

[54] **DIAPHRAGM PUMP**
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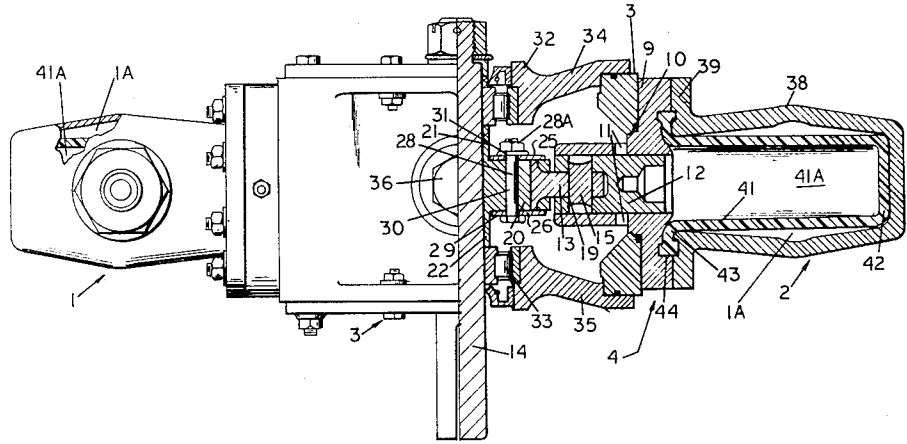
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[57] **ABSTRACT**
This disclosure is directed to a diaphragm pump having a crankcase housing to which there is connected a pump casing and a cooperating piston assembly. A flexible, cup-shaped diaphragm is interposed between the pump casing and the piston assembly so that a pumping chamber is formed with the pump casing on one side of the diaphragm and a pressure fluid chamber is formed on the other side of the diaphragm. A means defining a working fluid inlet and outlet is disposed in communication with the pumping chamber, and a means is provided for venting the pressure fluid chamber. In operation the action of the piston assembly on the fluid-filled pressure chamber effects the actuation of the diaphragm member to produce a pumping action on the working fluid.

