(No Model.) 2 Sheets—Sheet 1.

E. PETERSEN.

TUBULAR STEAM BOILER.

No. 475,150. Patented May 17, 1892.

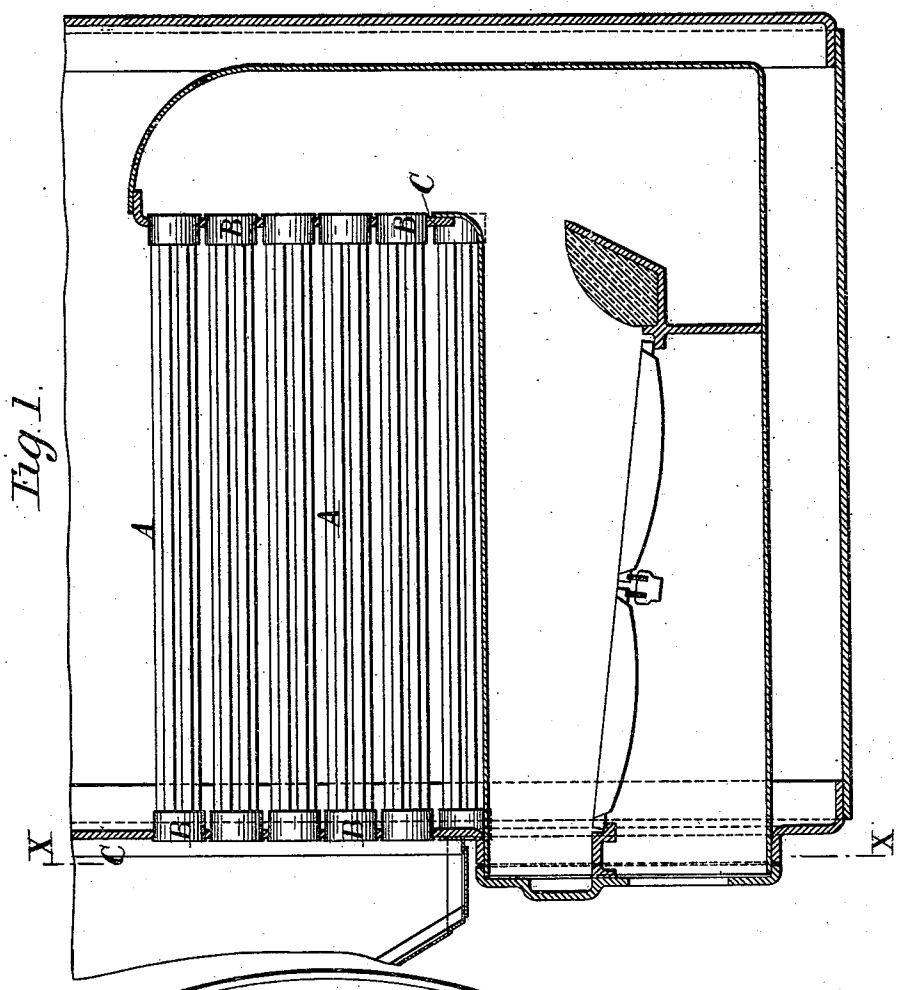

Fig. 1.

