No. 637,862. Patented Nov. 28, 1899.

J. B. FURNEAUX.

WATER TUBE STEAM BOILER.

(Application filed Aug. 23, 1898.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.

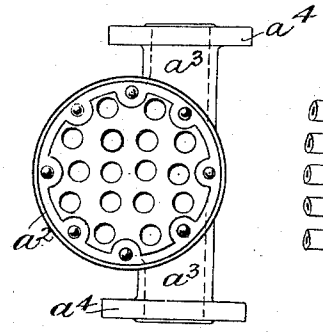


Fig. 2.

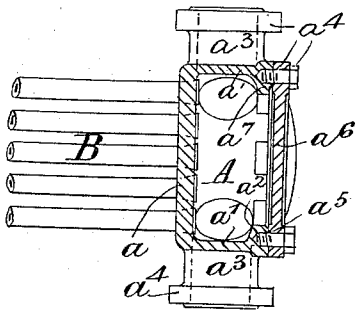


Fig. 5.

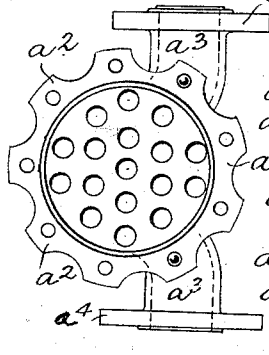
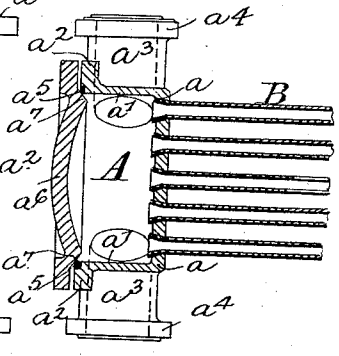


Fig. 6.



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(No Model.) 3 Sheets—Sheet 2.

Fig. 3.

