No. 832,081. PATENTED OCT. 2, 1906.

S. A. REEVE & E. P. NOYES.

LIQUID LEVEL CONTROLLER.

APPLICATION FILED APR. 23, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

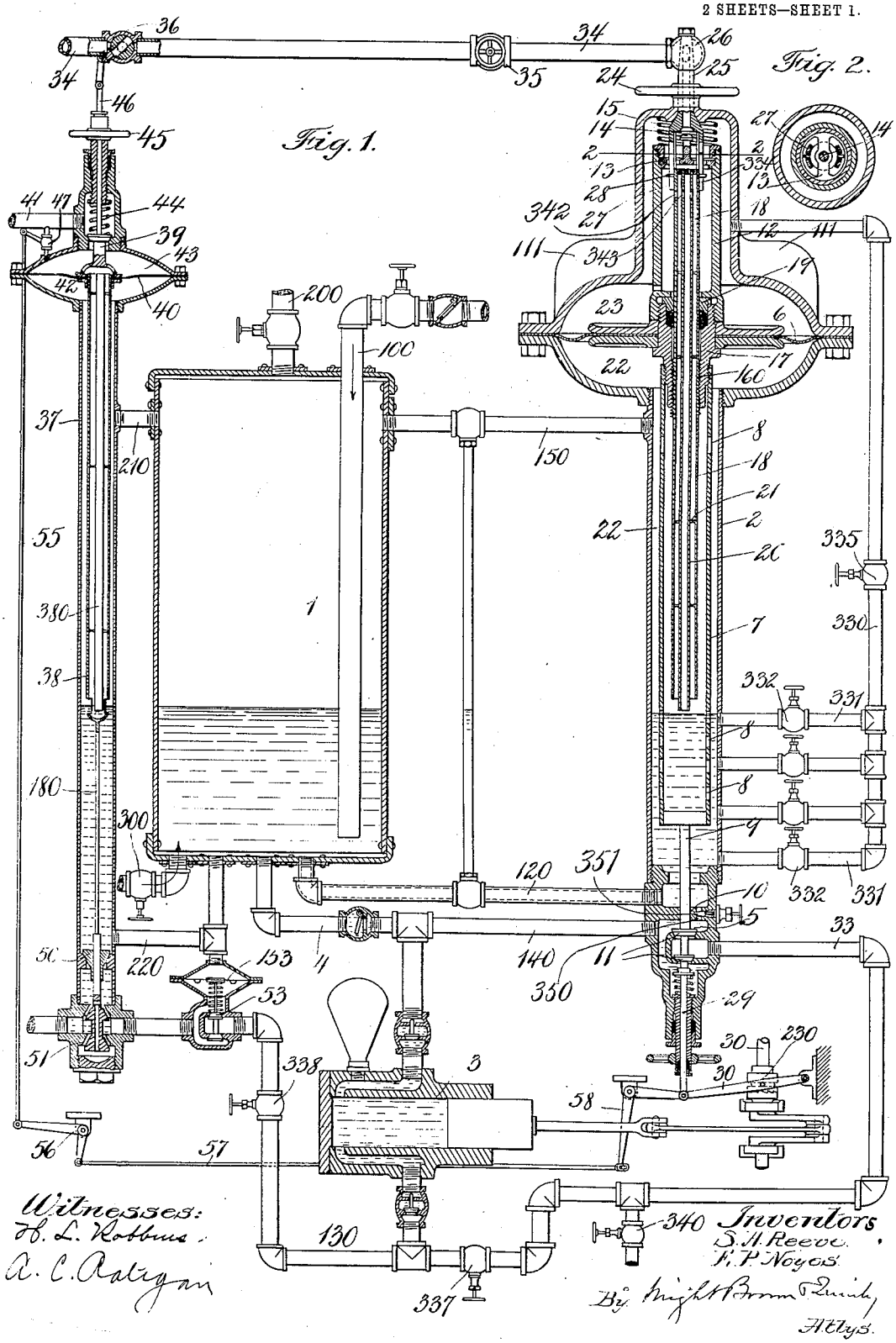


Fig. 2.

