March 17, 1970 G. J. GREENE, JR 3,500,753

INJECTION PUMP APPARATUS

Filed April 16, 1968 2 Sheets-Sheet 1

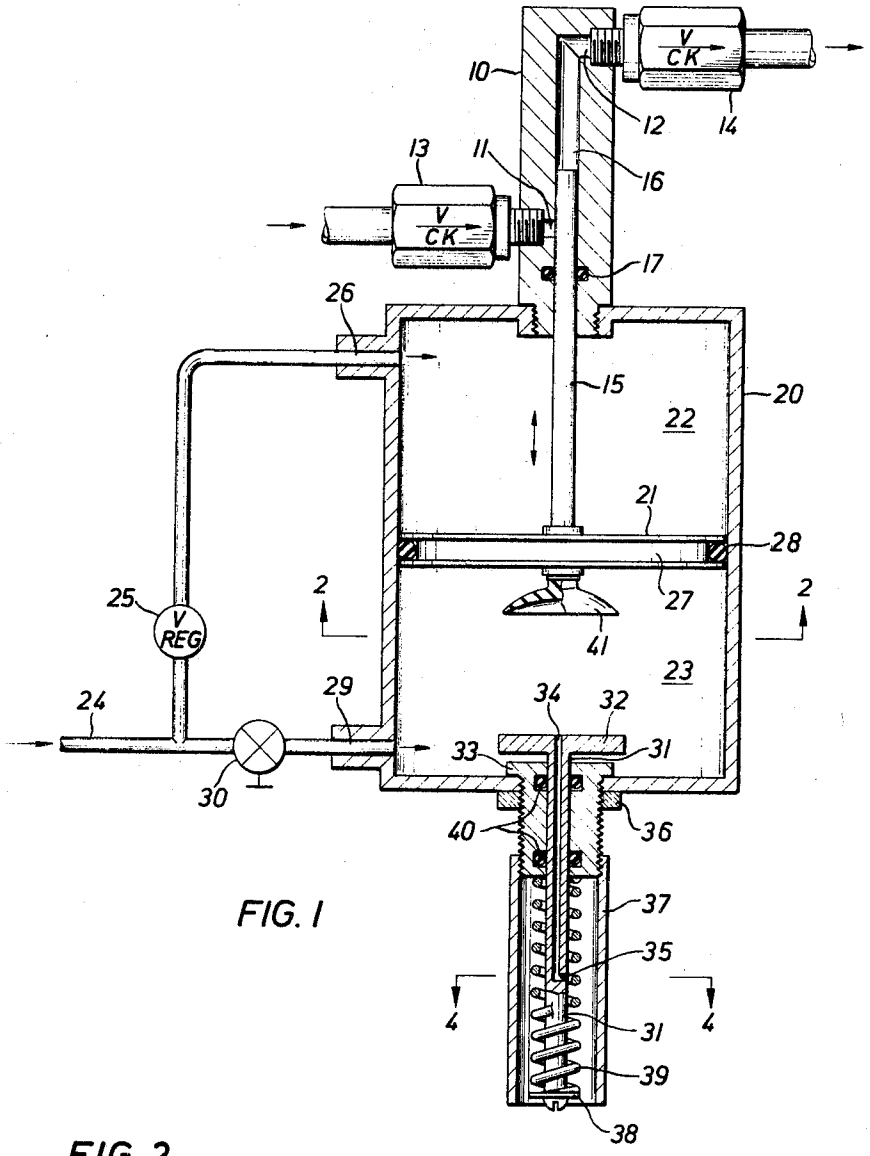
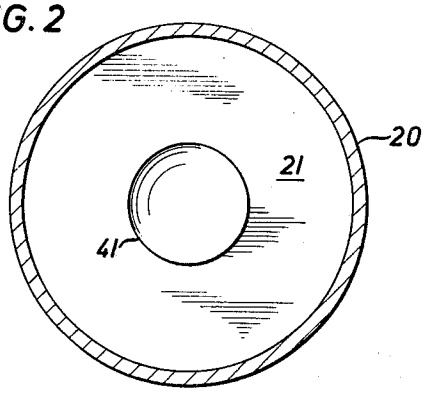


