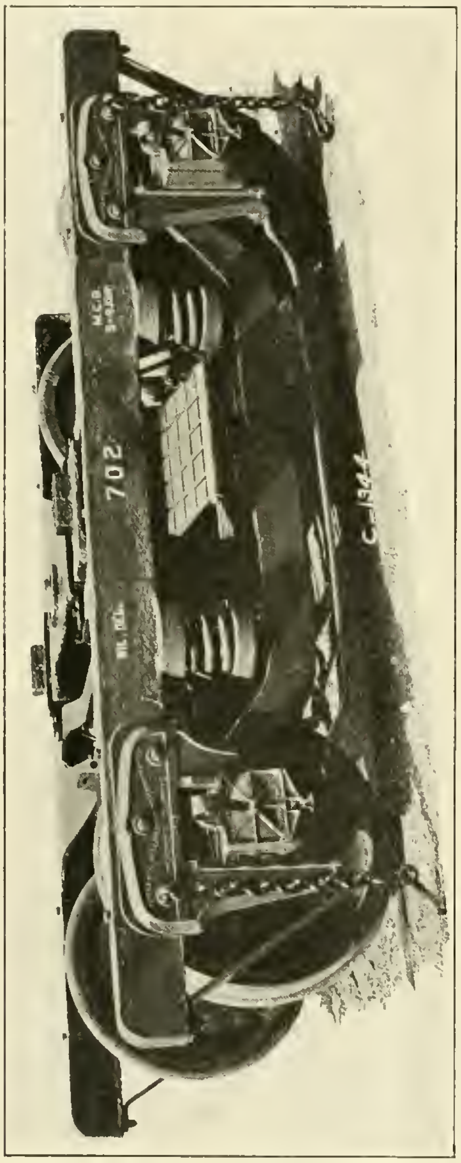
Second—Regulate the feed water, so that the supply will be just equal to the evaporation.

Third—Fire lightly, scattering the coal well over the grate bars, so that the dust and gases from each particle of green coal will be arrested and consumed instead of being thrown out of the stack in black smoke when the engine is fired heavily, or fed more than it can comfortably digest.—*Circular issued by J. Osborne, Supt. Canadian Pacific.*

## STEEL UNDERFRAME COACHES.

CENTRAL RAILROAD OF NEW JERSEY.

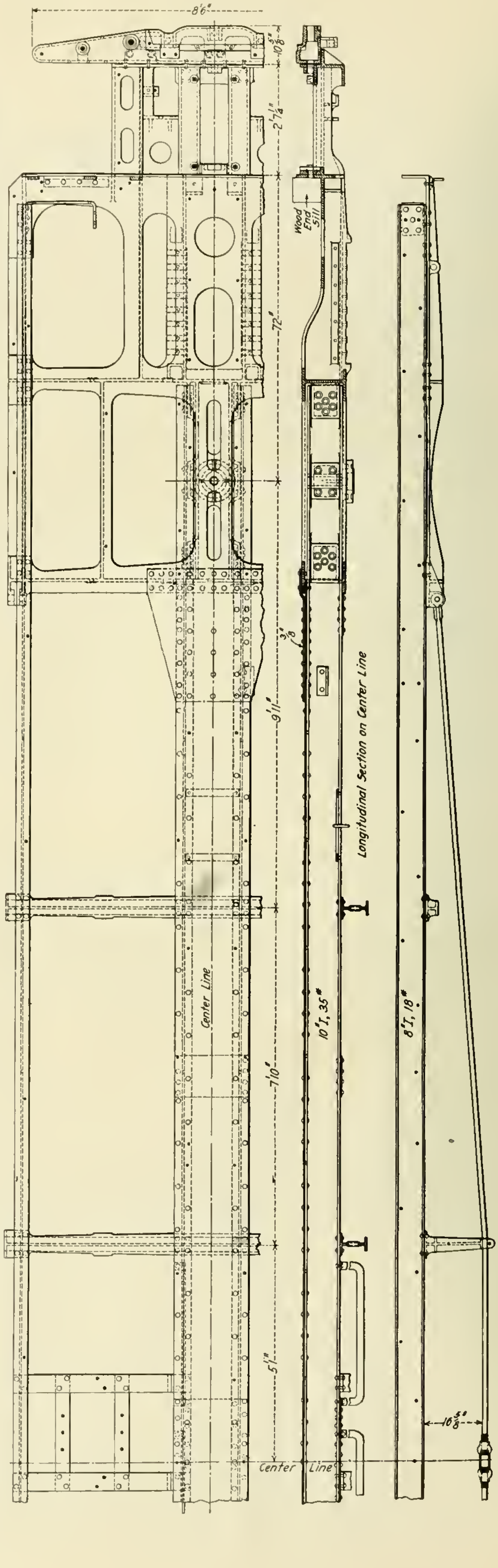
The Central Railroad of New Jersey has recently received fifteen coaches from the Harlan & Hollingsworth Corporation, of Wilmington, Del., which have steel underframes of a rather unique design. The end of the underframe, extending from a point 2 ft. 4 in. back of the center plate and including the center plate, double body bolster and platform, is in the form of a steel casting which was designed and built by the Commonwealth Steel Company, of St. Louis, Mo. The ends of the 10-in. I-beams, 35 lbs. to the foot, that form the center sills are securely riveted to these end castings. The I-beam center sills have a ¼-in. cover plate extending between the cast steel ends;



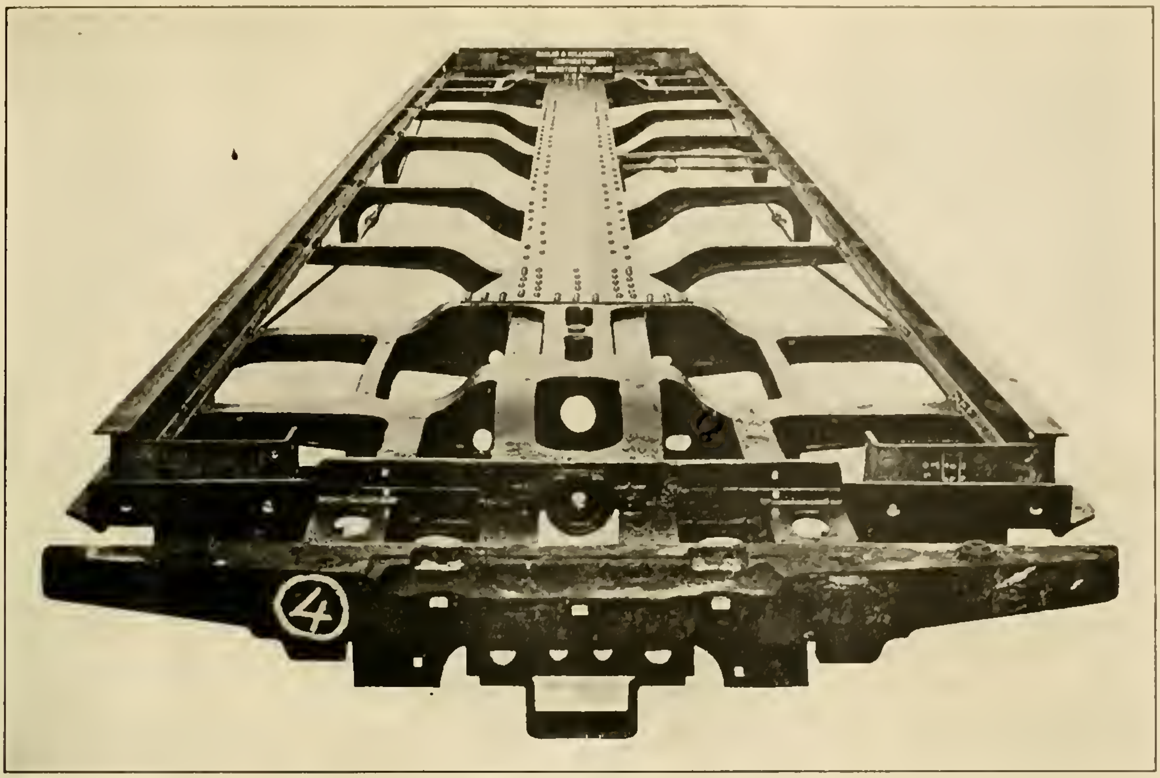

FOUR-WHEEL TRUCK FOR STEEL UNDERFRAME COACHES.

the connection between the center sills and end castings is reinforced by the ⅜-in. gusset plate, as shown.

The four cross bearers are of cast steel and extend underneath the center sills, and are riveted to them. The two near the center of the car are designed with ends to form queen posts for the 1⅝-in. truss rods. The side sills are 8-in. I-beams, 18 lbs. to the foot, and extend between the wooden end sills. As shown by the cross sectional view of the car, there are two intermediate wooden sills, 5 x 8 in. in section. The steel I-beams forming the side sills are covered with 4½ x 8-in. wooden timbers on the outside and 2 x 8-in. timbers on the inside. The floor and the wooden superstructure, which is of the usual construction, are secured to these wooden sills. Miner tandem




PARTIAL VIEW OF STEEL UNDERFRAME FOR CENTRAL RAILROAD OF NEW JERSEY COACHES.

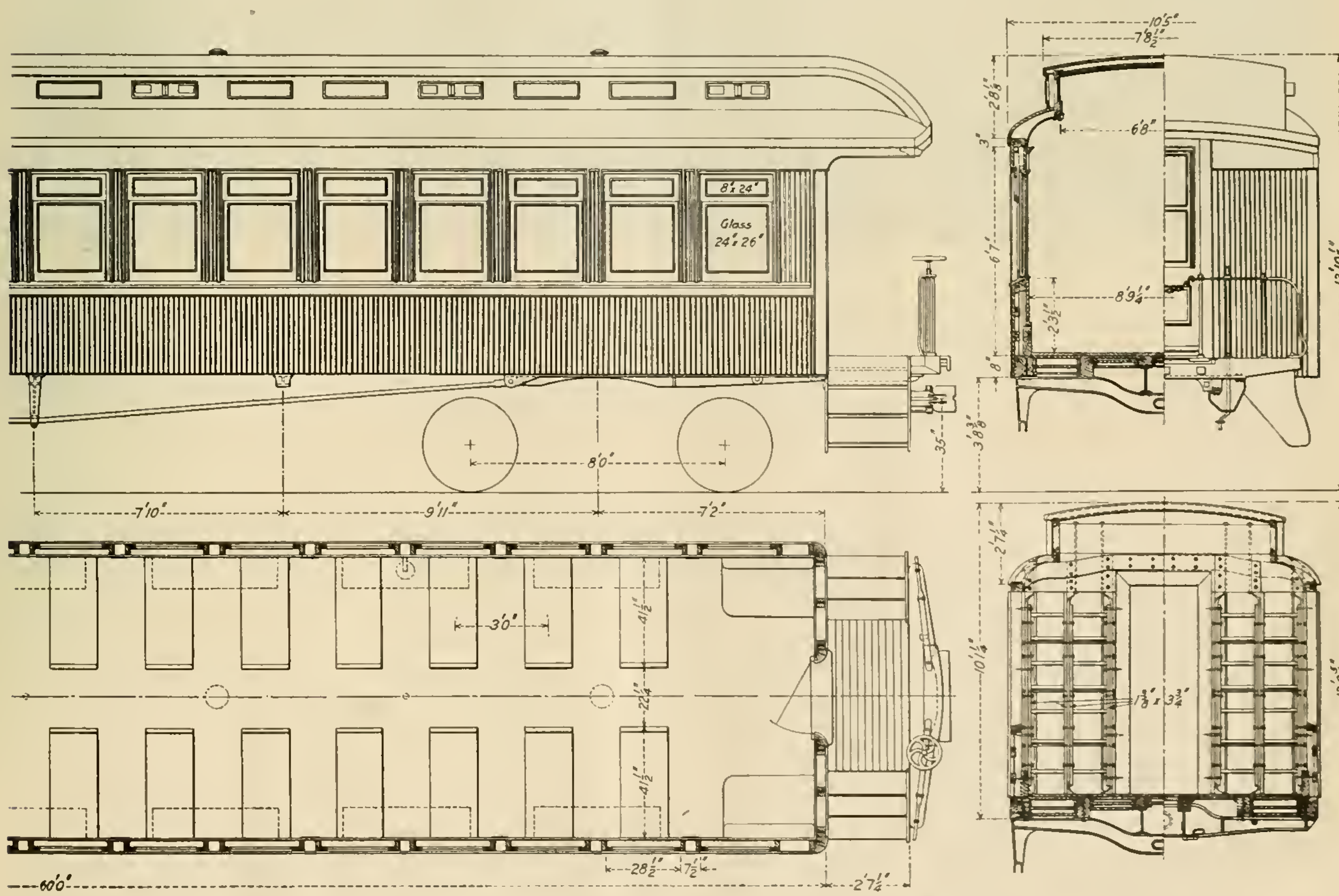


STEEL UNDERFRAME FOR PASSENGER COACHES, C. R. R. OF N. J.

draft gear is used in connection with a three-stem coupler. Following are the general dimensions of the car:

| | |
|---|---|
| Length over end sills | 60 ft. |
| Length inside | 59 ft. 3½ in. |
| Width over side sills | 9 ft. 8 in. |
| Width inside | 8 ft. 10½ in. |
| Height from rail to top of car | 13 ft. 10½ in. |
| Distance between truck centers | 45 ft. 8 in. |

The car weighs 90,000 lbs. and has a capacity for 74 passengers. The four wheel trucks have 36-in. forged steel wheels; the axles have 5 x 9-in. journals. The truck frame, bolster and spring plank are of cast steel, furnished by the Commonwealth




CENTRAL RAILROAD OF NEW JERSEY COACHES WITH STEEL UNDERFRAMES.