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2 SHEETS—SHEET 2.

Fig. 6

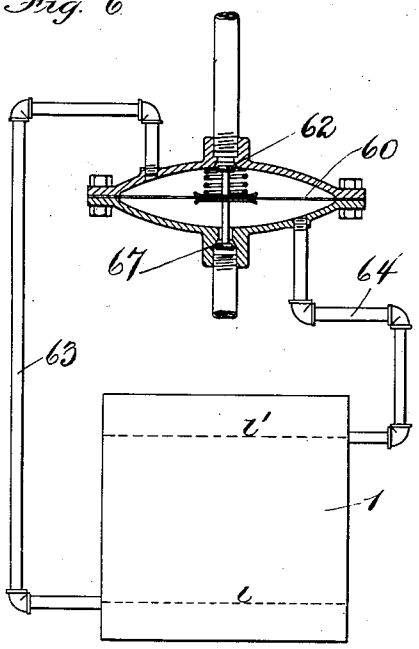


Fig. 7.

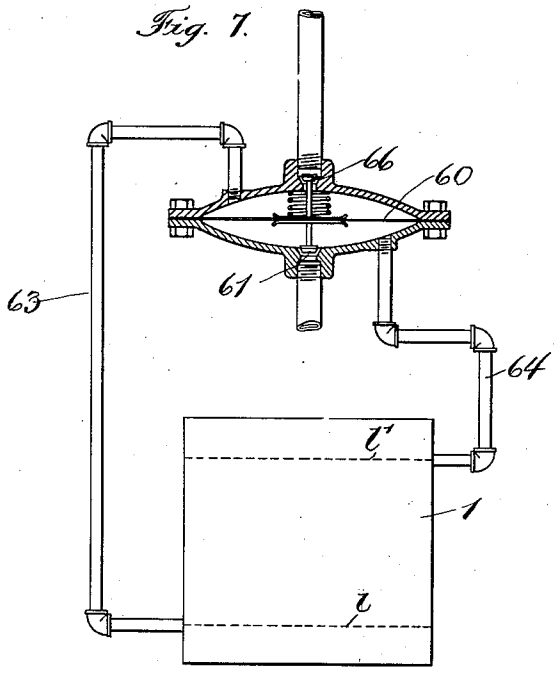


Fig. 4.

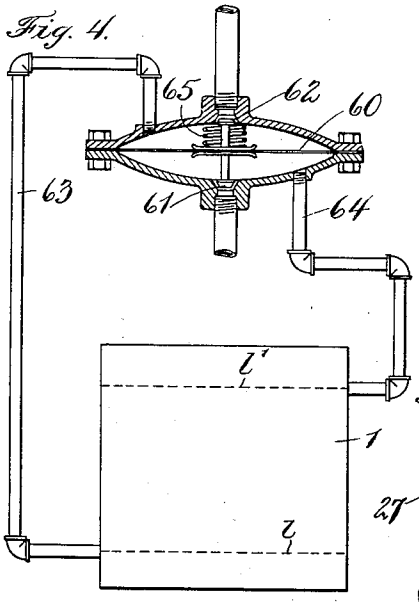


Fig. 5.

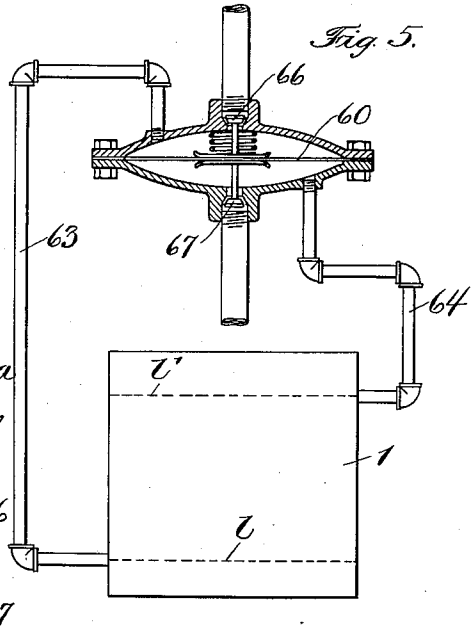


Fig. 3a

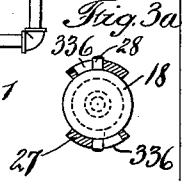
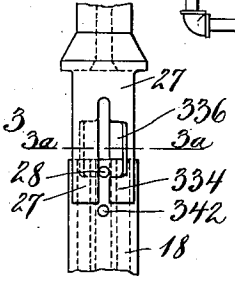


Fig. 3



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UNITED STATES PATENT OFFICE.

