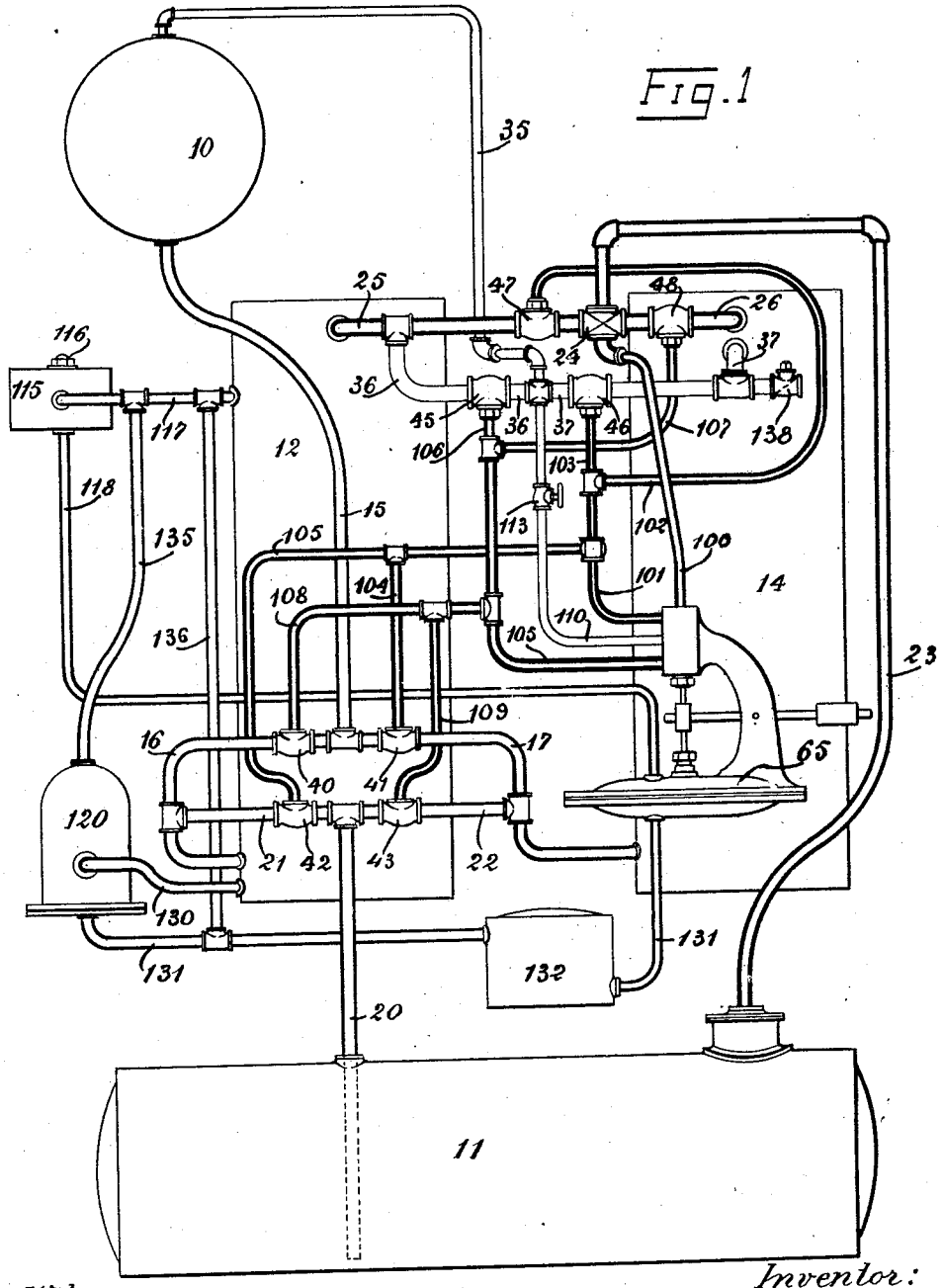
Sept. 28, 1926. 1,601,478

W. L. OSWALD

STEAM PUMP OR BOILER FEEDER

Filed July 5, 1923 2 Sheets-Sheet 1

Fig. 1




Witnesses:

