(No Model.) 3 Sheets—Sheet 1.

J. BAIRD.

STEAM BOILER.

No. 460,906. Patented Oct. 6, 1891.

Fig. 1.

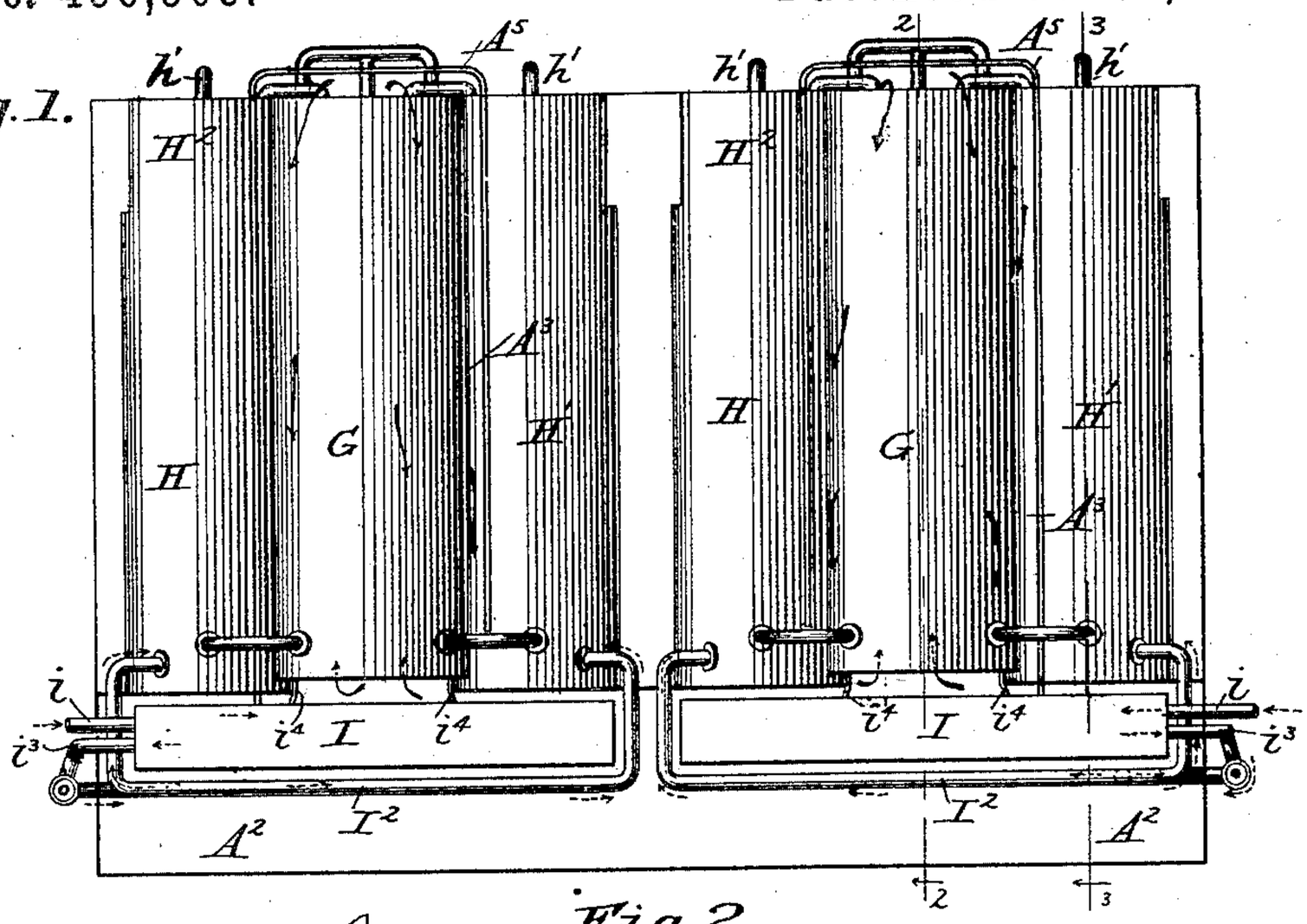

Fig. 2.

ON LINE 2—2

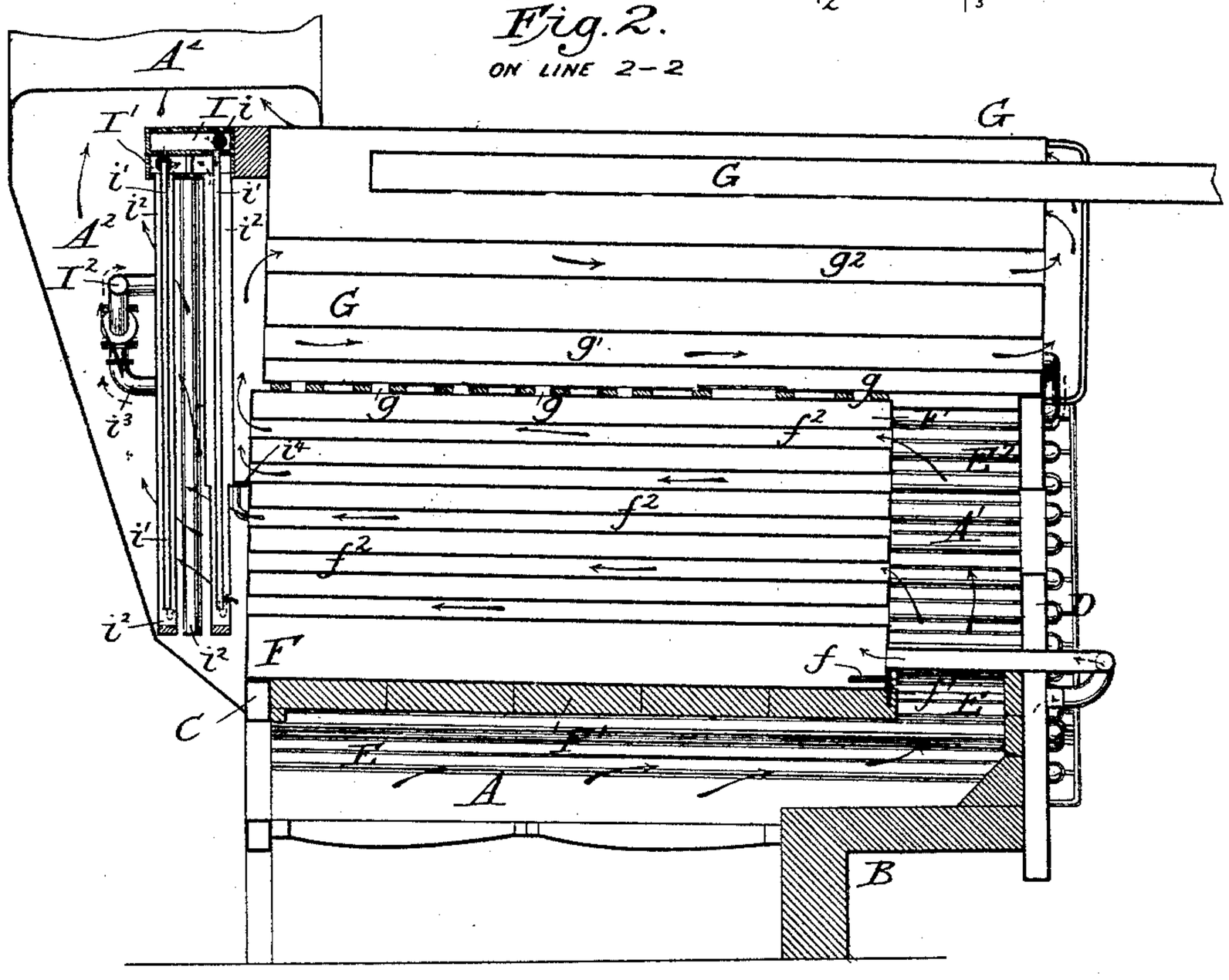

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