Aug. 3, 1965 R. F. SMITH 3,198,128

MECHANICAL PUMP

Original Filed July 5, 1961 2 Sheets-Sheet 1

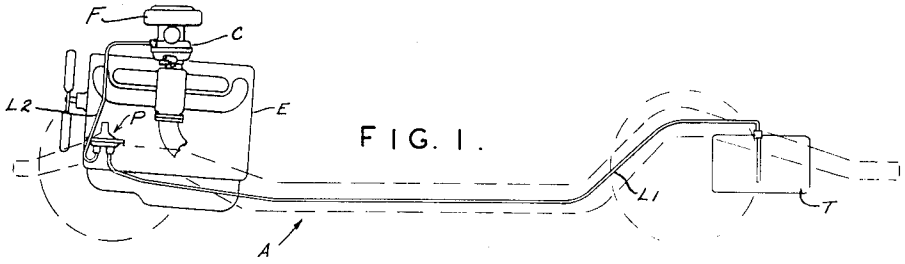


FIG. 1.

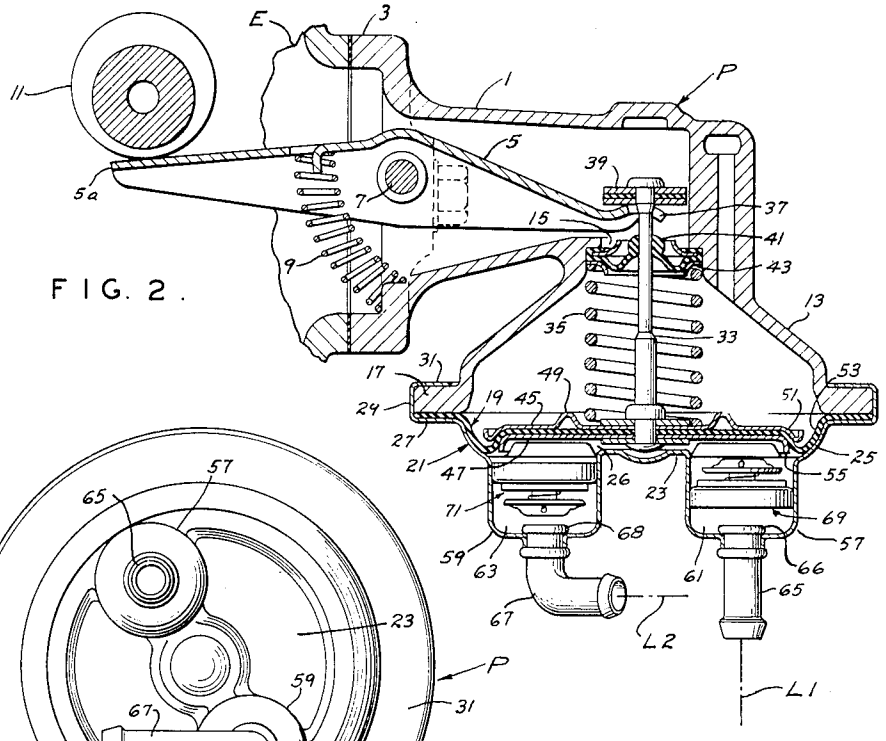


FIG. 2.

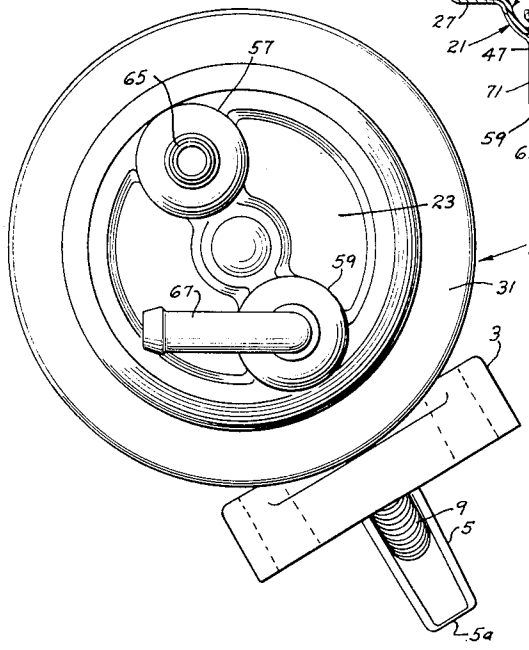


FIG. 3.

