United States Patent [19]

Nagel et al.

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[54] **PISTON PUMP**

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[52] **U.S. Cl.** **417/386;** 417/388

[51] **Int. Cl.** **F04b 7/08;** F04b 35/02

[58] **Field of Search** ..... 417/383, 478, 394, 386, 417/385, 387, 388; 165/84; 222/146 R; 137/340

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[57] **ABSTRACT**

The disclosure relates to a piston pump which includes a housing having a hose therewithin with the hose having opposite flanged ends, each flange being sandwiched between a portion of the housing and a flange ring, a valve casing outboard of each flange ring, a valve in each casing, and tie rod means coupling each valve casing to the housing with the tie rod means including nuts for securement and release.

4 Claims, 5 Drawing Figures

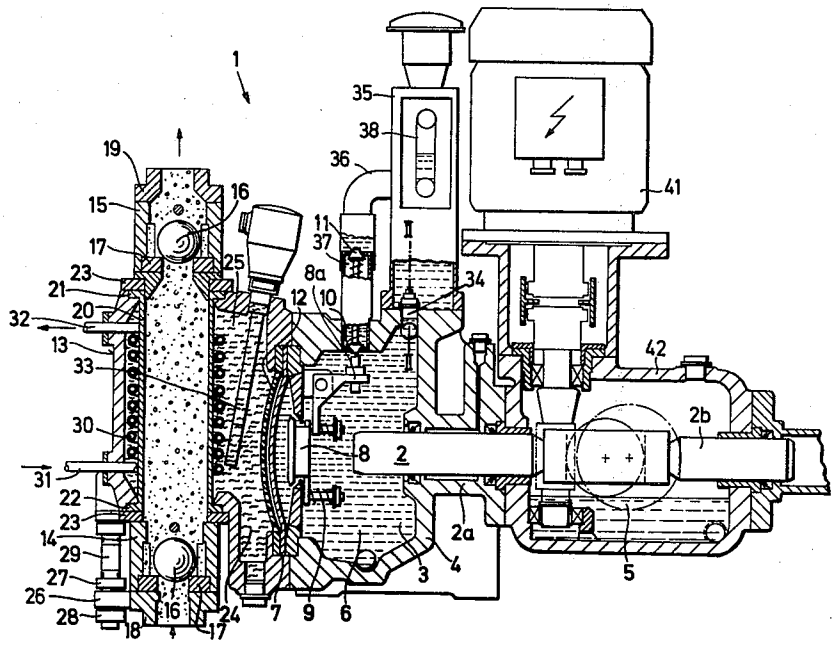


FIG. 1

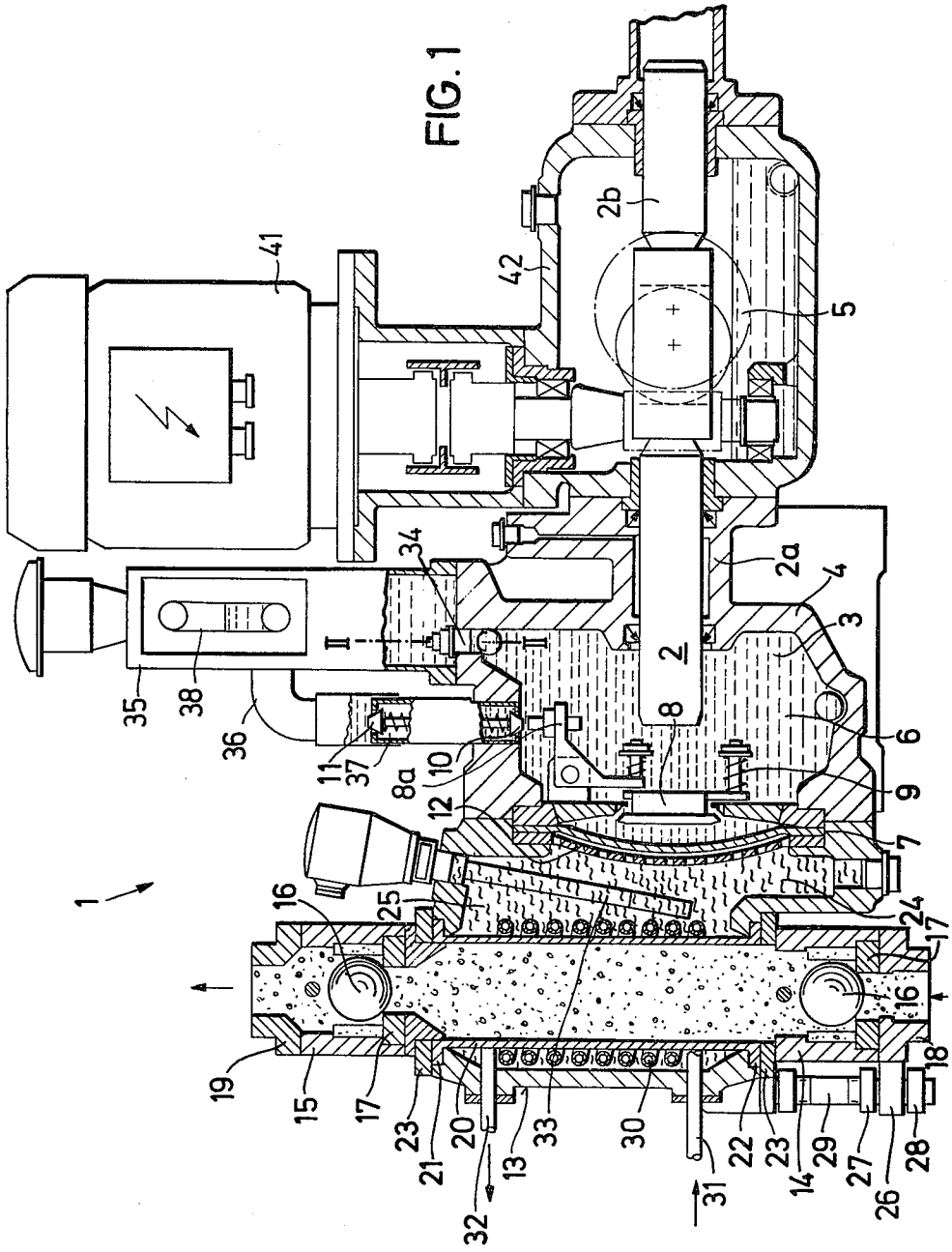

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FIG. 2

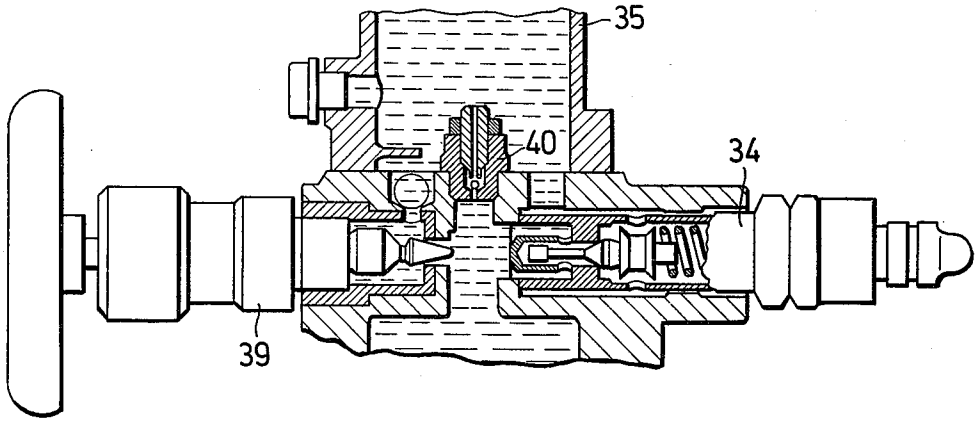


FIG. 5

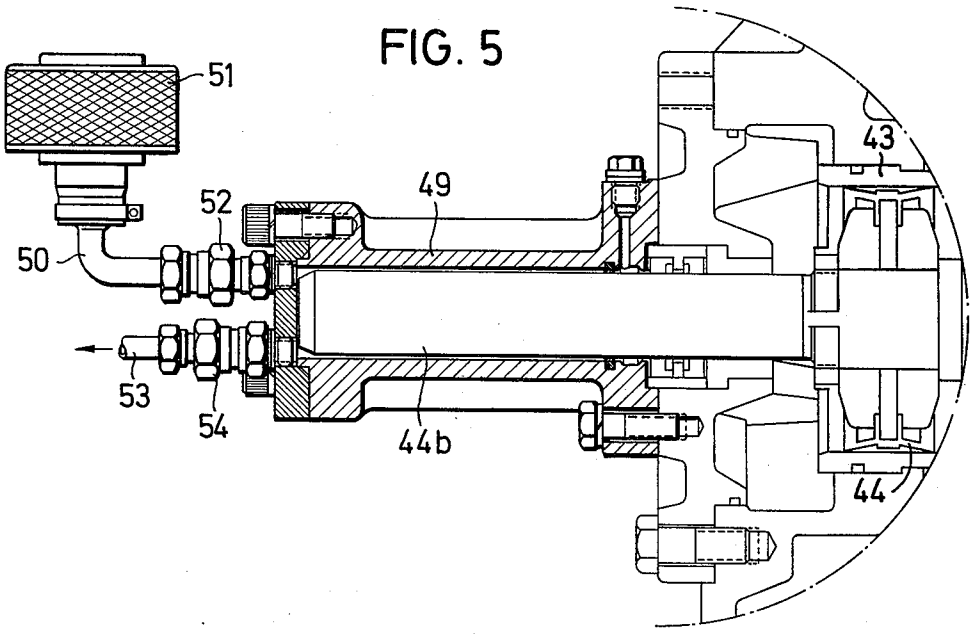


FIG. 3

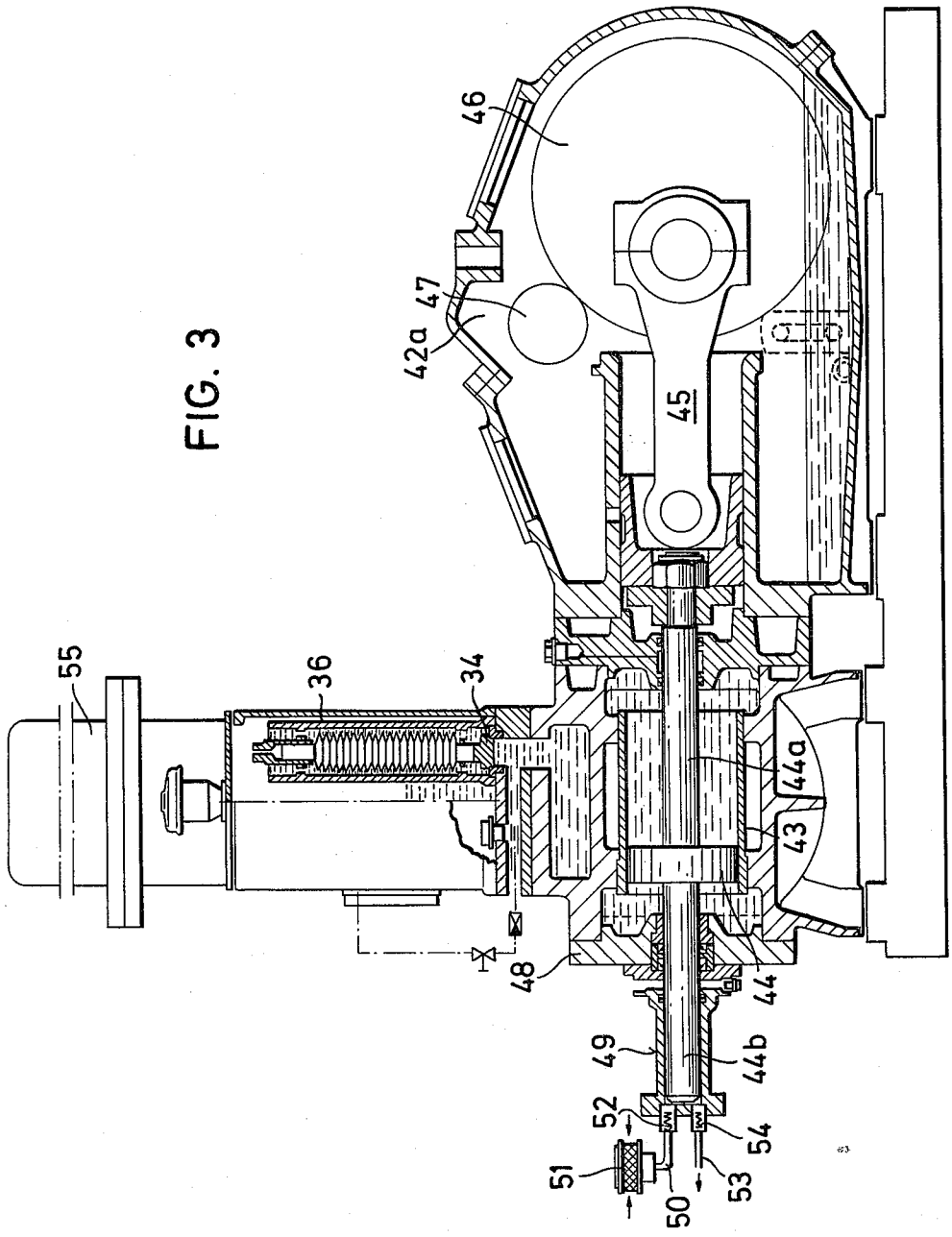
