Oct. 25, 1960 C. M. ARMBRUST 2,957,487

AUTOMATIC LIQUID FEED APPARATUS

Filed Feb. 6, 1956 3 Sheets-Sheet 1

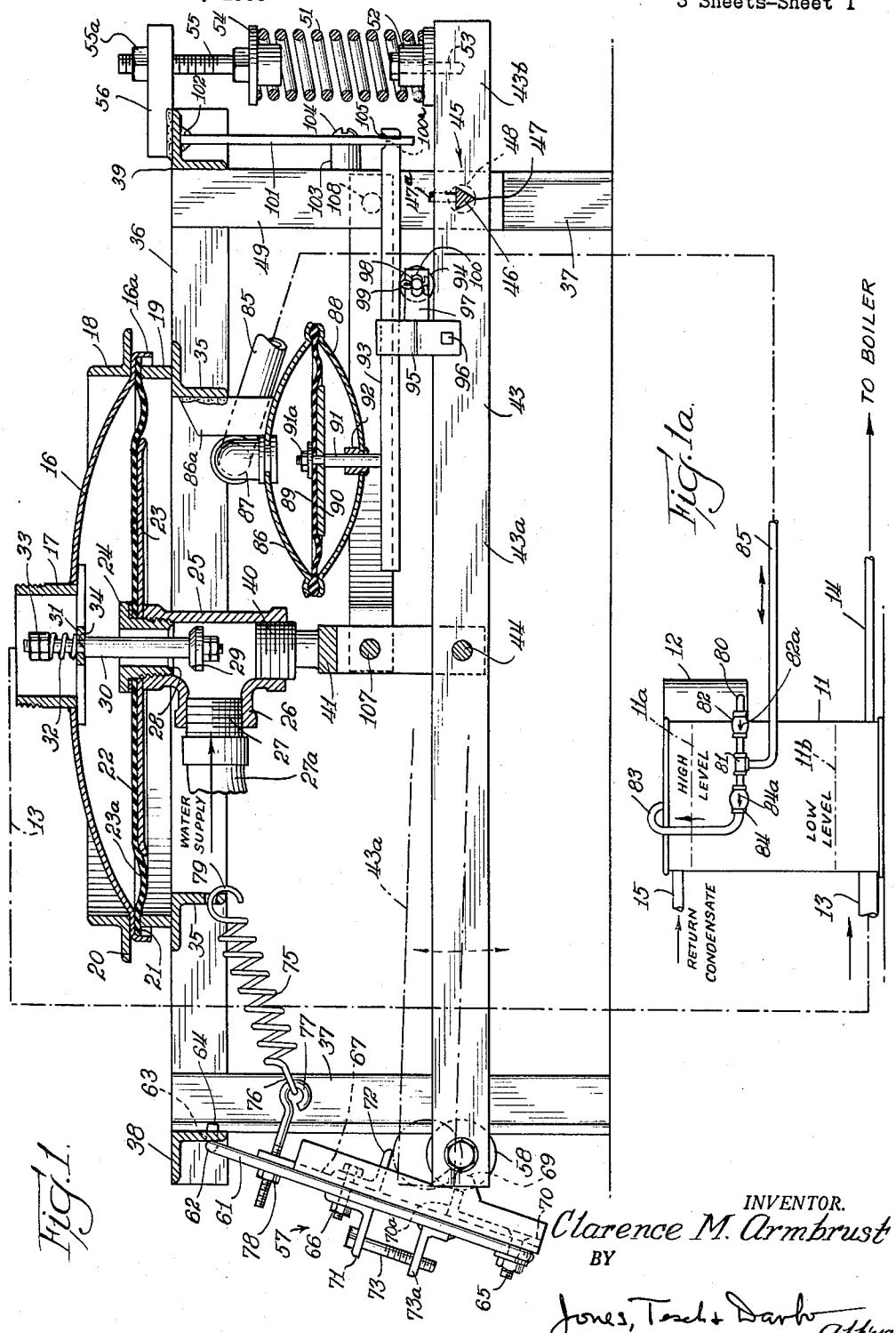


Fig. 1.

Fig. 1a.