Steel Company. Waycott high speed brake beams are used. The car is lighted by Pintsch gas one-flame mantle lamps, furnished by the Safety Car Heating & Lighting Co., of New York.

## PENNSYLVANIA ELECTRIC LOCOMOTIVES.

The first of the initial order for twenty-four electric locomotives, which are to be used for handling the Pennsylvania Railroad trains into the New York Station, has been delivered and is in operation on the electrified tracks of the Long Island Railroad. It is the result of several years co-operative development between the Pennsylvania Railroad Company and the Westinghouse Electric and Manufacturing Company and is distinctively a high powered machine, built for high speed operation.

In wheel arrangement, weight distribution, trucks, and general character of the running gear it is the practical equivalent of two American type locomotives coupled permanently back to back. The motors are mounted upon the frame and are side connected through jack shafts to the driving wheels by a system of cranks and parallel connecting rods, similar to steam practice. The connecting rods are all rotating links between rotating elements, and are thus perfectly counterbalanced for all speeds. The employment of this transmission permits the mounting of the motors upon the frame, secures their spring support, and, in common with the rest of the locomotive, the centre of gravity at approximately the same height above the rails found desirable in the best high speed steam experience.


ELECTRIC LOCOMOTIVE FOR HANDLING PENNSYLVANIA RAILROAD TRAINS INTO NEW YORK STATION.

The same freedom of motion in the wheels and axles that is charactristic of the present steam locomotive is also secured. In these locomotives the variable pressure of the unbalanced piston of the steam locomotive is replaced by the constant torque and constant rotating effort of the drive wheel, and the pull upon the draw-bar is thereby constant and uniform. It might appear that by this arrangement of driving a return has been made to steam locomotive practice as regards counterbalancing difficulties, but it will, upon examination, be seen this is not true. There are no questions of unbalanced reciprocating weights involved; all weights are revolving ones and directly counterbalanced, so that as far as pounding upon the track is concerned, the effect is precisely the same as though the whole were driven without any pins or rods.

The starting requirements of this locomotive are unusually severe; it will be called upon to start a train of 550 tons trailing load upon the tunnel grades under the river, which are approximately two per cent. The guaranteed tractive effort of 60,000 lbs. is amply within the capacity of the electrical equipment. The normal speed with load upon a level track is 60 miles an hour, but the locomotive is capable of speed much in excess of this. The total weight of the locomotive is 332,100 lbs., of which 208,000 lbs. is carried by the drivers. At maximum capacity, it develops 4000 h.p. For sustained heavy output, the motors are designed for forced ventilation, but the initial service will not require this provision.

It will be seen that the locomotive is an articulated machine, and that each half carries its own motor and has four driving wheels 68 in. in diameter and one four-wheel swing bolster swivel truck with 36 in. wheels. Each section has its own cab of sheet steel extending the length of the frame, communication between the two cabs being provided through a standard Pullman vestibule. The rigid wheel base of each half is 7 ft. 2 in., and the total wheel base of each half is 23 ft. 1 in.; that of the whole locomotive being 55 ft. 11 in.

The running gear and mechanical parts were built by the Pennsylvania Railroad at their Juniata shops at Altoona. The electrical equipment was built and the apparatus assembled by the Westinghouse Electric and Manufacturing Company at their East Pittsburgh Works.

*Frames.*—The frames are of cast steel, of large cross section and massive construction, having an unusually high factor of safety. They are of sufficient strength to allow the engine to be raised by jacks, applied at fixed points provided in the construction, with all pedestal binders removed. The upper surfaces of the side frames are especially broad and furnish bases for the feet of the motor frames, which fit over the top members of the side frames with heavy flanges. There are five heavy crossties between the frames consisting of bumper, articulation and jackshaft girders, body bolster and drive wheel crosstie. Additional transverse strength is given by the steel motor frame which is bolted to the side frames.

The bumper and articulation girders are so proportioned that a bump equivalent to a static load of 500,000 pounds (150,000 pounds applied on centre line of draft cylinder and 350,000 pounds applied on centre line of platform buffer) will produce no stress exceeding 12,000 pounds per square inch in the frames. The jackshaft girder is of inverted U section, arranged to give rigid support to the jackshaft bearing brasses. It also carries upon facings the driver brake cylinder; the brake lever fulcrum is integral with the girder.

The crosstie between the driving wheels is of diagonal design, especially fitted for stiffening the bottom members, and also providing a base for the front driver brake hanger pin. This tie fits between the upper and lower members of the side frames and assists in rigidly supporting the heel of the motor frame. The articulation girder is unusually rigid diagonally in the horizontal plane and is designed to accommodate the articulation gear details. The body bolster carries the swivel truck centre pin and is of ample strength to withstand all braking strains.

*Wheels and Axles.*—The driving wheels are 68 inches in diameter with tires 3 inches thick and have cast steel centres and rolled steel tires and are fitted with retaining rings. The truck wheels are of rolled steel 36 inches in diameter. The driving wheel centres are fitted with quartered crank pins and counter-balances; these latter are offset from direct opposition to the cranks to correct the transverse unbalance that would otherwise exist.

The axles, jackshafts and motor shafts are of special carbon steel, oil-tempered and annealed. They are of large diameter, finished all over and each has an axial hole throughout.

*Cranks.*—The motor shaft cranks are forged with integral counter-balances, accurately located in quartering positions and press-fitted and keyed to the shaft. The jackshaft cranks are forged integrally with the shaft in quartering position. Their counter-balances are keyed in position. As with the driving wheels, the counter-balances of the motor shafts and the jackshafts are offset from direct opposition to the cranks in order to complete the balance. All crank pins are of special carbon steel, oil-tempered and annealed, of ample diameter, bored axially and press-fitted to their respective cranks and wheels.

*Connecting Rods.*—The connecting rods are of special carbon steel, oil-tempered and annealed. Inasmuch as under the action of the brake shoes the wear of the axle and the take-up of the wedges in the pedestal tend to decrease the distance between the axle and the jackshaft, the main rod is adjustable at each end, so fitted that all take-up shortens the rod and furnishes compensation. The type of adjustable head is that employed on Pennsylvania Railroad Class E-3 locomotives. All other rods are fitted with solid bushed ends.

*Draft Gear.*—The bumper ends of the locomotive are fitted with Westinghouse friction draft gear, standard M. C. B. couplers and platform buffers of Pennsylvania Railroad standard type.

*Articulation Details.*—The articulation ends are fitted with permanent couplings of long twin drawbars and Westinghouse friction draft gears so designed that the leading half serves as a leading truck and the other half as a trailer in whichever direction the locomotive may be moving. The coupling gear is so designed as to oppose any possible "nosing" tendency or buckling action of the halves.

*Spring Rigging.*—The spring rigging is composed of equalizing beams, semi-elliptic springs, links and hangers of the usual type.

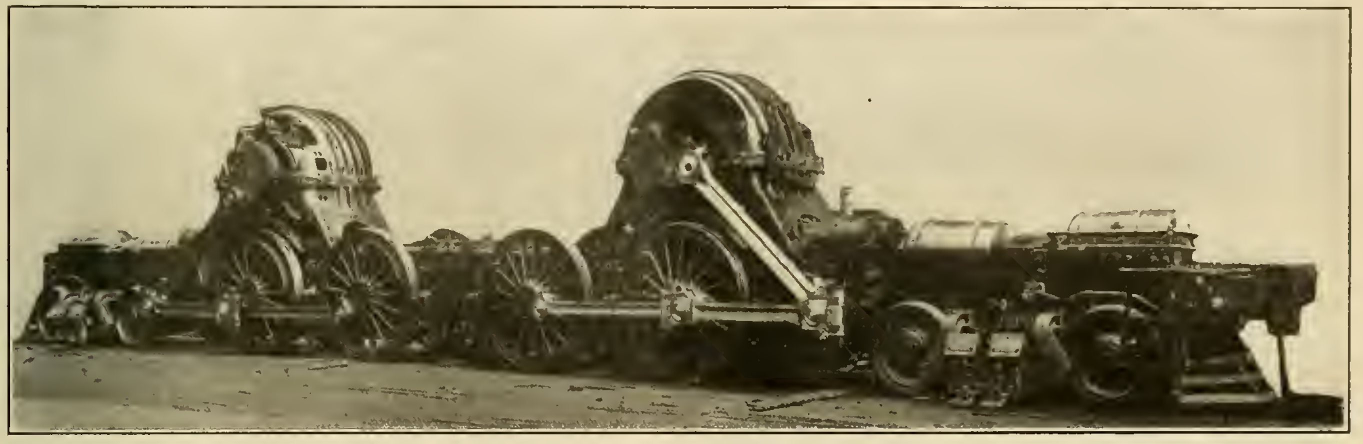
*Cabs.*—The cab of each half is an independent structure, complete in itself, so constructed that it may be lifted bodily from the running gear with the floor and all the auxiliary apparatus and set upon any convenient flat surface or trestle support without damage, leaving the motor and running gear accessible for any desired overhauling and permitting attention to be given at the same time to the machinery in the cab. The cabs are identical in construction and fittings, and so arranged that they are interchangeable.

The location of the cabs in assembling is determined by dowels fitting in corresponding holes in the running gear. They are held in place by a number of bolts sufficient for security. The cabs are amply lighted by electric lamps. Bulkheads and doors are so arranged that the motor and air compressor compartments, containing nearly all of the auxiliary apparatus, may remain lighted at all times with no intrustion of light in the controller compartment to affect the vision of the driving engineer. Provision is to be made for heating the cabs by steam furnished from electric steam boilers within the cabs.

Each cab is fitted with an overhead collector of the pantagraph type, located on the roof, for power supply over gaps of the third rail in the yards. The sanders and overhead collectors are operated by foot push buttons located near the master controller within easy reach of the driving engineer.

*Headlights.*—Each cab carries on its own roof, at the end, an electric headlight having for its illuminating element a 50 c.p. stereopticon lamp operated from the main current, with suitable resistances, on 240 volts. These headlights are not intended to be of high candle power, or to have a searchlight quality, although they might readily have been made so, as the electric current is at hand. It was considered of great importance to avoid the blinding effect on the motorman of a powerful light,

*Air Brakes.*—Each half is supplied with complete Westinghouse air brake equipment actuated by a motor driven air compressor and a 600-volt motor for both automatic and direct braking of locomotive and train. The compressor also furnishes air for the electro-pneumatic switches and its displacement is 65 cubic feet of free air per minute. The entire system is especially designed for these locomotives and the foundation brake rigging is suitably proportioned for the weights and arranged for delivery of 85% braking power at 50 pounds cylinder pressure.



ELECTRIC LOCOMOTIVE WITH CABS REMOVED, PENNSYLVANIA RAILROAD.

Electric Equipment.

The motive power is delivered from two interpole motors on direct current at 600 volts. The design of these motors was governed by the necessity of commutating the heavy draughts of power required to accelerate the heavy trains on the tunnel grades. For this purpose the design not only affords great electrical stability but renders it possible to use the economical, flexible and efficient field control. Each motor will develop 2,000 h.p. on a current of 2,900 amperes at 600 volts. The weight of each motor complete without crank is 42,000 pounds.

The motor frames are cast steel shells divided horizontally and bolted rigidly together. The motor is of open construction affording easy access to all parts. It is especially provided with powerful self-ventilation. If the full power of the locomotive is to be used more frequently than contemplated, ventilation by air blast can be used to greatly increase the output. Semi-circular openings in the lower half of the frame provide seats in which the bearing housings are rigidly bolted. The lower half of the frame is provided with four feet for mounting and bolting on the side frames of the running gear, and these feet have machined flanges fitting over the top members on the side frames and stiffening the structure against transverse movement on the part of the motors. In addition to being securely bolted, the feet of the frame are firmly wedged in place.

The motors have ten main poles and ten interpoles, with heavy strap field windings. The main field is split in two halves, both being used together in slow speed operation. One of these sections is shunted in control. The armature core is built of soft steel punchings assembled with the commutator. The commutator bars are of hard drawn copper clamped by cast steel rings over mica insulation. For relief of the driving mechanism from excessive strains in the event of short-circuit in the powerful motors an adjustable friction clutch of novel design and tested efficiency in action is provided between the armature spider and the motor shaft.

*Third Rail Shoes.*—Each half unit is supplied with two pairs of rail shoes of appropriate size and strength, suitably connected and fused. One pair of shoes is mounted on a hard wood beam on each side of the swivel or four-wheel truck.

*Control.*—The control is of the Westinghouse shunted field control, and by utilization of the unit-switch system the motors may be grouped in "series" or in "multiple" at will. Electro-pneumatic switches, actuated by air from the brake compressor and operated by magnets controlled from the master controller, are provided to regulate the field strength of the motors by shunting and by cutting out a portion of the field winding, in addition to the "series parallel" grouping, thus giving increased economy of operation and additional running points, greatly improving facility and economy of operation.

The bridging system is used for passing from "series" to "multiple" connections. The motor fields are arranged to be reversed for changing the direction of motion and reversing is accomplished by unit switches. The master controller is simple in operation and the cab is so arranged that the entire controlling mechanism of the locomotive and train is within reach of the driving engineer.

While it is not intended that the half units be operated independently, the cabs are identically equipped and the windings, connections and control are such that in the event of the disabling of one motor the train may be operated under reduced power by the second motor, the same resistances being employed as for the two.