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STEAM PUMP OR BOILER FEEDER

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Fig. 4

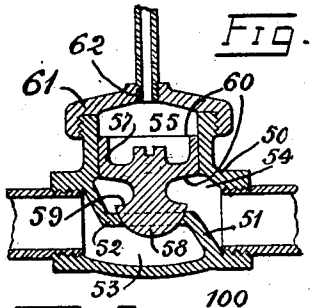



Fig. 5

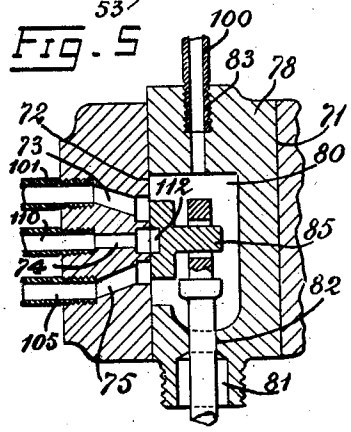



Fig. 3

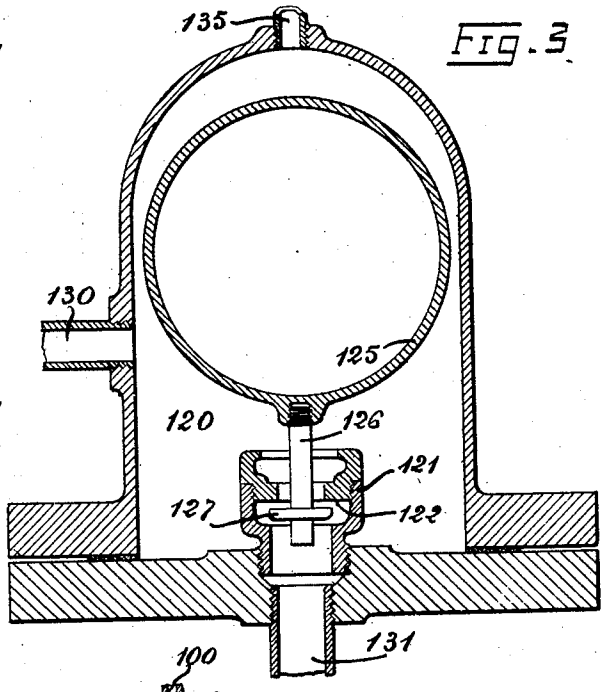



Fig. 6

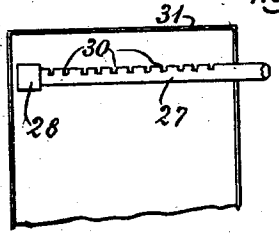



Fig. 2




Witnesses:

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Patented Sept. 28, 1926. 1,601,473

# UNITED STATES PATENT OFFICE.

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## STEAM PUMP OR BOILER FEEDER.

Application filed July 5, 1923. Serial No. 649,614.

This invention relates to steam pumps, boiler feeders and steam traps though it is noted that the invention is not limited to any of these nor in some respects even to steam or pressure devices.

The invention particularly relates to that form of trap or boiler feeder having a control tank, means for the intake of liquid into the tank and its discharge alternately therefrom, and means for supplying steam pressure to the upper part of the tank when the liquid is flowing therefrom.

One object of the invention is to provide a device adaptable for continuous or intermittent flow of liquid therefrom.

Another object is to provide an apparatus or device of this kind in which the steam pressure is supplied when the liquid is at the upper level of the control tank and is retained therein until the lower level is reached.

Another object of the invention is to provide in an apparatus or device of this kind suitable means for venting the control tank when liquid is rising therein, and for preventing the venting while steam is entering.

Another object of the invention is to provide an apparatus or device of this kind in which water hammer and the too sudden or extensive cooling of steam will not take place.

Other objects of the invention are to improve generally the simplicity and efficiency of such devices and to provide a device or apparatus of this kind which is durable, economical to manufacture and operate, and which will not get out of order.

The inventive features for the accomplishment of these and other objects are shown in connection with my improved steam pump or boiler feeder which, briefly stated, comprises a master tank and an auxiliary tank between the levels of a water feed reservoir and the boiler to be fed, and means for conducting water from the reservoir to the tanks and its discharge alternately from the tanks into the boiler. Means are provided for supplying counter balancing steam pressure discharging it through a perforated pipe into the upper part of the tanks when the water is flowing from the tanks into the boiler, and for venting the upper part of the tanks when the water is entering therein. A system of steam operated valves controls the flow of the fluids in all of said means whereby the above described actions take place and this system is controlled by a steam control means including a diaphragm chamber having a diaphragm therein for actuating a control valve directing steam to the valves of said system and actuated by the diaphragm. Said diaphragm is shifted by a float control means itself controlled by the water level of the master tank only and at the upper and lower water level limits therein.

Other objects of the invention will appear as the description proceeds; and while herein details of the invention are described, the invention is not limited to these, since many and various changes may be made without departing from the scope of the invention as claimed.

In the accompanying drawing, showing by way of example, one of many possible embodiments of the invention,

Fig. 1 is a diagrammatic elevation showing the assembly of the device;

Fig. 2 is an axial sectional view, partly in elevation, showing the diaphragm chamber and steam control valve;

Fig. 3 is a vertical axial sectional view, showing the float control means;

Fig. 4 is a longitudinal vertical sectional view of one of the steam pressure operated valves;

Fig. 5 is a vertical sectional view of the control valve, drawn on a larger scale than Fig. 2; and

Fig. 6 is a transverse vertical sectional view, partly in elevation, showing the perforated steam discharge pipe.

My improved pump or boiler feeder is shown in combination with an elevated water feed reservoir 10 and a pressure boiler 11 to be fed; though the invention is not limited either to a pump or boiler feeder. The apparatus itself comprises a master tank 12 and an auxiliary tank 14 between the levels of the reservoir and boiler, and operating means for causing the alternate intake of water from the reservoir to the tanks and its discharge alternately from the tanks into the boiler. It is noted that the invention is not limited to the inclusion of the auxiliary tank, as this is not necessary to the operation of the apparatus, but provides for continuous operation as distinguished from intermittent operation.

The operating means comprises a water feed pipe 15 extending from the lower part of the reservoir to near the lower level of the tanks 12 and 14 where it communicates with master and auxiliary water feed branch pipes 16 and 17 joining the lower end of the feed pipe and extending into the lower part of the respective tanks 12 and 14 for feeding water into the tanks. A discharge pipe 20 extending from near the lower part of the master and auxiliary tanks and discharging into the boiler is fed by discharge branch pipes 21 and 22 extending from said feed branch pipes 16 and 17 respectively to the discharge pipe for discharging water from the tanks into the boiler.

Means are provided for supplying counter balancing steam pressure in the upper part of the tanks when the water is flowing from the tanks into the boiler. Said means comprises a pressure steam pipe 23 leading from the upper part of the boiler to near the upper part of said tanks 12 and 14 where it is provided with a T or X-connection 24 joining the steam pipe with master and auxiliary branch steam pipes 25 and 26, each having a discharge part 27 (Fig. 6) extending transversely into the upper part of the master or auxiliary tanks respectively and provided with a cap 28 to seal the end and with transverse hack-saw cuts 30 at the upper part for directing incoming steam against the upper head 31 of the tank to cause the steam to lose its velocity before coming into contact with the water to avoid the too sudden condensation of steam and water hammer.

Vent means for permitting the egress of air from the upper part of the tanks when the water is entering therein, comprises a main relief pipe 35 communicating with the upper part of the reservoir 10 and communicating with branch relief pipes 36 and 37 extending from main pipe respectively to said auxiliary tank 14 and to the master steam branch pipe 25 at a point near the master tank.