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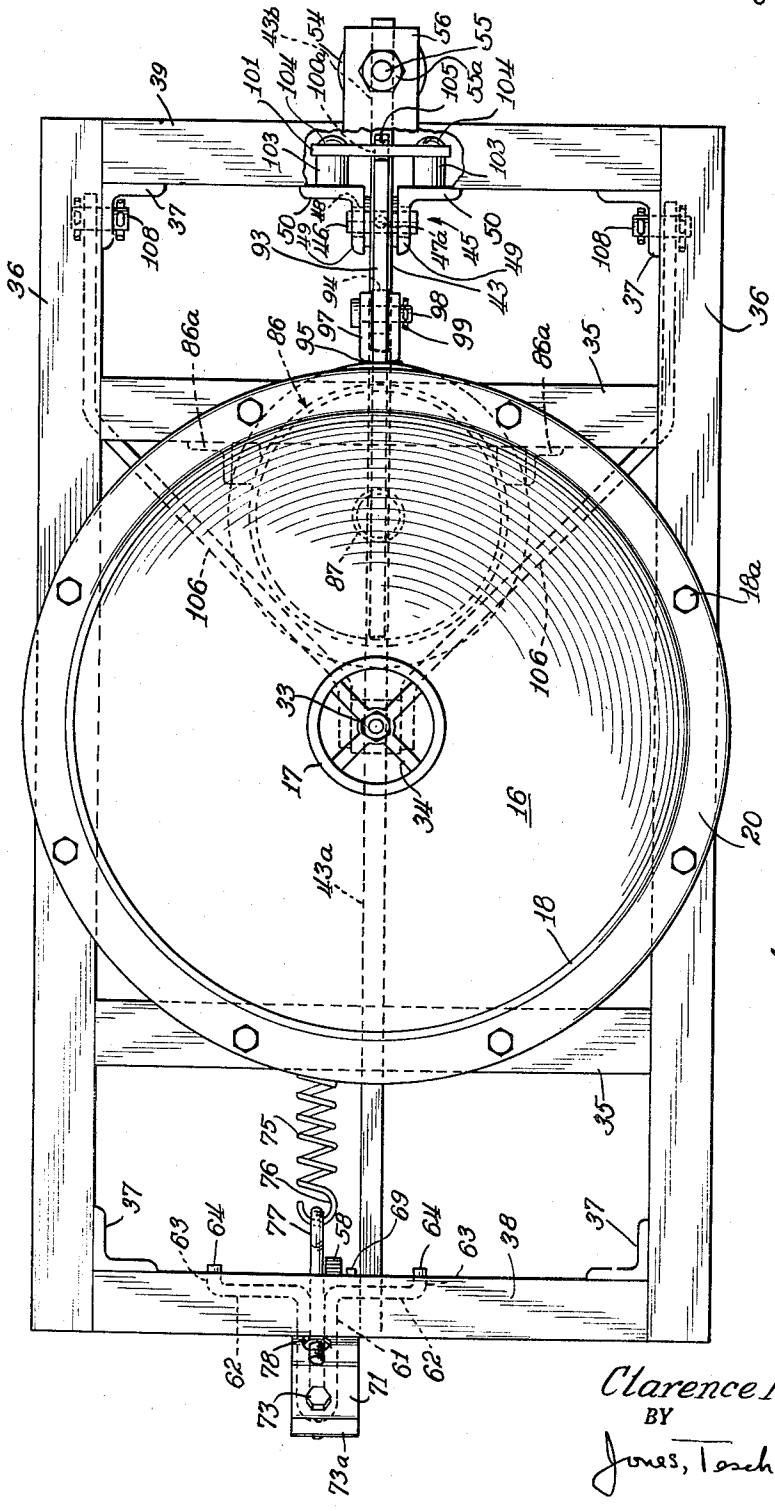


Fig. 2.