A master controller with latches handle and suitable operating points is placed in each end of the locomotive and the circuits thereto are so arranged that when two or more locomotives are coupled together all may be operated simultaneously from any one of the master controllers. All switches are operated from the master controller entirely at the will of the motorman or engine driver. The resistances are of the three-point cast grid type. The grids have such capacity that when one motor is cut out of service the locomotive will operate with the remaining one. Under such circumstances the locomotive will exert a tractive effort of 25000 pounds with the train accelerating at a rate of one-tenth mile per hour per second until the resistance grids are cut out.

Suitable receptacles and jumpers are provided to establish the necessary low voltage control circuits between the locomotive half units and between the adjacent locomotives. A duplicate set of small storage batteries is supplied in each half unit for operation of the control circuits; and relays with suitable resistances are provided for shunting part of the current of the compressor motor through the batteries for automatic charging. An exceptionally quick-acting circuit-breaker is supplied on each half unit and connected between the junction of the third rail shoe and the overhead collector cables and the switch groups. The main switch is on the line side of the circuit-breaker.

## THE HEAT TREATMENT OF SPRING STEEL.*

Lawford H. Fry.

The following is an account of a series of tests made at the Baldwin Locomotive Works in 1907, to determine the effect of certain heat treatments on the transverse elastic limit, and on the modulus of elasticity of the steel commonly used in America for locomotive carrying springs. The points under investigation were:

1. The effect of annealing.
2. The comparative effect of quenching in water and in oil.
3. The effect of reheating the steel to various temperatures after complete cooling in water or in oil.

The steel experimented upon was basic open hearth spring steel, furnished by the Carnegie Steel Company, and its chemical composition was:

| | Per cent. |
|---|---|
| Carbon | 1.01 |
| Manganese | 0.38 |
| Phosphorus | 0.032 |
| Sulphur | 0.032 |
| Silicon | 0.13 |

The test pieces used were 1 in. in diameter and 14 in. long, with a uniform circular cross section. Ten test pieces were cut from the same bar of steel, stamped with Nos. 11 to 20 and treated as indicated in Table I, which also shows the effect of the treatment on the physical quality of the steel.

### Method of Heating and Cooling the Test Pieces.

In the experiments, the temperature at which the specimens were quenched was not varied, as experience has shown that there is a definite temperature for any given steel, size of work and method of quenching, at which the steel should be quenched to obtain the best results. Steel can be hardened by heating it to and quenching it at any temperature equal to or higher than its "critical point," but the higher the temperature at which it is quenched the coarser becomes the grain and the more brittle the steel. It is, therefore, desirable to quench the steel close to the critical point, but in practice it is found necessary to allow a certain margin above the theoretical hardening temperature. This margin above the critical point is affected by the sizes and shape of the work and the method of quenching. Having been once determined this proper quenching temperature should be always used, any variation in the final degree of hardness being produced by a change in the temperature at which the temper is drawn, or the heat conductivity of the quenching bath.

By means of a magnet the "critical point" or point of recalescence of the steel experimented upon was found to be 1,360 degrees F. Previous experience with the steel has shown that for annealing, the steel should be heated to 40 or 50 degrees above the critical temperature, and that for hardening it should be brought to 50 or 100 degrees above the critical temperature, the exact temperature being determined by the size of the work and the effectiveness of the cooling bath.

For the present investigation the following temperatures were decided upon, they having been indicated by previous experience to be the most desirable:

| | Degrees F. |
|---|---|
| For annealing | 1,400 |
| For quenching in oil | 1,450 |
| For quenching in water | 1,425 |

All the operations were carried out at these temperatures, and the heats at which the temper was drawn and the mode of quenching were the only variables in the heat treatment. The test pieces were heated in a lead bath specially constructed to secure control and uniformity of temperature. The lead was contained in a cast iron pot placed in a circular brick lined furnace. Six burners uniformly spaced admitted a gas blast at a tangent with the brick walls, so that the flame rotated around the lead bath without impinging upon it at any point. The temperature of the lead bath was registered by means of a Bristol electric pyrometer.

* A paper read at the Copenhagen Congress of the International Society for Testing Materials, September 7-11, 1909.

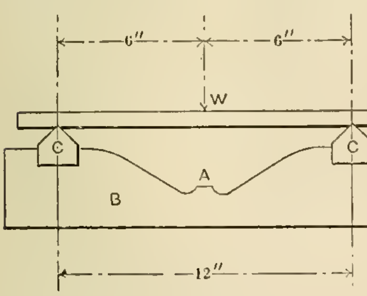
For annealing, the test pieces were plunged in the lead, the bath heated to 1,400 degrees and kept at that heat for two hours, and then allowed to cool off naturally with the furnace, the top of the pot being covered. The time of cooling was 14 hours.

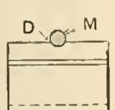
For hardening the test pieces were brought to the temperature indicated above and then quenched: 1, In oil at a temperature of 80 degrees F., the oil conforming to the Baldwin Locomotive Works specification for tempering oil, which requires a fire test of 600 degrees F. or over, and a specific gravity of not less than 25 degrees B. at 60 degrees F.; or, 2, in pure running water at 60 degrees F. The test pieces while being quenched were kept agitated until cooled to the temperature of the bath.

For drawing the temper up to 600 degrees F., the test pieces were placed in an oil bath heated by gas, the temperature being registered by means of a mercury thermometer; for drawing the temper above 600 degrees F. the test pieces were placed in the lead bath, the temperature being registered by the Bristol pyrometer. After the temper was drawn to the desired temperature, the test pieces were taken out of the bath and left to cool naturally in the air.

METHOD OF TESTING.

All the specimens were tested transversely. They were placed on supports 12 in. apart and the loads applied in the middle. The arrangement of the forged steel base B and the tool steel blocks C is shown in the sketch. The bottom of the base was carefully planed and finished and the tool steel blocks C, supporting the specimens, had been scraped to fit the base exactly, so as to allow of no play or deformation when the loads were applied. The top of the tool steel blocks was rounded off at D, to the shape of the test pieces, so as to give a good bearing; but even so it was found that the blocks would cut into the test pieces 0.001 or 0.002 in., and in order to remove as far as possible any error in the measurement of the deflections due to this cause, the specimens were subjected, before the test was begun, to the repeated application and release of a load which stressed them to about two-thirds of the elastic limit. This load was applied and released often enough to seat the test piece on the supports, without giving it a permanent set. When the test piece was seated, the test proper was begun, and the height and deflections of the bars measured at their centers with an inside micrometer, measuring 0.00001 in., one point of which rested in a small center punch hole in the base, shown at A. The deflections were increased by steps of 0.0005 in. at a time and the loads measured for each increment of deflection. After having begun a test, the test piece was not released until the test was ended, as




this was found to be the most accurate method; there is, therefore, no record of the permanent sets above the elastic limit.

COMPUTATION OF RESULTS.

The results obtained are shown in Table I. The elastic limit is that point where the ratio of deflection to stress ceases to be appreciably constant, and the deflection begins to increase at a faster rate than the stress. The fiber stresses, elastic limit and modulus of elasticity were calculated from the usual formulæ for a simple beam supported at both ends and loaded at the middle as follows:

$$S = \frac{Wlc}{4I} \quad \ldots (1) \qquad f = \frac{Wl^3}{48EI} \quad \ldots (2) \qquad E = \frac{Wl^3}{48fI} \quad \ldots (3)$$

and combining (2) and (3)

*Table I. Results of Tests of Spring Steel.*

| No. of tests. | Heat treatment. | Elastic limit. Pounds per square inch. | Modulus of elasticity | Diameter of test piece. Inches. | Moment of inertia. | Breakage deflection.—Inches. |
|---|---|---|---|---|---|---|
| 17 | Annealed in lead at 1400° F. | 78,500 | 27,550,000 | 0.991 | 0.01730 | Did not break. |
| 11 | Hardened in oil at 1450, drawn to 560° F. | 137,500 | 28,700,000 | 1.000 | 0.04909 | Did not break. |
| 14 | Hardened in oil at 1450, drawn to 500° F. | 160,400 | 27,150,000 | 1.000 | 0.04909 | Did not break. |
| 19 | Hardened in oil at 1450, drawn to 400° F. | 177,600 | 29,080,000 | 0.991 | 0.04730 | Did not break. |
| 12 | Hardened in oil at 1450° F., not drawn | 187,400 | 28,610,000 | 0.993 | 0.04772 | Did not break. |
| 16 | Hardened in water at 1425, drawn to 1050° F. | 180,700 | 28,070,000 | 0.997 | 0.04850 | Did not break. |
| 13 | Hardened in water at 1425, drawn to 900° F. | 233,900 | 28,860,000 | 0.998 | 0.04870 | Did not break |
| 15 | Hardened in water at 1425, drawn to 750° F. | 240,800 | 29,220,000 | 0.994 | 0.04790 | 0.744 |
| 20 | Hardened in water at 1425, drawn to 600° F. | 219,800 | 30,120,000 | 0.991 | 0.04730 | 0.175 |
| 18 | Hardened in water at 1425° F., not drawn | 212,000 | 29,960,000 | 0.991 | 0.04730 | 0.175 |

Test pieces 17, 11, 14, 19, 12, 16, 13 did not break under a deflection at the middle of 1.1 inch.

Test pieces with uniform round cross-section placed on supports 12 in. apart, load applied in middle. Chemical analysis of steel used: Carbon, 1.01; phosphorus, 0.032; manganese, 0.38; sulphur, 0.032; silicon, 0.13.

$$f = \frac{Sl^2}{12Ec} \qquad E = \frac{Sl^2}{12fc}$$

where

$S$ = maximum fiber stress in pounds per square inch.

$W$ = load in middle in pounds.

$l$ = span = 12 in.

$I$ = moment of inertia of cross section = $\frac{\pi d^4}{64}$ for a round section.

$f$ = deflection in the middle in inches.

$E$ = modulus of elasticity.

$c$ = distance of neutral axis to outermost fibers = $\frac{d}{2}$

$d$ = diameter of test pieces in inches.

DISCUSSION OF THE RESULTS.

*Annealing.*—The steel used in the tests, when thoroughly annealed in the manner above described, had an elastic limit of 78,500 lb. This, as shown below, is equal to about one-half the elastic limit generally obtained with this steel when given a "spring temper," and is equal to about one-third the elastic limit of the same steel when quenched in water and drawn to 750 degrees F.

*Oil Hardening.*—The highest elastic limit obtainable with the steel used, when quenched at 1,450 degrees F. in oil, was 187,400 lb. per square inch, and this was obtained when the temper was not drawn after quenching. The higher the temperature to which the temper was drawn, the lower the elastic limit fell. Drawing to 400 degrees F. gave 177,600 lb., drawing to 500 degrees F. gave 160,400 lb., and drawing to 560 degrees F. 137,500 lb. per square inch elastic limit. None of the oil-treated specimens broke under a 1.1 in. deflection. The usual "spring temper" given in shop practice would be: Quenching from about 1,450 degrees F. in oil and drawing the temper to between 400 degrees and 575 degrees F. It will be seen that this practice would give an elastic limit varying from about 130,000 lb. to about 175,000 lb. per square inch, and an average of about 150,000 lb. per square inch.

*Water Hardening.*—When the steel was quenched at 1,425 degrees F. in water and the temper not drawn after quenching, the steel was brittle and broke at 212,000 lb. modulus of rupture, the elastic limit being the same as the modulus of rupture, and the deflection of the breaking point being 0.171 in. (The term "modulus of rupture" has a conventional meaning. It expresses in pounds per square inch the apparent maximum fiber stress, tension or compression of a member transversely loaded, as it is just on the point of breaking; the stress being calculated by the common beam theory, with its three important assumptions, which are known to be inaccurate above the elastic limit.)

Drawing the temper to 500 degrees F. gave an elastic limit of 219,800 lb., with the elastic limit still equal to the modulus of rupture; or, in other words, the ratio of stress to strain was constant up to the breaking point. The deflection at the breaking point was 0.175 in. Drawing the temper to 750 degrees F. gave the highest elastic limit, 240,800 lb. per square inch, and the modulus of rupture was then higher than the elastic limit, viz., 389,000 lb. per square inch. The deflection at the breaking point was 0.744 in. If the temper was drawn to 900 degrees F. the elastic limit fell slightly, being 233,900 lb. and the specimen did not break under a 1.1 in. deflection. When the temper was drawn to 1,050 degrees F. the elastic limit dropped to 180,700 lb. and the test piece did not break under a 1.1 in. deflection.

### The Modulus of Elasticity.

The results of the tests show that the modulus of elasticity is practically constant, and apparently independent of the heat treatment given. The modulus of elasticity is difficult to determine accurately, on account of the precision required in measuring the deflections and loads, which vary by very small amounts. It is to be noted that any error in the measurements is likely to make the value of the modulus smaller than it really should be. The modulus of elasticity is the ratio of the stress to the strain, or in this case the modulus of elasticity, $E$, varies as $\frac{\text{stress}}{\text{deflection}}$ Now, all measurements of the deflections have a tendency to be too large and consequently the values found for $E$ have a tendency to be too small, because the blocks and base on which the specimens rest are compressed to a certain amount by the loads on the test pieces, and if not perfectly fitted the blocks take a certain set which, together with the compression of the support, is measured with the true deflection of the test pieces and added to the true deflection in all the computations. Also, the softer the test pieces the more difficult it is to prevent the supports from denting it under load. The values obtained for the modulus of elasticity varied from 27,150,000 to 30,420,000. It would seem that the higher values are more probably correct, and that the true modulus of elasticity of the steel apparently lies between 29,000,000 and 30,000,000 and is probably unaffected by the heat treatment.

