

Jan. 24, 1956

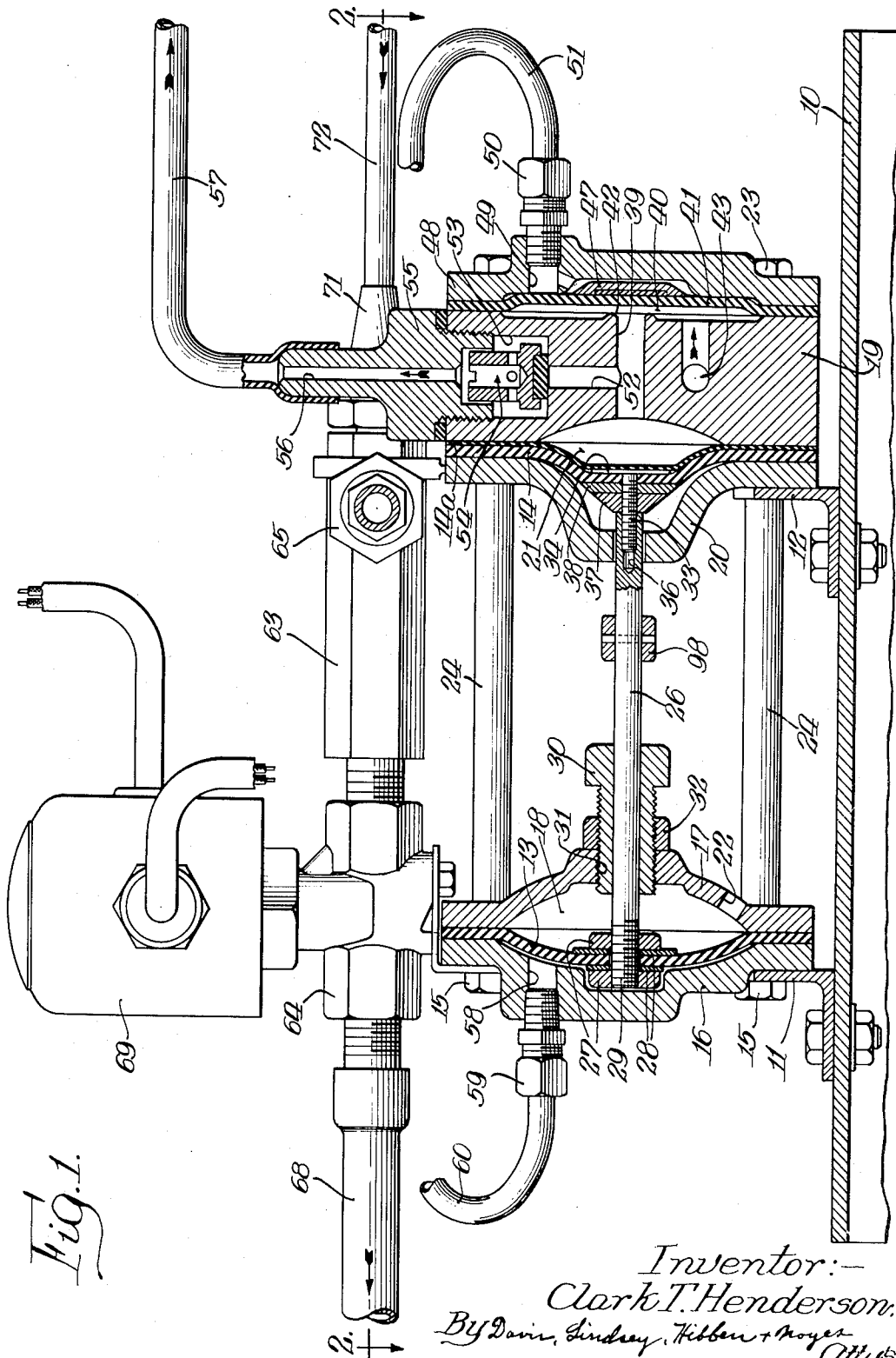
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2,732,069