13 Claims, 2 Drawing Figures



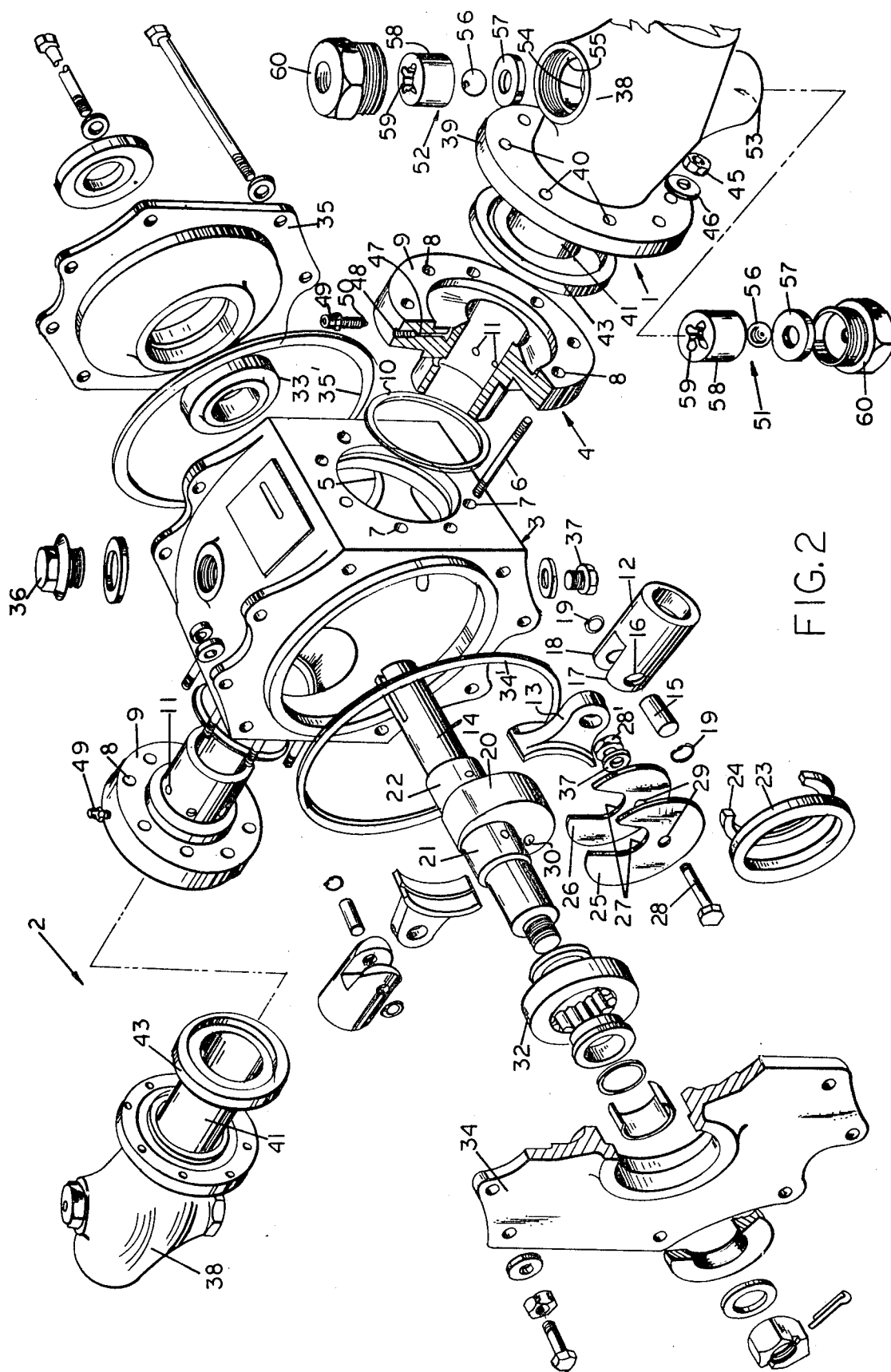


FIG. 2

DIAPHRAGM PUMP

SUMMARY OF THE INVENTION

The present invention relates to a pump of the kind in which the pumping action is effected by the working of a flexible diaphragm.

There is provided by the present invention a pump of the kind in which the pumping action is effected by the working of a flexible diaphragm, wherein the diaphragm per se is such that it can be sealed against a pump member to constitute a flexible, fluidtight partition within the pump chamber dividing the chamber into two compartments, one to receive the fluid (hereinafter called the pressure fluid) to cause working of the diaphragm, and the other to provide the space into which is received the fluid to be pumped (hereinafter called the working fluid) and from which the working fluid is expelled on working of the diaphragm.

Pumps of the kind to which the present invention relates will generally be employed to deliver the working fluid under a high pressure, e.g., 1,000 p.s.i.g., and a bore and accordingly will usually provide a one-way valve in the inlet line and in the outlet line to prevent backflow of the working fluid.

The diaphragm may be of a nonuniform thickness and preferably is in a form to constitute an open vessel. A preferred form of such a vessel is that of a tube closed at one end (herein below referred to as the first end) by an integral wall and providing access to the tube at the other end (therein below called the second end). The tube may be cylindrical in shape and provided with an external, peripheral flange upstanding laterally from the tube at the second end, by which it can be sealed against the pump member. The girth of the tube may be thickened e.g., over an axial length thereof substantially equidistant from the ends, but as presently preferred the tube is of a substantially uniform wall thickness, for example, from 0.2 to 0.25 inch thick. If the tube is to be produced by molding, it may be tapered from the second end to the first end for convenience of manufacture. It is preferred in a pump of the present invention that the pump chamber and the location of the diaphragm therein be such that an axial portion of the tube substantially equidistant from the ends thereof, crosses and preferably lies normal to, a direct line passing between the inlet to and the outlet from the pump chamber for the working fluid.