### Conclusions.

Steel of 1 per cent. of carbon, when quenched in cold water from above its "critical point," is usually too hard and too brittle to be used for the making of springs or tools. The theory of the hardening of steel tells us that there are two ways of modifying this hardness and brittleness of the steel. They are: First, allowing some of the carbon fixed in the "hardening" form by quenching, to change back to the "annealing" form, by reheating the steel above 400 degrees F. The higher this reheating or "drawing of the temper" is carried, the softer the steel becomes; second, using a quenching bath having a lesser heat conductivity. The slower the steel is cooled from above the "critical point" to about 400 degrees F., the more carbon is allowed to change to the "annealing" form and the less the steel hardens. By the second method, steel can be obtained of different degrees of hardness without "drawing the temper" after hardening the steel. These two methods of regulating the hardness of steel in hardening can also be used jointly.

These points are illustrated in the tests. The higher the temper is drawn after hardening the lower the elastic limit falls; also a lower elastic limit is obtained with the test pieces quenched in the bath having the lesser heat conductivity, viz., oil. The tests show that the elastic limit of 1 per cent. carbon steel can be made to vary from 78,500 lb. per square inch to 240,800 lb. per square inch by changes in the heat treatment, and that very small changes in the "drawing of the temper" are sufficient to effect the elastic limit of steel. This proves once more that the heat treatment of steel is a delicate and accurate operation, and that to obtain good and uniform results it is necessary to have means of heating the steel uniformly to the proper temperature and cooling it at the desired rate in a cooling medium, the temperature and heat conductivity of which can be kept reasonably constant.

## FLEXIBLE STAYBOLTS—A CRITICISM.

To the Editor:—

The writer has been much interested in the different papers written on the subject of "flexible stays," particularly those before the American Society of Mechanical Engineers. It would seem to me that a large amount of the time spent on the study of relieving stays by flexibility has been wasted, since the real meaning of a stay is to "hold fast," and if it is made partially flexible it cannot "hold fast," the way in which the meaning of the "stay" is intended to convey.

It seems to me that staybolt maintenance will continue to be a source of anxiety to the motive power department as long as present construction exists. No one can conclusively certify to the exact conditions of the strains set up in the firebox plates, due to the expansion and contraction, and if it is assumed that the strains go in a direct line, and an attempt is made to relieve them by using a flexible stay, it will be found that when the allowance has been made to take care of the strain in one part of the plate, it will crack in exactly the opposite part.

This question of breaking stays and cracking firebox sheets and tube plates is surely a problem, but from my own experience my opinion is that an attempt to solve it by studying the design of staybolts will be of little use. I have come to the conclusion, after long study, that the only way of getting rid of the present strains set up in the plates is by the proper formation of the sheets themselves and to so construct them that the expansion and contraction from the front tube plate to the back of the firebox will be as nearly balanced as possible. By flanging to accomplish this we not only relieve the strains on the staybolts but also increase the direct heating surface in the firebox, which is of course an important advantage, as it is done without enlarging the grate surface.

The writer, in studying this subject, made quite a number of experiments on different shapes in order to find out what flexibility could be put into the plate itself between each row of staybolts. It was finally found that on a 5 in. section, 1 in. wide, curved to a depth of 1¼ in., a pull of 900 lbs. would elongate it 1-20 of an inch. From these experiments the writer was satisfied that by flanging between each row of staybolts, covering the sides and crown in one plate, starting at the first row of staybolts from the mud ring, and returning thereto would practically neutralize all the strains that were set up in the firebox. It will be seen that the stay in this case is of no great importance. The construction, however, permits an increase in the diameter of the staybolts from 1 in. to 1⅛ in., and the centres of the stays can be increased to 5 in. instead of 4 in., thus reducing the number by from 300 to 350.

I have also made a large number of experiments on relieving the strains of the tube plates by flanging, and giving them flexibility permitting the front and back tube plates to work together, and allowing the tubes to expand and contract en masse, thus reducing tube leakage and preventing cracking of plates.

Large consolidation boilers have been working, with these improvements, under 200 lbs. steam pressure for nearly one year, and have not broken a single staybolt, from which it would appear that the mode of formation and flanging has neutralized all the strains set up in the firebox, as well as taking all the tension off the mud ring, thereby preventing mud-ring troubles, leaky stays and tubes, and effecting a large saving in fuel from the increased heating surface. It would appear that the balancing of the expansion and contraction in these boilers, from the front tube plate to the back of the firebox, has practically been realized, and with reasonable care being used in dumping the fire at terminals, these boilers would run indefinitely without having an expander put in any of the tubes.

From actual experience it has also been found that fireboxes with these formations do not scale any more than fireboxes with plain surfaces.

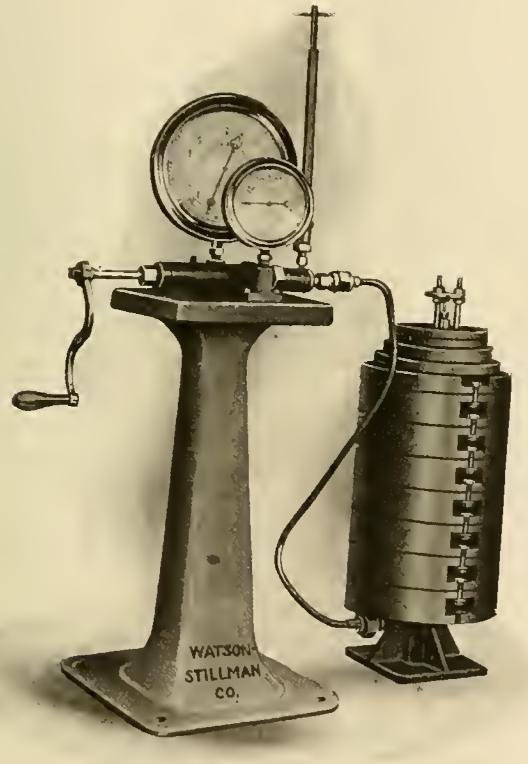
In conclusion, it was stated in a discussion before the American Society of Mechanical Engineers, that the trouble of staybolts in high pressure locomotive boilers is a permanent factor in the cost of locomotive maintenance, and has an important bearing on the safety of the public. Any innovation intended to increase their durability or reliability is, therefore, worthy of the most careful demonstration and service trial.

William H. Wood, *Engineer*.

Media, Del. Co., Pa.

## CALIBRATING APPARATUS FOR HIGH PRESSURE GAUGES.

The bursting of machine parts and fittings from excessive pressure is usually accompanied by considerable danger, expense and delays for repairs. This is especially true with the extremely high working pressures under which liquids and air are often used. It is therefore quite important to know the pressure conditions within any apparatus using these sources of power and the gauges should be calibrated at regular intervals. Under the higher hydraulic pressures the same gauge will frequently show different percentages of error at different pressure readings, and these can be compensated for in ascertaining the true pressure only by comparing with a "master" gauge of known accuracy or by loading with a known pressure. The apparatus shown in the illustration performs these two functions of testing by comparison with a master gauge and of testing the accuracy of the master gauge.




Calibrating Apparatus for Gauges.

For the first purpose, only the part on top of the stand is required. This consists primarily of a cross made of hydraulic bronze. The gauge to be tested, which may register any pressure up to 16,000 pounds per square inch, and the master, are attached to the front and back ends of the cross respectively. At the left is a crank-operated screw displacement piston, by means of which the desired pressure may be produced within the pressure chamber. A suitable stuffing box prevents leakage past the piston. To the right end is connected a stop valve and filling cylinder. This permits some of the liquid to be withdrawn from the pressure chamber before removing the gauge being tested and filling after a gauge is put on. There is thus no danger of spilling the oil.

For testing the master gauge, the special weight-loaded hardened and ground steel piston and cylinder are attached at the right by means of flexible copper tubing, as shown. These parts are cut out by a stop valve when not testing the master. The cylinder is long enough to have the center of gravity of the weight below the center of support. When the weights are revolved the friction due to lifting the weights is practically eliminated. The apparatus is made by the Watson-Stillman Company, of New York.

## GAS-ELECTRIC MOTOR CARS.

The General Electric Company has sold to the Southern Railway Co. two of its latest type of gas-electric motor cars. These cars will be equipped with standard commutating pole railway motors of 100 h.p. Two of these motors are located on the forward truck, giving a motor capacity of 200 h.p. to each car. The current is supplied from a 600 volt generator, which is direct coupled to an 8-cylinder gas-engine in the forward compartment. A controller similar to that used on an ordinary trolley car is located convenient to the operator, and through this the current passes from the generator to the motors. Combined straight and automatic air brakes will be provided with the usual valves and accessories. The car bodies will be of steel, about 55 ft. long, with a seating capacity of 52 passengers. Both rear and center entrances are provided, thus furnishing a convenient means of dividing the two classes of passengers, as required in the South. The car bodies will be illuminated by electric light throughout. The order for these cars was placed with the General Electric Company after a thorough test of this type of car between Manassas and Strasburg last summer.

## M. M. & M. C. B. CONVENTIONS.

The executive committee of these associations has decided to hold the Master Mechanics' and Master Car Builders' conventions on the Million Dollar Pier, at Atlantic City, from June 15 to 22, 1910. The Master Car Builders' Convention will be first and will begin on Wednesday; the Master Mechanics' will open on the following Monday. The plan to bring both into one week did not carry. Headquarters will be at the Marlboro-Blenheim hotel. The permanent secretary of the Supply Men's Association is J. D. Conway, late chief clerk to the superintendent of motive power, Pittsburgh & Lake Erie Railroad. His headquarters will be in Chicago. The exhibits committee consists of B. E. D. Stafford, S. P. Bush and C. D. Storrs. The total space available for exhibits this year will be 69,000 square feet, an increase of 11,000 square feet over last year. The space charge will be forty cents per square foot.

Locomotives for the Pennsylvania Lines West.—The 1910 schedule for new locomotives of the Pennsylvania Lines West of Pittsburgh includes 30 Class K2 passenger engines, 13 Class B6 switching engines, to be built at the Juniata shops; 50 Class H8a freight engines to be built by the Baldwin Locomotive Works, and 5 Class H8a freight engines and 27 Class B29 switching engines to be built by the American Locomotive Company. This makes a total of 125 locomotives.

Insurance for Employees.—The B. F. Sturtevant Company, Hyde Park, Mass., has established at its works a branch of the Massachusetts Savings Bank insurance. The work is in charge of an instructor who goes among the men explaining the necessity and value of systematic saving. A large number of their employees have taken advantage of this proposition, arranging for insurance to amounts varying from $500 to $1,000.

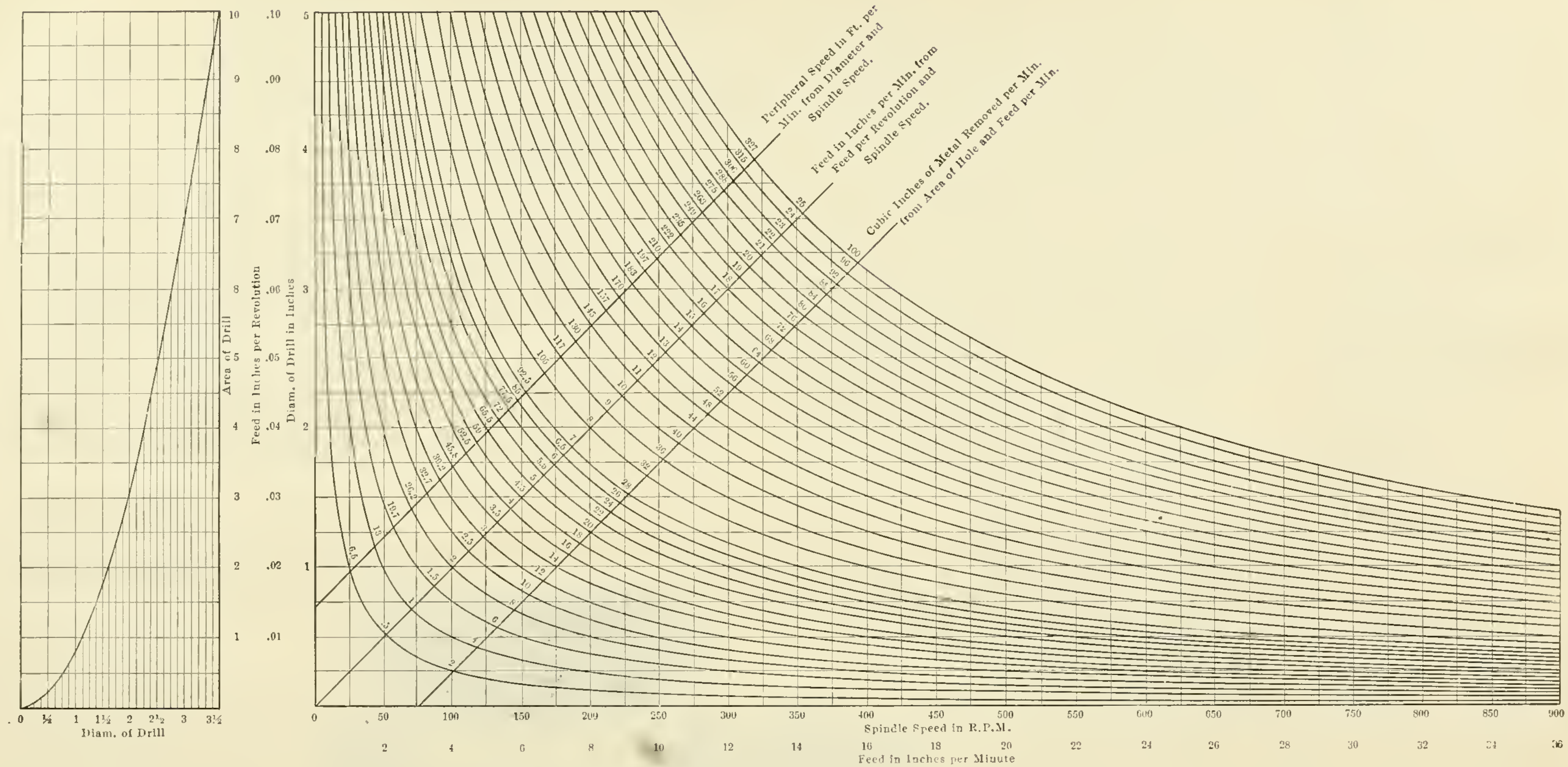



DIAGRAM FOR QUICKLY FINDING INFORMATION AS TO DRILL SPEEDS, CUTS, ETC.,

The above chart was presented at the recent convention of the Association of Car Lighting Engineers by J. Henry Klink, of the Westinghouse Electric & Mfg. Co.