FLUID FEED APPARATUS

Filed Jan. 10, 1950

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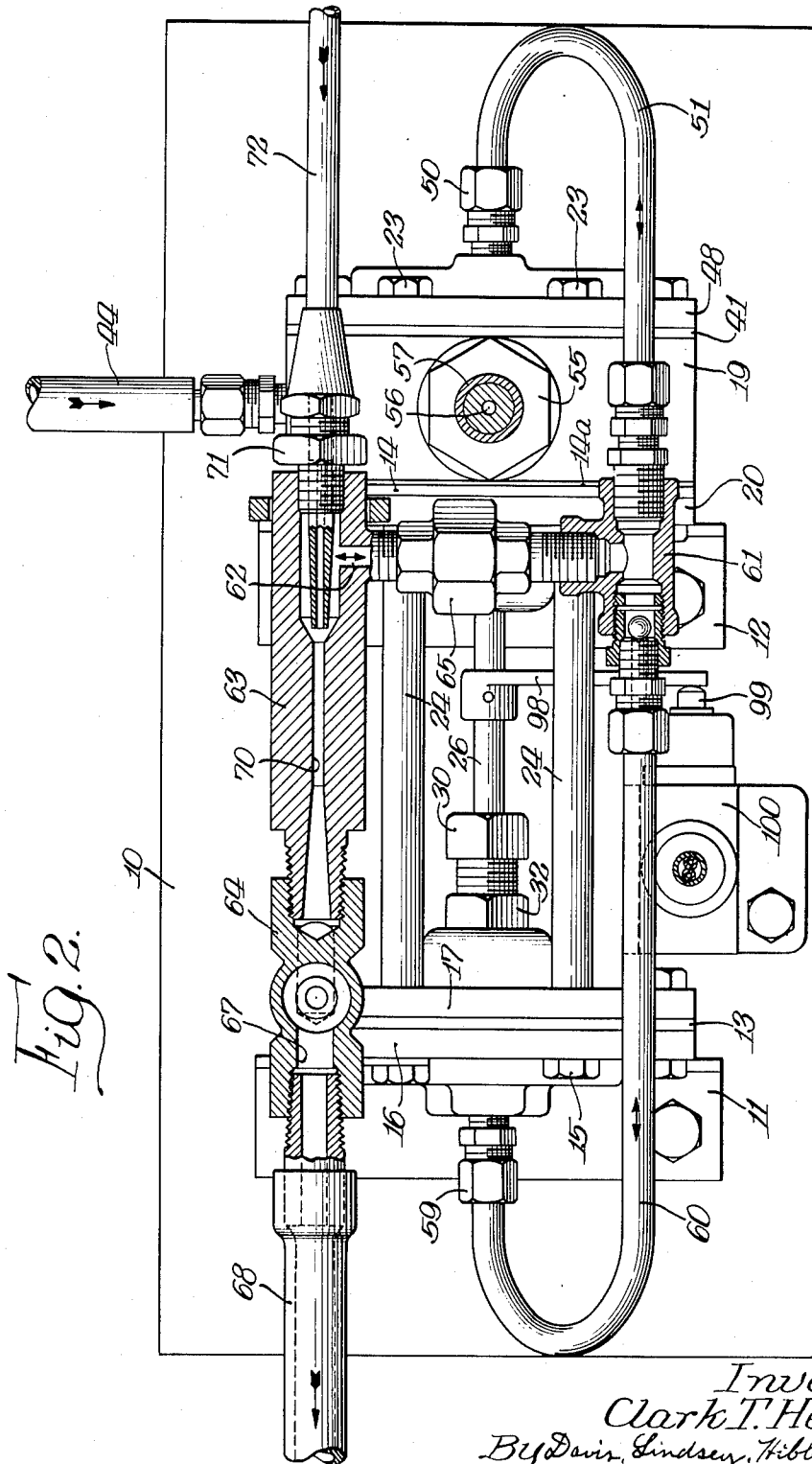
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FLUID FEED APPARATUS

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4 Sheets-Sheet 2



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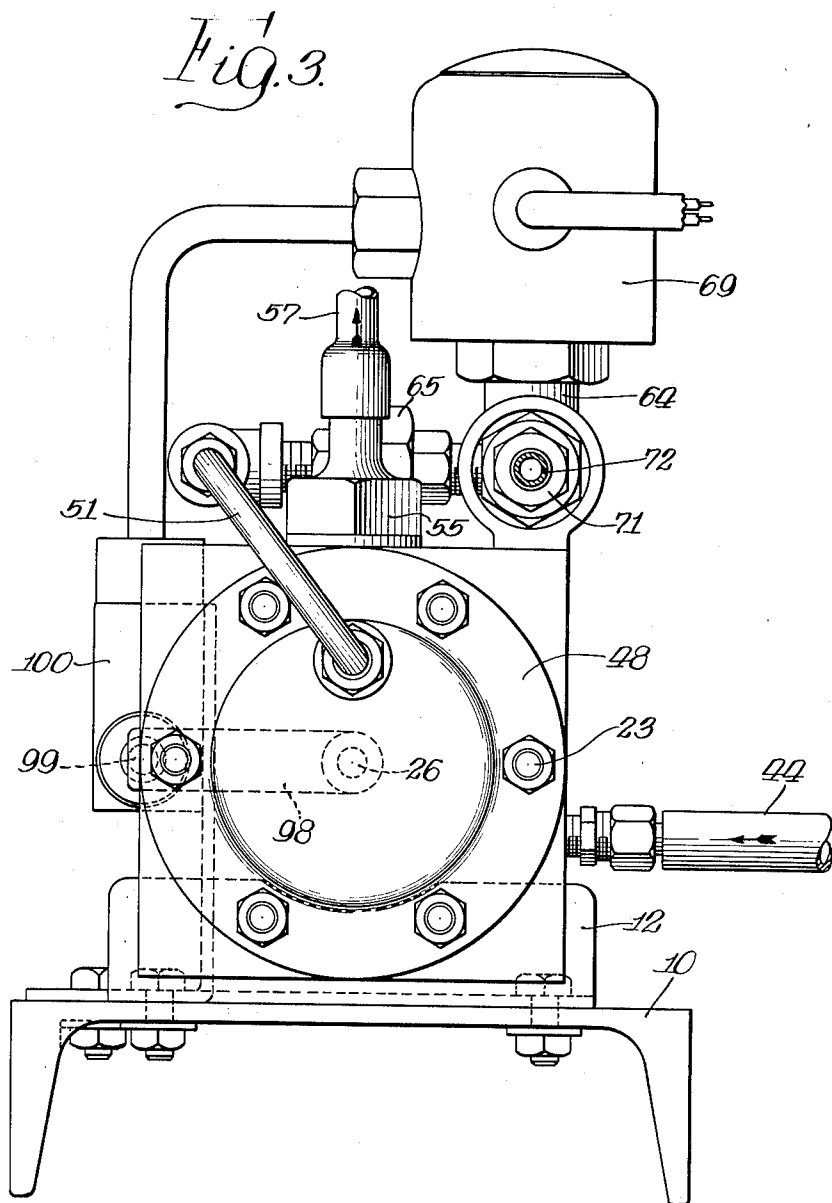
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4 Sheets-Sheet 3



