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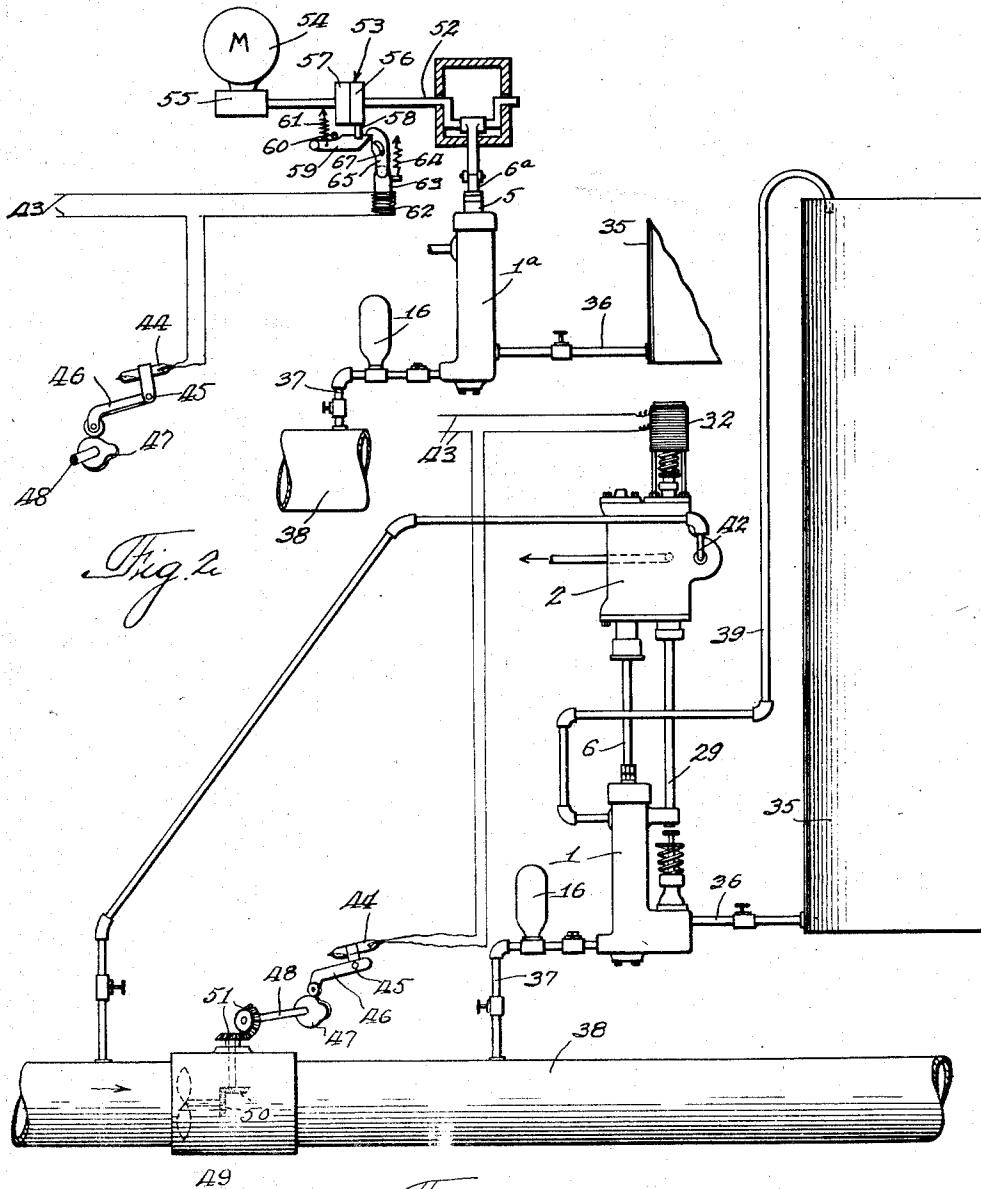
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2,252,939

