

Jan. 20, 1959

A. S. LIMPert ET AL
LIQUID PROPORTIONING PUMP

2,869,467

Filed May 15, 1956

3 Sheets-Sheet 1

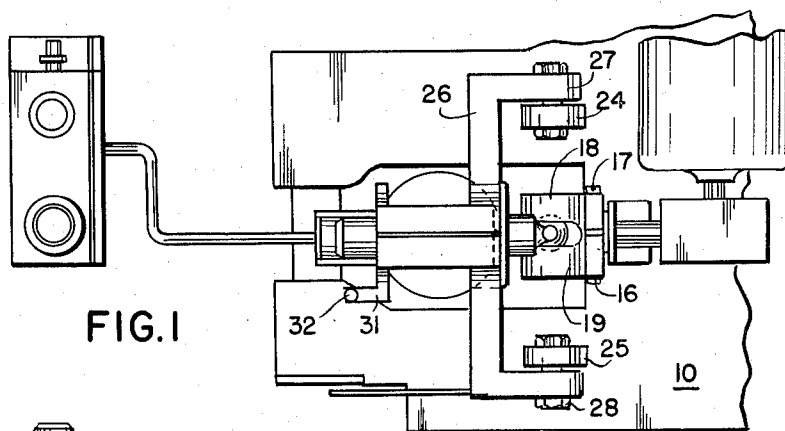


FIG. 1

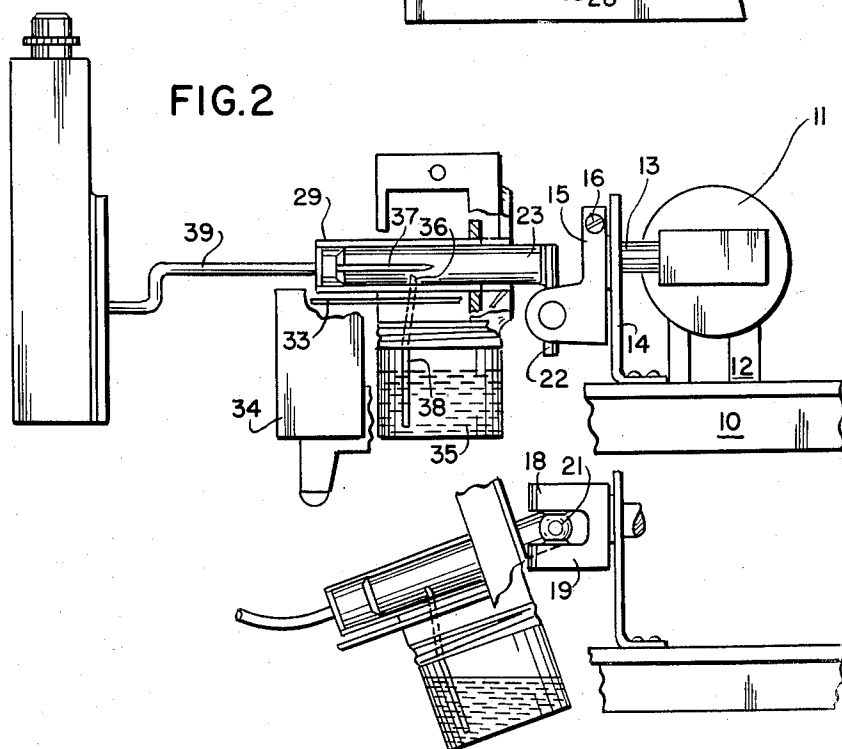


FIG. 2

FIG. 3

INVENTORS.
Alexander S. Limpert
Robin J. Limpert
by
Joseph F. Fallon
ATTORNEY

Jan. 20, 1959

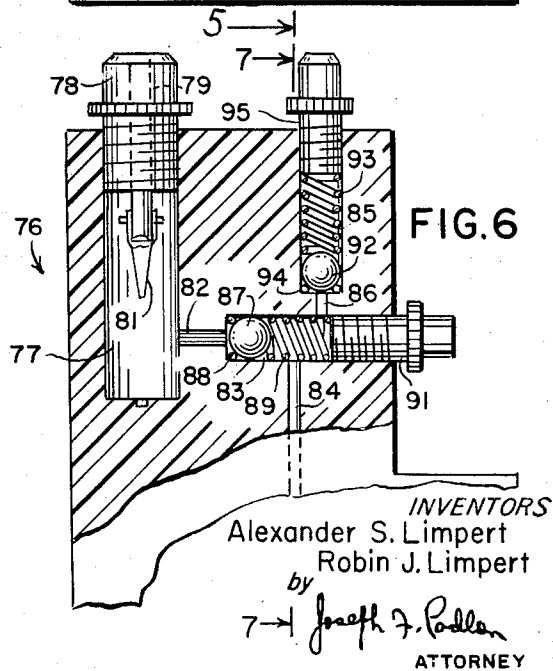
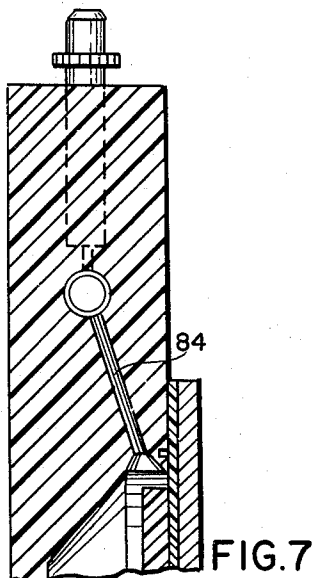
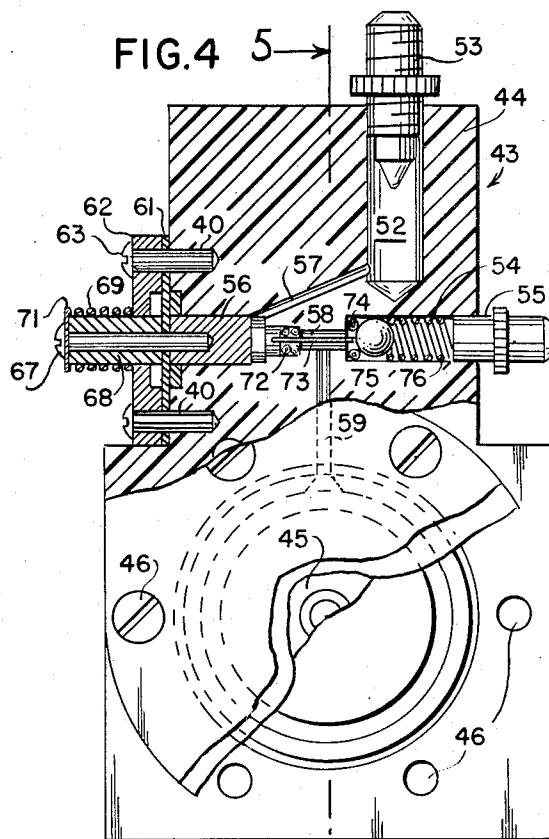
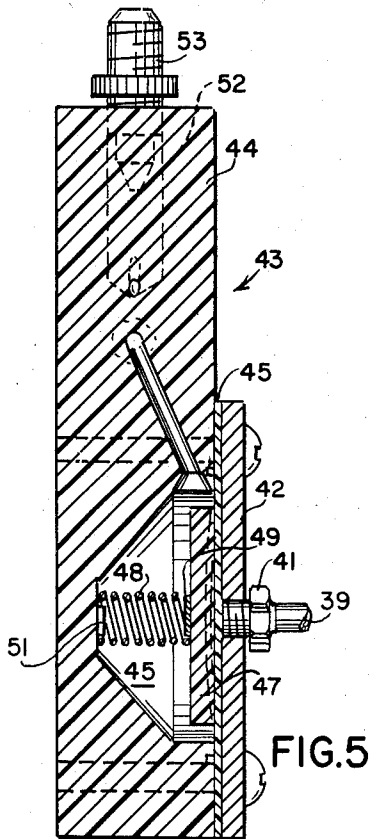
A. S. LIMPERT ET AL

2,869,467

LIQUID PROPORTIONING PUMP

Filed May 15, 1956

3 Sheets-Sheet 2



INVENTORS
Alexander S. Limpert
Robin J. Limpert
by Joseph F. Rodden
ATTORNEY

2,869,467

LIQUID PROPORTIONING PUMP

Alexander S. Limpert and Robin J. Limpert,
Bay Shore, N. Y.

Application May 15, 1956, Serial No. 585,100

12 Claims. (Cl. 103—37)

The present invention relates to pumping mechanisms for feeding or metering liquids at predetermined rates.

As is well known, certain fluid systems in use at the present time require that small quantities of chemical liquids be supplied thereto at fixed rates. Very often these chemical liquids are strong acids and alkalies that must be metered or fed to the fluid system in predetermined quantities and in carefully measured proportions. It is to this function that the present invention is directed.

Accordingly, an object of the present invention is to provide an improved metering or proportioning pump that is efficient, accurate and dependable in operation.

Another object of the present invention is to provide an improved proportioning pump for feeding liquids at predetermined rates and wherein the rate of feed may be adjusted while in operation.

Another object of the present invention is to provide an improved proportioning pump that is capable of operating against pressures that vary from atmospheric to very high.

Another object of the present invention is to provide a metering or measuring device which collects a definite amount of the liquid to be pumped and then quickly releases it through a siphon.

Another object is to provide a hydraulic pressure inducing means for actuating a diaphragm, said pressure inducing means operating without the conventional poppet, disc or other seated type of valves, and using instead a rotating and reciprocating piston operating in a cylinder. The motion of the piston being such, and the design being such as to open and close a single cylinder port at the proper part of its reciprocating stroke. Thus valve leakage, sticking, etc., are eliminated and perfect timing of the hydraulic pressure inducing pump is obtained.

Another object is to provide mechanical power operation of the inlet and outlet valves for the chemical liquid side of the pump, through the medium of a timed lever and cam.

Another object is to provide means for quick removal and replacement of the chemical diaphragm unit, without disturbing the hydraulic oil pressure inducing piston and cylinder unit.

