S. ELLIOTT.

TUBULAR STEAM BOILER.

APPLICATION FILED FEB. 5, 1908.

948,373. Patented Feb. 8, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

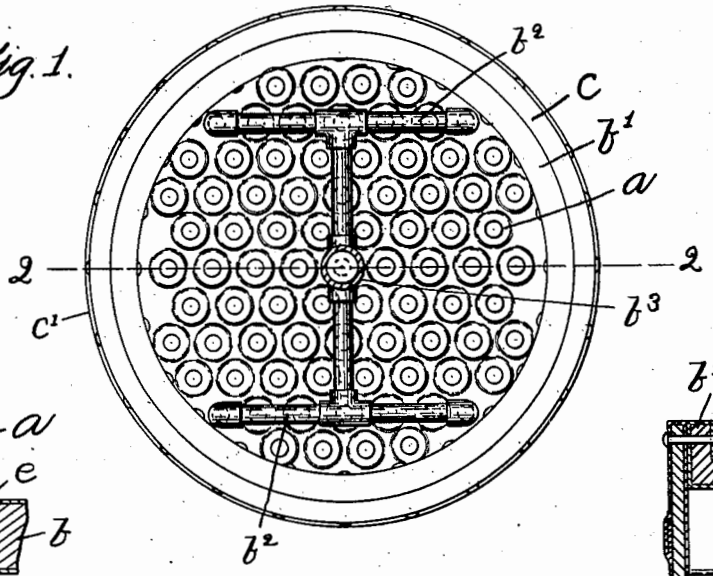
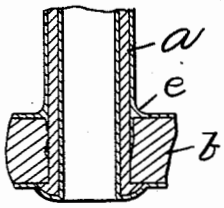


Fig. 3.



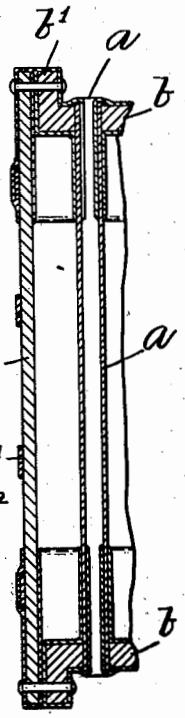


Fig. 5.

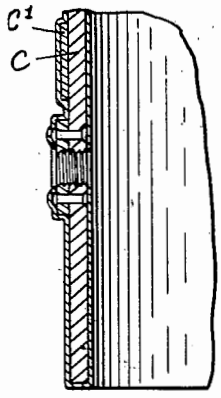


Fig. 4.

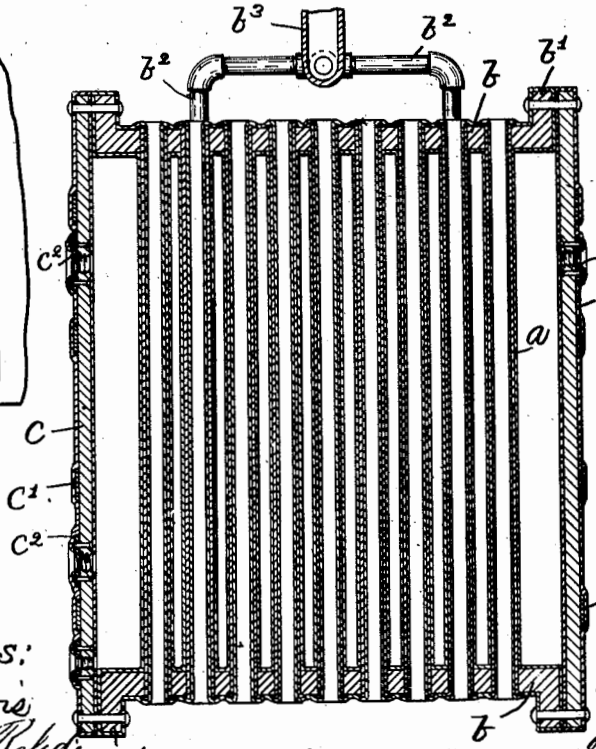


Fig. 2.