FEEDING DEVICE

Filed Nov. 4, 1937

3 Sheets-Sheet 1



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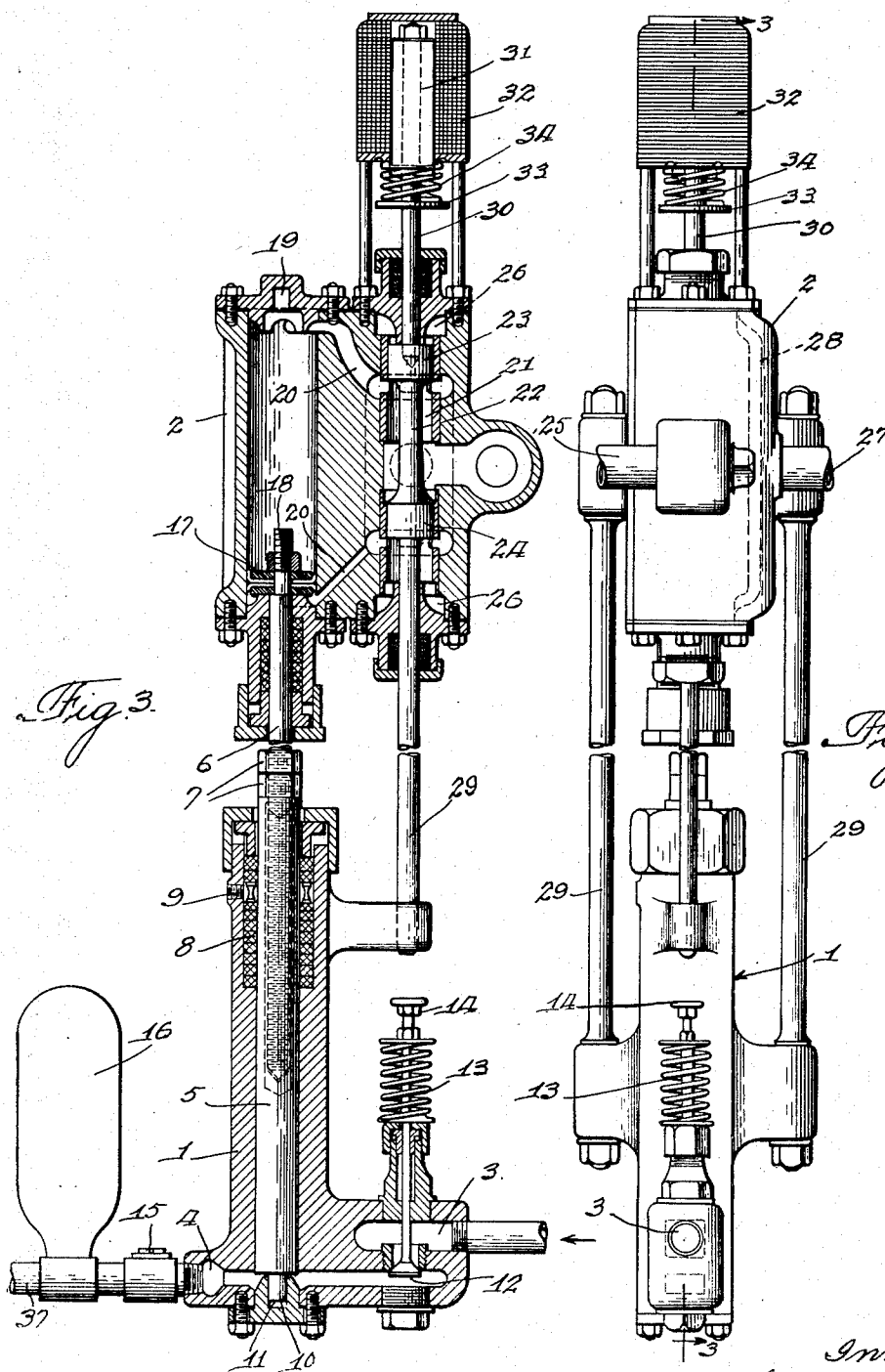
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FEEDING DEVICE