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LIQUID-LEVEL CONTROLLER.

No. 832,081. Specification of Letters Patent. Patented Oct. 2, 1906.

Application filed April 23, 1904. Serial No. 204,592.

To all whom it may concern:

Be it known that we, SIDNEY A. REEVE, of Worcester, in the county of Worcester, and EDWARD P. NOYES, of Winchester, in the county of Middlesex, State of Massachusetts, have invented certain new and useful Improvements in Liquid-Level Controllers, of which the following is a specification.

This invention relates to apparatus for controlling the inflow to or exit from a pressure chamber or vessel of liquid or gaseous fluid; and its object is to provide an improved device of this kind whereby a predetermined liquid-level or a predetermined volume of gaseous fluid may be automatically maintained in the pressure vessel or other useful function performed with reference to the vessel.

The invention as hereinafter specifically described involves the differential action of a constant pressure and a variable pressure on opposite sides of a movable member, such as a diaphragm, and it further involves the action of means such as a dip-tube attached to this diaphragm, whereby the opening or closing movements of the valves or other mechanism controlled by the diaphragm is rendered uniform instead of jerky and spasmodic.

The invention still further involves the employment of a plurality of devices of the described kind in combination in such manner as to control one by the action of the other and provide for various conditions within and without the pressure vessel, as will more fully appear.

Of the accompanying drawings, Figure 1 represents a sectional diagrammatic view of an apparatus constructed according to our invention. Fig. 2 represents a section on line 2 2 of Fig. 1. Fig. 3 represents a detail side elevation of the upper part of the dip-tube in one of the controlling devices and of means for rotating said tube to adjust its vertical height. Fig. 3ª represents a section on line 3ª 3ª of Fig. 3. Figs. 4 to 7, inclusive, are diagrammatic sectional views representing modifications.

The same reference characters indicate the same parts in all the figures.

In the drawings, 1 is a pressure vessel adapted to inclose liquid and gaseous contents in the lower and upper portions thereof, respectively. The liquid might be water and the gaseous fluid steam, as in a steam-boiler. The gaseous fluid may be other than the vapor of a liquid, as would be the case, for example, in one of the two chambers shown in Reeve patent, No. 588,178, August 17, 1897, showing air and gas chambers connected by water seal. A pump 3 supplies liquid to the vessel 1 from a suction-pipe 130 through a delivery-pipe 4.

100 is a second inflow-pipe for liquid or gaseous fluid, which might come from a condensing or other system, 200 is a main exit-pipe for the gaseous fluid, and 300 is an inlet to the lower part of the vessel adapted to connect, for instance, with a chamber such as hereinbefore mentioned, as described in the aforesaid Patent No. 588,178.

2 is a chamber connecting by pipes 120 150 with the lower and upper parts of the vessel 1, whereby liquid is maintained at the same level in vessel 1. The chamber 2 we consider practically a part or extension of the vessel 1 by reason of the pipes 120 150, and in some instances the controller may be built directly on the vessel whose contents are to be controlled, in which case the chamber 2 would merge with said vessel. Said chamber 2 connects at its upper end with a lower diaphragm-chamber 22, the chambers 2 and 22 being practically one chamber. The latter is included in a casing containing the diaphragm 6, on the upper side of which is a second or upper diaphragm-chamber 23. A hollow rod or tube 7, having holes 8 8, making it a skeleton structure, connects with the diaphragm at its upper end, and its extension 9, passing with a snug fit through a partition 10, connects with a by-pass valve 11. The latter controls the exit from a chamber 5, connecting by pipe 140 with the delivery of the pump and a by-pass pipe 33, leading back to the suction side of the pump.

