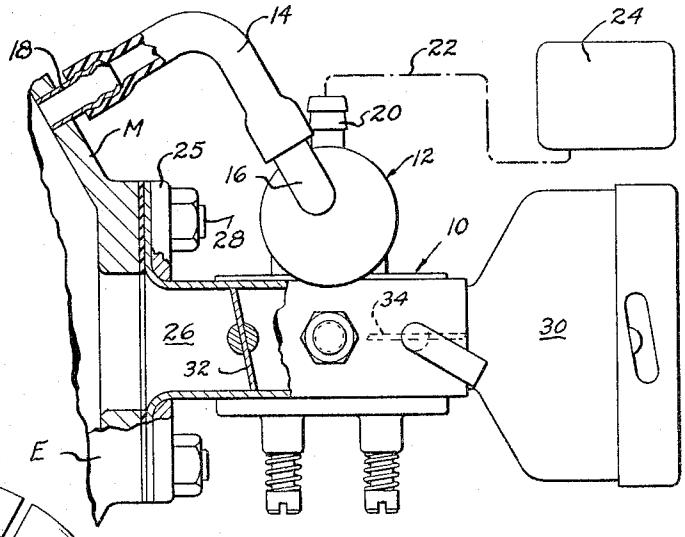
Oct. 11, 1966 R. E. KALERT, JR., ETAL 3,277,830

VALVED PUMP

Filed Nov. 2, 1964

FIG. 1.



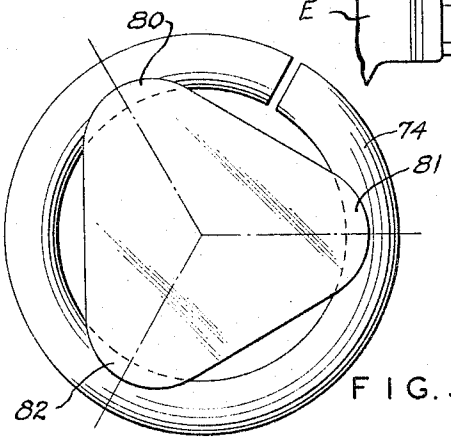


FIG. 3.

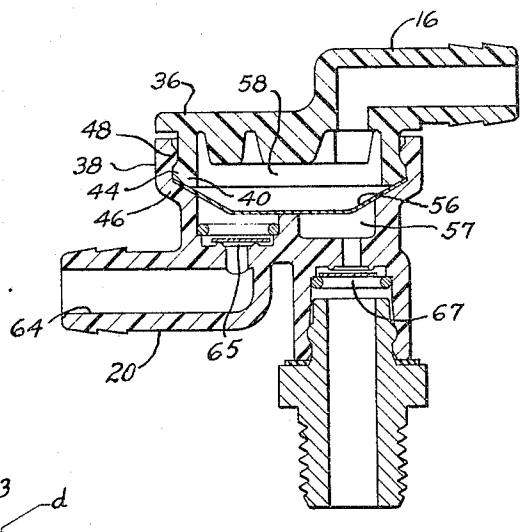


FIG. 2.

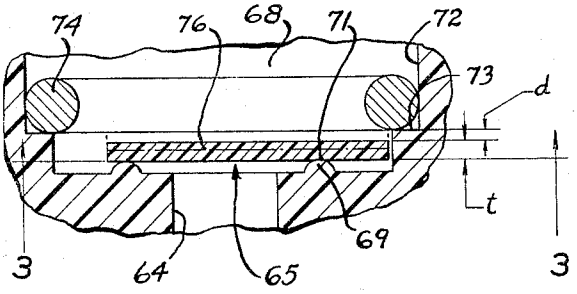


FIG. 4.

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VALVED PUMP

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5 Claims. (Cl. 103—44)

This invention relates to pumping devices, and more particularly to a diaphragm pump having check valves for regulating passage of liquid through the pump.