A further object of the present invention is to provide a proportioning or metering pump wherein trapped air bubbles that might cause erratic volume are eliminated.

In accordance with these and other objects, the present invention contemplates a dual pumping system. The first pump is of the cylinder piston type wherein the piston is driven by an electric motor and the cylinder is in communication with a reservoir of oil or other lubricant. As the piston reciprocates, oil is pumped to a diaphragm which comprises the second pump of the dual system. The reciprocation of the piston will cause periodic flexing of the diaphragm by means of the oil pressure on one side thereof. The other side of the diaphragm communicates with a chamber that forms part of the chemical liquid pumping system. The diaphragm in effect sep-

arates the oil pumping system from the liquid pumping system. The piston cylinder pump is of the rotating piston type in which the cylinder can be set at an angle to vary the stroke of the piston. In this way the volume of the oil against the diaphragm can be conveniently and accurately adjusted so that the quantity of liquid fed by the diaphragm pump can be predetermined.

The diaphragm chamber is closed, except for valve openings, by the flexible diaphragm held in place by a heavy plate. Oil from the piston pumping mechanism is supplied through the plate and can thus flex the diaphragm which is returned by a compression spring in the diaphragm chamber.

The invention will be more fully understood from the following description of a specific embodiment thereof taken with the drawings in which:

Fig. 1 is a plan view of the proportioning pump of the present invention;

Fig. 2 is a side elevation of the pump of Fig. 1;

Fig. 3 is a side elevational view similar to Fig. 2 showing the piston and cylinder disposed at an angle to increase the piston stroke;

Fig. 4 is a front view of the diaphragm chamber;

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 4;

Fig. 6 is a front view of a modified diaphragm chamber;

Fig. 7 is a sectional view taken on the line 7—7 of Fig. 6;

Fig. 8 is an elevational view of a modification of the present invention wherein a constant stroke piston pump is employed and a regulating cylinder determines the amount of oil volume against the diaphragm;

Fig. 9 is a detailed view of the cam operated valve mechanism used in the modification shown in Fig. 8; and

Fig. 10 is a sectional view of a metering or measuring device.

Referring now to the drawings and more particularly to Figs. 1 and 2, numeral 10 represents a base which may be made of cast iron and serves to support the pumping mechanism. A motor with gear reduction 11 is mounted on the base by means of brackets 12 and has a shaft 13 to the end of which a coupling 15 is secured by means of screw 16 and nut 17, said coupling rotating with the motor shaft. A pair of lugs 18 and 19 of the coupling support an apertured ball 21 which is located or seated in depressions on the inner surfaces of the lugs. A sliding fit is provided between the ball 21 and the seats on the inner surfaces of the lugs so that the ball is free to rotate. A pin 22 passes through the aperture in the ball and has a piston 23 secured at the other end thereof.

A pair of upstanding arms 24 and 25 which may be formed integral with the base casting 10 serve to support a U-shaped bracket 26 which is pivoted at each end to the arms 24, 25, by means of bolts 27 and 28, respectively. This pivotally mounted bracket 26 serves as a support for a cylinder 29 within which the piston 23 reciprocates and rotates. A bracket 31 is secured to the cylinder and has a screw 32 passing vertically there-through. The bottom end of the screw 32 contacts the base casting 10 and determines the position of the cylinder 29. It is readily seen then that by adjusting screw 32 the cylinder can be angularly raised or lowered. By turning screw 32 downward through bracket 31, the cylinder 29 mounted in U-bracket 26 will be swung upwardly and conversely a reverse adjustment of the screw will permit the cylinder to pivot downward to the position shown in Fig. 3. As the cylinder is so adjusted, the piston 23 is free to follow the cylinder due to the swivel or ball coupling 21. With the piston and cylinder in the position shown in Fig. 2, the piston stroke will be zero. It is seen, that as the motor shaft 13 rotates

3

coupling 15, the pin 22 will rotate in a vertical plane and though this will rotate the piston 23 there will be no reciprocating movement thereof. However, as the piston is permitted to pivot downwardly by adjusting screw 32, the driving arm is swung out of the vertical plane and will impart a reciprocating movement to the piston. With the cylinder disposed at a small angle the piston stroke will be correspondingly small and as the angle of the cylinder is increased the piston stroke will correspondingly increase.

The pumping action of the piston may be visually indicated by means of a pointer 33 secured to the piston. A calibrated plate 34 is conveniently mounted to the base casting 10 and calibrated in ounces per hour whereby the position of the pointer will indicate the quantity of liquid pumped depending of course upon the angular position of the cylinder and piston.

An oil reservoir 35 is secured to the underside of the cylinder and connects to the inlet port 36 thereof. The piston 23 has a single longitudinal groove 37 of sufficient length to register with the cylinder port 36 at the proper part of the stroke. The reservoir which is always vented to the atmosphere has an air-tight tube 38 extending downward into the oil supply and a drain is provided at the point where the piston enters the cylinder to collect any oil that may leak past the piston in order to return it to the oil reservoir. The ports of the piston and cylinder are so arranged that the interior of the cylinder is open to the oil reservoir only on the suction stroke of the piston. It is seen then that as the piston reciprocates, oil from the reservoir will be drawn upward into the cylinder and pumped under pressure through tube 39. Therefore, the oil reservoir not only provides lubrication for the piston and cylinder assembly but also supplies the liquid for the hydraulic operation of the diaphragm pump now to be described.