The pump chamber may be formed by a casing providing a clearance between the interior of the casing and the tube over the axial length thereof and the casing may be mounted on the member against which the diaphragm is sealed in which case the diaphragm may be sealed against the member by the casing. Preferably, the clearance provided between the interior of the casing and the tube is such as to increase from a minimum at each end of the tube to a maximum at the mid point thereof and it is also preferred that the pump chamber inlet and outlet for working fluid, are located in the casing at the place of maximum clearance from the tube.

The member against which the diaphragm is sealed may be provided with a valved through bore such that the compartment of the pump chamber receiving the pressure fluid can be vented to the exterior of the pump. The valve may be constituted by a nipple received in the exterior end of the bore such that the nipple can be screwed into and out of the bore, to close the bore when screwed thereunto to the maximum extent and to open the bore when unscrewed to some extent from the position the nipple occupies when the bore is closed. By means of the valved through bore, pressure within the compartment receiving the pressure fluid may be relieved and the valve through bore may also be used to allow air to be displaced from that compartment on the introduction of a liquid, e.g., oil, serving as the pressure fluid. It may also be used as a source of fluid pressure for actuating a pressure-relief valve for the other compartment, such that the valve once actuated vents the other compartment to a low-pressure source e.g., atmosphere, if and for as long as the outlet from the pump chamber for working fluid is closed.

The pump may comprise a piston and cylinder device, the cylinder of which opens into the compartment receiving pressure fluid so that by a reciprocating action of the piston on the pressure fluid, the diaphragm is caused to expand and retract.

The material of the diaphragm may consist of a suitable elastic material, e.g., natural or synthetic rubbers or a plastic material such as oil resistant plasticized polyvinylchloride.

The present invention will now be described, by way of example only, with reference to the accompany drawings in which:

FIG. 1 is an exploded view of a twin pump arrangement according to the present invention.

FIG. 2 is a plan view of the pump of FIG. 1 partly in section.

DETAILED SPECIFICATION

The two pumps indicated at 1 and 2 respectively are driven by a motor the crankcase or housing of which is indicated at 3. The two pumps are identical and generally only one, the right-hand one as seen in the FIG. 1 will be described. The pump comprises a cylinder block 4 received in a bore 5 in the crankcase and supported in position on double-ended bolts 6 received at one end in blind bores 7 in the crankcase and passing through bores 8 in a peripheral flange 9 of the cylinder. To provide a seal between the cylinder and the bore 5, an O-ring 10 is located on the cylinder between the flange 9 and the crankcase. The cylinder wall is provided with a circumferential ring of through bores 11 to enable oil to pass from the crankcase to the cylinder for a purpose to be described herein below. The cylinder receives a piston 12 linked to a connecting rod 13 of a crankshaft 14 of the motor by a gudgeon pin 15 passing through bores 16 in matched lugs 17, 18 of the piston and held in place by circlips 19. The connecting rod seats on an eccentric 20 formed on the crankshaft with two flanking bosses 21, 22 and the connecting rod is held in sliding contact with the eccentric by two retaining rings 23, 24 to prevent movement of the connecting rod away from the eccentric in a direction transverse of the crankshaft, and two retaining plates 25, 26 to prevent movement of the connecting rod away from the eccentric in a direction parallel to the crankshaft. The two plates are formed with U-shaped recesses 27 to enable them respectively to be received on the bosses 21, 22 to be against the retaining rings, and the plates are held in place by a bolt 28' passing through bores 29 in the plates and a bore 30 in the eccentric to receive a washer 31 and a nut 28 by which the bolt is secured.

The crankshaft is supported in two heavy-duty roller bearings 32, 33 carried in sideplates 34, 35 of the crankcase and the crankcase is provided with an oil filler plug 36 and an oil drain plug 37. Sealing rings 34', 35' respectively are provided to act as a seal between plates 34, 35 and the body 3 of the crankcase.

