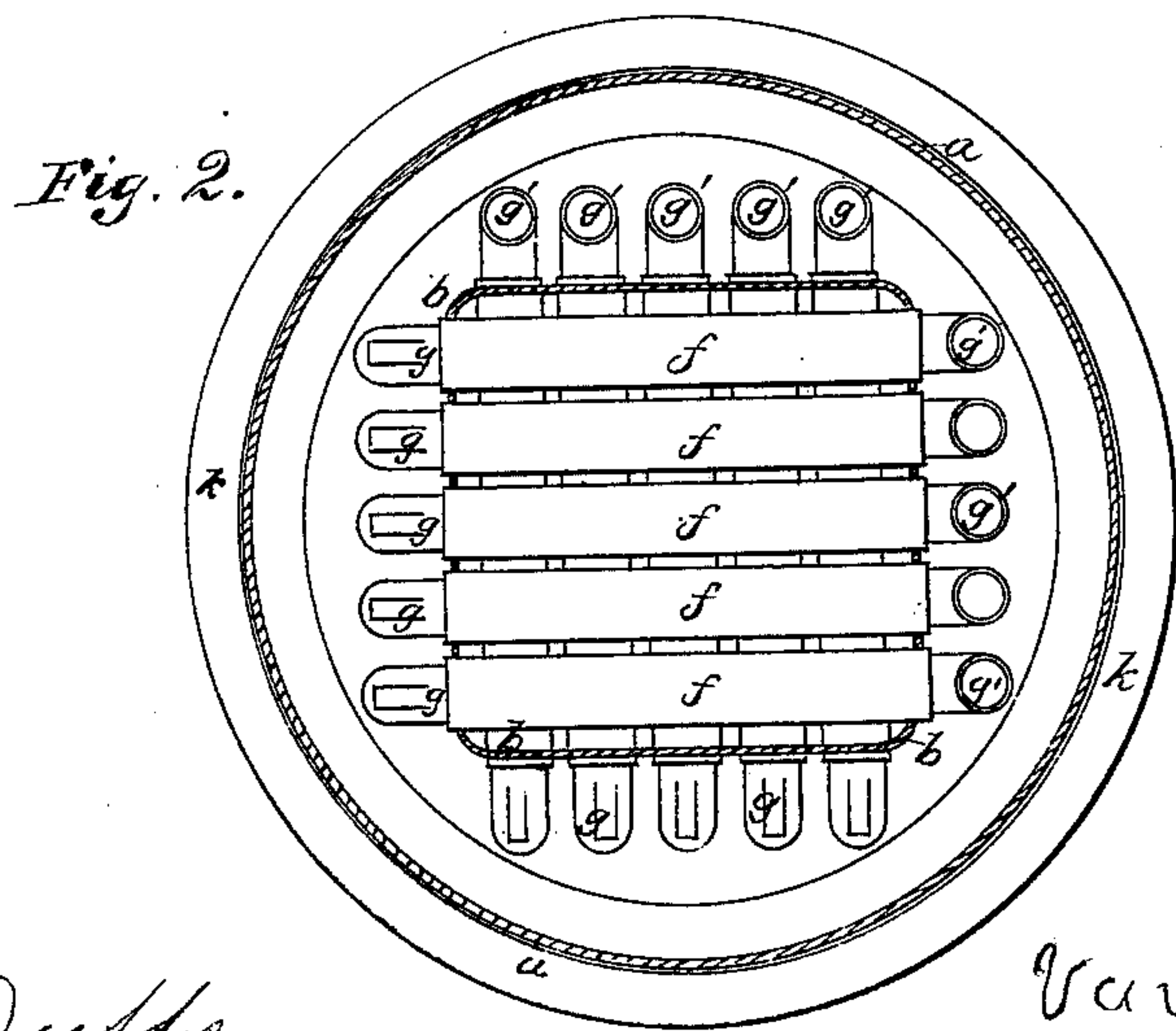