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3 Sheets-Sheet 2



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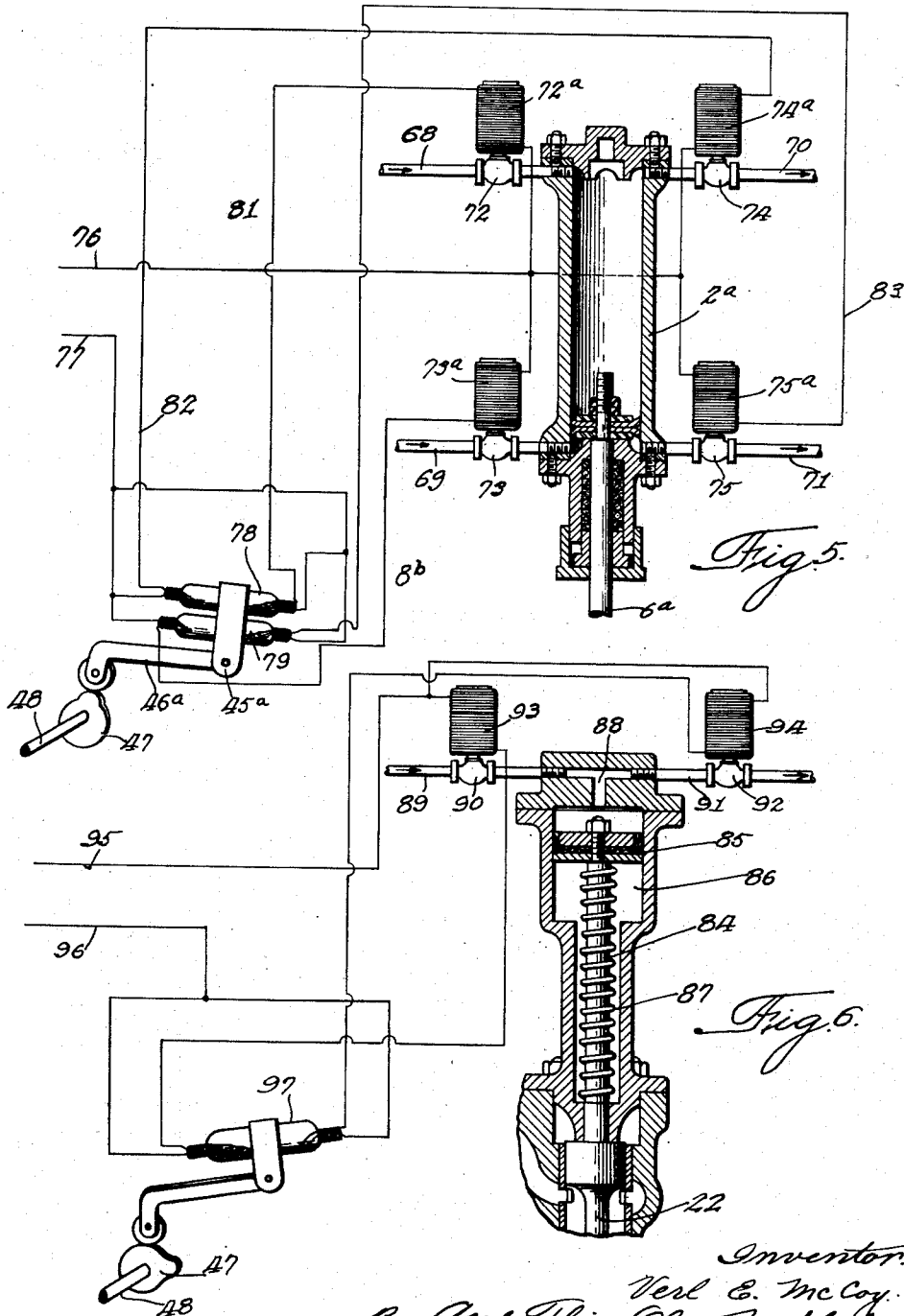
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FEEDING DEVICE

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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FEEDING DEVICE

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Application November 4, 1937, Serial No. 172,687

1 Claim. (Cl. 103—50)

This invention relates to an automatic solution feeding apparatus, and more particularly to a proportional feeding system and pump therefor, arranged to feed one fluid or solution into another fluid in substantially direct proportion to the flow of said second fluid in a suitable conduit.

It is an object of the invention to provide means for proportionally feeding a solution into a fluid pressure conduit in substantially direct proportion to the volume flow of the fluid.

Attempts have been made to use a differential pressure in the fluid system produced by a Venturi tube or other device for producing a vena contracta. However, the differential pressure produced in such a manner does not vary directly with the velocity of the flow, but more nearly as the square of the velocity, so that when such devices are used, there is wide variation in the feed which is not directly proportional to the volume flow in the system.

Various attempts have also been made to use so-called proportional pumps for introducing a solution into a fluid. However, many difficulties have been encountered in that the pumps have not been accurately controlled relative to the volume flow, and these methods have therefore been more or less unsatisfactory.

The present invention provides a solution feeding system and proportional pump therefor, in which the pump may be automatically controlled in direct proportion to the velocity of the fluid, and in such a manner that variations in the velocity cause proportional variations in the operation of the pump whereby the solution injected into the fluid is always substantially in direct proportion to the volume flow.

A further object is the provision of a proportional pump in which convenient means is provided for varying the capacity of the pump.

