(No Model.)

G. F. KNOX.

FEED WATER HEATER.

No. 419,530. Patented Jan. 14, 1890.

Fig. I.

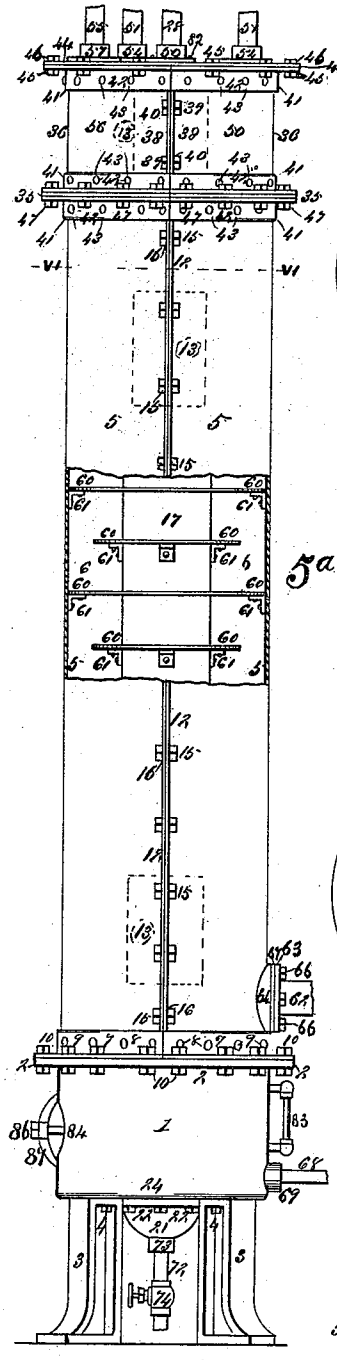


Fig. III.

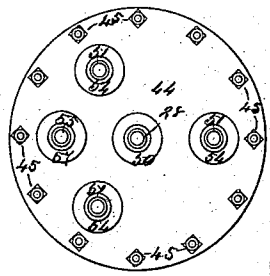


Fig. IV.

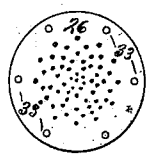


Fig. V.

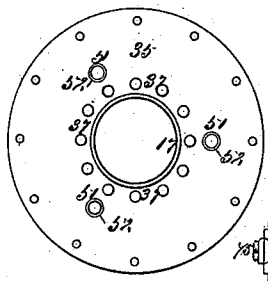


Fig. VI.

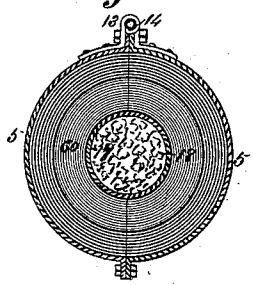
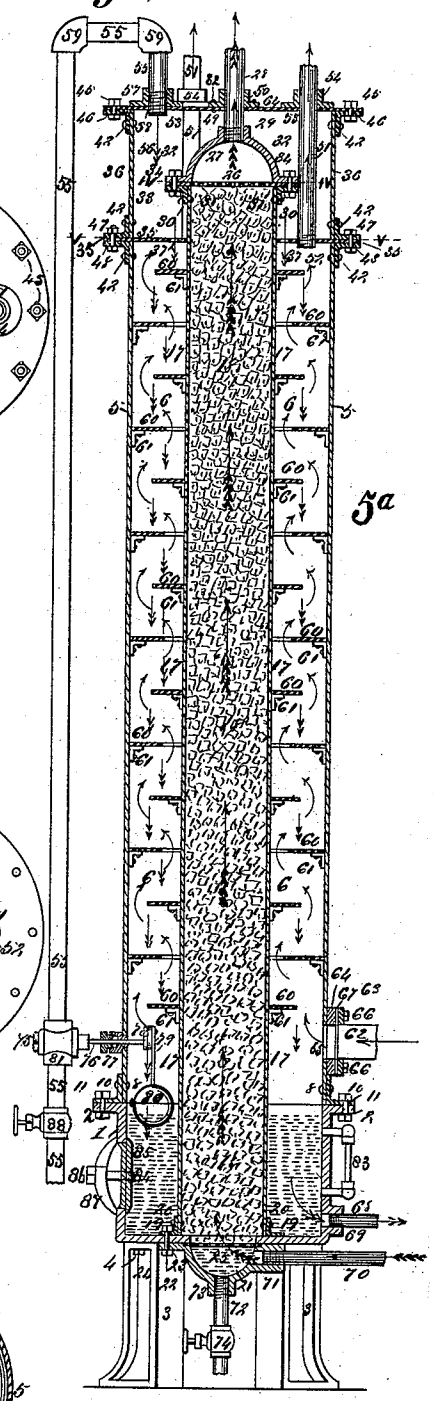


