United States Patent

Vanderjagt

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[45] **Oct. 24, 1972**

[54] **EXPLOSION-PROOF LIQUID FUEL PUMP**

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[21] Appl. No.: **144,548**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 23,866, March 30, 1970, abandoned.

[52] **U.S. Cl.** **417/404,** 91/345, 417/528

[51] **Int. Cl.**.....**F04b 17/00,** F04b 23/04, F011 31/12

[58] **Field of Search** 417/404, 528; 91/345

[56] **References Cited**

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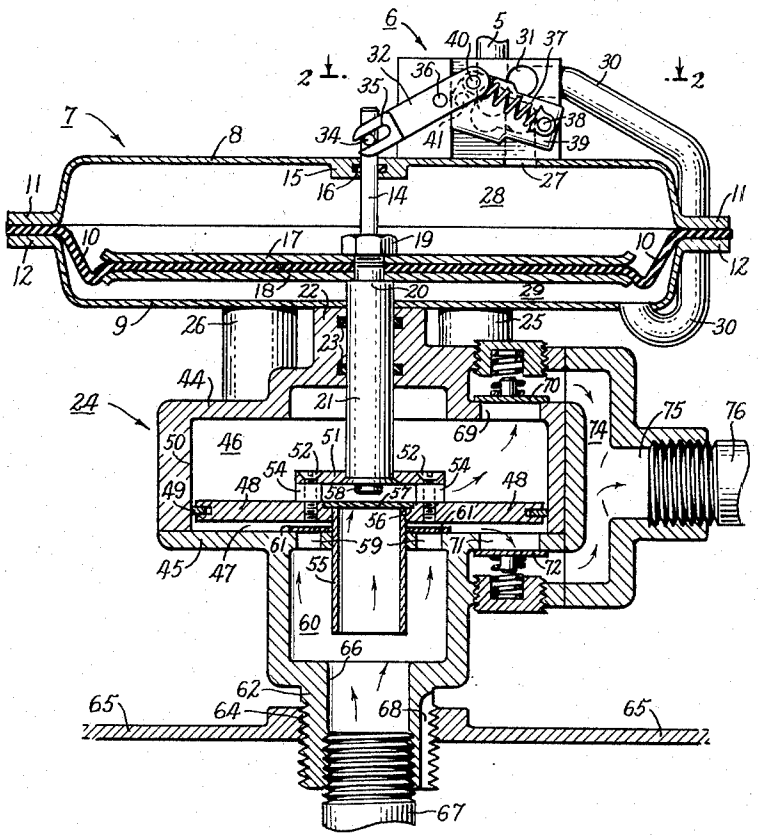
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Assistant Examiner—Richard E. Gluck
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[57] **ABSTRACT**

A double acting piston type liquid fuel pump is driven by an integrally constructed coaxial flexible-diaphragm gas piston within a dual compartment chamber. The compartments are alternately connected to a vacuum or pressure source through a reversible toggle valve operated by movements of the diaphragm.

14 Claims, 7 Drawing Figures



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SHEET 1 OF 3

Fig 1

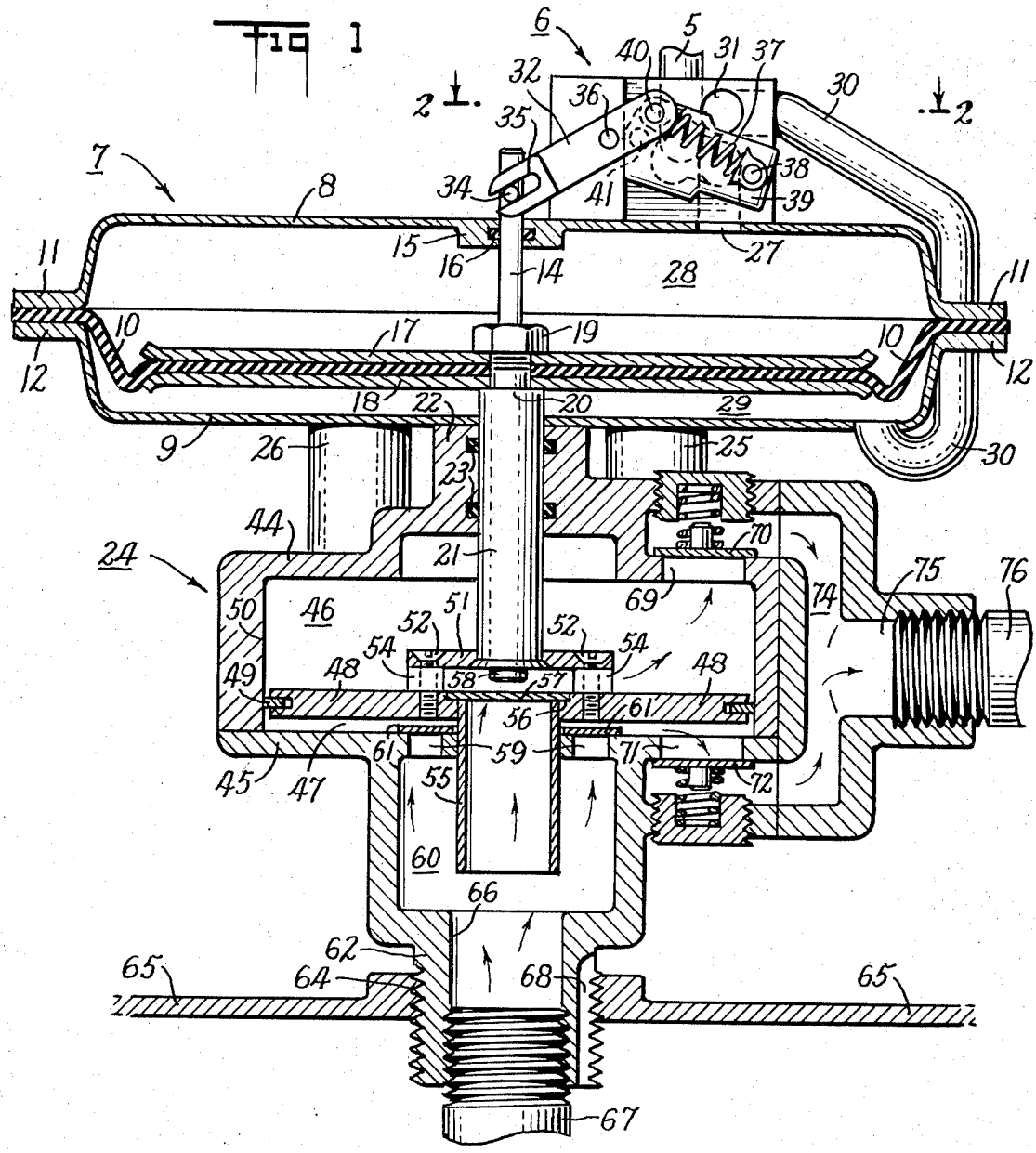
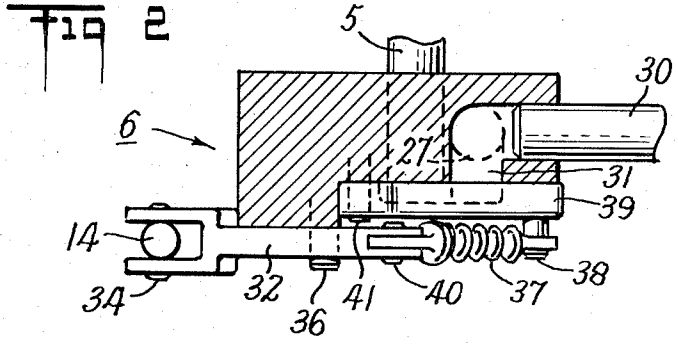