It is also an object to provide, in a system of the character described, a pump having an electrical control means, and means for operating the electrical control means in direct proportion to the velocity flow of the fluid in a suitable conduit.

Further objects will be apparent from the specification and the appended claim.

In the drawings:

Fig. 1 is a diagrammatic view of a complete solution feeding system and illustrates one embodiment of the invention in which a proportional pump may be intermittently operated by pressure from the fluid conduit or from any other suitable pressure source.

Fig. 2 is a diagrammatic view illustrating another embodiment of the invention in which a suitable pump may be operated by a continuously running motor, and in which the intermittent operation may be electrically controlled by the fluid in a pressure conduit.

Fig. 3 is a vertical sectional view through the proportional pump illustrated in Fig. 1.

Fig. 4 is a side elevation of the pump illustrated in Fig. 3.

Fig. 5 is a diagrammatic view of an electrical system for controlling the pump and illustrates a somewhat modified form of pump and pump control.

Fig. 6 illustrates another slightly modified electrical system for controlling a pump illustrated in Figs. 1, 3, and 4.

Referring to the drawings in detail, the embodiment illustrated in Figs. 1, 3, and 4 comprises a pump having a pump cylinder 1 and a power cylinder 2 with a suitable piston therein for operating a pump plunger in the cylinder 1. The pump is illustrated in detail in Figs. 3 and 4 in which the pump cylinder 1 is provided with an inlet 3 and an outlet 4. A reciprocating pump plunger 5 is mounted in the cylinder as illustrated, and internally threaded for connection to the piston rod 6 whereby the piston rod 6 and the piston 5 may be relatively adjusted. Lock nuts 7 are provided for securing the parts in adjusted relationship. The pump cylinder is provided with a suitable packing 8 to prevent leakage around the piston and a drain outlet 9 communicates with the packing 8 in order to prevent air infiltration into the pump cylinder.

The lower end of the plunger 5 is provided with a reduced cylindrical portion 10 which may extend into a corresponding opening 11 in the cylinder head to provide a shock absorbing cushion for the piston at the limit of its downward stroke. The inlet 3 is provided with a check valve 12 which is normally retained in closed position by means of a spring 13, but it may be opened by pressure on a plunger 14. The outlet 4 is also provided with a check valve 15. A so-called surge chamber 16 may be connected with the outlet of the pump if desired. The piston rod 6 extends into the power cylinder 2 and is provided with a piston head 17. This piston rod is provided with an upwardly extending cylindrical portion 18 which is adapted to enter an opening 19 in the upper cylinder head to provide a cushion for the upward stroke of the pump.

The cylinder 18 is provided at opposite ends with ports 20 communicating with the piston

valve chamber 21 in which is slidably mounted a piston valve 22. The piston valve 22 is provided with valve portions 23 and 24 and may be reciprocated to alternately connect the ports 20, with a pressure inlet 25. By this arrangement, when the piston valve is in the upward position shown, pressure is applied through the upper port 20 to the upper side of the piston 17, and when the piston valve is moved downwardly, the upper port may be connected to an exhaust passage and the lower port connected with the pressure inlet 25 whereby pressure will be applied to the lower end of the cylinder, and the pump piston will be raised.

When the piston valve 22 is in the position illustrated, the pressure inlet 25 communicates with the power cylinder 2 through the valve chamber 21 and the upper port 20, and the lower port 20 communicates with an exhaust passage 26 adjacent the end of the valve casing. When the position of the valve is reversed, the lower port communicates with the pressure inlet, and the upper port 20 communicates with a corresponding exhaust passage 26 adjacent the top of the valve chamber. These exhaust passages 26 communicate with an exhaust outlet 27 by means of a passage 28 illustrated in dotted lines in Fig. 4. It will be apparent that when the piston valve 22 is moved in one direction, the power piston 17 will be moved in the opposite direction and cause a corresponding movement of the pump plunger 5.

The stroke of the power piston 17 and the pump piston 5 may be varied by a suitable adjustment of the threaded connection between the connecting rod 6 and the piston 5 so that the capacity of the pump is changed and any desired proportional amount of solution may be pumped at each stroke in accordance with the adjustment of the pump plunger.