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4 Sheets-Sheet 4

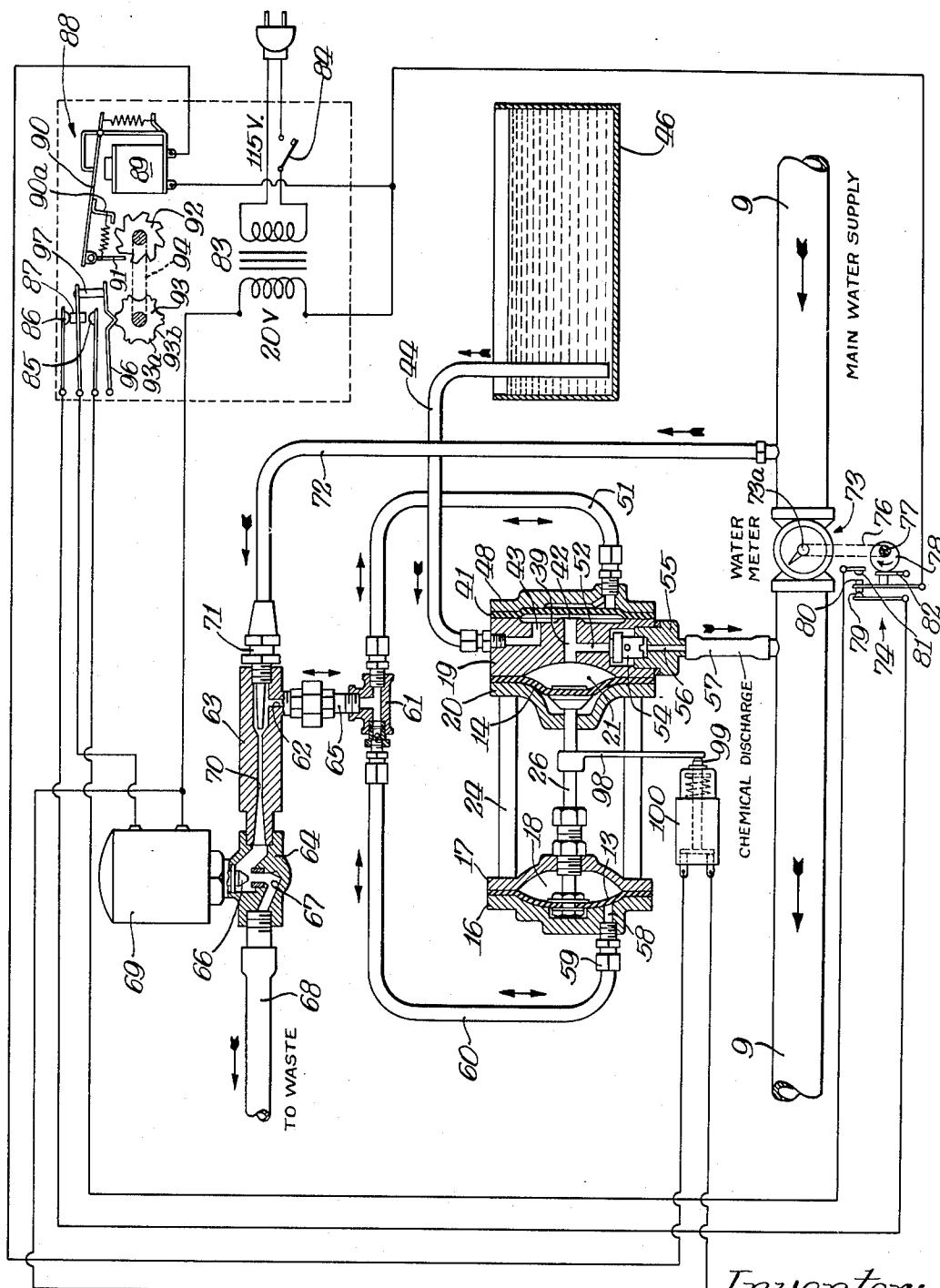


Fig. 4.

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2,732,069

FLUID FEED APPARATUS

Clark T. Henderson, Wheaton, Ill.

Application January 10, 1950, Serial No. 137,825

9 Claims. (Cl. 210—40)

This invention relates to a liquid feed apparatus and more particularly to a liquid feed apparatus for adding solutions such as sterilizing fluids, coagulants, stabilizing agents or the like to another fluid such as a flowing water supply.