Fig 2



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Fig. 3.

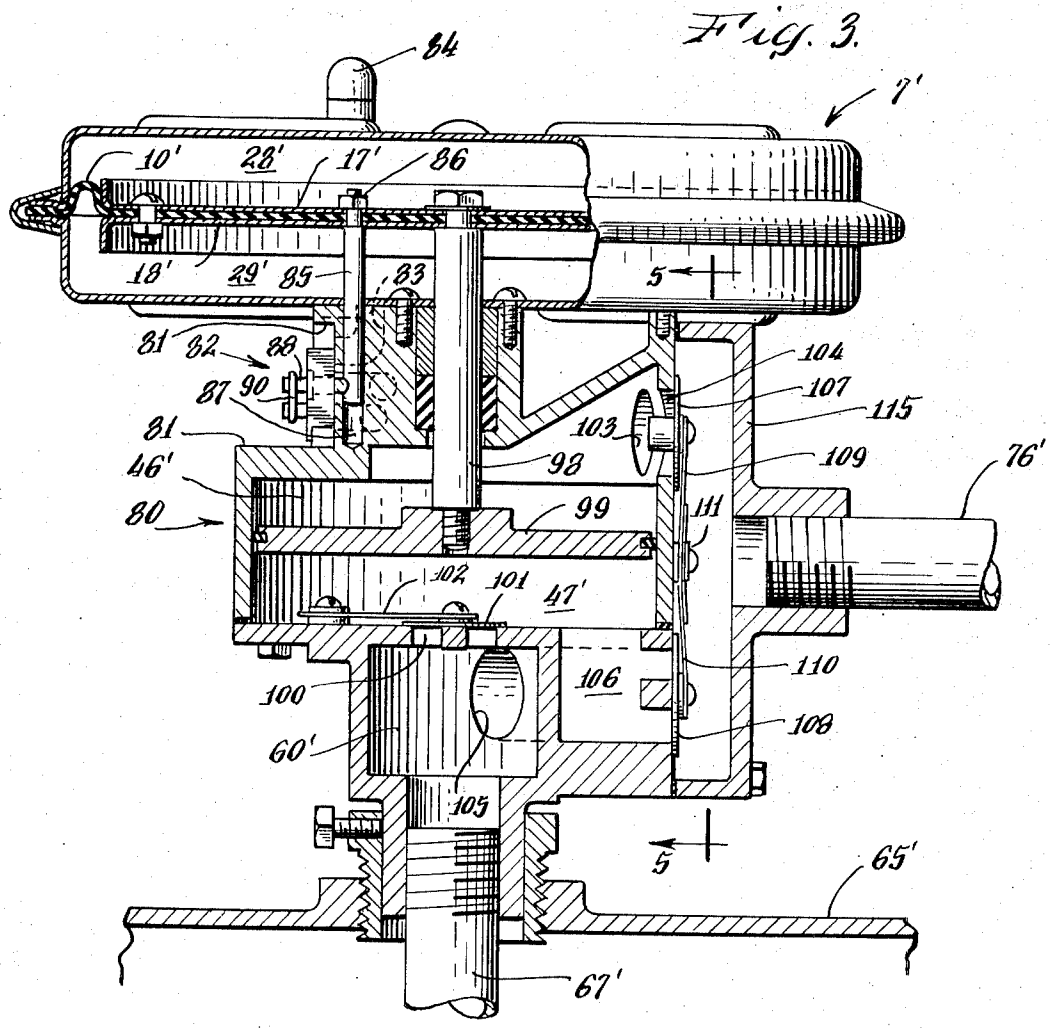
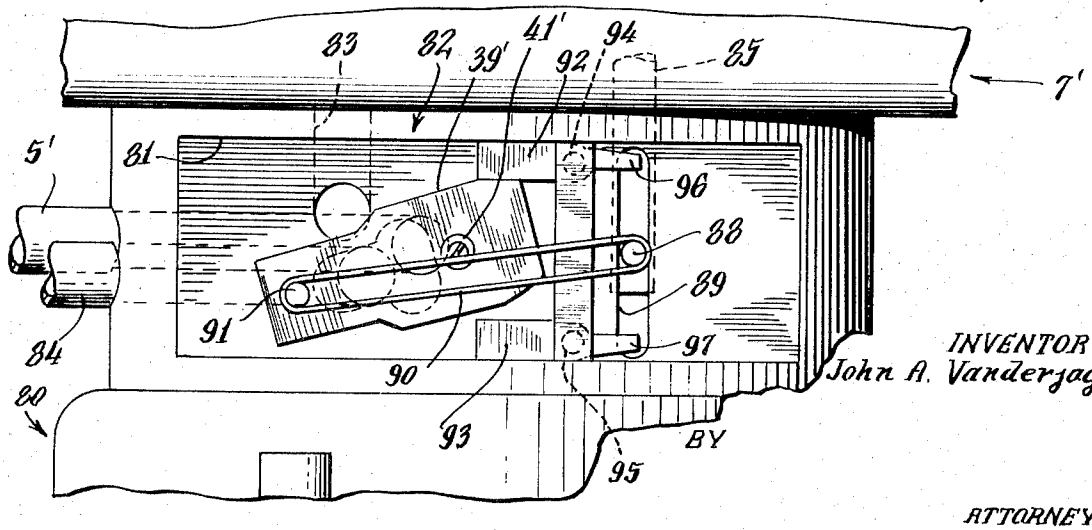