FIG. 1

FIG. 2



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INJECTION PUMP APPARATUS

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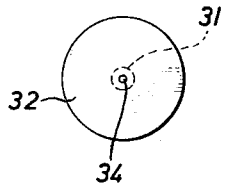

FIG. 3

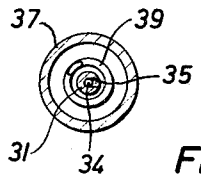

FIG. 4

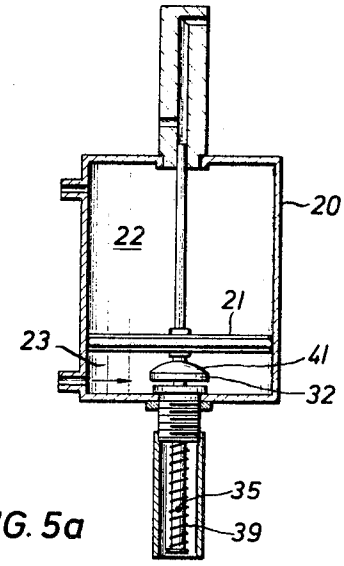

FIG. 5a

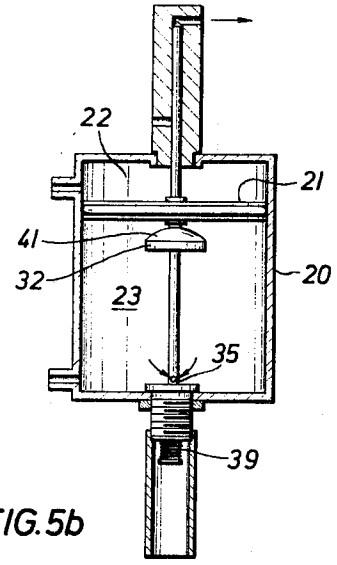

FIG. 5b

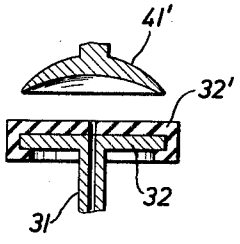

FIG. 6

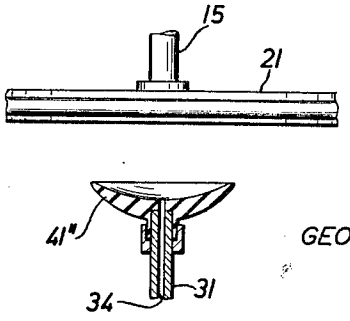

FIG. 7

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INJECTION PUMP APPARATUS

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Int. Cl. F04b *17/00;* F01l *15/02*
U.S. Cl. 103—50 17 Claims

ABSTRACT OF THE DISCLOSURE

This application discloses an injection pump operated by a fluid motor, with a valve assembly for the fluid motor which includes a vent tube functioning to control pressure build-up and venting on one side of the piston. The vent tube is axially moveable and is engaged by the piston of the fluid motor using a resilient cup which contacts the head of the vent tube and covers the vent hole.

Injection pumps are commonly used for metering a controlled amount of a liquid into a line on a continuous basis. The location of the line may be such that a convenient power source is not available, and the site may be inspected very infrequently. So, the motive power mechanism used for the injection pump must use a power supply readily transportable or available at the site, and the mechanism itself must be able to operate for long periods of time without maintenance or adjustment.

Pressurized gas has been found to be a preferred motive power source for injection pumps of this type, since a supply of gas is often available at the location for other purposes, or may be easily provided by a tank of pressurized air. The gas is used to operate the piston in a fluid motor, the piston of course being mechanically coupled to the plunger of the injection pump. A valve arrangement is needed to control the operating cycle of the fluid motor and the arrangement must provide for variable pumping rates or cycle times.