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MECHANICAL PUMP

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FIG. 6.

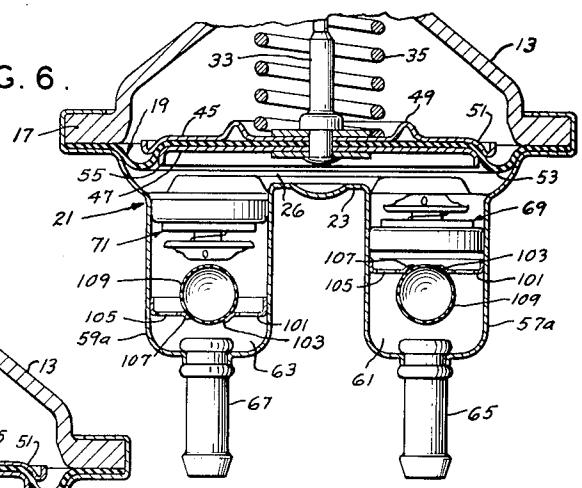
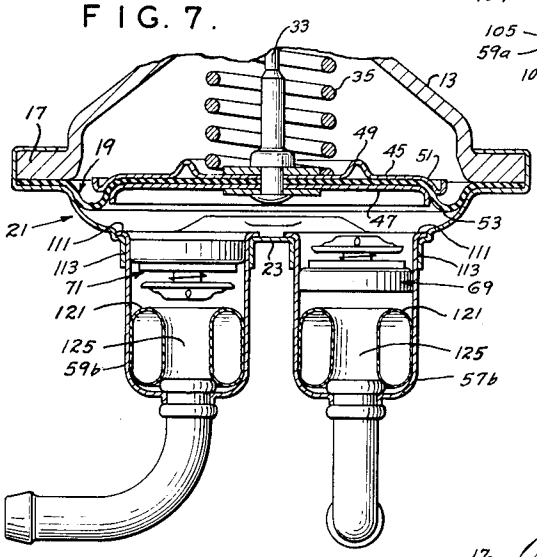


FIG. 7.



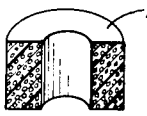
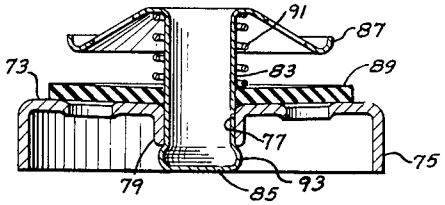


FIG. 8.

FIG. 4.



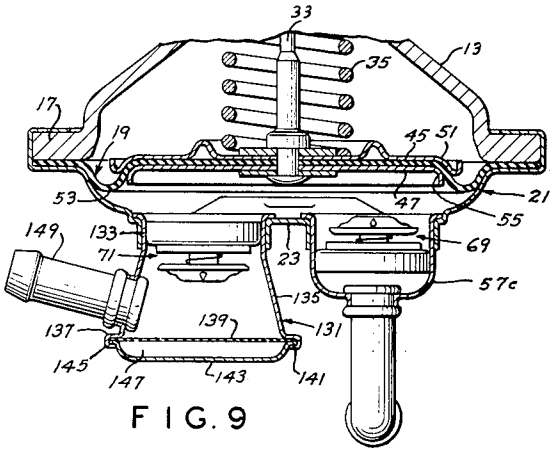


FIG. 9

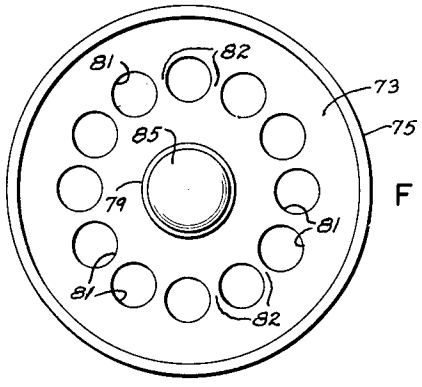


FIG. 5.

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3,198,128

MECHANICAL PUMP

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Original application July 5, 1961, Ser. No. 122,025, now Patent No. 3,150,601, dated Sept. 23, 1964. Divided and this application Jan. 26, 1962, Ser. No. 169,012

6 Claims. (Cl. 103—150)

This application is a division of co-pending application Serial No. 122,025, filed July 5, 1961 by Russell F. Smith, Eldon A. Johnson, and Edward M. Mason, now Patent No. 3,150,601.

