No. 621,775. Patented Mar. 21, 1899.

# G. F. DAY.

## FEED WATER HEATER AND PURIFIER.

(Application filed Dec. 22, 1897.)

(No Model.)

2 Sheets—Sheet 1.

Fig. 1.

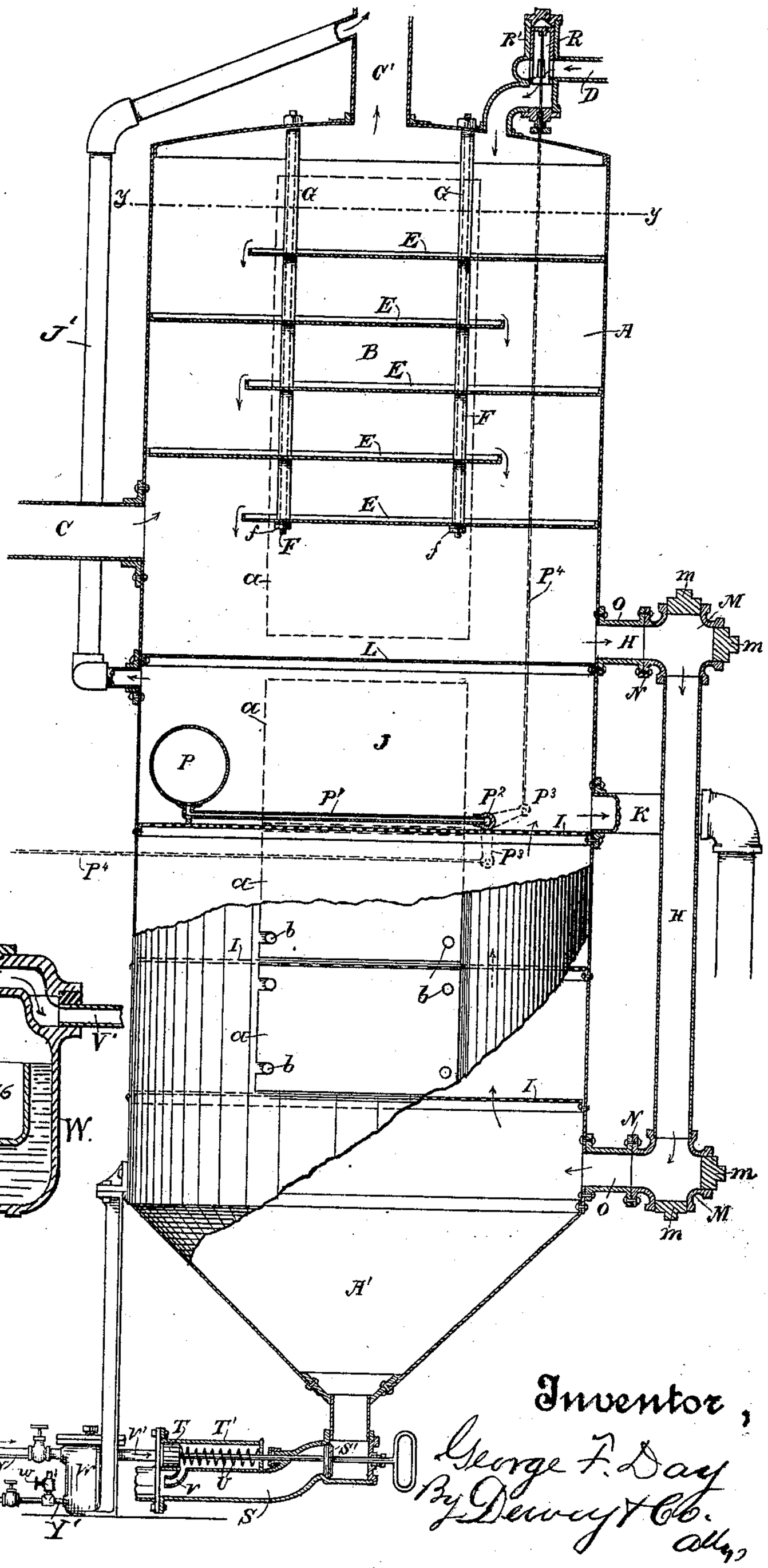


Fig. 5.

