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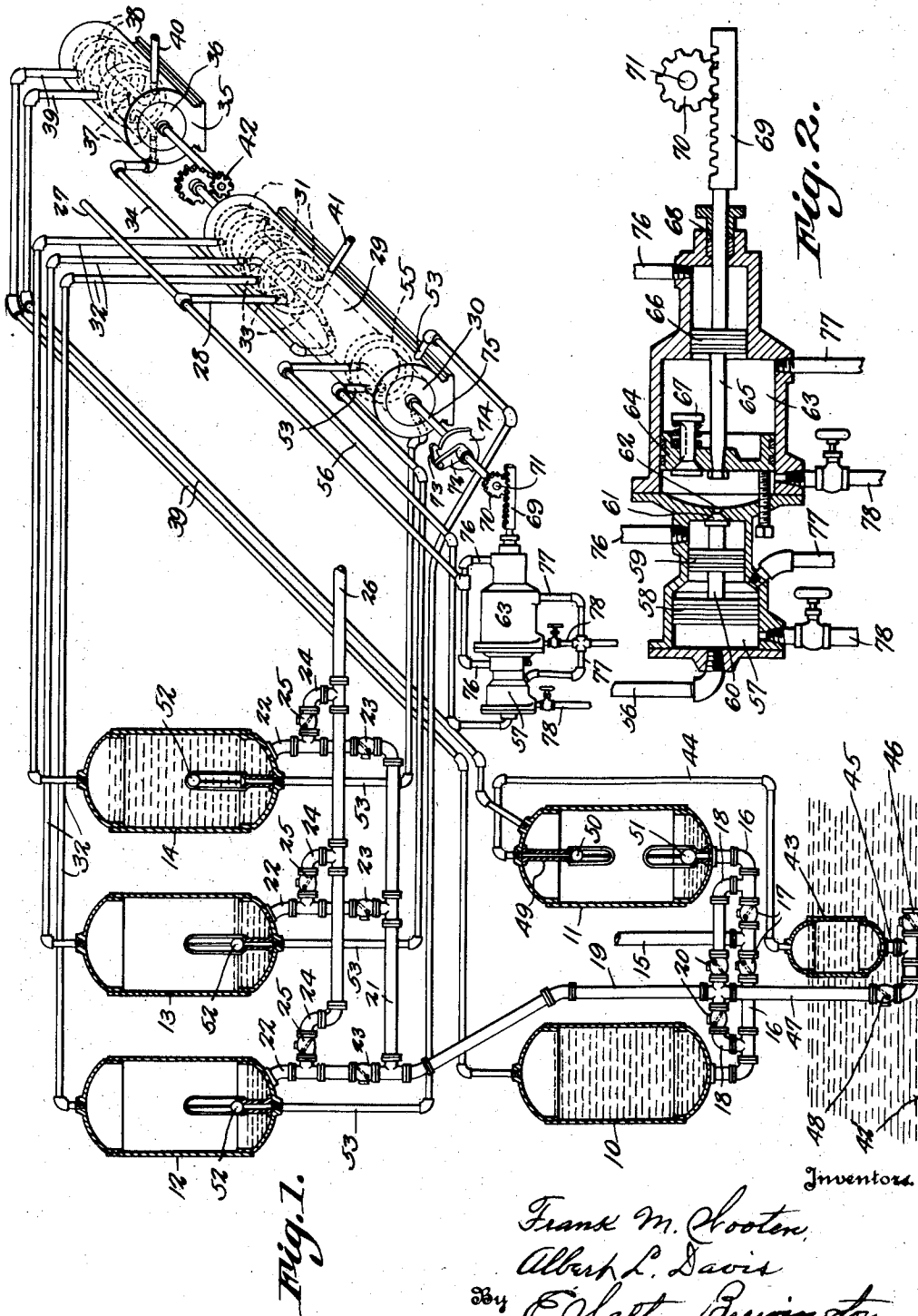
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1,887,000

