May 11, 1965 E. A. JOHNSON 3,182,601

FUEL PUMP

Filed Nov. 26, 1962

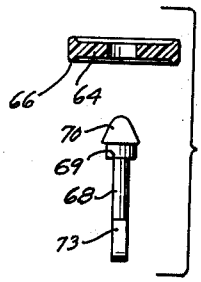


FIG. 5.

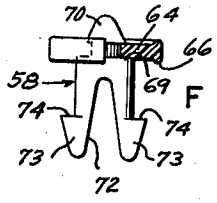


FIG. 6.

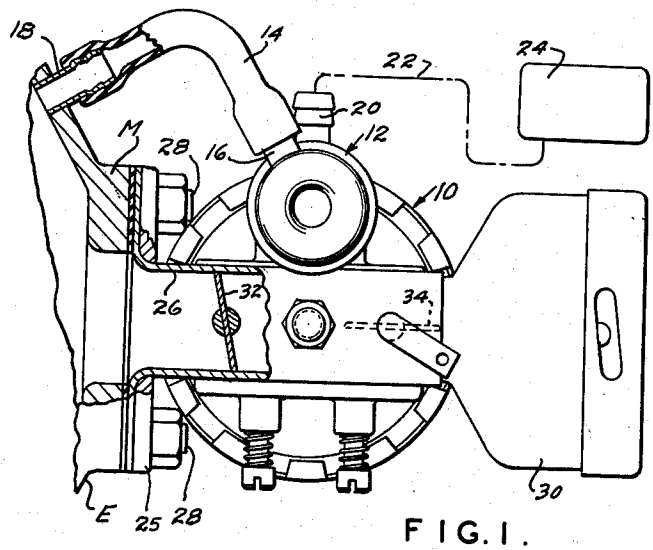


FIG. 1.

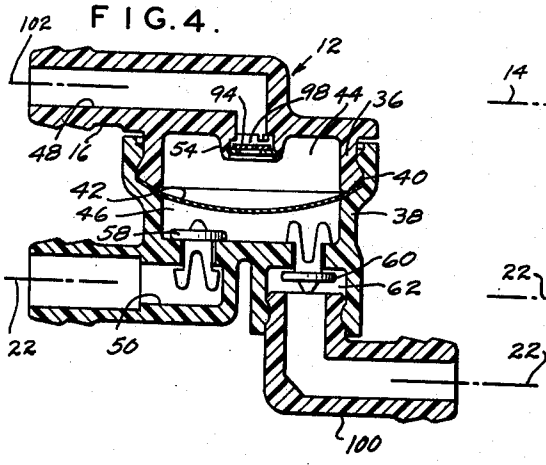


FIG. 4.

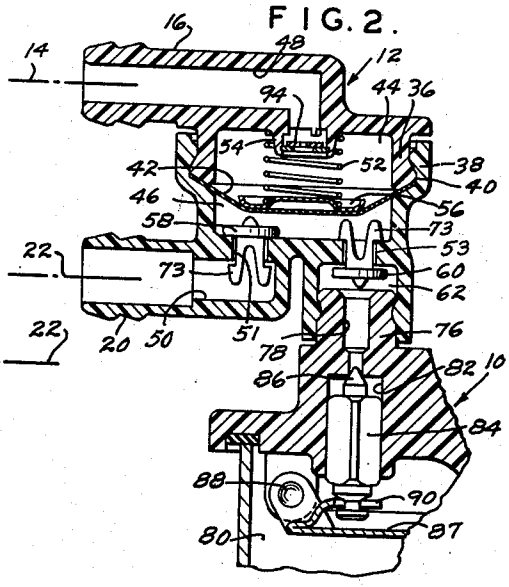


FIG. 2.

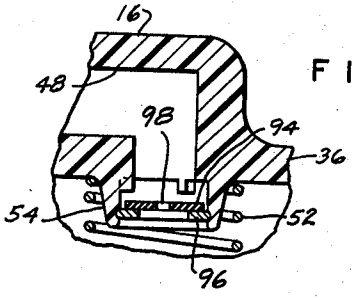


FIG. 3.

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FUEL PUMP

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The invention is directed to a fuel pumping device for small carburetors.

Many inexpensive small internal combustion engine installations comprise a source of fuel consisting of a fuel tank supported above the engine in order that the fuel to the engine can be gravity fed. However, since this is not an entirely satisfactory manner to supply fuel to the engine because of variations in fuel level, small diaphragm fuel pumps have been devised which can be added to the fuel system by mounting the pump either on the carburetor or somewhere in the fuel line between the carburetor and the source of fuel. Such fuel pumps consist of a small diaphragm forming a pair of chambers within a housing, one on either side of the diaphragm. One chamber is connected directly to the crankcase of the internal combustion engine, if it is a two cycle engine, or to the intake manifold in a four cycle engine installation. The other chamber in the housing is the pumping chamber for the fuel and is connected through check valve passages to the source of fuel and to the carburetor. Pulsations provided by the engine during operation reciprocate the pump diaphragm to pump fuel from the source into the carburetor.

