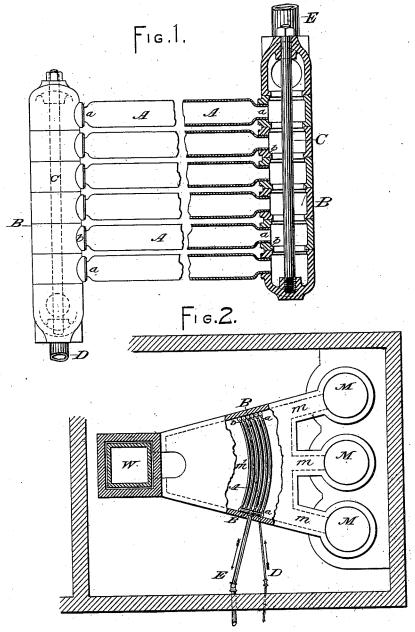
## G. H. CORLISS. Tubular Steam-Boiler.

No. 215,798.

Patented May 27, 1879.



WITNESSES: \_\_\_\_ W. C. Brookes Otto Miller NVENTOR:

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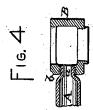
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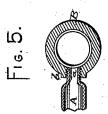
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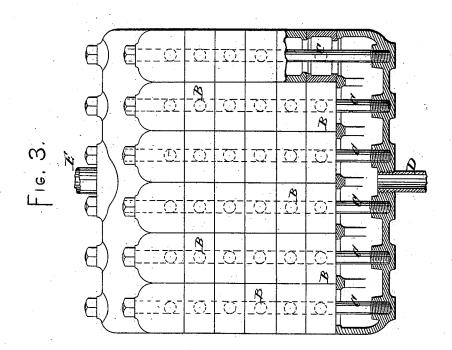
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## UNITED STATES PATENT OFFICE.

GEORGE H. CORLISS, OF PROVIDENCE, RHODE ISLAND.

## IMPROVEMENT IN TUBULAR STEAM-BOILERS.

Specification forming part of Letters Patent No. 215,798, dated May 27, 1879; application filed October 19, 1878.

To all whom it may concern:

Be it known that I, GEORGE H. CORLISS, of the city and county of Providence, in the State of Rhode Island, have invented certain new and useful Improvements relating to Tubular Heaters adapted to serve for steamgenerators and analogous constructions; and I do hereby declare that the following is a full and exact description thereof.

My improved tubular heater leads the hot gases transversely across a set of tubes in which the steam is to be generated or the water to be heated is circulated. It is desirable in such constructions to place the tubes nearer together than will afford adequate holding material in the tube-sheets or analogous material

in which the tubes are set.

I have devised a construction in which the metal in which the tubes are set is in the form of separate pieces or cases, matched together so as to form a continuous structure equivalent to a tube-sheet and its connections. I obtain sufficient holding metal, even under the disadvantageous conditions due to the separate pieces in which my tube-sheet is formed, by contracting the ends of the tubes. In other words, my tubes are small-sized and widely spaced at their ends, and between their ends are enlarged, so as to properly fill the heated chamber in which they are immersed, and to more efficiently extract the heat from the

My tubes present a large amount of heatingsurface, with only small capacity for movement of the water through them; but this latter, though limiting the capacity of the apparatus for very active circulation of the water and steam, which in some extreme situations is a disadvantage, is in all ordinary conditions, and especially in the moderate temperature to which I propose to expose my pipes, an advantage. The effective water-way is only that allowed in the most contracted part—the necks or ends. The water-way, being thus contracted in the tubes, can be more easily exceeded in the other parts of the circulatory apparatus, and being thus exceeded in the other parts, there is increased certainty that every tube, even those more unfavorably situated for receiving the current, will be subject to a proper circulation through it. In other words, the circu- A; but care must be taken neither to greatly

lation in any given tube will be necessarily moderate; but it will be more sure with my construction than with the ordinary one, in which the tubes are of uniform section throughout.

My tubes are curved. Any expansion and contraction may be allowed for by slight changes in the curvature.

The following is a description of what I consider the best means of carrying out the inven-

The accompanying drawings form a part of

this specification.