Referring now to Figs. 4 and 5, tube 39 through which the oil is pumped terminates in a coupling 41 which is screw threaded to a plate 42. The diaphragm chamber is generally indicated by numeral 43 and comprises a block 44 which may be of a plastic material such as Lucite, or other materials including metals which would resist the chemicals to be pumped. A liquid chamber 45 of generally frusto-conical contour is formed in the face of block 44 and is covered by diaphragm 45. The diaphragm is held in place by the plate 42 which is screwed to the face of block 44 by means of screws 46. A small Lucite or other chemical resistant material press plate 47 is located against the inner surface of the diaphragm and a tension spring 48 presses against the press plate 47 and against the inner surface of the frusto-conical liquid chamber 45. The spring is maintained in place by means of projection 49 on the press plate and projection 51 on the inner surface of the liquid chamber. It is apparent then from the description so far, that as the column of oil in tube 39 is pumped by the piston-cylinder pump, the diaphragm 45 is periodically flexed against the action of spring 48 to thereby cause a pumping action within the liquid chamber. It will be noted that the oil is returned at each stroke by the spring 48 through tube 39 and thence through the piston port 27 and cylinder port 36 through oil tube 38 to container 35.

The diaphragm chamber 45 has an inlet port 52 passing vertically down from the top thereof and is screw threaded to receive a coupling 53 which connects to a supply of the chemical liquid to be pumped. A horizontally disposed outlet port 54 is similarly screw threaded to receive an outlet coupling 55 which connects to the system (not shown) which is to receive the measured or metered liquid. The inlet port 52 connects to an intermediate chamber 56 by means of a downwardly sloping bore 57. Another bore 58 connects the intermediate chamber 56 with the outlet port 54 and bore 59 connects bore 58 with the liquid chamber 45 as clearly seen in Fig. 4. The intermediate chamber 56 is covered

4

by a diaphragm 61 which is held in place by means of plate 62 and screws 63 which pass through the plate and diaphragm to be received in threaded holes 40 in block 44. A valve plunger 64 is received in the chamber 56 and is screw threaded to receive screw 67 which passes through member 68. The screw 67 and hence plunger 64 are urged to the left as seen in Fig. 4 by means of a compression spring 69 which bears against plate 62 and the underside of a washer 71 located under the head of screw 67. The inlet valve is completed by means of a pair of O-rings 72 located at the smaller inner end of intermediate chamber 56, and a valve lifting pin 73. The outlet valve comprises an O-ring 74 in the inner end of the outlet port 54 and a ball 75 spring urged by means of compression spring 76 against the O-ring 74.

In operation it will be seen that depressing plunger 64 to the right first causes the plunger to seat against the two O-rings 72, closing the inlet valve and after this seating occurs further depression of the plunger 64 causes an extra flattening of the two O-rings 72 and a slight movement of pin 73 to the right thereby lifting the ball 75 from its seat against the O-ring 74 against which it has been urged by spring 76 and thus opening the outlet valve. When the plunger returns to its original position, these operations occur in the reverse order. Both of these valves are so arranged as to prevent trapping of air bubbles to prevent erratic pumping action and both valves cannot be open at the same time. As is seen, this is accomplished by keeping all trapping spaces vented to the exhaust or outlet valve. This mechanical valve arrangement is used only in connection with the cam 131 and lever 129 to be described hereinafter.

Reference will now be made to Fig. 6 wherein there is shown a diaphragm chamber which is a modification of that shown in Fig. 4. This modified diaphragm chamber is generally indicated by numeral 76. The lower portion of this modified diaphragm chamber is similar to the one above described and includes the liquid chamber covered by the diaphragm which is acted upon by the oil pumping system. An inlet port 77 is formed in the upper portion of the diaphragm chamber and is screw threaded to receive a coupling 78 to which the source of liquid (not shown) is applied and passed to the inlet port through a bore 79 in the coupling. A conical shaped filter 81 is secured by any suitable means to the coupling and serves to strain or filter the fluid as it passes to the inlet port 77. A bore 82 formed in the diaphragm chamber connects the inlet port 77 with an intermediate chamber 83 and a downwardly extending bore 84 interconnects the intermediate chamber with the liquid chamber similar to bore 59 in Fig. 4. The outlet port 85 also connects to chamber 83 by means of bore 86 as clearly seen in Fig. 6. Chamber 83 has a ball valve comprising ball 87 which bears against O-ring 88 under the pressure of compression spring 89. A plug 91 is screw threaded in the end of chamber 83 and the spring 89 bears against this plug. It is understood then that as the diaphragm is pulsed, the suction half of the pulsing cycle will draw the liquid from inlet port 77 through bore 82 and through the valve in chamber 83 and through bore 84 to chamber 45. Then as the diaphragm is flexed inwardly, the liquid in chamber 45 is forced upward through bore 84 into chamber 83 and then forced upward through port 86 and through the ball valve in the outlet port. This valve includes a ball 92 which is spring urged by compression spring 93 against O-ring 94 which serves the usual sealing function. The outlet coupling 95 is screw threaded to the upper end of the outlet port and as the diaphragm forces the liquid up into the outlet port at a fixed predetermined rate the liquid is thereby fed to the outside system in predetermined proportions.