This invention relates to pumps, and more particularly to a diaphragm pump of a type especially suitable for pumping automotive fuel to the carburetor for an internal combustion engine, the diaphragm of the pump being operable by a drive from the engine.

One of the problems occurring with conventional diaphragm fuel pumps is the problem of vaporization of fuel in the pump, with the attendant possibility of interruption of flow of fuel to the carburetor, this being customarily referred to as "vapor lock." It will be understood that the fuel is highly volatile, having a tendency to pass from the liquid to the vapor state, which tendency is of course increased by heating. Since the fuel pump is conventionally mounted on the engine to be driven thereby, heat is transferred from the engine to the pump, and thereby to fuel in the pump. Unless this heat is effectively dissipated, vapor lock may occur due to vaporization of fuel in the pump.

Accordingly, one of the objects of this invention is the provision of a pump which, while being of simple, economical construction, is adapted effectively to dissipate heat from the pump so as effectively to reduce the tendency for volatilization of fuel in the pump, thereby to reduce the possibility of vapor lock. In general, this is accomplished by utilizing a pump body of thin-walled heat-conductive construction such as to provide for transfer of heat outward through the wall of the body at such a rate as substantially to reduce the tendency for volatilization of fuel within the body. The pump body is formed to provide a pumping chamber and an intake cavity and a discharge body, and the pump includes a diaphragm closing the pumping chamber, an intake check valve in the intake cavity and a discharge check valve in the discharge cavity. With the body of thin-walled heat-conductive construction, heat is effectively dissipated from the pumping chamber and from the intake and discharge cavities, thereby maintaining fuel in the pump in a relatively cool state to reduce the tendency toward volatilization such as would otherwise be present. The pump body may be formed of relatively thin sheet metal, which provides for a simple economical construction while at the same time providing for effective heat dissipation. Additionally, the outside surface of the body may be made heat-reflective to decrease the absorbtion of heat by the body from ambient temperatures.

Further objects of the invention are the provision of means in the discharge cavity or in both the discharge and intake cavities for damping pulsations in pressure of fuel delivered by the pump, so as to maintain a more uniform rate of delivery of fuel to the carburetor, and the provision of an improved check valve construction such as to avoid distortion of the check valves when they are assembled with the pump body, thereby to maintain the accuracy of the seats of the check valves. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions

hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated,

FIG. 1 is a view in elevation illustrating a diaphragm pump of this invention in use on the engine of an automotive vehicle for pumping fuel from the fuel tank of the vehicle to the carburetor for the engine, the pump being of a type that may be referred to as an inverted pump;

FIG. 2 is a vertical section of the pump shown in FIG. 1;

FIG. 3 is a bottom plan of FIG. 2;

FIG. 4 is an enlarged vertical cross section of a check valve used in the pump;

FIG. 5 is a bottom plan of the FIG. 4 check valve;

FIG. 6 is a fragmentary vertical cross section of a pump similar to the FIG. 2 and including a first type of pulsation-damping means;

FIG. 7 is fragmentary vertical cross section similar to FIG. 6 illustrating a second type of pulsation-damping means and also illustrating certain modifications in the pump construction;

FIG. 8 is a half-section in perspective of a modified version of the pulsation-damping means of FIG. 7; and

FIG. 9 is a fragmentary vertical cross section similar to FIG. 2 illustrating another type of pulsation-damping means and also illustrating certain modifications in the pump construction.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring to FIG. 1 of the drawings, there is indicated at A an automotive vehicle having an engine E on which is mounted a fuel pump P of this invention. Fuel is delivered from fuel tank T of the vehicle through a line L1 to the fuel pump P and delivered by the latter through a line L2 to the carburetor C for the engine. The carburetor is mounted on the intake manifold of the engine, and an air filter F is shown mounted on the air horn of the carburetor.