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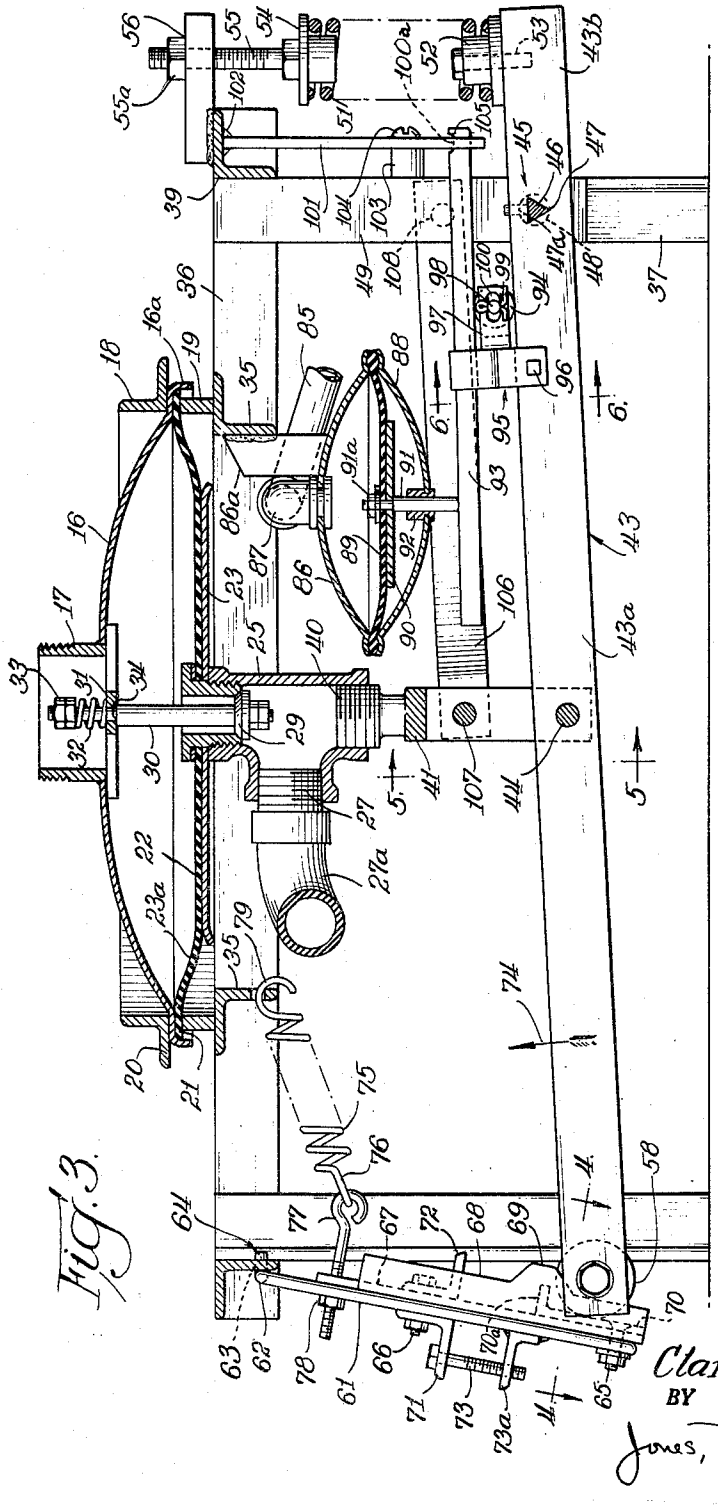


Fig. 3.

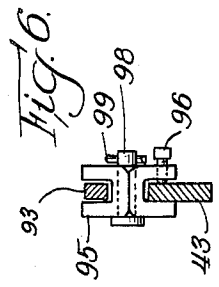


Fig. 6.

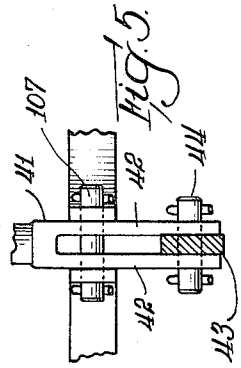


Fig. 5.

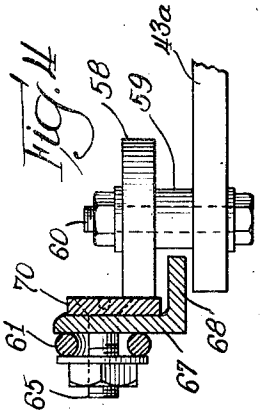


Fig. 4.