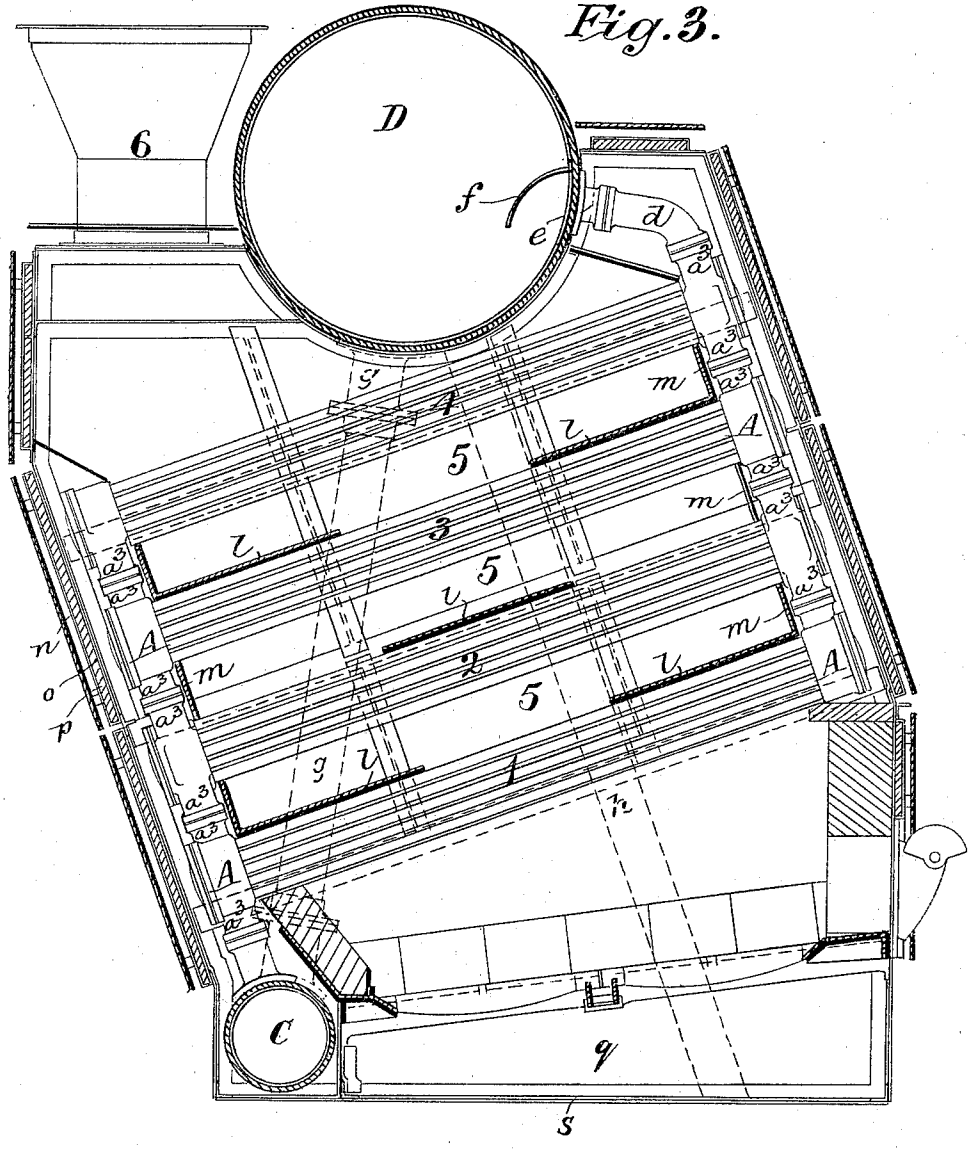

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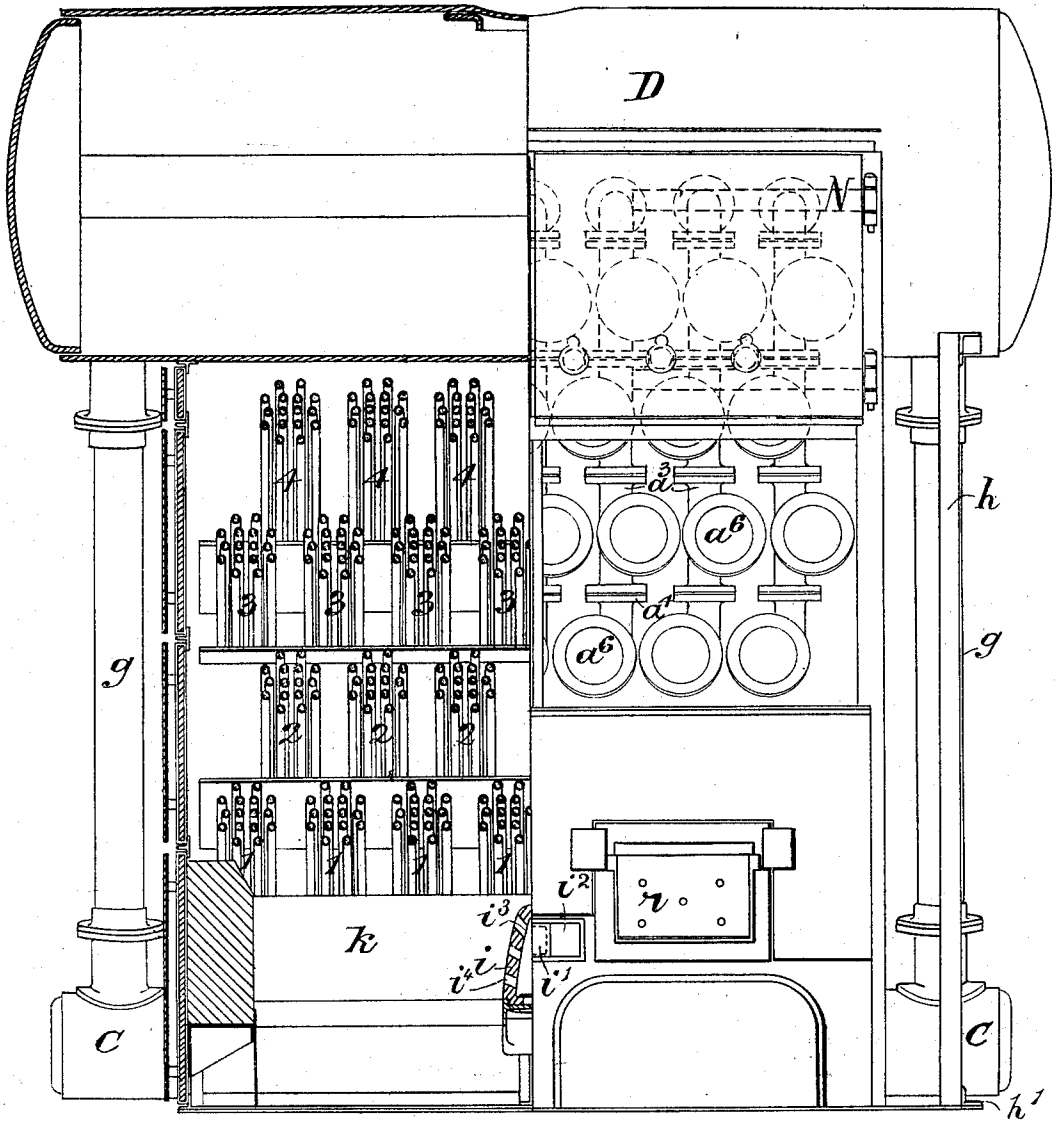
Fig. 4.



