rally of mild steel but often of wrought-iron. In English practice the fire-boxes are of copper and the tubes of brass ; in America the fire-boxes are of mild steel and the tubes of wrought-iron.@@1

The locomotive type of boiler is used for stationary engines of the portable, semi-portable, and semi fixed types, and also to a limited extent for marine engines in cases were lightness is of special advantage.

135. So long as marine engines used steam of a pressure less than about 35 lb per square inch the marine boiler was generally a

chambers, and return tubes above the flues. In one variety, called the double-ended boiler, there are furnaces at both ends of the shell, each pair leading to a combustion-chamber in the centre that is common to both, or to separate central chambers with a water space between them.

Figs. 53 and 54 show with some completeness a double-ended marine boiler of the most modern construction for high-pressure steam. At each end there are three furnaces in flues made of welded corrugated steel plates. The use of corrugated plates for flues, introduced by Mr Fox, makes thin flues able to resist collapse, and allows the flues to accommodate themselves easily to changes of temperature. One combustion-chamber is common to each pair of furnaces. It is strengthened on the top by girder stays and on the sides by stay-bolts to the neighbouring chamber and to the shell. The tubes are of iron, and a certain number of them are fitted with nuts so that they serve as stays be­tween the tube-plate of the combustion-chamber and the front of the boiler. The upper part of the front plate is tied to the opposite end of the boiler by long stays. The uptakes from both ends converge to the funnel base above the centre of the boiler’s length. The boiler shown is one of a pair, which lie side by side in the vessel, the uptake at each end being common to both. Each boiler has a steam-dome, from which the steam-pipe leads to the engine ; this consists of a small cylindrical vessel, with flat ends tied together by a central stay. Short pipes connect the dome near each end with the steam space of the main shell. The boilers of figs. 53 and 54, which are by Messrs Gourlay Brothers of Dundee, work at a pressure of 165 lb per square inch above the atmosphere, and are used with triple expansion engines. The shell is 121/4 feet in diameter, and 161/2 feet long. The plates are of mild steel 11/8 inches thick round the shell and 1 inch in the ends. The tube plates are 7/8 inch and 13/16 inch thick, and the corrugated flues 1/2 inch. The longitudinal seams are treble- riveted, with inside and outside covering plates. The circum­ferential seams are lap-joints double-riveted. There are 127 tubes at each end, 46 of which are stay-tubes. The tubes are of iron, 31/2 inches in external diameter. Above these are 18 longitudinal steel

box with flat sides, elaborately stayed, with a row of internal furnaces near the bottom opening into a spacious combustion- chamber enclosed within the boiler at the back, and a set of return tubes leading from the upper part of the chamber to the front of the boiler, where the products of combustion entered the uptake and passed off to the funnel. The use of higher pressures has made this form entirely obsolete. The normal marine boiler is now a short circular horizontal cylinder of steel with flat ends, with internal furnaces in cylindrical flues, internal combustion-

stays 23/4 inches in diameter. The steam-dome is a cylinder 2⅜ feet in diameter and 8 feet long, stayed by a central 31/2-inch rod of steel. The short fire-box stays are also of steel 11/2 inches in diameter, of 73/4 inches pitch, and are secured by nuts and washers at both ends. The central combustion- chamber has a round

and unstayed roof.

The top of each side

combustion - chamber

is stayed by three

steel girders 83/8 inches

× 21/4 inches in sec­

tion, secured by four

bolts to the roof-

plate below. A single-

ended marine boiler

by the same makers

is shown in fig. 55.

Boilers of this class

are in some instances

set athwartship in­

stead of longitudin­

ally, and bevelled on

the bottom, at the.

back, to accommo­

date them to the

shape of the hull. A

modification of the

cylindrical form is

occasionally used, in

which the section is an oval, with round top and bottom and flat sides. The combustion-chambers are sometimes made with rounded tops, which are tied to the back plate by gusset-stays and angle- irons. In naval practice the tubes are frequently of Muntz metal in place of iron. Another form of boiler, used to a considerable Navy extent in the British navy, is a long horizontal cylinder with two type.

@@@1 See a paper by Mr Fernie, *Min. Proc. Inst. C.E.,* 1883.