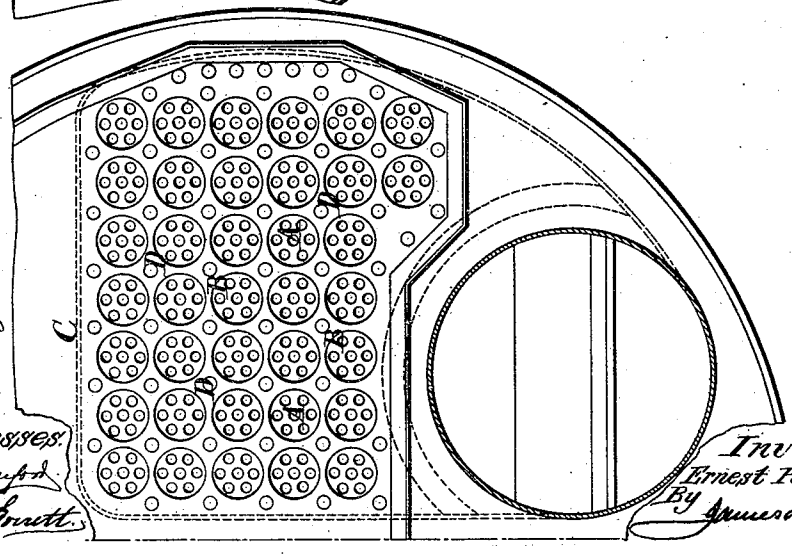

Fig. 2.

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 3

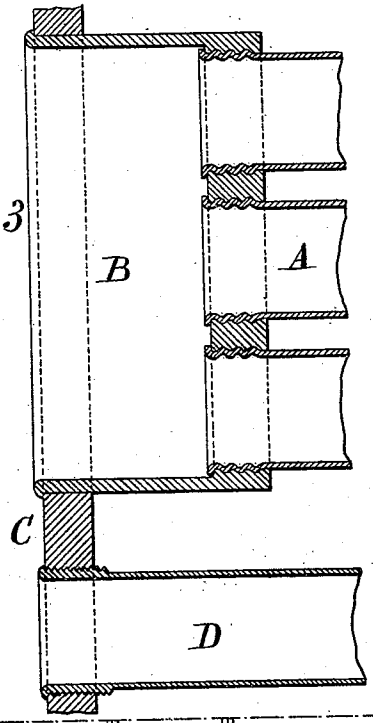


Fig. 4

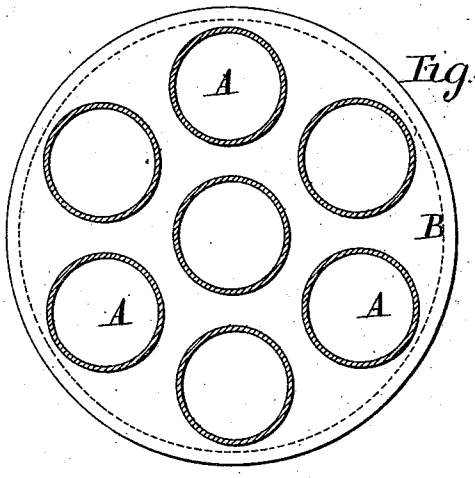
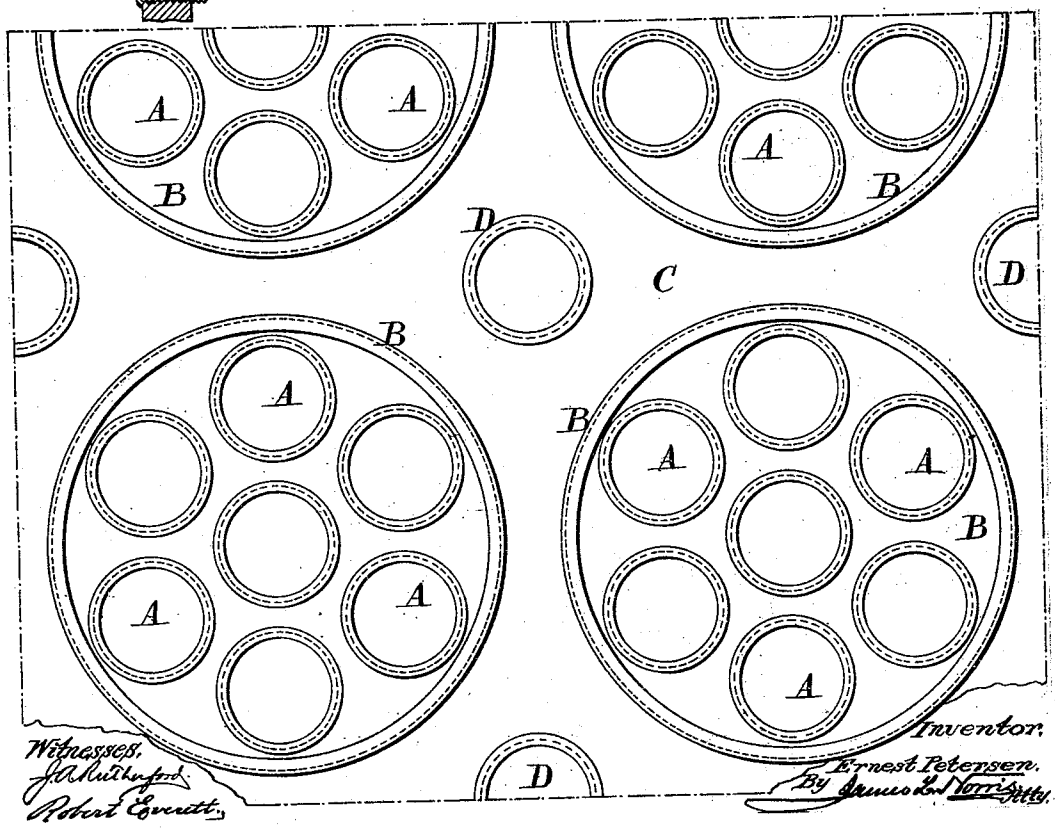