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UNITED STATES PATENT OFFICE.

JOHN BROKENSHIRE FURNEAUX, OF GATESHEAD, ENGLAND.

WATER-TUBE STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 637,862, dated November 28, 1899.

Application filed August 23, 1898. Serial No. 689,325. (No model.)

To all whom it may concern:

Be it known that I, JOHN BROKENSHIRE FURNEAUX, a subject of the Queen of Great Britain and Ireland, residing at Gateshead, in the county of Durham, England, have invented Improvements in Water-Tube Steam-Boilers, of which the following is a specification.

This invention has reference to a simple and efficient steam-boiler of the water-tube type so constructed with connected sections that a boiler of any desired power may be readily built up according to requirement by connecting together, and with the necessary lower water and upper steam and water chambers, a sufficient number of sections such as to present the required heating-surface, which sections are arranged with their tubes inclined horizontally in a suitable casing over a furnace, the products of combustion and hot gases from which are by suitably-arranged baffles caused to take a zigzag course as they ascend, the arrangement being such that after acting upon the tubes of the lowermost sections the hot gases and products of combustion enter a space free from tubes, in which as they proceed toward the tubes of the series of sections next above further combustion is promoted by addition of air that in practice leaks or finds its way into the spaces between the tubes, and, again, when the products of combustion and hot gases have passed between the tubes of the next higher series of sections they enter another space devoid of tubes, where in like manner further combustion is promoted, and so on as the gases ascend past the various sections of tubes and the various spaces between them on their way to the chimney, from which arrangement efficient combustion and utilization of resulting heat and consequent economy of fuel are attained.

Figure 1 of the accompanying illustrative drawings shows in end view, with the cover removed, a boiler-section according to this invention. Fig. 2 shows such a section partly in side elevation and partly in vertical section, portions of the tubes being cut away to economize space. Fig. 3 shows in longitudinal vertical section a boiler according to this invention built up with sections of the kind illustrated in Figs. 1 and 2, which sections are in Fig. 3 shown in side elevation. Fig. 4 shows the boiler as to one half drawn in front elevation and as to the other half drawn in vertical section in a plane at right angles to Fig. 3. Figs. 5 and 6 are similar views to Figs. 1 and 2, respectively, showing a modified construction.

The boiler-sections comprise each two boxes or headers A A, connected together by a group of tubes B. The inner end a of each box, Figs. 1 and 2, constitutes a tube-plate and is made thicker than the annular side a', which is provided with a flange a^2, the box being provided with a couple of tubular projections a^3, flanged at a^4 and adapted to make steam-tight joints with like tubular projections of adjacent boxes of other similar boiler-sections. These tubular projections may be arranged tangentially to the boxes, so that the sections can be arranged in a zigzag or staggered manner, as seen in end view, Fig. 4, and the tubes B of one section be arranged centrally below the two sets of tubes B of an adjacent pair of sections above them, thus insuring an effective intermingling of the hot gas, products of combustion, and air while passing among the tubes on their way to the chimney or uptake. The interior of each box A is just within the open end formed with an annular recess a^5, adapted to receive suitable packing, such as a copper ring, and each box is furnished with a flanged cover a^6, formed with a conical surface a^7 at the inner side, adapted to bear against and when bolted in place to make a tight joint with the packing-ring. The dimensions of the boxes A will vary according to requirement. The said boxes may be cast of high-grade cast-steel or malleable cast-iron, and in some cases the tube-plate part a may conveniently be, say, five-eighths of an inch thick, or thereabout, and the annular sides a' in such a case, say, three-eighths of an inch thick, or thereabout. Through the tube-plate parts a there are drilled a number of holes corresponding to the number of tubes the section is to contain. Into these holes are expanded the ends of the connecting-tubes B. Sometimes I bead over the ends of the tubes after expanding them into the tube-plates a. The securing of the tubes B in the said tube-plates may, however, be effected in any known and suitable way. The

