(No Model.) 2 Sheets—Sheet 1.

F. S. MORRIS.

MULTITUBULAR STEAM BOILER.

No. 338,861. Patented Mar. 30, 1886.

Fig. 2.

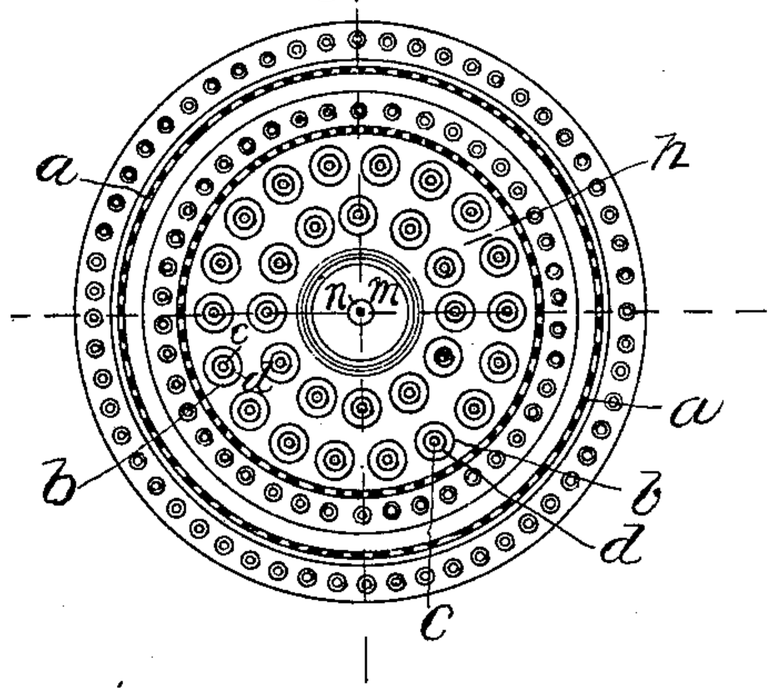


Fig 4.

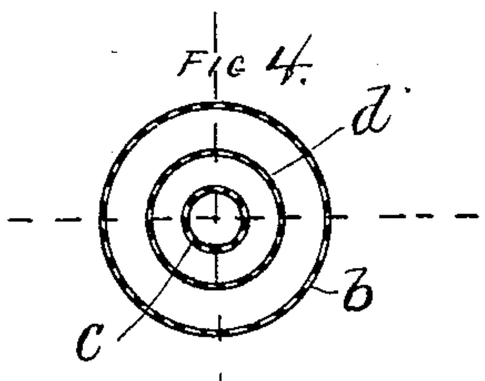


Fig. 3.