I provide a system of valves for controlling the flow of the fluids in all of said branch pipes whereby the above described alternate actions take place. Said system comprises master and auxiliary water feed valves 40 and 41 interposed in said feed branch pipes 16 and 17 and openable by the reservoir water pressure and closable, as will be explained, when stem pressure is within the tanks; master and auxiliary discharge valves 42 and 43 interposed in said water discharge branch pipes 21 and 22 and openable by water head and steam pressure in the tank and closable when the interior tank pressure is less than the boiler pressure; master and auxiliary vent valves 45 and 46 interposed in the vent branch pipes and constantly tending to open by the pressure within the tanks, and master and auxiliary steam valves 47 and 48 interposed in the steam branch pipes between said T and said auxiliary tank and the juncture of the master vent branch pipe with the steam branch and constantly tending to open by the boiler steam pressure in the steam branch pipes.

While the valves 40 to 43 may be plain check valves in the device as here shown, for lift pump work all of said valves 40 to 43 and 45 to 48 are preferably constructed to be operated by steam or other pressure control means whereby said valves are pressure actuated at the proper time for causing the water level in the tanks alternately to rise and fall in alternation with each other. It is understood that the invention is not limited to the same or any type of valve. As herein shown, each of said valves comprises a valve body 50 (Fig. 4) having a parition 51 having a seat 52 and forming an outlet chamber 53 and an inlet chamber 54. The valve is also formed with a piston chamber 55 joining the inlet chamber and receiving a piston 57 provided with an integral closure member 58 in the inlet chamber closable on the seat and of smaller active pressure area 59 in the inlet chamber than the pressure area 60 of the piston whereby the pressure in the inlet chamber 54 opens the valve. The inlet chambers of the respective steam and feed valves are disposed toward the steam pipe and the water feed pipe; while the inlet chambers of the vent and discharge valves are disposed toward the tanks. A cap 61 on the piston chamber closes the chamber and is provided with a pipe receiving opening 62 for the entry of controlling steam from a steam control means now to be described. The steam control means comprises a horizontal diaphragm chamber comprising upper and lower wall members 65 and 66, Fig. 2, between which is clamped a diaphragm 67 dividing the chamber into an upper constant pressure compartment 68 and a lower working pressure compartment 69. A bracket arm 70 on the upper wall member 65 of said chamber overhangs the chamber and has a large vertical opening 71 approximately coaxial with the diaphragm and having a vertical valve seat 72 (Fig. 5) provided with upper, lower and intermediate ports 73, 74 and 75 provided with screw threads at the outer ends. A control valve housing block 78 is fitted in said opening provided with a valve chamber 80 therein having an open side disposed over and communicating with said ports. Said housing block 78 has a lower stuffing box 81 and rod opening 82 and an upper steam passage 83. A slide valve 85 is vertically slidable on said valve seat and has sufficiently short outside lap to open one end port 73 before

the other end port 75 is opened, thereby to momentarily hold closed valves controlled thereby, as will be explained. An upper valve rod section 87 (Fig. 2) extending through said stuffing box 81 is secured to the slide valve, and a lower section 88 extending through a stuffing box 89 in the top wall of the diaphragm chamber passes through the diaphragm and a pair of flexible metallic disks 90 and 91 on both sides of the diaphragm and having their edges 92 turned away from the diaphragm. Nuts 93 clamp together the plates and the diaphragm and secure the rod section 88 thereto. An intermediate piece 99 connecting said sections has a transverse opening 95 therein. A counter balance lever 96 intermediately fulcrumed on the mid part of the bracket arm has one arm passing through said transverse opening and on the other arm carries a weight 97.

A control valve steam pressure pipe 100 extends from said T 24 and is screwed in said upper steam passage 83 of the control valve housing block for supplying steam to the control valve. An upper steam distributing pipe 101 extending from said upper port 73 is provided with branches 102, 103, 104 and 105, Fig. 2, extending respectively into the threaded opening of the caps of the steam inlet master valve 47, the relief auxiliary valve 46, the water feed auxiliary valve 41, and the discharge master valve 42, whereby when the control valve is down, steam pressure passing through pipes 100 and 101 and said branches holds all of said last mentioned valves closed. A lower distributing pipe 105 extending from said lower port and provided with branches 106, 107, 108 and 109 extending respectively to the threaded cap openings of the master relief valve 45, the auxiliary steam valve 48, the master water feed valve 40, and the auxiliary discharge valve 43, whereby when the control valve is up, all of said valves are held closed. A common valve relief pipe 110 connects said intermediate port 74 with the main relief pipe 35, whereby when said control valve 85 is down, the piston chambers of the master vent valve 45, the auxiliary steam valve 48, the master water feed valve 40 and the auxiliary discharge valve 43 are vented by way of the pipe 105, the recess 112 of the slide valve 85, the pipe 110 and the main vent pipe 35, thereby permitting said last mentioned valves to open, whereupon steam is admitted into the upper part of the auxiliary tank and water therein runs by gravity into the boiler, while at the same time the upper part of the master tank is vented and feed water enters the bottom of the same by gravity due to the height of the reservoir 10. The opposite actions take place when the control valve 85 is up.

An adjusting retarding valve 113 is provided in said relief pipe 110 for retarding the relief action of the valves to prevent the opening of the vent valves before the close of the steam valves, whereby loss of steam through the relief pipes 36 and 37 is prevented. This action of the valve 113 adds itself to the action of the short outside lap of the slide valve 85, permitting the sum of these actions to be adjusted; and while neither is herein omitted, it is noted that the presence of either one is not necessary to the operation of the other, and the invention as claimed is not so limited.