Heretofore, the various devices and pumping systems which have been developed and used for the purpose of adding sterilizing fluids, such as chlorine solutions, to the drinking water supply of cities and large towns have been large, complicated structures and have been so costly as to prohibit their purchase and use by smaller towns and villages. Consequently, thousands upon thousands of such smaller towns and villages have been unable to afford to their residents a definitely safe water supply. Furthermore, these former feeding devices required constant supervision by operators, and the various parts thereof were subject to wear and breakage requiring frequent repair and replacement with the result that the operational maintenance of these devices was the source of additional undesirable costs. Other apparatus such as that used in municipalities or in industry for adding coagulants to water ahead of filtration or for adding stabilizing agents to flowing water have likewise been subject to the same objections and disadvantages.

Another disadvantage inherent in such prior liquid feed systems has resulted from the use of valves which were not positive and efficient in their operation and involved the use of springs for valve actuation. Such valves were incapable of regular coordinated operation over a long period of time and were leaky and slow acting in their opening and closing operation.

It is, therefore, an object of the present invention to provide an improved form of liquid feed apparatus whereby one additive fluid such as a chemical solution, may be fed or added in predetermined quantities to another fluid, such as water, at a rate proportional to the rate at which said other fluid is flowing.

Another object of the present invention is to provide an improved liquid feed apparatus of the foregoing character which is of simple, inexpensive but efficient construction and has a relatively long operable life requiring only a minimum of attention during operation and affording low repair and replacement costs.

Another object is to provide a liquid feed apparatus for feeding an additive to another fluid under pressure such as a main water supply which comprises a pump and a variable pressure mechanism operable by said water supply pressure and adapted to effect pump operation by alternately creating a vacuum and an increased pressure on one side of the pump.

A further object is to provide a liquid feed apparatus of the foregoing character in which the pump is of the diaphragm type and the valve between the pump and the source of additive fluid is also of the diaphragm type, the variable pressure mechanism comprising an ejector adapted to create alternately a vacuum to open the valve and effect the pump suction stroke and an increased pressure to close the valve and effect the pumping stroke.

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A still further object is to provide an apparatus of the foregoing character in which operation of the variable pressure mechanism is controlled by mechanism operably engaged with the water flow meter in the main fluid supply line.

Another further object is to provide a liquid feed apparatus in which the valve for controlling the flow of liquid from the chemical supply tank to the main liquid supply is mechanically actuated for positive, leakproof operation at the desired point of time with respect to the suction and pumping strokes of the pump.

Other objects and advantages of the present invention will become apparent as this description progresses, reference being had to the accompanying drawings in which:

Figure 1 is a vertical sectional view of a liquid feed apparatus comprising one embodiment of the present invention;

Fig. 2 is a horizontal sectional view taken on the line 2—2 in Fig. 1, looking in the direction of the arrows;

Fig. 3 is an end elevational view of the apparatus as viewed from the right in Fig. 1; and

Fig. 4 is a diagrammatic and partial sectional view showing the general arrangement of the liquid feed apparatus of Figs. 1 and 3, inclusive, in relation to a source of additive fluid and a main water supply line and also showing the wiring diagram of the electrical valve controlling mechanism for the ejector.

The liquid feed apparatus comprising the present invention is shown in Figs. 1 and 3, inclusive, of the drawings, mounted on a base 10 and secured thereto by means of spaced angle irons 11 and 12. The reciprocating pump of the apparatus is of the diaphragm type comprising a power diaphragm 13 and a pumping diaphragm 14, each composed of any suitable resilient, flexible material, such as rubber or the like. The power diaphragm 13, at the left side of the pump as viewed in Fig. 1, is annular in form and is clamped at its peripheral edge portions between two complementary concave, circular body portions 16 and 17, these body portions providing an annular chamber 18 in which the power diaphragm 13 is operable for movement from left to right and return. The body portions 16 and 17 are held in assembled clamping position by a plurality of bolts 15 arranged around the marginal portions thereof. Similarly the pumping diaphragm 14, at the right side of the pump, is of circular form and is clamped at its peripheral edge portions between a valve block 19 and a body member 20. The valve block 19 and the body portion 20 are concave on their opposed sides and together form a pumping chamber 21 in which the pumping diaphragm is operable for movement from the left to right and return. The respective body portions of the pump forming the two chambers 18 and 21 in which the diaphragms are operable are joined together and rigidly maintained in properly spaced relation by a plurality of bracing bars 24.

The diaphragms 13 and 14 are each secured on the respective ends of a pump rod 26 reciprocally mounted in the body members 17 and 20. The power diaphragm 13 is secured on the left end of the pump rod 26 by means of a pair of nuts 27 and a pair of washers 28 between which the diaphragm 13 is clamped, the end of the pump rod 26 being threaded as at 29 for threaded engagement with the nuts 27. The pump rod 26 is slidably supported within a bushing 30 threadedly secured in a central opening 31 of the body member 17, the bushing 30 also serving as a stop member and being adjustable within the opening 31 in order to vary the length of the stroke of the pump rod 26. The length of the stroke is reduced as the bushing 30 is screwed inwardly or to the left toward the diaphragm 13 and is increased as it is screwed outwardly. The stop bushing 30 is retained in properly adjusted position by means of a lock nut 32

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threadedly secured on the outer threaded periphery thereof. The body member 17 is also provided with an unobstructed opening 22 extending therethrough to permit the egress and ingress of air as the diaphragm 13 is moved to the right or back to the left during the pumping and suction strokes.