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(No Model.) 2 Sheets—Sheet 2.

*Fig. 2.*

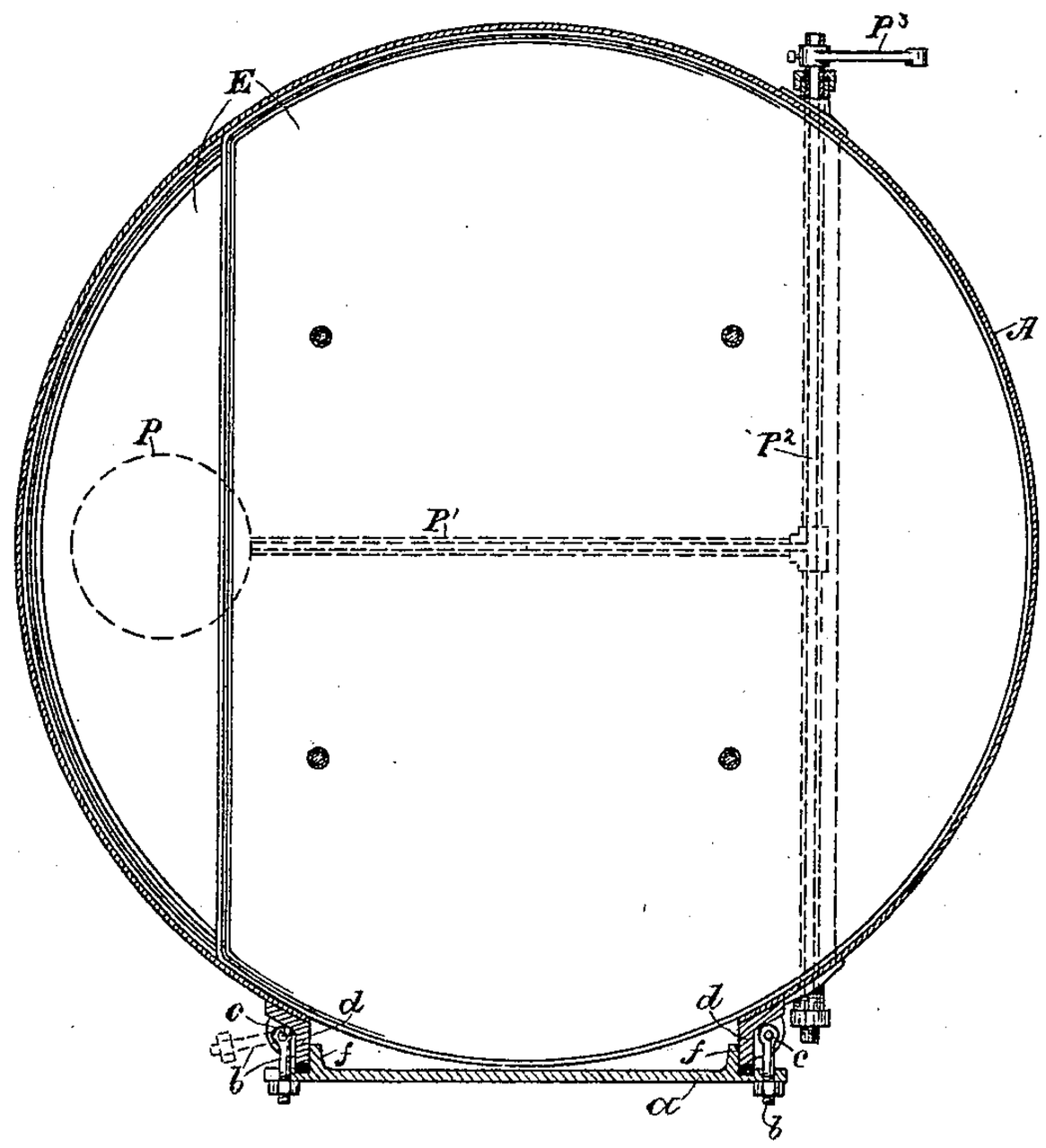
