(No Model.)

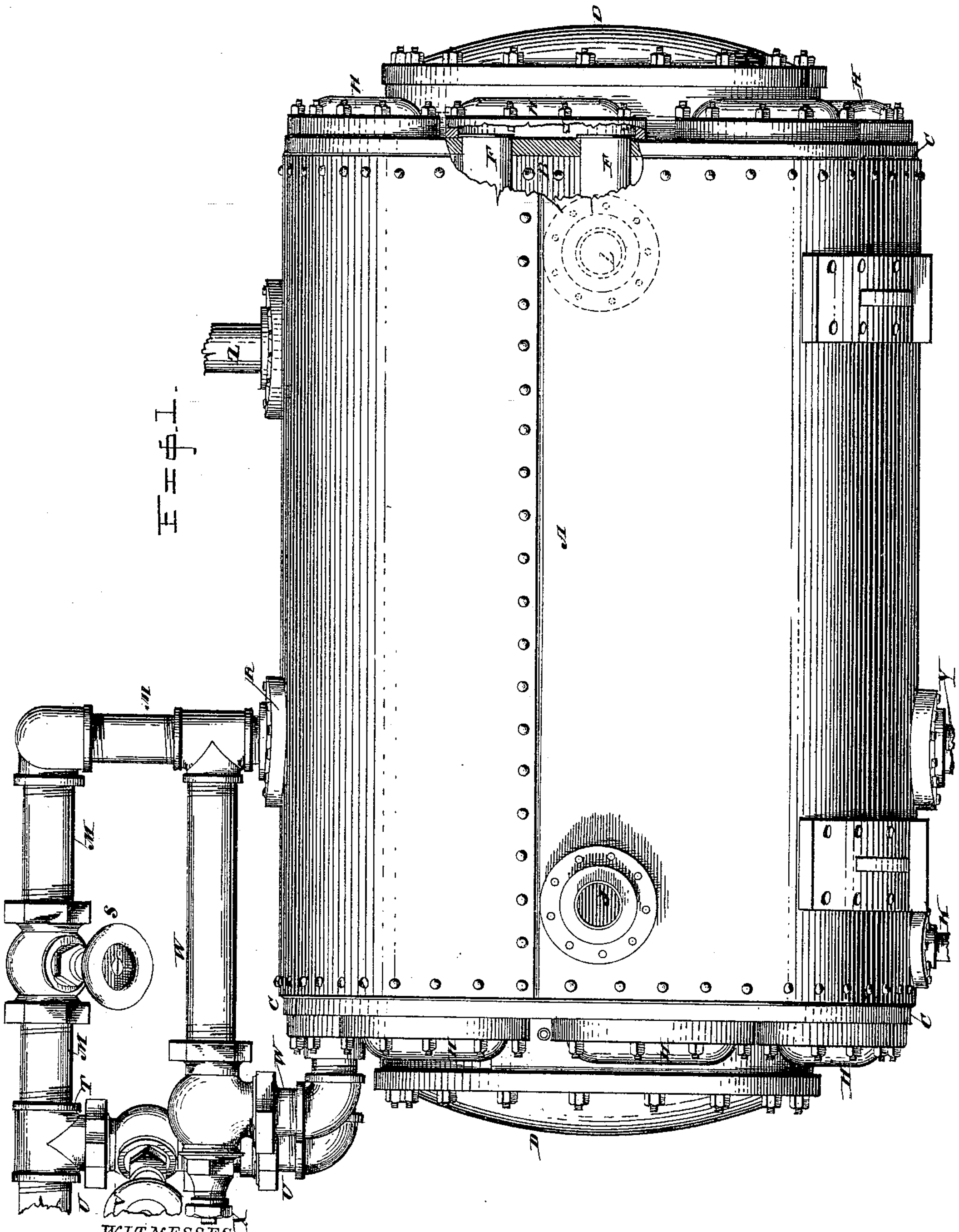
4 Sheets—Sheet 1.

W. C. ARMSTRONG.

FEED WATER HEATER.

No. 386,735.

Patented July 24, 1888.



WITNESSES

A. F. Liatman

Jas. H. Mahan.

INVENTOR,

William C. Armstrong

By H. A. Toulmin

his Attorney.