Fig. II.



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UNITED STATES PATENT OFFICE.

GEORGE F. KNOX, OF SAN ANTONIO, TEXAS, ASSIGNOR OF ONE- HALF TO EDWARD F. HOPPE, OF ST. LOUIS, MISSOURI.

FEED-WATER HEATER.

SPECIFICATION forming part of Letters Patent No. 419,530, dated January 14, 1890.

Application filed April 4, 1889. Serial No. 305,917. (No model.)

To all whom it may concern:

Be it known that I, GEORGE F. KNOX, of San Antonio, in the county of Bexar and State of Texas, have invented a certain new and useful Improvement in Combined Feed-Water Heaters, Filters, and Lime-Extractors, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification.

This invention relates to devices for the combined simultaneous heating and purifying of feed-water for engines, &c.; and the invention consists in features of novelty, hereinafter fully described, and pointed out in the claims.

Figure I is an elevation of the apparatus, in which the feed-water is heated and purified at the same time, with part broken away to show the interior of the apparatus. Fig. II is a vertical section of the same, and shows the supply-pipe which discharges water into the surmounting tank, the means for discharge of said water from said tank onto the alternating scatter-plates from which the spray descends to the hot well, the inlet-pipe for the product of the steam-exhaust from the engine to heat the spray, the hot well, and the filter that purifies the feed-water, &c. Fig. III is a top view of the apparatus, and shows the positions of the supply-pipe, the discharge-pipe that delivers the heated and purified feed-water to the boiler or other destination, as the case may be, and the exhaust-pipes through which escapes the exhaust-steam from the apparatus. Fig. IV is a horizontal section taken on line IV IV, Fig. II, and shows the top plate of the filter, through perforations in which the heated purified water is discharged into the surmounting dome preparatory to its entrance into the discharge-pipe that carries it to its destination. Fig. V is a horizontal section taken on line V V, Fig. II, and shows the circular plate that forms the bottom of the supply-tank, which plate also forms the top of the annular heating-chamber. Fig. VI is a horizontal section taken on line VI VI, Fig. I, and shows the hinged coupling of the vertical flanges of the sections at one side of the sectional cylinder and supply-water tank, which hinges, after the clamping-bolts are removed, provide the means for unfolding the sections of said cylinder and of the supply-water tank and the consequent opening up of the apparatus for cleaning the same.

Referring to the drawings, 1 represents the hot-well tank or basin, which is preferably of cast-iron cast in one piece, and is surmounted by a peripheral flange 2 at top, and rests on supporting-legs 3, that are secured to it by screw-bolts 4 or by any other suitable means.

5 5 represent the sections of the cylinder or outer shell 5^a of the annular heating-chamber 6. These two sections of the cylinder 5^a (which are preferably of sheet metal, but may be of cast metal) surmount and rest on the upper edge or brim of the hot well, tank, or basin 1, to which they are secured by sectional circle angle-irons 7, that are seated around the base of the cylinder 5^a, to which they are fastened by rivets 8, that pass through perforations 9 in said angle-irons and through the shell of the cylinder 5^a, and are riveted thereto; and screw-bolts 10 are seated in and pass through perforations 11 in the peripheral flange 2 of the hot-well basin, and through the lower flange of the circle angle-iron 7, and thus the sections of the cylinder 5^a are secured to said angle-iron and by it to the hot-well basin. The two sections of the cylinder are also provided with vertical union flanges 12, which are coupled together at one side of the column by hinges 13, the sections of which hinges are themselves coupled by the drop-pins 14. The inner flanges 12, both on the side of the cylinder that is hinged and on the reverse side also, are tightly clamped together and held by the screw-bolts 15, which at certain intervals pass through the perforations 16 in said union flanges, and where the hinges supervene similar screw-bolts, sufficiently elongated, pass through registering perforations in said hinges, as also through those in the union flanges, so as all along the junction-line to effect water and steam tight joints.