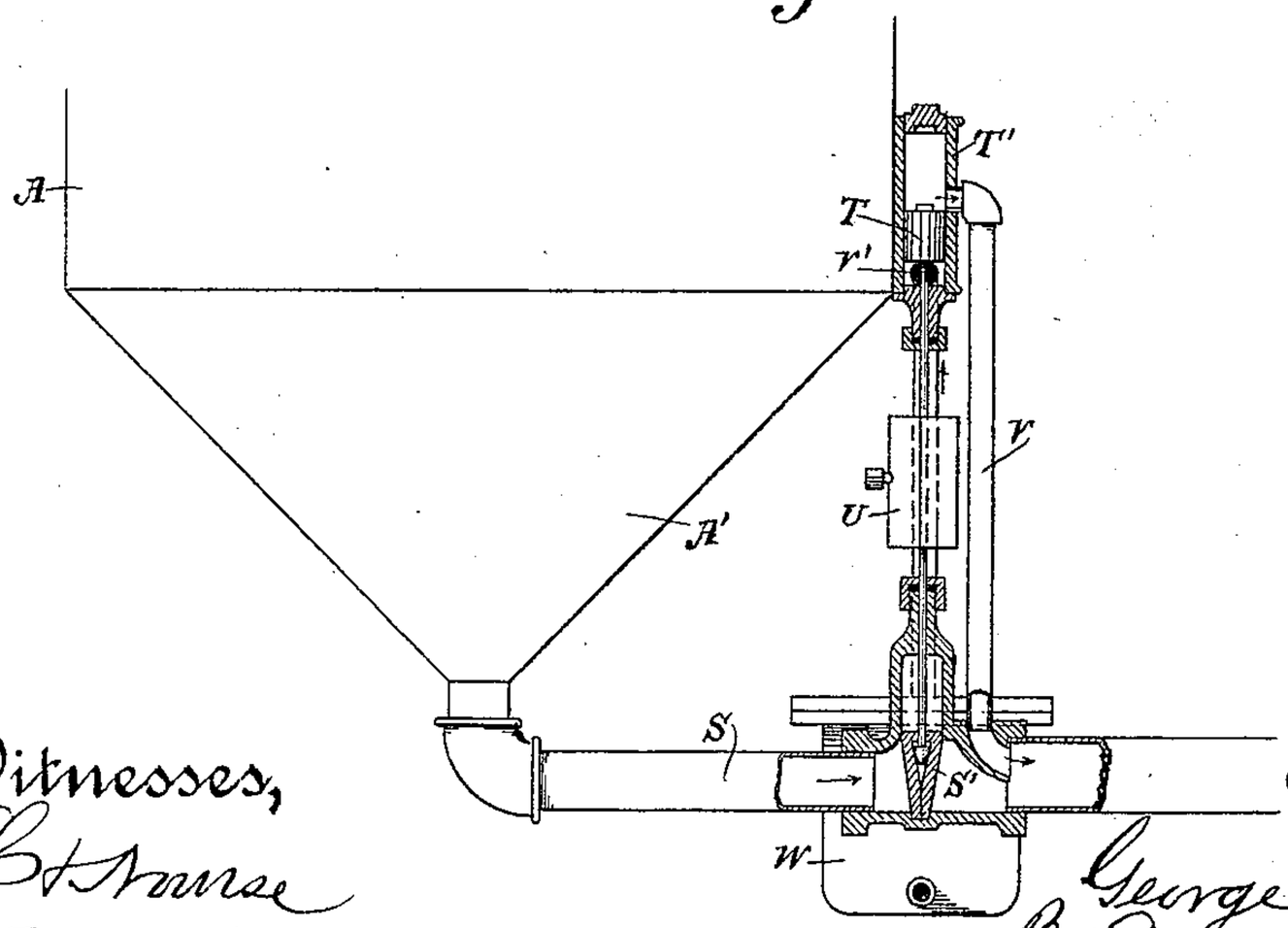



*Fig. 3.*

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# UNITED STATES PATENT OFFICE.