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 4 Sheets—Sheet 2.

W. C. ARMSTRONG.

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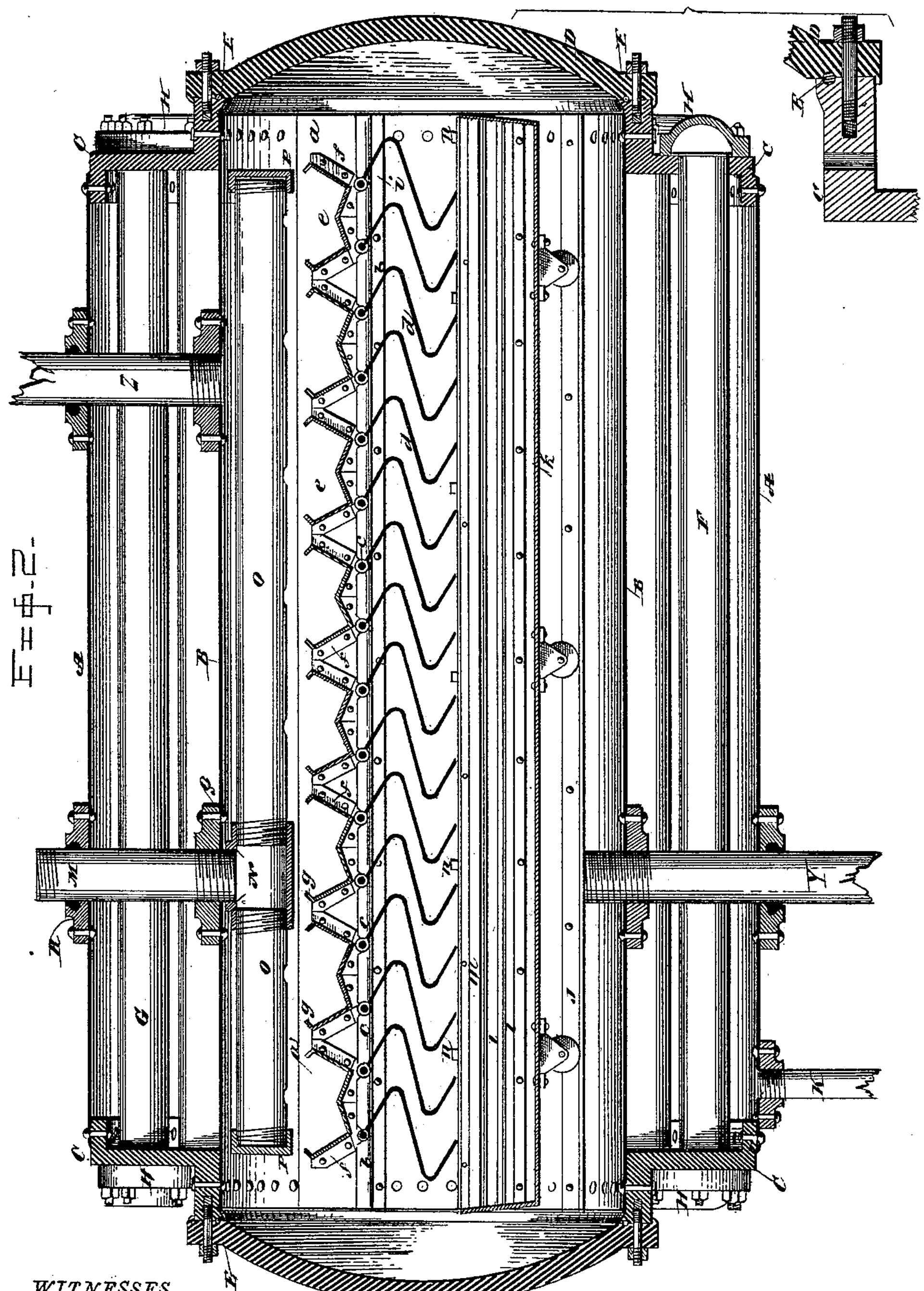

Fig. 2.

WITNESSES,

A. H. [illegible]

J. A. Mahan.

INVENTOR,

William C. Armstrong,

By H. A. Toulmin,

his Attorney.