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AUTOMATIC LIQUID FEED APPARATUS

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13 Claims. (Cl. 137—88)

This invention relates to automatic liquid feed apparatus more particularly for hydraulically controlling the flow of liquid to a condensate or make-up tank for boiler feed and eliminating the need for a float, motors, needle valves or the like, while providing full opening valving means.

In an important aspect, the invention includes the automatic control of an additive liquid to the boiler feed tank for water treatment or water purification, the additive being injected in response to increments of fresh water flow into the tank, while withholding the injection of the treatment additive during raising of the water level in the tank by reason of the return condensate.

A further important object of the invention is the provision of micrometer adjustments for the additive injection means whereby to insure an accurate measure by weight for any desired ratio of additive to water and eliminating troublesome conventional float type controls.

These and other objects and advantages will be apparent from the following description, taken together with the accompanying drawings, showing an illustrative embodiment of the invention, and in which drawings—

Figure 1 is a side elevational view, partly in section, of illustrative apparatus embodying the invention;

Figure 1*a* shows on a somewhat reduced scale, an illustrative boiler feed tank and additive container, with which it may be advantageously associated, broken lines leading from Figure 1 to Figure 1*a* indicating the operative piping relationship;

Figure 2 is a plan view of the structure of Figure 1 partly broken away for purposes of description;

Figure 3 is a view somewhat similar to Figure 1 showing an alternative position of the apparatus parts in the cycle of operation;

Figure 4 is a fragmentary plan section taken on the line 4—4 of Fig. 3 somewhat enlarged;

Figure 5 is a vertical partial section taken on the line 5—5 of Fig. 3; and

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

Referring in detail to the illustrative construction shown in the drawings, numeral **11** indicates a boiler feed tank with which the present invention is here shown associated, a liquid additive container **12** being suitably mounted adjacent to and here shown carried by the tank **11**. Fresh water for the tank may flow thereinto through the pipe **13** (Fig. 1*a*) which enters the tank **11** adjacent the lower end thereof, and liquid from the tank **11** is led by pipe **14** to the boiler (not shown), returned condensate flowing back to the tank through the pipe **15** entering the tank adjacent its upper end. It will be understood that water flowing into the tank through the pipe **13** is fresh water or what may be called "make-up" water, under pressure, such as, for example, in a city water system.

In accordance with the present invention, interposed in the pipe **13**, below the lower wall of the tank **11** is

the diaphragm bell **16**, a threaded hollow boss **17** thereon being suitably connected, as need not be here shown, with the pipe **13**. The periphery of the diaphragm bell **16** is suitably clamped between a pair of rim members **18** and **19**, the rim member **18** having a lateral flange **20** that protects the periphery **16***a* of the diaphragm bell. Clamped between the rim members **18** and **19** is also a peripheral margin **21** of the diaphragm **22** that is faced on its lower side by a plate **23** of reduced diameter and having a flexible portion **23***a* adjacent its periphery. The diaphragm and plate are centrally perforated for the reception of a threaded cap ferrule **24** that clamps to the diaphragm and plate a liquid inlet fitting in the form of an internally threaded T-coupling **25** into which the ferrule is screwed, the head of the T being arranged vertically and the leg **26** thereof being internally threaded for reception of threaded nipple **27** to which is connected a flexible conduit **27***a* that in effect is a continuation of pipe **13** and communicates with the fresh water supply, as a hose thereto.

The cap ferrule **24** at its inner or lower end provides a valve seat **28** for a valve **29** that is carried by a valve stem **30** that depends from a spider **31** secured in the diaphragm bell **16** in the opening therethrough provided by the hollow boss **17**. The valve stem **30** is carried on the spider **31** through the intermediation of a compression coil spring **32** the pressure of which may be regulated by nuts **33** to urge the valve stem upwardly until the shoulder **34** thereon abuts the spider, this shoulder **34** limiting upward movement of the valve stem with respect to the diaphragm bell **16**, while permitting a resilient engagement of the valve seat **28** and valve **29** to prevent damage to these parts when operated as later described.