18 20 represents a double dip-tube composed of outer and inner sections connected by bridges 21 and supported by the diaphragm 6, said tube having a threaded connection 160 with the hub of the diaphragm and passing through a stuffing-box 19 thereon to prevent leakage from chamber to chamber of the diaphragm-casing. A connection permitting upward and downward movement and rotary adjustment of the tube 18 20 for the purpose of adjusting its vertical position

with respect to the diaphragm 6 is afforded by hand-wheel 24, having a forked extension 27 within the dome of the upper diaphragm-chamber engaging pins 28 on the tube 18. A column 12, erected on the diaphragm, supports a valve 14, which controls a valve-seat at the bottom of a duct in the stem of the hand-wheel 24, said valve being formed on a plate 13, which is rotatable on the column 12 and has apertures for the passage of the forked extension 27. A spring 15, bearing on the upper end of the column 12, tends to hold the valve 14 open and the valve 11 closed. An extension 29 of the stem of valve 11 passes through the lower end of the controller-casing and is connected by lever 30 with a clutch 230, which affords a connection between the pump 3 and its driving-shaft. The duct through the stem 25 of hand-wheel 24 connects by a swivel-joint 26 with a leak-pipe 34, having stop-valve 35.

Assuming a small vent through valve 35 and assuming that the vessel 1 were a steam-boiler with the water-level below the orifice of dip-tube 18 20 and the pump 3 delivering water to the vessel 1, so as to raise the water-level, it is evident that when the water-level has risen to cover the ends of tube 18 20 the steam-pressure in vessel 1 and chamber 2 will be shut off from the upper diaphragm-chamber 23 and the pressure in said diaphragm-chamber will be reduced by leakage past valve 35. While a minute leakage is the preferred means of reducing the pressure in the upper diaphragm-chamber after the water has covered the inlet to said chamber and we consider that this expedient has many advantages, we do not wholly confine ourselves thereto. Condensation of the steam will also of course aid in reducing the pressure. The water then rises in tube 18 20 to a height depending upon the difference in the fluid-pressures above and below the diaphragm. The predominating pressure in the lower diaphragm-chamber 22 tends to raise the diaphragm 6 and open the by-pass valve 11. Elevation of the diaphragm brings the lower end of tube 18 20 out of the water in the chamber 2, thus venting said tubes of their water column, and tends to establish pressure equality in the upper and lower diaphragm-chambers 23 22. The valve 11 will therefore open only slightly. If the water-level continues to rise, the above action is repeated and a further opening of the valve 11 takes place until such opening is sufficient to by-pass enough water from the delivery of pump 3 to prevent further rise in the vessel 1 and chamber 2. Thus it will be seen that the diaphragm has a plurality of positions of equilibrium or balanced pressure corresponding to slightly different liquid-levels. The covering of the dip-tube destroys the pressure equilibrium and the raising of the inlet of said tube out of water neutralizes the force which destroyed said equilibrium. This is an important feature, for although our invention is operative and useful without it the use of the movable inlet prevents "see-sawing" of the diaphragm and enables it to work frequently and without violent movements. It will be noted that the dip-tube 18 20 constitutes a temporary reservoir for the storage of some of the water in vessel 1 and chamber 2 when the lower end of said tube is covered. Continued upward movement of the diaphragm 6 releases clutch 230 and stops the action of the pump. Extreme upward movement of the diaphragm closes the valve 14 against its seat and prevents any further venting of steam through the pipe 34, which latter, it may be remarked, leads to any suitable locality of lower pressure than the pressure carried in the vessel 1. Vertical adjustment of the dip-tube 18 20 in the diaphragm 6 effected by rotating the hand-wheel 24 obviously varies the normal water-level by varying the normal position of the lower end of tube 18 20.