(No Model.) 4 Sheets—Sheet 3.

W. C. ARMSTRONG.

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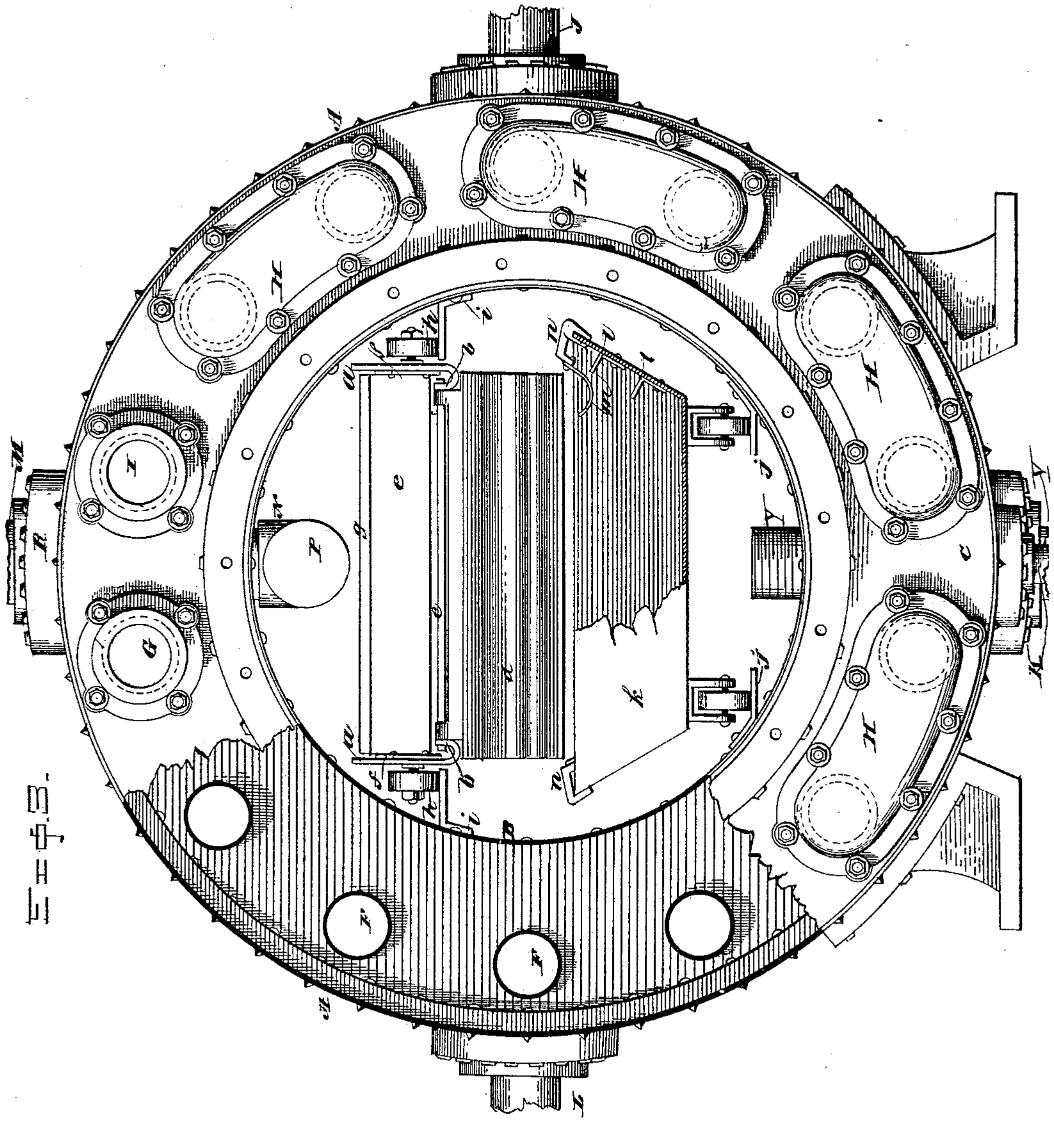


Fig. 3.

WITNESSES:

A. A. Graham
J. A. McMahon

INVENTOR,

William C. Armstrong.

By H. A. Toulmin,
his *Attorney.*

(No Model.) 4 Sheets—Sheet 4.