A surge chamber 115 (Fig. 1) at the upper limit level of the master tank having a plugged filling opening 116 has its upper part connected by an overflow pipe 117 at said upper limit level with the master tank. A pressure pipe 118 connecting the lower part of the surge chamber with the upper compartment of the diaphragm chamber is provided for maintaining a substantially constant and uniformly distributed pressure on the upper face of the diaphragm.

Now will be described control means whereby the control valve is shifted by the water of the master tank at the upper and lower water level limits therein. Said control means comprises a float chamber 120 at the lower level of the master tank provided with a drain valve 121 at the lower part, said valve having an upper seat 122. A float 125 (Fig. 3) in said chamber carries a pending float valve stem 126 provided with a closure disk 127 disposed below said seat 122. A pipe 130 (Fig. 1) connects the lower part of the master tank with the mid part of the float chamber, whereby as water rises in the master tank, the float is raised and seals the valve 121. A pipe 131 connecting the lower part of the drain valve with the lower compartment 69 of the diaphragm chamber has interposed therein a water cooling chamber 132 to protect the diaphragm against hot water from the master tank. A riser 135 extends from the upper part of the float chamber to the overflow pipe 117 whereby water in the float chamber rises whenever the water in the tank rises, thus to hold the float valve 121 closed while the water in the master tank is going either up or down, and until the lower level is reached in the master tank and float chamber, whereupon the float lowers and releases the float valve and the pressure on the lower face of the diaphragm to permit the pressure on the upper face thereof to shift the control valve down thereby to open the water feed valve 40 and the vent valve 45 to cause the water in the master tank to rise. A pressure pipe 136 connects the overflow pipe with the connecting pipe 131, whereby the water in the master tank, when, and not before, it reaches its upper limit, may overflow into the connecting pipe to cause the raising of the diaphragm and

the control valve thereby to open the water discharge valve 42 and the steam supply valve 47 and cause the water in the master tank to rise. An inlet check valve 138 (Fig. 1) communicating with the auxiliary vent branch pipe 37 between the vent valve and the tank is provided for admitting air into the upper part of the tank 14 should condensing entrapped steam therein tend to suck up water to above the discharge end of the steam pipe 26 in the auxiliary tank, where it would cause water hammer when steam is next admitted to the tank.

This device will perform the duties of a direct return steam trap, that is, it will discharge water under little or no pressure, as in the reservoir 10, into the steam boiler 11 or other pressure vessel. In general it follows the principles of the direct return steam trap, but it embodies new and important improvements. It may be adapted to either intermittent flow, as when the tank 14 is cut out or omitted; or it may be used for continuous filling and discharging, as when both tanks 12 and 14 are used. It is controlled directly by the height of water in the master tank 12, instead of by pressure, thus adapting it for duties such as pumping into open tanks or draining pipes and vessels carrying alternately high and low pressure, etc.

The operation as a continuous boiler feeder, pump or lifting trap is as follows:

At the start the compartment 68 above the diaphragm, the pipe 118 and the surge chamber 115 are filled with water the plug 116 being removed for that purpose, and is then replaced. The surge chamber 115 acts as a surge space to allow the diaphragm to flex without materially altering the head of water in the pressure pipe and surge chamber. This gives at all times a constant downward pressure on the diaphragm, and as this pressure is only partly counter-balanced by weight 97, it tends to force the diaphragm and slide valve 85 (Fig. 5) to their lower position, thereby uncovering the upper port 73. Boiler pressure steam is thus passed through the pipe 100 and passage 83 into slide valve chamber 70, and then flows through port 73 into the pipe 101 and branch pipes 102, 103, 104 and 105 into piston chambers of valves 47, 46, 41 and 42, thus closing these valves. Simultaneously any pressure in the piston chambers of valves 45, 48, 40 and 43 escapes or vents through pipes 106, 107, 108, 109, 105, the port 75, (Fig. 5) the recess 112, port 74, and pipes 110 and 35 into the reservoir 10. This venting of the piston chamber permits valves 45, 48, 40 and 43 to open, the latter action being caused by steam or water pressure in the inlet chamber 54 of the valve pressing against the piston 57 with a greater total force than against the valve member 59, since the former has a greater area than the valve seat orifice. The downward flexing of the diaphragm therefore results in the opening of valves 45, 48, 40 and 43 and the closing of the others. Boiler pressure steam now enters auxiliary tank 14 by way of the pipes 23 and 26, and at the same time any pressure in the master tank 12 is released through pipes 25, 36 and 35 into reservoir 10, whereupon water in the reservoir 10 flows by gravity into tank 12 by way of pipes 15 and 16, and the open valve 40. Part of this water continues into float chamber 120 through the pipe 130 and then through the valve 121 (Fig. 3) into the pipes 131 and cooling chamber 132 into the lower compartment 69 of the diaphragm chamber through pipe 21. As the water rises in the master tank 12 it rises correspondingly in the float chamber 120 and the riser 135 and soon the buoyancy of the float 125 closes the valve 121 preventing any further flow from the float chamber into the pipe 131 or into the lower compartment 69. As the water continues to rise in the master tank, the float chamber and then riser 135 become filled, but the water is unable to gain further entrance to pipe 136 until it reaches the height of the overflow pipe 117 whereupon it flows down and floods the pressure pipe 136, bringing its weight suddenly upward against diaphragm through the pipe 131. This moves the diaphragm upward, reversing the position of slide valve 85 and in turn valves 40 to 48, whereby the pressure in the auxiliary tank 14 escapes throguh pipes 37 and 35 and steam pressure enters the master tank through pipes 23 and 25. As a result water flows from the reservoir 10 into the auxiliary tank 14 by way of pipes 15 and 17, while simultaneously water flows from the master tank into the boiler through pipes 16, 21 and 20. As the water lowers in the master tank it lowers to the same extent in the riser 135 and then in the float chamber and eventually becomes too low to provide buoyancy for the float 125, whereupon the valve 121 is opened by the weight of the float and the water which had been trapped in the pressure pipe 136 flows into the float chamber through the pipe 131. This relieves the pressure under diaphragm which therefore moves downward under the weight of the water in pipe 118 and chamber 115. This reverses all the valves, and the auxiliary tank discharges through pipes 17, 12 and 29, while the master tank simultaneously fills as before.