The pumping diaphragm 14 is secured on the right end of the pump rod 26 by means of a screw 33 extending through a central aperture of the diaphragm and having an enlarged flat head 34 for engagement with the right surface of the diaphragm. The threaded shank of the screw 33 is received within a threaded bore 36 in the right end of the pump rod 26 and a tapered clamping nut 37 and a washer 38 are mounted on the screw 33 between the rod 26 and the diaphragm 14 to serve as an enlarged base against which the diaphragm 14 is clamped by the screw head 34. Secured to the right surface of the diaphragm 14 and to the outer surface of the screw head 34 is a thin rubber sheet 14a which serves to protect the screw head 34 from any possible chemical action of the additive fluid. By the foregoing construction, it is evident that upon movement of the power diaphragm 13 to the right or to the left as viewed in Figs. 1 and 4, the pumping diaphragm 14 will correspondingly be moved either to the right or to the left.

The pumping chamber 21 in which the pumping diaphragm 14 is operable is connected by a horizontal passage 39 with a valve chamber 40 in which a diaphragm 41 is operable for limited movement either to the right or to the left to open or close the port 42 through which the passage 39 connects with the valve chamber 40. The valve chamber 40 is formed by a shallow concavity on the right side of the valve block 19 and by a complementary opposed concavity of a valve plate 48. The valve diaphragm 41 is circular in form and is clamped at its peripheral edge portions against the valve block by the valve plate 48, the body member 20, the diaphragm 14, the valve body 19, the diaphragm 41 and the valve plate 48 being secured together as an assembly by bolts 23.

As shown particularly in Fig. 4, a pipe 44 extends downwardly into a tank 46 in which is contained a supply of the chemical solution or additive fluid to be injected or fed into the water supply pipe 9 in predetermined quantities. When the port 42 of the valve block 19 is not closed by the valve diaphragm 41, a quantity of the chemical solution on the suction stroke of the pump from right to left may be withdrawn from the tank 46 through the pipe 44, a valve block passage 43 and into the valve chamber 40 from which it passes into the main pump chamber 21 through the horizontal valve passage 39. The diaphragm 41 has secured to its right side, as viewed in Fig. 1, a slightly concave annular plate 47. This plate 47 is mounted on the diaphragm 41 in registry with the valve port 42 and serves as a stiffener to insure proper closing contact of the diaphragm 41 against the edges of the port 42 and the valve block 19 when pressure is applied against the right side of the diaphragm 41, as will be more fully explained hereinafter.

The closure plate 48 is also provided with an opening 49 therethrough in which a fitting 50 having a pipe 51 connected thereto, is secured, the purpose of which will be more fully explained hereinafter. The valve block 19 is also provided with a vertical passage 52 from the lateral passage 39 and a connecting valve chamber 53 in which a check valve 54 is mounted for reciprocation from open to closed position and return in the conventional manner. The outer end of the check valve chamber 53 is closed by a fitting 55 threadedly secured therein, this fitting 55 having a vertical passage 56 therein connected with a chemical pipe 57 which in turn is connected to the main water supply pipe 9. For convenience, the pump is shown in inverted position in the diagrammatic view of Fig. 4.

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The left body portion 16 of the pump is provided with a lateral passage 58 extending therethrough to the chamber 18. In this lateral passage 58 there is threadedly secured a fitting 59 having a pipe 60 connected thereto. The pipe 51 which connects to the valve chamber 40 and the pipe 60 which connects to the diaphragm chamber 18 are each connected by proper fittings to a T member 61, as shown particularly in Fig. 4 of the drawings, which in turn is connected to a short horizontal pipe 65 secured in alignment with a short vertical ejector passage 62 of a hydraulic ejector 63. The ejector 63 has secured to its left end a valve body 64 having a solenoid controlled valve 66 vertically reciprocable therein for opening and closing the passage 67 through the valve body. The valve body 64 is connected at its left end to a pipe 68 which may be connected to any source of disposal such as waste. A solenoid device 69 is mounted on the top of the valve body 64 and is connected in an electrical circuit, also to be more fully described hereinafter, the opening and closing movement of the valve 66 being effected as this solenoid 69 is energized or deenergized, respectively.

The ejector 63, which may be operable by the fluid under pressure from the main supply pipe 9 or operable by a fluid pressure from any other source separate and apart therefrom, is provided with a restricted horizontal passage 70 extending therethrough and to the right end of the ejector there is secured a fitting 71 to which is connected an intake pipe 72 which connects the ejector 63 with the main water supply pipe 9.