W. C. ARMSTRONG.

FEED WATER HEATER.

No. 386,735. Patented July 24, 1888.

Fig. 5.

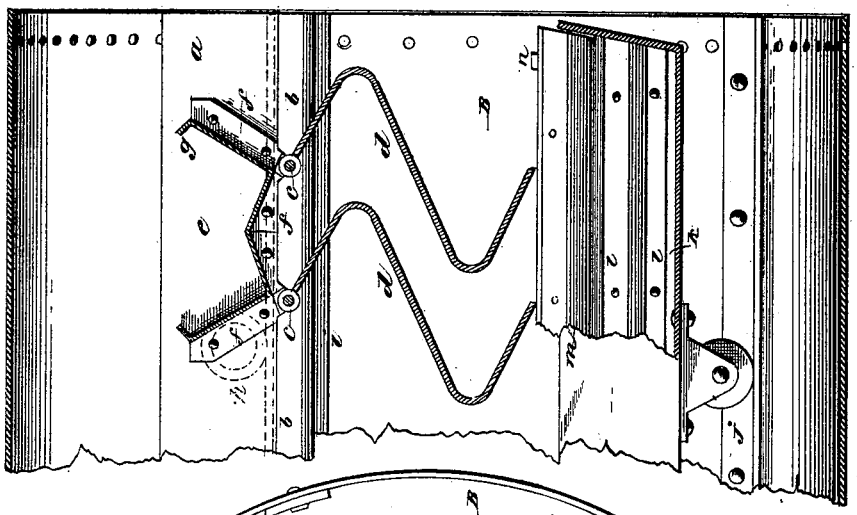
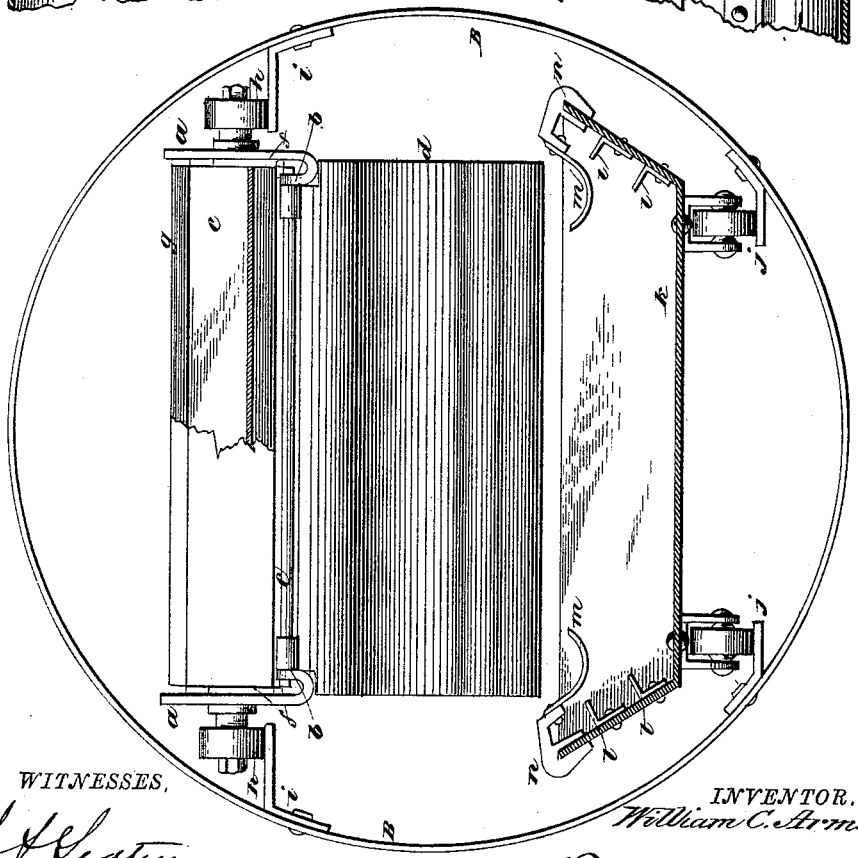


Fig. 4.



WITNESSES,

A. H. Heatyman

J. A. Mahan

INVENTOR.