It will be noted that the height of water in the master tank is the factor that governs the pressures in both tanks, and hence the filling and discharging of both. It thus might result, at times in the filling up of the auxiliary tank to the steam admission pipe 26, which would give rise to objectionable water hammer when the live steam en-

tered for the next discharge, were it not that the steam is vented through the separate pipe 37 at a lower level than the pipe 26. With this arrangement when the water reaches height of the pipe 37, the water closes this pipe which is the only vent port the tank has and the escape of steam or air is cut off and the steam or air is trapped at the top of the tank, which thus prevents the water rising further. The water may however flow out through the pipe 37 into the pipe 35, but when it has reached a height in the pipe 35 corresponding in pressure to the height of water in the reservoir 10 it will stop. This water will be blown out of the pipes 37 and 35 at the next venting of the auxiliary tank. The inlet check valve 138 which opens inwardly, assists in the above action by allowing air to be sucked into the auxiliary tank whenever the latter develops a vacuum by reason of the rapid condensing of steam when water first enters at the start of each refilling of the auxiliary tank. In the master tank the precautions against water hammer just described are unnecessary, as the certainty of admission of boiler pressure steam when the water has reached the level of the pipe 25 makes too high a water level impossible.

The operation of the device and intermittent feeder pump or trap is substantially the same as above relative to the master tank, the auxiliary tank and the associated valves being cut out or omitted. The master tank then functions alone as already described.

It will be noted that when the device is used as a boiler feeder, the valves 40, 41, 42 and 43 may be in the form of check valves, the valves 40 and 41 opening toward the respective tanks 12 and 14 to let the water flow in by gravity when the tanks are vented, and automatically closing to prevent water being forced back to the reservoir 10 when steam pressure enters the tanks. In like manner the valves 42 and 43 would open toward the boiler to let the water enter the boiler by gravity when counterbalancing steam is supplied to the tanks, but would close against boiler pressure as soon as the tanks were vented.

It is noted that the tank 12, the overflow pipe 117, the float chamber 120, the pipe 130 and the riser 135 all constitute a single master chamber or tank equivalent to an arrangement whereby the float 125 and valve 121 are placed inside the master tank, with the float chamber and pipes 123 and 135 omitted, and pipe 136 simply carried inside or outside the tank to the level of the overflow pipe 117. Therefore the invention is not limited to the particular arrangement shown. Neither is the invention limited to the particular type of valves 40 to 48 and 85, nor the combination of indirectly controlled valves rather than to valves controlled directly by the diaphragm 67 or some other level or pressure operated means.

This device possesses among others, the following advantages:—

1. It may be constructed as either a single intermittent acting device or a duplex device, the latter giving a constant discharge.

2. Wrought steel tanks may be used, reducing the weight as compared with cast bowls, and the weight is all in stationary parts of light construction and can be used for the supporting platform.

3. As the tanks do not move they may easily be insulated to conserve heat.

4. Most of the parts of the trap can be bought on the open market, reducing investment in patterns, stock and the like.

5. Most of the special parts can be of the same size for all sizes of traps, reducing the number of special parts that must be made to cover a large line of sizes.

6. The chief control parts, namely the valves 45 to 48 and 85, may be placed a distance from the main parts of the trap, where they will be more easily watched and adjusted.

7. As the water in the tanks is not agitated by any tilting action, and the steam is sprayed into the tanks so as to lose its force before coming in contact with water, the water will not absorb any considerable amount of heat from the operating steam and water hammer will not be developed.

8. The special method of venting the auxiliary tank 14 avoids the chance of the steam inlet pipe in this tank becoming submerged and giving rise to large heat absorption by the water and water hammer.

9. The construction is such that a direct return trap may readily be converted into a lifting trap, or vice versa.

10. The mechanical elements are simple and may be proportioned to function reliably on any pressure.

11. The movement of lever weight 97 will give evidence of operation or non-operation and is suitable for connection to a distant signal or recording device.

12. The valve 121 has the full boiler pressure on both sides at all times and has to open against only the pressure due to the head of water in tank 12 whereby little power is required to operate it.

13. The valve action is caused to occur at definite high and low water lines by means of the float valve 121.

14. All of the parts apt to require adjustment, such as the packings 81 and 89 (Fig. 2) may be located anywhere below the low water line of the master tank.

I claim as my invention:

1. In combination, a tank; a conduit communicating with the tank; a control means for causing the water in the tank to rise

when water in the conduit is low and to cause the water in the tank to lower when water in the conduit is high; and means for retarding the flow of water from the tank into the conduit until water in the tank is high; and means for retarding the flow of water from the conduit until the water in the tank is low.

2. In combination, a tank; a conduit receiving water from the tank when the water in the tank is high; a control means for causing the water in the tank to lower when water in the conduit is high, and causing the water in the tank to lower when the water in the conduit is high; and means for automatically opening the lower part of said conduit when the water in the tank is low, thereby to lower the water in the conduit to cause the water in the tank to rise.

3. In combination, a tank; a conduit; a control means controlled by water in the conduit for causing the water in the tank to rise when the water in the conduit is low and to cause the water in the tank to lower when water in the conduit is high; said conduit having an upper inlet to the tank whereby when the water in the tank reaches said upper inlet water overflows into the conduit to raise the water therein to cause the water in the tank to lower; and means for automatically connecting the lower part of the conduit to the tank only when the water in the tank is low, thereby to lower the water in the conduit and cause the water in the tank to rise.