The pump chamber 1A is formed by a casing 38 comprising an external peripheral flange 39 provided with through bores 40 by means of which the casing 38 is received on bolts 6. The diaphragm of the pump is in the form of a generally cylindrical tube 41 closed at one end by an integral end wall 42 and open at the other end defining pressure fluid chamber 41A. The diaphragm may be molded from a plasticized polyvinylchloride containing an additive to render the diaphragm oil resistant and for convenience of molding, the diaphragm may be tapered from the open end to the closed end. The diaphragm is formed with a peripheral flange 43 extending laterally away from the cylindrical wall at the open end and the flange terminates in a lip 44 so that a radial section of the flange is T-shaped See FIG. 1.

The purpose of the lip 44 will be explained herein below. When the diaphragm is molded from plasticized polyvinylchloride, the wall section of the tubular form typically will be approximately 0.20 to 0.25 inch thick for an axial length of substantially 5 inches and the lip 44 typically will be approximately 0.4 inch thick for the above-mentioned wall thickness i.e., the lip projects either side of the flange by substantially 0.1 inch.

It may be seen that the diaphragm per se is in a form such as to be able to contain a liquid viz in the form to constitute a vessel or cup. An advantage of a diaphragm in this form is that it can readily be sealed against a pump member such as the cylinder flange 9. This not only promotes efficiency of operation of the pump but makes the diaphragm easy to replace. The peripheral flange 9 of the cylinder constitutes the pump member against which the diaphragm is sealed and the sealing is effected by clamping the peripheral flange 43 between the flange 9 of the cylinder and the flange 39 of the pump chamber casing by means of nuts 45 received on the bolts 6, the nuts 45 being used with plain washers 46. For the purpose of clamping the diaphragm, flanges 9 and 39 are recessed as indicated to receive the flange of the diaphragm, the recesses being deepened to receive the lip 44 in order firmly to anchor the diaphragm in place. The cylinder flange 9 is bored to provide a through bore 47 enlarged towards the end opening at the circumferential surface of the flange 9 to form a tapped hole or bore 48 which is internally screw threaded. The boss or hold receives a nipple 49 such that when the nipple is screwed fully into the boss the bottom aperture 50 of the nipple seats against the wall of the boss but such that when the nipple is unscrewed to some extent the aperture 50 is exposed to allow of the passage of fluid from the bore 47 through the nipple.

The pump also comprises two nonreturn valves, each generally indicated at 51 and 52 (FIG. 2), one, 51 being to prevent flow from the pump chamber to the inlet line thereto for working fluid and one 52 to prevent flow from the outlet line for working fluid to the pump chamber. The two valves are housed in respective bores 53, 54 in the pump casing, each of which provides an internal shoulder 55. Each valve comprises a ball 56 serving as the valve member, and a valve seat formed by a ring 57 e.g., of Delrin, a nylon-type plastic. The ring of each valve engages a valve body 58 having an axial bore 59 or cruciform section, which is axially bored out by a cylindrical bore (not visible) over substantially half the length of the body from the bottom end to receive the ball 56 so that the ball can move axially to and away from the ring 57 respectively to close and open the valve. Each valve is held in place by a union nut 60. The ring 57 of the valve 51 acts against the inwardly directed face of the nut 60 and the valve body against the internal shoulder 55. The ring 57 of the valve 52 acts against the shoulder 55 in the valve body and against the inwardly directed face of the union nut 60.

To prepare the pumps for operation, the crankcase is filled with oil. The oil is caused to pass through bores 11 into the cylinder of each pump when the piston 12 is partly withdrawn, air being vented through bore 47 and nipple 49 which is left unscrewed for this purpose. The oil from the crankcase constitutes the pressure fluid and passes from the cylinder into the diaphragm. When the crankcase is filled to the extent that the diaphragm and cylinder are filled with oil, the nipple on each pump is screwed down and the pumps are ready to operate.