William C. Armstrong.

By H. A. Toulmin.

His Attorney.

UNITED STATES PATENT OFFICE.

WILLIAM C. ARMSTRONG, OF SPRINGFIELD, OHIO.

FEED-WATER HEATER.

SPECIFICATION forming part of Letters Patent No. 386,735, dated July 24, 1888.

Application filed September 8, 1887. Serial No. 249,085. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM C. ARMSTRONG, a citizen of the United States, residing at Springfield, in the county of Clark and State of Ohio, have invented certain new and useful Improvements in Feed-Water Heaters for Steam-Boilers, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to improvements in feed-water heaters for steam-boilers; and the principal objects which I have in view are those of arresting and collecting the impurities suspended in the water, so as to prevent the well-known injurious deposits or accumulations in steam-boilers, and of utilizing both the exhaust-steam from the engine and live steam from the boiler jointly, or steam from either of these sources without steam from the other, as the medium by which to raise the temperature of the water before or during the time of precipitating and collecting its suspended impurities.

With these objects in view my invention consists, essentially, of an outer and an inner shell with suitable heads, into the space between which shells exhaust-steam is introduced, while into the inner shell live steam is conducted, of a tortuous water-passage in the annular space between the shells for the initial raising of the temperature of the water, and of a series of impurity-collectors located within the inner shell and arranged to receive the water, which is conducted into said shell, and to divide and distribute it into a number of smaller bodies and upon numerous surfaces before it passes to the boiler, whereby the impurities, the precipitation of which is effected or aided by the high temperature of the water, are collected and held while the water passes on to the boiler free of them.

The invention further consists in certain peculiarities in the arrangement of the pipes for introducing the cold water into the tortuous passage and the inner shell, either separately or at the same time, and for conducting the water heated by the exhaust-steam also into the inner shell.

The invention still further consists of certain peculiarities in the impurity-collectors, as will be more fully hereinafter explained.

In the accompanying drawings, forming a part of this specification, and on which like reference-letters indicate corresponding parts, Figure 1 represents a side elevation of my improved apparatus; Fig. 2, a longitudinal vertical sectional view of the same; Fig. 3, a partial end elevation and partial sectional view thereof; Fig. 4, an enlarged end view of the inner shell, showing some of the interior impurity-collectors in section and some in elevation; Fig. 5, a vertical longitudinal sectional view, on a large scale, of a portion of the inner shell and the interior impurity-collectors.

The letter A designates the outer shell of my improved feed-water heater, and the letter B the inner shell thereof, both consisting, preferably, of sheet metal, as boiler-iron, and of cylindrical form. The inner shell is considerably smaller than the outer shell to leave an annular space between the two shells of ample capacity for the purposes to be hereinafter explained, and are held together by two metallic annuli, C, preferably of cast-iron. To these annuli the shells are riveted, as shown in the drawings, or otherwise secured. The annuli also form the heads for the outer shell, while the heads for the inner shell are constituted by two removable metallic disks, D, preferably of concavo-convex form to add to the outward appearance of the apparatus. These disks are bolted, as shown, or otherwise strongly secured to the annuli, and any suitable packing may intervene between them and the annuli to prevent the escape of the water and steam. The form of packing shown consists of a small copper wire, E, laid into coincident grooves in the adjacent surfaces of the respective annuli and disks or heads. When the heads are firmly bolted to the annuli, the wires are tightly compressed in the grooves and a tight and lasting joint formed. The annuli are provided with a series of holes in that portion which stands between the outer and inner shells, and in these openings are firmly secured a number of water-pipes, F, which run from one annulus to the other annulus within the annular space between the two shells. These pipes are all in communication with each other in the following manner—that is to say, the pipe G (see Fig. 3) of the series (which is the one into which the water first passes) is connected

with the next pipe to the left of it in said figure, at the far end of the apparatus from that shown in the said figure, by a metallic cap, H. (See Fig. 2.) Then the next pipe to the left of the one last spoken of is connected with it at the nearest end of the apparatus in said figure by another and similar cap, H. (Said end of the apparatus being broken away in Fig. 3 at the part referred to, the last-named cap consequently does not appear.) This connecting of each pipe at one end with another pipe at one side of it and at the other end with another pipe at the other side of it continues on throughout the whole series, so that the water entering the pipe G of the series will pass back and forth through the succeeding pipes until it finally reaches the last or discharge pipe, I, of the series, having in the meantime longitudinally traversed the annular space between the two shells as many times as there are pipes.