Heretofore, liquid pumps of the type contemplated have been effectively utilized in many applications such as on small internal combustion engines, for boats, power tools, lawnmowers and the like. Such engines are generally characterized by a relatively high rate of pulsation frequency. As a consequence, the normal check valve structure associated with fuel pumps for such engines, realize a notable decrease in efficiency due to the effect of inertia on reversible moving parts.

More precisely, the oscillating valve element of the normal check valves are found to be inadequate to pump fuel in an effcient manner. Thus, it has been necessary to resort to spring biasing means or other appropriate mechanisms, operable with the valve, or alternatively to utilize a gravity fuel feed system in place of a valved pump.

The present invention is particularly adapted to overcome the aforementioned valve problems particularly, as applied to high velocity pumping units. For example, small inexpensive diaphragm fuel pumps which can be added to a fuel system line between the carburetor and the source of fuel. Examples of such fuel pumps are disclosed in co-pending application, Serial Number 220,638, filed August 31, 1963, now Patent No. 3,178,055, entitled Fuel Pump, co-pending application, Serial Number 239,-898 of Eldon A. Johnson, filed November 26, 1962, now Patent No. 3,182,601 and entitled Fuel Pump, and co-pending application, Serial Number 338,175 filed January 16,1964, now Patent No. 3,218,978 entitled Diaphragm Device, Ralph E. Kalert, Jr., the entire disclosures of which are incorporated by these references.

Fuel pumps of the type presently contemplated consist generally of a diaphragm within a housing, forming a pair of chambers, disposed on either side of the diaphragm. One chamber is connected directly to the crankcase of an internal combustion engine in the instance of a two-cycle engine, or to the intake manifold in a four-cycle engine installation. The other chamber in the housing is a pumping chamber for the fuel, and is connected through check valve passages to the source of fuel for delivery of the latter to the carburetor. Pulsations provided by the engine during operation, reicprocate the pump diaphragm to urge fuel from the source into the carburetor. Check valves, embodied in the pump are operable by fluid pressure and biased between open and closed positions.

Air pressure pulsations in the engine are created by movement of a reciprocating piston to sequentially provide positive and negative pressures in the pumping chamber. For example, in a two-cycle unit, on the power stroke of the engine, air in the crankcase is compressed and provides a positive pressure to drive the pump. During the compression stroke of the piston, negative pressure is created in the crankcase and provides the suction required to displace the pump diaphragm in a suction stroke. Thus, the pump diaphragm flexes backward and forward upon compression and power strokes of the piston.

In a similar manner, operation of a four-cycle unit will

create pressure pulsations at the intake manifold which in turn act against the pump diaphragm to institute an oscillating movement.

Alternating pressure variations on the pump's respective check valve cause a free floating valve plate to alternate between open and closed positions. The valve plate, when in one position, is biased into contact with a valve seat defining a valve inlet, thereby regulating flow of fluid through said valve inlet. In a second or withdrawn position, the valve plate is spaced from the valve seat thereby defining an annular liquid flow passage.

The present pump structure, in brief, comprises a pair of interfitting body members which are snapped together to clamp or grip the diaphragm positioned between said two body members. The body members are formed with closely fitting and matching portions. Thus, one member may be rotated relative to the other about a common axis thereby allowing the pump assembly to be adapted to any carburetor structure without requiring a specific fixed arrangement of pump suction and discharge nipples for each particular installation. The diaphragm is tightly sealed and gripped about a marginal portion when the two interfitting body members are snapped into telescoping registry.

It is therefore, an object of the present invention to provide a valved pump, embodying pressure actuated valves including gravity biased movable valve members.

It is a further object of the invention to provide a pulse acuated fuel pump for a two cycle or a four cycle internal combustion engine, in which highly pressure sensitive check valves regulate fluid flow through a pumping chamber.

Another object is to provide a high speed, pressure sensitive pump having valves at the pump suction and discharge respectively, and adapted to rapidly oscillate between open and closed positions.