As appears in FIGS. 1–3, pump P is a so-called inverted pump, i.e., its inlet and outlet are located at the bottom of the pump. As shown in detail in FIGS. 2 and 3, pump P comprises a rocker arm housing 1 which is open at one end (its left end as appears in FIG. 2), this end being referred to as the inner end of the housing. This housing is of generally rectangular form in vertical cross section and of decreasing height from its inner end to its outer end (which is closed). At its inner end it has a flange 3 for attaching it to the engine E. A rocker arm 5 is pivoted at 7 in the housing for rocking motion on a horizontal axis transverse to the housing. Arm 5 has a portion 5*a* projecting out of the open inner end of the housing, and is biased to rock clockwise as viewed in FIG. 2 by a spring 9. When the pump is mounted on the engine, the free end portion 5*a* of the rocker arm is engaged by an engine-driven eccentric or cam 11. On rotation of the cam through half a revolution from its FIG. 2 position (wherein the low point of the cam engages portion 5*a* of the rocker arm), the rocker arm is rocked counterclockwise from its FIG. 2 position against the bias of spring 9. The latter is adapted to return the arm clockwise during the succeeding half-revolution of the cam.

Extending downward from the rocker arm housing 1 at its outer end is a hollow conical pump head 13. An opening 15 is provided between the interior of housing 1 and the hollow head 13 at the top of the latter. The conical head has an outwardly projecting comparatively thick flat flange 17 at the bottom. The bottom of this

flange constitutes a seating surface for the margin of an annular diaphragm 19 consisting of a relatively thin disk of flexible fuel-resistant material, such as a suitable synthetic rubber, which, when in unstressed condition, is flat or substantially flat. The outer margin of the diaphragm is clamped against the bottom of flange 17 by a pump body 21 which, as illustrated in FIG. 2, is of one-piece thin-walled sheet metal construction, formed of shallow cup shape, having a bottom or end wall 23 and a flaring, rounded annular peripheral wall 25 defining a pumping chamber 26, with an outwardly extending annular flat flange 27 at the top of wall 25, and a cylindric rim 29. The body 21 is maintained in assembly with head 13 by spinning the flange 29 over on rim 17 of the head as indicated at 31, with the margin of the diaphragm clamped between flange 17 and flange 27 under sufficient pressure to provide a fuel-tight seal all around the margin of the diaphragm.

The diaphragm is adapted to be pulled or flexed upward by a diaphragm-actuating rod 33 and to be flexed downward by a spring 35. Rod 33 extends upward through head 13 and through the opening 15 at the top of the head into the rocker arm housing 1. The rocker arm 5 has a slot 37 at its end in housing 1 receiving the rod 33. The latter has a collar 39 at its upper end engageable by this end of the arm 5. The rod extends slidably through an oil seal and rod guide 41 held in an annular recess at the top of the head 13 by the reaction on a seal retainer ring 43 of the spring 35, this spring being a coil compression spring surrounding the rod. The diaphragm is mounted on the lower end of the rod 33 between a pair of circular plates 45 and 47, plate 45 being the upper plate and plate 47 the lower plate. The upper plate is formed with an annular corrugation or rib 49 forming a seat for confining the lower end of spring 35. The upper plate is of larger diameter than the lower plate and the margin of the upper plate which overhangs the lower plate is flared outward and downward to provide a rim 51 constraining the diaphragm to have an annular, free, nonreversing loop 53. The lower plate has a curved rim 55 engaging the loop. In the downward position of the diaphragm illustrated in FIG. 2, the outside of the loop engages the rounded flaring wall 25 of the pump body 21. When arm 5 is rocked counterclockwise by cam 11, it lifts the rod and pulls the diaphragm upward. This loads the spring 35. Then when arm 5 rocks clockwise, spring 35 is adapted to drive the diaphragm and rod downward.

The sheet metal pump body 21 is formed with two integral deep-drawn rounded-bottom cylindrical cup-shaped projections 57 and 59 extending downward from the bottom wall 23 of body 21 on opposite sides of the center of the bottom wall. Projection 57 defines an inlet passage or intake cavity 61 and projection 59 defines an outlet passage or discharge cavity 63. An inlet nipple 65 is provided at the lower end of projection 57, and an outlet nipple 67 is provided at the lower end of projection 59. In FIG. 2, inlet nipple 65 is shown as a straight nipple, and outlet nipple 67 is shown as an elbow nipple. It will be understood that, in the installation shown in FIG. 1, supply line L1 is connected to inlet nipple 65 and discharge line L2 is connected to outlet nipple 67.