Referring again to Figs. 2 and 3, it will be seen that the caps H consist of elongated shells which are bolted or otherwise secured by a strong and tight joint to the outer faces of the annuli C, and extend, respectively, over the ends of two pipes. The above refers to the means which contains the water during the time of the initial heating thereof in those instances in which the heating of the water by the exhaust-steam is done before subjecting the water to the heating action of live steam. The exhaust-steam is brought into contact with the series of pipes described by being introduced into the annular space between the inner and outer shells through a suitable pipe-connection established between said space and the exhaust-port of an engine. The letter J refers to a portion of this pipe which is shown as connected with the outer shell. (See Figs. 1, 3, and 6.)

The letter K refers to the outlet of the condensed steam, while the letter L designates the exhaust-steam-outlet pipe. These pipes have cut-offs to control these outlets.

I will now refer to the introduction of the water into the inner shell, the outlet of the water therefrom and into the boiler, and the introduction of live steam into the inner shell.

The letter M designates the water-inlet pipe, which extends through the outer and inner shells, and through a suitable coupling, N, connects with the water-distributing pipe or pipes O, the lower side of which is perforated at suitable intervals, and whose ends are closed by removable caps P, secured by screw-threads or otherwise, so as to be removable for the purpose of cleaning the interior of the distributer, if desired, the head or heads D being removed. Any proper means may be employed for effecting a tight connection between the pipe M and the shells. I prefer to screw the inner end of said pipe through a stout metallic washer, Q, secured to the inner shell, and to pass said pipe through a similar washer, R, secured to the outer shell, recessed as shown and provided with a filling of lead or other similar metal poured into the recess and tapped firmly against the pipe. (See Fig. 2.) The pipe M extends to the source of water-supply, an ordinary feed-water pump intervening, and at S is provided with a cut-off which controls the admission of water to the distributer.

At T a branch pipe, U, extends to and connects with the pipe G of the series of pipes already referred to. The pipe U is provided with a cut-off, V, which controls the admission of water to the said series of pipes. It will be observed that by means of these cut-offs the water which passes respectively to the series of pipes and to the distributer inside the inner shell can not only be controlled as to quantity, but either or both supplies may be cut off entirely. If it be desired not to use the exhaust-steam water-heating appliances, the cut-off V is turned to cut-off position and the water allowed to pass to the distributer only; or, if the water which is to pass to the distributer is to do so only after having first been subjected to the initial heating, the cut-off S is turned to cut-off position and the cut-off V is opened. In the latter case the water, after having circulated through the several pipes F, G, and I, passes through the pipe W to the pipe M, (being in communication both with the pipe M and the pipe I or the last of the series of pipes.) At X the pipe W is provided with a cut-off which prevents the water from passing from the pipe M into the pipe I when the initial heating appliances are not in use. Again, if it be desired to introduce the water conjointly into the series of pipes and the distributer O, the cut-offs are all properly adjusted for this purpose. The water, after having become highly heated in the inner shell, passes therefrom into the pipe Y, (see Fig. 2,) and thence directly to the boiler. The pipe Y is connected with the inner shell, and its joint is made tight with the outer shell in the manner described in reference to the pipe M. The live steam is introduced into the interior of the inner shell through the pipe Z, which connects with the steam-dome or steam-space of the boiler in any suitable manner, and with the inner shell and through the outer shell in the manner shown in Figs. 1 and 2, which is like that described in reference to the pipe M.

The live steam, it will be observed, on entering the inner shell, comes into immediate contact with the water therein, and thus the temperature of the water is raised to a degree proportionate to the pressure of the steam in the boiler and its consequent heat when it reaches the water. In this connection it should be observed that the exhaust-steam is brought in contact with the series of pipes already alluded to, as distinguished from being in contact with the water itself. This, however, is not a material consideration, but is a mere incident.