When water under pressure passes through the main water supply pipe 9, a quantity of such water under pressure passes up through the intake pipe 72 and into the ejector 63. If the valve 66 on the discharge side of the ejector is in closed position as dictated by the electrical control means to be described hereinafter, water pressure is built up in the ejector 63, the pipe 65 and in the pipes 51 and 60. The pressure in the pipe 51 builds up a pressure in the valve chamber 40 against the right side of the valve diaphragm 41 causing it to move to the left so as to close the port 42 of the horizontal passage 39 of the pump valve block 19. Simultaneously, water pressure in the pipe 60 is applied against the left side of the power diaphragm 13 causing it to move to the right within the chamber 18 which results in movement of the pump rod 26 to the right on its pumping stroke. As the rod 26 moves to the right on the pumping stroke, the pumping diaphragm 14 is also moved to the right in chamber 21, causing the chemical solution previously withdrawn from the tank 46 and now in the chamber 21, to be forced outwardly from the valve block 19 through the passages 39 and 52, past the check valve 54, and out through the passage 56 of the fitting 55. The chemical solution is thus pumped into the chemical discharge pipe 57 and into the main water supply pipe 9. It is to be noted that the valve diaphragm 41 is closed at the beginning of the pumping stroke and prevents leakage of the solution backwardly into the valve chamber 40 from the pump chamber 21 during the pumping stroke. It is to be further understood that the area of diaphragm 13 is approximately one hundred fifty percent (150%) of the area of diaphragm 14, which insures that fluid can at all times be positively pumped into the main water line 9 against the pressure therein, the pressure in the pipe 9 being the operating pressure on diaphragm 13.

When a quantity of chemical solution is to be withdrawn from the tank 46 and forced into the pumping chamber 21 on the suction stroke following the pumping stroke, the valve 66 next to the ejector 63 is moved to open position by the solenoid 69 so that water under pressure passes upwardly through the intake pipe 72 and passes through the ejector 63, the valve body 64 and through the pipe 68 to waste. This ejector action over the vertical passage 62 in the ejector 63 tends to create a

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vacuum or reduces the pressure in the pipes 51, 60 and 65, with the result that the power diaphragm 13 is caused to move to the left within the chamber 18 from the extreme right hand position it attains at the end of the pumping stroke to the position shown in Fig. 1. This causes the rod 26 to pull the pumping diaphragm 14 also to the left and thus draw into the chamber 21 a quantity of chemical solution from the tank 46. As the diaphragms 13 and 14 commence to move to the left on the suction stroke, the reduced pressure or vacuum in the pipe 51 causes the valve diaphragm 41 to move to the right so as to open the port 42 of the lateral passage 39 of the valve body 19. With the port 42 open, the chemical solution is permitted free passage from the tank 46 into the chamber 21 so that as the pumping diaphragm 14 continues its movement to the left a quantity of the chemical solution is drawn into the pumping chamber 21. Following this, the valve 66 is then closed so that pressure is again built up in the pipes 65, 51 and 60 to cause the valve diaphragm 41 to close the valve port 42 and to move the diaphragms 13 and 14 to the right for the pumping stroke as above described, whereupon the chemical fluid within the pump chamber 21 is forced out into the main water supply pipe 9 through the discharge pipe 57.

The pumping action of the apparatus above described is made to feed at a rate proportional to the flow of the water in the main water supply pipe 9 by means of a fluid meter, an electric clock or any other equivalent metering or timing device by which a definite quantity of additive may be fed at predetermined intervals or to predetermined quantities of the main fluid. In the preferred embodiment, a water meter, indicated generally by the numeral 73, is shown in Fig. 4, in conjunction with an electrically operated control mechanism which will now be described. The fluid meter 73 which is interposed in the main water line 9, may be of the conventional type and is mechanically connected to a three-way electric switch 74 in such a manner that whenever a predetermined volume of fluid has passed through the meter 73, the three-way switch 74 will be shifted from one position to the other to complete one circuit or another. As shown somewhat diagrammatically in Fig. 4, a rotating part or shaft 73a of the meter 73 is connected by a chain 76 to a rotatable switch shaft 77 on which is secured a cam 78. The three-way switch 74 is provided with contacts 79, 80 and 81, the contacts 79 and 80 being adapted to be closed in engaged position when the cam 78 is in the position shown in Fig. 4 bearing against the presser member 82. When the cam 78 has rotated 180° from its Fig. 4 position, the contacts 79 and 80 will be out of engagement and contact 80 will then be in engagement with contact 81.

The contact 80 of the three-way switch 74 is connected to the secondary coil of a step-down transformer 83 connected to a 115 volt electric outlet through a main control switch 84 and the secondary coil of the transformer 83 in which there is produced a reduced operating current of 20 volts, is connected to the valve solenoid 69. The contact 79 of the three-way switch 74 is also connected to the valve solenoid 69 through engaged contacts 86 and 87 of a second three-way switch indicated generally by the numeral 88. When the foregoing electrical circuit is closed through the contacts 86 and 87 of the second three-way switch 88 and through the contacts 79 and 80 of the three-way switch 74, the solenoid 69 will be energized to hold the valve 66 in elevated or open position, thus permitting the water under pressure from the pipe 72 to be ejected through to waste and thus to cause a reduction in pressure or the creation of a vacuum in the pipes 65, 51 and 60 for the purposes above described.

The valve 66 may also be held in elevated position when the electric circuit is closed through the contacts 30 and 31 of the three-way switch 74, after the cam 78 thereof has rotated 180° away from its Fig. 4 position, and after the contact 87 is in engagement with the contact 85 of the three-way switch 88. Thus the solenoid

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69 may be energized in either extreme position of the meter cam 78, the circuits being closed in one position through contacts 79 and 80 of switch 74 and contacts 86 and 87 of switch 88 and in the other position through contacts 80 and 81 of switch 74 and contacts 85 and 87 of switch 88. The solenoid 69 is thus deenergized when the cam 78 is moving from one extreme position to the other as above described and during this period of deenergization the valve 66 is in its down closed position.