Briefly described, the invention comprises a pump having interfitting body members, one of said members being cup-shaped and having an outer annular rim and an annular shoulder adjacent the rim forming a seat. The other of the body members includes an annular extension telescoping within the cup-shaped member and adapted to be disposed adjacent the annular shoulder. A disc like diaphragm is positioned across, and sealed along its marginal portion between the annular extension and the annular shoulder. The annular seat and the annular extension embody complementary oppositely facing generally smooth and generally parallel surfaces. The diaphragm is positioned between the smooth surfaces of the annular seat and the annular extension thereby to peripherally seal and secure the diaphragm.

Said other annular member includes a first opening providing a fluid inlet or suction, a second opening for the pump discharge, and check valves disposed in each of said first and secondary openings. Each valve includes a light weight valve member positioned between the valve seat, and an abutting element to permit limited movement of the valve member thereby actuating the valve between open and closed positions.

In the drawings, FIGURE 1 is a segmentary plan view in partial cross section of a fuel system comprising a carburetor attached to the manifold of an engine, having the pump of this invention installed on the carburetor and connected to a source of fuel;

FIGURE 2 is a sectional view of the pump of FIGURE 1 showing the pump mounted on the carburetor;

FIGURE 3 is a segmentary view on an enlarged scale taken along line 3—3 of FIGURE 4 and;

FIGURE 4 is a segmentary view in cross section on an enlarged scale of the suction or inlet valve of the pump shown in FIGURE 2.

FIGURE 1 illustrates a fuel system embodying a pumping device for four-cycle operation. A carburetor indicated at **10** is mounted on intake manifold M of an internal combustion engine E, which, as mentioned, is a four-cycle arrangement. A fuel pump **12** is mounted to carburetor **10** and is connected by a flexible tubing **14** extending from nipple **16** to fitting **18** to provide an air conduit between the engine intake manifold and pump **12**.

Another laterally extending nipple **20** is connected by fuel line **22** to a source of fuel, such as tank **24** schematically shown.

The carburetor is of a well-known type and consists primarily of a tubular air and fuel mixture conduit **26** attached by a flanged end **25** to the engine manifold, through a stud **28** depending from the engine block. At the inlet end of conduit **26**, an air filter housing **30** communicates with opening **26**. Housing **30** holds a porous filter element for removing dust and other particles from air entering the carburetor.

Rotatably mounted within the carburetor are a throttle valve **32** and a choke valve **34** to control the flow of air through the carburetor. Other details of the carburetor are well known to the art, and are not further illustrated.

Carburetor **10** is operated in a conventional manner to provide an air flow into the engine manifold, and to mix with said air a controlled amount of fuel to provide the proper combustible air/fuel mixture. Details of fuel pump **12** are shown more specifically in FIGURE 2. As there illustrated, pump **12** consists essentially of interfitting oppositely facing cup-shaped body members generally designated **36** and **38**. Upper cup-shaped member **36** includes an annular extension **40** forming an inner rim. Lower cup-shaped member **38** embodies an annular rim **46** with an annular lip **48** formed on the inner circumference thereof.

Body members **36** and **38** are designed so that the lower cylindrical end of body member **36** will coaxially telescope into the open rim lip **48** of cup-shaped member **38**. The interfitting of body members **36** and **38** requires a structure or material characterized by a degree of resilience when said members are snapped together. One material which furnishes the necessary resilience is a plastic as, for example, an acetal resin. It is understood that other types of plastics or resilient materials may be employed as well for forming said body members **36** and **38**.

Annular lip **48** is formed such that the rim of member **38** will expand by a flowing of the plastic material to permit bead **44** to enter and snap against seat **46**. Bead **44** is dimensionally slightly larger than the diameter of lip **48**, resulting in a tight fit between the two portions because of the mismatch.

A flexible, pump diaphragm **56** is fitted against seat **46** within cup-shaped member **38**. When bead **44** is snapped into annular groove **40** the lower flat surface of **44** presses tightly against diaphragm **56**.