Fig. 3
ON LINE 3-3

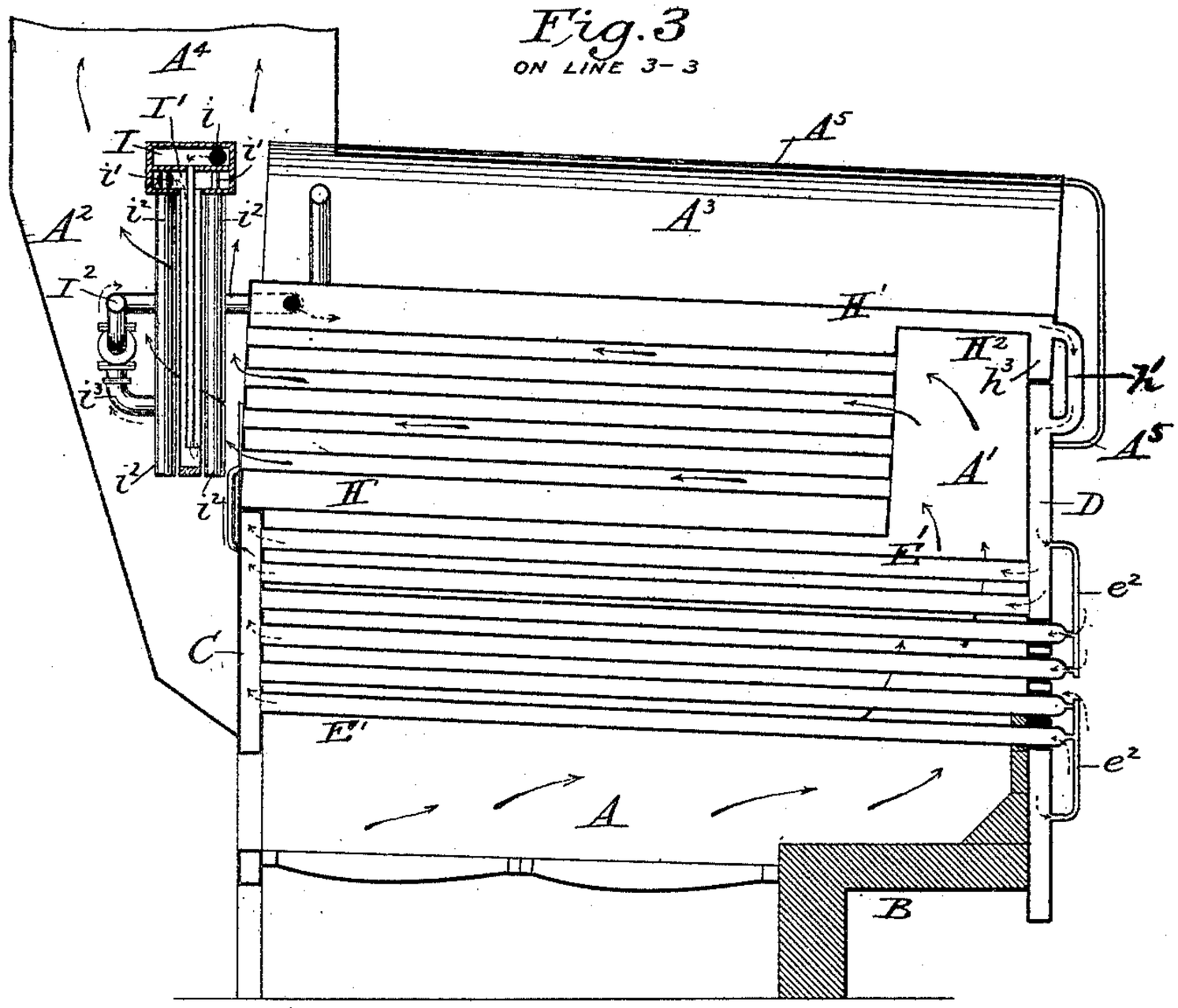


Fig. 4.