Fig. 4.



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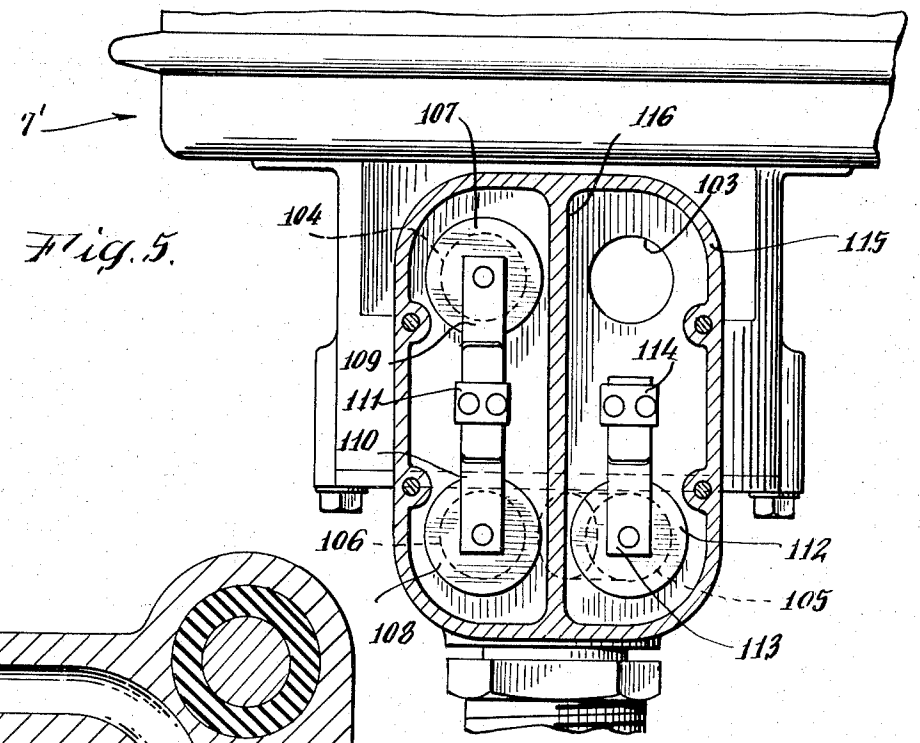


Fig. 5.

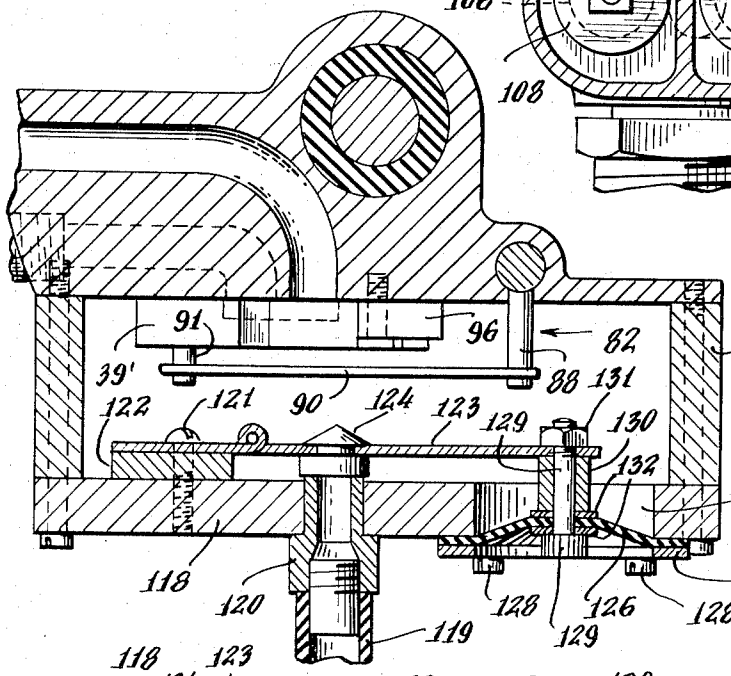


Fig. 7.