Valve mechanisms for fluid motors of this type, for operation of injection pumps, have been quite widely used; however, such pumps have had the disadvantage of including a relatively complex valve mechanism for controlling the cycle of the motor. Primarily, the disadvantages of such devices have been the lack of reliability for operation over long periods of time, and a likelihood of being fouled by debris, etc.

It is the primary feature of this invention to provide a motive power mechanism for an injection pump, pri marily a fluid motor having a valve assembly which is reliable for operation in remote locations over long periods of time, and which permits variation of the pumping rate with rather close control.

In accordance with one embodiment of this invention, a fluid motor for operating the plunger of an injection pump is provided with a valve assembly which includes a vent tube operable to cause pressure buildup on, and venting, one side of a piston in the fluid motor, in alternate half cycles. Movement of the vent tube is controlled by a resilient cup which engages a flat plate-like head of the vent tube. A vent passage extends through the vent tube from the head to a vent aperture which is open to atmosphere when the tube is in the outward position, then is open to the interior of the cylinder when the piston pulls the tube inward. The cup thus holds the vent head, then releases, as the piston moves back and forth. Either the cup or the plate may be slightly resilient to facilitate sealing.

Novel features which are believed to be characteristic of the invention are set forth in the appended claims.

The invention itself, however, as well as further features and advantages thereof, may best be understood by reference to the following detailed description of particular embodiments, when read in conjunction with the accompanying drawing, wherein:

FIGURE 1 is an elevation view in section of an injection pump and fluid motor according to one embodiment of the invention;

FIGURE 2 is a sectional view of the apparatus of FIGURE 1, taken along the line 2—2 in FIGURE 1;

FIGURE 3 is a top view of the valve plate in the apparatus of FIGURE 1;

FIGURE 4 is a sectional view of a portion of the valve assembly in the apparatus of FIGURE 1, taken along the line 4—4 in FIGURE 1;

FIGURES 5*a* and 5*b* are simplified sectional views of the apparatus of FIGURE 1 to show the steps in the operation;

FIGURE 6 is a detail view in section of the cup and plate assembly in another embodiment of the apparatus of FIGURE 1; and

FIGURE 7 is a detail view of another embodiment of the cup and plate arrangement.

It will be noted that like parts appearing in several views of the drawings will bear like reference numerals. The drawings are considered a part of this specification and are incorporated herein.

With reference now to FIGURE 1, an injection pump along with a fluid motor for driving the pump is illustrated. The pump itself comprises a cylindrical pump housing **10** having an inlet port **11** and outlet port **12**. One-way check valves **13** and **14** are connected to the inlet and outlet ports to permit fluid flow only in the direction indicated. The inlet is connected through the check valve to a source of liquid supply which may be under pressure or may be static. The outlet is connected through the check valve **14** to the line or chamber into which the liquid is to be injected at a controlled rate. A rod **15** extends into a central cylindrical bore or chamber **16**, and reciprocating movement of the rod **16** produces the pumping function. When the rod **15** moves downward, a reduced pressure exists in the chamber **16** so that fluid will be drawn in the port **11** through the check valve **13**. The check valve **14** will prevent return of liquid through the outlet port **12**. In this manner, the bore **16** will be filled with liquid from the supply during the downward stroke of the piston **15**. Then, when the piston **15** is moved upward, an increased pressure existing in the bore **16** will cause the check valve **13** to close, while the check valve **14** will permit the liquid to flow through the outlet port into the chamber or line where it is utilized. The diameter of the rod **15** is somewhat smaller than the inside diameter of the bore **16** so that liquid may be still drawn in through the inlet port **11** even though the top of the rod **15** is higher than the port **11**. Sealing is provided by an O-ring **17**. Thus, during the pressure stroke, or upward stroke of the rod **15**, liquid will not be forced down along the sides of the rod **15** past the O-ring seal.

For a given diameter of the piston **15**, and a given length of stroke, it is thus seen that a fixed amount of liquid will be pumped for each stroke. Injection pumps of this type are used for metering the amount of a chemical in liquid form injected into a pipeline which carries a petroleum product, or for similar operations. In any event, the device is capable of operating at quite high pressures, 6,000 p.s.i. or more in a typical embodiment, and is able to inject controlled amounts of from a few pints or less per day up to many hundreds of gallons per day, depending upon the stroke rate and diameter of the piston **15**. The fluid motor which provides the primary feature of the invention as described below, provides a

nechanism for producing a controlled reciprocating movenent of the rod **15**.