17 represents a central cylindrical shell, that rises vertically from the center of the

bottom of the hot-well basin upward within the cylinder 5^a, and which central shell is filled with charcoal 18 or other filtrant. A circle angle-iron 19 embraces the base of said central shell, to which it is secured by rivets 20.

21 represents a semi-globular water tank or basin, which is secured to the bottom of the hot-well basin, from which it hangs pendent, and to the lower flange of the angle-iron 19 by screw-bolts 22, that pass through perforations 23 in the peripheral flanges 24 of the basin 21 and through the said bottom of the hot-well basin and said angle-iron.

25 represents a circular perforated plate, which forms a cover for the basin 21, and intervenes between the same and the filtrant in the filter-chamber above it.

26 represents a perforated plate that surmounts the central shell, which incloses the filter-chamber, and which itself is surmounted by a semi-globular dome 27, which receives the hot purified feed-water from the filter and delivers it to the discharge-pipe 28, which carries it to the boiler or other destination. The threaded end of said discharge-pipe is tight-seated within the flanged collar 29 in the apex of the dome, which receives the feed-water and from which it is dispensed. A circle angle-iron 30 is secured around the summit of the cylindrical shell 17 by rivets 31, and screw-bolts 32 pass through perforations 33 through said angle-irons, said perforated plate and the peripheral base-flange 34 of the dome, and tightly secure the joint of said parts.

35 represents a circular ring-plate, which surmounts the cylinder 5^a and surrounds the shell of the filtering-chamber. The said plate sits on and projects peripherally from the top of the said cylinder 5^a, and is itself surmounted by the vertical sections 36 36 of the cylindrical water-supply tank or basin 56, to which the ring-plate 35 forms the bottom, and which bottom is provided with perforations 37, through which the feed-water gradually percolates into the annular heating-chamber to be operated on. The sections 36 36 of the cylindric water-supply tank are provided with vertical union flanges 38 at their junction-line, which are on line with the similar union flanges of the sections 5 5 of the cylinder 5^a, that surrounds the annular heating-chamber, and on one side the flanges are coupled together by a hinge vertically directly over the hinges already described, that couple said sections 5 5. The hinge that connects the sections of the cylindric water-tank is a counterpart of those that connect the cylindric sections 5 5 beneath, as shown in Fig. VI, and is alike numbered and so need not be again here described.

Screw-bolts 39 engage in perforations 40 in the union flange 38 of the water-tank and tightly enforce the connection to produce water-tight joints on each side of the tank, and a similar screw-bolt, but sufficiently elongated, may be passed through perforations in the hinge that registers with the perforations 40 in the union flanges, so that when the apparatus is set up the said joints may be made water-tight.

41 represents sectional circle angle-irons that embrace the top of the sections 5 of the cylinder 5^a, as also duplicates thereof, both the base and top of the sections 36 of the cylindrical water-tank. These angle-iron sections, as do those at the base of the sections 5, are so placed that their junction ends register with the junction edges of the semi-cylinders that they embrace. The circle angle-irons 41 are secured to the cylindrical sections they embrace by rivets 42, which pass through perforations 43 in the vertical flanges of the angle-irons and the sectional cylinders.

44 represents the circular top plate that covers the supply-water tank and surmounts the whole cylinder 5^a.

The horizontal flanges of the sectional circle angle-irons 41, that embrace and are riveted, as stated, to the top of the sections 36 of the water-tank, are secured to the said top plate by screw-bolts 45, which pass through perforations 46 in said angle-irons and said top plate and are screwed down, so as to secure a tight joint. Similar screw-bolts 47 pass, respectively, through perforations 48 in the horizontal flanges of the union angle-irons 41, that embrace and are riveted to the top of the cylinder 5^a, and through those sections that are riveted to the base of the sections 36 of the cylindrical tank, and also through the intervening ring-plate 35, that separates the annular heating-chamber from the water-tank, and the screw-nuts of said bolts being screwed down tight a water and steam tight joint is effected thereby. The discharge-pipe 28, that rises from the apex of the semi-globular dome 27, passes through a hole 49 in the center of the top plate 44 and through the angle-flange collar 50, which is secured to said top plate by rivets 82. Three exhaust-steam pipes 51, whose threaded lower ends have a steam-tight engagement in the screw-threaded perforations 52 in the ring-plate 35, ascend through perforations 53 in the top plate 44 and through the angle-flange collars 54. These pipes carry off the exhaust-steam after it has been fully utilized, and act also as blow-off pipes to facilitate the ascent of the steam through the annular heating-chamber.

55 represents the supply-pipe, which receives the feed-water from the hydrant or any other convenient and suitable supply, and delivers it into the cylindrical water-supply tank 56. The said supply-pipe enters the said tank through the angle-flange collar 57 and the perforation 58 in the top plate of the tank, and union elbow-joint pipes 59 connect the sections 55 of the water-supply pipe.

60 represents scatter-plates, that are secured by rivets to brackets 61, which by the same

means are secured in alternate succession to the central cylindrical shell 17 and to the sectional cylinder 5^a in the annular heating-chamber 6.

62 represents the exhaust-steam pipe from an engine or other device using steam, the flanged collar 63 on the front end of which pipe is secured to the projecting boss-collar 64, that surrounds the open port 65, that passes through one of the sections 5 near its base, and is secured to said cylinder by the screw-bolts 66, which pass through said flanged collar, through the packing-ring 67, of rubber or other suitable material, that intervenes between the flange-collar and boss-collar, so that when said bolts are screwed home a steam-tight joint is effected.

68 represents the suction-pipe to the boiler-feed pump, the screw-threaded end of which pipe is tight-seated within the screw-threaded collar-flanged opening 69, that enters the hot well near its base, and 70 is the return force-pipe from the boiler-feed pump, the screw-threaded end of which has a steam-tight screw-seat within the collar-flanged opening 71 into the semi-globular tank 21, beneath the central filter-chamber.

72 represents the blow-off pipe, whose screw-threaded upper end is steam-tight, seated within the screw-flanged collar 73 at the bottom of the semi-globular tank or basin 21, and 74 is a globe-cock which is adjustable within said pipe to provide, respectively, an open or closed port, as is differentially required when blowing off, flushing, or otherwise. This blow-off pipe, which is used when cleansing the heater, discharges into the sewer or any other suitable drainage.