Figure 1 is an elevation, partly in section, showing a set of my tubes and immediate connections. Fig. 2 is a plan view of the same and some further parts on a smaller scale. Fig. 3 is a side view of the series of end castings, the lower portion being in section to show the interior. A portion of the other set of end castings or casings at the other side of the apparatus is shown at the top. The remaining figures represent a small portion detached. Fig. 4 is a vertical section, and Fig. 5 a horizontal section, through one of the tube ends and the connected end casting.

Similar letters of reference indicate corre-

sponding parts in all the figures.

Referring to Fig. 2, M are upright boilers, of any suitable construction. (Seen in plan.) m are passages leading the hot products of combustion from the top of the boiler horizontally toward the chimney. m' is a capacious chamber, in which all the products of combustion from the three boilers are received and commingled. This chamber converges or contracts its width from the boilers toward the chimney W. The curved tubes are preferably so placed, as shown, that they shall present the hollow side of the curve toward the chim-

A are the large bodies, and a the contracted ends, of my curved tubes. In manufacturing them, I take tubes having the proper large diameter throughout, and, heating the ends successively, reduce them by quick blows in

proper swages.

My experiments indicate that it is practicable to make quite abrupt shoulders, joining the necks a with the enlarged parts or bodies weaken the metal in the shoulders nor to leave it too much thickened in the neck. The tubes are bent to the right curvature either in a hot or cold condition, and the necks a are threaded on the exterior.

The end casings are marked B. They are adapted to match tightly together and be held by a stout through-bolt, C. Each tube end a is secured into a thickened side, b, of a cas-

ing, B.

The formation of the end casings Bb in separate pieces—one for each tube—allows the screw-connections to be formed by springing away the tube a little and turning the chamber Bb until it is properly connected; but I prefer to screw the chambers Bb each firmly upon its proper tube before applying them together. In applying the parts together each tube may be sprung a little, so as to either reduce or increase its length, by increasing or lessening its curvature, to allow its casings Bb to match properly against the adjacent ones above and below.

An active circulation is allowed through all the casings and through all the tubes. The water is admitted to the set through the pipe D at one end, and the water and steam are allowed to escape through the pipe E at the other end. There is a cross-connection at the bottoms of the several receiving-chambers, (shown in dotted lines on the left in Fig. 1;) and there is a corresponding cross-connection at the tops of the several delivering-chambers. (Seen in strong lines at the top, on the right, in Fig. 1.) The other parts are free to warp and spring as required in expansion and contraction. One pipe, D, supplies the water to the whole. One pipe, E, conducts away the steam or water, or both, which is delivered at the other end of the set. I esteem it preferable that E shall be of greater diameter than D.

In mounting my sets of tubes, I prefer that the end chambers B shall abut firmly, but with tolerable tightness, against the side walls of the hot passage m', in which they are mounted. They may rest on any suitable supports below, or they may be suspended by any suitable ties from above. The latter is preferable, as it gives greater freedom for differences of expansion and contraction between the several parts of the construction.

The pipes, arranged as shown within the chamber m', receiving spent gases from the boilers M, may be used for generating steam, or for any of the various uses in connection with steam apparatus, as heating feed-water or superheating steam.

Modifications may be made in the details within wide limits. The number of pipes in each vertical series may be increased or reduced. The number of such series may be in-

creased or diminished.

I can use the sets of tubes in a different form of heated chamber from the chamber m'; but I consider my invention better adapted for dealing with the spent heat from the boiler than for use in close proximity to a glowing fire.

In case of incrustation, my tubes may be cleaned by chemical action on the inside, or by percussion on the outside, in very nearly the same way as ordinary tubes or other parts of boilers.

I claim as my invention—

- 1. The cylindrical tubes A, curved as shown, with contracted necks a, screw-threaded, as shown, in combination with the end chambers B B, formed in separate sections and secured by bolts C, adapted to serve as herein specified.
- 2. The tapering chamber m', adapted to convey the hot products of combustion from the boilers M to the chimney W, in combination with the castings or end chambers B B, correspondingly arranged, and the tubes A a, curved as shown, so as to join the end chamber at right angles, as herein set forth.

In testimony whereof I have hereunto set my hand this 16th day of October, 1878, in the presence of two subscribing witnesses.

GEO. H. CORLISS.

Witnesses:

JEREMIAH MILLER, ED. W. RAYNSFORD.