

THE Railway and Marine World

With which are incorporated The Western World and
The Railway and Shipping World, Established 1890

Devoted to Steam and Electric Railway, Marine, Grain Elevator, Express, Telegraph,
Telephone and Contractors' interests

Old Series, No. 232.
New Series, No. 150.

TORONTO, CANADA, AUGUST, 1910.

For Subscription Rates,
See page 655.

Improvements in Locomotive Boilers.

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A. Boilers with smoke tubes; precautions in constructing and maintaining tubes and tube plates.

THE TYPE OF BOILER generally used in Canada is that with a round top fire-box of what is termed the extended wagon top style, in which the diameter of the circular portion of the fire box and the rear portion of the barrel is larger than that of the front portion of the boiler. Usually the course of the boiler next the fire-box and the front course of the boiler are both cylindrical in form, joined together by a middle taper course. The dome is usually placed on the course next the fire box.

Representative examples of this type of boiler are illustrated in fig. 1, showing a boiler used on the Lake Shore and Michigan Southern Ry., and fig. 2, showing a boiler used on the Union Pacific Rd. They may be regarded as good examples of recent boiler designs in Canada and the U.S. A few of the largest administrations, such as the Pennsylvania Lines including allied roads, and the Great Northern, are using the Belpaire fire-box, while others, such as the Illinois Central and Canadian Pacific Railways, have used the Belpaire more or less extensively, but in each case the latest engines have been equipped with round top boilers.

Examples of recent design in Belpaire boilers are shown in fig. 3, illustrating a boiler used on the Pennsylvania Rd., and fig. 4 showing one used on the C.P.R. These drawings also show a boiler barrel of the tapered form illustrated in the two examples of round top fire-box boilers. This form of barrel is not, however, in universal use, as several roads are using barrels of the parallel or straight top type, the courses usually being rolled cylindrically, and varying in diameter by the thickness of the plates alone. The type of barrel used is largely determined by the conditions governing the permissible weight of the boiler, but, with the same limitations as to the water space around the sides of the fire-box, the number of flues that may be placed in a boiler is limited by the diameter of the boiler at the fire-box end, and it is possible for the diameter of the boiler at the front end to be somewhat smaller without affecting this number. A lighter boiler with the same amount of heating surface can thus be obtained than is possible where a parallel form of barrel is used.

On roads on which the weight of the engine is limited by the weight per

axle, the additional weight entailed at the front end of the engine by the use of a straight or parallel barrel, makes but little difference, but, where the weight of the engine is limited by the strength of the bridges over which it has to run, which is usually the case, the tapered boiler barrel has enabled the weight of a boiler with a given heating surface to be somewhat reduced, and it is consequently in general use. This question has also been affected by the tendency to increase the distance between the flues, and the amount of water space between the inner and out-



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er fire box sheets at the sides. The latter, especially, has been an important factor in the more extended use of the tapered barrel, as with a small water space the saving in weight obtained by reducing the diameter of the barrel at the front end would not be as great as is the case with the wider spacing in recent use.

The extensive use of the round top fire-box is explained by the results obtained from it being on the whole, satisfactory. The Belpaire form of box has no doubt an advantage in the fact that the stresses in the various plates and stays can be accurately determined by calculation, whereas in the round top

boiler, especially one of the radial stayed type, these stresses cannot be determined with the same degree of accuracy. The service, however, of many thousands of round top boilers has fully demonstrated the safety of this type when properly constructed and maintained, and has proved the correctness of the calculations by which their strength is determined. The Belpaire fire-box is somewhat more expensive to construct than the round top, and adds a certain amount to the weight of the boiler without a corresponding increase in the heating surface; hence the largely preponderating use of the simpler round top type. Although the round top type has proven entirely safe and somewhat cheaper to construct than the Belpaire, it is open to question whether its extensive adoption is justified from the standpoint of cost of maintenance.

The Belpaire fire-box has given a certain amount of trouble not found in the other type by the cracking of the throat sheet in the O. G. shaped portion between the upper corners of the fire-box and the boiler barrel. The cause of this is not entirely plain, but it is possibly due to the connection between the fire-box and the barrel of the boiler, in the ordinary type of Belpaire, being rigid only at the points where the straight or curved sides and top of the fire-box joint directly to the barrel. This weakness has been remedied in the design shown in fig. 3, in which it will be noticed that the sides of the fire-box are curved to conform to the shape of the barrel for a considerable distance, and fig. 4, in which the same arrangement has been extended to both top and sides, so that the connection at this point has been considerably strengthened, and, experience shows that this difficulty has been to a large extent overcome.

With this exception the maintenance of Belpaire fire-boxes has been less than that on round top types, on account of the more equal distribution of the stresses. In the round top radial stayed type the staybolts at the upper corners of the inside firebox are required to transmit a considerable strain in a horizontal direction through the crown sheet, in order to prevent the outer fire-box sheet from moving outward on account of the pressure in the boiler, and in fact there is little doubt that a certain amount of movement outwards occurs. This has led to a considerable breakage of staybolts along the upper rows of the fire-box, and consequently to the introduction of staybolts of a flexible type which can accommodate themselves more freely to the relative movement of the inner and outer fire-box sheets. There is little doubt, from the experience obtained on