1. To Find Cutting Speed.—From the intersection of the horizontal line corresponding to the diameter of the drill and the vertical line corresponding to the spindle speed, follow the nearest curve and use the value found in the oblique line of the figures marked cutting speed.

2. To Find Feed in Inches per Minute from Feed per Revolution and Spindle Speed.—From the intersection of the horizontal line corresponding to the feed in inches per revolution and the vertical line corresponding to the spindle speed, follow the nearest curve and use the value found in the oblique line of the figures marked feed in inches per minute.

3. To Find Area of Drill from Diameter of Drill, Use Curve on Left Side of Figure.—Find the intersection of the vertical line corresponding to the diameter of the drill with the curve. Follow the horizontal line passing through this intersection and obtain the area under the area of the drill in the vertical column.

4. To Find Cubic Inches of Metal Removed per Minute.—From the intersection of the horizontal line corresponding to the area of the drill and the vertical line corresponding to the feed per minute, follow the nearest curve and use the value found in the oblique line of the figures marked cubic inches of metal removed per minute.

Knowing Diameter of Drill, Spindle Speed and Feed per Revolution.—Find the cutting speed from 1. Find metal removed per minute from 2, 3 and 4.


THREE-SPINDLE HORIZONTAL DRILLING MACHINE.

## THREE-SPINDLE DRILLING MACHINE.

The three-spindle drilling machine shown in the illustration is specially adapted for drilling frogs and switches when assembled. The spindles are 1⅞ in. in diameter and are mounted in bushed bearings. The center one is mounted in a fixed bearing and the two outer ones in movable saddles which may be adjusted from a minimum distance of 3½ in. to a maximum distance of 9½ in. between centers.

The carriage upon which the spindles are mounted has three changes of feed and a hand fast and slow movement. The work table is 60 in. wide and 48 in. long. The machine is furnished complete with a pump, piping and attachments for lubrication. The spindles are driven through a bronze spiral gear and a steel pinion. The machine may be driven from a countershaft or by an individual motor. It is manufactured by the Newton Machine Tool Works, Inc., of Philadelphia, Pa.

## VANADIUM STEEL FOR FORGING DIES.

Our attention was recently directed to a plant that had been using carbon steel dies in very severe service for hot forging and drawing work. The dies were giving an average service of two days and breaking from crystallization and other defects in the steel. It was decided to try vanadium steel in the hope that the remarkable properties of vanadium in retarding or eliminating crystalization would give the dies a longer period of usefulness. The dies were used in the same manner, by the same man, on the same machine and for the same service as the carbon dies, and at the time of writing had been in use over four months.

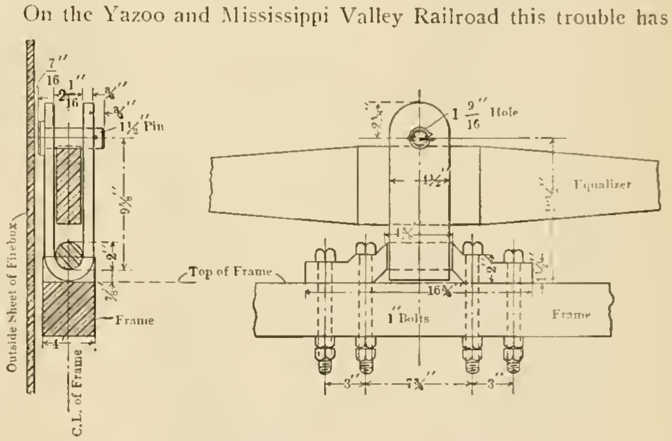
CO-OPERATIVE ENGINEERING COURSES.—You all know about the co-operative course for engineering established three years ago at the University of Cincinnati; boys who have passed through the high schools can enter this six-year course, working one week at the shop and one week at the university, earning, during the period of six years, about $1,800. About 200 of these boys are now employed in Cincinnati shops. While there are exceptions to the rule, as a class these boys have surprised their employers as to the character and quality of work they are able to do. In fact, the experience has been very satisfactory. Right in the beginning there was considerable skepticism on the part of manufacturers and a reluctance to accept these boys. The shops to-day are offering to take on more new men than the university facilities, at present, can take care of.—*Frederick A. Geier, before the National Machine Tool Builders' Association.*

## PIVOTED EQUALIZER STAND.

WALTER D. TICKELL.

It has been the experience on some roads, where the track is not maintained in the best of conditions, that the rigid equalizer stand on narrow firebox locomotives is occasionally broken, due to the gib bearing at the stand wearing unequally and getting out of line with the spring hanger bearing. Where this occurs the tendency is to cant the equalizer and the heavy shock from rough track will break off the stand.

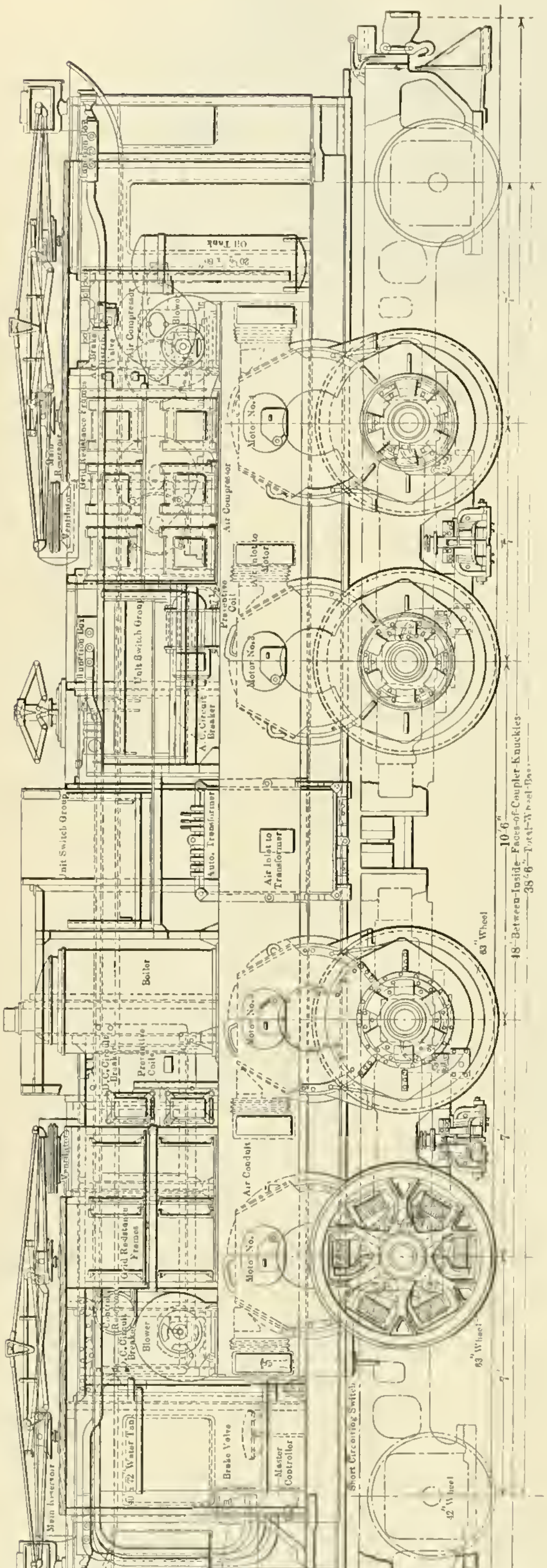
On the Yazoo and Mississippi Valley Railroad this trouble has




PIVOTED EQUALIZER STAND.

been overcome by a pivoted equalizer stand, which is shown in the accompanying illustration. The construction will be clear from the drawing, the parts being of forgings and requiring very little machine work. This type of stand can easily be arranged for an offset equalizer center and experience has shown that it makes a most satisfactory fulcrum bearing, which costs practically the same to make and apply as does the rigid stand.

FIRES ON PENNSYLVANIA RAILROAD PROPERTY.—1,397 fires occurred in 1908 on Pennsylvania Railroad property valued at more than $260,000,000. It was damaged only to the extent of $346,149. Of these fires, 274 were extinguished by the railroad's employees with the company's own apparatus with slight loss. The reduction of its fire loss to such a minimum means that the railroad has had to make it practically impossible for a conflagration to start in its yards and terminals. It has been working to this end for thirty odd years, and to-day its system of fire protection is said to represent the most extensive and comprehensive undertaking of its kind as yet made by any private corporation.



ELECTRIC GEARED FREIGHT LOCOMOTIVE, NEW YORK, NEW HAVEN & HARTFORD RAILROAD.

## ELECTRIC GEARED FREIGHT LOCOMOTIVE.

New York, New Haven & Hartford Railroad.

The Westinghouse Electric & Manufacturing Company has recently completed an electric freight locomotive of large capacity, for use on the electrified section of the New York, New Haven & Hartford Railroad, between Stamford and New York City. The locomotive was designed primarily for handling fast freight service, but will also be used for hauling heavy passenger trains. It will be given a thorough test in the freight service with a view to eventually handling all of this class of work electrically.

The mechanical parts were designed by the Baldwin Locomotive Works, and the mechanical department of the N. Y., N. H. & H. R.R., and were built at the Philadelphia works of the Baldwin Company. The design includes various features of special interest. The general plan of the trucks and running gear has been worked out in accordance with a patent granted to S. M. Vauclain, July 6, 1909. This patent describes an articulated locomotive in which the truck frames are connected by an intermediate draw-bar. One truck has only a rotative motion about its center-pin, while the other has a fore-and-aft as well as a rotative motion, in order to compensate for the angular positions of the trucks and draw-bar, when the locomotive is traversing curves. The tractive force is transmitted through the truck frames and draw-bar, instead of through the main frame.

In the present instance, the 2-4-4-2 wheel arrangement has been adopted. Each truck has two pairs of driving wheels, and a single pair of leading wheels. The driving wheels are held in alignment by cast-steel bar-frames, similar to those ordinarily used in steam locomotive practice. The frames are placed outside the wheels, and are braced transversely under the center of the locomotive by heavy steel castings provided with draw pockets in which the intermediate draw-bar is seated. This bar transmits the full tractive force developed by the motors of the leading truck from one truck frame to the other. Train connections are effected by means of two radial draw-bars, one of which is placed at each end of the locomotive. The draw-bars are pinned to cast-steel cross-ties, which brace the truck frames between the driving and leading wheels. The latter are mounted on radial-swing trucks of the "Rushton" type. The truck radius bars are pivoted to the same cross-ties as the main draw-bars. The wheel loads are equalized as in steam locomotive practice, the springs of the leading wheels being connected to the driving springs by equalizing beams. One of the trucks is cross-equalized under the center of the locomotive. The frame is spring supported by the cross-equalizer, on each side of the center line. This arrangement should promote steady riding, and tends to prevent side-rolling at high speed.

The cab is built of steel plate, and measures 43 ft. 6 in. in length, covering the entire locomotive. The frame that supports the cab is composed of two 12-in. channels, united at the ends by plates and angles. This frame is braced transversely by five cast-steel cross-ties—one over each truck center-pin, one at mid-length, and one near each end of the locomotive. The truck center-pins carry no weight and, as before explained, one of them is allowed a fore-and-aft as well as a rotative motion.

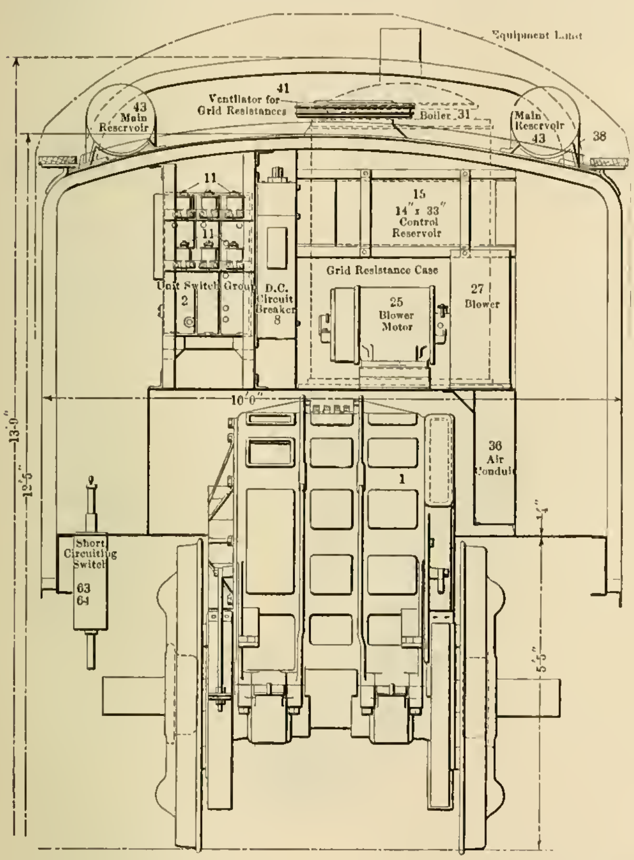
The cab is supported on the intermediate and end cross-ties, the weight being transferred through coiled springs, which are placed in suitable pockets. The cab frame is held in alignment by the truck-center pins, while the lower spring pockets are free to slide over the truck-frame cross-ties. The springs over the end cross-ties are placed 30 in. apart, transversely. The middle cross-tie carries four springs; these are placed at the corners of a rectangle and are 84 in. apart, transversely, and 53 in. longitudinally. As both the trucks are free to rotate about their center-pins, the displacement of the spring pockets, even on a 20-degree curve, is comparatively slight. To assist in reducing shocks and keeping the two truck frames in alignment, chafing castings and spring buffers are interposed between the frames, under the center of the locomotive. It is believed, from experience gained with previous locomotives, that the plan of running-gear and cab support adopted for this engine, will tend to avoid nosing, promote easy riding and minimize shocks on the truck and roadbed.