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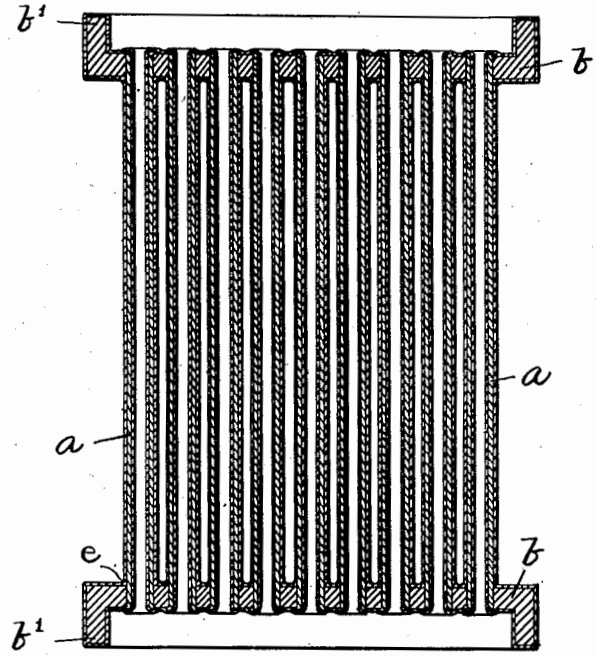
2 SHEETS—SHEET 2.

Fig. 6.



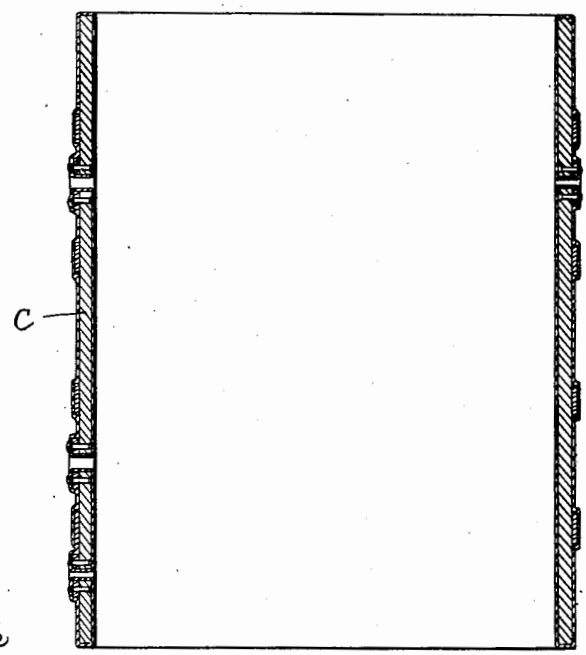


Fig. 7.

Witnesses:
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UNITED STATES PATENT OFFICE.

STERLING ELLIOTT, OF NEWTON, MASSACHUSETTS.

TUBULAR STEAM-BOILER.

948,373. Specification of Letters Patent. Patented Feb. 8, 1910.

Application filed February 5, 1908. Serial No. 414,292.

To all whom it may concern:

Be it known that I, STERLING ELLIOTT, of Newton, county of Middlesex, State of Massachusetts, have invented an Improvement in Tubular Steam-Boilers, of which the following is a specification.

This invention relates to tubular steam boilers. In the manufacture of boilers of this type it has been customary to expand the ends of the tubes into the holes in the tube plates, and to bead or turn the ends of the tubes over upon the exterior surfaces of said plates to thereby connect the tubes with the plates. Oftentimes the boiler leaks at the joints, due to imperfect connections of the tubes therewith, and also to imperfect connections between the shell and tube plate, which is very objectionable. Furthermore, the boiler immediately begins to corrode both interiorly and exteriorly, interiorly by the action of the water which is contained in it, and exteriorly by the action of the "sweat" which accumulates on it, when cold, due to the moisture of the air condensing on it, and as a result of such corrosion the life of the boiler is materially shortened.

The invention has for its object to provide all parts of the boiler or essentially all parts thereof, which are exposed to the water and to the air, but particularly all parts which are exposed to the water, with a covering, which is united to the surfaces which are thus exposed, and which fills all accessible interstices between the end portions of the tubes and the tube plates, said covering consisting of a non-corrosive metallic substance having a high melting point, to thereby prevent leakage at the joints and to prevent corrosion or to retard the action of corrosion to such an extent as to materially lengthen the life of the boiler. Such a non-corrosive covering preferably extends continuously over the entire exterior and interior surfaces of the tubes and of the tube plates to which they are connected, but especially extends continuously over the surfaces thereof which are exposed to the water, or at least, over the end portions of the surfaces thus exposed, and forms fillets around the tubes at the junction of the tubes and the tube plates; and such a non-corrosive covering also extends continuously over the interior and exterior of the shell and parts attached to its outer side or applied thereto, but especially over the surface thereof which is exposed to the water.