Reference will now be made to Figs. 8 and 9 in considering a modification of the present invention in which the stroke of the cylinder piston pump remains constant

and the volume of the fluid pumped can be preset and adjusted by a regulating unit. This unit includes an oil reservoir 101 mounted on a cast iron base 102. By means of bracket 103, a cylinder 104 is mounted in at a fixed angle as shown in Fig. 8. The bracket 103 may be secured in any suitable manner and encircles the cylinder which is maintained in place by screw 105 passing through the end of the bracket. A piston 106 which is similar to piston 23 of Fig. 2, reciprocates and rotates within the fixedly mounted cylinder 104. A driving arm 107 is secured to the end of the piston and passes through an aperture in ball 108 which is mounted between the arms 109 of a coupling 111. Motive power is supplied by a motor 112 having a shaft 113 which through a suitable reduction gear box 114 serves to mount the coupling 111. It is seen from the description so far that as shaft 113 rotates, coupling 111, arm 109 will rotate thereby causing the piston to reciprocate and rotate within its cylinder in a manner similar to that above described with reference to Figs. 1 and 2. Since the cylinder 104 is fixedly mounted, the stroke of the piston cannot be varied and hence the column of oil pumped by the piston must be adjusted by other means hereinafter described.

The cylinder 104 has an inlet port 115 and the piston has a longitudinal groove 116 extending along the outer surface thereof. As the piston reciprocates and rotates, oil from reservoir 101 is thereby drawn into the interior of the cylinder and pumped through a tube 117 which passes through the cylinder head 118. Therefore, as the piston-cylinder pump operates, a column of oil is pumped under pressure to the succeeding diaphragm pump. In order to adjust the pressure of the backward and forward moving column of oil, a regulating unit generally indicated by numeral 118 is interposed in the oil line. This unit includes a cylinder 119 having an inlet port to which tube 117 connects. An outlet tube 121 connects with an outlet port in cylinder 119 and by means of a coupling 122 connects to a diaphragm chamber generally indicated by numeral 123 which may be similar to the diaphragm chamber shown in detail in Figs. 4 and 5. A piston 124 within the regulating cylinder is maintained in place by a screw 125 passing through a cylinder head 126. The screw is screw threaded to the cylinder head and serves to limit the motion of the piston 124. Compression spring 127 bears against the upper surface of the piston and against the lower or inner surface of the cylinder head 126. It is understood then, that by manually adjusting screw 125, the piston is permitted to reciprocate more or less, thereby varying the amount of oil that is permitted to press against the diaphragm, and hence varying the amount of chemical liquid pumped by the diaphragm.

The diaphragm chamber 123 may be one or the other of the type in either Fig. 4 or 6, hereinabove described. In the case of Fig. 4 or mechanical valve diaphragm chamber, a pivotally mounted lever 129 is cyclically operated by a cam 131 which is mounted on the coupling 111. The lever arm 129 is spring urged to its normal position by a spring 132 secured at one end to the arm and anchored to a bracket 133 which may be conveniently secured to the gear box. The lever is oscillated by the cam 131 in timed relation with the piston of the oil pressure pump. The cam in turn operates the inlet and outlet valves on the diaphragm chamber 123. Fig. 9 shows the arrangement whereby arm 129 controls the inlet and outlet valves of the diaphragm chamber. As the arm oscillates, a plunger 134 is permitted to move under the action of spring 135 to periodically operate the inlet valve. Similarly, the outlet valve of the diaphragm chamber 123 is controlled by the oscillating arm 129, since both valves are operated through the medium plunger 134. The arrangement of both inlet and outlet valves being such that both of them can never be open at the same time.

Referring now to Fig. 10 there is shown a metering or measuring device generally indicated by numeral 140

which can be coupled to the inlet valve of the diaphragm chamber in order to visually indicate the quantities of liquid being pumped. This measuring device comprises a transparent cylinder 141 hermetically connected at its upper end with the source of liquid by means of a coupling 142. A siphon 143 and a tube 144 are each located within the measuring device as shown in Fig. 10. On its lower side, the siphon connects to a chamber 145 which is in direct communication with the suction valve of the diaphragm pump as hereinabove described. The chamber of the diaphragm pump should be as large or larger than chamber 145 so that ample room may be provided for the intermittent siphon tube which then quickly empties into the inlet valve chamber 145 of the diaphragm pump. Since the volume of the upper chamber is known, it is only necessary to know the period of time it takes to fill, in order to know the volume of liquid being pumped per unit of time. This metering or measuring device can be added as an accessory to either of the pumps above described.