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## FEED-WATER HEATER AND PURIFIER.

SPECIFICATION forming part of Letters Patent No. 621,775, dated March 21, 1899.

Application filed December 22, 1897. Serial No. 663,008. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE F. DAY, a citizen of the United States, residing in the city and county of San Francisco, State of California, have invented an Improvement in Feed-Water Heaters and Purifiers; and I hereby declare the following to be a full, clear, and exact description of the same.

My invention relates to improvements in apparatus for heating and purifying water which is to be supplied to boilers for steam purposes.

It consists in the parts and the constructions and combinations of parts hereinafter described and claimed.

Figure 1 is a partial vertical section through my apparatus. Fig. 2 is a horizontal section of the same on line *y y* of Fig. 1. Fig. 3 is a modification of the device for discharging the sediments automatically. Fig. 4 is a sectional view of the trap W.

A is an outer shell of metal of sufficient length and diameter, having in the upper part a chamber B, into which leads the pipe C, bringing exhaust-steam from the engine or steam from other available source for the purpose of heating the interior of the chamber, and C′ is the discharge-pipe through which said steam escapes from the chamber.

Water to be purified is delivered into the chamber through the pipe D, having a controlling gate or valve which will be more fully described hereinafter. Within the chamber are a series of segmental trays E, which are suspended approximately horizontal, having upturned flanges or lips, so that the water delivered from the supply-pipe falls upon the uppermost tray, spreading thereon in a thin sheet, discharging thence upon the next tray below, and so on through the whole series to the bottom of the chamber. These trays are arranged to project alternately from opposite sides of the chamber and are sufficiently shorter than the full diameter of the chamber so that the water overflows from the edge of the upper upon the rear portion of the next below, then from the opposite edge of said succeeding tray upon the next, and so on. If these segmental trays are fixed permanently around the interior of the chamber, they partake of a certain amount of vibration or pulsation which is caused by the movement of the engine and the constant impulse of the exhaust-steam, and this eventually cracks or breaks the trays and necessitates their being replaced.

In my present invention I have shown a means for suspending the trays, consisting of the vertical rods F, extending down through the top of the chamber and having surrounding tubular sections G of such length that the upper sections extend from the top of the chamber down to the first tray, the next sections extend from the bottom of this tray to the top of the next one, and so on to the lower end. Nuts *f* are screwed upon the lower ends of these bolts or rods or they may be otherwise secured, and the structure of trays is thus firmly secured together, and being suspended from the upper part of the chamber they are free to move in unison, and not being held rigidly to the body of the chamber they will not be injuriously affected by the pulsations before described. They are also thus easily removed for the purpose of cleaning the scale or deposit which may accumulate upon them from time to time.

From the chamber B the purified water passes through a pipe H and is delivered into the lower part of the casing A, which has, as shown, a conically-shaped bottom A′. Above this conically-shaped bottom and above the inlet from the pipe H are fixed screens I at intervals, forming independent chambers within which the filtering material of any desired description is placed, so that the water delivered into the chamber A′ rises upward through the screens I and filtering material and is eventually delivered into the clear-water chamber J, from which it is conveyed to the point where it is to be used through a pipe K. L is a flanged partition or diaphragm extending across the casing and separating the chamber B from the chamber J. The flanges of all these diaphragms I and L are turned downwardly and are riveted around the periphery of the casing A, the curvature of the flanges forming little peripheral channels which eventually fill with sediment and serve to calk the joints and prevent leakage at this point.