The invention also has for its object to provide the boiler with a plurality of outlets for the steam which lead from the same steam space and which are connected to a common delivery pipe, whereby the supply of steam may be taken from the boiler at different points.

Figure 1 is a plan view of a tubular steam boiler embodying this invention. Fig. 2 is a vertical section of the boiler shown in Fig. 1, taken on the dotted line 2—2, one row of tubes only being shown. Fig. 3 is an enlarged detail of the end portion of one of the tubes showing its connection with the tube plate. Fig. 4 is a detail showing the end portion of the boiler shell. Fig. 5 is a sectional detail of one of the tubes and portions of the two tube plates and a portion of the shell, the ends only of which are covered. Fig. 6 is a vertical section of one of the elements of the boiler having a continuous non-corrosive metallic covering united thereto, and Fig. 7 is a vertical section of the other element of the boiler having a continuous non-corrosive metallic covering united thereto.

a represents the tubes, *b* the tube plates having holes for the tubes and having marginal flanges *b'*, and *c* the tubular cylindrical shell which is attached to the flanges of the tube plates. These parts may be formed in any well known or suitable manner, so far as my invention is concerned. The end portions of the tubes are projected into the holes in the tube plates and slightly but not severely expanded to thereby connect them therewith. The tubes and tube plates, thus assembled, are in condition to have applied to them, both interiorly and exteriorly, a non-corrosive metallic substance having a high melting point which forms a protecting covering which is united to the surfaces to which it is applied, and which fills all accessible interstices at the joints, and forms fillets around the tubes at the junction of said tubes and tube plates. The shell *c*, when adapted to be attached to the tube plates, is likewise in condition to be similarly treated. As a non-corrosive metallic substance having a high melting point I prefer to employ brass, but I may employ any other suitable material which is adapted for the purpose. I particularly prefer brass

for the reason that its melting point is so high that the temperature of the boiler even under extraordinary conditions will not melt it. To easily apply the non-corrosive metallic substance to both the interior and exterior surfaces, I prepare a bath of molten brass and into this bath I entirely submerge the assembled tubes and tube plates, or I may only dip the end portions thereof, and also entirely submerge the tubular shell, which at such time is not attached to the tube plates, or I may only dip the end portions thereof. In Fig. 2 the parts are represented as entirely covered, and in Fig. 5 the end portions only are covered. Previous to attaching the tubes to the tube plates, both the tubes and tube plates, are subjected to any suitable abrading treatment or pickling process and the shell is likewise treated. The brass is caused, by means of a suitable flux, to unite to all of the surfaces with which it comes in contact. The non-corrosive metallic substance may, however, be united to the surfaces in any other suitable manner. When the parts are thus coated it will be seen that both the interior and exterior surfaces of the tube plates are uniformly covered and thereby, protected from corrosion, and that the covering is united to said surfaces, and as said plates are coated previous to the shell *c* being attached to them, the flanges *b'* thereof are entirely covered, and thereby protected. Furthermore, that both the exterior and interior surfaces of the tubes, or at least the end portions thereof, according to the depth the boiler is dipped in the molten metal, are uniformly covered and thereby protected from corrosion, and that the covering is united to said surfaces. Furthermore, that the coverings on the end portions of the tubes and on the tube plates, if the end portions of the assembled parts are separately dipped in the molten metal, or the single covering on the tubes and tube plates, if the assembled parts are entirely submerged, is continuous, in that it extends over or throughout both the tubes and tube plates, in intimate contact therewith, in an unbroken or continuous layer. Furthermore, that all accessible interstices between the ends of the tubes and the tube plates on the interior surfaces of said tube plates are filled from both sides of the tube plates, and that at the junction of the tubes and tube plates fillets, represented at *e*, Fig. 2, are formed around the tubes which are integral with the covering which is united to tubes and tube plates, and also with the material which enters the interstices between said tubes and tube plates. By coating the tubes interiorly from end to end, so as to prevent corrosion along their entire length, smooth inner surfaces are produced and maintained which largely prevents the deposit and accumulation thereon of soot, but coating the tubes exteriorly, where exposed to the action of the water is of the greatest importance. Furthermore, it will be seen that all the exposed surfaces of the shell, or at least the end portions thereof, according to the depth it is dipped in the molten metal, are covered and thereby protected from corrosion and that the covering is united to the surfaces thereof. Furthermore, that by covering the connected tubes and tube plates in the manner described or in some equivalent manner, whereby a continuous or integral covering is provided for and united to said parts, having integral fillet around the tubes at the junction of the tubes and tube plates, the tubes need not necessarily be as severely expanded into the holes in the tube plates as is now the practice, which reduces the cost of assembling the parts, and avoids the danger of dishing the tube plates from the combined strain of a number of small severely expanded tubes.