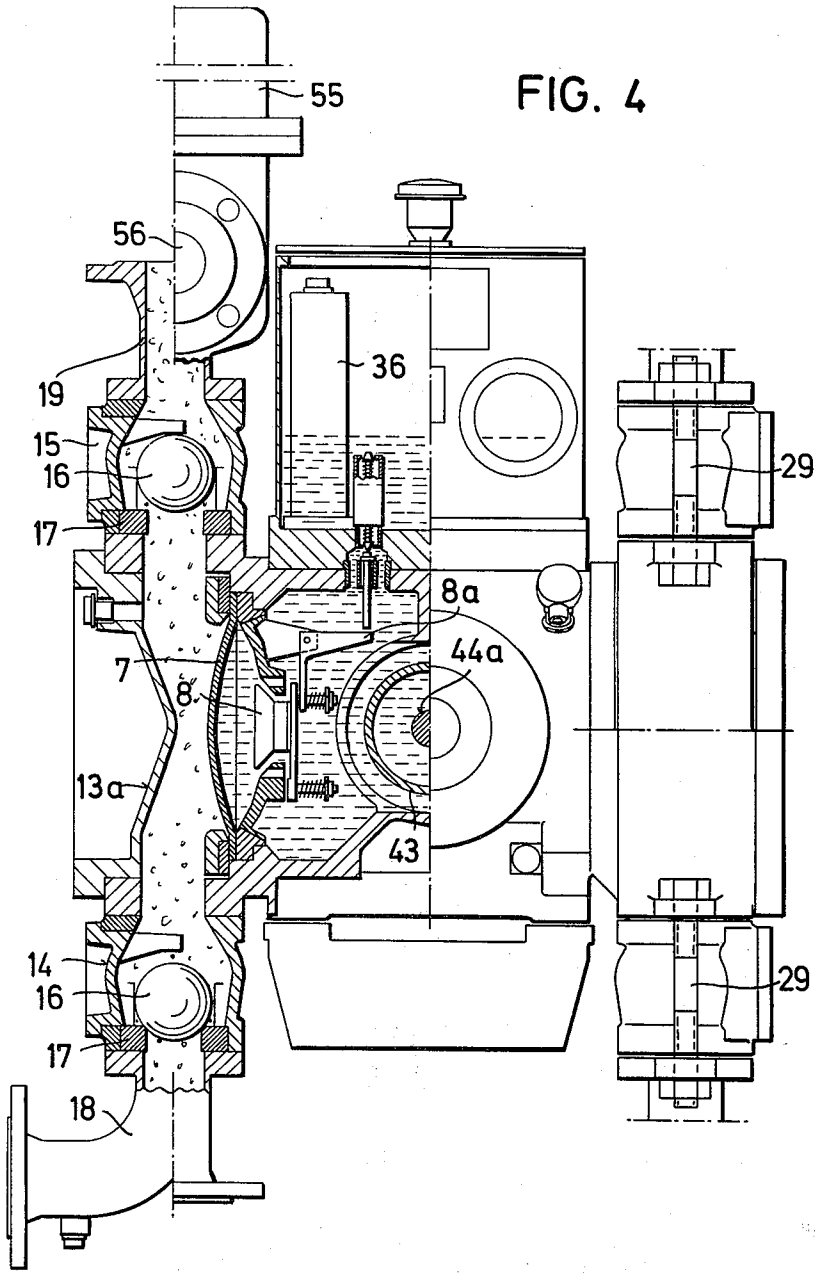


FIG. 4



PISTON PUMP

The present invention relates to a piston pump wherein the material, generally a liquid, is delivered by a pumping action between inlet and outlet valves arranged in a housing. The material to be pumped is moved by a diaphragm which is displaced by the motion of a piston, generally reciprocal, which is transmitted through a stored fluid media.