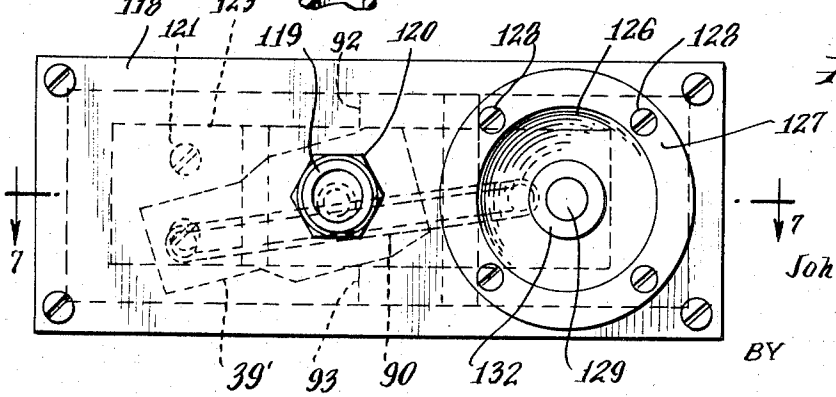


Fig. 6.

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EXPLOSION-PROOF LIQUID FUEL PUMP

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of my copending application Ser. No. 23,866, now abandoned, filed Mar. 30, 1970 for Explosion-Proof Liquid Fuel Pump.

In the heavy construction and road building industries which use fossil fueled machines such as power shovels, back-hoes, bulldozers, cranes, etc., as well as in farming with tractors, harvesters and the like, it is necessary to fuel such machines in the field where the work is underway, as it is wholly impractical to drive the machines to a central fuel depot or filling station. Accordingly, all such equipment users must have a fuel delivery truck capable of refueling these machines on location in the field. Large fuel tank trucks as employed by the oil companies hold much more fuel than is ordinarily required for the farmer or contractor's day-to-day operations, and they are uneconomical for a small operator to own and maintain. Consequently most contractors and farmers use a small truck, such as a pick-up truck, in which they carry one or more 50 gallon barrles of fuel around to their various machines for refueling once or twice a day, as may need be. Because construction and farm workers have sometimes been known to syphon off fuel into their own personal automobiles when the boss is not around, most contractors seek to supply each construction machine with only enough fuel for one day's operation. The simplest way to transfer fuel from these fifty gallon drums into a working machine in the field is by means of a hand pump, but this is laborious and time consuming. Small electrical pumps have been proposed for this purpose but they pose the danger of fire or explosion from an electrical spark, and therefore they are not approved by Underwriters. Pumps driven by power take off from the rotating shaft of the truck engine, as employed in the large tank trucks of the oil companies, are impractical for most farmers or contractors because they require costly modification of the truck engine and drive mechanism.

OBJECTS OF THE INVENTION

Accordingly, a principal object of the present invention is to provide an inexpensive, portable, powered fuel pump which is explosion-proof.

Another object of the invention is to provide such a fuel pump which may be easily attached to the internal combustion engine of any automobile or truck to derive its motive power therefrom.

A further object of the invention is to provide a liquid pump operable from a vacuum line.

Another object is to provide such a pump operable from a pressurized air source.

Another object is to provide a liquid pump which automatically stops operating when there is no further call for liquid, without requiring a cut-off switch control.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a vertical cross-sectional view of one embodiment of a pump of the invention;

FIG. 2 is a top view, partially in section, of the vacuum control valve taken along the line 2—2 of FIG. 1;

FIG. 3 is a vertical cross-sectional view of a modified form of the invention;

FIG. 4 is an enlarged illustration of the vacuum control valve of the pump of FIG. 3;

FIG. 5 is a cross-section taken substantially along the line 5—5 of FIG. 3;

FIG. 6 is a front view of a pressure regulator usable with the pump of the invention; and

FIG. 7 is a cross-section taken substantially along the line 7—7 of FIG. 6.

BRIEF DESCRIPTION OF THE INVENTION

In general the pump of the invention comprises a double acting piston pump having integrally joined therewith, by a common reciprocating piston shaft, a double acting diaphragm motor adapted for connection to either a source of compressed air or the vacuum system of an internal combustion engine in a truck or other automotive vehicle. A toggle valve on the device is operated by the reciprocating diaphragm to alternately apply vacuum or pressure to opposite sides of the diaphragm whereby the piston shaft is caused to reciprocate. A liquid intake port of the pump includes a threaded nipple extension adapted to screw into a bung hole in the top of a gasoline drum. A flat linear portion is machine cut into the external threaded surface of the intake nipple to provide an air vent into the drum through the bung hole. Internal threads within the intake nipple receive a short length of threaded pipe which extends downwardly into proximity with the bottom of the fuel drum so that substantially the entire liquid contents of the drum can be removed by the pump.