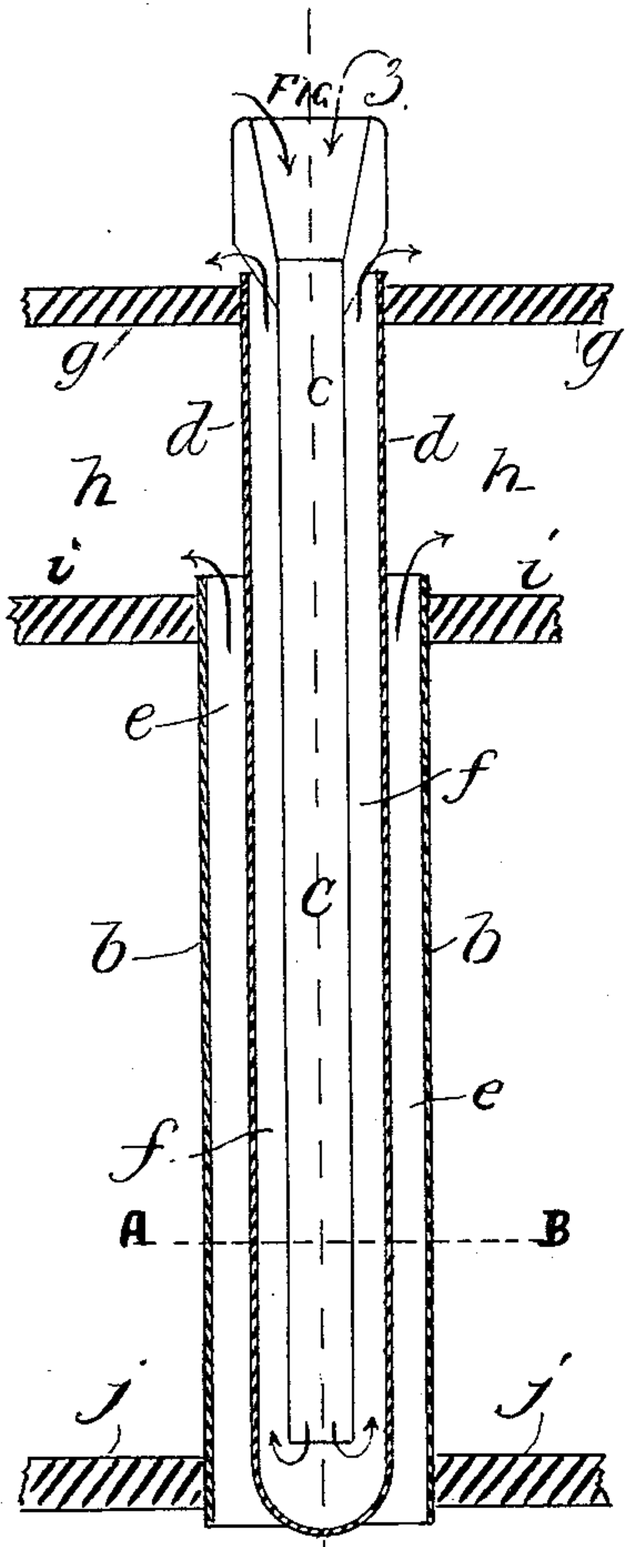
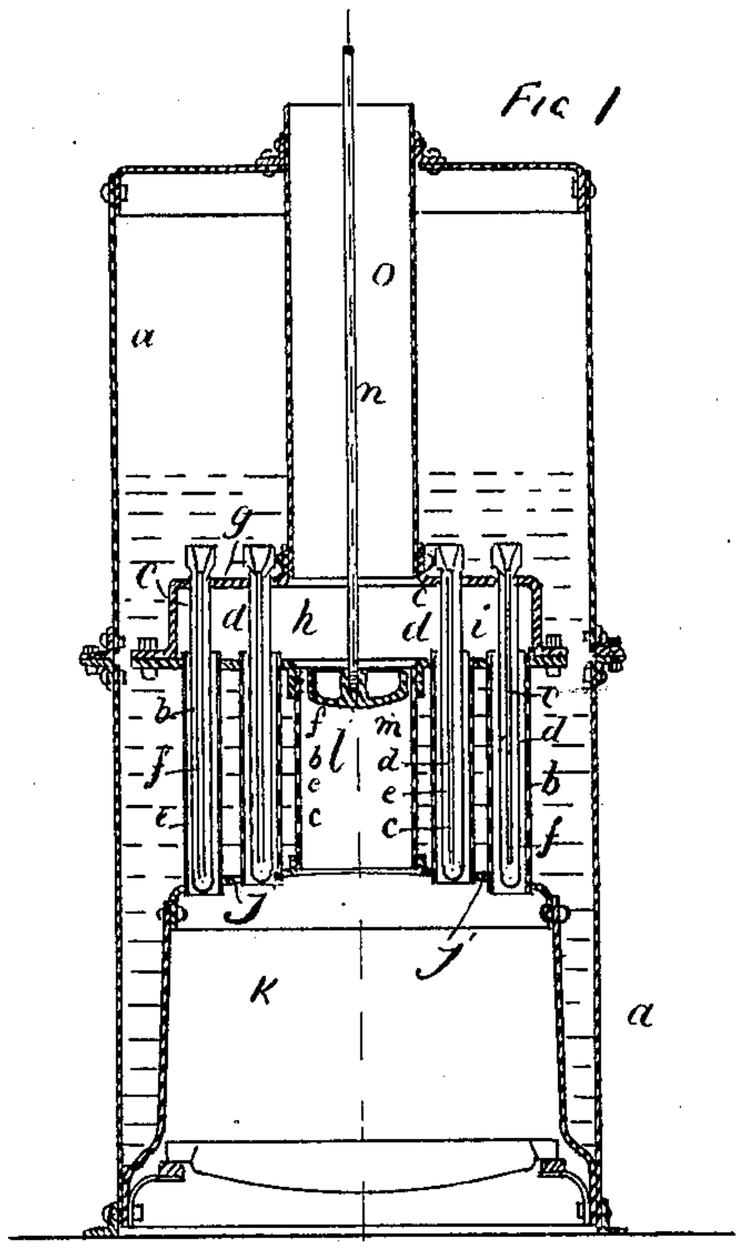


Fig 1



Witnesses.
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F. L. Browne

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(No Model.) 2 Sheets—Sheet 2.

F. S. MORRIS.

MULTITUBULAR STEAM BOILER.

No. 338,861. Patented Mar. 30, 1886.