The diaphragm valve structure just described is carried on a table-like supporting frame having transverse angle members **35** and longitudinal members **36** that support the rim ring **19** for the diaphragm assembly and thus provide a frame thereabout as best seen in Fig. 2. The longitudinal frame members **36** are supported by legs **37** that are reinforced by end angle bars **38** and **39**, the four legs **37**, with the other frame members just referred to, thus constituting an open frame-like support for the diaphragm valve already described and other parts associated therewith next to be described. Bolts **18***a* clamp the diaphragm parts together and to the frame.

Still following the present invention, the other or lower end of the head of the T-coupling **25** has threaded therein into a screw block **40**, the shank of which is integral with a depending bifurcated yoke **41**, the furcations **42** of which receive between them a beam lever **43** that extends lengthwise of the frame between the legs thereof intermediately of the height of the frame and extending beyond the legs at each end, the lever **43** being on edge, i.e., having its greater width extending vertically.

The lever **43** is articulated intermediately of its length as at **44** with the yoke **41**, the yoke **41** serving as a link for causing simultaneous movements of the diaphragm **22** and lever **43** in a vertical plane, it being understood that the diaphragm **22**, T-coupling **25**, and yoke **41** all move together as a unit, this being permitted by the flexible water supply inlet hose **27***a*, the periphery **16***a* of the diaphragm of course remaining stationary. Movement of the lever **43** in a downward direction under the influence of the yoke **41**, or of the yoke in an upward direction under the influence of the lever, takes place on the pivot **45** of the lever which includes a lever trunnion **46** that is desirably of triangular cross-section, upon the lower edge **47** of which the lever bears, thus providing an anti-friction, or so-called knife edge bearing, the trunnion **46** passing through the circular open-

ings 48 in the parallel flanges 49 that are portions of hanger means for the lever 43 comprising a pair of depending angle members that have coplanar portions 50 that are spaced apart just sufficiently to receive the lever 43 freely therebetween and are secured at their upper ends to the frame end cross member 39. Trunnion 46 is made rigid with lever 43 by set screw 47*a*.

The lever 43 thus has a relatively long lever arm 43*a* extending to the left of its pivot 45 (with which lever arm 43*a* the yoke 41 is articulated) and a relatively short lever arm 43*b* extending to the right of the pivot. A relatively heavy compression coil spring 51 is mounted at its lower end on the lever arm 43*b*, on a spring centering member 52 that is bolted to the lever arm 43*b* by the bolt 53. At its upper end, the spring 51 is engaged by a spring centering device 54 depending by a shank 55 that passes threadedly through a jib block 56 suitably secured centrally of the frame cross member 39. The spring centering device 54 is adjustable by its threaded shank 55 and nut 55*a* to vary the compressive force of the spring 51 downwardly on the shorter lever arm 43*b* of the lever 43, which force tends to rotate the lever clockwise on its pivot 46 and thereby to raise the diaphragm 22 so that the valve seat 28 is moved away from the valve 29 and a passageway is open from the inlet hose 27*a* to the boiler feeder tank 11 to raise the level of water in the tank. By adjustment of the spring 51 as just indicated the spring 51 may be caused to counterbalance the weight of the diaphragm 22, T-coupling 25, yoke 41, and lever arm 43*a* to open the valve means 28—29 to admit water under pressure into tank 11 and a predetermined high level of water in the tank may be arrived at, which may be designated as its level 11*a* (Fig. 1*a*). When such level is reached the head or weight of such water will overbalance the force of spring 51, and acting upon the diaphragm 22, will close the valve mechanism 28—29 by moving the diaphragm downwardly while at the same time acting through the coupling 25 and yoke 41 will move the longer lever arm 43*a* downwardly or counterclockwise against the force of the spring 51.