When the valve 22 is moved to its extreme downward position, it causes a suction stroke of the pump piston to draw in a charge of solution through the inlet 3 and the check valve 12. In order that no additional power may be required of the pump on the suction stroke, other than that sufficient to draw in the charge of solution, the piston valve 22 may be provided with a downward extending stem 29, which is positioned in alignment with the end of the plunger 14 of the check valve 12. Therefore when the control valve 22 is moved downwardly to start the upward stroke of the pump piston, the stem 29 automatically opens the check valve 12 against the compression of the spring 13 thereby permitting the solution to freely enter the pump chamber. Whenever the valve 22 is moved to the upward position shown, the pump piston is caused to move downwardly thereby forcing the pump charge out of the pump cylinder through the check valve 15.

The piston valve 22 is also provided with an upwardly extending rod 30 on which is mounted a portion 31 adapted to provide an armature for a solenoid 32. A disc 33 may be secured to the rod 30 and compression spring 34 is provided between the disc and the solenoid 32. It will therefore be apparent that when the solenoid 32 is energized the valve piston 22 will be raised to the position shown, and when the solenoid is deenergized the piston valve will be moved to its extreme downward position by means of the spring 34.

The pump and other elements of the proportional system may be arranged as illustrated in

Fig. 1. That is, the pump inlet 3 may be connected to a solution tank 35 by means of a conduit 36, and the pump outlet 4 may be connected, by means of a conduit 37, to a fluid pressure conduit 38 in which it is desired to inject an amount of solution directly proportional to the volume flow therein. Also the outlet 9 adjacent the pump packing 8 may be connected to a return pipe 39 which may communicate with the solution tank 35. The pressure inlet 25 for the power cylinder 2 may be connected by means of a suitable conduit 40 to the fluid conduit 38 to receive pressure therefrom for operating the pump. However, if desired, the power inlet 42 may be connected to any suitable pressure source. It also will be understood that the pump may be operated by either pneumatic pressure or hydraulic pressure if desired.

In order to control the solenoid 32 so that the pump will intermittently be operated to inject solution proportional to the volume flow, an electrical circuit comprising conductors 43 may be connected to any suitable source of electrical power, and one of these conductors may be provided with a switch 44 for making and breaking the circuit. This switch preferably comprises the usual mercury tube having contacts therein and which may be pivotally mounted at 45 on a cam lever 46. This cam lever is provided with a roller resting on a cam 47 which is in turn secured to a shaft 48. The shaft 48 may be driven from a suitable flow meter, which in the present embodiment comprises a propeller 49 positioned in the path of the fluid flow through the conduit 38. The propeller 49 is arranged to rotate the cam shaft 48 by means of suitable beveled gears 50 and 51, and in accordance with the velocity of the fluid in the conduit 38.

Fig. 2 illustrates another embodiment of the invention in which the pump piston 5 is provided with a piston rod 6a which may be connected to a crank shaft 52 as shown. The crank shaft 52 is driven through a suitable clutch 53 by means of a continuous running motor 54 and a speed reducing mechanism 55. The clutch 53 is normally disengaged and comprises a driving member 56 and a driven member 57. The clutch is preferably of a type which may be automatically controlled to permit only one revolution when desired. In the embodiment illustrated, the clutch comprises the usual dog controlled clutch in which the dog is provided with an outwardly extending arm 58 which normally rests on a detent lever 59 which latter is retained against a stop 60 by means of a spring 61. In this position the clutch is disengaged. In order to permit the engagement of the clutch, a solenoid 62 is provided with an armature 63 which is normally held in the position shown by means of a spring 64. The armature is provided with a pawl 65 which is movable with the armature, and which is provided with a slot 66. When the solenoid 62 is energized, the pawl 65 which engages the end of the detent 59 is moved by the armature to release the dog arm 58 and permit the engagement of the clutch. A fixed pin 67 extends into the slot 66 and during the movement of the pawl 65 to cause engagement of the clutch, the pawl is moved laterally to release the detent 59 which immediately returns to the position shown and disengages the clutch after a single revolution. The solenoid 62 may be connected to the controlling switch 44 by means of the conductors 43 in the same manner as previously described for the embodiment illustrated in Fig. 1.

Fig. 5 illustrates a slightly different embodiment in which the piston valve for controlling the pump may entirely be eliminated and the admission of pressure to the power cylinder 2a may be controlled by independent electrically operated valves which selectively control the inlet ports and the exhaust ports. The embodiment shown comprises pressure inlet conduits 68 and 69 and corresponding exhaust outlets 70 and 71. The pressure inlets are provided with suitable electrically operated valves 72 and 73, and the exhaust outlets are similarly provided with electrically operated valves 74 and 75. These valves may be electrically controlled by suitable solenoids as shown. In the embodiment illustrated, one terminal of each of the solenoids is connected to a suitable conductor 76 and the opposite terminals may be connected to a conductor 77 through suitable switches 78 and 79. The conductors 76 and 77 are connected to any suitable power source. The switches 78 and 79 may be two-way switches of any suitable type, preferably of the "mercury tube" type in which contacts are provided at each end of the tube, and the respective contacts at each end are electrically connected when the tube is tilted in a corresponding direction.