The nipples 65 and 67 are fixed to the respective deep-drawn projections 57 and 59 by inserting the respective collared ends 66 and 68 into a central aperture in the bottoms of the respective projections 57 and 59 and swaging the metal of the projections tightly against the nipple ends, as shown to form a fuel tight seal. The collared nipple ends 66 and 68 each have grooves formed in the surface of the collars so that the swaged metal is pressed into the grooves to prevent a rotational displacement of the nipples. The sheet metal construction of the pump thus lends itself to a universal adjustment of the nipple 67, for example, in 360° to accommodate any required directional departure of the inlet fuel line L2. In a similar manner nipple 65 may also be formed with an elbow to accommodate any directional approach of inlet line L1. This universal adjustability of the nipples 65 and 67 provides a flexibility of use with different engine arrangements, which is not available in pumps fabricated from castings.

An intake check valve 69 is provided in the intake cavity 61 and a discharge check valve 71 is provided in the discharge cavity 63. Nipple 65 provides for connection of supply line L1 to intake cavity 61 upstream from the intake check valve 69 and nipple 67 provides for connection of discharge line L2 to discharge cavity 63 downstream from the discharge check valve 71. These check valves are of identical construction. As shown in FIGS. 4 and 5, each check valve comprises a circular sheet metal valve seat 73 having a cylindric rim 75 sized for a press fit in either cavity 61 or cavity 63, as the case may be. Seat 73 has a central hole 77 with an annular boss 79 around the hole extending in the same direction as the rim 75. Surrounding the central hole is a series of ports 81 arranged in a circle around the center hole. The dimension of each of these ports as measured along the stated circle is less than the distance measured radially of the seat 73 from the periphery of the center hole 77 to the periphery of the seat 73. More particularly, the ports are circular holes of smaller diameter than the center hole. They are equally and closely spaced around the stated circle at intervals such as to leave spoke-like portions 82 of the valve seat 73 between the ports with these spoke-like portions narrower than the diameter of the ports. Seat 73 is preferably dished inwardly to a slight extent in the direction in which rim 75 and boss 79 project therefrom (i.e., downwardly dished as viewed in FIG. 4). This dishing may be of the order of 1½°, for example. Fitted in the boss 79 is a hollow sheet metal stem 83 which is closed at its lower end as indicated at 85 in FIG. 4. Stem 83 has an apertured mushroom head 87 at its other end constituting a spring seat. A ring-shaped disk valve member 89, which may be made of a suitable fuel-resistant synthetic rubber for cushioned sealing, is slidable on the stem and is biased toward engagement with the valve seat by a coil compression spring 91 surrounding the stem and reacting from the head 87. In assembling the stem with the valve seat, the stem 83 is pressed in the central hole 77 in the valve seat and the closed end of the stem is deformed as indicated at 93 to lock the stem in the seat and seal the central hole.

The intake check valve 69 is pressed in the intake cavity 61 with its stem 83 extending upward and the discharge check valve 71 is pressed in the discharge cavity 63 with its stem extending downward (see FIG. 2). It has been found that, with the ports in the valve seat formed as herein described, rather than being formed as relatively long slots in the valve seat, stresses such as would cause distortion of the valve seats during the operation of pressing the seats into the cavities are avoided, and the original accuracy of the seats is preserved. At the same time, the total port area is adequate for flow of fuel.

In the operation of the pump shown in FIG. 2, diaphragm 19 is flexed up and down by the action of cam 11 and spring 35. On an upward (suction) stroke of the diaphragm, the intake check valve 69 opens and the discharge check valve 71 closes, and fuel is drawn into the pumping chamber 26 below the diaphragm. On a downward (discharge) stroke of the diaphragm, the intake check valve 69 closes and the discharge check valve 71 opens, and fuel is forced out through line L2 to the carburetor. Since the pump body 21 is formed of sheet metal, it is of thin-walled heat-conductive construction such as to provide for transfer of heat outward therethrough at such a rate as substantially to reduce the tendency for volatilization of fuel within the body, thereby reducing the possibility of vapor lock. In this respect, it will be observed that heat transmission occurs not only through walls 23 and 25 of pumping chamber 26 but also

through the walls and bottoms of projections 57 and 59, all of which are thin-walled, so that heat is dissipated at a relatively rapid rate. The rate may be increased by making the outer surface of the pump body heat-reflective, as by bright zinc plating of the exterior of the pump body. With such plating, heat is reflected from the body for cooler operation of the pump and increased transmission of heat from fuel in the pump body to the exterior.