To avoid undesirable fluttering of the diaphragm 22 and provide a quick, positive action of the mechanism, the lever arm 43*a* is yieldingly fixed in on or off positions for the purposes just described. In the present embodiment the lever 43 is at all times in engagement with a spring detent device here indicated generally by the numeral 57. In this instance, the longer lever arm 43*a* carries a roller 58 at its outer end projecting laterally therefrom on a hub 59, the roller and hub being rotatably mounted on the pin 60. The detent mechanism 57 includes a U-shaped bar iron 61 that is swingly carried on the frame cross member 38 by having the free ends of the U turned laterally as at 62 and then hooked into holes 63 in the angle iron as at 64. Passed through the straps or legs of the U and spaced vertically thereon are a pair of bolts 65 and 66 that clamp to the U-bar, on its face adjacent the roller 58, a track plate 67 that is angled to provide a guide edge 68 that has an extension 69 thereon. The roller 58 rides on the track plate 67 when the lever arm 43*a* is in uppermost position, and, when the lever arm 43*a* is in lowermost position, on a spacer plate 70 that is held to the U-strap of the detent mechanism by the bolt 65. The spacer plate 70 has an integral detent projection 70*a* at its upper end and the roller 58 takes a normal position on one side or the other of this detent projection. When the lever 43 is positively actuated as already described the roller 58 rides over the detent projection 70*a* forcing the detent device 57 to swing outwardly for this purpose. Fig. 1 (full lines) shows the roller riding over the projection 70*a*. The bolt 66 also clamps to the U-bar 61 a pair of lug members 71 and 72. By means of the take-up screw 73 that threadedly engages a fixed lug 73*a* on the U-bar, the position of the lug 72 may be adjusted vertically on the detent mechanism 57 to act as a positive stop limiting upward movement of the lever arm 43*a* in the direction of the arrow 74 (Fig. 3). Normally the limit of downward movement of the lever arm 43*a* as by engagement of the valve 29 with the valve seat 28 is indicated in Fig. 3. The intermediate movements of the lever arm 43*a* between these limits, as already referred to, when the roller 58 rides over the detent projection 70*a* of the detent mechanism, accompanied by swinging movements of the detent mechanism 57, is yieldingly resisted not only by weight of the detent mechanism but also by the expansion coil spring 75 that is hooked at one end 76 to an eye-bolt 77 secured to the U-strap 61 as at 78, the spring 75 being anchored at its other end as at 79 to the adjacent cross member 35 of the frame. In the movements of the roller 58 over the detent projection 70*a*, the guide extension 69 retains the roller in engagement with the detent, the guide flange playing between the roller and the lever arm. As already intimated, the full line position for the lever 43 in Fig. 1 shows an intermediate position of the lever arm 43*a* and one in which it will not normally come to rest, since it will either move farther upwardly to the position shown in dotted lines in Fig. 1, under the influence of the spring 51, to admit fresh water to the tank, or will move downwardly to the position shown in Fig. 3, under the influence of the head of water in the tank 11 on the diaphragm 22, to shut off the entry of fresh water, in either of which positions it will be yeildingly held by the detent mechanism 57 as already described.

Still following the present invention, and turning now to the expedients for injecting a predetermined quantity of additive liquid into the water in the tank 11, as seen somewhat diagrammatically in Figs. 1 and 1*a*, the pipe 80 leads from the lower end of the container 12 to a T 81, a suction check valve 82 being interposed in the pipe 80, between the container 12 and the T. On the other side of the T 81, the pipe 83 leads into the upper end of the tank 11, a check valve 84 being interposed in the pipe 83 between the T 81 and the tank 11. It will be understood that the check valves 82 and 84 permit the flow of liquid therethrough only in the direction of the arrows 82*a* and 84*a* respectively. From the T 81 a third pipe 85 leads into the upper portion of a diaphragm pump 86, by an elbow 87. The diaphragm pump 86 is hung by brackets 86*a* from frame cross-member 35 opposite the one to which the spring 75 is hooked, being thus relatively nearer the pivot 45 of lever 43. The pump has a lower wall 88 and an intermediate flexible diaphragm 89, the center plate 90 of which of reduced diameter carries an actuator in the form of a depending plunger pin 91 that is secured to the plate and diaphragm at 91*a* and passes through an annular guide 92 in the pump lower wall 88. The plunger 91 rests at its lower end on a calibrating device that here includes an adjustable bar 93 that in turn rests on a wheel 94 which is held on the upper edge of the longer arm 43*a* of the lever 43, the bar 93 being held to the periphery of the wheel 94 and the wheel to the lever arm by a sliding clamp 95. Clamp 95 has an upper portion of U-shape in which the bar 93 freely rests. Clamp 95 has a lower inverted U-portion that straddles the lever arm 43*a* and is secured thereto at any selective longitudinal position thereon by set-screw 96 that passes through one arm of the clamp to impinge upon the lever arm. Adjustment of the clamp 95 also determines the position of wheel 94 longitudinally of the lever arm, the wheel being connected to the clamp by a yoke 97, axle 98 and cotter pin 99, the ends of the yoke arms desirably having elongated slots 100 therein for the wheel axle 98 to permit self adjustment of the wheel therein, as by a limited lost motion connection. One end of the bar 93 is hooked into a slot 100*a* in the free lower end of a strut plate 101 that at its upper end is secured at 102 to the underface of the frame end cross member 39 and, intermediately of its height, is secured to the coplanar portions 50 of the lever hanger