While the invention has been described with respect to particular embodiment thereof it will be readily understood and appreciated that variations and modifications of the invention may be made without departing from the scope or spirit thereof.

What is claimed is:

1. A pump comprising
 - a housing for containing a supply of pressure fluid,
 - said housing having opposed bores,
 - a pump assembly disposed in communication with each of said bores,
 - each pump assembly including a cylinder block receivable in its respective bore,
 - said cylinder block defining an open-ended cylinder having an integrally formed mounting flange,
 - means for securing said cylinder block to said housing,
 - a piston reciprocally mounted in each of said open-ended cylinders,
 - a crank shaft having an eccentric thereon rotatably journaled in said housing,

- means operatively connecting said piston to said eccentric whereby rotation of said eccentric effects reciprocation of said piston,
 - a pump casing having an open end and a closed end,
 - a mounting flange circumscribing said open end, said mounting flange being contiguously disposed to the flange of said cylinder block,
 - means for securing said pump casing flange to said cylinder block flange,
 - an expansible tubular diaphragm extending within said pump casing,
 - said tubular diaphragm having an open end adjacent the open end of said pump casing and an opposite closed end disposed contiguous the closed end of said pump casing,
 - said diaphragm having a laterally extending peripheral flange adjacent the open end thereof,
 - said diaphragm flange being clamped between the pump casing flange and the cylinder block flange,
 - said diaphragm flange having an enlarged lip at the periphery thereof,
 - and said cylinder block flange and pump casing flange having complementary recesses formed therein for accommodating the enlarged lip of said diaphragm flange in the assembled position,
 - said diaphragm dividing said pump casing into an inner pressure fluid chamber, disposed in communication with said cylinder, and a pump chamber,
 - an inlet port means and an outlet port means disposed in communication with said pump chamber, and
 - valve means disposed in each of said inlet and outlet port means for controlling the flow of working fluid through said pump chamber when said pump is actuated.
2. The invention as defined in claim 1 wherein said cylinder has a plurality of circumferentially spaced bores in communication with the interior of said housing to enable the pressure fluid to flow from said housing to said cylinder.
 3. The invention as defined in claim 1 wherein the closed end of said diaphragm engages the closed end of said pump casing.
 4. The invention as defined in claim 1 and including a connecting rod operatively connected between said piston and eccentric,
 - means for preventing radial movement of the connecting rod away from the eccentric, and
 - means to prevent lengthwise movement of the connecting rod away from the eccentric.
 5. The invention as defined in claim 1 wherein said valve means include
 - a valve seat,
 - a ball valve adapted to valve said valve seat and a valve guide for containing said ball valve.
 6. The invention as defined in claim 1 wherein the body member of said diaphragm means is of nonuniform thickness.
 7. The invention as defined in claim 1 wherein the internal wall of the pump casing closely surrounding the diaphragm adjacent the ends of the diaphragm and wherein the clearance between the interior of the pump casing and the diaphragm body member is such as to increase from a minimum at each end of the body member to a maximum at the midpoint thereof.
 8. The invention as defined in claim 7 and including:
 - means defining a working fluid inlet and a working fluid outlet formed in said pump casing,
 - said fluid inlet and outlet being located in the casing at the point of maximum clearance between the diaphragm body member and said casing.
 9. The invention as defined in claim 1 and including means for venting the pressure fluid chamber to the exterior or the pump.
 10. The invention as defined in claim 9 wherein said venting means includes a valved-through bore, a nipple adapted to be received in the exterior end of said valved-through bore whereby said nipple can be screwed into and out of said bore

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to close said bore when screwed thereinto a maximum extent, and to open the bore when unscrewed to some extent from the position the nipple occupied when the bore was closed.

11. The invention as defined in claim 1 wherein the material of the diaphragm consists of a flexible plasticized material.

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12. The invention as defined in claim 1 wherein the material of the diaphragm consists of rubber.

13. The invention as defined in claim 1 wherein the material of the diaphragm consists of polyvinylchloride.

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