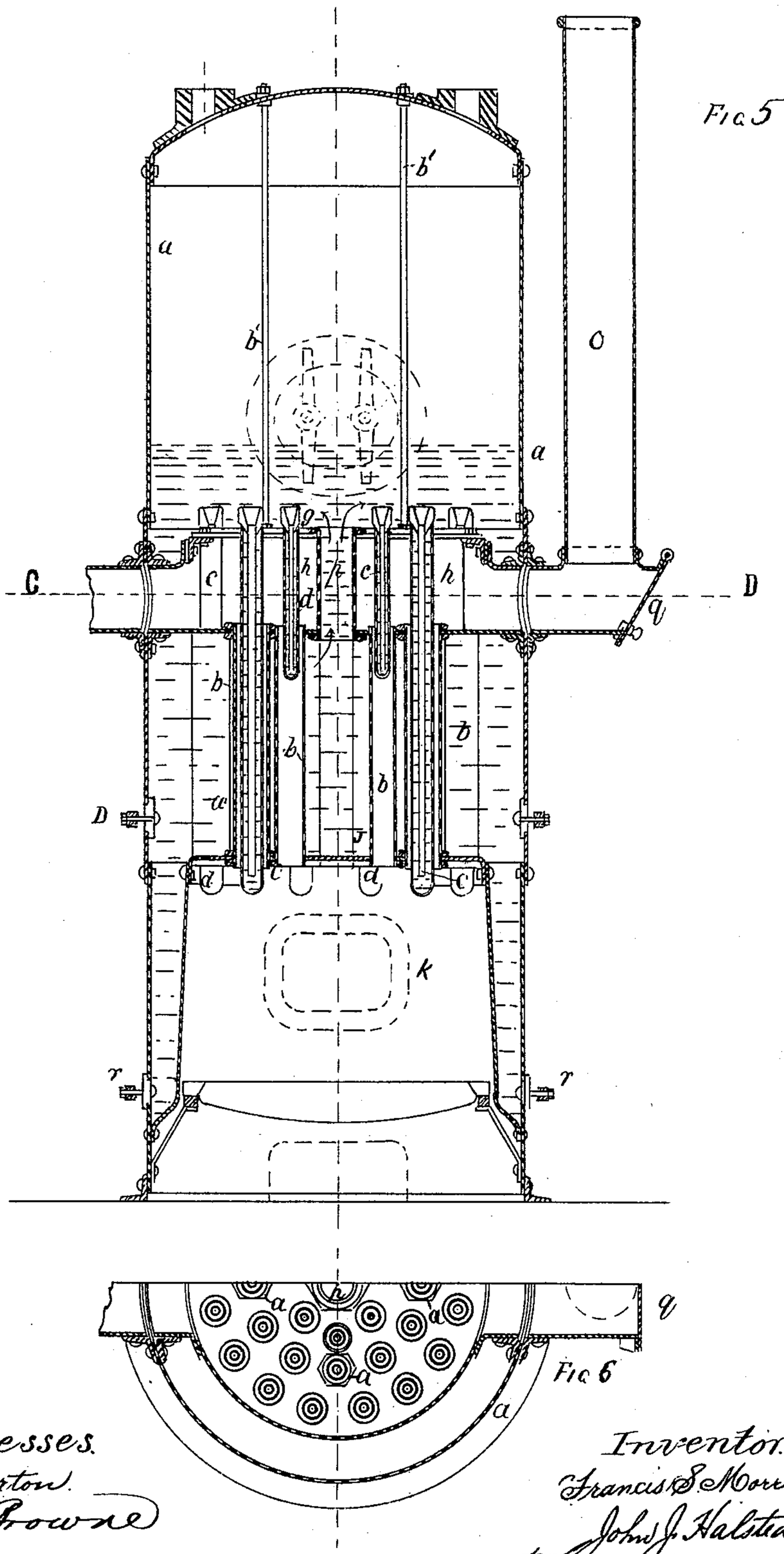

Fig 5

Fig 6

Witnesses.
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UNITED STATES PATENT OFFICE.

FRANCIS S. MORRIS, OF LONDON, ENGLAND.

MULTITUBULAR STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 338,861, dated March 30, 1886.

Application filed September 22, 1885. Serial No. 177,841. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS SANDERS MORRIS, a subject of the Queen of Great Britain, residing at London, England, have invented new and useful Improvements in Multitubular Steam-Boilers, of which the following is a specification.

This invention relates to improvements in multitubular steam-boilers, the improvements having for their object to provide an increased and more efficient heating-surface than hitherto, whereby steam is more rapidly generated and at a less expense of fuel than by the ordinary construction of boiler.