In four cycle engine installations of such a pump, it has been found that when the air chamber of the pump is connected to the engine manifold, the suction or negative pressures provided by the engine are ample, but the positive pressures provided to the pumping diaphragm under certain operating conditions are relatively small. For example, in four cycle engines as the speed increases so does the positive pressure, but at low speeds the positive pressure is of a small value, in the order of one inch of water pressure. It is desirable in pumps and fuel systems of this type that the fuel furnished to the carburetor be maintained at a constant pressure in the fuel line so that, with proper adjustments at the carburetor, the supply of fuel will be constant and will not be dependent upon the speed of operation of the engine. Because of low positive pressure at low speeds in four cycle operation, it is necessary to provide an additional means for aiding the pump to maintain a constant fuel pressure at all speeds.

In two cycle installations of a small diaphragm pump, the air chamber is normally connected to the engine crankcase and the air pressure pulsations created in the crankcase by movement of the piston backward and forward provide the positive and negative pressures in the pumping chamber. For example, on the intake stroke of the piston, the air in the crankcase is compressed and provides a positive pressure to drive the pump. Upon the exhaust and compression stroke of the engine, negative pressure is created in the crankcase and provides the suction required to move the pump diaphragm in a suction stroke. The value of the pressures created in the crankcase is related to the position of the carburetor choke and throttle.

The positive pressures in the crankcase of two cycle engines may vary from three pounds to ten pounds per square inch, while the negative pressures applied to the pump diaphragm vary from two inches of water pressure at wide open throttle to four to six inches of water pressure at low speeds. Because of the great differences between the positive and negative engine pressures, the pump action is erratic in that the negative pressure often is insufficient to pull the diaphragm in a fuel suction stroke before the high positive pressures drive the pump in a pumping stroke. This results in inefficient pump operation since the suction strokes are small and little fuel is pulled from the source through the pump.

It is thus an object of the invention to provide a small diaphragm fuel pump for an internal combustion engine which will provide a constant positive pumping stroke in a four cycle installation.

It is another object of this invention to provide a diaphragm fuel pump which will be adapted to utilize the available negative pressures for pumping fuel efficiently.

It is a further object of this invention to provide a small diaphragm fuel pump for four cycle installations in which the negative and positive pressures applied to the diaphragm are of values to provide a uniform pumping action.

It is another object of this invention to provide a diaphragm fuel pump for two cycle installation in which the positive pressures applied to the pump are minimized to provide a more efficient pumping action.

The installation is in a small diaphragm pump for both four cycle and two cycle operation. When the pump is used in a four cycle engine, a spring is provided in the air chamber of the pump to drive the pump in a pumping stroke. The spring is loaded by the negative pressures in the intake engine manifold which are sufficient to fully load the spring. Because the positive pressures in the intake manifold are small and variable, these pressures are effectively eliminated from pump operation and the spring is utilized to provide a uniform pumping stroke. In two cycle operation of the pump, a valve structure is provided having a controlled aperture therein so that the high positive pressures available in two cycle operation are reduced and the variation in positive pressure is evened out under all conditions of engine operation. This provides an operative positive pressure for the pump and one which is not excessive to adversely affect pump operation. In two cycle engine operation as the negative pressures are relatively less, the valve structure opens completely to provide the full application of the negative pressures to operate the pump diaphragm during engine operation.

FIGURE 1 is a plan view of a fuel system comprising a carburetor attached to the manifold of an engine with the novel pump of this invention installed on the carburetor and connected to a source of fuel.

FIGURE 2 is a partial sectional view of the novel pump structure and the associated carburetor of FIGURE 1.

FIGURE 3 is an enlarged partial sectional view of the pump structure shown in FIGURE 2.

FIGURE 4 is a sectional view in elevation of a modification of the pump of FIGURE 2 for two cycle installation.

FIGURES 5 and 6 are detailed views of the valve structures used in the pumps of FIGURES 1 through 3.