The second three-way switch 88 also comprises an electromagnet 89, which upon being energized attracts a spring urged arm 90 having a downwardly extending pawl 91 to cause it to move downwardly to actuate a ratchet wheel 92 in a counterclockwise direction. The ratchet wheel 92 is operably connected with a wheel 93 such as by a chain 94 so that rotation of the wheel 92 will cause rotation of the wheel 93. The arm 90 is also provided with a stop finger 90a which serves to engage the ratchet 92 and prevent over rotation thereof when the ratchet 92 is rotatably advanced by the finger 91. The wheel 93 has a plurality of radial projections 93a and recesses 93b on its outer circumferential edges and is engaged on its upper side by a spring bar 96 having an upwardly directed finger 97 adapted to engage and hold the contact 87 in upward position in engagement with the contact 86. The contact 87 is held in its upper position when the spring arm 96 is engaged by one of the radial projections 93a of the wheel 93 and is permitted to return to its lowered position in engagement with the contact 85 when the recess 93b is up so that the circuit is completed through the three-way switch 88 in either position.

A depending arm 98 is fixed to the pump rod 26 and the free end of this arm is adapted to engage a spring pressed plunger 99 of a switch 100 to close the switch contacts therein when the pump rod 26 reaches its extreme position at the left. Closing of the contacts of the switch 100 completes the electrical circuit to the relay magnet 89 which pulls down the arm 90 to rotate the wheels 92 and 93. Rotation of the wheel 93 moves the radial projection 93a from under the switch spring arm 96 and the spring arm then engages the wheel 93 in the recess 93b with the result that engagement of the contact 87 with the contact 86 is broken, thus opening the circuit to the valve solenoid 69 and causing the valve 66 to close. In this closed position of the valve 66, water pressure is built up in the pipes 65, 51 and 60 causing movement of the diaphragms 13 and 14 to the right and the consequent pumping of the chemical solution from the pump chamber 21 into the main water supply line 9, as above explained. When the switch contact 87 moves downwardly, it engages the contact 85 so that a solenoid energizing circuit will be completed when contacts 80 and 81 are in engagement.

As the pump rod 26 moves to the right, the arm 98 moves out of contact with the switch plunger 99 of the switch 100 thus breaking the engagement between the contacts in the switch 100 and opening the circuit to the electro-magnet 89 and releasing the arm 90 out of engagement with the ratchet wheel 92. This circuit to the electro-magnet 89 is broken at the beginning of the pumping stroke and is not reestablished until the end of the return stroke. When the pumping stroke is begun, the cam 78 is in its Fig. 4 position with the contacts 79 and 80 of the switch 74 still in engagement but the circuit has already been broken as the contacts 86 and 87 have already broken off engagement. At the end of the pumping stroke, the cam 78 has completed its 180° rotation from its Fig. 4 position to permit engagement between the contacts 80 and 81. When the engagement is thus made, the circuit is completed through contacts 85 and 87 of switch 88 and contacts 80 and 81 of switch 74 which energizes the solenoid 69 and raises the valve 66 to open position. Pressure is thus reduced

in the pipes 65, 60, and 51 and the pump starts on its suction stroke as above explained.

It is thus apparent from the foregoing description of the details of structure and mode of operation of the one embodiment of the present invention, that a liquid feed apparatus has been provided which is not only positive and efficient in operation and capable of feeding liquid to a main water line in direct proportion to the rate of flow of the water in said line, but which is also of simple and relatively inexpensive construction requiring the outlay of a minimum amount of money for incorporation thereof into small municipal water systems. The general structural arrangement of the parts is such that the apparatus requires little or no attention in order to maintain it in efficient working condition and its repair and replacement costs are reduced to a bare minimum, all springs, stuffing boxes and the like of former structures which require frequent replacement and repair having been eliminated. The valve diaphragm 41 is positive in its opening and closing movements under the positive variations in pressure in the pipe 51 and all the disadvantages attendant in the old type of check valve systems have been eliminated.

Although there has been illustrated in the drawings and described in detail above one preferred embodiment of the present invention, it is to be understood that modifications in the details of construction and mode of operation may be made without departing from the spirit and scope of the appended claims.

I claim:

1. A liquid feed apparatus for feeding an additive liquid to a second liquid which comprises a pump adapted to be connected to a source for said additive liquid and to said second liquid for withdrawing a quantity of additive liquid from said source on the suction stroke and for forcing said additive liquid into said second liquid on the pumping stroke and a valve between said pump and said source of additive liquid adapted to be in closed position during the pumping stroke and in open position on the suction stroke, and a variable pressure mechanism adapted to be connected to a conduit for liquid under pressure and connected to said valve and said pump and operable by said liquid under pressure for creating alternately a vacuum to simultaneously effect opening of the valve and a suction stroke of said pump and a pressure to simultaneously effect closing of said valve and a pumping stroke of said pump.