The pipe H connects at top and bottom with heads M, into which it is screwed. These heads have flanges, as shown at N, and are

bolted to short sections O, which in turn are bolted upon the side of the casing A. Each of the heads M is provided with screw-plugs *m*, one in line with the pipe H and the other in line with the horizontal section O and the interior of the casing, so that by removing these plugs access is had to the pipes for temporary cleaning. If it is desired to remove the pipe H, it is only necessary to remove the bolts which secure the heads M to the sections O and the pipe can be entirely removed. This is a convenience in fitting the pipe to its place and allowing it to be readily removed for cleaning out the scale which deposits in this pipe, as well as upon the trays and in the chamber from which it leads.

The supply of water to the apparatus received through the pipe D is controlled directly by the amount of water contained in the clear-water chamber J. This is effected by means of a float P, connected with a lever-arm P′ and a fulcrum-shaft $P^2$, to which the opposite end of this lever-arm is connected, this shaft extending outwardly through stuffing-boxes in the sides of the chamber J and having upon the outer end a crank-arm $P^3$. From this arm a rod $P^4$ extends upwardly through a stuffing-box and connects with a valve R, movable within the casing R′, which is interposed between the supply-pipe D and the chamber B, into which it discharges. This valve R is a balanced piston-valve, as shown, and is movable vertically within the chamber R′, and when the float P rises by the filling of the chamber J the valve R will be correspondingly moved, and the supply of water to the purifying-chamber B will be cut off to a greater or less extent. When the supply in the chamber J decreases, a corresponding sinking of the float P will again open the valve R, and thus automatically control the supply of water.

In many condensing-engines, such as those used on cable-traction railways, the variation in the amount of power needed is excessive, sometimes dropping from seven hundred or eight hundred horse-power to fifty and as suddenly rising again. This causes a proportionate variation in the condensation and in the supply of water for the boilers, so that the feed-pump may sometimes supply too much and at other times it may be pumping only air. I overcome this difficulty and automatically regulate the action of the pump to the needs of the engine by connecting the rod $P^4$ with the valve governing the steam-supply to the pump, so that it cuts off the steam and reduces the motion of the pump when the engine is running light and the condensation is small and opens the throttle when more water is to be pumped. As the float P may at some time leak, so that water would enter it, and might eventually make it so heavy that it would not properly operate, I have shown the lever-arm P′ as being made hollow and connecting directly with the bottom of the float P, as shown. The fulcrum-shaft $P^2$ is also hollow, and this pipe P′ connects directly with it. The shaft extends outwardly through stuffing-boxes in the case A, as previously described, and the outer ends being open any water which may enter the float P will find its way out through and discharge exterior to the casing. This will also give notice if any leakage or derangement of that sort had occurred within the apparatus.

By the construction herein described the water passing into the lower conical chamber A′ deposits a great deal of sediment within that chamber, and in order to draw it off from time to time it is necessary to have an opening and controlling cock or valve for the purpose. In the present case I have shown the lower end of the cone A as riveted to a brass conically-shaped casting A′, and a discharge-pipe connects with this casting. In order to automatically discharge the sediment, so that it does not depend upon the faithfulness of an attendant, I have shown a device which is operated by a steam-trap of any suitable construction, so that at regulated intervals the valve will be opened and a discharge of the contents of the chamber A′ take place. This trap and mechanism may be connected in various ways. In Fig. 1 I have shown the discharge-pipe S extending horizontally, having a valve S′ seated within it. The stem of the valve passes through stuffing-boxes and connects with a plunger T, movable in a cylinder T′. This plunger is normally forced against the end of the cylinder by a spring, (shown at U,) and when in this position it covers a curved discharge-pipe V, which opens into the pipe S, as shown. The end of the cylinder T′ is connected by a pipe V′ with any suitable or desired form of steam-trap W, which is supplied with steam through a live-steam pipe Y.