4. In combination, a water reservoir; a master tank and an auxiliary tank between the levels of the reservoir and the boiler to be fed; means including water feed branch pipes and discharge branch pipes for conducting water from the reservoir to the tanks and discharging it from the tanks into the boiler; means including steam pressure branch pipes to the respective tanks for supplying steam pressure in the tanks when the water is flowing therefrom; means including branch vent pipes for venting the tanks when the water is entering therein; master and auxiliary water feed valves interposed in said feed branch pipes and openable by the reservoir water pressure and closable when steam pressure is within the tanks; master and auxiliary discharge valve pipes interposed in said discharge branch pipes and openable by water head and steam pressure in the tank and closable when the interior tank pressure is less than the boiler pressure; master and auxiliary vent valves interposed in the vent branch pipes and constantly tending to open by the pressure within the tanks; master and auxiliary steam valves interposed in the steam branch pipes constantly tending to open by the boiler steam pressure in the steam branch pipes; and additional control means whereby the valves are actuated when the water of the master tank is at its upper and lower water-level limits.

5. In combination, a control tank; pipes for the intake of liquid into the tank pipes for supplying fluid pressure to the tank when the liquid is flowing therefrom; valves in said pipes for controlling the flow of the fluids therein comprising a valve body having a partition therein having a seat and forming an outlet chamber, an inlet chamber, and a piston chamber joining the inlet chamber; a piston in the piston chamber provided with an integral closure member in the inlet chamber closable on the seat and of smaller active pressure area in the inlet chamber than the piston whereby the pressure in the inlet chamber opens the valve; a cap on the piston chamber having therethrough a threaded pipe receiving opening for the entry of controlling fluid; a fluid control means whereby said valves are actuated at the proper time for causing the water level in the tanks alternately to rise and fall in alternation with each other; and distributing pipes from said control means to said threaded openings.

6. In combination, an elevated water feed reservoir; a master tank and an auxiliary tank between the levels of the reservoir and the boiler to be fed; means for conducting water from the reservoir to the tanks and its discharge alternately from the tanks into the boiler; means for supplying counterbalancing steam pressure into the upper part of the tanks when the water is flowing from the tanks into the boiler; vent means for permitting the egress of air from the upper part of the tanks when the water is entering therein, said means comprising: a main relief pipe communicating with the upper part of the reservoir and extendng to near said tanks; branch relief pipes extending from said main pipe respectively to said auxiliary tank and to the master tank.

7. In combination, a control tank; means for the intake of liquid into the tank and its discharge alternately therefrom; a pressure operated valve openable by pressure of fluid passing therethrough and supplying fluid pressure to the tank when the liquid is flowing therefrom; and a control means for supplying fluid pressure to said valve whereby the valve is closed, and for venting said valve whereby the valve is opened.

8. In combination, a control tank; means for the intake of liquid into the tank and its discharge alternately therefrom; a pipe for supplying fluid pressure to the tank when the liquid is flowing therefrom; a valve for controlling the flow of the fluids in said pipe, said valve comprising a closure member openable by the pressure in the pipes, a piston chamber and a piston therein for actuating the closure member; and a

control means for supplying fluid pressure to said piston chambers whereby the valves are closed, and for venting said piston chamber, whereby the valves are opened.

9. In combination, a master tank; an auxiliary tank; pipes for permitting the alternate intake of water into the tanks and its discharge; pipes for supplying counter-balancing fluid pressure in the upper part of the tanks when the water is flowing from the tanks; valves for controlling the flow of the fluids in said pipes each of said valves comprising a closure member openable by the pressure in the pipes, a piston chamber and a piston therein for actuating the closure member; and a control means for supplying fluid pressure to said piston chambers whereby the valves are closed, and for venting said piston chamber, whereby the valves are opened.

10. In combination, a master tank; an auxiliary tank; master and auxiliary feed pipes for permitting the intake of water into the tank; master and auxiliary pipes permitting the alternate discharge of water therefrom; master and auxiliary steam pipes for supplying counter-balancing fluid pressure in the upper part of the tanks when the water is flowing from the intake; master and auxiliary pipes for venting the tanks when the water rises therein; pressure operated valves for controlling the flow of the fluids in all of said pipes whereby the above described actions take place; a control valve for controlling the pressure valves; a control valve pipe supplying steam to the control valve; a steam distributing pipe extending from said control valve and provided with branches extending respectively to the valves of the master steam pipe, the auxiliary vent pipe, the master discharge pipe and the auxiliary feed pipe; and a steam distributing pipe extending from said control valve and provided with branches extending respectively to the valves of the auxiliary steam pipe, the master vent pipe, the master feed pipe, and the auxiliary discharge pipe.

11. In combination, a master tank; an auxiliary tank; pipes for permitting the alternate intake of water into the tanks and its discharge therefrom; master and auxiliary steam pipes for supplying counter-balancing fluid pressure in the upper part of the tanks when the water is flowing from the tank; master and auxiliary pipes for venting the tanks when the water rises therein; normally open pressure operated valves for controlling the flow of the fluids in all of said pipes whereby the above described actions take place; a control valve for controlling the pressure valves; a control valve pipe supplying steam to the control valve; and a steam distributing pipe extending from said valve and provided with branches extending respectively to the valves of the master steam pipe, the auxiliary vent pipe to cause the valves to close, the other pressure valves remaining open whereupon steam is admitted into the upper part of the auxiliary tank and water therein runs by gravity into the boiler, and whereupon the upper part of the master tank is vented and feed water enters the bottom of the same by gravity.

12. In combination, a control tank; means for the intake of liquid into the tank and its discharge alternately therefrom; a steam pipe for supplying fluid pressure to the tank when the liquid is flowing therefrom; a relief pipe for venting the tank; pressure operated valves for controlling the flow of the fluids in said pipes and having threaded openings; a control valve having a chamber having a steam inlet passage and a vertical valve seat and upper, lower and intermediate ports in the seat; a diaphragm chamber communicating with said tank; a diaphragm therein actuated by fluid pressure in the chamber; a slide valve slidable on said valve seat and adapted to cover the upper and lower ports; a valve rod connecting the slide valve and the diaphragm; a control valve pressure pipe to said passage of the control valve; and an upper steam distributing pipe extending from said upper port into the threaded opening of the valve of the steam pipe, and a lower distributing pipe extending to the valve of the relief pipe to cause the valve to open.