Though the present invention has been described with reference to specific embodiments thereof, it is understood modifications and combinations of the above elements may be made without departing from the spirit or scope of the present invention as defined in the appended claims. For example with the present invention, it is possible to handle two different liquids at one time by a single motor, and proportion both of them individually. This is accomplished by using two oil pressure inducing piston and cylinder assemblies on a single motor. These two oil pressure inducing assemblies may be connected in the manner herein described to two separate diaphragm chambers. The volumes of each cylinder may be varied by varying their angles as shown in the system of Figs. 1, 2, 3 or by an oil regulating cylinder as shown in the embodiment.

It will be also noted according to the invention that there is provided an easily and quickly renewable or replaceable valve means wherein the O-rings of proper flexible material float on a valve seat. Also a ball valve is provided which rests on and covers the opening in the O-ring as shown in Figs. 4 and 6. By such arrangement the pressure of liquid acting against the ball urges the ball and O-ring against the valve seat.

We claim:

1. A pumping system for feeding liquid at a predetermined rate comprising an oil reservoir, a first pump having a cylinder and piston, said cylinder being fixedly mounted in said reservoir, a motor providing a rotating shaft, mechanical coupling means interconnecting the motor shaft and piston to apply a reciprocating and rotating motion to said piston whereby oil from the reservoir is pumped by the action of the rotating reciprocating piston, a second pump including a diaphragm chamber, said chamber including a flexible diaphragm, an inlet port and an outlet port, first valve means and second valve means located within said diaphragm chamber, a pivotally mounted arm adjacent said coupling means, cam means secured to said motor shaft to oscillate said arm, means interconnecting said first and second valves, plunger means contacting said arm and said first valve means whereby said oscillating arm periodically opens and closes said first and second valve means, tube means connecting said cylinder and the outer surface of said diaphragm whereby the action of said first pump periodically flexes said diaphragm and an oil regulating cylinder interposed in said tube means.

2. A pumping system for feeding liquid at a predetermined rate comprising an oil reservoir, a first pump having a cylinder and piston, said cylinder being fixedly mounted in said reservoir, a motor providing a rotating shaft, mechanical coupling means interconnecting the motor shaft and piston to apply a simultaneous reciprocating and rotating motion to said piston whereby oil from

the reservoir is pumped by the action of the rotating reciprocating piston, a second pump including a diaphragm chamber, said chamber including a liquid chamber, a diaphragm covering said liquid chamber, an inlet port adapted to receive liquid to be pumped and an outlet port formed in said diaphragm chamber; first valve means and a second valve means located within said diaphragm chamber, a pivotally mounted arm adjacent said coupling means, cam means secured to said motor shaft to oscillate said arm, means interconnecting said first and second valves, plunger means contacting said arm and said first valve means whereby said oscillating arm periodically opens and closes said first and second valve means, tube means connecting said cylinder and the outer surface of said diaphragm whereby the action of said first pump periodically flexes said diaphragm and an oil regulating cylinder interposed in said tube means.

3. A pumping system for feeding liquid at a predetermined rate comprising an oil reservoir, a first pump having a cylinder and piston, said cylinder being fixedly mounted in said reservoir, a motor providing a rotating shaft, mechanical coupling means interconnecting the motor shaft and piston to apply a reciprocating and rotating motion to said piston whereby oil from the reservoir is pumped by the action of the rotating reciprocating piston, a second pump including a diaphragm chamber, said chamber including a liquid chamber, a diaphragm covering said liquid chamber, an inlet port adapted to receive liquid to be pumped, an outlet port and an intermediate chamber, each of said inlet port, outlet port, intermediate chamber and liquid chamber being joined by bores formed in said diaphragm chamber, first valve means located within said inlet port, second valve means, located within said outlet chamber, a pivotally mounted arm adjacent said coupling means, cam means secured to said motor shaft to oscillate said arm, means interconnecting said first and second valves, plunger means contacting said arm and said first valve means whereby said oscillating arm periodically opens and closes said first and second valve means, tube means connecting said cylinder and the outer surface of said diaphragm whereby the action of said first pump periodically flexes said diaphragm.

4. A pumping system for feeding liquid at a predetermined rate comprising an oil reservoir, a first pump having a cylinder and piston, said cylinder being fixedly mounted in said reservoir, a motor providing a rotating shaft, mechanical coupling means interconnecting the motor shaft and piston to apply a reciprocating and rotating motion to said piston whereby oil from the reservoir is pumped by the action of the rotating reciprocating piston, a second pump including a diaphragm chamber, said chamber including a liquid chamber, a diaphragm covering said liquid chamber, an inlet port adapted to receive liquid to be pumped, an outlet port and an intermediate chamber, each of said inlet port, outlet port, intermediate chamber and liquid chamber being joined by bores formed in said diaphragm chamber, first valve means located within said inlet port, second valve means, located within said outlet chamber, a pivotally mounted arm adjacent said coupling means, cam means secured to said motor shaft to oscillate said arm, means interconnecting said first and second valves, plunger means contacting said arm and said first valve means whereby said oscillating arm periodically opens and closes said first and second valve means, tube means connecting said cylinder and the outer surface of said diaphragm whereby the action of said first pump periodically flexes said diaphragm and an oil regulating cylinder interposed in said tube means.