Motion of the reciprocating pump piston on the up stroke creates vacuum at the liquid intake port thereby drawing fuel upwardly through a first flap valve into the lower portion of the pump cylinder. On the down strike of the pump piston the first flap valve closes under the pressure of liquid thereabove while a second flap valve opens to partially relieve this pressure and to admit liquid into the upper portion of the pump cylinder, above the piston. At the same time, during the down stroke of the pump piston, a spring loaded liquid release valve in the cylinder wall below the piston is opened by the remaining fluid pressure and allows excess liquid to pass through an exhaust passage to a liquid discharge port. After a very few reciprocating cycles of the piston the entire internal volume of the pumping cylinder, both above and below the piston, becomes filled with liquid and the pump is fully primed. On succeeding strokes of the piston liquid is alternately passed through an upper spring loaded release valve above the piston and the lower spring loaded valve beneath the piston to produce a continuous flow of liquid through the discharge port. By connecting a fuel hose to the discharge port, with a hand operated (or au-

tomatic) shut off valve at the delivery nozzle of the hose, the fuel tanks of machines in the field can easily be supplied with any desired amount of gasoline. When the shut off valve at the delivery nozzle is closed the pump stops due to the back up of pressure in the pumping cylinder, and there is no need to operate a separate switch or other control to turn off the pump. As soon as the delivery nozzle is again opened the pump resumes operating to deliver a steady flow of liquid fuel.

DETAILED DESCRIPTION

Referring now in greater detail to FIG. 1 of the drawing, which is a vertical cross-sectional view of one embodiment of the device, the structural arrangement of parts and the combination of elements which comprise the invention will be described. A flexible air hose 5 is connected to the air intake, or vacuum line, of an internal combustion engine (not shown). The vacuum hose 5 connects through a dual port toggle valve, indicated generally at 6 in FIG. 1, to alternate sides of a vacuum cylinder indicated generally at 7. Vacuum cylinder 7 is enclosed by an upper annular wall 8 and a corresponding lower annular wall 9 with a flexible diaphragm 10 securely clamped between outer peripheral edges 11 and 12 of walls 8 and 9, respectively. A vertical piston shaft 14 passes through a central bearing 15 in the upper wall 8 and is hermetically sealed by an O ring 16 therein. The piston shaft 14 supports and carries a pair of rigid circular piston discs 17 and 18 clampingly held in contact with opposite faces of flexible diaphragm 10 by a locknut 19 tightened against an annular shoulder portion 20 of a larger diameter cylindrical lower extension 21 of the piston shaft 14. The bottom wall 9 of vacuum cylinder 7 is secured to an upper bearing end 22 of a liquid pumping cylinder indicated generally at 24 in FIG. 1, and is further supported by brackets 25 and 26 also mounted on the pump cylinder 24.

In the position shown in FIG. 1, vacuum from line 5 is applied through port 27 of toggle valve 6 to the upper chamber 28 of vacuum cylinder 7, while the lower chamber 29 is connected through a flexible hose 30 to atmospheric pressure through open port 31 of toggle valve 6. In this position the piston shaft 14 has completed its down stroke and the vacuum applied to chamber 28 now causes the vacuum piston 17–18 sealed at its periphery by flexible diaphragm 19, to rise under the influence of atmospheric pressure in chamber 29. As piston rod 14 rises it causes a rocker arm 32, driven by a pin 34 in rod 14 riding in slot 35 to rotate about a supporting pivot pin 36 in valve 6, thereby compressing a spring 37 mounted between pivot 38 on valve cover 39 and pivot 40 on the end of rocker arm 32. Valve cover 39 is pivotally mounted on valve 6 by a pivot pin 41. As piston rod 14 approaches the upper limit of its travel, rocker arm 32 reaches a horizontal position at which pin 34 and pivots 40, 41, and 36 are substantially aligned and spring 37 is substantially fully compressed. A slight further upward motion of piston rod 14 brings pivot 40 below this horizontal linear alignment whereupon spring 37 releases its compressed energy to rapidly swing its opposite end, affixed to valve cover 39 by pivot 38, into its uppermost position thereby rotating valve cover 39 about its pivot 41 to quickly open valve port 27 to atmospheric pressure and to connect valve port 31 to vacuum line 5. Now, with atmospheric pressure introduced into chamber 28 and the vacuum applied to chamber 29, the piston 17–18, sealed by flexible diaphragm 10, commences its downward stroke until it again reaches its lowest position and the snap acting valve member 39 of toggle valve 6 returns to the position shown in FIG. 1. In this manner continuous vertical reciprocating motion is imparted to piston rod 14 and its opposite enlarged end 21 which slides up and down in effect a hermetic sealing engagement with sliding shaft 21.

Reference is not had in greater detail to the construction and operation of the liquid pumping portion of the device indicated generally at 24 in FIG. 1. The dual acting pump cylinder 24 is formed of an upper cylindrical casting 44 securely joined to a lower cast part 45 enclosing therebetween dual pumping chambers 46 and 47 which are separated by a rigid cylindrical piston 48 having a piston ring 49 mounted in its periphery for maintaining intimate sealed contact with the inner cylinder wall 50. Piston 48 is rigidly connected to the lower end 21 of piston shaft 14–21 by an annular disc 51 which is welded or braised onto the shaft 21 and secured to the piston 48 by a plurality of machine screws 52 passing through a corresponding plurality of spacers 54. A hollow cylindrical tube 55 is mounted through a central coaxial opening in piston 48 and is secured thereto in a manner forming at its upper end an annular valve seat 56. A rigid valve disc 57 is seated in the annular recess of valve seat 56 but is free to move upward therefrom under the influence of liquid pressure. When valve disc 57 moves upwardly it is guided laterally by a slight clearance between its outer periphery and the sidewalls of spacers 54. Valve disc 57 is also limited in its upward travel by an extension 58 on the lower end of piston shaft 21, the clearance between disc 57 and extension 58 being only sufficient to allow fluid to flow upwardly through hollow cylinder 55, around the periphery of valve seat 56 and the periphery of raised disc 57, and through the space between spacers 54, in the direction shown by arrows in FIG. 1.