My invention consists in a special construction, and in which tubes known as "field-tubes", or analogous tubes, are employed in combination with fire-tubes, by inserting such field or analogous tubes within the fire-tubes, all as hereinafter more particularly set forth.

In carrying out my invention the fire-tubes are of sufficient area to allow of an annular space being left between and around the field-tubes. The field-tubes hang pendently from a tube-plate, which plate forms the top of a chamber which I propose to call the "secondary combustion-chamber." In the bottom plate of this chamber are fixed the fire-tubes, their lower ends being expanded into the bottom tube-plate, which forms the top of the ordinary or primary combustion-chamber or fire-box. The field-tubes are regulated in length by the fire-tubes, being continued in length till they are flush with the bottom tube-plate, or they may extend below the fire-tubes, and their extremities conjointly with their orifices of the fire-tubes are mostly immediately above the furnace and directly exposed to the action of the flames. The products of combustion being conducted through the annular spaces around the field or analogous tubes, become thoroughly and substantially divided and well utilized before they reach the secondary combustion-chamber, and finally pass out from the boiler through an uptake connected with this upper chamber. I sometimes dish the tube-plate, forming the top of the primary combustion-chamber or fire-box, and into which, as above stated, are expanded the lower ends of the fire-tubes. The convexity of the plate will be toward the interior of the water-space. By this means the disposition of extraneous matter in the "pockets" is greatly facilitated, and will so prevent the accumulation of scale and incrustation around and between the tubes; but I do not in all cases so dish the tube-plate. In some cases I find it advantageous to employ a large central fire-tube without a field-tube, and having, if required, a baffle. This central tube facilitates the clearing of the secondary combustion-chamber and assists in regulating the draft.

In order to enable my invention to be fully understood, I will proceed to describe the same by reference to the accompanying drawings, in which—

Figure 1 represents a vertical section of a vertical multitubular steam-boiler constructed according to my invention, and in which all the field-tubes are shown of uniform length, and having their lower ends level with the extremities of the fire-tubes. The boiler is shown provided with a large central fire tube. Fig. 2 is a horizontal section of the same. Fig. 3 is a vertical section, drawn to a larger scale, of one of the combined field and fire tubes, showing also a portion of the top and bottom plates of the secondary combustion-chamber and top plate of the fire-box. Fig. 4 is a horizontal section on line A B of Fig. 3. Fig. 5 is a section of a vertical boiler having a central water-tube and field-tubes of unequal lengths, some of the latter projecting downward beyond the bottoms of the fire-tubes. Fig. 6 is a horizontal section on line C D of Fig. 5.

Similar letters in all the figures represent similar or corresponding parts.

Referring to Figs. 1 and 2, *a* represents the shell of the boiler, which shell is of ordinary construction. *b b*, Figs. 1, 2, 3, and 4, are the fire-tubes. *c c* are the circulating-tubes, placed within water-tubes *d d*, the said tubes *c* and *d* together forming what are known as "field-tubes," which are inserted within the fire-tubes *b*, as clearly shown in Figs. 3 and 4. *e e* are the spaces left around the field-tubes *c d*, and between the same and the fire-tubes *b*. *f f* are the usual water-spaces between the tubes *c* and *d*. *g* is the tube-plate from which the field-tubes *c d* are pendently hung, and *h* is the chamber which I call the "secondary combus-

tion-chamber," of which the tube-plate *g* forms the top. *i* is the bottom-plate of the chamber *h*, from which plate *i* are suspended the fire-tubes *b*. *j* is the bottom tube-plate, which forms the top of the ordinary or primary combustion-chamber or fire-box, *k*, and into which are expanded the lower ends of the fire-tubes *b*. In this arrangement the lower ends of the field-tubes *c d* are shown level with those of the fire-tubes *b*, which latter are flush, or nearly so, with the bottom tube-plate, *j*. They are, in fact, expanded into the said plate in the ordinary manner. *l* is the large central fire-tube leading from the fire-box *k* to the secondary combustion-chamber *h*. *m* is the baffle in the fire-tube *l*, which baffle *m* can be operated by means of a rod, *n*, so as to raise and lower the same for the purpose of regulating the draft through the fire-tubes *b*. *o* is the uptake for conveying the products of combustion from the chamber *h* out of the boiler. I have here shown the tube-plate *j* (forming the top of the primary combustion-chamber or fire-box) dished, the convexity being toward the interior of the water-space, as shown.