5. A pumping system for feeding liquid at a predetermined rate comprising an oil reservoir, a first pump having a cylinder and piston, said cylinder being fixedly mounted in said reservoir, means for operating the pump, mechanical coupling means interconnecting the means and piston to apply a reciprocating and rotating motion to said piston, said piston having a longitudinal groove along the outer

surface thereof, said cylinder having an oil inlet port whereby oil from the reservoir is pumped by the action of the rotating reciprocating piston, a second pump including a diaphragm chamber, said chamber including a liquid chamber, a diaphragm covering said liquid chamber, an inlet port adapted to receive liquid to be pumped, an outlet port and an intermediate chamber, each of said inlet port, outlet port, intermediate chamber and liquid chamber being joined by bores formed in said diaphragm chamber, first valve means located within said inlet port, second valve means, located within said outlet chamber, a pivotally mounted arm adjacent said coupling means, cam means secured to said motor shaft to oscillate said arm, means interconnecting said first and second valves, plunger means contacting said arm and said first valve means whereby said oscillating arm periodically opens and closes said first and second valve means, tube means connecting said cylinder and the outer surface of said diaphragm whereby the action of said first pump periodically flexes said diaphragm and an oil regulating cylinder interposed in said tube means.

6. In a pumping system, pumping means, a cylinder and piston therefor, coupling means interconnecting the piston and the pumping means, applying a simultaneous reciprocating and rotating motion to said piston, oil entry means for said cylinder, said piston having a longitudinal groove along the surface thereof, a second pump including a diaphragm chamber, said chamber having a diaphragm covering said liquid chamber, resistance means in the chamber for opposing the action of the diaphragm, an inlet port adapted to receive liquid to be pumped, an outlet port and an intermediate chamber, each of said inlet port, outlet port, intermediate chamber and liquid chamber being joined by bores formed in said diaphragm chamber, first valve means located within said inlet port, second valve means, located within said outlet chamber, a pivotally mounted arm adjacent said coupling means, cam means secured to said motor shaft to oscillate said arm, means interconnecting said first and second valves, plunger means contacting said arm and said first valve means whereby said oscillating arm periodically opens and closes said first and second valve means, tube means connecting said cylinder and the outer surface of said diaphragm whereby the action of said first pump periodically flexes said diaphragm and an oil regulating cylinder interposed in said tube means.

7. In a system for feeding liquids at varying rates, a first pump including a revolving drive shaft, a cylinder inclined at an angle with regard to said shaft, said cylinder having a head with an opening therein and a port in its side, a tube hermetically connected at one end to said port, an atmospheric hydraulic fluid reservoir, means for maintaining the other end of said tube under the hydraulic liquid in said reservoir, a piston having a driving pin affixed to one end thereof and extending beyond its center axis, a longitudinal port on the outside of said piston, a universal coupling means for interconnecting said revolving drive shaft and said piston driving pin whereby the piston is caused to simultaneously make one complete revolution and one complete reciprocation with each revolution of the revolving drive shaft, means for varying the angle of said cylinder thereby effecting variation of the piston stroke, a second pump comprising a flexible diaphragm, a chamber containing inlet and outlet valves, a cover plate having an opening therein, means for holding said plate, diaphragm and chamber together in leak-proof relation, a spring in said chamber holding said diaphragm against said cover plate, said spring being at least strong enough to hold said diaphragm against the cover plate when any vacuum is produced in said chamber and a hermetic fluid tube connecting the cylinder head of the first pump and the opening in the cover plate of the second pump.

8. In a system of the character described, a first pump, a second pump, said first pump comprising an inclined

cylinder having an opening in its head and a port in its side, a tube hermetically connected at its one end to said cylinder port and having its other end immersed in hydraulic oil at atmospheric pressure, a piston in said cylinder, a grooved port on the side of said piston, a revolving shaft, a universal coupling ball joint for interconnecting said piston and said revolving shaft to simultaneously produce one rotation and one complete reciprocation of said piston for each revolution of said revolving shaft, means for varying the angle of said cylinder to change its stroke length, the aforesaid cylinder and piston ports being timed so as not to pump hydraulic fluid from said cylinder head opening when the pump is operating until the cylinder head is hermetically connected to the second pump, said second pump comprising a chamber having inlet and outlet valves, a cover plate having an opening therein, a flexible diaphragm acting as the common wall between said chamber and said cover plate, means securing said diaphragm and plate in leakproof relationship to each other, a spring in said chamber for pressing said diaphragm tightly against said cover plate, said spring being capable of exerting a pressure at least great enough to hold said diaphragm against said plate under any vacuum in said chamber, and a hermetically connected tube connecting the opening of the cylinder head of the first named pump with the opening in the cover plate of the second pump.