general arrangement of several series of such boiler-sections adopted in the formation of a boiler will be readily understood on reference to Figs. 3 and 4, which illustrate a boiler comprising four series of sections arranged one series above another and with their tubes inclined to the horizontal. By inclining the tubes only slightly, as shown, so that they are more horizontal than vertical, the hot gases flow practically at right angles to them, whereby a greater efficiency is obtained from such gases than is the case where the gases flow at a small acute angle or nearly parallel to the tubes. As will be seen, the upper tubular projections a^3 of the first or lowermost series of boiler-sections 1 are secured to (so as to make a steam-tight joint with) the lower tubular projections a^3 of the second series of boiler-sections 2, whose upper tubular projections a^3 are in like manner connected to the lower tubular projections a^3 of the third series of boiler-sections 3, which by their upper tubular projections a^3 are in like manner connected to the lower tubular projections a^3 of the fourth or uppermost series of tubular sections 4. The lower tubular projections a^3 at the lower ends of the boiler-sections of the lowermost or first series are connected steam-tight with flanged tubular projections c of a transverse lower water and sediment chamber or mud-drum C. The upper tubular projections a^3 of the boiler-sections of the uppermost series 4 are in steam-tight connection, by flanged elbow-pipes d, with flanged tubular projections e of the upper water and steam chamber or drum D, which is made of comparatively large size and in which there is arranged a longitudinal baffle f to deflect water and steam entering the chamber D from the boiler-sections.

Each set of superimposed sections constitutes an element that is independent of the other elements and is separately removable and replaceable. The sets of tubes B of the several sections are arranged at such a distance apart as to form spaces 5, that are free from tubes and in which further combustion of the hot gases and products of combustion, after the same have passed the series of tubes below, is promoted by addition of air that in practice leaks or finds its way into such spaces.

6 is the chimney or uptake.

The tubes B of the lowermost sections are preferably made of an internal diameter of about one and one-half inches, the tubes of the remaining sections being about one inch in internal diameter. By this means a rapid circulation of water is effected through each tube and formation of deposit therein prevented.

g are return-pipes which connect the upper water and steam chamber D with the lower water-chamber C near their respective ends.

h shows a support, of which there may be one in front of each tube g to aid in supporting the chamber D. These supports h are inclined oppositely to the return-pipes g and may conveniently be constructed of channel or H section.

In boilers of sufficient size to require two or more divisions of the fire-grate I make the mid-feathers between them of either perforated hollow fire-bricks or perforated hollow cast-iron in such wise as to form between the two or each two divisions of the grate a fore-and-aft air-duct, whose front end is provided with a fixed grid, over which there is arranged a sliding grid in such wise that the openings for admission of air may be more or less closed to regulate the quantity of air entering the duct and passing from it through the perforations of the mid-feathers into the divisions of the grate. Such an arrangement is indicated in Fig. 4, where i is part of a hollow perforated mid-feather arranged to divide the fire-grate into two divisions k, one only of which can be seen in Fig. 4, and i' the sliding grid and i^2 a fixed grid for controlling the passage of air into the air-duct i^3, whence it passes through the perforations i^4 in the mid-feather into the furnace or furnaces. The furnace or furnaces is or are suitably lined with a refractory material.

$l\,l\,l\,l$ are baffle-plates arranged on the sets of tubes and adapted to give a zigzag direction to the ascending products of combustion and hot gases, which in the example shown are divided thereby into two main streams which unite at the top.

$m\ m\ m\ m\ m\ m$ are cast-iron ribbed end baffles.

In the example shown the inclosing casing is composed of inner and outer wrought-iron or steel plates n o, with interposed layer p of asbestos or silicate cotton or other bad conductor of heat. The casing may be made in removable sections or hinged sections. In Fig. 4, N is a hinged section.