By placing the water-tubes *d* entirely within the fire-tubes, as hereinbefore described and shown in Fig. 1, they will be protected from the results of careless stoking, as the risk of the water-tubes becoming loosened through being struck is entirely obviated. This I consider in some cases to be an important improvement on an ordinary hanging water-tube boiler. The products of combustion formed in the primary combustion-chamber *k* are conducted through the annular spaces *e* around the water-tubes *d* in the direction shown by the arrows in Fig. 2, and become thereby thoroughly and substantially divided, and well utilized before they reach the secondary combustion-chamber *h*, whence they pass through the uptake *o* and out of the boiler. The circulation of the water in the field-tubes *c d* takes place in the usual manner—that is to say, from the inside of the shell *a* of the boiler down through the tubes *c*, and then up through the tubes *d* in the direction shown by the arrows in Fig. 3.

The secondary combustion-chamber *h* is of great importance with a sharp draft and when burning certain kinds of fuel, as the escaping volatile portions of the fuel become reignited upon reaching this chamber *h*, which thereby becomes a most efficient heating-surface.

In the boiler shown in Figs. 5 and 6 the arrangement of the field-tubes and fire-tubes is substantially the same as that hereinbefore described when referring to Figs. 1, 2, 3, and 4; but I have shown the boiler provided with a center water-tube, *p*, to facilitate circulation from the under side of the upper fire-tube plate, *i*. The steam formed around the fire-tubes *b* and under the fire-tube plate *i* is thereby assisted in escaping, thus materially aiding the general circulation of the water in the boiler. The boiler is also provided with small field-tubes and fire-tubes, as shown, to allow of sufficient space being left between the larger tubes, as the space occupied by the insertion of the central or auxiliary water-tube prevents a sufficient number of tubes of equal diameter being advantageously arranged in the tube-plates.

a' a' a' a' are stay-tubes for staying the upper and lower fire-tube plates, *i* and *j*. In addition to the stay-tubes *a'*, I also employ the usual stays, *b'*, connecting the tube-plate *g* with the top of the boiler. I consider it advantageous to employ the stay-tubes *a'*, inasmuch as it is dangerous to allow the tube-plates *i* and *j* to depend entirely for their support on the ordinary fire-tubes, as the tubes in time become worn away.

o represents the uptake, which, by reason of the central water-tube, *p*, being employed, is placed at the side of and outside the boiler, instead of passing through the center thereof, as in Fig. 1. For the purpose of equalizing the distribution of the heat, I sometimes employ two of such uptakes *o*, communicating with the chamber *h*, one placed at each side of the boiler. *q* is a door to allow of cleaning out the chamber *h*.

r r are hand-holes for cleaning out other parts of the boiler. The bottom tube-plate, *j*, is shown flat instead of being dished, as in Fig. 1, and the larger field-tubes *c d* are shown slightly extended below the bottom ends of the fire-tubes *b*.

The lower ends of the field-tubes *c d* and fire-tubes *b* are, as will be seen by referring to Figs. 1 and 5 of the drawings, immediately above the furnace *k*, and will therefore be directly exposed to the action of the flames.

It will be observed that ample provision is made for thoroughly cleaning my improved boilers from scale and other extraneous matter common to all classes of boilers.

Among the many advantages to be derived from the use of boilers constructed according to my invention, the following may be mentioned as those of primary importance: A great economy is effected in the consumption of fuel, owing to the increased and more efficient heating-surface. My improved arrangement of tubes admits of a considerable reduction in the size of a boiler as compared with those of ordinary construction.

While retaining all the valuable features of a field or analogous pendent water-tube, I produce a greater efficiency as regards the localization and concentration of the products of combustion around the field or analogous water-tubes, and at the same time I utilize heat not previously employed to raise steam in ordinary water-tube boilers by transmitting the said heat to the water around the fire-tubes.

The objection often experienced in boilers having pendent water-tubes—*videlicit*, the liability of the tubes becoming loose—can be obviated by my arrangement of shrouding the said water-tubes.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. A multitubular steam-boiler having a series of fire-tubes extending down to the fire-chamber, a series of field or analogous tubes inserted in said fire-tubes, a large central fire-tube, *l*, communicating with the secondary combustion-chamber *h*, and a baffle at the top of the fire-tube *l* for regulating the draft through the fire-tubes, all substantially as shown, and for the purposes described.

2. A multitubular steam-boiler having a series of fire-tubes extending down to the fire-chamber, a series of field or analogous tubes inserted in said fire-tubes, a large central fire-tube, *l*, communicating with the secondary combustion-chamber *h*, a central uptake or chimney above the same, and a baffle at the top of the fire-tube *l*, operated by means of a rod, *n*, passing up through the central chimney, all substantially as shown, and for the purposes set forth.

FRANCIS S. MORRIS.

Witnesses:
G. J. REDFERN,
F. W. PRICE.