9. In a variable feed pump, an oil immersed cylinder set at a fixed angle, said cylinder having an outlet in its head end and a port through its side, a piston having a drive pin affixed to its base extending outside its axis, a longitudinal port in said piston extending from its head part way down its outside surface, a revolving motor shaft, a universal joint means interconnecting said piston pin and said revolving motor shaft so as to simultaneously produce one complete rotation and one complete reciprocation of the piston for each revolution of the motor shaft, a second pump comprising a chamber, inlet and outlet valves for said chamber, an opening covered by a flexible diaphragm, a cover plate, means for securing said chamber, diaphragm and cover plate in pressure tight relationship, a spring in said chamber holding said diaphragm against said cover plate, said spring being at least strong enough to prevent said diaphragm from moving away from said plate when any vacuum is produced in said chamber, an opening in said cover plate communicating with said diaphragm, a connecting tube for hermetically connecting the cylinder head opening of the first pump with the opening in the aforesaid cover plate of said diaphragm chamber, timing means for causing the cylinder port to be in registry with the piston port for somewhat more than the last half of the suction stroke of said piston, and out of registry for all other parts of the suction and compression strokes, regulator means including a spring loaded piston in a cylinder, the head of which is in hermetic liquid communication with the hydraulic fluid leaving the cylinder head of the aforementioned first pump, and motion limiting means for restricting or stopping the stroke of said spring loaded piston.

10. A pump for the variable metering of liquids, consisting of a first pump having a cylinder mounted at an angle, said cylinder having an opening in its cylinder head, and a single port in its side, a piston in said cylinder having a single longitudinal port communicating with its head, a rotating driving shaft, a universal ball coupling means interconnecting said driving shaft and said piston to produce one rotation and one complete reciprocation for each revolution of the driving shaft, means for varying the angle of said cylinder whereby the stroke of the piston may be varied, a tube one end of which is connected in a leakproof manner to said cylinder port and the other end immersed in hydraulic fluid in an atmospheric fluid reservoir, port timing of the piston and cylinder ports so arranged that the two ports are not in regis-

try with each other for the first part of the suction stroke and are in registry with each other and the fluid immersed tube above mentioned for the balance of the suction stroke, and are out of registry with each other for the entire exhaust stroke of said piston, a second pump consisting of a diaphragm having a pumping chamber hermetically mounted on its one side and a cover plate hermetically mounted on the other side, said pumping chamber having inlet and outlet valves, a spring pressing said diaphragm against said cover plate with a pressure great enough to resist inward movement of the same when any vacuum is produced in said chamber, an opening in said cover plate, tubing hermetically connecting said opening with the opening in the cylinder head of the first pump.

11. In a variable volume liquid feeder system, a primary pump consisting of a cylinder mounted at an angle, a port in the wall of said cylinder, a tube connected to said port in a leakproof manner, a hydraulic fluid reservoir open to the atmosphere, means for maintaining the open end of said tube immersed in said hydraulic fluid, a head for said cylinder having an opening therein, a piston having a single port, a pin rigidly connected to the base of said piston extending outside the axis of the same, a motor driven rotating drive shaft, a universal joint coupling for interconnecting said piston pin and said rotating shaft so as to cause the piston to simultaneously make one complete reciprocation and one complete revolution for each revolution of the rotating drive shaft, a secondary pump comprising a chamber having inlet and outlet valves, a flexible diaphragm for closing said chamber, a cover plate having an opening therein, means for securing said chamber, diaphragm and cover plate in leakproof relationship, a spring within said chamber for forcing said diaphragm tightly against said cover plate, tube means for hermetically connecting the opening in the cylinder head of the primary pump and the opening in the cover plate of the secondary pump.

12. In a variable volume liquid feeder system, a primary pump consisting of a cylinder mounted at an angle, the angle of said cylinder being variable without affecting the timing of the port in the wall of said cylinder, a port in the wall of said cylinder, a tube connected to said port in a leakproof manner, a hydraulic fluid reservoir open to the atmosphere, means for maintaining the open end of said tube immersed in said hydraulic fluid, a head for said cylinder having an opening therein, a piston having a single port, a pin rigidly connected to the base of said piston extending outside the axis of the same, a motor driven rotating drive shaft, a universal joint coupling for interconnecting said piston pin and said rotating shaft so as to cause the piston to simultaneously make one complete reciprocation and one complete revolution for each revolution of the rotating drive shaft, means for varying the angle of said cylinder to vary the piston stroke, a secondary pump comprising a chamber having inlet and outlet valves, a flexible diaphragm for closing said chamber, a cover plate having an opening therein, means for securing said chamber, diaphragm and cover plate in leakproof relationship, a spring within said chamber for forcing said diaphragm tightly against said cover plate, tube means for hermetically connecting the opening in the cylinder head of the primary pump and the opening in the cover plate of the secondary pump.

References Cited in the file of this patent

UNITED STATES PATENTS

2,303,597	Adelson	Dec. 1, 1942
2,343,962	Dodson	Mar. 14, 1944
2,517,645	Erikson	Aug. 8, 1950
2,738,731	Browne	Mar. 20, 1956

FOREIGN PATENTS

1,038,510	France	Sept. 29, 1953
-----------	--------	----------------