device by pacer 103 and screws 104, the bar 93 having a semi-circular notch 105 in its upper edge which registers with the slot 100*a* and provides a friction minimizing fulcrum for the bar.

Because of the length of the lever arm 43*a* it is desirable to stabilize this on its pivot 45 and such stabilization is here exemplified by reaches 106 that are articulated with the yoke 41 at 107, centrally of the frame, and diverge therefrom to have their outer ends parallel with the frame members 36 and articulated therewith as at 108.

Operation of the apparatus is as follows:

When the lever arm 43*a* moves downwardly from the position shown in broken lines in Fig. 1 to the position shown in Fig. 3 under the influence of the head of water in the tank 11, thereby moving the diaphragm 22 to close the valve 29 on the valve seat 28 to shut off the supply of water to the tank against the force of the spring 51, then, at the same time that this occurs, the pump diaphragm 89 drops under the influence of gravity and the head of liquid in the pipe 85 from the position shown in Fig. 1 to the position shown in Fig. 3, the pump plunger 91 following the calibrator bar 93 downwardly. By reason of a drop in pressure thus created above the diaphragm 89, a quantity of the liquid additive is sucked or drained from the container 12, past the valve 82, into the pipe 85 and thereby into the pump 86 above the diaphragm 89. At this time liquid will not flow from the pipe 83 into the pipe 85 by reason of the valve 84. The diaphragm pump 86 is now cocked or loaded with a shot of additive, and will remain so until the next phase in the cycle.

This next phase occurs when the height of the liquid head in the tank 11 drops from the high level to a predetermined low level, which may be indicated at 11*b* (Fig. 1*a*) thereby reducing the weight of the combined water and additive on the diaphragm 22, thereby diminishing the load on the control spring 51 and causing this spring to move the lever arm 43*a* upwardly from the position shown in Fig. 3 to the position shown in dotted lines in Fig. 1. At this time, fresh water is admitted to the tank through the supply hose 27*a* by reason of the opening of the valve 29, and, at the same time, the bar 93 is raised causing the diaphragm 89 to move upwardly thereby injecting a shot of additive from the pump through the pipes 85 and 83 into the tank 11 along with the additional fresh water.

In each operation of the lever arm 43*a* and the diaphragm pump 86, the action is desirably sharp, by reason of the holdback or detent spring loaded device 57, so as in one phase to load the pump 86 and in the other phase to inject the contents of the pump into the tank.

Calibration of the stroke of the diaphragm pump plunger 91 is accomplished in this instance by the adjustment of the calibrating wheel 94, on the lever arm 43*a*, longitudinally of the bar 93. Since the fulcrum point 105 of the bar 93 is both offset laterally from the pivot 45 and is at a greater distance above the lever arm 43 than the diameter of the wheel 94, as the latter is moved to the left in Fig. 1 (by first loosening the set screw 96 and then sliding the clamp 95 on both the lever arm and the bar) the distance vertically which the lever arm 43*a* will lift the bar 93 is increased and consequently the amplitude of movement of the bar 93 at its end contacting the plunger pin 91 is augmented. Thus a micrometer adjustment, that is by small increments, may be made of the stroke of the plunger 91, to vary the amount of additive which is first drawn into the diaphragm pump 86 and then ejected from it into the tank.