AUTOMATIC HIGH PRESSURE BOILER FEED SYSTEM

Filed April 14, 1931

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

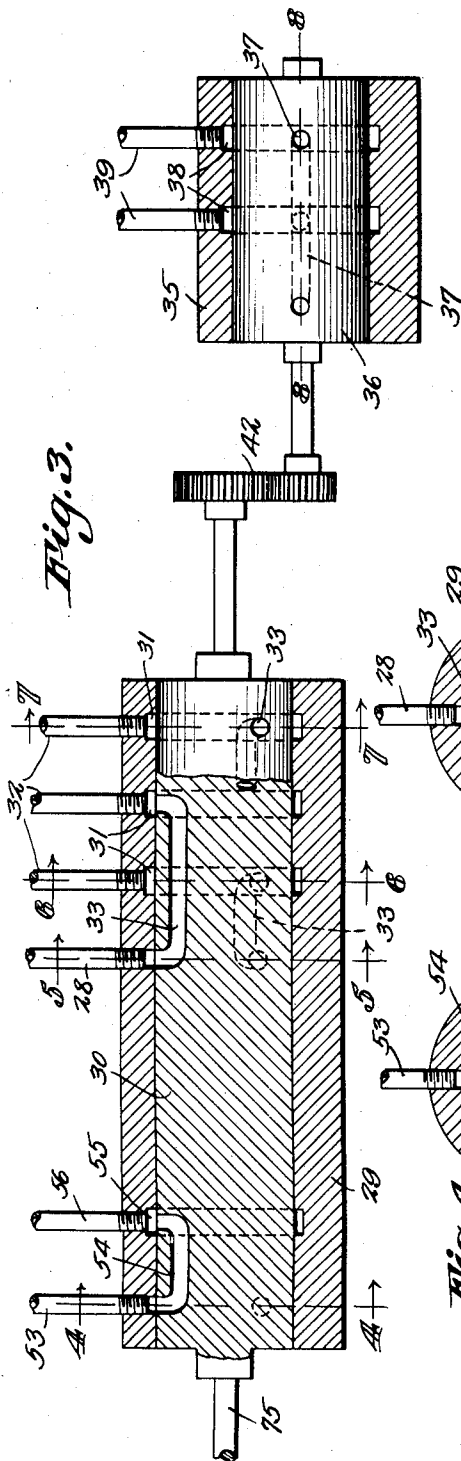
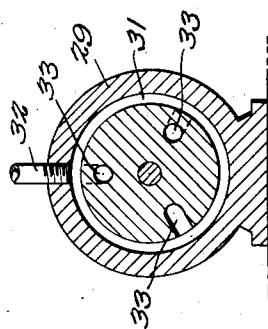
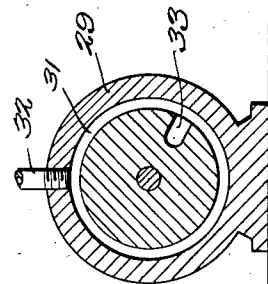
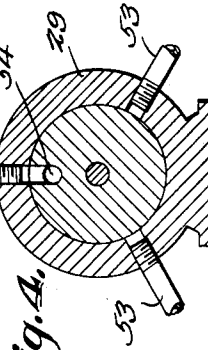
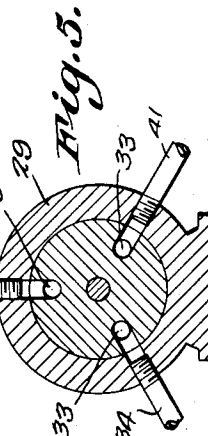


Fig. 3.

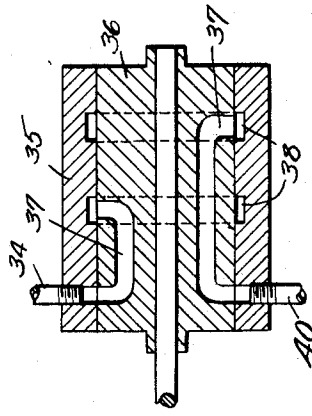
Fig. 5.

Fig. 4.



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Fig. 8.