37 is a second chamber connected by pipes 210 220 with the upper and lower parts of the vessel 1 for keeping a level in 37 the same as in 1, said chamber 37 connecting with a chamber 42 on the under side of a diaphragm 40. 43 is a chamber above said diaphragm communicating with the lower part of chamber 37 through the interior of a double dip-tube 38 380, similar to tube 18 20, and preferably having its inlet end at a slightly lower level than the inlet end of tube 18 20. Diaphragm 40 carries a downwardly-seating valve 39, controlling exit from chamber 43 to an outlet-pipe 41, which may connect with any lower-pressure locality or with the pipe 34, and on its lower side through an extension 180 of the outer tube 38 the diaphragm connects with an upwardly-seating valve 51, controlling inflow to vessel 1, but not controlling the feed-water in pipe 130. Extension-rod 180 has a sliding fit in a downwardly-seating check-valve 50, which prevents backflow from vessel 1 into the suction-pipe 130. A downwardly-acting spring 44 tends to seat valve 39 and open valve 51. A minute vent from chamber 43 to pipe 41 is controlled by a valve 47, and the latter connects by rod 55, bell-crank 56, rod 57, and bell-crank 58 with the stem 29, attached to diaphragm 6. A rise of the rod 55 due to depression of diaphragm 6 tends to open vent-valve 47. There may be a slight differential of upward pressure causing valve 39 to act as a safety-valve, if desired.

The diaphragm 40 is connected by a stem 46, passing outside of the upper end of controller-casing with a vent-valve 36 in the pipe 34, which is normally closed when diaphragm 40 is depressed and opens when said diaphragm rises.

53 is a valve in the suction-pipe 130 of the

pump actuated by a diaphragm 153, which receives on its lower side the pressure of said suction-pipe and on its upper side the pressure of the vessel 1. The function of valve 53 is to open the suction-pipe 130 at all times when the pressure of vessel 1 is superior to the pressure in suction-pipe 130 and to close it when the suction-pipe pressure is superior, the latter operation cutting out the pump 3 and allowing the valve 51 to control inflow from conduit 130 to the vessel 1. Under any circumstances other than a preponderating pressure in 130, at which time the pipe 130 acts as a "natural-flow" conduit, the valve 51 has no function.

In the conjoint operation of the two diaphragm devices shown on opposite sides of the vessel 1 the leakage-valve 35 is preferably wide open and its function performed by the automatically-controlled valve 36. It is evident that the diaphragm 6 cannot operate until there is a vent through 36, and this will not occur unless the liquid is above the level of the lower end of dip-tube 38 380. When such condition occurs, there being a vent through valve 47, the lower end of dip-tube 38 380 is covered, pressure decreases in diaphragm-chamber 43, and liquid rises in the dip-tube. The diaphragm 40 rises, opening valves 39 and 36, and the diaphragm 6 is put in condition for operation. Parts may be so proportioned that the main deterrent to further rise of liquid-level in 1 is at first an escape of liquid through pipe 41 past the open valve 39, said liquid rising through the tube 38 380. A further rise of liquid in vessel 1 resulting in the covering of the lower end of dip-tube 18 20 is followed by rise of the diaphragm 6 and by-passing of liquid from the pump-delivery past valve 11. An extreme rise of diaphragm 6 results in disengaging clutch 230 and stopping the pump in the manner hereinbefore described. Such extreme rise further results in closing the valve 14 and the valve 47, thus stopping all vent past these valves.

In the event of superior pressure in supply-pipe 130 the valve 53 closes and cuts out the pump, and entrance of liquid from pipe 130 into the vessel 1 is controlled by valve 51, said valve tending to close when the liquid-level has risen to cover the end of dip-tube 38 380 and cause the rise of diaphragm 40.

If it is desired to control the volumes of a gaseous fluid entering the vessel 1, the valve 14 controls the exit of said fluid, said valve acting as that of a gas-trap—that is to say, when gaseous pressure depresses the liquid-level in vessel 1, forcing the liquid out through 300, tube 18 20 will be uncovered and diaphragm 6 depressed, permitting the gaseous fluid to escape past valve 14. When liquid-level is restored to normal by a reduction of gaseous pressure and volume, the liquid covers inlet of tube 18 20 and diaphragm rises and closes valve 14. It will thus be seen that under various conditions of supply and pressure in the interior of and external to the vessel 1 the apparatus described effectively controls both liquid-level and gaseous volume.

Should the vessel 1 be an internal-combustion generator, such as shown in the aforesaid Patent No. 588,178, having an output of non-condensable products of combustion, a supplemental action takes place in the chamber 23 or 43 when the inlet end of either dip-tube 18 20 or 38 380 is covered. In such case the pressure drop in 23 or 43 is aided by the cooling of the non-condensable gases in said chamber. The abstraction of heat from these gases is facilitated by the addition of fins to the walls of the chambers, as represented at 111 in connection with the chamber 23 in Fig. 1.

It will be noted that the tubes 20 and 380 have their inlets slightly below the inlets of tubes 18 and 38. The object of this is to facilitate the emptying of these tubes of liquid when their ends are uncovered. The gaseous fluid and the liquid have separate avenues of ascent and descent, the former tending to ascend through the outer tube 18 or 38 and the latter to descend through the inner tube 20 or 380. When the water-level falls below 18, the pressure blows the contents of tube 18 up into the upper diaphragm-chamber 23, while the contents of tube 20 fall back into the lower part of chamber 2. This construction greatly facilitates the venting of the double dip-tube. A body or lake of water above the diaphragm is no disadvantage; but the pipe 330, hereinafter described, might obviously have its upper end at a lower level than shown to fully drain the upper diaphragm-chamber, if desired.

Figs. 4 to 7, inclusive, represent various combinations of valves controlled according to our invention. In these figures, 1 indicates the pressure vessel in each instance, the inflow and outflow pipes for the supply and exit of fluids being omitted from the illustration. In Fig. 4 the diaphragm 60 controls oppositely-seating valves 61 62, similar to the valves 11 and 14 in Fig. 1, the valve 61, however, being above the level of liquid in vessel 1. The upper diaphragm-chamber is connected with vessel 1 by pipe 63 at a lower level *l*, and the lower diaphragm-chamber is connected by pipe 64 at an upper level *l'*. If liquid is below the level *l* or above the level *l'*, the fluid-pressures are equalized on opposite sides of the diaphragm and spring 65 closes valve 61 and opens valve 62. When the liquid-level is between the lines *l* and *l'*, the pressure below the diaphragm predominates, closing upper valve 62 and opening lower valve 61. Fig. 5 shows an upper downwardly-closing valve 66 and a lower upwardly-closing valve 67. Fig. 6

illustrates upper and lower upwardly-closing valves 62 and 67. Fig. 7 shows upper and lower downwardly-closing valves 66 61.

Thus far the apparatus has been described as maintaining a substantially constant liquid-level. Either controller, however, may be equipped as a trap adapted to effect an intermittent discharge between predetermined maximum and minimum liquid-levels. To effect this, the upper diaphragm-chamber 23 in addition to the inlet which it has from the vessel 1 through tube 18 20 by way of certain openings 342 343, near the upper ends of said tubes, has a lower-level inlet from the pressure vessel by way of a pipe 330, connecting chamber 23 with the lower part of chamber or casing 2. Pipe 330 has a stop-valve 335 and several branches 331, connecting with chamber 2 at different heights and equipped with stop-valves 332, whereby a single one only of these branches may be in use at one time.

334, Fig. 3, represents one of two valve portions on the forks of the tube-rotating member 27, which act as valves controlling the ports or openings 342. By the rotation of member 27 these valve portions may be brought either into or out of line with the path of movement of ports 342, thus making the valve portions operative or inoperative at will. Wide slots 336 for the pins 28 afford lost motion, which allows the valve-adjusting rotary movement of member 27 to take place without rotating the tube 18.

When the pipe 330 and the valve portions 334 are in commission, the valve 11 may be utilized to control the discharge from vessel 1 and chamber 2 through pipe 33 and valved discharge branch 340, the pump 3, if desired, being cut out by stop-valves 337 338. When the valve 11 acts as a discharge-valve, it is necessary to open communication between chambers 2 and 5, for which purpose there is provided a passage 350 in the partition 10, controlled by a stop-valve 351. This passage is preferably of smaller aperture or cross-section than the outlet controlled by valve 11, but is sufficient to handle the maximum discharge for which the trap is designed. This reduces the velocity past the valve by a contracted passage antecedent to the valve, and thus avoids cutting of the valve-seat, which is an objection in many traps.

Assuming one of the branches 331 of pipe 330 to be open and the others closed, it is evident that as liquid accumulates and rises in chamber 2 it will have no effect on the pressure in chamber 23, as this is maintained through the ports 342. When liquid has accumulated far enough to cover the end of dip-tube 18 20, a difference of pressure is established between chambers 22 and 23 and the diaphragm 6 rises and opens the discharge-valve 11. This rise of the diaphragm also causes valve portions 334 to close ports 342 without affecting the pipe 330, since the diaphragm independently controls the dip-tube inlet to the upper diaphragm-chamber. It is now evident that the normal pressure in chamber 23 can only be restored through pipe 330, and therefore when the liquid falls below tube 18 20 the diaphragm 6 does not drop, but keeps the valve 11 open until that branch 331 which is open has been uncovered. Pressure is then restored in chamber 23 and valve 11 closed. The pipe 330 may be kept open through one or more of its branches even when the apparatus is not acting as a trap in order to drain the upper diaphragm-chamber 23, as previously described.

A useful feature in the construction and arrangement of our controller consists in the location of the diaphragm and the pump-valve at remote points, so that the former may be above the water-level and the latter below, making it unnecessary to carry the water-pipe and valve above the water-line, and also the provision of a simple hydraulic packing in the partition separating the boiler-section of the controller-casing from the pump-valve chamber which enables the valve-stem to work with great freedom, but which would be difficult to maintain if the valve were at the same end of the casing as the unsubmerged diaphragm.

In this application we do not broadly claim the controller in its generic form, but have confined ourselves to certain specific features and combinations thereof. The main structure although here shown together with said features and combinations is made the subject of a separate application, Serial No. 282,286, filed in part substitution for the present application.

We claim—

1. In a liquid-level controller, the combination of a pair of pressure-chambers, one of which has an inlet subject to the level of the liquid to be controlled and a leakage-outlet, and means subject differentially to the pressures in said chambers for controlling said outlet.

2. In a liquid-level controller, the combination of a pair of pressure-chambers, a movable partition separating the two, an inlet to one of said chambers adapted to be alternately covered and uncovered by the liquid whose level is to be controlled, an outlet from said chamber, and a valve actuated by said partition and adapted to close said outlet by the movement of said partition caused by the covering of said inlet.

3. In a liquid-level controller, the combination of a casing provided with chambers whose relative pressure is controlled by the liquid-level, one of said chambers having an outlet, a differential member interposed between said chambers, a dip-tube carried by said member and having an adjusting-screw

connection therewith, an externally-accessible rotary adjuster mounted on said casing and having a connection with said tube for rotating the latter, and a valve for controlling said outlet having a rotatable support on said member traversed by said adjuster.

4. In a liquid-level controller, the combination of a vessel adapted to contain a liquid and an elastic fluid under pressure, a chamber having an inlet from said vessel subject to the liquid-level therein and an outlet, and means operated by differences in pressure in said chamber caused by variations in the liquid-level in said vessel for controlling said outlet.

5. In a liquid-level controller, the combination of a pressure vessel, a plurality of devices separately controlled by the level of liquid in said vessel and controlling said level, and means whereby one of said devices renders the other operative and inoperative.

6. In a liquid-level controller, the combination of a pressure vessel, a chamber having an inlet from said vessel subject to the liquid-level therein and an outlet, a differential member actuated by the pressure in said chamber and controlling said level, a second differential member subject to the vessel-pressure and controlled by the liquid-level, and a valve controlled by said second member and controlling said outlet.

7. In a liquid-level controller, the combination of a pressure vessel having an outlet and a liquid-inlet, and devices, one of which controls the operation of the other and both controlled by the level of liquid in said chamber for controlling inflow of liquid thereto and outflow of fluid therefrom.

8. In a liquid-level controller, the combination of a pressure vessel having means to supply it with liquid, a liquid-outlet, and a plurality of devices controlled by the liquid-level in said vessel, one of which controls the supply of liquid to said chamber and the other the exit of liquid therefrom, one of said devices controlling the operation of the other.

9. In a liquid-level controller, the combination of a pressure vessel, a plurality of chambers having inlets from said vessel adapted to be alternately covered and uncovered by the liquid therein, a plurality of movable members subject to the pressures in said chambers, outlets from said chambers, and valves controlling said outlets, the valve of each chamber being controlled by the movable member of the other chamber.

10. In a liquid-level controller, the combination of a pressure vessel having a natural-flow liquid-supply conduit, a pump connected with said vessel for supplying liquid to the latter, means controlled by the liquid-level in said chamber and controlling the pump-supply of liquid, and means controlled by said liquid-level and controlling the natural-flow supply of liquid.

11. In a liquid-level-controlling apparatus, the combination of a pressure vessel and its liquid-supply conduit adapted to contain varying relative pressures, a pump in said conduit, and means controlled differentially by the pressures in said vessel and said conduit for controlling the supply of liquid to the pump.

12. In a liquid-level controller, the combination of a pressure vessel having a natural-flow liquid-supply conduit, a pump connected with said vessel for supplying liquid thereto from the natural-flow conduit, means controlled by the liquid-level in said chamber and controlling the pump-supply of liquid, means controlled by said liquid-level and controlling the natural-flow supply of liquid, and a valve controlled differentially by the pressure in said vessel and in said natural-flow supply-conduit for controlling the supply to the pump.

13. In a liquid-level controller, the combination of pressure-chambers, one of which has inlets at different levels subject to the liquid to be controlled, and means controlled differentially by the pressures in said chambers for controlling one of said inlets independently of the other.

14. In a liquid-level controller, the combination of a pressure vessel, a chamber having inlets from said vessel at different levels, and liquid-level-controlled means for automatically closing one of said inlets during movement of the liquid-level in one direction and opening it during movement in the opposite direction.

15. In a liquid-level controller, the combination of two pressure-chambers, a differential member interposed between the two, and liquid-level-controlled means for automatically changing the pressure relation between said chambers at one level of the liquid, maintaining the changed relation during a predetermined change in level, and restoring the original relation at a different level, whereby said differential member is operated to perform its function.

16. In a liquid-level controller, the combination of two pressure-chambers, a differential member interposed between the two, a dip-tube carried by said member, forming an inlet from the pressure vessel to be controlled to one of said chambers and subject to the liquid-level, a second inlet to said chamber subject to the liquid at a different level, and valve mechanism actuated by movement of the differential member for controlling communication between said dip-tube and its said chamber.

17. In a liquid-level controller, the combination of two pressure-chambers, a differential member between them, a dip tube hav-

ing a threaded adjusting connection with said member and subject to the liquid-level at its lower end, said tube having an opening to one of said chambers, an inlet to the latter chamber subject to the liquid at a different level, and an externally-accessible tube-rotating member having a valve portion controlling said opening.

18. In a liquid-level controller, the combination of a pressure vessel having a drainage-outlet, a differential member controlling said outlet and subject on one side to the pressure in said vessel, a chamber for containing an opposing pressure having inlets from said vessel at different levels, and valve mechanism actuated by movement of said differential member controlling one of said inlets.

19. In a device of the character specified, the combination of a pressure vessel, a controller actuated according to the liquid-level in said vessel, a forced-feed device, a by-pass conduit for diverting the feed from said vessel, a valve actuated by said controller and controlling the by-pass, a passage connecting the liquid-space of the pressure vessel with the by-pass at a point antecedent to said valve and adapted to conduct a liquid-outflow from the vessel under control of said valve, and means for opening and closing said passage.

20. In a liquid-level controller, the combination of a variable-level chamber, a controller actuated according to the level in said chamber, a discharge-outlet, a valve controlling said outlet and actuated by said controller, and a discharge-passage leading from said chamber to the valve and of an aperture smaller than that of the discharge-outlet.

In testimony whereof we have affixed our signatures in presence of two witnesses.

SIDNEY A. REEVE.
EDWARD P. NOYES.

Witnesses:
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A. C. RATIGAN.