The trap W is shown in detail in Fig. 4. Its cup-shaped portion 10 is a float, and water entering through the inlet Y′ will fill up the space in the outer case 12, and its action upon the float while the outer chamber is slowly filling is to press upward upon the valve-stem 13 and thus close the conical point of this stem into the seat in the main portion of the valve 14 and also to close the valve 14 against its seat. The object of this construction in this particular trap is to have a small discharge opened by the conical valve of the stem 13 to allow the discharge to commence, and as soon as the pressure is relieved the valve 14 drops by gravitation, as it fits around the enlarged head carried by the stem 13, which serves as a guide for it, and this allows the water to be discharged from the cup 10. The water enters the cup 10 by overflowing when the outer chamber 12 is filled up to a level with the top of the cup 10, and as soon as this cup is filled sufficiently to overcome its buoyancy it sinks and by its weight pulls down the valve-stem 13, opening the smaller escape controlled by it, which allows the steam in the cavity of the main

valve to escape, and the valve will then drop and open the larger discharge-passage 15, through which the discharge of the water takes place, as the pressure within the outer chamber acts upon the surface of the water in the cup 10 and forces it up through the pipe 16, as shown by the arrow.

Water is supplied to the pipe Y′ by a connection with the boiler feed-pump or other source of supply and controlled by a cock or valve *w*. This is set so that the trap will be caused to act at regular intervals, and by opening the valve 14, actuated by the trap, steam will be admitted through the pipe V′ into the cylinder T′. This forces the piston T along the cylinder T′ until the pipe V is exposed, when the steam passes into this pipe, and as the discharge is in the line of the pipe S it acts with a powerful suction through the pipe S and the open valve S′ to draw any deposit from the conical chamber A′ and discharge it. The suction thus produced also serves to draw centrally from the top of the water within the chamber A′, and thus any oil or other light substance which would float upon the water will be drawn through a central discharge thus produced and discharge with the other sediment, thus leaving the water clear of oil to pass up through the filters into the clear-water chamber. The steam entering the trap also acts to force out the water accumulted therein and to equalize the pressure between the trap and boiler by being united to the steam-pipe. As soon as the action of the steam-trap has discharged the contents of the chamber A′ the valve will be again closed, and the spring U will then act to return the piston T to its normal position, at the same time closing the valve S′, leaving the apparatus in its normal condition.

In Fig. 3 I have shown a slightly-different arrangement of the parts, in which the cylinder T′ is bolted upon the side of the chamber A in a vertical position and the valve stem or rod is actuated by a weight instead of a spring. The valve may be in the form of a gate-valve instead of a puppet-valve; but the essential operation is the same, the connection and action of the steam-trap operating to periodically open the valve S′ and to discharge a jet of steam into the outlet-pipe S, so as to clear the sediment from the chamber.

Access is had to the various compartments of the apparatus by means of doors *a*. Instead of securing these doors by bolts, which would necessitate the lifting of the doors to remove them, I make the doors with holes along one edge for eyebolts *b*, which are secured to the doors by nuts. The eyes are turnable upon pins *c*, which are outside of the flanges *d*, surrounding the door-openings. Interior flanges *f* are formed upon the doors to guide them to their places in closing. Exterior to the flanges *f* are packings which close upon the flanges *d* of the door-openings to make a tight joint. The opposite edges of the doors from the hinge-bolts are slotted to receive swivel locking-bolts. When these are loosened, the doors will swing upon the eyebolts, and by reason of their position will at once lift them from their seats as they begin to open.

When my apparatus is used under pressure, or where there is some back pressure from the engine-exhaust, it is necessary to relieve the surface of the water in the clear-water chamber from the pressure, which would otherwise prevent the water from rising freely through the filters. This I do by connecting the upper part of the chamber J with the purifying-chamber or with the exhaust-steam pipe, as by means of an exterior pipe connection J′.

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

1. In a feed-water heater and purifier, the combination of an outer shell or casing with transverse diaphragms separating it into independent superposed chambers, one of which is a clear-water chamber, an inlet-passage to the lower part of the uppermost chamber for exhaust-steam, an outlet therefor from the top of the chamber, a relief-pipe exterior to the casing and connecting the clear-water chamber with the said exhaust-outlet, and a water-conveying pipe connecting with the lowermost chamber, horizontally-disposed trays in the form of circular segments loosely suspended from the top of the uppermost chamber by hanging rods with surrounding spacing-sleeves and securing-nuts, said trays having upturned peripheral edges, and the cut-away portions disposed to form alternate passages for steam and water upon opposite sides of the chamber.