I will now describe the preferred form of the devices I employ for dividing the water into a number of parts or quantities for the

purpose of collecting its impurities, and for the purpose of exposing it in comparatively thin sheets to the action of the steam in the inner shell.

The letter *a* designates a supporting-plate, preferably of stout sheet-iron, of about the same length as the inner shell, and having its lower edge turned inward and upward to form a ledge, *b*, as shown in Fig. 4, which is notched at intervals to receive a number of rods or pintles, *c*, to each of which is secured a depending zigzag or irregular-shaped impurity-collector or collecting-plate, *d*. These plates or collectors are placed at intervals, as already suggested, along the supporting-plate *a*, and are made either of sheet or cast metal, preferably the former, and of such form (preferably that shown) as that the water trickling down upon them, in the manner presently to be described, will spread itself upon them in a thin sheet and run down slowly from one angle of the collector to the other, and from that onto or into the device presently to be described. The water while in these thin sheets becomes highly heated by the steam contained within the inner shell, and, being spread over the vast number of surfaces constituted by the collectors, is found to leave the essential quantity of its suspended impurities adhering upon or to the collectors, and is thus greatly purified by the time it drips from the collectors.

The letter *e* refers to a series of metallic boxes or troughs arranged transversely within the inner shell and secured at their ends to the supporting-plates *a* by means of the flanges *f*, which are turned outward from the ends of the walls and bottom of the troughs. They are preferably of the form shown—that is to say, their bottoms are inclined from the center downward to the sides—thereby forming angular pockets, in which more or less sediment settles and adheres, while the upper edges of the sides are turned inwardly to form inclined ledges *g*, under which sediment collects as the water gradually trickles over and upon the upper faces thereof, and thence down and along the outer walls of the sides and upon the sediment-collectors *d*. The perforations in the distributer O are so placed with respect to the troughs *e* as to discharge water into them. The collectors *d* and the troughs *e* are so relatively arranged that while the water passing from one side of each trough to the upper side of the collector below thence trickles along that entire side of the collector, the water which passes over the other or left-hand side of the troughs, as seen in Fig. 2, is caught more or less by both of the collectors which extend under said edge. Again, as the second bend in each collector, save the last to the left of the series, extends somewhat under the first bend in the next succeeding collector, any water which may happen to drop from the first bend of the said succeeding collector is caught by the first-named one. The supporting-strip *a* is provided with several rollers, *h*, which run upon suitable tracks, *i*, secured to the interior of the shell B. By this means the troughs and collectors can be readily run out of the said shell upon a suitable temporary track or platform whenever it is desired to cleanse or repair them or to do these things concerning the interior or any part fixed with the interior of said shell, one or both of the heads D being first removed. Upon other tracks, *j*, is supported a long basin, *k*, (or it may be substituted by a number of shorter ones,) which stands beneath the troughs and collectors above described and receives the water which trickles from them, and which has now become essentially or largely deprived of its impurities.

While not necessary, yet I prefer to provide the inner walls of the sides of the basin *k* with several flanges, *l*, which act to collect more or less sediment as the water rises in the basin and trickles over its upper edge and along the outer walls of its sides down and into the shell B. I also, by preference, employ a long gutter, *m*, consisting of a strip or strips of sheet metal bent to the desired form and secured at intervals to a series of conveniently-shaped hooks, *n*, adapted to fit over the upper edges of the sides of the basin *k*. These gutters also take up essentially whatever slight sediment still remains suspended in the water. The basin *k* can also be removed when an occasion requires. The principal function of the gutters *m*, however, is that of collecting the floating impurities, (such as magnesia, which is prevalent in water in some districts.) As the water rises high enough in the basin to pass over the edge thereof, the floating impurities collect and accumulate in the gutters as the water draws them toward the edge of the basin by its slow current in that direction. The outer edges of the gutters are higher than the edges of the basin, and so the floating impurities are thus checked. It should also be observed that the outer shell acts as a jacket around the inner shell and keeps the heat from radiating from the inner shell and the cold external air from reaching it. This makes the live steam introduced into the inner shell more effective. Again, the exhaust-steam between the two shells also acts to prevent the heat of the inner shell from radiating at the same time that it increases the heat of that shell by its own high temperature. These are valuable features of my invention and effect economy in the use of the live steam, while still adding greatly to the effectiveness of the apparatus as a heater and as an impurity-collector, for it is well known that the impurities more readily leave the water the higher its temperature. In this connection it should also be observed that the exhaust-steam may be introduced into the space between the shells for the purpose of securing these ends, even when the water is not introduced into the series of pipes.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a feed-water heater, the combination, with an outer and an inner shell and heads which secure them together with a space between them, and which close their ends, of water-passages in said annular space, water-pipes which conduct water into the inner shell, sediment-collectors therein, and suitable steam and water inlet and outlet openings.