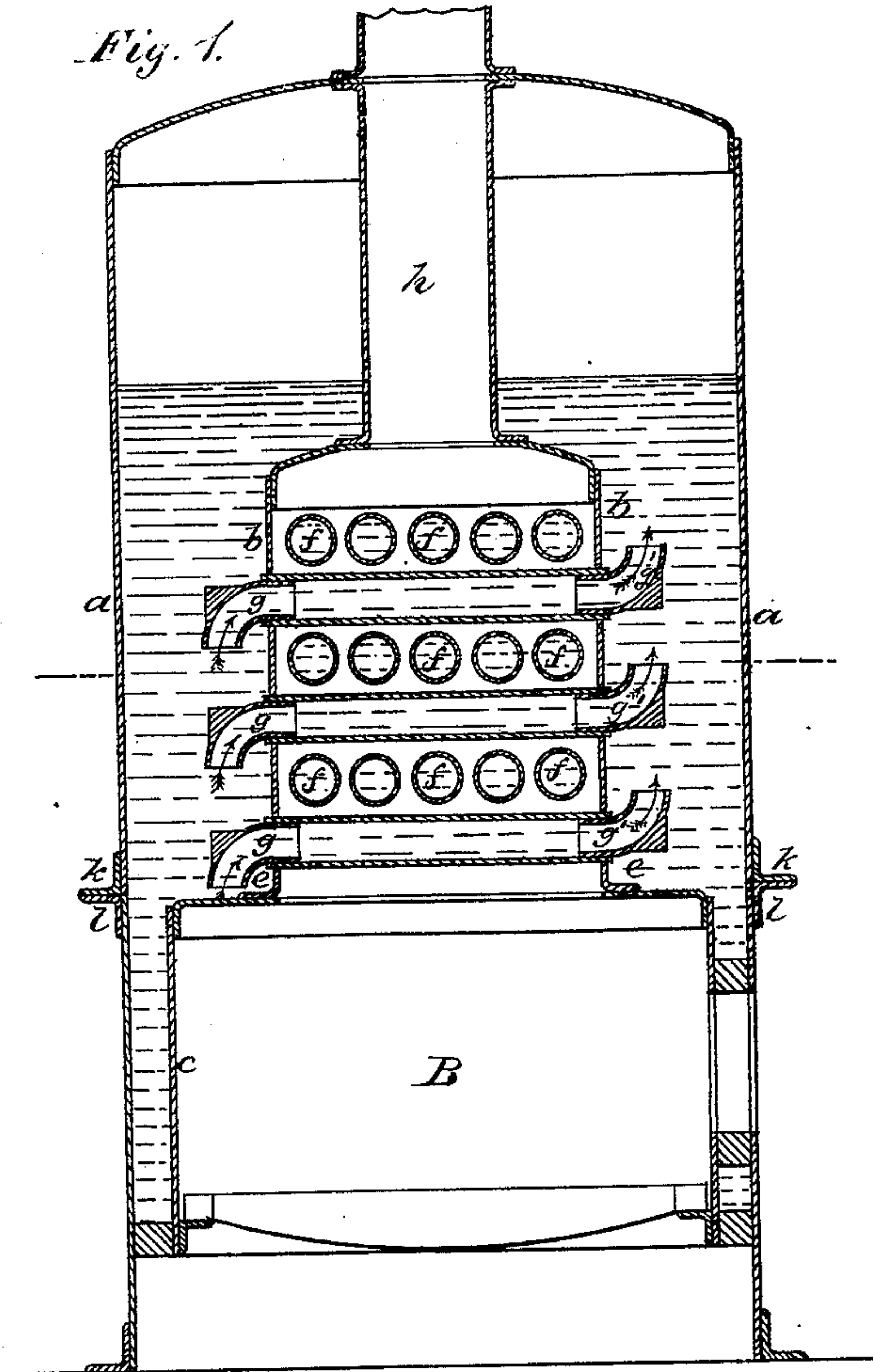