The fluid motor comprises a large cylindrical chamber 20 which has a floating piston **21** positioned therein. The piston **21** is free to move in an up-and-down reciprocating motion within the cylinder **20**, and the rod **15** which functions as the piston of the injection pump is connected to this piston and moves therewith. The piston **21** divides the cylinder **20** into an upper chamber **22** and a lower chamber **23**, and so, of course, movement of the piston will be dependent upon the pressure differential between these chambers **22** and **23**. In one embodiment, a fixed pressure of a fairly low value of about 4 p.s.i. is maintained in the upper chamber **22** by a gas supply **23** connected through a regulator valve **25** to an inlet port **26**. The pressure at the gas supply **24** may be, for example, 25 p.s.i., although this value is not critical. The regulator valve **25** is of conventional design and merely functions to maintain a constant low pressure in the upper chamber **22**.

The piston **21** is a circular disc having a peripheral groove **27** into which fits an O-ring **28** functioning to seal the upper and lower chambers **22** and **23** from passage of gas from one to the other. This sealing becomes necessary when the cycle time is very lengthy, sometimes approaching an hour, wherein a slight amount of gas leakage would be quite objectionable.

Pressurized gas is admitted to the lower chamber **23** through an inlet port **29** which is connected to the gas supply **24** through a valve **30**. The setting of the valve **30** determines the cycle time of the fluid motor by determining the pressure admitted to the lower chamber. Depending upon the setting of the valve **30**, pressurized gas will be continually admitted to the lower chamber; however, in the condition illustrated in FIGURE 1 the lower chamber **23** will be vented to atmosphere through the valving assembly.

The valve arrangement includes an elongated rod or tube **31** having a flat circular plate or head **32** fixed to the top, the rod **31** extending through a valve fitting **33**. A vent passage **34** extends from the top of the plate **32** through the rod **31** a substantial length to terminate at a hole **35** located a distance along the rod about equal to the stroke of the piston **21**. In the position shown the lower chamber **23** is vented to atmosphere through the passage **34** and the hole **35**. The remainder of the valve assembly may include a nut or other fastening means **36** holding the fitting **33** in place, along with a cylindrical shield **37** which merely functions to prevent mechanical damage to the rod **31**. A flange **38** is positioned at the lower end of the rod **31** to engage a spring **39** which is in compression between the flange **38** and the lower end of the fitting **33**.

A pair of O-ring seals **40** surround the rod **31** within the fitting **33** to prevent escape of pressurized gas along the rod. These sealing O-rings prove an important feature of the invention as will be explained in relation to the operation of the unit.

The control mechanism for the fluid motor includes the valve stem or rod **31** along with the plate **32**, which is engaged by a resilient cup **41** fixed to the lower side of the piston **21**.

In operation, the fluid motor mechanism may be first observed when in the condition of FIGURE 1, that is, with the valve member **31** in the lower position as shown, the vent passageway **34** being open to prevent any buildup of pressure in the lower chamber **23**. Thus the pressurized gas in the upper chamber **22** admitted through the regulator valve **25** will force the piston **21** in a downward direction at a fairly low rate. During this downward stroke, the withdrawal of rod **15** from the chamber **16** will cause the chamber **16** to fill with the fluid being pumped, through the check valve **13**. Gas will continue to be admitted through the inlet **29** to the lower chamber **23**, but there will be no pressure buildup due to the vent **34** through the rod **31** and the hole **35**.

In the next step, the piston **21** will reach its lowermost position as seen in FIGURE 5*a*, wherein the cup member **41** will come into engagement with the top of the plate **32**. This will close the vent passageway **34** and prevent any more of the gas in the lower chamber **23** from escaping. A slight buildup of pressure in the chamber **23** will now cause a pressure differential across the cup member **41** so that it will compress slightly against the plate **32** and will be held firmly in engagement therewith.