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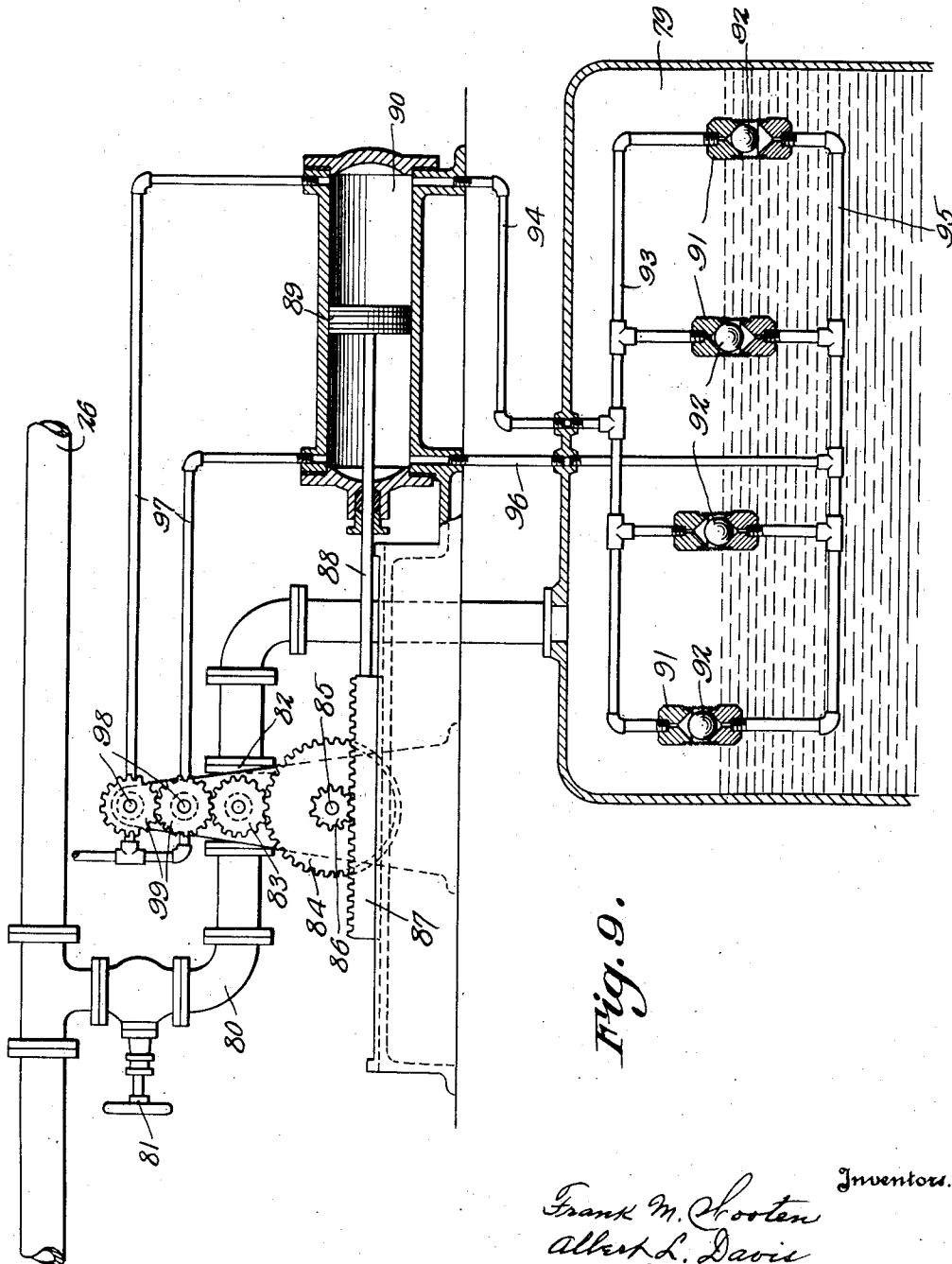


Fig. 9.

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UNITED STATES PATENT OFFICE

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AUTOMATIC HIGH PRESSURE BOILER FEED SYSTEM

Application filed April 14, 1931. Serial No. 529,918.