The principal dimensions of this locomotive are as follows:

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Driving wheels, outside diameter | 63 in. |
| Driving wheels, center diameter | 56 in. |
| Driving-axle journals | 8 in. x 13 in. |
| Truck wheels, diameter | 12 in. |
| Wheel-base, rigid | 7 ft. 0 in. |
| Wheel-base, total | 38 ft. 6 in. |
| Length between coupler faces | 48 ft. 0 in. |
| Height over all | 13 ft. 9 in. |
| Width | 10 ft. 0 in. |
| Approximate weight, total | 260,000 lbs. |
| Approximate weight on driving wheels | 188,000 lbs. |

A characteristic feature of the heavier details is the free use of cast steel. This is particularly true of the truck frame cross-ties, which are interesting examples of mechanical design. The tendency to follow approved steam locomotive practice is also evident in many of the mechanical details.

The electrical equipment, which was built and mounted by the




CROSS-SECTION, NEW HAVEN ELECTRIC LOCOMOTIVE.

Westinghouse Electric & Manufacturing Company, comprises four 350-horse-power single-phase geared motors, together with the necessary auxiliary apparatus for their operation from the 11,000-volt alternating-current or 600-volt direct-current circuits of the electrified sections which the locomotive will traverse. The motors are placed directly over the axles and are mounted solidly on the truck frames. Each end of the armature shaft is provided with a pinion; these mesh with gears mounted on a quill surrounding the axle and carried in bearings on the motor frame, similar to the usual axle bearings. The quills are provided with six driving arms on each end, which project into spaces provided between the spokes in the driving wheels. Each of these arms is connected to an end of a helical spring, the other ends of the spring being connected to the driving wheels.

This arrangement of drive smooths out the torque pulsations, and at the same time allows for vertical movement of the axles. In addition to the spring connection between the quills and drives, flexibility is provided between the pinions and motor shaft, to equalize the torque on the gears. The quills are of large diameter, permitting unrestricted motion of the wheels and axles. The center of gravity of the motors, as well as that of the entire locomotive, is high, avoiding the transmission of strains and shocks from the track and roadbed to the motors.

The motors, of the standard Westinghouse type, have twelve poles built into a solid frame, and are designed for forced ventilation. When operating on 25-cycle alternating-current with forced ventilation, each of the four motors will carry continuously a load of 300 horse-power. An air-blast transformer is provided for lowering the trolley line voltage to that required by the motors. The control apparatus is of the well-known Westinghouse electro-pneumatic type.

When operating on alternating current, all four motors are connected in multiple and the control is obtained entirely by changing the connections to various voltage taps on the main transformer. On direct current the motors are first grouped all in series, and then two in series and two in parallel, in combination with various resistance steps. Provision is made for cutting out any one of the four motors singly on either alternating current or direct current. A master controller and brake valve are located in each end of the cab so that the locomotive can be operated from either end, and the system of control is such that two or more locomotives of this type can be coupled together and operated from one master controller.

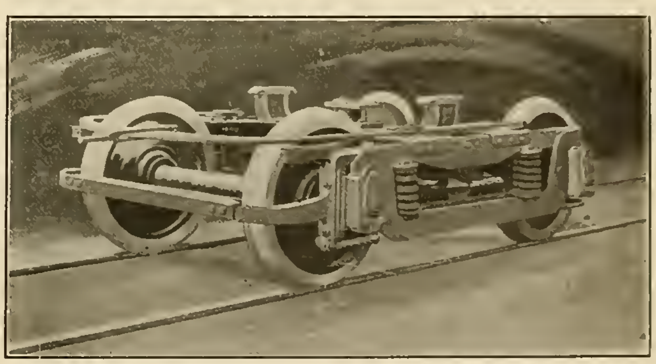
Two pneumatically-operated pantagraph trolleys are provided for collecting current from the 11,000-volt overhead alternating-current line. Pneumatically-operated third-rail shoes are used to collect current on the direct-current third-rail section. A steam heater outfit is provided on the locomotive for heating the cars of the trains, when used in passenger service. The drawings show the arrangement of control apparatus which is located in the center of the cab with a passage on each side. Twenty windows are provided, affording ample lighting of the cab interior.

The locomotive will be capable of hauling a freight train having a maximum weight of 1500 tons, at a speed of 35 miles per hour. When used in passenger service, 800-ton trains will be hauled at a maximum speed of 45 miles per hour.

## A NEW TRUCK FOR ELECTRIC CARS

A new truck in the design of which strength, simplicity, rigidity and a thorough consideration of the features of maintenance were the controlling influences is being built by the J. G. Brill Co., Philadelphia, and was shown for the first time at the recent convention at Denver. The accompanying illustrations show its general features and construction.

Each side frame is forged, including the pedestals, in a solid piece, a construction which eliminates built-up work. While the type of frame is similar to the frames which are used for

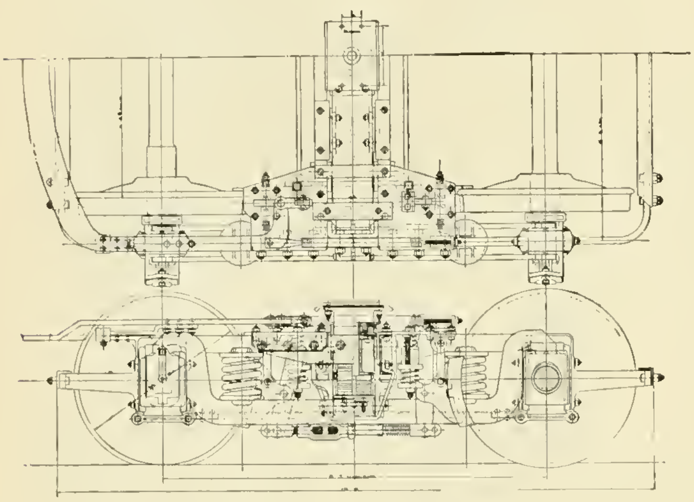


BRILL TRUCK FOR ELECTRIC CARS.

the distinctively Brill types of trucks there are certain essential differences, most notable of which is the reduction of the amount of metal in the truck frame, which makes the No. 27—M. C. B. truck, as it is designated, much lighter than most other high speed trucks of the same size. The reduction of metal and consequent reduction in weight occurs through the reduced dimensions of the pedestal yokes and end crossings which is made possible because of the forged construction and because the load upon the truck is brought to the journal boxes through the equalizing springs and equalizing bars, so that the truck frame beyond the point of support on the equalizing springs is not subject to heavy load or severe strains except those which occur when the truck enters a curve at high speed. In the design of the frame, the top of the yoke and the top of the frame have been placed in alignment and the extensions to which the angle iron end crossings are bolted are placed in line with the axle centers.

The transom construction is most substantial. The deep channels which are employed for this purpose are held in position by wrought single and double corner plate brackets and wrought gusset plates. The gusset plate construction in particular has been given special attention as the squareness of the truck depends to a large extent on the construction at this point. The plates are of ample dimensions for the most severe strains, and are folded over the side of the forged frame and bolted to the frame with bolts which also pass through the wrought plate brackets. This method of bolting the gusset places the minimum number of bolts in shear and secures unusual strength and rigidity.

One of the weak points of many M. C. B. trucks has been the tie bar construction, and the construction at this point in



TRUCK FOR ELECTRIC CARS.

this design, it is believed, is a marked advance. Channel tie bars connect the inner pedestals and short tie bars connect each pair of pedestals. The tie bars are bolted through the frame in such a manner that they form a rigid reinforcement to the pedestals and, by a simple device, absolutely remove the shearing strain from the bolts. The short tie bars can be readily removed and the wheels and axles dropped.

The bolster is cast steel, including the lugs for the side bearings, and rests on two elliptical springs which in turn bear on two part castings in such a manner that shims can be readily placed between the springs and the castings to compensate for wheel wear or settling of the springs. The chafing plates on the bolsters and transoms can be taken off and renewed without removing the bolster from the truck. Both of these features are designed to reduce maintenance charges. An additional feature of the bolster chafing plate is its ample vertical dimension which secures better support to the bolster against tilting and insures uniformity of wear.

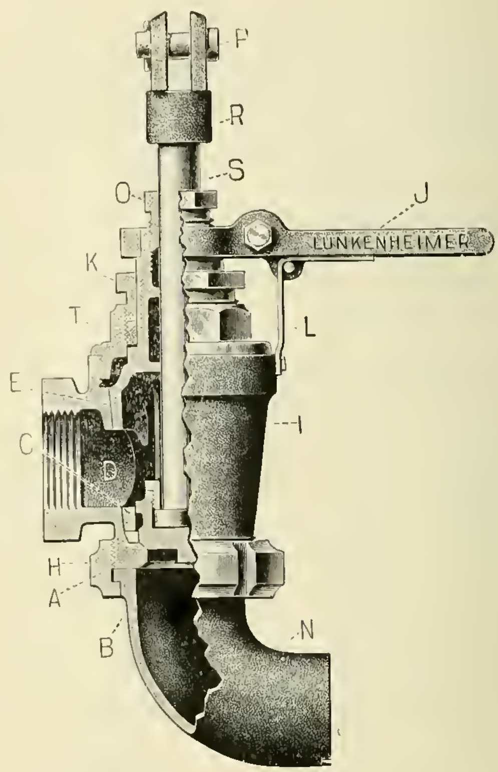
The construction of the end crossings is an interesting detail. The crossings, which serve as an extra safeguard in holding the truck square, are angle irons and are bolted to the extensions of the side frames. The side frame extensions are curved around for extra clearance and present a broad surface where they are bolted to the angle iron crossings, which secures increased strength at this point.

The manner in which this truck has been developed during the past three years, it is believed, has eliminated all experimental features.

## LOCOMOTIVE BLOW-OFF VALVE.

The detail construction of the Lunkenheimer improved locomotive blow-off valve is shown by the accompanying illustration. In its construction is involved the use of two distinct valves within a single body: one of these is for regular use, while the other is provided for emergency service, to be operated only in case of possible failure of the main valve. This emergency provision is the means of avoiding considerable annoyance and expense. The valve is operated by hand, and is so constructed as to eliminate all tendencies to fouling, sticking or leaking; it is positive in every action.

Connection to the boiler is made at D, while the outlet from the valve is through the malleable iron ell terminating at N. The main disc and seat are at the lower end of the stem S, the




LUNKENHEIMER LOCOMOTIVE BLOW-OFF VALVE.

operation of the former being effected by vertical movement of the stem S, through suitable levers attached to the fork P, and carried to a readily accessible point on the running board. By lifting the main valve as high as it will go, full and uncontracted area is provided for the blow-off passage from C to B. The emergency feature, for use in case of possible failure of the main valve, is provided in the key or taper plug valve E, made a ground fit in the body I and operated when required by rotation of the lever handle J. Ordinarily, this emergency key remains in the open position, as shown, giving free passage through from the inlet to the main valve. Should the latter leak or give trouble in any respect, preventing its tight closing, the key may be rotated to close the inlet opening. Then the main valve is raised to its extreme open position and all blowing-off operations are performed by manipulation of the emergency valve. The main valve should be restored promptly to working condition, so as to release the key plug for its intended function as an emergency feature.

Stuffing-boxes at O and K insure against leakage around the stem S of the main valve or the neck of the emergency key. The lever handle J is held firmly in either open or closed position by the spring L, which engages suitably placed notches in lugs on the body I. Immediately above the valve disc D is formed a flange, not only guided by ribs as the valve is raised and lowered, but also providing for positive cleaning of the seat A as the valve is closed. This flange fits loosely within the key, being a few thousandths of an inch smaller in diameter. When, therefore, the lower edge of this flange approaches and passes the edge of the key opening, there is caused a gradual wire-drawing of the escaping water, more and more of which bursts at once into steam, and, by its high velocity, becomes quite effective in washing away any sediment which may have collected on or near the seat. A serious cause of trouble is thus eliminated. If the sediment is not removed it prevents the proper seating of the disc and allows slight leakage, which rapidly increases as the resultant cutting action progresses. Serious injuries, also, are often caused by attempts to close tight a blow-off valve upon whose seat has lodged a piece of boiler scale or other hard substance, thus possibly ruining both the disc and the seat. Should a piece of boiler scale become lodged in the opening and prevent closure of the main valve, it may generally, by a partial turn of the emergency key, be so broken up as to pass out in fragments when the key is returned to the open position. Practical service has shown several points of peculiar advantage creditable entirely to the double character of this blow-off valve. It can also be reground readily should the seat become worn. As all parts of the valve are made to standard gauges and templets, any worn out or broken part can be quickly renewed.