Now, as the vent to atmosphere remains closed as it is covered by the cup member **41**, pressure will continue to build up in the lower chamber **23**, soon exceeding that in the upper chamber **22**. At this point, the piston **21** will begin to move in the upward direction. Movement of the rod **15** upward applies pressure to the fluid in chamber **16**, closing the the check valve and opening the outlet valve **14**. Due to the large difference in diameters of the piston **21** and the rod **15**, a relatively small pressure differential in the lower chamber **23** over the upper chamber **22** can cause a very large pumping pressure in the chamber **16**.

As the piston **21** continues to move upward, it will pull the valve rod **31** and plate **32** along with it since the cup **41** will continue to engage the plate **32**. The spring **39** will be compressed as the rod **31** moves upward, but the large pressure differential across the cup **41** and the plate **32** will prevent the rod **31** from being pulled downward, this pressure differential increasing as the pressure in the lower chamber **23** increases.

As the piston **21** approaches the top of its upward stroke, the rod **31** will be raised to an extent such that the hole **35** will pass upward through the fitting **33** to a position so that the hole **35** is exposed above the top of the bore **34**. This is the position illustrated in FIGURE 5*b*. At this point, the pressure differential across the cup **41** will be destroyed by pressurized gas entering the hole **35** and passing upward through the bore **34** into the lower side of the cup **41**. Then, the cup **41** will no longer hold the plate **32**, so the compressed spring **39** will force the rod **31** downward to resume the position shown in FIGURE 1. This will cause the lower chamber to be vented to atmosphere through the passageway **34** since the hole **35** will now be below the valve fitting and so the piston **21** will begin its downward stroke.

Referring now to FIGURE 6, a slightly modified version of the invention is illustrated wherein the cup **41'** is composed of metal or other rigid material, and the plate **32** includes a slightly resilient covering **32'** which functions to provide the seal to permit the cup **41'** to engage the plate and pull the rod **31** upward. The covering **32'** may be composed of neoprene or Teflon, for example.

Rather than use a gas at a low pressure in the chamber **23** to force the piston **21** downward on the return stroke, a spring surrounding the rod **15** and extending from the top of the cylinder **20** to the top of the piston **21**, may be employed. The spring would be designed to exert a rather light pressure, equivalent to that produced by about 4 p.s.i. gas pressure in the chamber **22**.

Depending of course upon the pressure at the supply **24**, and the setting of the regulator **25**, as well as the liquid pressure against which the pump **10** is acting, the mechanism of FIGURE 1 may be adjusted by varying the setting of the valve **30** to provide a wide variety of pumping rates or volume of liquid output from the injection pump **10**. For example, for a pump piston diameter, i.e., diameter of the rod **15**, of ⅛ inch the volume output per day might be varied from about 1 pint to 2 or 3 gallons. By increasing the pump piston size, larger volumes may be provided. For example, with a diameter of the rod **15** of 2 inches, the liquid output volume per day may be varied up to 600 gallons, this also requiring a

higher gas supply pressure at the line **24**. The variation in pumping rate for a pump of a given size, is controlled by the speed of the upward stroke, the downward stroke remaining about the same. For example, the upward stroke might be varied from a few seconds up to perhaps one or two minutes by means of the valve **30** in a small unit, or almost an hour in a large unit.

In FIGURE 7, an embodiment of the invention is shown wherein the resilient cup **41''** is mounted in the head of the vent tube **31**, rather than on the piston **21**. Here the flat lower surface of the piston functions as the plate.

While the invention has been described with reference to particular embodiments, it is understood that this description is not meant to be construed in a limiting sense. various modifications of the disclosed embodiments, as well as other embodiments of the invention, may be apparent to persons skilled in the art upon reference to this description.