I will now describe the automatic device by which the supply of feed-water is made self-adjusting and dependent on the exhaust of the water in the hot well. 75 represents a cut-off valve of usual construction that works within the valve joint-pipe 81, which joint-pipe connects two sections of the water-supply pipe 55. The operating-rod 76, that carries and actuates said valve, passes horizontally through the steam-tight packing-box 77 and is rigidly attached to the crank-arm 78, from which hangs pivoted the pendent rod 79, to which is attached the buoyant ball 80, that floats on the surface of the water in the hot-well basin. As the water subsides in said hot well, the lowering of its surface carries with it the buoyant ball 80, that floats thereon, which, by its pendent connecting-rod 79, turns the crank-arm 78, the operating-rod 77, and the cut-off valve 75, by which the port in said valve is brought nearer into coincidence with the tube-opening of the supply-pipe, so as to increase the supply of feed-water. It will thus be seen that the lower the surface of the water falls in the hot well the nearer will the open ports of said valve be brought to register with the tube-openings of the supply-pipe, and also, vice versa, when the supply exceeds the demand and the water in the hot well in consequence rises the valve-ports are thereby turned in the reverse direction to any degree required, even, if need be, before the water rises sufficiently to flood the steam-port 65 to constitute the valve a complete cut-off until the subsidence of the water in the hot well. While I prefer to use said ball-and-valve device to automatically regulate the supply of feed-water to the apparatus, yet when desired a common globe-valve similar to the one shown and described in the blow-off pipe, and which is then actuated by the hand of the operator, may be substituted in the place of said automatic device. 83 represents the glass water-gage that indicates the height of the water in the hot well, so that the operator may observe if the necessary supply of feed-water is cut short from any cause. 84 represents the hand-hole in the side of the hot-well basin, to give access to the same for cleansing it of scale and deposits of mud, lime, &c. The shutter-plate 84, that (when the apparatus is in operation) closes the hand-port, is retained to its seat, so as to preserve a water-tight joint, by the screw-bolt 86, which passes through the concavo-convex plate 87, and whose screw-threaded end engages in said shutter-plate and brings it tightly home to its seat. 88 represents a globe valve or cock in the water-supply pipe 55, which is used as a cut-off when it is desired to shut down the operation of the apparatus, and it may also be used to regulate the supply of feed-water when it is not desired to use the floating ball-valve. The supply-pipe may either take the water direct from the hydrant or any other water-supply that has sufficient head to deliver into the supply-tank 56 at the summit of the apparatus, or the water may, when circumstances make it desirable, be transferred from a preparatory feed-water heater, for the invention is applicable in either case.

The operation of the apparatus is as follows: The feed-water enters through the supply-pipe 55 into the supply-tank 56, from which it percolates at the speed required, as indicated by the straight arrows, through the perforations 37 in the circular ring-plate 35, which forms the bottom of the supply-tank and the top of the annular heating-chamber. The water as it thus percolates into said heating-chamber drips onto the succession of scatter-plates 60, that are, as shown in Figs. I and II, respectively, alternately projected outwardly from the central cylindrical shell 17, that incloses the filter, and inwardly from the sections 5 5 of the cylinder 5^a, forming the outer wall of the annular heating-chamber 7. The water drops and splashes from one scatter-plate to another in its descent from the supply-water tank at the summit of the apparatus to the hot well at its base, dashing alternately outward and inward in a fine spray from scatter-plate to scatter-plate.

At the same time the hot steam, provided by an engine exhaust-steam-pipe 62, enters through the open port 65, near the base of the cylinder 5^a, and as it ascends, as indicated by curved arrows within said heating-chamber, it comes in contact with the descending feed-water, which, being separated into a fine spray as it dashes from plate to plate, is quickly heated by the ascending steam. During the utilization interchange of temperature between the ascending steam and descending spray, a large portion of the lime, sulphur, dirt, and other impurities that are contaminating the feed-water is deposited on the scatter-plates. By the time the water has reached near the base of the heating-chamber it has come to be in a highly-heated condition. When on a line with the open steam-port 65 it encounters the superheated steam on its first entrance within the chamber, and while experiencing the still further sudden increase in temperature thereby engendered, the remainder of the lime, sulphur, and other impurities still left in the water is precipitated to the bottom of the hot well. The water is drawn from the hot well by any suitable engine-pump that is not subservient to the adverse movement of the steam that evaporates from the water, and said water, passing through the suction-pipe 68, is forced, *via* the return-pipe 70, into the semi-globular tank or basin 25, and through the filtrant within the central shell, from which the pressure discharges it through the perforated plate 26 into the semi-globular dome 27, and finally through the discharge-pipe 28 to the boiler, when used for feed-water, or when the apparatus is used for purifying purposes, as in breweries, bakeries, hotels, &c., to their clear-water tank or reservoir. There is an especial advantage in the water increasing in temperature as it passes downward, the steam at the same time rising upward and at the water's highest temperature meeting the steam when hottest, thereby causing the remnants of lime, sulphur, or any other impurities therein to be precipitated or extracted, or should there in some cases be a very small amount of said impurities left, the filter is abundantly able to cleanse out the last vestige thereof and furnish to the boiler or reservoir, as the case may be, perfectly-pure feed-water. When it is desired to blow off or flush the apparatus to cleanse it, when the globe valve or cock in the blow-off pipe is turned to register its open port in line with the tube-opening of the pipe the cleansing is usually easily effected, the supply-water being turned on and the pump being operated at the same time. When, however, the scale and deposit in the hot well are so extensive that it is desired otherwise to remove them, the hand-hole plate is removed, as stated, and easy access is thus had thereto. When it is desired to open up the cylinder 5^a, or the cylindric water-tank, the clamping and connecting screw-bolts are removed from the flanged edges of their section-plates and from the angle-irons and hinges, when the sections can be easily opened out on their hinges, so as to remove the scale from the scatter-plates, &c., and to clean up the heater and tank, also, when required. It is very seldom required, however, to open up the water-supply tank 56, and it will be seen that when half of the bolts that connect the said tank with the cylinder 5^a are removed, the latter is free to be opened out on its hinges without disturbing or opening the tank. Should it be desired to take the sections of the cylinders completely apart, the drop-pins 14 can be drawn out of the hinges 13, and thus the hinges and the sections they carry are uncoupled.