V. PENDRED.
Vertical Steam-Boiler.

No. 218,397.

Patented Aug 12, 1879.



Witnesses.
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UNITED STATES PATENT OFFICE

VAUGHAN PENDRED, OF LONDON, ENGLAND, ASSIGNOR TO GEORGE H. CHRISTY, OF PITTSBURG, PENNSYLVANIA.

IMPROVEMENT IN VERTICAL STEAM-BOILERS.

Specification forming part of Letters Patent No. **218,397**, dated August 12, 1879; application filed May 17, 1879; patented in England, March 14, 1871.

To all whom it may concern:

Be it known that I, VAUGHAN PENDRED, of London, county of Surrey, England, have invented or discovered a new and useful Improvement in Vertical Steam-Boilers; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—like letters indicating like parts—

Figure 1 is a sectional elevation of a vertical boiler embodying my invention. Fig. 2 is a horizontal cross-section in the plane of the line *x x*, Fig. 1.

My invention is applicable to boilers of various styles and shapes; but it is most conveniently employed in upright cylindrical boilers, or in boilers having a form approximating thereto.

The outer shell of such a boiler is represented at *a*. The inner shell, *b*, is, by preference, square, or nearly so, in horizontal cross-section, with rounded corners, as shown. The space between the shells is the water and steam space, and the heat or flame and products of combustion pass along the space inclosed by the inner shell.

The present invention consists in the construction and mode of operation of heating and circulating tubes in boilers having the general features referred to, substantially as hereinafter described and claimed.

Across from one wall to the other of the inner shell, *b*, I carry a series of water-heating tubes, *f*, in any desired number and order of arrangement, the ends of the tubes making tight joints with the shell.

In one mode of embodying the invention I arrange curved, bent, or angular nozzles *g g*, Figs. 1 and 2, on or in the ends of these tubes, those *g* at one end being arranged with their open mouths in a downward direction, and the nozzles *g'* at the opposite end being arranged with their open mouths in an upward direction, whereby under the effects of the heat a circulation of the water will be established and kept up by an inflow at the nozzles *g* and an outflow at the nozzles *g'*. These

tubes *f* are arranged, preferably, in layers, as shown, the tubes of one layer being side by side, at short distances apart, and those of the next layer being similarly arranged, but extending in a direction crosswise or transverse to the tubes of the first layer; but, if so desired, all the tubes may extend in the same direction, each tube of one layer then coming above or below the space between two tubes of the next layer below or above. Nor is it essential that all the nozzles on one side of the inner shell, *b*, should open in the same direction, as some may open up and some down, though the nozzles of the opposite ends of each tube should open in opposite directions—one up and the opposite one down.

The nozzles may be single or double, or other like modifications of structure may be introduced, which accomplish substantially the same result in substantially the same way.

The mode of making and putting together these parts may be varied at pleasure. Such a system of heating and circulation tubes may be arranged over any suitable fire-chamber, *B*, or in the line of the flow or passage of heat or flame and products of combustion from any suitable heat-producing apparatus to any suitable chimney, stack, or conduit, as *h*.

In such a structure the water is caused to flow in somewhat of a zigzag or circuitous direction, and all parts of the body of water, or nearly all, will be caused to pass through the tubes, so as to be raised uniformly and quickly to the desired high temperature; also, the heat, flame, and products of combustion passing through the spaces between the tubes *f* will be so broken up or subdivided as to exert, practically, the maximum of heating effect on the pipes and the water passing through them.

While, as already stated, the parts described may be made and put together in any desired way, it will be found convenient to make the inner shell of a single sheet, and flange its lower end, as at *e*, as a means of securing it to the bottom plate; also, to get at the inside for cleaning, flanged joints *k l*, secured by removable bolts, may be made in the shell *a*, in which

case like detachable joints should be made where the smoke-pipe *h* passes through the top or cap of the boiler.

I claim herein as my invention—

In combination with the heat-conduit flue of a steam-generator, a series of water heating and circulating tubes, *f*, arranged horizontally across such flue, and upwardly and down-

wardly opening or inclined nozzles at the ends of the tubes, substantially as set forth.

In testimony whereof I have hereunto set my hand.

VAUGHAN PENDRED.

Witnesses:

M. E. WELDON,

WM. HAMILTON HART.