The switches are suitably mounted on a cam lever 46a which may be pivoted at 45a and the cam lever is provided with a suitable roller resting on the cam 47, which latter is controlled by the flow meter previously described. The solenoid 73a controlling the power inlet valve 73 may be connected to conductor 77 through the conductor 80 and switch 79, and the solenoid 72a controlling the valve 72 may be connected to the conductor 77 by means of conductor 81, and switch 78, the valves being so positioned relative to the control solenoids that, with the switches in the position shown, the solenoid 72a will be energized and the corresponding inlet valve 72 will therefore be open to admit pressure to the cylinder. Also the solenoid 73a will be deenergized and its corresponding inlet valve 73 will be closed. The exhaust valve solenoid 74a is connected to the conductor 77 by means of a conductor 82 and switch 78, and the valve solenoid 75a may be connected to the conductor 77 by means of a conductor 83 and switch 79.

With the switches in the position illustrated, the pressure inlet solenoid 72a and the exhaust solenoid 75a are energized and their corresponding valves 72 and 75 are therefore open. At the same time the pressure inlet solenoid 73a and the exhaust solenoid 74a are deenergized and their corresponding valves 73 and 74 are closed, and therefore the piston will remain in its downward position shown, and the pump will not operate until the switches 78 and 79 are tilted in reverse direction. When the switches 78 and 79 are tilted in the opposite direction in response to the operation of the flow meter, the operating conditions of the solenoids will be reversed and therefore the pressure inlet valve 73 and exhaust valve 74 will open, and the pressure inlet valve 72 and the exhaust valve 75 will close and the piston 17 will be raised to provide a suction stroke of the pump. As soon as the switches are again tilted a pressure stroke of the pump will take

place, which will inject a charge of solution into the fluid pressure conduit in proportion to the volume flow therein.

Fig. 6 illustrates another embodiment of the invention in which a somewhat modified electrical means is provided for operating the slide piston valve 22 illustrated in Fig. 3. In this embodiment the piston valve is provided with an upwardly extending stem 84 having a piston head 85 thereon operating in a cylinder 86. A compression spring 87 is provided to normally hold the piston in its raised position as shown. The cylinder 86 is provided with a pressure and exhaust passage 88 to which is connected a pressure inlet conduit 89 having a controlling valve 90. An exhaust conduit 91 is also connected to the passage 88 and provided with an exhaust valve 92. The valves 90 and 92 may be provided with solenoids 93 and 94 respectively for operating the valves. One terminal of these solenoids is connected to a suitable electrical power source by means of a conductor 95 and the opposite terminals of the solenoids are connected to a power conductor 96 by means of a two-way switch 97 which is mounted for control by the previously described flow meter in the same manner as shown in Fig. 5.

With the switch 97 in the position illustrated, the exhaust solenoid 94 is deenergized and the power inlet solenoid 93 is energized. Therefore the exhaust valve 92 is open and the pressure valve 90 is closed, and the piston will remain in the raised position. When the switch 97 is tilted in response to the operation of the flow meter, the condition of the valves is reversed, and the valve 90 will be closed and pressure admitted to force the piston valve downwardly against the compression of the spring 87. When the switch is tilted in the reverse direction the condition of the valves will again be reversed and the spring 87 will raise the piston.

It will be apparent that the embodiments illustrated in Figs. 5 and 6 are arranged to cause the intermittent operation of the pump directly in proportion to the velocity of the fluid in the conduit 38 and therefore the solution injected will be directly proportional to the volume flow therein.

Modifications may be made by those skilled in the art, and it is desired therefore that the invention be limited only by the prior art and the scope of the appended claim.

Having thus described this invention, what is claimed and desired to be secured by Letters Patent is:

A proportional pump comprising a cylinder, having an inlet and an outlet adjacent one end, a reciprocable piston in said cylinder, a check valve in said inlet, a check valve in said outlet, means for intermittently operating said piston, control means for said operating means, and means operated by said control means to open said inlet check valve substantially instantly and simultaneously with the start of the suction stroke of said piston irrespective of the length of stroke, and adjustable means to vary the length of stroke of said piston.

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