Diaphragm piston pumps of the above-described type are known, as are those where there is a space between the valves closed by means of a hose or a bellows body which includes flanged ends to which the material to be moved is conducted by pressure being exerted upon the hose through the displacement of the diaphragm.

The pump hose reacts to the action of the piston and/or the diaphragm through a neutral (generally liquid) medium line therebetween. Due to the straight flow of the material through the pump hose this construction is eminently suitable for handling highly viscous materials, abrasive materials, slurries, and the like. The pump hose is of such a size, that at maximum output of the effective flow cross section in the hose there is only about a ten percent difference during displacement as compared to a null period. The hose does not itself expand but is simply pressed or compressed out of its normal generally tubular configuration. Therefore, since expansion is not a problem pump hoses may be made from materials with relatively inferior expansion capacities but otherwise having excellent durability against corrosive or similar abrasive materials.

In known diaphragm piston pumps of this type, it has been found that the pump design does not meet requirements which are laid down for the safety of pump operation, namely as regards the shape of the constructional parts on the one hand and relative to the danger of overstressing the elastic parts (hose pump) on the other. Because of this in conventional diaphragm piston pumps only fairly low outputs can be handled and these pumps are generally used only for chemically abrasive or agressive media as opposed to abrasive sludges which generally cannot be transmitted or conveyed by such pumps.

The major object of the present invention is to provide a novel diaphragm piston pump of the type mentioned wherein the same can be operated, supervised and overall attended to simply and quickly without risk subject to the provision of appropriate safety devices. A primary distinguishing characteristc of the present invention includes valve casings at ends of the pump housing or housing head which are secured thereto by means of tie rods and use is made of independent flange rings for gripping in conjunction with the valve casing the flanges of the pump hose. Due to this design there is achieved a rapidity of mounting and demounting for cleaning or other purposes. The valves, the pump hose, etc. can be inspected readily and thorough flushings and cleanings can be carried out with negligible downtime.

With this design, upon the dismantling of the valve casing, the diaphragm operative fluid is prevented from flowing outwardly from the pump housing even though the valve casings are removed. Even upon the removal of the valve casings, the flange rings hold the pump hose in its mounted position which enables the pump hose and its position to be accurately checked without

pump chambers containing the operative fluid being emptied or cleaned.

Preferably the valve casings are secured to the housing by tie rods in the form of threaded bolts having nuts at opposite sides of flanges of the valve casings. This construction provides pressure seating of the valve casings against the housing and insures smooth ventilation of the valve casings without endangering the clamping strength of the pump hose.

In further keeping with this invention the pump casing may include means for heating or cooling the material which is moved through the pump hose by, for example, providing a heating or cooling coil which encircles the pump hose. This permits the diaphragm piston pump to become relatively insensitive to extremely high or low temperatures and renders the same eminently suitable for the handling of foodstuffs and pharmaceutical products.

In further keeping with this invention a device is provided for indicating a rupture in the pump hose or in the diaphragm through the use of an optical and/or acoustical probe.

Another object of the present invention is that of providing the piston pump with a reserve tank having an overflow pipe and an excess pressure valve with the reserve tank having a predetermined volume and being controlled by preset valves.

The overall arrangement of the latter is such as to prevent the diaphragm from becoming overstretched or stretched out. In addition this type of arrangement produces a joint at the excess pressure valve which is immersed in oil as opposed to gas, thereby providing a fluid seal which is notably safer than a conventional gas seal. The totality of the system is basically immersed in fluid and since all elements have been included in the pump layout calculations uncontrolled bursting of the diaphragm is prevented and the delivery of the pump is in noway adversely effected as might otherwise occur if care were taken during a normal operation.