In small boilers having a large number of tubes the tubes are placed very close together. This increases the liability of cracking the tube plates between the tubes when said tubes are severely expanded in place, or subsequently when the tubes are reëxpanded for the purpose of stopping leaks.

Obviating the necessity of expanding and reëxpanding the tubes into the holes in the tube plates permits the employment of thinner tube plates than has heretofore been customary to use with a corresponding increase in the heating efficiency and a reduction in the cost as well as weight.

The shell *c* of the boiler may be reinforced by means of bands *c'* or by any other suitable means adapted to encircle it, and in such case the reinforcing means will be applied to the shell before the shell is subjected to treatment, then the shell will be subjected to the aforesaid treatment resulting in both the shell and the reinforcing means having a continuous non-corrosive metallic covering or coverings having a high melting point, united to its interior and exterior surfaces, which fills all accessible interstices between said shell and the reinforcing means thereon. Arranging the reinforcing means on the shell previous to subjecting the shell to treatment permits the employment of a much thinner shell than has been customary to employ with a corresponding reduction in the cost and weight, and if bands are employed as the reinforcing means they may be arranged to cross the grain of the metal of the shell, and when covered to become practically one piece.

The tubular, cylindrical shell *c* of the boiler will have attached to its outer side several plates c^2, having holes through them arranged opposite corresponding holes in the shell for the purpose of connecting an indicator thereto or for other purposes. These

plates are attached to the shell before the shell is subjected to treatment and the shell having the plates attached to it is then subjected to treatment in the manner before described, resulting in both the shell and plates having a continuous non-corrosive metallic covering having a high melting point united to its interior and exterior surfaces, which enters all accessible interstices between the plates and shell.

In steam boilers there is a tendency for the water to lift when the outlet valve is opened and in some cases, especially in small boilers, when the pressure is high and the water level also high the water is carried through the throttle into the engine with very undesirable results. Such action not only draws the water from the boiler with a great loss of heat, but has a bad effect on the running of the engine. To obviate this objection two or more openings are provided in the top tube plate, which are located some distance apart, and made quite small, and said openings which serve as outlets leading from the same steam space are connected by pipes b^2 with a common delivery pipe b^3, which latter serves as an outlet common to all the aforesaid small openings in the top of the boiler. The areas of the several small outlets will approximately equal the area of the common outlet.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a tubular steam boiler, a tube plate and a set of tubes connected therewith, and a continuous non-corrosive metallic covering having a high melting point united to both the exterior and interior surfaces of the tubes and to both the interior and exterior surfaces of the tube plate, and forming integral fillets around the tubes at the junctions thereof with the tube plate, substantially as described.

2. In a tubular steam boiler, a set of tubes and a pair of tube plates to which said tubes are connected at their opposite ends, and a continuous non-corrosive metallic covering having a high melting point united to both the exterior and interior surfaces of the tubes and to both the exterior and interior surfaces of both tube plates, and forming integral fillets around the tubes at the junctions thereof with the tube plate, substantially as described.

3. A tubular steam boiler composed essentially of a pair of tube-plates and a set of tubes attached thereto, entirely coated with a continuous, non-corrosive metallic substance having a high melting point, and a shell, also entirely coated with a like substance, attached to said tube-plates, substantially as described.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

STERLING ELLIOTT.

Witnesses:
B. J. Noyes,
H. B. Davis.