This invention relates to boiler feed systems and has special reference to an automatic high pressure boiler feed system, especially adapted to marine duty.

5 The invention further relates to a valve regulator for automatically controlling the extent of opening of the water supply valve of a boiler in accordance with the water level condition within the boiler.

10 One important object of the invention is to provide an improved general construction of apparatus for the purposes specified.

15 A second important object of the invention is to provide an improved boiler feed device whereby the usual feed pump or injector will be rendered unnecessary and may be eliminated.

20 A third important object of the invention is to provide an improved device for this purpose capable of feeding a battery of boilers and equally efficient when all of the boilers of the battery are in use and when one or more of such boilers are out of use, as for repairs, during partial shut-downs of a factory, while a ship on which the boilers are located is in port or under like conditions of partial disuse of the battery.

25 A fourth important object of the invention is to provide an improved boiler feed wherein the losses due to heat losses in large bodies of condensate outside of the boilers such as in hot wells and elsewhere, the friction losses in pumps, the losses due to the operation of injectors and such other losses as are inherent in present apparatus for the purpose will be greatly reduced and, in some cases eliminated, so that a very great economy may be effected in fuel consumption.

30 A fifth important object of the invention is to provide an improved device for this purpose which will be entirely automatic in operation so that the watchful care of a water tender is rendered unnecessary and the services of such persons as are commonly employed for this especial purpose may be eliminated.

35 A sixth important object of the invention is to provide an improved apparatus for this purpose so arranged that water will be fed to the boilers of a battery in strict accordance

with the requirements of the individual boilers so that the water level in each boiler will be kept at the level desired in that boiler independently of the variations tending to exist because of variations in firing and water 55 evaporation in the several boilers of a battery.

A seventh important object of the invention is to provide an improved boiler feed system whereby the deterioration of a boiler 60 due to chilling, and consequent alternate contraction and expansion, caused by the intermittent introduction of considerable quantities of water well below the boiling temperature is eliminated, the water being introduced at a temperature close to the boiling point and in an even and regular flow so that the temperature of water within the boiler is kept at substantially uniform manner. 70

With the above and other objects in view, the invention consists in general of certain novel details of construction and combinations of parts hereinafter fully described, illustrated in the accompanying drawings, 75 and specifically claimed.

In the accompanying drawings like characters of reference indicate like parts in the several views, and:—

Figure 1 is a perspective view, partly in section showing the layout of the pipe, tanks and valves for the water feeding mechanism of this invention. 80

Figure 2 is a longitudinal section through a valve actuating device used herewith. 85

Figure 3 is a longitudinal section through the main valves shown in Figure 1.

Figure 4 is a section on the line 4—4 of Figure 3.

Figure 5 is a section on the line 5—5 of Figure 3. 90

Figure 6 is a section on the line 6—6 of Figure 3.

Figure 7 is a section on the line 7—7 of Figure 3. 95

Figure 8 is a section on the line 8—8 of Figure 3.

Figure 9 is an enlarged detail view, partly in elevation and partly in section, and showing the means used for regulating the feed of 100

water to an individual boiler forming one of a battery.

In the embodiment of the invention here disclosed, and which is capable of many variations to meet the requirements of variations in boiler installations, there is shown a pair of closed tanks 10 and 11 which are located so that their high water level is below the condenser (not shown) commonly used to receive and condense the exhaust steam from the various engines and other apparatus receiving live steam from the boilers to which this present invention is attached. For convenience the tanks 10 and 11 will be designated the primary or receiving tanks. A set of three tanks 12, 13 and 14, preferably termed secondary or supply tanks, are positioned above the high water level of the boilers to be fed, the low water level in these tanks being preferably at least six feet higher than the boiler water level. A supply pipe 15 leads from the before mentioned condenser and is provided at its lower end with branches 16 each of which enters a primary tank at its lower end. Each branch 16 is provided, adjacent its junction with the pipe 15, with a check valve 17 each of which opens away from the condenser and toward the tank to which the respective branch is attached. Between each valve 17 and the respective tank the pipes 16 are provided with branches 18 which are united by a cross fitting to a riser 19. Check valves 20, opening toward the riser, are provided at each side of the cross fitting in the branches 18. The riser 19 extends upwardly to a header 21 running below the tanks 12, 13 and 14 and risers 22 extend upwardly from this header to the respective supply tanks. An upwardly opening check valve 23 is provided in each riser 22. A branch 24 extends laterally from each riser 22 above the respective valve 23 and is provided with a check valve 25 opening away from the riser and these branches are all connected to the main boiler supply pipe 26 leading to the several boilers of the battery in a manner presently to be described.