In further keeping with this invention, the overflow pipe and/or the reserve tank is provided with an inspection glass which enables readily checking of the pumping control. A bottom drip valve is preferably brought into contact with a movable recovery plate for the diaphragm by means of a link rod or the like which provides pressure compensation should there be any simultaneous pressure exertion due to any irregularity on the part of the pump hose or the work piston.

In further accordance with this invention, another object is locating the excess pressure valve, the overflow pipe and the associated valves at a position above the pump housing which contains the pumping fluid. By mounting these elements in an appropriate upper or higher up position control elements for the pump fluids are to a large extent protected against sludge deposits. This is particularly important because should a diaphragm rupture more often than not the hydraulic chamber is not thoroughly cleaned and residues of sludge remaining in this chamber would produce sedimentary impurities which would adversely affect the overall operation of the pump.

In further accordance with this invention the overall pump housing including control elements and hydraulic elements thereof are provided as complete replacement components which fit into the housing in an elevated position. The interior of the housing including all control equipment therein is preferably readily in-

spected through anit-fog segments and thus the operation of the pump can be checked rapidly and efficiently at any time.

In further accordance with this invention the supporting plate for the diaphragm is a unit separate and apart of itself, and is solid, i.e. free of drilled passages. In this manner the supporting plate allows the oil to flow freely back and forth through a gap by virtue of spring force alone. When the pump is shut down or there is a defective pressure valve, the pressure of the material being handled within the hose is transmitted to the diaphragm which due to its continuous venting forces the pressure medium (generally oil) of the pressure chamber into a pressure-free reservoir chamber and ultimately into a rear collecting vessel.

In accordance with a further object of this invention, a piston compressor is attached to the piston of the diaphragm piston pump and a pressure line from the piston compressor is permanently connected to an air vessel for continuous ventilation. In arranging the piston for the diaphragm piston pump in a direction transverse to the direction of movement of the diaphragm the piston rod is capable of being withdrawn from the pump housing to enable the free end of the rod to serve as a piston for the compressor. Thus, with the added compressor not only is the constructional improvement for the overall device achieved, along with more efficient control of the diaphragm piston, but since the cylinder of the compressor is simultaneously a guide bushing for the piston rod there is achieved a uniform and homgeneous flow or handling of the material because of the elimination of the conventional differential action of conventional pistons.

With the above and other objects in view that will hereinafter appear, the nature of the invention will be more clearly understood by reference to the following detailed description, the appended claims and the several views illustrated in the accompanying drawing. In the Drawing:

FIG. 1 is a longitudinal side elevational view partially in cross section of a novel hose diaphragm piston pump constructed in accordance with this invention, and illustrates a reservoir for the operative fluid, an associated piston and diaphragm, a valve casing at each end of a valve housing, a pump hose within the housing, and an associated flange ring united to the housing by tie rods and nuts.

FIG. 2 is an enlarged sectional view taken along line II—II of FIG. 1, and illustrates a reserve tank and its associated excess pressure valve.

FIG. 3 is a side elevational view partially in cross section of another piston pump of this invention.

FIG. 4 is a side elevational view partially in cross section of the piston diaphragm pump of FIG. 3.

FIG. 5 appearing on the sheet of the drawing containing FIG. 2 is a cross sectional view of the lefthandmost portion of the piston diaphragm pump of FIG. 3, and illustrates the piston compressor on a larger scale.

A novel diaphragm piston pump constructed in accordance with this invention is illustrated in FIG. 1 of the drawings and is generally designated by the reference numeral 1. The piston pump 1 includes a piston 2 which projects into an area or volume 3 of a pump housing 4 which includes a housing portion 2*a*. The piston 2 is driven or reciprocated at a rear end (unnumbered) thereof through a crank or an eccentric gear 5 coupled to a driving device (not shown) which imparts reciprocal motion to the piston 2. The area 3 of the pump housing 4 is filled with a stored fluid or liquid 6 (pump fluid) with the area 3 at the left end of the housing 4, as viewed in FIG. 1, being sealed by means of a diaphragm 7. The diaphragm 7, as viewed in FIG. 1, bells or curves outwardly to the left in a convex fashion. Within the housing 4 is a collection plate 8 operated by compression springs 9 which control a valve 10 through a bell crank lever 8*a*. An aperture supporting plate 12 is arranged in front of the diaphragm 7 and limits the belling out or bending of the diaphragm to the left as viewed in FIG. 1. Preferably, though not necessarily, the diaphragm piston pump 1 also includes an additional piston 2*b* in axial alignment with the piston 2 which may permit the overall arrangement to operate as a twin diesel.