13. In combination, a control tank; means for the intake of liquid and discharge into and from the tank; a steam pipe for supplying fluid pressure to the tank; pressure valves in said pipes; a diaphragm chamber; a diaphragm thereacross dividing the chamber into an upper compartment and a lower compartment; conduit means connecting the lower part with the tank; a bracket arm on said chamber and having a vertical opening having a valve seat and upper, lower and intermediate ports in the seat; a control valve housing block fitted in said opening and having a lower stuffing box and an upper steam inlet passage; a slide valve slidable on said valve seat and adapted to cover and uncover the upper and lower ports and alternately to connect them with the intermediate port; a valve rod extending through said stuffing box and secured to the slide valve, and secured to the diaphragm, and an intermediate piece connecting said sections; a lever intermediately fulcrumed on the arm and connected to said rod; a weight carried on the outer arm of the lever; and distributing pipes connecting said upper and lower ports with the respective pressure valves.

14. In combination, a control tank; means for the intake of liquid into the tank and its discharge alternately therefrom; a relief

valve for venting the tank when the water flows therein; a separate pressure valve for supplying fluid pressure to the tank when the liquid is flowing therefrom; and a control means whereby the valves are separately operated; said means closing the relief valve before the pressure valve is opened.

15. In combination, a control tank; means for the intake of liquid into the tank and its discharge therefrom; a steam pipe for supplying fluid pressure to the tank when the liquid is flowing therefrom; a relief pipe for venting the tank; pressure operated valves for controlling the flow of the fluids in said pipes and having threaded openings; a control valve having a chamber having a steam inlet passage and a vertical valve seat and upper, lower and intermediate ports in the seat; a slide valve slidable on said valve seat and short enough to uncover the upper and lower ports at the same time; means for actuating the slide valve; a control valve pressure pipe to said steam inlet passage of the control valve; an upper steam distributing pipe extending from said upper port into the threaded opening of the valve of the steam pipe, and a lower distributing pipe from the lower port of the valve of the relief pipe.

16. In combination, a control tank; means for the intake of liquid into the tank and its discharge alternately therefrom; pressure operated and relief valves for supplying fluid pressure to the tank when the liquid is flowing therefrom, and for venting the tank; means for supplying fluid pressure for actuating each valve in one direction and for venting the valve to permit it to actuate in the other direction; and means for retarding the venting fluid.

17. In combination, a control tank; means for the intake of liquid into the tank and its discharge alternately therefrom; a pressure pipe for supplying fluid pressure to the tank when the liquid is flowing therefrom; a relief pipe for venting the tank; pressure and relief valves for controlling the flow of the fluids in said pipes respectively, each of said valves comprising a closure member openable by the pressure in the pipes, a piston chamber and a piston therein for actuating the closure member; a control means for supplying fluid pressure to said piston chambers whereby the valves are sometitmes closed at the same time and removing the pressure for venting said piston chamber, whereby the valves are opened; and adjustable means for retarding the flow of venting fluid.

18. In combination, a valve comprising a closure member openable by the pressure in the valve, a piston chamber and a piston therein for actuating the closure member; a pressure pipe leading to the chamber for operating the valve; means for venting the piston chamber including a common relief pipe, and an adjusting valve in said relief pipe for retarding the relief action.

19. In combination, a control tank; means for the intake of liquid into the tank and its discharge alternately therefrom; a pressure pipe for supplying fluid pressure to the tank when the liquid is flowing therefrom; a relief pipe for venting the tank; pressure and relief valves for controlling the flow of the fluids in said pipes respectively, each of said valves comprising a closure member openable by the pressure in the pipes, a piston chamber and a piston therein for actuating the closure member; a control valve having pressure inlet passage and a vertical valve seat and upper, lower and intermediate ports in the seat; a slide valve slidable on said valve seat; a pressure distributing pipe extending from one of said ports into the threaded opening of the valve of the pressure pipe; another distributing pipe extending to the valve of the vent pipe; a common relief pipe in said intermediate port; and an adjusting valve in said relief pipe for retarding the relief action.

20. In combination, a control tank; means including a control valve for controlling the alternate intake of water in the tanks and its discharge alternately therefrom; a diaphragm chamber; a diaphragm therein dividing the chamber into upper and lower compartments; means operatively connecting the diaphragm with the control valve for operating the latter; conduit means operatively connecting the lower chamber with the tank; a surge chamber at the upper limit level of the tank having a plugged filling opening; a horizontal overflow pipe connecting the upper part of the surge chamber with said upper limit level of the tank; and a pressure stabilizing pipe connecting the lower part of the surge chamber with the upper compartment of the diaphragm chamber for maintaining a substantially constant and uniformly distributed pressure on the upper face of the diaphragm.

21. In combination, a tank; a control means for controlling the change of liquid level in the tank; a conduit for communicating pressure between the water in the tank and the pressure control means; and means for at times rendering the conduit inoperative.

22. In combination, a tank; a liquid pressure control means for controlling change of water level in the tank; a float chamber communicating with the lower level of the tank; a connecting pipe connecting the float chamber with the pressure control means; a float in the chamber; means operated by said float for cutting off said chamber from the connecting pipe when water in the float chamber rises; a riser from the float chamber to the upper part of the tank; and a

pressure pipe connecting the upper part of the riser with the connecting pipe.