Making the pump body of sheet metal not only provides a thin-walled construction for effective heat dissipation, but also provides an economical construction, the pump body itself being economical to manufacture and economical to assemble with the rocker arm housing 1, the assembly operation simply involving the spinning over of rim 29 of the pump body on flange 17 of the head 13. A typical pump body having a diameter (measured at rim 29) of three and one-half inches may be made of suitable steel plate 0.035 inch thick, for example. In general, the advantages of the invention may be attained with a pump body having a wall thickness less than 0.050 inch.

FIG. 6 illustrates a pump similar to that shown in FIG. 2 provided with means for damping pulsations in pressure of fuel delivered by the pump so as to maintain a more uniform rate of delivery of fuel to the carburetor. As shown in FIG. 6, the cup-shaped projections of the pump body 21 are drawn deeper than in FIG. 2, and are designated 57*a* and 59*a*. In each cup is press-fitted a partition 101 having a central hole 103 and a circular series of ports 105 around the central hole 103. The portion of the partition around the center hole is cupped as indicated at 107 to form a seat for a hollow resilient compressible ball 109 which may be made, for example, of a suitable fuel-resistant synthetic rubber. In the intake cup 57*a* the partition is arranged with seat 107 extending upward and ball 109 below the partition. In the discharge cup 59*a*, the partition is arranged with seat 107 extending downward and ball 109 above the partition. The hollow resilient compressible balls 109 act like air chambers or air domes to damp pulsations of pressure of fuel in the intake and discharge cavities by contraction and expansion thereof, and tend to equalize pressure of fuel delivered to the carburetor.

FIG. 7 illustrates a modification in which the cup-shaped projections of the pump body 21 are constituted by separately formed cup members 57*b* and 59*b*. Each of these has an outwardly extending rim 111 at its upper end and extends down through an opening 113 provided in the bottom wall 23 of the pump body, the rims engaging the bottom wall 23 and being suitably soldered thereto. This three-piece type of construction for the pump body 21 has the advantage over the one-piece type of pump body shown in FIG. 6, for example, in that, for a given cup height, it permits the cups to be arranged closer together, as may be desirable. In this respect, it will be observed that with deep-drawn integral cups as in FIG. 6, it is necessary that the cups be relatively widely spaced to permit deep drawing.

FIG. 7 also illustrates another type of pulsation damping means comprising an annular hollow resiliently compressible member 121 axially positioned in each projection 57*b* and 59*b*, each of these members being made, for example, of a suitable fuel-resistant synthetic rubber. The central passages 125 through these members provide for flow of fuel, and pulsations are damped by contraction and expansion of the members, which act like air chambers or air domes.

FIG. 8 illustrates a modification of the pulsation damping members of FIG. 7, showing an annular resiliently compressible member 121*a* made of closed-cell foam rubber of a fuel-resistant variety. Such members may be conveniently obtained by segmenting an extruded tube of the closed-cell foam rubber material. They are placed in cups 57*b* and 59*b* in the same manner as members 121 shown in FIG. 7.

FIG. 9 illustrates another arrangement for pulsation damping on the discharge side of the pump only. As shown therein, the intake cup, designated 57*c*, is a relatively short cup (as in FIG. 2), formed as a separate piece and soldered to the pump body as in FIG. 7. The discharge cup comprises a shell 131 having a cylindric upper end portion 133 received in an opening in the bottom wall 23 of pump body 21 in the same manner as in FIG. 7, and a flaring lower portion 135. The discharge check valve 71 is pressed into the cylindric portion 133. The flaring lower portion has an outwardly projecting flat annular flange 137 at its lower end constituting a seating surface for a diaphragm 139 made, for example, of a suitable fuel-resistant synthetic rubber. The outer margin of the diaphragm is clamped against the bottom of flange 137 by the rim 141 of an inverted dome 143 and the parts are held in assembly by spinning a rim 145 on flange 137 over on the rim 141 of the dome. The diaphragm 139 and the dome provide an air chamber 147 sealed off from the shell 131, pulsations being damped by flexing of the diaphragm. The discharge nipple 149 is connected to shell 131 above the diaphragm 139.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A diaphragm pump, particularly for pumping a volatile liquid such as automotive fuel, comprising a pump head, a sheet metal pump body secured to said pump head, a diaphragm having its margin clamped between the pump body and the pump head, said pump body having an end wall and an annular peripheral wall defining with the diaphragm a pumping chamber, said body further having a pair of side-by-side cup-shaped projections extending from its end wall and opening into the pumping chamber, an intake check valve in one of the cup-shaped projections and a discharge check valve in the other of said cup-shaped projections for controlling the flow of fuel into and out of the pumping chamber, a discharge outlet communicating with said other cup-shaped projection downstream of the discharge check valve, a discharge cavity formed in the other projection between the discharge outlet and the check valve, and means in the discharge cavity downstream of the discharge check valve for dampening pulsations in pressure of the fuel delivered by the pump to the discharge outlet, said means comprising a generally transverse partition across the discharge cavity and having a generally central opening therethrough, a resilient generally ball-shaped member removably seated over the opening thereby tending to equalize the pressure of the fuel being delivered by the diaphragm pump, and at least one additional opening in said transverse partition to permit the flow of fuel through the discharge cavity when the ball-shaped member is seated over said first mentioned opening.