FIGURE 1 discloses a fuel system utilizing the invention. A carburetor indicated at **10** is mounted upon the intake mainfold M of an internal combustion engine E, which in this particular showing is a four cycle engine. A fuel pump **12**, in accordance with hte invention, is mounted on the carburetor and is connected by a flexible tubing **14** from a nipple structure **16** to a fitting **18** to provide an air conduit between the engine intake manifold and the pump **12**. Another laterally extending nipple structure **20** is connected by a fuel line **22** to a source of fuel, such as a fuel tank **24** schematically shown. The carburetor is of a known type and consists mainly of a tubular air and fuel mixture conduit **26** attached by a flanged end **25** to the engine manifold, such as by stud **28** extending from the engine block. At the other end, an air filter housing **30** provides an opening to the mixture conduit **26**. Within the filter housing **30** is a porous filter for removing dust and other particles from the air entering the carburetor. Within the carburetor are rotatably mounted a throttle valve structure **32** and a choke valve structure **34** to control the flow of air through the carburetor. Other details of the carburetor are well known and are not shown nor need be described at this time.

Carburetor **10** is operated in a conventional manner to permit air flow into the engine manifold and to mix with the air a controlled amount of fuel to provide the proper combustible air and fuel mixture. Details of the fuel pump **12** are shown more specifically in FIGURE 2. The pump **12** consists essentially of a pair of cylindrical cups **36** and **38** whose rims are telescoped together with a groove and rim connection. When the rim of cup **36** has a rib **40** fitted into a groove formed around the rim of cup **38**, rib **40** snaps into the groove of cup **38** to provide a tight fit. A diaphragm **42** is positioned between cups **36** and **38** so that when they snap together the peripheral edge of diaphragm **42** is sealed between the adjacent cup portions as shown in FIGURE 2. Diaphragm **42** is of any appropriate material such as a fabric coated with a fuel resistant synthetic rubber material to provide sufficient flexibility and strength. Diaphragm **42** forms with cup **36** an air chamber **44** and with cup **38** a fuel pumping chamber **46**. Nipple **16** extends laterally from the top of cup **36** while the nipple **20** extends laterally from the bottom portion of cup **38**. Nipple **16** is formed with a passage **48** therethrough which connects air chamber **44** with a flexible tubing **14** to the manifold M of the engine. In a similar manner, a fuel inlet passage **50** extends through the nipple **20** to connect the fuel chamber **46** with the fuel line **22** leading from the fuel tank **24**. A spring **52** is positioned between a short hollow boss structure **54** extending from the top of cup **36** at one end and at the other fits in a dished plate **56** supported by the diaphragm **42**.

An inlet valve structure **58** is inserted in a short portion **51** of passage **50** leading into the chamber **46**, and in a similar manner an outlet valve structure **60** is fitted within a short outlet passage **53** through the bottom of cup **38** connecting the chamber **46** with an outlet chamber **62**.

The valve structures are shown in detail in FIGURES 5 and 6 and consist of a small disk **64** made of synthetic fuel resistant material, such as an acetal resin. Disk **64** has a central aperture therethrough and a rim structure **66** extending from the two flat surfaces thereof. A plastic molded valve stem **68** has a rounded head **70** at one end having a flanged portion abutting one surface of disk **64**. A flanged shoulder portion **69** of stem **68** abuts the other surface of disk **64** to tightly hold disk **64** to stem **68**. The stem **68** is bifurcated at **72** at its other end to form a pair of legs **73**. Each of the legs **73** is formed with a projecting surface **74**. The valves are mounted within the pump structure by inserting the valve washer **64** over the respective fuel passage **51** or **53** and then inserting the head **70** of the valve stem **68** through the fuel passage and the aperture of the valve washer **64**. The flanged portions of head **70** lock the valve stem **68** to the washer on one side, while the projecting leg portions **74** of the valve stem project beyond the diameter of the fuel passage to lock the valve structure within the fuel passage at the other end. FIGURE 2 shows the assembled position of the valve in the inlet passage **51** and outlet passage **53** of the fuel pump.

In FIGURE 2, the fuel pump **12** is installed on the carburetor **10**. The outlet chamber **62** of the fuel pump consists of a cylindrical recess which can be snapped over a projecting apertured boss **76** extending upwardly from the body of the carburetor **10**. The boss **76** has an inlet passage **78** which is connected with the inside of a fuel chamber **80** through a valve passage **82**. A carburetor needle valve **84** is positioned within the valve passage and has a tapered end **86** for blocking fuel flow from the inlet passage **78**. The valve **84** of the carburetor may have a triangular or rectangular section and is mounted for sliding movement in the cylindrical passage **82**. Valve **84** is operated by a lever **87** pivoted at **88** and has a lever arm **90** locked to the inlet valve **84** for its operation. Lever **87** can be moved by either a float structure or a diaphragm in the fuel chamber **80** to open and close the valve **84**.

In the installations shown in FIGURES 1 and 2, the pump **12** is connected to the manifold of a four cycle internal combustion engine. The effective positive pressures within the manifold of such an engine during operation are not of such value to be relied upon for pump operation. The negative pressures are those provided during the intake stroke of the piston and may vary from a negative pressure of 8 to 10 inches of mercury at closed and partially open throttle to a negative pressure of two to ten inches of water at wide open throttle. During engine operation at low speeds, the negative pressure will move the diaphragm **42** upwardly in a fuel suction stroke and thus load the diaphragm. However, the positive pressures, at any speed, are normally so small that insufficient pressures are provided to force the diaphragm downwardly in a pumping stroke, as viewed in FIGURE 2. Therefore, in accordance with this invention, a spring **52** is provided in the air chamber **44** of the fuel pump to aid in the pumping stroke of the engine. Since the negative pressures are more than sufficient to pull the diaphragm upwardly in a suction stroke the spring **52** is selected so that it may be adequately loaded by the negative pressures. The action of the spring then is such that, during the positive cycle of the pump, the spring will aid the positive pressures available to force the diaphragm downwardly in a pumping stroke. The spring provides at all times a constant pumping pressure for the fuel in chamber **46** so that at no time during engine operation will the pumping stroke be deficient in forcing fuel to the carburetor.

An alternate structure is shown in the pump of FIGURES 2 and 3 in the form of a small valve disk **94**, which rests on a valve seat **96**. A small central aperture **98** is formed through the valve disk **94**. The purpose of the valve **94** is to substantially eliminate positive pressures from acting on the pump diaphragm because of their undependability and thus rely for pump action only on the negative pressures and the spring bias. The operation of the modification of FIGURES 2 and 3 is such that under negative pressures the valve **94** opens and allows the chamber **44** to be partially evacuated. The negative pressure is sufficient to draw the diaphragm upwardly, as viewed in FIGURES 2 and 3 and to load the spring **52**. Upon application of positive pressures, however, the valve **94** is closed and the positive pressures have little or no value in aiding the diaphragm in its downward or pumping stroke. This is provided by the spring **52** alone, although it is within the concept of this invention that the aperture **98** in the valve disk **94** may be adjusted to enable the positive pressures to aid the spring, if desired.

Otherwise, the presence of the aperture **98** enables the flow of air into the chamber **44** as the diaphragm is pressed downwardly in the pumping stroke. In this case aperture **98** should be large enough to not retard the diaphragm in the discharge stroke.

FIGURE 4 shows a modification of the pump disclosed in FIGURES 2 and 3. Structures identical to those in FIGURES 2 and 3 are given the same reference numerals. The pump of FIGURE 4 is shown as mounted on a fitting **100** instead of on a carburetor. Fitting **100** may be placed anywhere in the line **22** from the tank **24** to the carburetor **10**. For example, the pump could be mounted directly on the engine for ease of installation. In this modification of FIGURE 4, the spring **52** of the pump of FIGURE 2 is eliminated and the valve disk **94** is retained. For operation with a two cycle engine, the air passage **48** is connected by a flexible air conduit, schematically shown at **102**, to the crankcase of the engine. In two cycle operation, the positive pressures provided in the crankcase occur during the downward stroke of the piston in its power and intake stroke. The pressures in the crankcase build up from a value around three pounds per square inch, for example, at low speed operation of the engine around 2,000 r.p.m. to ten pounds per square inch pressure at high engine speeds around 10,000 r.p.m. These pressures are more than sufficient to operate the pump diaphragm **42** in its pumping stroke. However, if the variable high positive crankcase pressures are applied directly to the fuel through the diaphragm **42**, the corresponding variable fuel pressures, which result, are difficult to control by the fixed adjustments in the carburetor. For example, excessively high positive pressures in the pump chamber **44**, at high speed operation of the engine, would force an excessive amount of fuel into the carburetor chamber **80** causing the carburetor to go rich. This would result either in an inefficient operation of the engine or to stop the engine completely. A constant fuel pressure at the carburetor is one which can be adjusted for by the manual carburetor adjustments to provide a consistent flow of fuel to the engine at all speeds of engine operation. Accordingly, it is desirable that these variable high positive pressures be reduced to a substantially constant positive pressure so that fuel delivered to the carburetor will also remain substantially at a fixed value for all conditions of engine operation.

In two cycle operation, the negative pressures in the crankcase provided by the compression and exhaust stroke of the engine are relatively small in comparison to the positive pressures. For example, at low engine speeds around 2,000 r.p.m., the negative pressures may be between five or six inches of mercury. At high engine speed around 10,000 r.p.m., the negative pressure falls to less than 2 inches of mercury at wide open throttle. These low negative pressures are often insufficient to properly load the diaphragm **42** for its intake stroke when high positive pressures must first be eliminated from the pumping chamber and the pumping diaphragm pulled upwardly to its fullest extent.

Therefore, also in accordance with the invention, the valve disk **94** of FIGURE 4 operates to close the air passage **48** of the pump during the positive pulse of engine operation in the manner described above relative to the pump of FIGURES 2 and 3. The aperture **98** in the disk **94** is provided with a size such that sufficient air will flow through the valve **94** into the air chamber **44** to provide the positive pumping stroke of the diaphragm **42**. The size of the aperture, for example, may be around $\frac{1}{32}''$. The action of the valve **94** is such as to level off and dampen the positive pulses applied to the diaphragm chamber **44** so that for most of the engine operation, the positive pressure in pump chamber **44** is at a consistent four or five pounds per square inch. This pressure is not excessive and the negative pulse then is able to clear the chamber **44** quickly enough to permit fuel pressure in

chamber **46** to return the diaphragm **42** to its uppermost position for a pumping stroke.

Thus, by eliminating the high positive pressures applied to the diaphragm a more efficient pump action is provided, since the negative pressures are now sensed to a greater degree within the air chamber **44** than when coupled with excessively high positive pressures. Furthermore, by providing a consistently constant positive pressure for the pumping stroke of the pump, the fuel pressure delivered from the pump is at a constant pressure. This permits the carburetor inlet valve control to operate consistently and retain fuel within the carburetor fuel chamber **80** at a constant value.

I claim:

1. A pulse pump for a fuel system, said pump comprising a body member enclosing a cavity, a diaphragm sealed around its periphery across said cavity and forming with said body member an air chamber on one side of said diaphragm and a fuel chamber on the other side of said diaphragm, said diaphragm having a movable portion, inlet and outlet passages through said body member and opening into said fuel chamber to provide fuel flow therethrough, an inlet check valve in said inlet passage and an outlet check valve in said outlet passage, an air passage through said body member opening into said air chamber to provide pulses thereto, resilient means in said air chamber between said body member and said diaphragm portion to bias said diaphragm into said fuel chamber in a pumping stroke, a valve seat in said air passage adjacent the air chamber and extending generally in a horizontal plane, and a free floating valve disk within the air passage over the valve seat adapted to seat by gravity against the valve seat, said valve disk responsive to pressure within the air passage and being unseated upon a predetermined negative pressure being exerted in the air passage, a positive pressure in the air passage aiding gravity seating of said valve disk so that the disk is seated across said air passage upon movement of the diaphragm in its pumping stroke and is opened upon movement of the diaphragm in its suction stroke thereby to control the effect of positive pressure in the air passage on the pumping stroke of the diaphragm.

2. A pulse pump for a fuel system, said pump comprising a body member enclosing a cavity, a diaphragm sealed around its periphery across said cavity and forming with said body member an air chamber on one side of said diaphragm and a fuel chamber on the other side of said diaphragm, said diaphragm having a movable portion, inlet and outlet passages through said body member and opening into said fuel chamber to provide fuel flow therethrough, an inlet check valve in said inlet passage and an outlet check valve in said outlet passage, an air passage through said body member opening into said air chamber to provide pulses thereto, a valve seat in said air passage adjacent the air chamber and extending generally in a horizontal plane, and a free floating valve disk within the air passage over the valve seat adapted to seat by gravity against the valve seat, said valve disk responsive to pressures within the air passage and being unseated upon a predetermined negative pressure being exerted in the air passage, a positive pressure in the air passage aiding gravity seating of said valve disk so that the disk is seated across said air passage upon movement of the diaphragm in its pumping stroke and is opened upon movement of the diaphragm in its suction stroke thereby to control the effect of positive pressure in the air passage on the pumping stroke of the diaphragm.

3. A pulse pump for a fuel system, said pump comprising a body member enclosing a cavity, a diaphragm sealed around its periphery across said cavity and forming with said body member an air chamber on one side of said diaphragm and a fuel chamber on the other side of said diaphragm, said diaphragm having a movable

portion, inlet and outlet passages through said body member and opening into said fuel chamber to provide fuel flow therethrough, an inlet check valve in said inlet passage and an outlet check valve in said outlet passage, an air passage through said body member opening into said air chamber to provide pulses thereto, and a check valve in said air passage being seated across said air passage upon movement of the diaphragm in its pumping stroke to reduce the flow of air into said air chamber, said check valve having an aperture therethrough of a predetermined size to limit the flow of air into said air chamber under positive pressure.

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