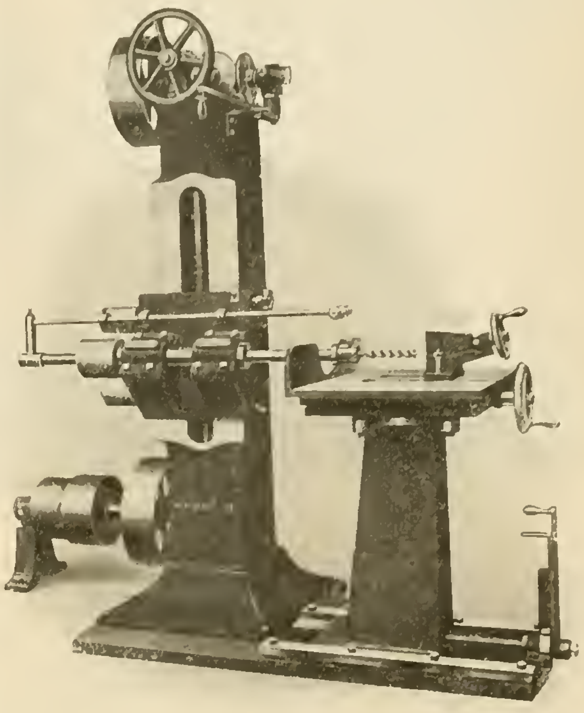
The passages at all points are fully equal to the connecting pipe. Thus the flow of water is entirely free and quite direct. Should the water in the boiler foam while on the road, the engineer or fireman can open the blow-off by reaching out on the running board to the operating lever. These valves are in use on a number of railroads and the Boston & Maine has adopted their use in connection with the cleaning out or flushing of ash pans. It is manufactured of a high grade of bronze composition, insuring strength and durability, by the Lunkenheimer Company, of Cincinnati, Ohio.

## SINGLE SPINDLE HORIZONTAL CAR BORING MACHINE

The single spindle universal horizontal car boring machine, shown in the illustration, is designed for boring heavy timbers and is specially valuable because of its adaptability to meet various requirements as to size, depth, position and angle of holes. The column is substantial and has planed dovetailed slides on its front, forming the support for the boring spindle carriage which is gibbed to the column slide.

The boring spindle rests in a secondary sleeved spindle which carries the driving pulley at its end, the sleeved spindle thus never coming in contact with the journal boxes, preventing irregularity of wear. The boring spindle carriage has vertical adjustment, being raised and lowered by means of a power feed screw operated by a friction drive controlled by a hand lever, or by the hand wheel; thus it is raised and lowered to any desired height either by hand or power feed. The driving belt remains uniformly taut in all positions. The boring spindle has a horizontal stroke or movement of 15 in., being brought forward by hand. The square column table stand which carries the turning and sliding straight, or angular boring table, is supported on the base plate of the machine and is adjustably attached to it by means of double dovetail slides, so that it can be placed at various distances from the main column. This adjustment is accomplished by a screw motion operated by a lever arrangement with ratchet and pawl.

The sliding and turning straight and angular table is supplied with a dovetail slide, a screw feed, and a radial dovetailed disk upon which the table turns for angular boring, thus enabling the operator to make a close adjustment of the material in relation to the boring spindle, and providing for end and angular boring. The table has an excellent and convenient adjusting guide fence and clamp for holding the material. A hand and power feed roller table, about 10 ft. long by 27 in. wide, can be furnished with this machine instead of the column table described. It will clamp 22 in. wide by 16 in. thick and carries six rollers, the central one being fluted and supplied with a hand wheel feed, the center and two end rolls being geared together by a chain and driven by either hand or power feed. The col-



HORIZONTAL UNIVERSAL CAR BORING MACHINE.

umn table is recommended for short material and angular boring only, while for long material and straight boring the roller table is more desirable.

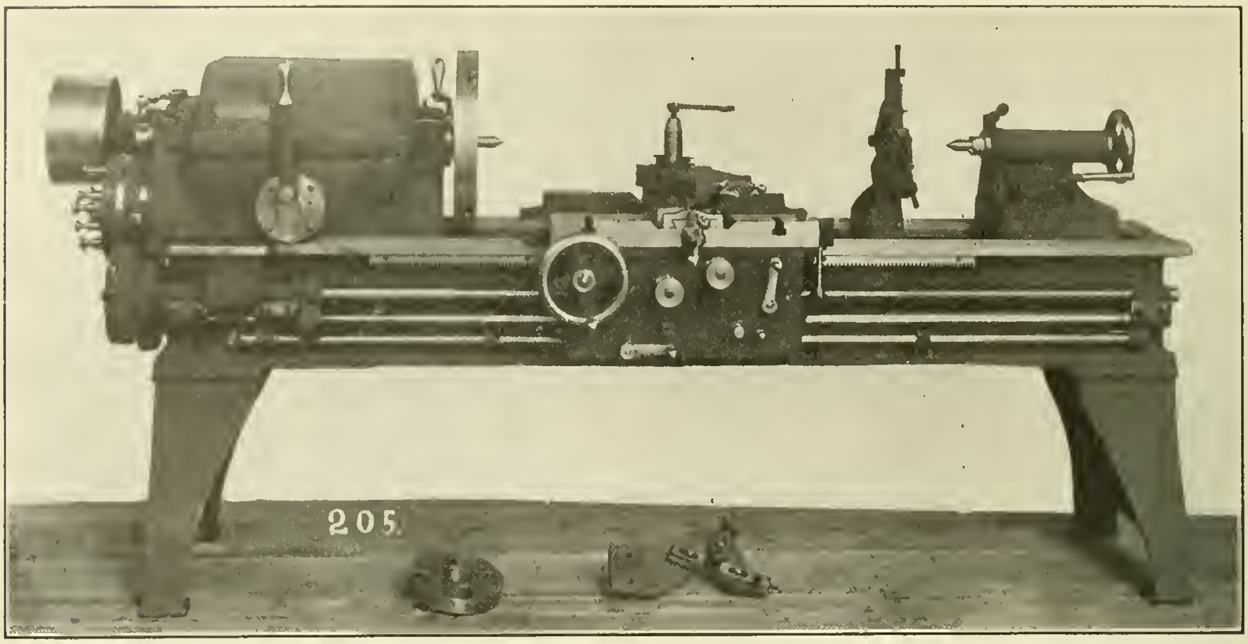
The machine, fitted with a roller table occupies a floor space of 7 by 10 ft., and with the column table 7 by 3 ft. It requires 5 h. p. for driving and weighs 2,100 lbs. with the column table and 3,600 with the roller table. It is manufactured by The Bentel & Margedant Company, Hamilton, Ohio.

## BOOK NOTES.

Methods of the Santa Fe—Efficiency in the Manufacture of Transportation. By Charles Buxton Going. 124 pages, 6½ x 9½ in. Published by *The Engineering Magazine*, 140 Nassau street, New York City. Price, $1.00.

About a year ago Mr. Going, editor of *The Engineering Magazine*, made a five weeks' trip over the Santa Fe in order to study the betterment work closely. As a matter of fact *The Engineering Magazine* is the only journal, other than the AMERICAN ENGINEER AND RAILROAD JOURNAL, that has seemed to grasp the importance of the work on the Santa Fe and to closely follow its development. Mr. Going's observations appeared in his magazine in five installments under the following titles: Peculiar problems of the road and their solution; the stores-keeping, shop order and works-order systems; manufacturing policies for the economical maintenance of motive power; administration, supervision and extension of the bonus system; the apprentice system and relations with employees. The demand for the numbers containing these articles has made it necessary to reprint them in book form.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The thirtieth annual meeting will be held in the Engineering Societies Building, 29 West Thirtieth-ninth street, New York, December 7 to 10.



ENGINE LATHE WITH AN ALL-GEARED HEAD.

## ALL-GEARED HEAD LATHE.

An 18-inch lathe with an all-geared head, manufactured by The Hamilton Machine Tool Company, Hamilton, Ohio, is shown in the illustration. Twelve spindle speeds are provided, using a single speed countershaft, any one of which may be obtained easily and quickly. The arrangement of the headstock is quite simple; the driving pulley is placed on the end of the back gear shaft, relieving the spindle of the strain due to the pull on the belt. The driving pulley is of good diameter and wide face and the driving mechanism is such that ample power may be transmitted at all spindle speeds.

A friction clutch, operated by the lever at the left of the headstock, makes it possible to stop the driving mechanism instantly, allowing the driving pulley to run idle. The gears are engaged by shifting those on the spindle to the right or left, as required, by means of the lever at the front of the head. No clutches are used between these gears, which engage by direct contact, and when throwing them in the friction clutch should be disengaged. This operation is practically instantaneous, consequently no time is lost in changing speeds, and the omission of additional clutches greatly simplifies the construction, making it less liable to get out of order and providing a more positive drive. A plate on the headstock shows the different speeds available and the correct position of the levers for each. The spindle is of crucible steel, of large diameter, and runs in hard phosphor bronze boxes. The gears required are ten in all, only four being employed at one time. They are of wide face and coarse pitch, accurately cut, and run smoothly and without excessive noise. The headstock is cast in two parts, the lower section forming a reservoir in which the speed changing gears are constantly immersed in oil. The upper part is securely bolted in position, forming a brace which effectually prevents vibration under heavy cuts; at the same time it can be quickly taken off, leaving the gearing entirely exposed.

A motor drive may be applied, if desired, the usual practice being to mount a constant speed motor over the headstock and connect it directly to the driving shaft. This all-geared head may be furnished on Hamilton lathes from 14 to 36 inch in size.

## PERSONALS.

T. W. Jackman has been appointed master mechanic of the Montana division of the Oregon Short Line, with office at Pocatello, Idaho, succeeding Henry Carrick, retired.

G. W. Lillie has been appointed superintendent of the new shops of the St. Louis and San Francisco Railroad at Springfield, Mo. The office of supervisor of car department has been abolished.

Samuel G. Thomson has been appointed assistant engineer of motive power of the Philadelphia & Reading Ry. and subsidiary lines, with office at Reading, Pa. The positions of mechanical engineer and electrical engineer have been abolished.

J. F. Enright, superintendent of machinery of the International & Great Northern Ry. at Palestine, Tex., has been appointed superintendent of motive power and car department of the Denver & Rio Grande R. R., with office at Denver, Colo.

W. L. Jones, general foreman car repairs, of the St. Louis-Louisville lines of the Southern Ry. at Princeton, Ind., has been appointed general foreman car department, of the St. Louis, Brownsville & Mexico Ry., with office at Kingsville, Tex.

Eli Emory Hendrick, president of the Hendrick Manufacturing Company, Carbondale, Pa., died on Monday, October 25th.

W. T. Dorman has been appointed road foreman of engines of the St. Louis & San Francisco R. R., with office at De Quincey, La.

W. C. Steers has been appointed assistant master mechanic of the Cincinnati, Hamilton & Dayton Ry. at Lima, Ohio, succeeding J. J. Kelker, resigned.

Thomas Mahar has been appointed master mechanic of the Harlem division of the New York Central & Hudson River R. R., succeeding H. B. Whipple, resigned, and also master mechanic of the Putnam division on account of duties transferred from the master mechanic of the Hudson division; his office is at White Plains, N. Y.

John G. Neuffer, formerly superintendent of machinery of the Illinois Central R. R., the Yazoo & Mississippi Valley R. R. and the Indianapolis Southern Ry. at Chicago, has been appointed superintendent of motive power of the Chicago Great Western R. R., with office at Chicago, succeeding W. E. Symons, assigned to special service.

J. N. Mowery, mechanical engineer of the Lehigh Valley R. R. at South Bethlehem, Pa., has been appointed an assistant master mechanic of the Auburn division, with office at Auburn, N. Y.

J. W. Small, superintendent of motive power of the Southern Pacific of Mexico and the Sonora Railway at Empalme, Sonora, Mex., having resigned, that office is now abolished and all reports previously made to the superintendent of motive power will hereafter be made to R. H. Ingram, assistant general manager at Empalme.

J. D. Conway, chief clerk to the superintendent of motive power of the Pittsburg & Lake Erie R. R. at Pittsburg, and secretary of the Pittsburg Railway Club, has been elected secretary of the Railway Supply Manufacturers' Association. He will have charge of the renting of space for exhibits at the convention in Atlantic City next year and will be located at the offices of the association in the Old Colony Building, Chicago.

J. A. Tuttle and J. F. Nally, formerly master mechanic and traveling engineer, respectively, of the Colorado division of the Union Pacific Railroad, have in accordance with the new organization on that railroad been appointed assistant superintendents. They are still charged with the responsibilities before devolving upon them, and in addition will assume such other duties as may be assigned to them from time to time. All communications intended for them in their official capacity will be addressed simply to the assistant superintendent, Denver, Colo.

John Caldwell, treasurer of the Westinghouse Air Brake Company, was stricken with heart disease and died in his office Tuesday morning, November 23, before a physician could reach him. Mr. Caldwell was one of the trusted lieutenants of George Westinghouse, with whom he had been associated since the inception of the Westinghouse Air Brake Company. He was born in Ireland about seventy years ago, his father being a Presbyterian minister. He came to Pittsburgh when twelve years of age and followed mercantile lines until 1869, when the air brake company was organized, he then taking a position as bookkeeper, which place he retained for ten years. He was director and vice-president of the Bank of Pittsburgh and a trustee of the Carnegie Institute since its foundation. Mr. Caldwell was a Scottish Rite Mason and a member of the Royal Legion. He enlisted as a private in the 61st Pennsylvania Volunteers during the Civil War and was mustered out as a second lieutenant. He had a world-wide reputation as an art connoisseur and a collector of rare books, his collection being claimed as one of the most valuable in existence. In addition to a widow he leaves a son, daughter and sister.