The ash-pit q may be open or closed, according to requirement. The fire door or doors r may be of the Martin or other convenient type.

A boiler constructed as described possesses many practical advantages, of which the following may be mentioned; It can be easily erected by unskilled persons, for which purpose the plate s, which forms the bottom of the ash-pit q, may be simply placed on the ground, no special foundation being necessary if the ground is firm. To this plate the brackets which carry the lower water-chamber C are bolted and also the angle-irons h', to which the bottom ends of the channel-iron supports h are bolted. The water-chamber C is then lifted into position, and to it the return-pipes g are bolted, and the supports h are bolted to bottom angle-irons h'. This having been done at both ends of the plate s, a seat is thus provided for the large steam and water drum D, which can be readily lifted into its place, so as to rest on these double-angular supports, which are then

bolted to the drum. The several sections to form each element are then built up and secured to the chamber C and drum D, these elements being set up from right to left or left to right, as may be most convenient. The boiler can be readily made of any desired width and with one, two, three or more furnaces below the group of sections, the heating-surface increasing in proportion to the width of the boiler. The tubes B of the various sections can be readily inspected and, if need be, removed and replaced without disturbing the sections, and the several sections, except the bottom ones, which have the larger tubes, are interchangeable, the several joints being easily broken and remade. Again, owing to the drum D being made large and the water-level being maintained therein normally at about a height containing the axis of the drum a large reservoir of water is provided in the boiler, so that overheating of the tubes B and consequent damage thereof and also priming are not liable to take place, while owing to the said tubes being of small size they are not liable to dangerous explosion. Furthermore, by the provision of the free spaces 5 between the sets of tubes a very efficient combustion of fuel is attained.

What I claim is—

1. In a water-tube boiler, a steam-generating system of waterways composed of sections each comprising a group of tubes, and headers receiving the ends of said tubes and each provided with one or more tangential union projections, said projections alternately in lateral position relative to the tubes in a vertical series of sections, substantially as and for the purpose described.

2. In a water-tube boiler, a steam-generating system of waterways composed of sections each comprising a group of tubes and cylindrical headers receiving the ends of the tubes in their inner confronting sides and each having one or more tangential union projections, said projections alternating in lateral relation to the tubes in a vertical series of sections, substantially as and for the purpose described.

3. In a steam-boiler, the combination of an upper steam and water drum, a lower water or mud drum, inclined return-pipes connecting the end portions of said drums, and supports or props inclined oppositely to said pipes and connected at their upper ends with the upper drum, and at their lower ends with a suitable base.

4. In a water-tube boiler, removable tubular sections each consisting of a pair of boxes of circular cross-section provided on their outer sides with removable end covers secured by bolts, and with flanged tubular unions projecting tangentially from their periphery, and a bundle of straight tubes secured to the inner side walls of said pair of boxes, substantially as described.

5. In a water-tube boiler, a tubular section comprising two end boxes A and a bundle of tubes B secured to the inner side walls of said boxes, said boxes being made of cylindrical shape with tangentially-arranged flanged tubular projections, and provided with removable end covers that are removably secured to the box by bolts, adjacent parts of each box and cover being adapted to receive and hold jointing material between them, substantially as described.

6. A water-tube steam-boiler comprising an upper water and steam drum, a lower water-chamber, inclined return-tubes connecting the lower side of the drum to the upper side of said chamber at the end portions of each, inclined supports arranged at an angle to said return-tubes and connected to said drum, and a boiler-casing located between the two pairs of return-tubes and supports and inclosing the furnace or furnaces and the steam-generating elements connecting said drum and chamber, substantially as described.

7. In a water-tube boiler, the combination with an upper water and steam drum, and a lower water-chamber, and a casing of a plurality of steam-generating elements connecting said drum and chamber, inclosed within said casing, and built up of a number of sections each of which comprises a pair of boxes connected by a bundle of straight tubes and provided with tangential tubular unions, the sections in each element being connected up by their tubular unions so that they are alternately to right and left of one another, substantially as described.

Signed at Gateshead, in the county of Durham, England, this 8th day of August, 1898.

JOHN BROKENSHIRE FURNEAUX.

Witnesses:
J. A. DIXON,
THOS. HENDERSON.