2. A fluid feed apparatus for feeding an additive fluid to a main fluid supply flowing under pressure in a system having a water flow meter disposed therein, which comprises a pump adapted to be connected to a source for said additive fluid and to said fluid supply conduit for withdrawing a quantity of additive fluid from said source on the suction stroke and for forcing said additive fluid into said fluid supply system on the pumping stroke, a movable valve between said pump and said source of additive fluid, a variable pressure mechanism operable by the main fluid supply pressure comprising an ejector device connected to said pump and to said valve and adapted to be connected to said main fluid supply under pressure through which a quantity of said main fluid supply under pressure may flow to discharge and to said pump and valve, a valve adapted to be alternately opened and closed to provide for or prevent the flow of said main fluid through the ejector for creating alternately on one side of said pump a vacuum to effect the suction stroke thereof and an increased pressure to effect the pumping stroke thereof and for creating alternately on one side of said first valve a vacuum to effect movement of the valve to open position for the suction stroke of the pump and an increased pressure to effect movement of the valve to closed position for the pumping stroke, and mechanism for operating said first valve adapted to be operably connected with said meter and controlled

thereby in response to the passage of a predetermined quantity of the main fluid supply therethrough.

3. The combination of a fluid-operated reciprocating type motor having a reciprocating element movable in opposite directions in response to the application of vacuum and pressure fluid thereto, a fluid operated ejector, a conduit for receiving fluid under pressure from a main conduit and constantly connected to said ejector for constantly supplying fluid under pressure thereto, means connected to the discharge of said ejector and adapted to be opened and closed for providing intermittent flow of fluid from said conduit through said ejector, and means responsive to the flow of fluid in said main conduit for repetitively opening and closing said first-mentioned means, said ejector being connected to said motor and being operable to apply vacuum to said element when said first-mentioned means is opened to permit flow through said ejector and to apply pressure fluid to said element when said first-mentioned means is closed to prevent flow through said ejector.

4. The combination of a fluid-operated reciprocating type motor having a reciprocating element movable in opposite directions in response to the application of vacuum and pressure fluid thereto, a fluid operated ejector, a conduit for receiving fluid under pressure from a main conduit and constantly connected to said ejector for constantly supplying fluid under pressure thereto, means connected to the discharge of said ejector and adapted to be opened and closed for providing intermittent flow of fluid from said conduit through said ejector, and means responsive to the flow of fluid in said main conduit and the reciprocation of said element for repetitively opening and closing said first-mentioned means, said ejector being connected to said motor and being operable to apply vacuum to said element when said first-mentioned means is opened to permit flow through said ejector and to apply pressure fluid to said element when said first-mentioned means is closed to prevent flow through said ejector.

5. In an additive fluid feed apparatus, in combination, a pump having intake and discharge passages and including a diaphragm arranged to drive said pump in reciprocation by the alternate application of pressure and vacuum to one side thereof, a check valve in said discharge passage, a diaphragm valve in said intake passage adapted to be positively opened and closed by the alternate application of vacuum and pressure to one side thereof, and a single means for simultaneously applying vacuum to the diaphragms of said pump and said intake valve to simultaneously effect the suction stroke of said pump and the opening of said diaphragm valve and alternatively simultaneously applying pressure to said diaphragms to simultaneously effect the pumping stroke of said pump and the closing of said diaphragm valve.

6. Apparatus for feeding additive liquid to a main under pressure comprising a diaphragm pump having intake and discharge passages adapted to be connected, respectively, with a source of additive liquid and with said main; a check valve in said discharge passage; a diaphragm valve in said intake passage adapted to be positively opened and closed by the alternate application of vacuum and pressure to one side thereof; and an hydraulic system for driving said diaphragm pump and operating said diaphragm valve comprising an ejector having an inlet adapted to be continuously connected to a source of liquid under pressure, said ejector being connected to said diaphragm pump and said diaphragm valve; a valve in the discharge of said ejector to control the flow of liquid through said ejector; and means for opening and closing said ejector discharge valve to alternatively apply vacuum and pressure simultaneously to said diaphragm pump and said diaphragm valve to operate said pump and said diaphragm valve.

7. Apparatus for feeding additive liquid to a main under pressure comprising a diaphragm pump having in-

take and discharge passages adapted to be connected, respectively, with a source of additive liquid and with said main; a check valve in said discharge passage; a diaphragm valve in said intake passage adapted to be positively opened and closed by the alternate application of vacuum and pressure to one side thereof; a diaphragm motor for driving said diaphragm pump; an hydraulic system for driving said diaphragm motor and operating said diaphragm valve comprising an ejector having an inlet adapted to be continuously connected to a source of liquid under pressure, said ejector being connected to said diaphragm motor and said diaphragm valve; a valve in the discharge of said ejector to control the flow of liquid through said ejector; and means for opening and closing said ejector discharge valve to alternatively apply vacuum and pressure simultaneously to said diaphragm motor and said diaphragm valve to operate said pump and said diaphragm valve.

8. Apparatus in accordance with claim 7 wherein the ejector discharge valve is a solenoid valve and the means for opening and closing said solenoid valve comprises an electromechanical system including a control device responsive to the volume of flow of liquid in the main.

9. Apparatus in accordance with claim 7 wherein the ejector discharge valve is a normally closed solenoid valve and the means for opening and closing said solenoid valve comprises an electro-mechanical system including a flow

meter disposed in the main and arranged to initiate action to open said ejector discharge valve to effect the suction stroke of the pump and means associated with the pump operative to initiate action to re-close said ejector discharge valve at the end of the suction stroke to effect the discharge stroke of said pump.

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