A main steam pipe 27 leads from the boilers and is connected by a branch 28 with one end of a valve casing 29 wherein is mounted a rotary valve member 30 which is rotated intermittently by mechanism hereinafter described. In this end of the valve casing are formed internal grooves from alined points of which extend pipes 32 leading to the respective supply tanks. In the rotary member 30 are three ports 33 each having one end movable, through the rotation of the valve 30 into and out of alinement with the port at the end of the branch 28 and respectively having their other ends opening into the respective grooves or passages 31. These ports are equally spaced around the valve so that, with each movement of one-third of a revolution of the valve a respective pipe 32 and supply

tank are placed in communication with the steam supply branch 28. Further, a port is formed, in the path of the inlet ends of these ports 32, in the casing 29 at an angular distance of 120° in the direction of rotation of the valve 30 and another port is similarly formed at 120° in the opposite direction. A pipe 34 leads from the first of these ports just mentioned to a valve casing 35 wherein is mounted a rotary valve member 36 having a pair of ports 37 formed therein. These ports 37 each have one end arranged to move into and out of registry with the pipe 34 as the valve 36 rotates and are arranged at 180° apart in the valve 36. Each port 37 has its remaining end opening into a respective internal groove or steam passage 38 formed in the casing 35. Pipes 39 lead from respective grooves 38 to the respective primary tanks 10 and 11, opening into the tops of said tanks. A bleeder or exhaust pipe 40 communicates with the casing 35 at 180° from the pipe 34 and a pipe 41 similarly forms a bleeder or exhaust pipe from the casing 29. Gearing 42 connects the valves 30 and 36 in such manner that the valve 36 makes one-half revolution to each one third revolution of valve 30.

We may now consider the operation of this part of the apparatus as the operation of these parts covers the actual collection of the condensate and its return to the boilers. As the condensate flows down the pipe 15 it will rise in one of the primary tanks and not in the other. This is because the valve 36 will after valve index be so positioned as to place the pipe 39 from tank 11 receiving the condensate into communication with the bleeder 40. The other tank, say 10, is at the same time caused by the position of the valve 36 to be in communication with the pipe 34. At the same time one of the secondary tanks, which has just been emptied, will be placed in communication with the pipe 34 by the position of the valve 30. Now, as will be presently seen, this particular secondary tank still has a volume of steam which has not fully expanded. Suppose this to be tank 13. Tank 12, at this time will be placed by valve 30 in communication with exhaust 41 so that all pressure therein is relieved and tank 14 will be placed in communication with steam supply pipe 28. The following action will then take place. Live steam, under full boiler pressure, blows down tank 14 and its contents pass in the supply line 26 and thus into the boiler. Simultaneously, condensate rises in tank 11 and tank 10 is blown down by the expanding steam in tank 13 passing through the respective pipe 32, valve 30, pipe 34, valve 36 and respective pipe 39. As the condensate leaves tank 10 it flows up riser 19 into the header 21 and through the respective branch 22 into tank 12. This action continues until tanks 10 and 14 are emptied and tanks 12 and 11 are filled. The valves now shift

again and tanks 13 and 11 are placed in communication, tanks 13 and 10 are opened to the steam exhaust and tank 12 placed in communication with the live steam supply and the filled tanks 12 and 11 are similarly emptied and the tanks open to the exhaust similarly filled. This is followed on each shift of valves 30 and 36. In order to save an appreciable amount of steam we have adopted three secondary tanks since each working position of the valves requires that one tank having partially exhausted steam therein be placed in communication with the full primary tank, one secondary tank must be open to permit filling and the third secondary tank must deliver to the boilers. It will also be noted that it is only necessary to have two primary tanks since these fill and empty alternately. The check valves, of course, are used to prevent back flow through the pipes and to ensure that the condensate will always travel forwardly from the condenser to the boilers.

To compensate for any steam losses that may occur and to ensure proper water supply when the quantity of condensate is not sufficient to maintain proper boiler water levels (as when blowing down a boiler or for other cause) a fresh water supply 42 is provided below the water level of which is arranged a small closed auxiliary tank 43 having its upper end communicating with the upper end of tank 11 by a pipe 44. This tank is gravity filled through a pipe 45 provided with an inwardly opening check valve 46. A riser 47 having an upwardly opening check valve 48 therein leads from pipe 45 to the cross fitting at the lower end of riser 19. The tank 11 has a downwardly extending internal pipe 49 at its upper end with which the pipe 44 communicates. At the lower end of pipe 49 is a cage holding a float valve 50 which rises and closes pipe 49 as condensate rises in tank 11 providing there is sufficient water in the system.

A second float valve 51 is arranged to close the outlet branch 16 upon the condensate in tank 11 dropping to a predetermined height.

Now, if in the course of operation there is not enough condensate in tank 11 to fill the tank and lift valve 50, as soon as steam enters the tank 11 it will blow the tank down to expel whatever water may be above the level of the outlet and force it up into the proper secondary tank. When this water has been expelled, if steam is still entering tank 11 (the valves not having been indexed) it will flow through pipe 44 upon seating of valve 51 and will blow down the tank 43 to force its contents into the riser and thus add to the volume of water in the secondary tank. Obviously, the primary tank 11 will be emptied before the auxiliary tank because the lift is less from the primary to the auxiliary tanks than from the auxiliary to the second-

ary tanks. It is not necessary that both primary tanks be connected to the auxiliary tank as extra water is required only at comparatively long intervals.

Considering now, the, automatic means by which the valves 30 and 36 are actuated at the proper times. Each of the tanks 12, 13 and 14 is provided with a float valve 52 which acts, when the tank is nearly empty, to close an outlet from which a pipe 53 leads to the remaining end of the casing 29, these pipes being connected to the casing in a plane perpendicular to the axis thereof and at angular intervals of 120°. The valve 30, at this end, has a single port 54 in constant communication with an internal groove or steam passage 55 in the casing at one end and moving successively into registration with the pipes 53 as the valve indexes. A pipe 56 leads from the passage 55 to the head of a cylinder 57 having a relatively large piston 58 therein. This cylinder has its opposite end reduced and provided with a relatively small piston 59 fixed to the piston 58 in spaced relation thereto by a stem 60 which projects beyond the piston 59 and is provided with a valve 61 normally closing a port 62 in the remaining head of the cylinder. This port opens into a second large cylinder 63 wherein moves a piston 64 connected by a stem 65 with a relatively small piston 66 moving in a reduced end of the cylinder 63. In the piston 64 is a spring pressed and normally closed check valve 67 arranged to open only when the piston 64 moves to bring this valve into contact with the shoulder of cylinder 63 between the large and small ends. The stem 65 extends outwardly from the cylinder through a stuffing box 68 and carries on its outer end a rack 69 meshing with a pinion 70 mounted on a shaft 71. An arm 72 is fixed on this shaft and carries a pawl 73 which works over a three toothed ratchet 74 fixed on the stem 75 of valve 30. The proportions of the ports are such that each movement of the piston 64 towards the small end of its cylinder rotates the stem 75 one-third of a revolution. The steam pipe 27 is provided with branches 76 opening into the respective reduced cylinder ends. Exhaust pipes 77 lead from between the large and small pistons of each cylinder and needle valve controlled bleeders 78 lead from the large ends of each cylinder. The operation is as follows: The float valves of the secondary tank which is full is opened so that water under pressure passes from this tank to the left of piston 58 and, due to the large size of this piston, holds valve 61 closed against the pressure of the live steam against piston 59 urging valve 61 to open. The filled secondary tank empties sufficiently to permit valve 52 to seat and close off further flow of water into cylinder 57. The bleeder 78 of this cylinder

has its valve so adjusted as to leak very slowly but still sufficiently to reduce the pressure, between the time of seating of valve 52 and the completion of emptying the secondary tank, and allow the live steam pressure behind piston 59 to force piston 59 to the left and open valve 62. Steam now enters cylinder 63 and forces piston 64 to the right since the total pressure on piston 66 is less than that on piston 64. This operates the rack and thus turns valve 30 one-third of a revolution and valve 36 one half of a revolution. The valve 67 opens and steam behind the piston 64 passes out through this valve and escapes through exhaust 77. Now, the next secondary tank that affects cylinder 57 will be the one which has just been filled, raising float 52, and is being blown down, therefore it will close valve 61. The large end of cylinder 63 is now bled through its bleeder 78 and piston 64 moves to the left ready for the next operation. The exhausts 77 serve to equalize cylinder displacement between the large and small pistons. It will now be plain that each time one of the secondary tanks is emptied the control valves are actuated and the system placed in condition for emptying the next secondary tank and that the shifting of the valves is controlled by such emptying. Consequently the system operates automatically in exact accordance with the water evaporation in the boilers.

We will now consider the means by which flow from the secondary tanks is properly distributed to the boilers of the battery. Each boiler 79 is connected to the pipe 26 by a branch 80 provided with a cutoff valve 81 for manual operation. In the pipe 80 is also a regulating valve 82 having on its stem a gear 83 with which meshes a gear 84 fixed on a shaft 85 carrying a gear 86. A rack 87 meshes with the gear 86 and is carried by a piston rod 88 whereon is mounted a piston 89 working in a cylinder 90, the piston being normally central of the cylinder. Within the boiler 79, or in suitable communication therewith are double check valve casings 91 having vertically disposed confronting valve seats between which move float valves 92. Preferably there are four of these valves arranged in vertically stepped relation so that, with the boiler water level at its desired normal height two of the valves will be open above and closed below while the other two are closed above and open below. A manifold 93 connects the upper ends of casings 91 with a pipe 94 and thus to one end of the cylinder 90. A similar manifold 95 connects the lower ends of casings 91 with a pipe 96 and thus to the opposite end of the cylinder 90. Exhaust pipes 97 lead from the opposite ends of the cylinder 90 and are controlled by adjusting valves having stems 98 connected by gearing 99 to the gear 83 to operate with

the valve 82. Normally, these exhaust control valves permit a constant but very slight leakage from the two ends of the cylinder and the leakage from the two ends is equal with the piston 89 in normal position. Since, under the same normal conditions, two valves 91 are open to one end of the cylinder and two open to the other end, pressure will escape equally through both ends of the cylinder. If the water level in the boiler drops slightly, a third valve will open upwardly and close downwardly. Consequently there will be a greater supply offered to the right end of cylinder 90 (as in Fig. 9) and less to the left end. Pressure will build up to the right of piston 89 and the piston will move to the left which causes valve 82 to open somewhat. Conversely, if the water level rises the action will be reversed and valve 82 will close to a certain extent. Obviously, a greater drop or rise in the water level will cup off all valves from the corresponding end of the cylinder and move the valve 82 to a greater extent. It is to be noted that the exhaust control valves are arranged so that the valve controlling flow from the end nearer the piston, when it is displaced from its control position, is closed slightly more than normal while the valve at the opposite end is correspondingly opened. By this means, when the water level is restored to normal so that the flow to each end of the cylinder 90 is through two valves 91, less pressure will escape from one end than the other and pressure will build up at the first end to restore the piston to central position and thereby restore the control valves to normal position. Obviously, if there be several boilers and the water levels in all keep uniform in varying from normal, all valves 82 will be uniformly affected to open or close.

The operation of each feature of the invention having already been described in connection with the specific constructions involved, it is not deemed necessary to now describe the operation in its entirety.

There has thus been provided a simple and effective device of the kind described and for the purpose specified.

It is obvious that minor changes may be made in the form and construction of the device without departing from the material principles thereof. It is not, therefore, wished to confine the invention to the exact form here shown and described, but it is wished to include all such as properly come within the scope claimed.

Having thus described the invention, what is claimed as new is:—

1. In a boiler feed system, a pair of primary condensate receiving tanks, a series of secondary tanks, piping connections between the primary and secondary tanks arranged to conduct water from the primary to the secondary tanks, a condensate supply

pipe opening into the primary tanks, a boiler feed pipe connected to the secondary tanks to receive water therefrom, steam pressure lines each connected to a respective tank, valve means controlling the flow of steam through the steam pipes and arranged to cause alternate supply to and exhaust from the primary tanks in succession and to cause supply to and full exhaustion from the secondary tanks in succession, and means for actuating the valve means and controlled to operate upon the emptying of each secondary tank.

2. In a boiler feed system, a pair of primary condensate receiving tanks, a series of secondary tanks, piping connections between the primary and secondary tanks arranged to conduct water from the primary to the secondary tanks, a condensate supply pipe opening into the primary tanks, a boiler feed pipe connected to the secondary tanks to receive water therefrom, steam pressure lines each connected to a respective tank, valve means controlling the flow of steam through the steam pipes and arranged to cause alternate supply to and exhaust from the primary tanks in succession and to cause supply to and full exhaustion from the secondary tanks in succession, and means controlled by the steam pressure in one of said primary tanks for intermittently adding a supply of fresh water to the secondary tanks.

3. In a boiler feed system, a pair of primary condensate receiving tanks, a series of secondary tanks, piping connections between the primary and secondary tanks arranged to conduct water from the primary to the secondary tanks, a condensate supply pipe opening into the primary tanks, a boiler feed pipe connected to the secondary tanks to receive water therefrom, steam pressure lines each connected to a respective tank, valve means controlling the flow of steam through the steam pipes and arranged to cause alternate supply to and exhaust from the primary tanks in succession and to cause supply to and full exhaustion from the secondary tanks in succession, a self filling auxiliary fresh water tank, a steam pipe leading from one of the primary tanks to the auxiliary tank, and a water pipe arranged to conduct water from the auxiliary tank to the secondary tank by means of the steam pressure in the primary tank.

4. In a boiler feed system, a pair of primary condensate receiving tanks, a series of secondary tanks, piping connections between the primary and secondary tanks arranged to conduct water from the primary to the secondary tanks, a condensate supply pipe opening into the primary tanks, a boiler feed pipe connected to the secondary tanks to receive water therefrom, steam pressure lines each connected to a respective tank,

valve means controlling the flow of steam through the steam pipes and arranged to cause alternate supply to and exhaust from the primary tanks in succession and to cause supply to and full exhaustion from the secondary tanks in succession, means controlled by the steam pressure in one of said primary tanks for intermittently adding a supply of fresh water to the secondary tanks, and means for actuating the valve means and controlled to operate, upon the emptying of each secondary tank.

5. In a boiler feed system, a pair of primary condensate receiving tanks, a series of secondary tanks, piping connections between the primary and secondary tanks arranged to conduct water from the primary to the secondary tanks, a condensate supply pipe opening into the primary tanks, a boiler feed pipe connected to the secondary tanks to receive water therefrom, steam pressure lines each connected to a respective tank, valve means controlling the flow of steam through the steam pipes and arranged to cause alternate supply to and exhaust from the primary tanks in succession and to cause supply to and full exhaustion from the secondary tanks in succession, a self filling auxiliary fresh water tank, a steam pipe leading from one of the primary tanks to the auxiliary tank, a water pipe arranged to conduct water from the auxiliary tank to the secondary tank by means of the steam pressure in the primary tank, and means for actuating the valve means and controlled to operate upon the emptying of each secondary tank.

In testimony whereof we affix our signatures.

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