Some of the advantages of this feed-water heater and purifier are: It obviates the necessity of putting any back-pressure on the engine; heats the water by actual test to 210° and 212° Fahrenheit; extracts all lime, sulphur, mud, and other impurities from the water, and keeps the boilers free from scale or deposit; also, the simple construction of the heater and the facility of removal of the scale and deposit afforded by the sectional construction of the outer shell of the apparatus provide the means for opening up the same when cleaning.

I have shown and described a sufficient number of clamping-bolts along the vertical flanged edges 12 of the sections 5 to enforce a tight joint along the flanges; but, if desired, a large proportion of said bolts may be dispensed with by providing vertical re-enforce clamping iron bars on each side of the flanges, through perforations in which bars, registering with others in the flanges, screw-bolts are secured. It is evident that when the nuts on said bolts are screwed home tight the stiffness of the clamping-bars pressing against the flanges will preclude the necessity of using as many bolts.

It will be seen that as no part of the apparatus is subjected to dry heat, the scale and deposit are generally sufficiently soft and free, when the valve in the blow-off pipe is opened, for the steam in blowing off or the water in flushing to thoroughly cleanse the apparatus. Then steam when blowing off may be furnished by the engine that provides steam to the exhaust-steam pipe 12 by connecting, if desired, with the pipes 28 and 51 at the top of the apparatus, when it is desired that the blow-off shall be direct from top to bottom.

In conclusion, I call attention to the fact that there are no coils or other secretive parts in the apparatus, but when opened up for cleaning all parts are readily accessible to both the eye and the hand.

I claim as my invention—

1. In a feed-water heater and purifier, the combination of the cylinder forming the heating-chamber, the scatter-plates within said cylinder that spray the water in its descent, the surmounting supply-tank with a perfo-

rated bottom above said heating-chamber, and the exhaust-steam pipe that supplies the exhaust-steam from an engine to said heating-chamber arranged to heat the water and facilitate the deposit of impurities on the scatter-plates, &c., substantially as described, and for the purpose set forth.

2. In a feed-water heater and purifier, the combination of the supply-pipe, the sectional cylinder forming the heating-chamber, the scatter-plates in said chamber, the supply-tank above said chamber from which the water percolates on said scatter-plates, and the exhaust-steam pipe that discharges steam through the open port that enters near the base of said chamber for heating the water, substantially as described, and for the purpose set forth.

3. In a feed-water heater and purifier, the combination of the supply-pipe, the supply-tank into which said pipe discharges, the said tank having a perforated bottom through which the water percolates, the vertically-divided cylinder forming the annular heating-chamber, the scatter-plates alternatingly located in diverse directions in said chamber, the said plates arranged to spray the water while heating as it falls from plate to plate, and the exhaust-steam pipe that discharges through an open port near the base of said annular heating-chamber, substantially as described, and for the purpose set forth.