A pump head 13 is attached to the pump housing 4 and has attached in turn thereto valve casings 14 and 15. Ball valves 16 are housed within the valve casings 14 and 15 and each cooperates with a respective valve seats 17 in a known manner. The valve casings 14, 15 are provided with flanges 18 and 19. A hose or bellows type hollow body 20, normally referred to as a pump hose, is disposed between the valve casings 14 and 15. The pump hose 20 includes radially outwardly directed flanges 21, 22 at axially opposite ends thereof. The flanges 21, 22 are used to clamp the hose 20 within the housing 13 by means of flanges or rings 23 in the manner readily apparent from FIG. 1 of the drawing. The pump hose 20 is simply a straight line connection between the valves or valve casings 18, 19 and operates to conduct the material which is to be moved directly in a straight line between the latter-noted casings and the valve 16 associated therewith. Arrows (unnumbered) associated below and above the ball valve 16 indicate the direction of flow of the material to be transported which in FIG. 1 is from bottom to top such that the lower valve 16 may be considered a suction valve and the upper valve 16 may be considered a pressure valve as these terms are considered in the direction of opening.

An area, volume or space 24 in the pump head or housing 13 is filled with a hydraulic medium 25 and represents a second stored fluid for effecting pumping action of the pump hose 20 upon the reciprocation of the piston 2. The intermediate medium 25 may also be employed for heating or cooling the material passing through the hose 20 by means of a coil 30 encircling the hose 20 and being provided with an inlet 31 and an outlet 32 with the latter being connected to the reservoir and the former being connected to a source of heating or cooling media.

The flanges 18, 19 of the valve casings 14, 15 include lugs 26 which are secured between nuts 27 and 28 screwed upon tie rods 29 fixed to the housing 13. In order to dismantle the valve casings 14, 15 it is necessary to remove only the nuts 28, while these same nuts not only maintain the casings 18, 19 assembled but also provide the clamping force necessary to secure the pump hose 20 in its assembled position by exerting a clamping force thereagainst through the flange rings 23. In effect the flanges 21, 22 of the hose 20 are clamped between the rings 23, 23 and the housing 13 by virtue of the tie rods 29 and the nuts 28 associated therewith as they interact through the casings 14, 15. Additionally, the piping connected to the valves can be released by means of the nuts 28 which permits access

to the valves as well as to the pump hose **20** to enable cleaning and flushing to be carried out in an expeditious manner.

A combined hose and diaphragm rupture registering device or probe **33** is positioned within the space or volume **24** of the pump housing **13.** The probe **33** operates such that the capacitive operation of the intermediate medium **6** mixing with the material being handled or passing through the hose **20** brought about through a rupture of the diaphragm **12** is utilized by the probe through conductivity limit switches for cutting off power to the pump **1** and/or for emitting an optical or acoustical signal. In order to assure that the probe is efficiently operable large differences in dielectrics of liquids involved are chosen, namely different dielectrics for the medium being pumped through the hose **20,** the pump liquid within the chamber **3,** and the intermediate medium or liquid within the chamber **24.**

Preferably a reserve tank **35** is connected above an excess pressure valve **34** of the diaphragm piston pump **1** and is also provided with an overflow pipe **36** within which are located the valves **10** and **11** (FIG. **1**). The valves **10** and **11** enclose a chamber **37** of a predetermined volume. The latter volume is designed to allow the full content of the overflow pipe to enter into the hydraulic space or volume **3** between the piston **2** and the diaphragm **7** without causing the diaphragm to be overstretched or pressed too much to the front or its left left as viewed in FIG. **1.** A complete liquid seal is achieved within the overall pressure system. A window **38** is provided as an efficient means for checking the pump control gear by observing the actual oil level. A bypass valve or similar bypass means **39** regulates the material being handled whereas a ventilating valve **40** is provided for continuous ventilation in a conventional manner.