2. A diaphragm pump, particularly for pumping a volatile liquid such as automotive fuel, comprising a pump head, a sheet metal pump body secured to said pump head, a diaphragm having its margin clamped between the pump body and the pump head, said pump body having an end wall and an annular peripheral wall defining with the diaphragm a pumping chamber, said body further having a pair of side-by-side cup-shaped projections extending from its end wall and opening into the pumping chamber, an intake check valve in one of the cup-shaped projections and a discharge check valve in the other of said cup-shaped projections for controlling the flow of fuel into and out of the pumping chamber, a discharge outlet communicating with said other cup-shaped projection downstream of the discharge check

valve, a discharge cavity formed in the other projection between the discharge outlet and the check valve, and means in the discharge cavity downstream of the discharge check valve for dampening pulsations in pressure of the fuel delivered by the pump to the discharge outlet, said means comprising a resilient annular member positioned within the discharge cavity of the cup-shaped projection adjacent the discharge outlet and defining a passage for the fuel between the discharge check valve and the discharge outlet whereby pulsations are dampened by the resilient annular member.

3. A diaphragm pump as set forth in claim 2 wherein the resilient annular member has an annular wall of a substantially uniform cross section, the wall being hollow and formed of a fuel-resistant synthetic elastomeric material whereby the annular member contracts and expands upon flow of fuel to the discharge outlet.

4. A diaphragm pump as set forth in claim 2 wherein the resilient annular member comprises a closed-cell foam rubber material.

5. A diaphragm pump as set forth in claim 2 wherein each of the check valves comprises a circular sheet metal valve seat and a cylindrical rim extending generally at a right angle from a face of the seat, said rim being sized for press fitting within its respective cavity of the sheet metal body, said sheet metal seat having a central circular hole and a series of equally spaced circular ports arranged in a circle around the central hole, the diameter of each of the ports being less than the distance from the periphery of said central hole to the periphery of said valve seat and less than the diameter of said central hole, said ports being spaced around said circle at intervals such as to leave spoke-like portions of the valve seat between the ports narrower than the diameter of said ports, a stem fitted in said central hole and having a head on the end thereof opposite the valve seat, a disk valve member slidable on the stem toward and away from the valve seat for opening and closing the ports, and a spring reacting from said head biasing the disk valve member toward said valve seat for closing the ports.

6. A diaphragm pump for pumping automotive fuel, comprising a pump head, a sheet metal pump body secured to said pump head and having a wall thickness less

than 0.050 inch, the outer surface of the sheet metal body being heat-reflective, a diaphragm having its margin clamped between the pump body and the pump head, said pump body having an end wall and an annular peripheral wall defining with the diaphragm a pumping chamber, a coil spring biasing the diaphragm toward said end wall, said body further having a pair of cup-shaped projections extending from its end wall and opening into the pumping chamber, an intake check valve in one of the cup-shaped projections and a discharge check valve in the other of said cup-shaped projections for controlling the flow of fluid into and out of the pumping chamber, a discharge cavity being formed by the respective projection downstream of the discharge check valve and an intake cavity being formed by the respective projection upstream of the intake check valve, and means in the intake and discharge cavities for dampening pulsations in pressure of the fuel being delivered by the diaphragm pump, said dampening means comprising an unsecured generally hollow resilient member arranged in each of the cavities adjacent the respective check valve therein and having an arcuate surface compressible to permit contraction and expansion of the hollow member upon pulsations of fuel in the cavities.

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