2. In a feed-water heater, the combination, with inner and outer shells and heads which secure them together with a space between them, and which close their ends, of a continuous water-passage traversing said annular space, a water-pipe which leads into the inner shell, pipe-connections between said pipe and the inlet end of the continuous passage, pipe-connections between the outlet of the said passage and said water-pipe, and cut-offs in said pipe-connections and said water-pipe, sediment-collectors located within the inner shell, and suitable steam-openings and a water discharge opening.

3. In a feed-water heater, the following elements: an outer and an inner shell and suitable heads which connect them together with a space between them, and which close their ends, a series of pipes passing through said space, caps connecting their ends to form a continuous passage, a water-pipe leading into the inner shell, a water-distributer therein, pipe-connections between the inlet and discharge ends of the passage composed by said series of pipes and said water-pipe, cut-offs in said pipe-connections and said water-pipe, a series of water-troughs under the water-distributer and in the inner shell, sediment-collectors beneath said troughs, a basin beneath the said collectors, and steam inlets and outlets for said shells, and a water-outlet.

4. In a feed-water heater, the combination, with a shell and heads which close its ends, of water-pipes leading thereto and therefrom, a steam-opening, a water-distributer, a series of troughs into which the water is discharged, a series of sediment-collectors beneath the troughs, and a basin beneath the collectors.

5. In a feed-water heater, the combination, with an outer and an inner shell and heads which secure them together with a space between them, and which close their ends, of a series of pipes passing lengthwise through said space, two of which connect with inlet and discharge pipes, and caps which connect each pipe at one end with a pipe on one side of it and at the other end with a pipe on the other side of it, substantially as described, to form a continuous water-passage.

6. In a feed-water heater, the combination, with a shell, of a water-pipe, a water-distributer within the shell connected with said pipe, and a series of transverse troughs within the shell and beneath the distributer, whereby the water is introduced into the shell and distributed into separate compartments, whence it overflows.

7. In a feed-water heater, the combination, with a shell, of a horizontal series or succession of troughs, and a horizontal series of irregular-shaped sediment-collectors located beneath the succession of troughs, and a longitudinal basin located beneath the collectors and arranged to receive the water from them, substantially as described.

8. In a feed-water heater, the combination, with a shell and its head, one or both of which are removable, of tracks secured within the shell, supporting-plates sustained by wheels fitted upon the tracks, and a series of transverse water-troughs connected to said plates, the whole being removable from the shell.

9. In a feed-water heater, the combination, with a shell and its heads, one or both of which are removable, of a basin removably supported within the shell.

10. In a feed-water heater, the combination, with a shell and its heads, one or both of which are removable, of tracks therein, one above the other, supporting-plates sustained by wheels on the upper tracks, a series of transverse water-troughs connected to said plates, a series of serpentine sediment-collectors suspended from said plates beneath said troughs, a basin supported by the wheels on the lower tracks, and having interior flanges and gutters, said plates and basin being removable from the shell.

11. In a feed-water heater, a water-trough having its bottom inclined downwardly from the middle and the upper edges of its sides inclined inwardly.

12. In a feed-water heater, the combination, with an outer shell and an inner shell, arranged with a space between the two shells, and heads which close the ends of said shells, of sediment-collectors mounted within the inner shells and steam and water inlet and outlet openings for said shells, whereby a steam-jacket is formed round the inner shell, water introduced into the interior of said shell and the impurities thereof separated therefrom, and the water also subjected to the heating action of the steam during the time of its confinement in the said inner shell.

In testimony whereof I affix my signature in presence of two witnesses.

W. C. ARMSTRONG.

Witnesses:
E. S. WALLACE,
JAS. H. MAHAN.