The excess pressure valve **34,** the overflow pipe **36** and the valves **10, 11** are mounted as high as possible upon the overall pump **1** to keep them free of any sludge deposits. This is of particular importance should leakage occur between the valves **10** and **11** which assures safe functioning of the lower associated leakage control element.

The pump **1** also includes a housing **41** containing all hydraulic control components which is mounted above a drive housing **42.** As is readily apparent from FIG. **1** all control components are in but a single housing and thus the full set, such as the components **41, 42,** can be readily replaced.

FIGS. **3** through **5** illustrate another diaphragm piston pump of this invention wherein a cylinder **43** slidably receives a reciprocable piston **44** movable transversely to the direction of motion of the diaphragm **7.** The piston **44** is connected to an eccentric disk **46** by a connecting rod **45** with the disk **46** being driven by a pinion **47** housed within a housing portion **42***a*. A piston rod **44***a* carrying the piston **44** includes an extension **44***b* which projects outwardly of a cap **48** of the housing **42***a*. The piston rod portion **44***b* reciprocates within a cylinder **49** which serves as a compression cylinder closed at its front end except for an air supply line **50** having a filter at **51** and the non-return valve **52.** At this same end a line **53** with an intermediate non-return valve **54** serves for discharging compressed air from within the chamber defined by the cylinder **49.** The line **53** leads to an air vessel **55** (FIG. **3**) which is arranged above a discharge line **56** (FIG. **4**) for the material which is to be moved or removed from the pump. Continuous ventilation of the air vessel **55** is achieved by means of the piston compressor coupled to the diaphragm piston pump which provides compensation for intermittent operations.

Referring specifically to FIG. **4,** the diaphragm piston pump does not include a pump hose for the material being handled and instead a portion **13***a* of the housing is conformed to define a nozzle with the diaphragm **7.** The portion **13***a* of the housing narrows most at its midpoint and opens at each end thereof. Therefore, the portion **13***a* of the housing and the diaphragm **7** is reduced to a predetermined cross section and then is brought back to its initial cross section during the operation of the pump. In this type of arrangement it is advisable to set the diaphragm **7** as tightly as possible and therefore the clamping of the diaphragm **7** is in a plane tangential to the housing **13***a*.

While preferred forms and arrangement of parts have been shown in illustrating the invention, it is to be clearly understood that various changes in details and arrangement of parts may be made without departing from the scope and spirit of this disclosure.

What is claimed is:

1. A piston pump comprising a deformable passage through which a media is adapted to flow from an inlet thereof toward an outlet thereof, a housing defining a normally closed fluid chamber, a piston mounted for reciprocal motion at least partially within said fluid chamber, means for reciprocating said piston whereby fluid within said fluid chamber is pulsated, means for utilizing the pulsating fluid to drive the media through said passage, a reservoir for said fluid, conduit means for placing said reservoir in fluid communication with said fluid chamber, valve means in said conduit means for selectively introducing fluid from said conduit means into said fluid chamber, said valve means include a pair of valve seats and a valve body associated with each valve seat, pressure responsive mechanically movable means in said fluid chamber responsive to pressure within said fluid chamber for opening said valve means to permit a predetermined volume of fluid to flow through said conduit means into said fluid chamber, and excessive pressure relief valve means for relieving pressure within said fluid chamber by bleeding fluid therefrom into said reservoir.

2. The piston pump as defined in claim **1** wherein the fluid bleeding caused by the operation of said excessive pressure relief valve means creates a reduction in the volume and pressure of the fluid within said fluid chamber, only one of said valve bodies is opened by said valve opening means, and the other of said valve bodies is thereby automatically opened by reservoir pressure in excess of the reduced pressure of the fluid within said fluid chamber.

3. The piston pump as defined in claim **2** wherein said valve opening means includes a bell-crank having opposite arms, means mounting said bell-crank for pivotal movement in said fluid chamber, one of said arms being aligned for moving said one valve body upon pivotal movement of said bell-crank in a predetermined direction, and means movable in response to the reduced pressure of the fluid within said fluid chamber for pivoting said bell-crank in said predetermined direction through motion imparted thereto through the second of said arms.

4. The piston pump as defined in claim **3** wherein said movable means is a dish mounted for reciprocal motion generally parallel to the reciprocal motion of said piston.

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