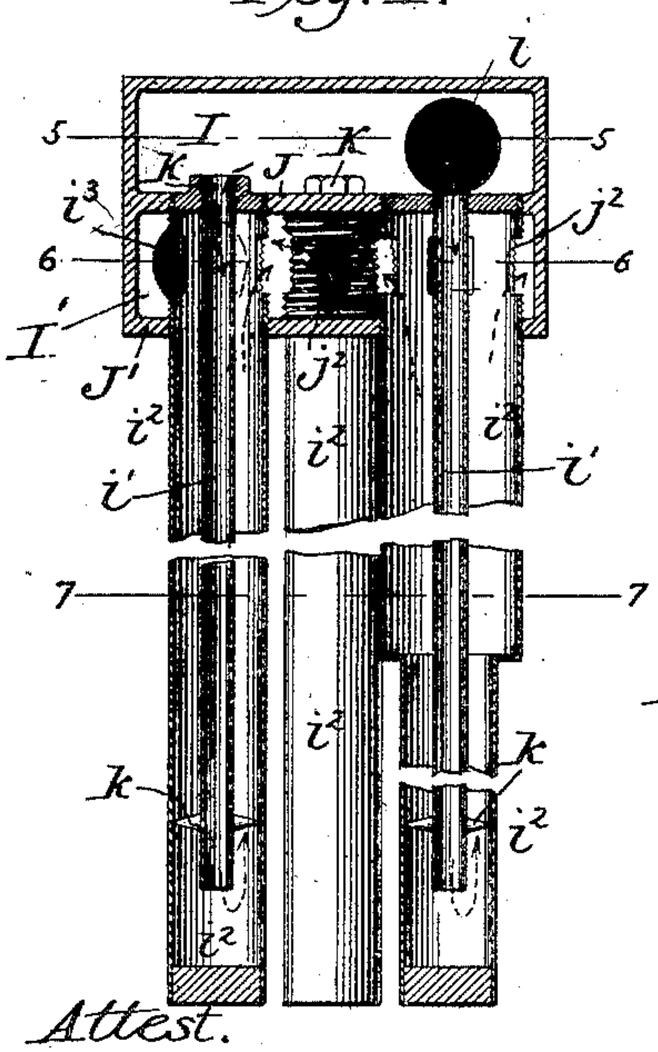


Fig. 5.
ON LINE 5-5

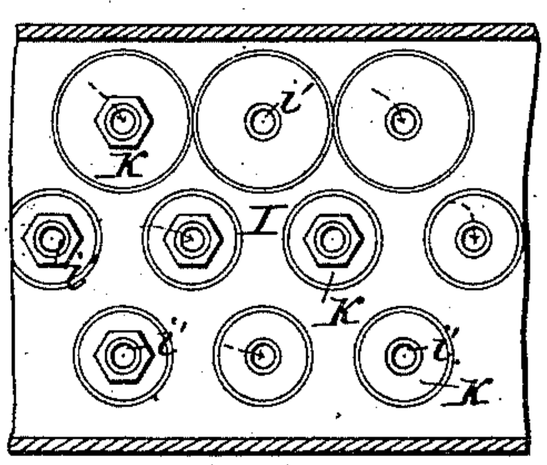


Fig. 6
ON LINE 6-6

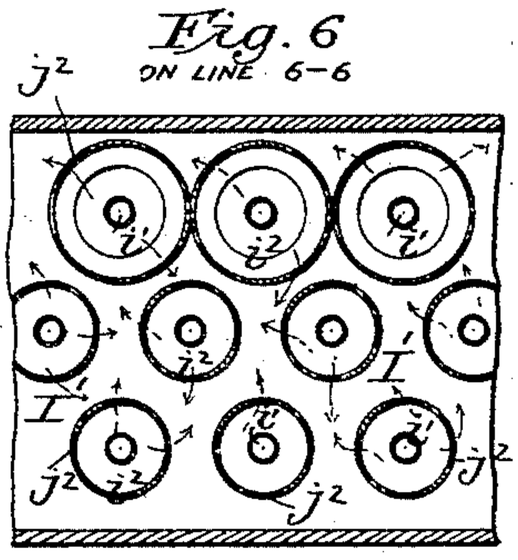


Fig. 7
ON LINE 7-7

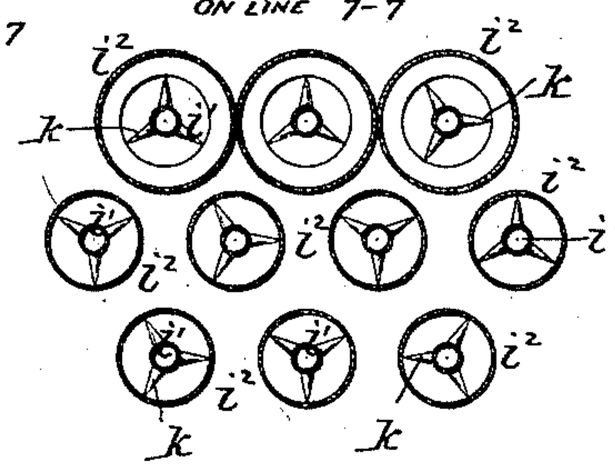
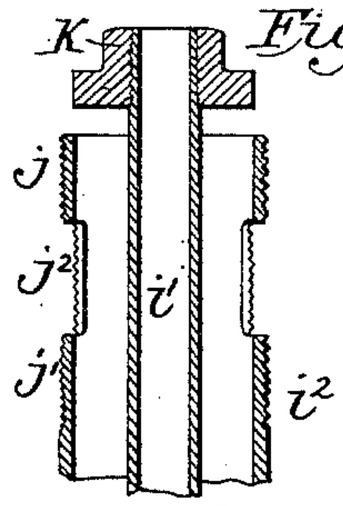


Fig. 8.



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(No Model.) 3 Sheets—Sheet 3.

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STEAM BOILER.