4. In a feed-water heater and purifier, the combination of the supply-pipe, the supply-tank 55, the cylindric flanged plates 5, forming the annular heating-chamber, the screw-bolts that couple said flanges together, the perforated ring-plate 35, that forms the top to said heating-chamber and the bottom to said supply-tank, the cylindrical shell 17, that surrounds the filtrant-chamber, the scatter-plates within the heating-chamber, which alternately project from the inner cylindrical shell and from the outer cylindrical plates, and the hot-well tank or basin 21, on which said cylindric plates 5 rest, substantially as described, and for the purpose set forth.

5. In a feed-water heater and purifier, the combination of the water-supply tank provided with a perforated bottom through which the water percolates, the top plate 44 of said supply-tank, the cylindric flanged plates forming the heating-chamber, the hinges that couple said flanges on one side of the apparatus, and the screw-bolts that clamp the flanges together on both sides of the apparatus to effect a water and steam tight joint, the hot-well tank or basin, the angle-irons with their connecting-rivets and clamping screw-bolts that respectively connect said hot-well tank to the cylindric plates and the summit of said plates to the supply-tank, also the rim of said tank to its top plate, substantially as described, and for the purpose set forth.

6. In a feed-water heater and purifier, the combination of the supply-pipe, the supply-tank provided with a perforated bottom through which the water percolates, the sectional flange forming the heating-chamber, the hot-well tank or basin, the automatically-operated floating ball-cock that regulates the water-supply, and the exhaust-steam pipe that furnishes the steam that heats the water, the said steam-pipe discharging through the open port near the base of the heating-chamber, substantially as described, and for the purpose set forth.

7. In a feed-water heater and purifier, the combination of the supply-tank provided with a perforated bottom through which the water percolates, the sectional cylinder 5^a, forming the heating-chamber, the cylindrical shell 17, that incloses the filter-chamber, which filter is provided with charcoal or other suitable filtrant, the scatter-plates arranged within the heating-chamber so as to respectively alternately project from the cylindric shell that incloses the filter and that which forms the heating-chamber, so that the water which percolates through the bottom of the supply-tank sprays from plate to plate, dashing each time in a reversed direction, the exhaust-steam pipe that furnishes the steam that heats the feed-water from any adjacent engine or generator and supplies it through the open port 65, near the base of the heating-chamber, arranged so that as the hot steam ascends it intermingles with the fine spray of water as it dashes from one scatter-plate to another, the hot-well tank or basin, the semi-globular dome that surmounts the filter-chamber and that receives the purified water from said filter, the perforated plate that intervenes between said filter and said dome, the semi-globular basin 21 beneath the filter, and the perforated plate that intervenes between said basin and said filter, substantially as described, and for the purpose set forth.

8. In a feed-water heater and purifier, the combination of the supply-pipe, the globe valve or cock 88 in said pipe, the supply-tank provided with a perforated bottom through which the water percolates, the sectional cylinder 5^a, the heating-chamber, the cylindric shell which incloses the filter, the scatter-plates 60 within the heating-chamber, the exhaust-steam pipe that furnishes the steam through the open port 65 of the cylinder 5^a, the hot-well tank, the semi-globular basin 21 beneath said tank, the semi-globular dome that receives the purified feed-water from the filter, the discharge-pipe that receives said water from said dome, the suction-pipe 68, through which is drawn water from the hot well by the action of any suitable engine-pump, and the return-pipe 70, through which said water is forced into the basin 21 through the filter, the surmounting dome, and the discharge-pipe to its destination, substantially as described, and for the purpose set forth.

9. In a feed-water heater and purifier, the

combination of the supply-pipe, the supply-tank with a perforated bottom through which the water percolates, the cylinder 5^a, forming the heating-chamber and upholding the supply-tank, the cylindric shell 17, that incloses the filter within said heating-chamber, the scatter-plates that spray the water as it descends through the heating-chamber, the blow-off pipe 72, globe-valve 74 in said pipe, and the exhaust-steam pipes 51, substantially as described, and for the purpose set forth.

GEORGE F. KNOX.

In presence of—
JAMES SIMPSON,
OTTO OTTESEN.