Through the bottom wall 45 of pumping cylinder 24 a plurality of openings 59 are symmetrically positioned about the axis of piston rod 14–21 and connect the chamber 47, beneath piston 48, with the lower and small cylindrical chamber 60 into which hollow cylinder 55 extends. Openings 59 are normally closed by an overlying annular valve washer 61 which is loosely fitted around cylinder 55, as shown in FIG. 1. The lower portion of chamber 60 is constricted into a smaller diameter nipple portion 62 which is externally threaded to fit into a threaded bung hole 64 in the top of a fuel drum 65. The inner cylindrical wall 66 of nipple portion 62 is threaded to receive the end of a threaded pipe 67 which extends downwardly into proximity with the bottom (not shown) of fuel drum 65. Along one vertical portion of the exterior threaded surface of nipple portion 62 a flat surface is milled to provide an air vent 68 between the nipple 62 and the bung hole 64 of drum 65. In the upper wall of cylinder casting 44 a fluid exit valve opening 69 is normally closed by a spring loaded valve 70, while in the lower cylinder wall 45 a corresponding fluid exit valve opening 71 is normally closed by a spring loaded valve 72, as shown in FIG. 1. In operation the valve openings 69 and 71 are

alternately connected with a common fluid exit channel 74, as valves 70 and 72 are alternately opened. Fluid exit channel 74 opens into a liquid exhaust port 75 to which is threadably connected a flexible fuel delivery hose 76.

The operation of the pumping cylinder 24 is as follows: with the pump piston 48 at the bottom of its down stroke, as shown in FIG. 1, the lifting force on piston shaft 14-21 produced by atmospheric pressure in chamber 29 and vacuum in chamber 28, as described hereinabove, causes piston 48 to rise into pump chamber 46, thereby creating vacuum in pump chamber 47. Atmospheric pressure entering drum 65 through air vent 68 forces liquid in the drum to rise through pipe 67 into fluid admitting chamber 60. As piston 48 continues to rise the fluid pressure in chamber 60 lifts valve washer 61, which rides freely upwardly on the exterior surface of hollow cylinder 55 to admit liquid through openings 59 into the expanding volume of chamber 47, between piston 48 and bottom cylinder wall 45. During the upstroke of piston 48 the valve disc 57 remains seated in valve seat 56 to maintain the piston opening closed. Since the pumping apparatus of the invention is normally installed in a vertical position as shown in FIG. 1, gravity holds the disc 57 in its closed position even at the start of a dry stroke when only air is in the upper chamber 46. However, if the device is to be operated in other than the vertical position shown, then a small compression spring (not shown) may be inserted around the extension and 58 of piston shaft 21 to spring load the valve disc 57 into its closed position during the upstroke.

When piston 48 reaches the top of its upstroke the chamber 47 beneath the piston is substantially filled with liquid. As the downstroke of piston 48 commences, valve washer 61 is forced down by increasing fluid pressure and closes openings 59. The fluid in chamber 47 under pressure of the piston 48 downstroke now opens spring loaded valve 72 which allows liquid to pass through valve opening 71, exit channel 74 and exit port 75 into delivery hose 76. At the same time, during the downstroke of piston 48, the pressure of fluid previously accumulated in chamber 60 lifts valve disc 57 allowing fluid to flow through hollow cylinder 55 and the open spaces between spacers 54 into the upper pumping chamber 46. After only a very few strokes of piston 48 the upper chamber 46 as well as the lower chamber 47, and the fluid admitting chamber 60, are all completely filled with liquid from the drum 65, and the pump 24 is fully primed. Now on each successive upstroke fluid in chamber 46 is forced out through valve opening 69, while on each successive downstroke fluid in chamber 47 is forced out through valve opening 71, to produce a continuous flow of fluid through exit channel 74 and exit port 75 into delivery hose 76.

If the fluid delivery hose 76 is closed at its opposite end by a liquid shut-off valve (not shown) then fluid pressure back-up on both sides of piston 48 will prevent further operation of the pump 24 or of its integrally connected vacuum motor 7, and the internal combustion engine to which vacuum line 5 is connected will continue to operate normally, drawing its air for combustion through whichever of the toggle valve ports such as 31 happens to be open at that time. To protect the connected internal combustion engine from intake of dust or other deleterious foreign matter along with the air intake, a cover with an air filter (not shown) should be mounted over the toggle valve 6.

FIG. 2 of the drawing, which is a top cross-sectional view taken along the line 2—2 of FIG. 1, merely helps to clarify an understanding of the operating relation between the various parts of the toggle valve 6, as explained hereinabove with reference to FIG. 1 of the drawing.

FIGS. 3–5 illustrate a modified form of the pump of this invention. The principles of operation are basically the same as those previously described. Accordingly, a number of parts are also similar and, where appropriate, they have been given the same reference numerals but with a prime attached. This modification is mechanically simplified and more compact. As illustrated, the upper portion of the pumping cylinder 80 defines a recess 81 within which is mounted a toggle valve 82. The toggle valve 82 is functionally similar to that previously described and includes a pivoted valve cover 39′ mounted on pivot 41′. In this version, the vacuum hose 5′ is connected to the toggle valve in the same manner. The upper port connects directly to chamber 29′ through a passage 83 while the lower port is connected to chamber 28′ by means of a hose 84. In this modification, the toggle valve is actuated by a push rod 85 mounted directly on the diaphragm by means of a nut 86. The push rod 85 reciprocates in a vertical bore 87 and carries a pin 88 which extends outwardly through a slot 89 formed in the housing. An elastic O ring 90 interconnects the pin 88 on push rod 85 with a pin 91 on valve cover 39′. As pin 88 moves up and down in response to movement of the diaphragm and push rod 85, the O ring alternately passes over the pivot 41′, thereby causing the valve cover 39′ to pivot in the manner previously described. Positive initiation of valve cover movement is afforded by an upper flipper 92 and a lower flipper 93. The flippers are mounted on pivots 94, 95. Each flipper includes a respective arm 96, 97 which extends into the path of pin 88. As the pin 88 moves alternately to the upper and lower limit of its stroke, it contacts the respective flipper arm which pivots, giving the initial impetus to rotation of the valve cover 39′.