Fig. 5.



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UNITED STATES PATENT OFFICE.

ERNEST PETERSEN, OF KERTCH, RUSSIA.

TUBULAR STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 475,150, dated May 17, 1892.

Application filed October 8, 1891. Serial No. 408,170. (No model.) Patented in England August 22, 1890, No. 13,238; in France June 18, 1891, No. 214,267; in Germany June 19, 1891, No. 60,378; in Belgium September 30, 1891, No. 96,604, and in Italy October 27, 1891, LX, 19.

To all whom it may concern:

Be it known that I, ERNEST PETERSEN, a citizen of Russia, residing at Kertch, Crimea, Russia, have invented new and useful Improvements in Tubular Steam-Boilers, (for which I have obtained Letters Patent in Great Britain, dated August 22, 1890, No. 13,238; in France, dated June 18, 1891, No. 214,267; in Germany, dated June 19, 1891, No. 60,378; in Belgium, dated September 30, 1891, No. 96,604, and in Italy, dated October 27, 1891, Vol. LX, No. 19,) of which the following is a specification.

My invention relates to tubular steam-boilers, more particularly marine boilers, wherein horizontal or inclined fire-tubes are fixed in tube-plates; and it has for its object to greatly increase the heating-surfaces offered by the tubes, and consequently to effect a considerable economy in fuel by more effectually taking up the heat from the flames and combustion-gases.