2. In a feed-water heater and purifier, the combination of an outer shell or casing, with transverse diaphragms separating it into independent superposed chambers, one of which is a clear-water chamber, exhaust-steam inlet and outlet passages in the upper chamber, an exterior relief-pipe connection from the clear-water chamber to said exhaust-outlet passage, independent segmental trays loosely suspended within said chamber and a water-inlet discharging upon the uppermost tray, passages with flanged couplings connecting with the bottom of the upper chamber and with the lower sediment-chamber, and a pipe removably bolted thereto, said pipe having heads at each end, with removable plugs or caps at right angles with each other and in line with the pipe and with the passages into the chambers respectively.

3. In a feed-water heater and purifier, an outer shell or casing with transverse diaphragms separating it into independent superposed chambers, the uppermost chamber having independent segmental loosely-suspended trays, steam and water inlets and outlets, a lower sediment-chamber with which the upper chamber is connected as shown,

filtering-chambers and a clear-water chamber superposed successively above the sediment-chamber and beneath the upper heating-chamber, an exterior relief-pipe connection between the clear-water chamber and the steam-outlet, a hollow float connected by a hollow arm with a hollow shaft, the ends of which extend outward through stuffing-boxes in the sides of the clear-water chamber, a crank-arm upon one of said projecting ends, a balanced valve controlling the water-supply to the upper chamber and a connection between said valve and the crank-shaft of the float.

4. In a feed-water heater and purifier of the character described, the combination of an outer casing with sediment, purifying, clear-water and heating chambers superposed therein in the order shown, with steam and water conducting pipes, an exterior relief-pipe connection between the clear-water chamber and the exhaust-steam outlet, a lever-arm fixed to a shaft which projects through stuffing-boxes in the side of the clear-water chamber and a float fixed to the opposite end of the lever within the chamber, a crank-arm upon the exterior end of the shaft, a water-inlet-controlling valve connected with and controlled by the movements of the crank and float, and a connection between the crank and the pump-actuating mechanism whereby both are controlled by the supply of water in the chamber.

5. In a feed-water heater and purifier, an outer shell or casing with transverse diaphragms separating it into an upper heating-chamber, a lower sediment-chamber connected therewith, purifying and clear-water chambers superposed in the order shown between the sediment and heating chambers, and an open-pipe connection from the upper part of the clear-water chamber to the exhaust-pipe exterior to the apparatus.

6. In a feed-water heater and purifier, means for periodically discharging sediment from the sediment-chamber consisting of a discharge-pipe, a valve by which said pipe is normally closed, a piston connecting with the stem of said valve movable within a cylinder, a steam-trap and a pipe connecting said trap with the cylinder, a valve within the trap opened periodically by the action of water supplied to the trap, whereby steam is admitted to actuate the piston and open the discharge-valve of the sediment-chamber.

7. In a feed-water heater and purifier, a sediment-collecting chamber, a discharge-pipe leading therefrom, a valve normally closing said discharge-pipe, a piston movable in a cylinder and connecting with said valve, a steam-trap having a pipe connecting it with the cylinder, a valve actuated by the collection of water within the trap and opened to allow steam to enter the cylinder whereby the piston is moved and the discharge-valve of the sediment-chamber is opened and a steam-jet tube delivering into the discharge-pipe of the sediment-chamber and simultaneously opened by the movement of the piston as herein described.

8. In a feed-water heater and purifier, a sediment-collecting chamber, a discharge-pipe leading therefrom, a valve normally closing said discharge-pipe, a steam-trap with a supply-pipe and regulating-cock whereby water is admitted to gradually fill and actuate the trap, a steam-pipe, a valve and intermediate mechanism, through which the valve of the sediment-chamber is periodically opened and the contents of the chamber discharged.

In witness whereof I have hereunto set my hand.

GEORGE F. DAY.

Witnesses:
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JESSIE C. BRODIE.