Diaphragm **56** is fabricated of an appropriate material such as fabric, coated with a fuel resistant synthetic rubber material to provide the desired flexibility and strength.

A fuel pumping chamber **57** is formed between diaphragm **56** and lower cup-shaped member **38**, while a substantially closed air chamber **58** is formed within upper cup-shaped member **36**. Positive pressure pulsations in intake manifold M are relatively small and variable when the pump is utilized with a four-cycle engine. Thus, a coil spring, while not presently shown, may be carried in body member **36**, and bear against the upper surface of the diaphragm.

The valve structure shown in FIGURE 2 at **65** and **67**, are substantially identical, being reversibly positioned however relative to liquid flow to regulate a unidirectional flow through chamber **57**.

Referring to FIGURE 4, each check valve is embodied in an elongated passage including an inlet **64** which opens into a well **68** formed in the lower surface of body **38** and communicated with chamber **57**. Said inlet includes a generally annular valve seat **69** disposed concentrically of the inlet **64** and further embodies a smooth seating surface **71** at the upper edge thereof.

The upper or opposed end of well **68** includes a counter bored portion **72** terminated at an annular shoulder **73**, which is spaced longitudinally from the seating surface **71**. Said shoulder is disposed substantially concentric with passage **64** thereby defining a stepped portion of the chamber.

An abutting member **74** is retained in well **68** and may, as shown in FIGURE 4, comprise a circular, split member, being inwardly deformed to be slidably received in well **68** and thereafter positioned against shoulder **73**. Release of said abutting member **74** permits the latter to assume a normal, radially expanded set, thereby locking itself in position within the cylindrical wall.

The abutting or positioning means may be disposed in an annular groove or similar track formed in the walls of the chamber to longitudinally position said member with respect to the seating surface **71**. Abutting member **74**, although presently illustrated in FIGURE 3, as a circular spring, defining a central opening may also assume other configurations adapted to the purpose as hereinafter described.

Valve member **76** includes a relatively thin, disc-like element being free floating, but nonetheless confined for longitudinal movement when subjected to fluid pressure between valve seating surface **71** and the inner surface of the abutting member **74**.

Said valve member **76** is so formed as shown in FIGURE 4 having peripheral edges disposed contiguous with adjacent cylindrical walls defining the lower end of well **68**. As further shown in FIGURE 3, said disc-like valve member although being slidably guided along the cylindrical walls is formed to engage said wall at a limited number of points and consequently form a limited area of contact with the surface of abutting member **74**.

In the embodiment presently shown, valve member **76** assumes a geometrical triangular configuration having three peripheral tabs **80**, **81** and **82** adapted to slidably engage adjacent wall of well **68**.

As shown by phantom lines in FIGURE 4, when valve member **76** is in the uppermost position thereby engaging abutting member **74**, contact with the latter is made entirely at the 3 discrete points peripherally spaced along the surface of member **74**. Thus, because of the minimized total contact area, there will be little tendency for adhesion of valve member **76** to the abutting member **74** as a result of capillary action between said respective members due to liquid retained therebetween.

Referring again to FIGURE 4, valve member **76** is relatively light, having a thickness of approximately .010 to .035 inch, and formed of Mylar, or a similar chemically resistant material not susceptible to deterioration by contact with liquid fuel. The lightness of member **76** permits ready movement thereof, between spaced end positions, thus minimizing the effects of inertia on said member. Valve element **76** although preferably formed of a plastic material such as Mylar or the like, might also be formed of a suitably light, rigid metal adapted to the purpose as a rapidly oscillating seal member.

The underside of valve member **76** is adapted to sealably engage the annular seat **71** sufficiently tight to avoid passage of liquid through the annular seating area.

As shown in FIGURE 4, the thickness of valve member **76** is adequate to define an annular opening between seat **71**, and the adjacent surface of valve member **76**. Thus, the maximum distance of travel of member **76** between spaced contact surfaces is minimized, and the valve is consequently more susceptible to slight pressure variations imparted by the diaphragm **56**.

The respective check valves are readily assembled into lower cover member **38** by first inserting the valve member **76** into well **68**, and thereafter radially deforming abutting member **74** to a diameter less than a diameter of

well 68, and inserting said member 74 to rest against shoulder 73. Release of the abutting member permits the latter to expand to its natural open position thereby forceably engaging the adjacent well walls.

With the respective check valve assemblies in place, cup-shaped members 36 and 38 are coaxially mounted with matching cylindrical portions aligned. This permits one of said members to be rotated relative the other about a common longitudinal axis of pump 12 to provide any desired angular relationship between liquid inlet nipple 36 and air connection nipple 16 thereby allowing adaptation of the pump to any carburetor or any installation.

Under test conditions, a fuel pump as herein described was operated in conjunction with a small two-cycle internal combustion engine, having a rotational velocity of approximately ten thousand revolutions per minute. In the check valve structure, as shown in FIGURE 4, the traveled distance "*d*" was fixed at about .007 inch by spacing ring 74 longitudinally from seat 71 an amount approximating the sum of the desired travel distance plus thickness "*t*."

Under the above operating conditions, and with pulse transmittal line connected to an internal combustion engine manifold, the rapid frequency of pulsations would prohibit an ordinary valve plate to function improperly and thus fail to move any substantial amount of liquid through the pump.

It was found however, that under the operating conditions noted above, that the novel valve arrangement herein described, provided a continuous, uninterrupted fuel flow from the fuel source through the pump discharge and to the engine carburetor.

It is clear that the presently described fuel pump and check valve arrangement provides a novel, highly efficient operational unit in which the moving valve element readily overcomes the previous difficulties inherent to high speed engine operation.

It is further understood that certain changes and modifications may be made in the disclosed structure of the check valve means and pump without departing from the spirit and scope of the invention.

We claim:

1. A rapid acting pulse pump including:

(a) a casing,

(b) a diaphragm disposed in the casing forming pressure and liquid chambers respectively therein, and being movable between forward and rearward positions,

(c) said pressure chamber being communicated with a source of pulsating pressure for acting against said diaphragm and for oscillating the latter between said forward and said rearward positions,

(d) said liquid chamber having suction and discharge openings,

(1) said suction opening being communicated with a supply of liquid to be pumped,

(e) valve means carried in at least one of said suction and discharge openings and being operable to regulate a flow of liquid passing through said liquid chamber, the improvement therein of:

(f) said valve means including:

(1) means forming a passage communicating with said liquid chamber and having a valve seat,

(2) a circularly cross-sectioned ring member disposed in said means forming a passage and being spaced downstream of said valve seat,

(g) a free floating valve member retained in said means forming a passage and being movable between said valve seat and said ring member for alternately contacting said respective members thereby opening and closing said passage to regulate the flow of liquid therethrough,

(h) said free floating valve member having a geometric shape formed with straight edges which terminate at arcuate junctures, the latter overlying at least a portion of said spring member,

(i) whereby when said valve member is urged against said ring member the area of contact therebetween will be limited to point contact at each of said arcuate junctures, thereby minimizing the holding force between said members caused by capillary action of liquid retained in areas adjacent to said respective points of contact.

2. In a pump as defined in claim 1 wherein said ring member includes:

(a) a circular spring member being outwardly biased to engage walls of said passage, and defining a central opening for passage of liquid therethrough.

3. In a pump as defined in claim 1 wherein said ring member includes:

(a) a substantially circular split spring retained in said means forming said passage and having an inner wall portion disposed to engage said valve member.

4. In a pump as defined in claim 1 wherein said valve member includes:

(a) a triangular shaped member having at least three arcuate junctures spaced substantially equally about the periphery of said valve member.

5. In a pump as defined in claim 1 wherein said valve member includes:

(a) a lightweight plastic member having at least three arcuate junctures.

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