In tubular boilers of present construction the tubes require to be made of comparatively large diameter (generally about three and one-fourth inches in diameter) in order to enable them to be conveniently fixed in the tube-plates by expanding them. Tubes of such a large size offer only a small heating-surface in proportion to the large volume of combustion-gases passing through them, and as a consequence a large proportion of such gases pass through without giving off their heat. Furthermore, in order to obtain a sufficient heating-surface with such tubes, it is necessary to employ such a number of them that the sectional area offered by them for the passage of the gases exceeds many times the inlet area for air of the fire-grate. The result hereof is that the combustion-gases mostly pass through the upper rows of tubes, leaving the lowermost ones either entirely or partially inoperative. According to my present invention I obviate these disadvantages by employing fire-tubes of small diameter applied in such a manner that, while the fixing by expansion can still be employed, both the heating-surface is large increased and the passage for the gases is considerably decreased. For this purpose the said tubes of small diameter are not fixed directly into the tube-plates, but have their ends fixed into corresponding holes formed in the closed inner ends of short tubes or cylindrical cups of large diameter, the outer ends of which are fitted by expanding them in the ordinary way into corresponding holes in the tube-plates. Thus, for example, I may fit a group of, say, seven tubes of one and one-fourth inches in diameter into the inner closed ends of cups of five inches in diameter, six thereof being arranged at equal distances apart round the circumference and the seventh in the center. As tubes of such small diameter cannot well be fixed in the cups by expanding them into the holes by an expanding-tool, I, according to one arrangement, form the holes in the latter of such a diameter that the cup requires to be expanded by heating for the tubes to be introduced into the holes thereof, so that on cooling the cup will be shrunk onto the ends of the tubes, thus forming a rigid combination of the group of small tubes with the two cups. In order to enable the compound tube thus formed to be readily removed, I prefer to make the holes at the circumference of the cup in such a position that the projecting ends of the tubes are made to abut against a recessed shoulder in the sides of the cup, so that on driving the cup at the one end inward for removing the tubes these and the other cups will be forced backward therewith as though they were all of one piece. The above-described construction has the further advantage over the fire-tubes now employed that whereas these are rendered quite useless on being removed only the cups have to be renewed with my construction, the tubes themselves being quite free from injury.

Although I have given the above-mentioned sizes of the tubes and cups as being suitable, they may be made larger or smaller.

The accompanying drawings show my above-described invention applied by way of example to a marine boiler.

Figure 1 shows a part longitudinal section of a boiler. Fig. 2 shows a part cross-section through the smoke-box on line X X; and

Figs. 3, 4, and 5 show, respectively, an enlarged part longitudinal section, a cross-section, and an end view of the compound tubes.

A A A are ordinary fire-tubes, but of considerably smaller diameter than those usually employed—say from three-fourths of an inch to one and three-fourths inches in diameter. The two ends of these tubes are let into steel cups B of, say, from five inches to seven inches in diameter, a group of seven tubes A being conveniently combined with one pair of cups, so that there is one central one and six arranged symmetrically round it, as shown. The cups B are accurately turned on their outer surface and fit into correspondingly and accurately bored holes in the tube-plates C, in which they are secured by being expanded in the usual manner, the projecting ends being by preference riveted over, as shown.

When the tubes A are of a small diameter, they may be secured to the cups B by merely shrinking the latter onto them, as before described; but if they are of sufficient size to allow of their being expanded by an expanding-tool, then I prefer to make the holes in the cup for receiving them with shallow grooves, so that by expanding the ends of the tubes into such grooves, as shown, the two parts are effectually secured together, so that when it is desired to remove one of the compound tubes this may be readily effected by removing the external bulge of the cup B at one end and then driving back the entire compound tube through the hole at the other end.

In addition to or instead of shrinking the cups B onto the ends of the tubes A or expanding these into the cups, as described, they may also be secured by brazing, or the tubes and cups may be welded together, or the cups may be cast onto the ends of the tubes, or the tubes and cups may even be formed of one casting of cast-steel. The tubes being effectually secured in the cups, as described, it will be seen that no leakage can occur, such as frequently takes place in the joints of the ordinary tubes with the tube-plates, and the outer surfaces of the cups being turned and the holes in the tube-plates accurately bored, as described, any leakage of these joints will also be practically prevented.

For facility of fixing and removal the cups may be slightly coned on their outer surface in such manner that the front cup has its outer end largest while the back cup has its inner end largest. Thus the holes in the tube-plates being coned in a corresponding manner, it will be seen that the fixing and withdrawal of the compound tubes from the front end will be greatly facilitated, as in driving them in the cups will at once be wedged tight in their holes. The holes in the tube-plates for receiving the compound tubes are arranged in parallel rows, and between each group of four is provided a tubular stay D, screwed into the tube-plates and riveted over on the outside.

By means of the above-described construction of compound tubes I am enabled, as before stated, to greatly increase the heating-surface of the tubes, while at the same time reducing their collective area for the passage of the furnace-gases, so that these are made to pass more or less uniformly through the whole of the tubes instead of passing in great measure through the upper tubes only. Furthermore, as the tubes in each group are considerably nearer to each other than to the tubes of the contiguous groups, it follows that the body of water between the tubes of each group will become more highly heated than the body of water between the contiguous groups, which will have the effect of producing a circulation of water round the individual tubes, whereby the steam will be effectually liberated therefrom and incrustation and burning of the tubes prevented.

The advantages of my above-described compound tubes may be summarized as follows:

First. By their use a very great increase of effective heating-surface is attained, resulting in a corresponding economy of fuel.

Second. Greatly increased durability of the boilers, inasmuch as the cause of the rapid wearing out of tubular boilers of present construction is due to the fact that the intense heat of the furnace is imparted to the water directly behind the back tube-plate in great measure through the back ends of the tubes, so that owing to the energetic steam production at that point the water is in great measure prevented from maintaining the effective contact with the tube-plate required for keeping it at a comparatively low temperature, and in consequence the tube-plate soon becomes burned. With my compound tubes, however, the flames have first to pass through the cups of comparatively large diameter, offering comparatively small surface for the transmission of heat before they enter the small tubes, and thus the energetic production of steam will only take place at a certain distance from the tube-plate, so that this will always have more or less solid water in contact with it.

Third. The total internal sectional area of the tubes being reduced to that actually required for the draft, instead of being greatly in excess in order to obtain the necessary heating-surface, as in ordinary boilers, they will all act efficiently for the transmission of heat, instead of the lower ones being comparatively inoperative, as at present, and as a consequence boilers affording a certain amount of steam-power can be made of smaller dimensions than at present.

Fourth. In those cases where the tubes are effectually secured to the cups either by expanding into grooved holes in the latter or by brazing or welding or casting the two together they will also act as stay-tubes, and consequently the separate stay-tubes, not requiring to be as strong as in ordinary boilers, can be made of uniform thickness with the

fire-tubes. As a consequence the whole of the tubes will expand uniformly, instead of the thicker stay-tubes expanding more than the fire-tubes, and thus producing unequal strains on the tube-plates, which cause the joints to leak.

Fifth. As a considerable proportion of the total steam-pressure to which the tube-plates of ordinary boilers are subjected is in the present case transferred to the inner flat face of the cups B, it follows that the tube-plates are subjected to a considerably-reduced total strain, so that either they can be made considerably thinner for bearing the ordinary steam-pressure, or if they are kept of the usual thickness the steam-pressure in the boiler can be considerably increased beyond that ordinarily used.

Sixth. As the fire-tubes can be made comparatively thin on account of their small size, the heat will be much more effectually transmitted through them.

Seventh. For the reason hereinbefore stated there will be an effectual circulation of water round the separate tubes, liberating the steam and preventing incrustation. When incrustation does occur, the tubes can be removed, even though it may be considerable, as the outside measurement of each group of tubes is considerably less than the diameter of the holes in the tube-plate, into which the cups are fixed.

Eighth. The labor and time expended in taking out and replacing the whole of the tubes of a boiler for cleaning purposes will be very considerably less than with an ordinary boiler, as instead of having to remove each tube separately a group of seven or other number forming a compound tube is removed at one time.

Having thus described the nature of this invention and the best means I know of carrying the same into practical effect, I claim—

In a tubular steam-boiler, the combination, with the tube-plates, of compound fire-tubes consisting of cups of large diameter fixed by expanding into corresponding holes in the tube-plates and projecting with their closed end a certain distance into the water-space of the boiler, in the closed ends of which cups are fixed the ends of a number of fire-tubes of small diameter, substantially as and for the purposes set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 24th day of September, A. D. 1891.

ERNEST PETERSEN.

Witnesses:

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