Peter H. Peck, for twenty-one years master mechanic of the Chicago & Western Indiana and Belt Railroad of Chicago, who was granted a leave of absence from that position in August, 1908, has resigned his office and has been appointed secretary and treasurer of the Belt Line Coal Company, with office at Chicago. Mr. Peck was born November 28, 1844, at Cerro Gordo, Ill., and was in the Union army from 1862 to 1865, taking part in fourteen battles in the Tennessee and Atlanta campaigns. He began railway work in July, 1865, as locomotive fireman on the Des Moines Valley Railway and later was engineman on the Keokuk & Des Moines, both of which roads are now a part of the Chicago, Rock Island & Pacific. In January, 1876, he went to the St. Louis, Keokuk & Northwestern, now a part of the Chicago, Burlington & Quincy, and in 1878 to the Hannibal & St. Joseph, now also a part of the Burlington. In November, 1882, he was made division master mechanic of the latter road, in which position he remained for five years, becoming master mechanic of the Chicago & Western Indiana and Belt railways in May, 1887. He was president of the Western Railway Club in 1903, was president of the American Railway Master Mechanics' Association in 1905, and of the Car Foremen's Association in 1908.

R. C. Burns has been appointed general air-brake and steam-heat inspector of the Pennsylvania R. R., attached to the office of general superintendent of motive power at Altoona, Pa. He will confer with superintendents of motive power, master mechanics, general foremen and others on questions relating to his duties. His territory includes the Philadelphia, Baltimore & Washington R. R., Northern Central Ry. and West Jersey & Seashore R. R.

Dr. Ernst J. Berg, of Schenectady, has been appointed professor of electrical engineering, in charge of the department at the University of Illinois. Dr. Berg was born in Sweden in 1871. He graduated from the Royal Polytechnical Institute at Stockholm in mechanical engineering in 1892, and came to the United States in 1893. For the past seventeen years he has been associated with the General Electric Company, lately as expert advisor. It is announced that Professor Morgan Brooks, who is now absent on leave for foreign study, and is succeeded by Dr. Berg, will return to the University upon the expiration of his leave, as a professor in the same department.

## CATALOGS.

PLEASE MENTION THIS PAPER WHEN WRITING FOR THESE CATALOGS.

Belting.—The Peerless Belting Co., Buffalo, N. Y., is issuing a leaflet giving price lists and tables showing the amount of power transmitted by belts of different widths, and other handy rules in connection with belting.

Nippers and Pliers.—The Utica Drop Forge & Tool Co., Utica, N. Y., is issuing a pamphlet, printed in two colors, showing pliers and nippers in practically all styles and sizes. Each different style is very well shown by the illustration and is accompanied by prices. The catalog is titled "Plier Palmistry."

Gas Engine Air Compressors.—A self-contained unit comprising a gas engine and air compressor, both of which can be of any pracical size, is illustrated in a catalog being issued by the Flickinger Iron Works, Bradford, Pa. The details of the machinery are fully described. Other direct-connected sets consist of a gas engine connected to a pump.

"Cello" Steel is more dense than ordinary tool steel, and is made specially for dies, taps, reamers and any special tools where better results than can be obtained with the use of the ordinary tool steel are desired. It does not require any special treatment for hardening. The McInnes Steel Co., Ltd., Corry, Pa., is issuing a leaflet briefly stating what this steel is good for and how it should be treated.

Hoisting Machines.—Chain hoists, trolleys, traveling cranes, etc., are the subject of a catalogue being issued by J. C. Speidel, of Reading, Pa. This catalog contains illustrations and descriptive matter of a number of designs particularly suited for railroad shop uses. It shows trolley hoists for capacities up to 40,000 lbs., and includes turn-tables, switches and similar arrangements for this type of hoist. Hand and power cranes, elevators, etc., are considered.

Vises.—A booklet giving illustrations and tables of dimensions, weights and prices of a very complete line of vises for either wood or metal work, is being issued by the G. M. Yost Mfg. Co., of Meadville, Pa. This booklet also includes a brief description of the "Uwanta" wrench, which is claimed to be unequaled in its utility to stand punishment. Also a very handy adjustable holder for incandescent electric lights and an emergency clamp for repairing leaks in iron piping.

A New Wrench.—Rogers, Printz & Co., Warren, Pa., have designed a new type of adjustable wrench, which is also made as a pipe wrench, that embodies the wedge principle altogether for locking. It is quickly and easily adjustable to any size bolt or pipe within its range, and the greater the stress put upon it the more securely it is held in place. It contains but three parts and can be released or adjusted by the thumb, being easily operative with one hand.

Valves.—The Bashlin Co., Warren, Pa., is issuing a booklet illustrating globe valves designed with renewable discs and seat rings, the latter being arranged to be changeable when the valve is under pressure. For completely renewing the wearable parts of the valve it is not necessary to remove the valve body from the piping. The same system is used in check valves, blow-off valves and faucets. The booklet fully illustrates and describes the features of these valves and includes tables of prices.

Blow-off Valve.—The Lunkenheimer Company, Cincinnati, Ohio, is issuing an attractive pamphlet describing and illustrating in detail an improved form of locomotive blow-off valve.

Boiler Tube Expanders.—Self-feeding and self-releasing boiler tube expanders, operated by power or hand, with which it is impossible to overroll and ruin a tube, are the subject of a leaflet being issued by W. H. Nicholson & Co., Wilkesbarre, Pa. The same firm are also sending out a leaflet on expanding lathe mandrels.

Hydraulic Wheel Presses.—Simplicity in construction and convenience in operation are the special features on which the design of hydraulic wheel presses of all sizes manufactured by E. R. Caldwell & Co., Bradford, Pa., are based. A noticeable feature of this design is the location of the parallel bars, which are placed at a slight angle to permit the handling of the work with an overhead crane. Safety valves are provided to prevent overloading on all presses of 200 tons or more. A small catalog illustrating and describing this design, and including a table of full dimensions and weights, is being issued by this company, whose address is 34 Hilton street.

Blow-off Valve.—A new blow-off valve for locomotive and stationary boilers, which has a number of specially good features, is being manufactured by the Monarch Machine Works, Altoona, Pa. This valve has a seat which is fully protected when it is open. It operates with a quarter turn either way, has a very free discharge, and is provided with a renewable seat and disc. It is practically self-grinding in service and does not have to be removed from the boiler for repairs. One of these valves has been in constant service for over three years on a stationary boiler without costing anything for repairs and appears to be capable of giving a number of years further service without trouble. This valve is called the "Riggin" blow-off valve.

Water Treatment.—A handsome souvenir booklet on water treatment has been received from the Dearborn Drug & Chemical Works, Postal Telegraph Building, Chicago, Ill. The preface directs attention to the fact that the average thickness of locomotive boiler scale is 1/16 in., which means a loss of at least thirteen per cent. in fuel efficiency; for the fifty-one thousand locomotives in this country this would mean an annual loss of fifteen million tons of coal. The booklet describes in detail the laboratories and the facilities which the company has for studying water treatment and includes three sections describing the methods used for locomotive, stationary and marine boiler water treatment. Several pages are devoted to a description of the lubricating department.

Graphite Lubricant.—A leaflet being issued by the International Acheson Graphite Co., of Niagara Falls, N. Y., draws attention to the value of pure graphite as a lubricant, it being, in this case, blended with a high grade grease which acts simply as a carrier. The process for making unctuous graphite was discovered in 1906, with the result that a graphite can be obtained which is an absolutely perfect lubricant and contains no grit or impurities of any kind. It is made in an electric furnace of over 7,000 degs. F., and is not affected by heat or cold; cannot be decomposed and is not affected by acids and alkalies. A chart is included giving the results of tests with oil and graphite as a lubricant. This is in the form of a curve showing the coefficient of friction. The same company is also issuing a reprint of an address delivered before the American Academy of Arts and Science of Boston on the occasion of the presentation of the Rumford medal to Edward G. Acheson, president of this company, for his electric furnace products. This paper is titled, "Seventeen Years of Experimental Research and Development," and explains how carborundum was discovered, and also how the unctuous graphite used in the lubricants is produced. This paper reviews some of the most interesting and important phases of scientific development during the past decade.

Pipes and Fittings.—One of the finest catalogs that it has ever been our pleasure to examine is being issued by the National Tube Company, Frick Building, Pittsburgh, Pa. It is called catalog H and relates to the product manufactured at the Kewanee works of this company, embracing wrought pipe for steam, gas, water and air; cast, malleable iron and brass fittings, brass and iron body valves and cocks, radiators and coils, etc. The index, which opens the book, covers 28 pages, and is as complete as it is possible to make it. All articles are fully cross-indexed and it will be practically impossible not to find anything shown in the catalog no matter by what name it might be known, or under what head it might be sought. Each product is illustrated by a half-tone from beautifully retouched photographs, and tables, giving full dimensions and prices of each size manufactured, are included in each case. A particularly attractive section of the book is that showing the Kewanee unions and specialties, which is printed in three colors. When it is stated that the catalog occupies 470 pages, it will be understood that it is a full exposition on the subject with which it deals. The type matter is printed in a pleasing shade of green, which is much easier on the eyes than black. The illustrations, however, are printed in black ink. The catalog is most beautifully bound in flexible covers, and has gold edges.

Fuel Tests With Illinois Coal, issued as Circular No. 3 of the Engineering Experiment Station of the University of Illinois, presents the results of an elaborate series of tests conducted at the fuel testing plant of the United States Geological Survey. The circular is compiled by L. P. Breckenridge and Paul Diserens. It deals only with coals taken from mines within the State of Illinois. The investigations described include steaming tests under boilers, gas producer tests, washing tests, coking tests, briquetting tests, and tests to determine composition and heating value. From the results stated it appears (1) that the average calorific value of Illinois coal (ash and moisture free) is 14319 b.t.u.; (2) that its evaporative efficiency is but slightly affected by the moisture it contains; (3) that its evaporative efficiency decreases as the ash and sulphur content increases, and that when burned in a hand-fired furnace its evaporative efficiency decreases as the amount of fine coal contained in it increases; (4) the performance of Illinois coal in a gas producer compares favorably with that of any other bituminous coal tested at the U. S. G. S. laboratory; (5) one-fourth of all the samples tested may be used for the manufacture of coke; (6) briquetting improves the evaporative efficiency of Illinois coals only when the raw coal is in the form of slack or screenings. Copies of the circular may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

## NOTES

The Buda Company.—The Buda Foundry & Manufacturing Company will hereafter be known as The Buda Company. There will be no change in the organization.

T. H. Symington Company. It is announced that this company has purchased the Farlow draft gear, which device will be included among the specialties now manufactured by them.

Pressed Steel Car Company.—The offices of the Pressed Steel Car Company and the Western Steel Car & Foundry Company for the southern district will be removed from Atlanta, Ga., to the Munsey Building, Washington, D. C., on December 1st, 1909. L. O. Cameron, manager of sales, will be in charge.

The American Specialty Company of Chicago has recently been appointed sole export agent for the line of portable electric drilling machines manufactured by the Van Dorn Electric & Mfg. Co., of Cleveland, Ohio. They also have the agency for these tools in the Chicago and central western districts.

Motors for the Long Island Railroad.—The West Pittsburgh shops of the Westinghouse Elec. & Mfg. Co. are beginning to work on an order of railway motors for the Long Island Railroad, which represents almost $1,000,000, and calls for 260 motors of 200 h. p., which are to be used for equipping a number of the cars on the Long Island R. R. System.

Commonwealth Steel Company.—R. L. McIntosh, assistant mechanical engineer of the Missouri Pacific Railway, has resigned to enter the employ of the Commonwealth Steel Company at their Granite City shops. Mr. McIntosh was born in Milwaukee in 1879, graduated from The College of the City of New York in 1901, and served as special apprentice in the Susquehanna shops of the Erie Railway; then as a mechanic in the West Milwaukee shops of the C. M. & St. P. Ry.; from 1901 to 1905 he was employed by the Northern Pacific as material inspector, engineer of tests, mechanical office assistant and shop assistant. He was made assistant mechanical engineer of the Missouri Pacific in 1906.

The Scherzer Rolling Lift Bridge Company.—This company, with general offices in the Monadnock Block, Chicago, Ill., announces the receipt of several important orders for Scherzer rolling lift bridges, including one from the Baltimore & Ohio Railroad for the longest double track single leaf bascule bridge yet constructed. The Seaboard Air Line has recently installed a single track bridge of this type having a movable span of 196 ft., and another one is being constructed across the Savannah River; the San Pedro, Los Angeles & Salt Lake Railroad has just completed the longest single track bridge of this type on the Pacific coast. In addition to these, a bridge at Galveston, and several smaller ones, the company has recieved a number of foreign orders.

Westinghouse Electric & Mfg. Co.—S. L. Nicholson has been appointed general sales manager and has direct charge over the sales policies of the entire company. He has been with the company for eleven years in many different capacities, as salesman, as district department manager, and as industrial and power sales manager. He was the organizer and is the president of the American Association of Motor Manufacturers, an organization which has done much in the two short years of its life to improve the art of manufacturing motors.

Charles Robbins, who has for many years been connected with the industrial and power sales department in connection with the sale of industrial motors, has been appointed manager of this department.

G. Brewer Griffin has been appointed manager and is actively directing the sales policy of the detail and supply sales department, in which department transformers, meters, fans, heating appliances, switches, switchboards, railway line material, etc., are sold. He has been assistant manager of this department for six years past.