FIGS. 3 and 5 also illustrate some modifications to the liquid pump portion. The piston shaft 98 is secured to a solid piston 99. The lower chamber 60′ of pump cylinder 80 communicates with pumping chamber 47′ by an opening 100 closed by a valve disc 101 mounted on a leaf spring 102. The pumping cylinder 80 defines two ports 103, 104 which communic ate with the upper pumping chamber 46′. It also defines two lower ports 105, 106. Port 105 communicates with chamber 60′ while port 106 communicates with lower pumping chamber 47′. As will be seen most clearly in FIG. 5, ports 104, 106 are closed, respectively, by valve discs 107, 108 mounted on leaf springs 109, 110, secured to a common spring mount 111. Port 103 is open, but port 105 is also closed by a valve disc 112 on a leaf spring 113 supported by spring mount 114. Positioned atop the four ports is a manifold cover 115 having a central wall 116 forming one fluid channel interconnecting ports 104, 106 and another fluid channel interconnecting ports 103, 105.

The operation of the liquid pumping portion will now be explained by assuming that the pumping chambers and manifold are filled with the fluid to be pumped. As piston **99** rises, the liquid in the upper chamber **46'** pushes open valve disc **107**, causing liquid to flow into the manifold and out the delivery hose **76'**. Ports **105**, **106** remain closed by the respective valve discs **112**, **108**. The suction created in lower chamber **47'** permits the fluid in chamber **60'** to raise the valve disc **101** off its seat, allowing the pumped liquid to fill the lower chamber.

On the downstroke, the fluid in chamber **47'** is expelled through port **106**, lifting valve disc **108** so as to flow out the discharge line **76'**. At the same time, the fluid in chamber **60'** flows through port **105** lifting valve disc **112** and continues upwardly through port **103** to fill the vacuum being created in upper chamber **46'**.

FIGS. **6** and **7** illustrate a pressure regulator which may be connected to the device of this invention, over the toggle valve, to thereby convert it from vacuum to pressure operation. It comprises a housing **117** and a cover plate **118** enclosing toggle valve **82**. High pressure air is supplied from a supply line **119** through a bushing **120**. Mounted on the inside of cover plate **118**, by means of a screw **121** and a spacer **122**, is a spring **123**. Spring **123** is drilled at approximately its midpoint where it supports a rubber or plastic valve disc **124** which rests against and closes the end of bushing **102**. The right end of cover plate **118** defines a circular opening **125** closed by a resilient diaphragm **126** secured by a retaining ring **127** and screws **128**. The diaphragm is interconnected with the end of spring **123** by means of a cap screw **129**, bushing **130**, nut **131**, and washers **132**.

In operation, air from the compressor forces the valve disc **124** off its seat and it enters the housing **117**, passing through the open port of toggle valve **82** to one side of the motor diaphragm. The opposite side of the motor diaphragm is open to atmosphere through the channel in valve cover **39'**. If pressure within housing **117** exceeds a pre-selected value, it forces the diaphragm **126** outwardly which pulls the end of the spring **123** with it. This causes valve disc **124** to seat against bushing **120** and cut off the air supply.

While the invention has been described with particular application to the pumping of cumbustible liquid fuels for use in internal combustion engines, it will be understood that the portable liquid pump of the invention may be employed as well for pumping from reservoirs of other liquids, such as water for example. Also, it is to be understood that the invention may be powered either by connection to a source of vacuum or utilized with equal efficacy by connection to a source of compressed air, or other gases at a pressure greater than atmospheric pressure. The invention is thus a portable liquid pump powered by an integral motor capable of being driven by differential gas pressures.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A double acting liquid fuel pump of the reciprocating piston type comprising in combination:

A. a liquid pumping chamber comprising first and second sealed compartments separated by a first piston slidably movable therebetween,

B. A vacuum chamber comprising first and second hermetically sealed compartments separated by a second piston movable therebetween,

C. a linearly reciprocable piston shaft common to said first and second pistons, and having one end thereof extending through a wall of said first sealed vacuum compartment,

D. first valve means connected to and operable by said extending piston shaft end, and movable between first and second operating positions,

1. means on said valve for connection thereof to a vacuum line,

2. means connecting said valve when in a first position to said first vacuum compartment,

3. further means connecting said valve in its second position to said second vacuum compartment,

E. first and second liquid release valves in said first and second liquid pumping compartments on opposite sides of said first piston,

1. each of said release valves spring loaded into closed position but operable to open under the application of liquid pressure,

2. both of said liquid release valves connecting with a common liquid outlet port,

F. a liquid intake chamber having means for connection thereof to a reservoir of liquid,

G. first and second liquid check valves connected with said liquid intake chamber,

1. said first check valve mounted in said first piston and connecting said intake chamber with said first compartment of said liquid pumping chamber, and

2. said second check valve connecting said intake chamber with said second compartment of said liquid pumping chamber,

whereby upon movement of said first piston in a direction to decrease the volume of said first liquid compartment and increase the volume of said second liquid compartment said second check valve opens to admit liquid from said intake chamber into said second compartment, and upon motion of said first piston in the opposite direction said first check valve opens to admit liquid from said intake chamber into said first compartment.