No. 460,906. Patented Oct. 6, 1891

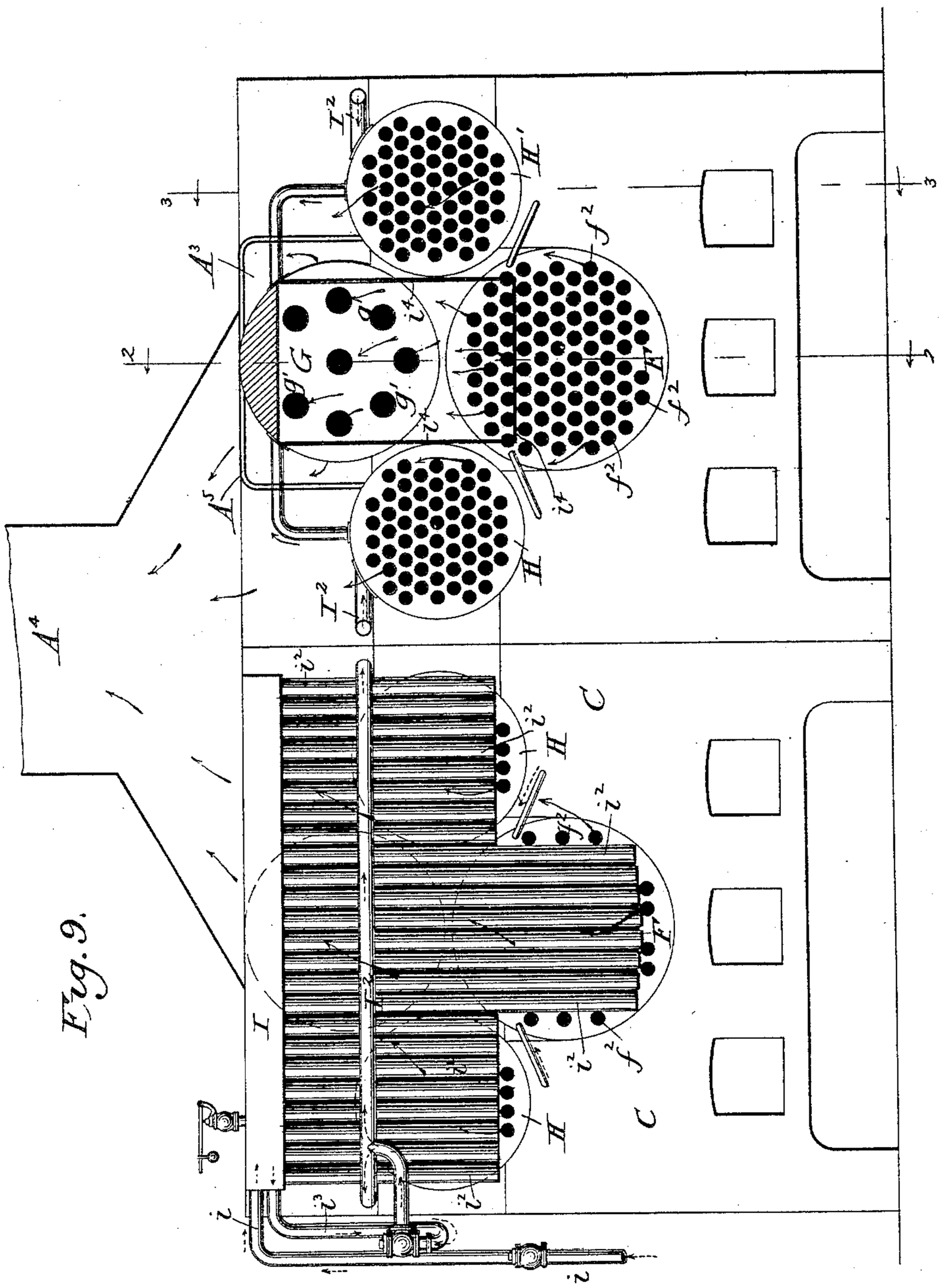

Fig. 9.

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UNITED STATES PATENT OFFICE.

JOHN BAIRD, OF NEW YORK, N. Y.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 460,906, dated October 6, 1891.

Application filed February 27, 1891. Serial No. 383,096. (No model.)

To all whom it may concern:

Be it known that I, JOHN BAIRD, mechanical engineer, a citizen of the United States, residing at No. 324 Lexington avenue, in the city, county, and State of New York, have invented certain new and useful Improvements in Steam-Boilers, of which the following is a specification.

My invention more especially relates to marine and stationary steam-boilers of the class having their flues horizontal or but slightly inclined. Its objects are to increase the efficiency of the boiler by raising the temperature of the feed-water to the highest practicable extent before it enters the boiler and to superheat the steam as it leaves the boiler, which ends I attain by certain organizations of instrumentalities hereinafter specified.

Experience has taught me that the products of combustion escape from the fire-tubes of a boiler at a temperature, usually about 600° Fahrenheit, which heat is rapidly carried off by the uptake and chimney. I have discovered that by so organizing the feed-water-heating apparatus as to take up a portion of the heat and detain it at this point I am not only enabled to heat the feed-water, but to increase the steam-generating capacity of the boiler itself. In order to do this in the most efficient manner, I suspend concentric feed-water tubes in front of or opposite the fire-tubes, so that the products of combustion impinge directly upon them, thus reducing the temperature of the hot gases, as far as I can ascertain, from a temperature, say, of about 600° to one of about 400° on reaching the chimney, the temperature of the feed-water being increased by about 100°. I further so organize these feed-water-heater tubes as to cause a portion of the products of combustion to circulate around the steam-pipes in the upper portion of the boiler to dry or superheat the steam therein.

My improvements are readily adaptable to almost any horizontal tube-boiler, but are particularly adaptable to one of the type shown in United States Letters Patent No. 437,745, granted to me October 7, 1890, which shows what I call a "four-shell" boiler.

In the accompanying drawings, which show so much of such a boiler embodying my improvements in the best way now known to me as is necessary to illustrate the subject-matter herein claimed, Figure 1 is a plan; Fig. 2, a vertical longitudinal central section therethrough on the line 2 2 of Fig. 1, and Fig. 3 a similar section through one of the side shells on the line 3 3 of Fig. 1; Fig. 4 a vertical transverse section through the feed-water heater on the line 4 4 of Fig. 1 on an enlarged scale; Figs. 5, 6, and 7, horizontal sections on a still larger scale on the correspondingly-numbered lines of Fig. 4, showing the details of the feed-water heater; and Fig. 8, a vertical central section through the upper portion of an inner and outer tube enlarged. Fig. 9 shows a front elevation of the boiler with the casing removed on one side and with the casing and feed-water tubes removed on the other.

Unless otherwise indicated the parts are of ordinary construction.

That end of the boiler at which the firing is done I call the "front," the opposite end the "back" or "rear." That side of the boiler on the left of a person facing its front I call the "left," the opposite side the "right." Short unfeathered darts indicate the direction in which the sections are shown. Solid feathered arrows show the course of the heat; corresponding unfeathered ones that of the steam, and dotted ones that of the water.

The products of combustion pass from the fire-box A around and through the various water and fire tubes by way of the back connection A′, front hood or uptake A^2, smoke-box A^3, and chimney or smoke-stack A^4.

The front and back heads C D are made of parallel plates properly stayed, with a water-space between them, and are connected by three series of water-tubes E E′ E^2, respectively arranged alongside the side walls of the furnace under and alongside the lower shell and in the space between the lower shell and side walls. They are respectively connected with the front head and pass water-tight through sleeves in the back head, being supplied with water therefrom by tubes e^2.

The various parts of the boiler are protected by brick-work B.

The lower shell F rests on the front head and extends rearward to the front end of the back connection, a suitable space being left between the shell and back head to form this connection. The bottom of this shell is cov-

ered with fire-brick F′, which is prevented from slipping back by a bolt *f*, passing through a plate *f′*, inserted therein. The bolt is made long enough so as to project some distance into the shell, so as to be surrounded by water, the temperature of which is much less than that of the back connection. Consequently the heat of the bolt is imparted to the water. The lower shell is filled with fire-tubes f^2.

The upper shell G lies over and parallel with the lower shell, with which it is connected at frequent intervals by pipes *g*. The front of this shell does not extend quite as far forward as that of the lower one, but it extends beyond it, over the back connection, and rests upon the back head. It is likewise traversed by fire-tubes *g′* g^2. This shell is normally about half full of water, leaving its upper portion for a steam-space. A perforated steam-pipe G′ leads from the upper part of this shell to the engine.

Intermediate or supplementary shells H H′ are arranged on opposite sides of and parallel with the upper and lower shells, their front ends being supported by the front head and their fire-tubes running to the front end of the back connection. A hood H^2, containing a water-space, connects these shells with a water-box h^3, which rests on the back head. A water-tube *h′* connects this water-box and head.

A casing A^5 incloses the top of the upper shell, leaving spaces A^3 around it, constituting a smoke-box, into which the flues of the upper shell open at the back, while the front of the smoke-box opens into the chimney.

Feed-water flows through a pipe *i*, provided with a suitable check-valve, into a horizontal box or channel I, arranged across the front of the boiler at or above the level of its top. Thence it descends through a series of pendent tubes *i′* inside of larger tubes i^2, through which it rises into a similar channel I′, (shown as parallel with and beneath the upper one,) from which it flows through a pipe i^3, connecting with an inlet-pipe I^2, terminating in the tops of the supplementary shells. The tubes *i′* i^2 are shown as arranged in rows in front of the boiler-shells, where they are in the direct path of the products of combustion escaping through the fire-tubes. These feed-water tubes are preferably arranged a short distance apart, so as to allow the products of combustion to circulate freely around them. The row of tubes in front of and next to the central portion of the upper and lower shells are differently arranged, the outer tubes being made larger in their upper portions, so as to touch each other and prevent the passage of the products of combustion therethrough. Deflecting-plates i^4 are so arranged as to close the space between these feed-water tubes, some portion of the upper fire-tubes of the lower shell, and all the tubes of the upper shell. As a consequence of this arrangement, while the heat from the lower fire-tubes of the lower shell circulates freely around the lower portion of the central feed-water tubes the products of combustion which pass through the upper fire-tubes of the lower shell are deflected by the upper portion of the central feed-water tubes and the deflecting-plates i^4 into the fire-tubes *g′* of the upper shell, through which they pass, and return through the smoke-box or spaces A^3 surrounding this shell, thus drying and superheating the steam in the upper shell and in the exit steam-pipe G′. The heat escaping from the fire-tubes of the side shells H H′ impinges upon and circulates among the pendent feed-water-circulating pipes opposite them, and thence passes up through the front hood.

In my patent, No. 437,745, the boiler was provided with a front hood, while the chimney was at the back. Portions of the hot gases passed directly back through the fire-tubes of the upper shell, while other portions passed directly back through a smoke-box surrounding this shell, in which horizontal feed-water-heater pipes were located, and were consequently exposed only to that portion of the heat passing through the smoke-box. Under my present organization the chimney is directly over the uptake, the feed-water boxes or channels are arranged directly across the uptake, while the water-circulating tubes are suspended in the uptake directly opposite the flues or fire-tubes of all the boiler-shells, thus exposing them not only to a higher temperature but to a much larger proportion of the hot gases; and I am also thus enabled to utilize the pendent pipes as a deflector to cause a portion of the hot gases to traverse the fire-tubes of the upper shell, as well as to return through the smoke-box from the back hood to the chimney, thus aiding in superheating the steam.

The products of combustion finally escape up through the chimney, passing on both sides of the feed-water channels I I′.

The inlet-tube I^2, it will be observed, passes horizontally through the uptake, in front of the pendent tubes, and enters the side shells of the boiler just below the water-line, owing to which the feed-water is additionally heated, even after leaving the pendent tubes, by the hot gases in the uptake, whereby its temperature is correspondingly increased.

My improvements are especially applicable to marine boilers. In such boilers the motion of the ship might rack or strain the connections of the pendent tubes with the channels, and thus produce leaks. I provide against such a contingency by the following construction: Screw-threads *j j′* on the upper ends of the outer tubes i^2 engage with corresponding female screw-threads in openings in the intermediate channel-plate J and bottom plate J′ of the lower channel, thus forming a tight joint and secure fastening and bracing the tubes against lateral vibration. Openings j^2 in the outer tubes, between the screws *j j′*, allow the water to circulate freely through the tubes in the lower channel. A hollow plug K

is screwed or otherwise securely fastened on the upper end of each inner tube i' and adapted to be similarly secured in the upper end of its corresponding outer tube i^2. Laterally-projecting spurs or pins k, projecting from the lower portions of the inner tubes, abut against the outer tubes and serve to hold them in fixed relation to each other.

The above-described construction not only secures close joints and sufficient lateral bracing, but renders each set of tubes readily removable by simply unscrewing the outer tubes from the channel-plates and then separating the inner and outer tubes. The upper plugs of the inner tubes and the lower ends of the outer tubes may be made hexagonal, polygonal, or otherwise adapted for the application of a wrench to facilitate their separation. The lower ends of the outer tubes may also be connected with each other and with the boiler or its casing by bars or braces to render them still more rigid, if desired; but this will ordinarily be found unnecessary. The deflector-plates i^4 also brace the tubes to some extent.

The boiler is supplied with suitable check-valves, safety-valves, blow-off valves, and proper connections between the various parts of the boiler for the passage of steam, water, and air when filling the boiler, most of which parts are shown, but which it is deemed unnecessary to describe in detail here, as their special construction and organization constitutes no part of the subject-matter herein claimed.

The operation of the boiler will readily be understood from the foregoing description.

What I claim as new and as of my own invention is—

1. Pendent feed-water-circulating tubes, substantially such as described, suspended directly in front of the two sets of fire-tubes of a horizontal boiler, as set forth, in combination with deflecting-plates, which in conjunction with said pendent tubes deflect the hot gases impinging thereupon from one set of tubes into the other, so as first to heat the feed-water and then superheat and dry the steam generated by the boiler.

2. Pendent feed-water-circulating tubes, substantially such as described, suspended directly in front of the fire-tubes of a series of boiler-shells, as set forth, in combination with deflecting-plates whereby a portion of the heat impinging upon the feed-water-circulating tubes is caused to circulate around and among them, while another portion is deflected through other fire-tubes to superheat and dry the steam.

3. The feed-water-heating apparatus hereinbefore described, consisting of the combination of feed-water-heater channels extending across the uptake above the normal water-line of the boilers, feed-water-circulating tubes suspended therefrom in front of the boiler-flues, and a pipe connecting the heater-channels and boiler-shells extending horizontally across the uptake to afford additional heating-surface, as set forth.

4. The combination, substantially as hereinbefore set forth, of a lower shell, an upper shell, supplementary shells, the fire-tubes of all these shells, an uptake, feed-water-circulation pipes suspended therein, and deflecting-plates which conduct a portion of the hot gases through the fire-tubes of the upper shell.

5. The combination, substantially as hereinbefore set forth, of a lower shell, an upper shell, supplementary shells, the fire-tubes of all these shells, an uptake, a smoke-box, a steam-pipe in the upper shell, feed-water-circulation pipes in the uptake, the enlarged upper ends of the central feed-water-circulation pipes, and the deflecting-plates whereby some of the hot gases are passed through the upper shell and smoke-box to dry and superheat the steam, while the remainder circulate freely among the water-circulation tubes.

6. The combination, substantially as hereinbefore set forth, of a lower shell, supplementary shells below the water-line of the boiler, the fire-tubes of these shells, an uptake, feed-water-circulation pipes suspended in the uptake opposite the discharge end of the fire-tubes, and the feed-water-inlet pipe extending across the uptake transversely to the feed-water-circulation pipes and connecting them with the supplementary shells.

7. The combination, substantially as hereinbefore set forth, of an upper shell, a lower shell, supplementary shells, their respective fire-tubes, an uptake, feed-water-heater channels at or above the normal water-line of the boilers, feed-water-circulation tubes suspended from said channels in the uptake, and a feed-water-inlet pipe extending across the uptake and connecting the feed-water-circulation pipes and channels with the shells.

8. The combination, substantially as hereinbefore set forth, of a lower shell, an upper shell, supplementary shells, the fire-tubes of all these shells, an uptake, a smoke-box, feed-water-circulation pipes suspended in the uptake opposite the discharge end of these fire-tubes, the enlarged upper portion of the central feed-water-circulation tubes, their deflecting-plates, and a feed-water-inlet pipe extending across the uptake and connecting the supplementary shells and feed-water-circulation system.

9. The combination, substantially as hereinbefore set forth, of an upper shell, a lower shell, supplementary shells, the fire-tubes of all the shells, an uptake, upper and lower feed-water channels therein, concentric feed-water-circulation tubes connecting these channels above or about the normal water-line of the boiler, and a transverse feed-water-inlet pipe connecting these channels and water-circulation pipes with the upper portion of the supplementary shells.

10. The combination, substantially as hereinbefore set forth, of supplementary shells, their fire-tubes, an uptake, upper and lower

feed-water channels above or about the normal water-line of the boiler, a feed-pipe connected with the upper channel, open-ended tubes depending from said channel, concentric outer tubes connecting said tubes with the upper channel, a feed-water-inlet pipe connecting the supplementary shells, and a pipe connecting the upper channel with this feed-water pipe.

11. The combination, substantially as hereinbefore set forth, of a lower shell, an upper shell, supplementary shells, their fire-tubes, an uptake, upper and lower feed-water inlet channels extending across the uptake above the normal water-line of the boilers, feed-water-circulation pipes extending from the channels to near the bottoms of the shells, and a transverse inlet-pipe in the uptake connecting the supplementary shells below the normal water-line.

12. The combination, substantially as hereinbefore set forth, of a lower shell, an upper shell, supplementary shells, the fire-tubes of all these shells, an uptake, a smoke-box, a steam-pipe in the upper shell, upper and lower feed-water-inlet channels in the uptake, a feed-pipe therefor, concentric inner and outer tubes depending from and connecting said channels, an inlet-pipe connecting the supplementary shells, a pipe connecting the inlet-pipe with the feed-water channels, and deflecting-plates which conduct a portion of the hot gases through and around the supplementary shells to dry and superheat the steam.

13. The combination, substantially as hereinbefore set forth, of the upper and lower feed-water channels, the outer feed-water-circulation tubes secured to the lower and intermediate channel-plates, the lateral openings therein communicating with the lower channel, the concentric inner water-circulation tubes, and their tubular plugs secured in the upper ends of the outer tubes.

14. The combination, substantially as hereinbefore set forth, of the upper and lower feed-water channels, the outer feed-water-circulation tubes secured to the lower and intermediate channel-plates and provided with openings into the lower channel, the open-ended concentric inner water-circulation tubes, their tubular plugs secured in the outer ends of their respective inner tubes, and the spurs or steady-pins interposed between the inner and outer tubes near their bottom.

In testimony whereof I have hereunto subscribed my name.

JOHN BAIRD.

Witnesses:
A. J. BAIRD,
ADDISON W. BAIRD.