The invention is not intended to be limited to details of construction shown for purposes of illustration and such changes, including additions and variations, may be made as fall within the scope of the appended claims without departing therefrom.

What is here claimed is:

1. In automatic liquid feed apparatus, in combination with a liquid holding tank and a liquid additive container, an inlet for a supply of liquid to the tank, a valve in said inlet, a diaphragm bell in communication with said inlet about said valve, a flexible diaphragm peripherally secured in said bell, a liquid inlet fitting carried by said diaphragm, a flexible liquid supply hose communicating with said fitting, said fitting having a valve seat cooperating with said valve to close the valve in the lowermost position of the diaphragm and fitting and to open the valve when the diaphragm and said fitting move upwardly, a lever having a relatively short arm and a relatively long arm, said long arm of the lever being articulated with said fitting, a spring pressing on the short lever arm urging the long arm of the lever upwardly to raise the diaphragm above said valve to admit liquid to the tank, through said fitting, a pipe for delivery of additives to said tank, a pump in communication with said additive pipe, an actuator for said pump, interconnecting means between said longer lever arm and said actuator to cause upward movement of the longer lever arm to move said actuator to inject additive into said tank, said actuator moving in the opposite direction under the head of additive in said pipe when said longer lever arm is moved downwardly to withdraw additive from said container, and a resilient detent engaging the said longer lever arm to releasably determine upper and lower positions of said longer lever arm.

2. The structure of claim 1 wherein the interconnecting means is adjustable to vary the stroke of the actuator.

3. The structure of claim 1 wherein the detent carries stop means limiting upward movement of the longer lever arm.

4. The structure of claim 1 wherein the lever is pivoted on a knife edge pivot.

5. The structure of claim 1 wherein the compression loading spring is adjustable.

6. The structure of claim 1 wherein the spring of the detent is adjustable.

7. The structure of claim 1 wherein the detent includes a depending element having a detent projection thereon and said longer lever arm has a roller riding over said projection when the lever is actuated, an expansion coil spring yieldingly retracting said detent member whereby said roller rides over said projection against the resilience of said expansion spring.

8. The structure of claim 1 wherein the diaphragm pump includes a depending plunger and the interconnecting means includes a bar fulcrummed at one end adjacent the pivot of the lever and extending approximately in the same direction as said longer lever arm thereabove, an adjusting member movable on the upper surface of said longer lever arm supporting said bar, the upper surface of said bar supporting said plunger, said adjusting member being movable longitudinally of the arm and bar, the fulcrum of the bar being such as to provide a different amplitude of the bar with respect to the lever whereby to vary the length of stroke of said plunger.

9. The structure of claim 8 wherein the adjusting member comprises a wheel running on the upper edge of the lever supporting the bar and selectively adjustable clamping means fixing the location of said wheel.

10. The structure of claim 1 wherein the valve is resiliently mounted.

11. In automatic liquid feed apparatus, a frame, a diaphragm bell mounted on said frame, a flexible diaphragm secured to said bell, a T-coupling supported centrally by said diaphragm, a valve stem mounted in said bell extending downwardly into said coupling, said coupling carrying a valve seat in the upper end of the T head, a valve on said valve stem cooperating with said valve seat, a flexible inlet hose communicating with the leg of the T, a plug in the other end of the T head, a depending yoke carried by said plug, a lever pivoted on

said frame, said lever arm having a longer lever arm and a shorter lever arm, the longer lever arm being intermediately articulated with said yoke, a compression spring between said frame and the shorter lever arm of said lever, a detent swingingly supported at the other end of said frame adjacent the outer end of said longer lever arm, an expansion coil spring anchored to the frame and to said detent urging the detent toward the lever arm, a roller on the outer end of the lever arm, said detent carrying a detent projection adapted to be ridden over by said roller, a stop on said detent limiting upward movement of the longer lever arm under the influence of said compression spring, an additive pump carried by said frame, and means actuated by said lever for actuating said pump.

12. The structure of claim 11 wherein the detent carries a guide for the roller.

13. The structure of claim 11 wherein a pair of reaches are intermediately articulated with said yoke and with the sides of said frame to stabilize said lever.

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