2. The combination of claim **1** wherein said second piston comprises a flexible diaphragm centrally mounted between symmetrically opposed walls of said vacuum chamber.

3. The combination of claim **1** wherein said first valve means comprises a toggle valve connected by a flexible linkage to the extending end of said reciprocable piston shaft.

4. The combination of claim **3** wherein said toggle valve vacuum connecting means includes a flexible

hose connectable to the vacuum line of an internal combustion engine.

5. A vacuum powered liquid pump comprising in combination

A. a hermetically sealed vacuum chamber having a pair of symmetrically opposed walls,
1. a flexible diaphragm piston centrally mounted within said vacuum chamber between said opposed walls,
B. a linearly reciprocating piston shaft connected to the center of said flexible diaphragm piston and having opposite ends thereof extending through centrally aligned sealed openings in said opposed vacuum chamber walls,
1. first valve means connected with and operable by one extending end of said piston shaft for alternately applying a vacuum to opposite sides of said flexible diaphragm piston to cause reciprocal movement thereof between said opposed vacuum chamber walls,
a. means connecting said valve means to a source of vacuum,
C. a dual compartment liquid pumping chamber having first and second liquid receiving compartments coaxially aligned with the other end of said reciprocating piston shaft and having a sealed linear bearing in a first wall thereof receiving and supporting said other end of said piston shaft within said liquid pumping chamber,
D. a second piston mounted on said other extending end of said piston shaft within the first compartment of said liquid pumping chamber and reciprocably movable between said first wall and an opposite second wall forming said first compartment of said pumping chamber,
1. the movement of said second piston being in synchronism with movement of said flexible diaphragm piston,
2. a first liquid entrance valve on said second piston normally open when said piston is moved in a first direction and closed when said piston is moved in a second and opposite direction,
3. a second liquid entrance valve on said second liquid chamber wall normally closed when said piston is moved in said first direction and opened when said piston is moved in said second direction,
a. said second liquid entrance valve connecting said first and second compartments of said liquid pumping chamber,
4. first and second liquid exit valves in said liquid pumping chamber on opposite sides of said second piston,
a. said first exit valve normally closed and said second exit valve normally open when said piston is moved in said first direction
b. said first exit valve normally open and said second exit valve normally closed when said piston is moved in said second direction,
c. a common passageway in said pump connecting both said first and second liquid exit valves with a single exit port, and
E. an entrance port of said pump connected with said second compartment of said pumping chamber and adapted for connection to a liquid reservoir.

6. The combination of claim 5 wherein said first valve means comprises a toggle valve having first, second and third ports, and said toggle valve is movable by said reciprocating piston shaft between first and second positions alternately connecting said third port to said first and second ports.

7. The combination of claim 5 wherein said reservoir connecting means comprises an internally and externally threaded nipple portion, the internally threaded portion being adapted to receive a threaded pipe end and the externally threaded portion being adapted to screw into a threaded oil drum bung hole, and a flat surface formed on said external threaded portion to provide an air vent to said drum through said bung hole.

8. A double acting liquid fuel pump of the reciprocating piston type comprising:

A. a liquid pumping chamber comprising first and second sealed liquid compartments separated by a first piston slidably movable therebetween;
B. a gas motor chamber comprising first and second hermetically sealed gas compartments separated by a second piston movable therebetween;
C. a linearly reciprocable piston shaft common to said first and second pistons;
D. first valve means operable by said second piston and movable between first and second operating positions,
1. means on said valve for connection thereof to a gas line,
2. means connecting said valve when in a first position to said first gas compartment,
3. further means connecting said valve in its second position to said second gas compartment,
4. push rod means remote and separate from said piston shaft connecting said second piston to said valve;
E. first and second liquid release valves respectively in said first and second liquid pumping compartments,
1. each of said release valves spring loaded into closed position but operable to open under the application of liquid pressure,
2. both of said liquid release valves connecting with a common liquid outlet port;
F. a liquid intake chamber having means for connection thereof to a reservoir of liquid;
G. first and second liquid check valves connected with said liquid intake chamber,
1. said first check valve connecting said intake chamber with said first liquid compartment, and
2. said second check valve connecting said intake chamber with said second liquid compartment,

whereby, upon movement of said first piston in a direction to decrease the volume of said first liquid compartment and increase the volume of said second liquid compartment, said second check valve opens to admit liquid from said intake chamber into said second compartment, and upon motion of said first piston in the opposite direction said first check valve means opens to admit liquid from said intake chamber into said first compartment.

9. The pump of claim 8 wherein said second piston comprises a flexible diaphragm centrally mounted

between symmetrically opposed walls of said gas chamber.

10. The pump of claim 9 wherein said first valve means comprises a toggle valve connected by a push rod to said flexible diaphragm.

11. The pump of claim 10 wherein said toggle valve has first, second, and third ports and is movable by said push rod between first and second positions alternately connecting said third port to said first and second ports.

12. The pump of claim 8 wherein the means for connecting said first valve to a gas line comprises a pressure regulator connectable to a compressed air source.

13. The pump of claim 12 wherein said pressure regulator comprises: an enclosure surrounding said valve; an inlet check valve in said enclosure; and means for resiliently loading said check valve toward its closed position.

14. The pump of claim 13 wherein said loading means comprises: a cantilevered spring within said enclosure; a diaphragm secured to the unsupported end of said spring and mounted in an opening defined by said enclosure; and a closure member for said check valve supported by said spring intermediate its ends.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,700,359 Dated October 24, 1972

Inventor(s) John A. Vanderjagt

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

Title Page: Correct assignee to read --Scienco, Inc.--

2, line 48 "strike" should be --stroke--.

Signed and sealed this 10th day of April 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents