

pipe leading to the tender, through which to relieve the boiler pressure when required, and store the heat in the tank feed water at times when this would be desirable and of practical advantage at the roundhouse.

OTHER SPECIAL FEATURES OF THE CONSTRUCTION.

The location of an independent and removable coal tank, with a maximum capacity for 10 tons of bituminous coal which will be more than an ample supply for this locomotive, to be arranged over the rear of the boiler at a point where the additional weight will be of advantage to provide more adhesive power, instead of as a dead weight to be hauled. This arrangement will at the same time provide, by gravity, a fairly automatic conveyance of the fuel into the automatic stoker hoppers at the rear of the boiler. This coal tank to be so applied in connection with the boiler that it can be lifted and readily removed when necessary to make renewals of stay-bolts or repairs to other parts of the boiler which may be located under the tank. Its construction, however, will admit of access to most of the flat sheet stays for test, inspection, and renewal purposes, and to the wash-out plug openings, when the coal space is loaded, and without its removal. Its position is such that the coal supply can be taken from the same facilities which are now provided for the coaling of modern power, and the top of the coal space plates being at the top of the overhead clearance limit, overloading and the consequent loss of fuel by its falling on the right-of-way cannot be practised, while the connection of the coal space with the hoppers to the stokers will also eliminate the usual loss of fuel from the tender gangways. The coal space to be arranged with a roller metallic covering, placed to cover the coal from the weather during severe conditions and from which there might result some retarding action to the fuel reaching the stoker hoppers by gravity, or with what assistance the fireman can give by pulling down from the rear, on account of it becoming wet or frozen.

The constant removal of the fuel from the lowest portion of the storage will also prevent liability for an accumulation of slacked coal in the tank, with the resulting corrosion of the plates, and for the decomposition of the fuel itself.

A compensating equalizing spring gear in connection with an under hung driver spring gear will be arranged over the three pairs of rear driver wheels, to maintain the framing in a normal position over the driver axles and to provide for the proper distribution of the additional and fluctuating weight over these parts, which will occur on account of the coal storage being located on the boiler. The under hung spring gear will of itself be able to carry the weight when the coal space is under a light load, but when filled with from 5 to 10 tons of fuel the compensating gear will come into play to take its proportion of the load and to maintain the proper adjustment, alignment and riding qualities.

The front cab for the engineer and the fireman, and its contained operating mechanism, will be located over the front of the boiler proper and the combustion chamber surrounding the dome. The front of the cab will be constructed to give an unobstructed view for the engineer, straight ahead, on either side of the track, and at curves, and to present the least atmospheric resistance.

The location of the dome at the front of the boiler, and in, and just forward of the rear of the cab, will admit of a very short travel of the steam from the boiler to the high pressure cylinder, making the control of the engines more positive and sensitive to the engineer's handling, by the reduced dry and steam pipe volume, and it will also reduce the loss in the boiler pressure through fric-

tion and make a higher initial pressure in the high pressure steam chest for the commencing of the work in that cylinder. This location of the dome will dispense with the necessity for another dry pipe connection to the boiler for the usual steam throttle box connections, such as for the operation of the stoker pistons, water pumps, blower turbines, lubricator, steam rail cleaner, steam gauge (except the fireman's at the rear of the boiler), steam heat and air pump equipment, all of which can be applied direct to the barrel sheet of the dome, which will locate them in a convenient position for the engineer, and give a full supply of dry steam. The usual pop and steam whistle stand and its additional hole in the boiler will be dispensed with by locating the three pop valves in the dome cap, and the steam whistle in and at the rear of the dome and the cab. This will simplify the rigging for operating the steam whistle, and by its better location the train crews will be able to hear the blasts more distinctly at the rear of a long train.

These connections and the cab location will eliminate any possibility of the obstruction of the engineer's view by steam trailing back from the parts referred to, or from defective piston and valve rod or other packing, which are located ahead of the cabs now, and cause considerable annoyance during severe weather. The main throttle valve rod will be connected through the front of the dome barrel, and the connection of the throttle valve and reversing gear will be such as to give the same response, in the movement of the locomotive, as with the present movement of these levers. It will be noted that with this arrangement, all parts concerned for the operation are more concentrated and convenient to the engineer, and with a much lesser arrangement of pipe fittings and holes in the boiler proper.

It has been learned through practical tests that have been made with air brake pumps in good order, that in the handling of the average freight train of to-day, six and seven-tenths per cent. of the total fuel consumed in the locomotive is used to generate the steam to operate the air pump. This is a very large percentage of power to be absorbed for this purpose, but which will continue so long as the present style of air pumps, which are apparently constructed with no consideration whatever being given to the economical use of steam, are used, and in connection with leaky train pipes. The only means whereby this waste can be reduced is through a higher initial pressure and by the superheating of the steam used to operate the pumps. With this in view, a superheater chamber has been arranged, cast in connection with the cast iron front ring to the combustion chamber. The steam pipe leaving the throttle valve at the dome passes straight ahead over the top of the boiler, to its connection to the smoke-box front. It there enters the superheater chamber, where, the pressure remaining constant, the volume must increase, and this increased and superheated volume will eliminate cylinder condensation, and effect a saving of from 10 to 15% in the use of heat, and a greater percentage in steam. All independent connections being made ahead of the combustion chamber, the liability of failure is reduced to the minimum.

To further increase the efficiency of the air pump, a differential of $2\frac{1}{2}$ inches has been made in the diameters of the steam and air cylinders, the latter being the larger. As the surplus of the normal steam pressure over and above the maximum main reservoir air pressure required is 160 lbs., or more than 170%, the extremely poor design in maintaining the present ratios is apparent, when economical operation is considered.

An acetylene gas or oil headlamp with an illuminated number bonnet to be located in the centre of the combustion chamber front

door, to replace the present arrangement of number plate, usually located at that point. The number as shown from the headlamp will answer for all the requirements of the train rules, both by day and night, and the headlamp so located will give a better illumination of the track and ahead, and be sufficiently high not to affect the line of vision of persons working at the head end of the locomotive, making couplings.

The cylinder exhaust steam pipe to the tender will be equipped with a six inch diameter air relief valve located just at the rear of the low pressure cylinder. This relief valve will automatically open, when the locomotive is drifting, and prevent suction into the cylinder of the steam from the minor exhausts; also act as a drain for any water of condensation.

The combustion chamber will be equipped with suitable cast iron flame baffles which will deflect the heated gases coming from the furnace, direct them to their outlet through the boiler tubes, and protect the steam pipe joints and the chamber proper sheets and connections from overheating. These baffles will be arranged so as not to obstruct the access to the boiler tubes for inspection, repairs or cleaning, and so they can be readily removed and replaced when necessary.

Located in the combustion chamber, where there will be the intense temperature that is required for steam superheating purposes, are the receiver pipes, or containers for the high pressure cylinder exhaust and the subsequent low pressure cylinder initial steam. These pipes will be of a simple and durable construction of cast iron, secured to allow for free contraction and expansion, and located to provide a fairly satisfactory surface that will absorb from the circulating gases the superheat for the contained steam.

The arrangement will also be such as not to obstruct the entrance to the combustion chamber for washing out, cleaning and repairs.

The capacity of these receivers will be about 35,500 cubic inches, or, approximately, $1\frac{1}{4}$ and $3\frac{1}{2}$ times the volume of the low and high pressure cylinders, respectively.

This, it will be noted, is a high ratio as compared with the usual practice of $2\frac{1}{2}$ and less of receiver per high pressure cylinder volume, and will, in addition to the provision for superheating, result in the advantages explained under the subject of cross-compounding.

Cast or malleable iron direct pressure and receiver steam pipes will be used for reason of their greater durability and reduced cost as compared with copper.

THE SPECIAL FEATURES IN THE OPERATION.

An engineer and fireman competent to handle any cross-compound type of locomotive now in service will have no difficulty in obtaining efficient and economical results from the proposed locomotive.

The only special features which require attention in operating are the stokers, blower, hot feed pump and the draining of the steam condenser space in the water tank.

The mechanical automatic feeding of the fuel to the furnace and the mechanical forced draft can be adjusted to suit the requirements of the tonnage, speed, weather conditions, gradient, quality of fuel, condition of the boiler and machinery and the train despatching.

The stokers and the draft, while being controlled automatically, can, without disturbing the adjustment of the automatic devices, be operated by hand when such may be required to overcome the conditions existing for the time being, and when it would not be advisable to disturb the automatic adjustments.

The accumulation of condensed water in the tank condenser chamber can be drained and pumped into the boiler at the required