What is claimed is:

1. A pneumatic motor for operating an injection pump comprising:

cylinder means with piston means moveable therein with means mechanically coupling the piston means to the pumping element of the injection pump,

means for biasing the piston means toward one end of the cylinder means,

means for supplying fluid under pressure to said one end of the cylinder means,

valving means at said one end of the cylinder means operative to vent the cylinder means during part of the cycle of the piston means and to seal the cylinder means during the other part, the valving means including

an elongated vent tube having a head to releasably engage one side of the piston means, the vent tube being axially moveable and extending through said one end of the cylinder means, the cylinder means being sealed when the head of the vent tube engages the side of the piston means and being vented when the head of the vent tube is released from the side of the piston means.

2. Apparatus according to claim **1** wherein the vent tube is a plate-like member, and a cup-like member is positioned on said one side of the piston means for engagement with the plate-like member.

3. Apparatus according to claim **2** wherein a vent passage extends along a substantial length of the vent tube, the vent passage communicating with the space between the cup-like member and the plate-like member and extending to a vent position spaced substantially along the tube.

4. Apparatus according to claim **3** wherein at least one of the cup-like member and the plate-like member includes at least a resilient surface.

5. Apparatus according to claim **4** wherein the cup-like and plate-like members are held in engagement during part of the cycle of the piston means by fluid pressure differential.

6. Apparatus according to claim **5** wherein the cup-like and plate-like members are held in engagement when the vent position of the vent tube is external of the cylinder means and are released when the vent position is drawn interior of the cylinder means.

7. Apparatus according to claim **6** wherein the vent tube is biased toward an outward position.

8. Apparatus according to claim **7** wherein the means for biasing the piston means toward one end of the cylinder means includes a supply of gas under pressure, while gas at a higher pressure is supplied to said one end of the cylinder means.

9. Apparatus according to claim **8** wherein the injection pump includes a chamber with a plunger moveable therein, along with an inlet port connected to a liquid supply through a check valve and an outlet port connected to a utilization chamber through another check valve, and wherein the plunger is a rod integrally connected to the piston means of the pneumatic motor.

10. Valve means for a fluid-operated piston within a chamber, comprising:

an elongated vent rod extending into one end of the chamber, the rod having an internal vent passage extending from adjacent its internal end to a vent aperture spaced substantially therefrom,

releasable engagement means associated with the internal end of the vent rod and with the side of the piston adjacent said one end of the chamber, the engagement means including mating surfaces, the vent passage of the vent tube communicating with the space between the mating surfaces, the engagement means being held while in engagement by fluid pressure differential when the vent aperture of the rod is external of the chamber and being released when the vent aperture is drawn interior of the chamber.

11. Apparatus according to claim **10** wherein the vent tube is biased toward a position external of the chamber.

12. Apparatus according to claim **11** wherein the vent tube is biased by a spring generally coaxially with the tube.

13. Apparatus according to claim **10** wherein at least one of the mating surfaces is provided by a resilient member.

14. Apparatus according to claim **10** wherein the pair of mating surfaces is provided by a cup-like member and a plate-like member.

15. Apparatus according to claim **14** wherein the cup-like member is mounted at said one side of the piston, and the plate-like member provides the head of the vent tube.

16. Apparatus according to claim **10** wherein the vent tube extends through the end of the chamber through sealing means.

17. Valve means for gas-operated piston means within a chamber, comprising:

an elongated vent rod extending into one end of the chamber, the rod having a vent passage extending from adjacent its internal end to a vent aperture spaced substantially therefrom.

releasable engagement means associated with the internal end of the vent rod and with the side of the piston means adjacent said one end of the chamber, the engagement means including mating surfaces, the vent passage of the vent tube communicating with the space between the mating surfaces, the engagement means being held while in engagement by gas pressure differential when the vent aperture of the rod is external of the chamber and being released when the vent aperture is drawn interior of the chamber.

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WILLIAM L. FREEH, Primary Examiner

U.S. Cl. X.R.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,500,753 Dated March 17, 1970

Inventor(s) George J. Greene, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 59, delete "on".

Column 1, line 60, before "one" insert -- on --.

Column 2, line 40, change "16" (second occurrence) to -- 15 --.

SIGNED AND
SEALED
AUG 11 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents