United States Patent

Sieper

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[54] DIAPHRAGM PUMP

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[51] **Int. Cl.** **F04b 39/10**, F04b 37/00

[58] **Field of Search** 417/542, 571, 471

[56] **References Cited**

UNITED STATES PATENTS

3,200,758	8/1965	Grabiel	417/471
3,304,880	2/1967	Gold et al.	417/471 X

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[57] **ABSTRACT**

A diaphragm pump intended particularly for use as a fuel pump for internal combustion engines has inner and outer housings separated by a diaphragm. The space contained between the diaphragm and the outer housing forms the working space of the pump through which the fluid is sucked in and discharged. This space is divided by a single unitary separating wall into three separate chambers. This is effected by clamping the edge of the separating wall between the diaphragm and the rim of the outer housing and forming the separating wall so that it also forms a second seal against the outer housing. This second seal extends round a closed path and the space between the outer housing and the separating wall within this seal forms a suction chamber and the space outside this seal is divided by a further part of the separating wall into a working chamber partly defined by the diaphragm and a pressure chamber. The separating wall is provided with a suction non-return valve between the suction chamber and the working chamber and an outlet nonreturn valve between the pressure chamber and the working chamber.

8 Claims, 4 Drawing Figures

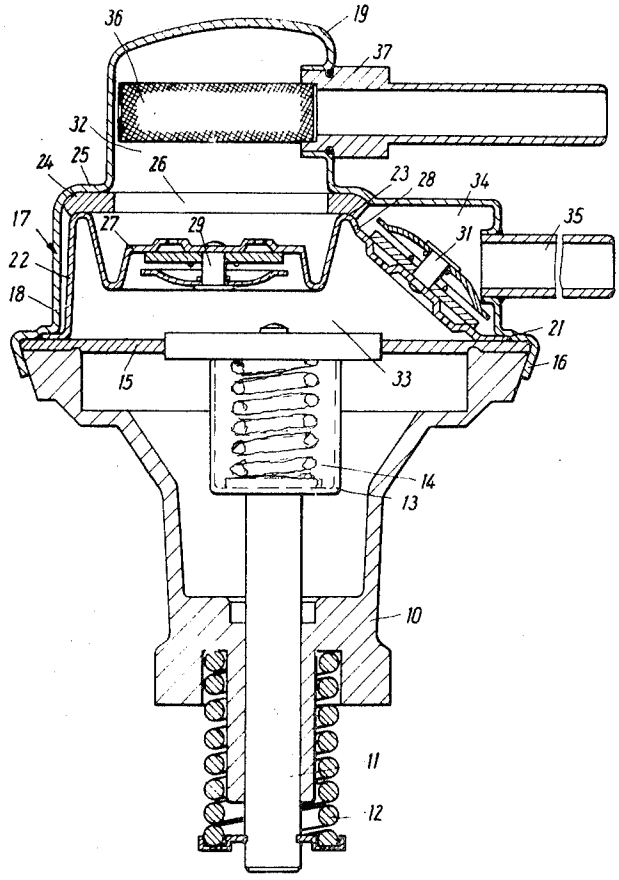

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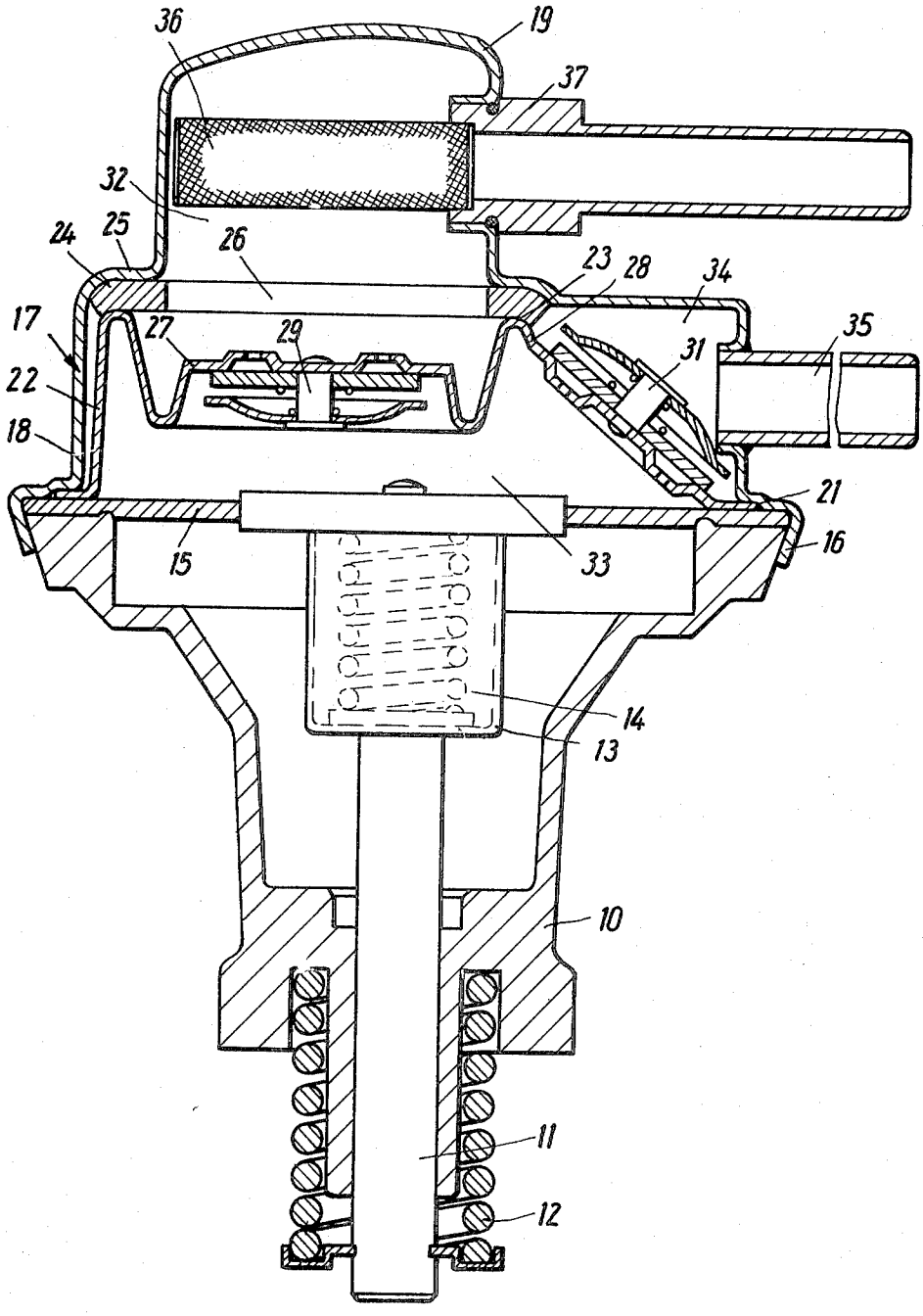
Fig. 1



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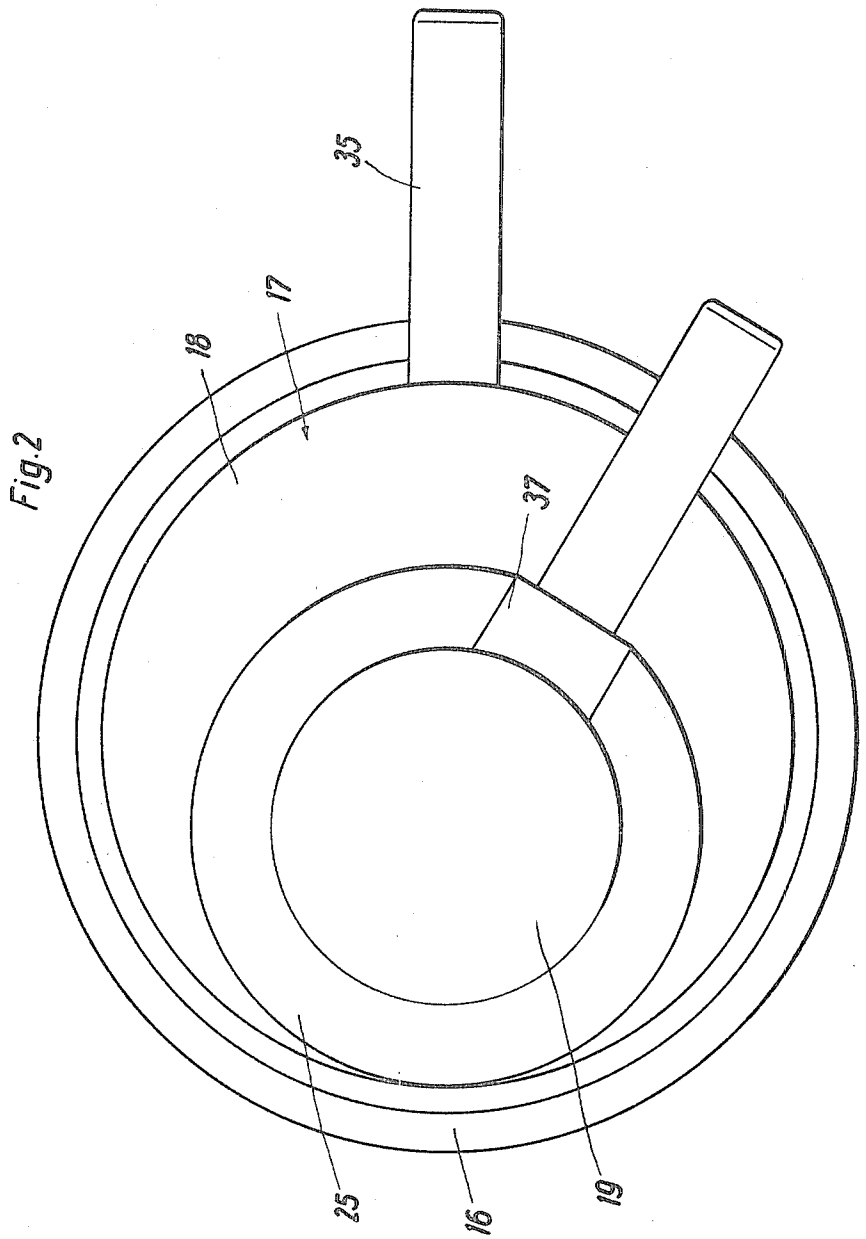

Fig. 2

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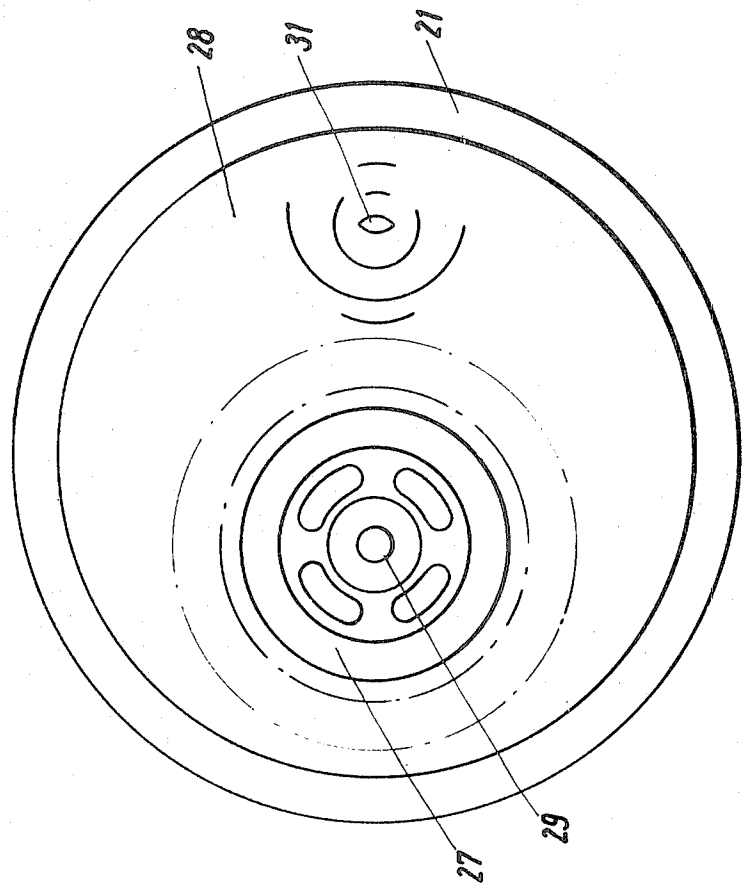

Fig.3

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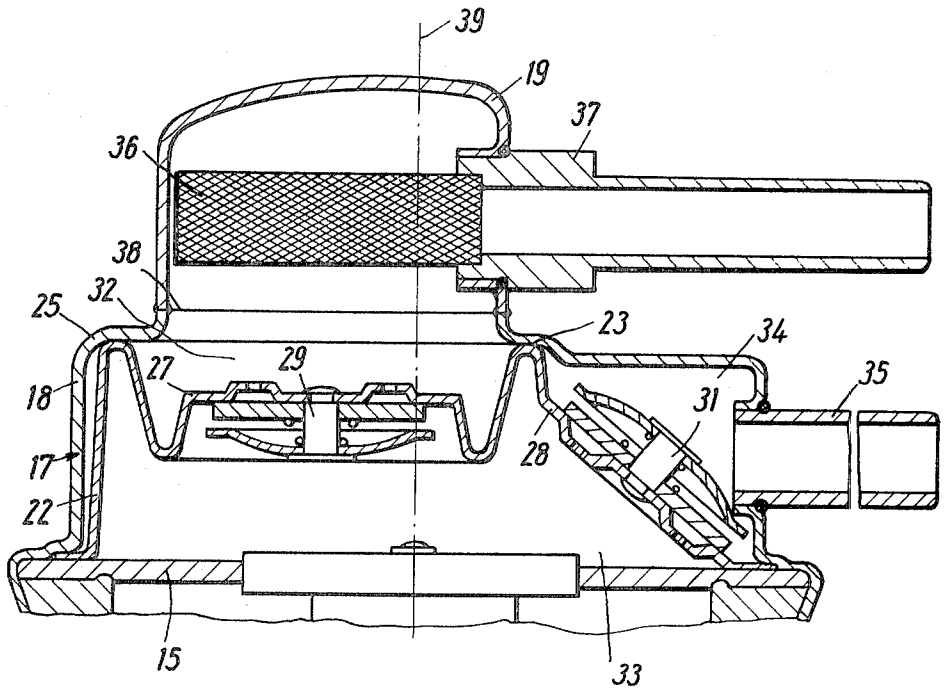
Fig. 4



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DIAPHRAGM PUMP

This invention relates to diaphragm pumps, such as fuel pumps for internal combustion engines of the kind comprising inner and outer housings separated by the diaphragm, the outer housing being situated on the working side of the diaphragm and containing a suction chamber, a pressure chamber and a working chamber.

Diaphragm fuel pumps are known in which the outer housing consists of two superposed housing parts. In the lower housing part there is a supporting wall whose outer edges are closely bonded to the diaphragm and to the housing part. The supporting wall contains one way inlet and outlet valves. The supporting wall separates the working chamber which is situated above the diaphragm, from the suction chamber which is situated above the inlet valve, and also from the pressure chamber which is situated above the outlet valve. For sealing the suction chamber from the pressure chamber it is necessary to provide a bush. The bush is situated between the supporting wall and a shoulder on the lower part of the outer housing. This pump is expensive to construct, due to the necessary seals between the suction chamber and the pressure chamber, and between the pressure chamber and the working chamber. The pump is therefore not economic to manufacture. Furthermore the pump occupies a great deal of space, due to the positioning of the valves next to each other, and is therefor comparatively large.

The object of the present invention is to provide a diaphragm pump of the kind described, which is suitable for use as a fuel pump and which is free from the disadvantages mentioned above. According to the invention therefore, in a pump of the kind described the outer housing contains a separating wall which is in one piece and which divides the volume enclosed by the outer housing into three separate chambers, a suction chamber, a pressure chamber, and a working chamber, this being arranged by having the separating wall sealed at its rim between the diaphragm and the rim of the outer housing, and again sealed at a different position to the inside surface of the outer housing along a closed line. This provides a pump which is easy to manufacture, simple to assemble and reasonably compact.

Since the separating wall is all of one piece it is easy to provide a suction valve and a delivery valve in the separating wall, one of these two valves being situated within the closed contact line, and the other between the closed contact line and the outer rim of the separating wall. The separating wall is constructed so that it effectively separates the three chambers of the pump from each other, that is to say the suction chamber, the working chamber and the pressure chamber, forming good seals between them. The present invention allows a fuel pump to be manufactured economically in series production at a high rate of output, while still maintaining a high degree of efficiency in the working pump.

A diaphragm pump which is particularly simple to manufacture is obtained by having the outer housing consisting of a cylindrical part whose diameter is substantially equal to the diameter of the diaphragm, and on top of this a cover part in the form of a dome. The separating wall is sealed to the outer housing at the transition position where the lower cylindrical part merges into the dome. This seal, between the separating wall and the outer housing may be formed directly where the two parts rest in contact with each other, or by means of an interposed annular seal. The arrangement consisting of a dome mounted on a cylindrical part allows the outer housing to be manufactured very easily, for example by a drawing operation, the cylindrical part and the dome being drawn in one piece. The separating wall, which is sealed to the outer housing at the transition point between the dome and the cylindrical part, can also be made in the same way. These parts can be drawn either in sheet metal or in a synthetic plastics.

The dome is preferably eccentric with respect to the cylindrical part, leaving a somewhat crescent shaped, inclined surface to take one of the valves. What is obtained in this way is that the two valves need not be positioned next to each other

in the same plane, or in parallel planes, as has hitherto been necessary. One of the two valves can be arranged at an angle to the other, without this in any way impairing the action of the pump. This gives a compact construction, in that the external diameter of the pump can be less.

Good operation of the pump is promoted by providing, between the separating wall and the merging of the cylindrical part and the dome, an annular seal which has a passage whose diameter is less than the internal diameter of the dome. This arrangement gives a damping effect which reduce pulsation in the suction and delivery pipes. It is merely necessary, if a bubble of vapor is formed, to ensure that the passage in the seal is always under the surface of the fuel in this suction chamber, taking into consideration the position in which the pump is installed.

Constructing the outer housing in one piece is particularly advantageous when the pumps are manufactured in series production in large numbers. On the other hand, if it is desired to manufacture pumps at a lower rate of output using simple production tools, it is preferable to make the outer housing in two parts which are joined together during assembly of the pump either by welding or by adhesion bonding. The contact edges between the two parts of the outer housing should be below a fuel inlet connection into the dome, and centered on the middle axis of the dome. This allows the angular position of the fuel inlet connection to be chosen as desired.

Two examples of diaphragm pumps in accordance with the invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a longitudinal section through a diaphragm fuel pump for use in an internal combustion engine;

FIG. 2 is a plan view of the pump shown in FIG. 1;

FIG. 3 is a plan view of the separating wall of the pump shown in FIG. 1, the outer housing having been removed; and,

FIG. 4 is a longitudinal section through part of a modified form of the pump shown in FIG. 1.

The pump shown in FIG. 1 comprises an inner or spring housing 10 in which an actuating rod is guided to slide up and down. This reciprocation is caused by a cam, not shown in the drawing, which acts on the lower end of the rod 11 and which is driven by the internal combustion engine to which the pump supplies the fuel. The rod 11 is under the influence of a spring 12 which urges the rod downwards to keep it in contact with the cam. At its upper end the rod 11 slides in a spring-loaded collar 13 containing a compression spring 14. The function of the spring 14 is twofold. Firstly it limits the pressure of the fuel at the delivery end of the pump and, secondly, it prevents damage to the pump diaphragm 15, to which the collar 13 is attached, when the rod 11 is attempting to cause the diaphragm to pump liquid faster than it can be accepted by the delivery part of the system. When this happens the movement of the actuating rod 11 is absorbed by the spring 14.

The diaphragm 15 is attached at its outer rim to the inner or spring housing 10. For this purpose the outer rim of the diaphragm is squeezed and secured between the rim of the inner housing 10 and the outwardly and downwardly turned rim 16 of an outer housing 17. In effect the outer housing 17 forms a continuation of the inner housing 10, the space bounded by these housings being separated by the diaphragm 15. The outer housing consists of a lower part 18, nearest to the diaphragm 15, and mounted on top of this a dome or upper part 19. The rim 16 of the outer housing 17 also secures and seals in place the outer rim 21 of a separating wall 22 which is in one piece and which is arranged within the outer housing 17 so that it divides the housing 17 into three chambers 32, 33 and 34. To do this, besides contacting the outer housing 17 at its rim, the wall 22 also contacts and seals, directly or indirectly, with the inner surface of the outer housing 17 along a closed contact line 23. In this example the contact is indirect through an annular seal 24. The upper surface of the seal 24, that it to say the surface of the seal remote from the diaphragm 15, rests in firm contact with the inner surface of the housing 17 along the transition surface 25 where the

dome or upper part 19 merges with the cylindrical inner part 18. In the example shown in FIG. 4 however, the seal is formed by direct contact between the wall 22 and the housing 17 along the line 23. If desired this may be augmented by using a coating composition, so as to form a welded or brazed or adhesive-bonded joint, both at the contact surface 23 of the separating wall 22 and also at the transition surface 25 of the outer housing 17. Returning to the present example, the seal 24 has an opening 26, forming a passage for the fuel, whose diameter is about the same as the internal diameter of the dome 19. However, this diameter may be less than that of the dome 19, in which case the position of the passage 26 is chosen so as to ensure that the passage is always below the surface of the fuel in the suction chamber 32 of the pump, taking into consideration the position in which the pump is installed.

As shown in FIGS. 1 and 2, the dome 19 is eccentrically mounted on the cylindrical part 18 of the housing 17. The seperating wall 22 has an annular surface 27 which is positioned approximately coaxially with the dome 19, the annular surface 27 being within the boundary of the closed contact line 23. The separating wall 22 has an inclined surface 28, which is somewhat sickle shaped, located between the contact line 23 and the outer edge 21 of the separating wall. The annular surface 27 contains an inlet valve 29. The sickle-shaped surface 28 contains an outlet valve 31. The separating wall 22 thus separates three individual chambers from each other, that is to say the suction chamber 32, which extends from the separating wall up into the dome 19, a working chamber 33 which is above the diaphragm 15 and below the separating wall 22, and a pressure chamber 34 which is above the sickle-shaped surface 28 and within the housing 17 radially outside the seal 24. The pressure chamber 34 has an outlet connection 35. The suction chamber 32 has an inlet connection 37, to which is attached a fuel filter 36. The inlet connection 37 can be unscrewed for cleaning the fuel filter 36. From the inlet connection 37 a pipe, not shown in the drawing, leads to a fuel tank.

The modification shown in FIG. 4 differs from the example shown in FIG. 1 essentially in that the separating wall 22 rests in direct contact with the transition surface 25 of the outer housing 17 as described earlier. This gives a tight seal without the use of any separate sealing part. The modified version shown in FIG. 4 also differs from the version of FIG. 1, in that the outer housing 17 is made in two parts, particular care being taken to ensure that the jointed surfaces 38 between the upper and lower parts 19 and 18 are under the level of the fuel inlet connection 37, and are central with respect to the middle axis 39 of the dome 19. What is obtained is that during manufacture of the pump the angular position of the inlet connection 37 can be adjusted as required, relative to the cylindrical lower part 18 of the housing, merely by rotating the dome 19. This type of construction, in two parts, also greatly facilitates manufacture of the outer housing 17. The two parts 18 and 19 can for example be made of sheet material or plastics using quite simple tools, for example they can be drawn. Here again the inlet connection 37 is made to screw into the dome 19 so that when it becomes necessary to clean the fuel filter 36, it can be removed easily.

The method of functioning of the diaphragm fuel pumps shown in the drawings is as follows:

The oscillation of the diaphragm 15, driven by the actuating rod 11, draws fuel from the tank in through the inlet connection 37. The fuel, after passing through the filter 36 into the suction chamber 32 flows through the inlet valve 29 during the suction stroke of the pump and so reaches the working chamber 33 above the diaphragm 15. During the driving stroke of the pump the diaphragm 15 deflects upwards, closing the inlet valve 29 and opening the outlet valve 31. This drives the fuel from the working chamber 33 into the pressure chamber 34, and so out through the outlet connection 35. The outlet connection 35 is connected by a pipe to the carburetor or injection pump of the internal combustion engine.

I claim:

1. A diaphragm pump including an inner housing, an outer housing, means attaching said housings to each other, a diaphragm, means fixing said diaphragm between said inner and outer housings, an integral unitary separating wall, including a rim, means sealing said rim between said diaphragm and said outer housing, and means forming a continuous closed path seal between said separating wall and said outer housing, whereby said separating wall divides said outer housing into three separate chambers consisting of a suction chamber, a pressure chamber and a working chamber, said working chamber being bounded in part by said diaphragm, said diaphragm being circular and said outer housing including a cylindrical part adjacent said diaphragm having a diameter substantially equal to that of said diaphragm and a dome part which is mounted on said cylindrical part, said closed path seal extending around the junction of said dome part and said cylindrical part.

2. A diaphragm pump as claimed in claim 1, wherein said dome part is eccentric to said cylindrical part.

3. A diaphragm pump as claimed in claim 1, further comprising a coating composition applied to one to the two parts consisting of said outer housing and said separating wall around said closed path, said coating composition effecting said closed path seal.

4. A diaphragm pump as claimed in claim 1, further comprising an annular sealing gasket interposed between said outer housing and said separating wall, said annular gasket forming said closed path seal and said annular gasket having an internal diameter less than the internal diameter of said dome part.

5. A diaphragm pump as claimed in claim 1, wherein said outer housing comprises a first part, a second part and means fixing said first part to said second part said means being selected from the techniques consisting of welding, brazing, and adhesive bonding.

6. A diaphragm pump as claimed in claim 5, wherein said two parts consist of an upper part and a lower part, said upper part defining said suction chamber and including means defining a fluid inlet to said suction chamber.

7. A diaphragm pump including an inner housing, an outer housing, means attaching said housings to each other in operative relationship, said outer housing consisting of a first portion and a second, dome-shaped portion which can be angularly positioned as required with respect to said first portion, a diaphragm, means fixing said diaphragm between said inner and outer housings, an integral unitary separating wall, including a rim, means sealing said rim between said diaphragm and said outer housing, and means forming a continuous closed path seal between said separating wall and said outer housing, whereby said separating wall divides said outer housing into three generally axially aligned separate chambers consisting of a suction chamber, a pressure chamber and a working chamber, said working chamber being bounded in part by said diaphragm, at least one suction valve, means mounting said suction valve on one side of said closed path seal, at least one delivery valve, and means mounting said delivery valve on the other side of said closed path seal, said suction valve allowing fluid to flow from said suction chamber into said working chamber and preventing return from said working chamber to said suction chamber and said delivery valve allowing fluid to flow from said working chamber to said pressure chamber and preventing return flow from said pressure chamber to said working chamber.

8. A diaphragm pump as claimed in claim 7, wherein the suction and delivery valves are mounted in said separating wall.

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