23. In combination, a tank; a control means for controlling the rise and fall of water in the tank; a diaphragm chamber having a diaphragm actuating the control means; a float chamber communicating with the lower level of the tank; a connecting pipe connecting the float chamber with the diaphragm chamber; a float in said float chamber; a valve for cutting off said float chamber from the connecting pipe when the float rises; an overflow pipe connecting with the upper part of the tank; a riser from the float chamber to the overflow pipe; and a pressure pipe connecting the overflow pipe with the connecting pipe, whereby the water in the master tank, when, and not before, it reaches its upper limit, may overflow into the connecting pipe to cause the raising of the diaphragm.

24. In combination, a tank; a control means for controlling the rise and fall of water in the tank; a diaphragm chamber having a diaphragm actuating the control means; a float chamber communicating with the lower level of the tank; a connecting pipe connecting the float chamber with the diaphragm chamber; a float in said float chamber; a valve for cutting off said float chamber from the connecting pipe when the float rises; an overflow pipe connecting with the upper part of the tank; a riser from the float chamber to the overflow pipe, whereby water in the float chamber rises whenever the water in the tank rises, thus to hold the float valve closed while the water in the tank is going either up or down, and until the lower level is reached in the tank and float chamber, whereupon the float lowers and releases the float valve and the pressure on the lower face of the diaphragm to permit the diaphragm to shift the control means; and a pressure pipe connecting the overflow pipe with the connecting pipe.

25. In combination, a control tank; a control means for controlling the alternate intake of water in the tanks and its discharge alternately therefrom; a diaphragm chamber; a diaphragm therein dividing the chamber into upper and lower compartments; means operatively connecting the diaphragm with the control means; a float chamber at the lower level of the tank provided with a drain valve at the lower part having an upper seat; a float in said chamber; a float valve pending from said float and provided with a closure disk disposed below said seat; a pipe connecting the lower part of the tank with the mid part of the float chamber; a connecting pipe connecting the lower part of the drain valve with the lower compartment of the diaphragm chamber; a horizontal overflow pipe connecting with the upper part of the tank; a riser extending from the upper part of the float chamber to the overflow pipe; and a pressure pipe connecting the overflow pipe with the connecting pipe.

26. In combination, a control tank; control means for admitting steam into the tank and controlling the intake of water in the tank and its alternate discharge therefrom; a system of valves; a control means for directing steam to valves of said system; a diaphragm chamber; a diaphragm therein dividing the chamber into upper and lower compartments; means connecting the diaphragm with the control means; a connecting pipe operatively connecting the lower chamber with the lower part of the tank; and a water cooling chamber interposed in said connecting pipe to protect the diaphragm against hot water from the tank.

27. In combination, a tank; means for the intake of water into the tank; a steam pipe for supplying steam to the tank; and means for automatically admitting air into the tank when steam condenses therein.

28. In combination, a tank; means for the intake of water into the tank and its alternate discharge therefrom; a steam pipe for supplying counter steam pressure in the upper part of the tank when water is flowing from the tank; a vent pipe entering the upper part of the tank below the level of the steam pipe for venting the tank when water rises therein; control valves in said pipes for controlling the flow of the fluids therein; and means for admitting air into the upper part of the tank.

29. In combination, a master tank; a vertical auxiliary tank; means for the alternate intake of water into the tanks and its alternate discharge therefrom; steam pipes for supplying counter-balancing steam pressure in the upper part of the tanks when the water is flowing from the tanks; an auxiliary vent pipe entering the upper part of the auxiliary tank below the level of the steam pipe for venting the auxiliary tank when water rises therein; a system of control valves in all of said pipes for controlling the flow of the fluids therein whereby the above described actions take place; means controlled by the water in the master tank for controlling said system; and an inlet check valve communicating with the auxiliary vent pipe between its valve and the tank for admitting air into the upper part of the tank should condensing entrapped steam therein tend to suck up water to above the discharge end of the steam pipe in the auxiliary tank.

30. In combination, a tank; a liquid pressure control means for controlling the change of liquid level in the tank; a conduit connecting the tank with the pressure control means; and means for at times closing the conduit; said pressure control means comprising a diaphragm chamber compris-

ing upper and lower members; a flexible diaphragm clamped between said members to form upper and lower chambers; thin metallic plates on opposite faces of the diaphragm and having their edges inclined away from the diaphragm; and actuating means passed through and clamping together said plates and diaphragm and slidably projecting through the upper member.

31. In combination, a tank; means for the intake of steam and water at a substantially lower temperature than the steam, and an inwardly opening check valve for automatically admitting air into the upper part of the tank.

32. In combination, a tank; means for the intake of cold water into the tank; a steam pipe for supplying hot steam to the tank; and means controlled by fluid pressures interior and exterior to the tank for automatically admitting air into the upper part of the tank.

33. In combination, a tank; means for the intake of water into the tank and its discharge therefrom; a steam pipe for supplying counter steam-pressure in the tank at a substantially higher temperature than the water; and an inwardly opening check valve for automatically admitting air into the upper part of the tank.

34. In combination, a tank; means for the intake of water into the tank and its discharge therefrom; a steam pipe for supplying steam pressure in the upper part of the tank when water is flowing from the tank; a vent pipe entering the upper part of the tank below the uppermost part thereof for venting the tank when water rises therein; means for controlling the flow of the fluids in said pipes; and means for admitting air into the upper part of the tank.

35. In combination, a water tank; means for supplying hot steam into the tank to force water to discharge from the tank; means for the intake of cold water into the tank after said discharge, whereby the steam in the tank is quickly condensed; and an inwardly opening check valve communicating with the tank slightly below the top of the tank; said valve having the new function of admitting into the top of the tank a resistant cushion of air substantially equal in thickness to said distance and serving the further new function of preventing the water from striking the top of the tank and causing water hammer.

36. In combination, a tank; means for the intake of steam and water; and an inwardly opening check valve for automatically admitting air into the upper part of the tank when steam condenses therein, in order to prevent water from rising into the upper part of the tank.

WALTER LESTER OSWALD.