Feb. 25, 1969 E. I. NILSSON 3,429,274

DIAPHRAGM PUMP, IN PARTICULAR FOR PUMPING VISCOUS LIQUIDS

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Fig. 1

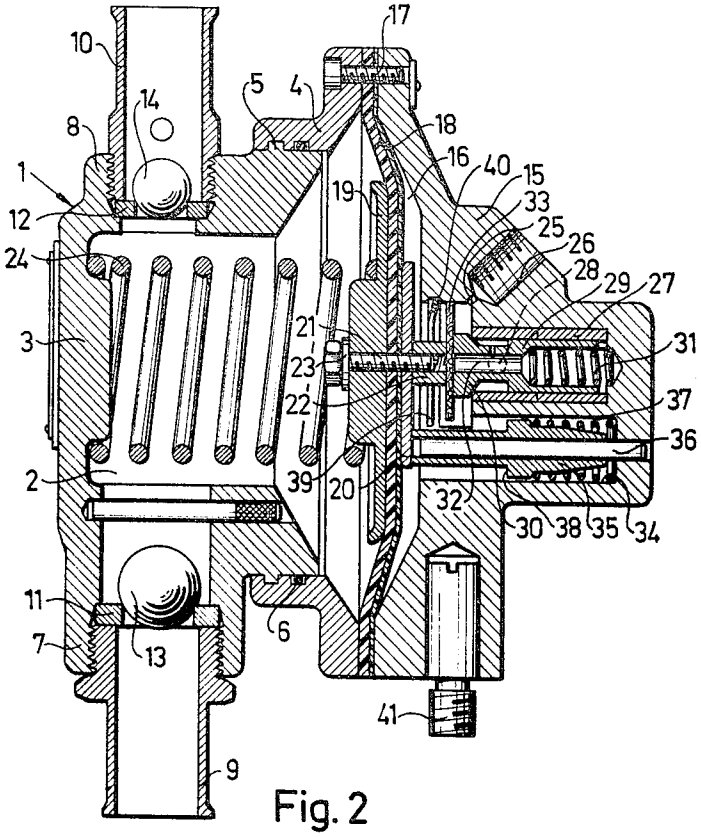
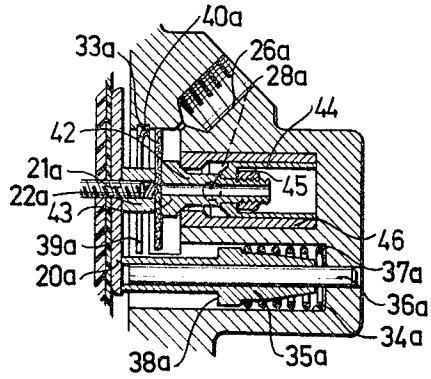


Fig. 2



INVENTOR

Erling Ingvar Nilsson

BY Pierce, Scheffler & Parker

ATTORNEYS

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DIAPHRAGM PUMP, IN PARTICULAR FOR PUMPING VISCOUS LIQUIDS

Erling Ingvar Nilsson, Lund, Sweden, assignor to AB Akerlund & Rausing, Lund, Sweden, a company of Sweden

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Int. Cl. F04b 43/06

ABSTRACT OF THE DISCLOSURE

A fluid operated diaphragm pump has a valve means for controlling the motive fluid. The valve means is mechanically and pneumatically guided by the movements of the diaphragm. The valve means is movable in one direction by the direct action of the diaphragm and is movable in the other direction at a moment determined by a follower means under the influence of the diaphragm.

The present invention relates to a diaphragm pump, in particular for pumping viscous liquids. An important purpose for which the pump is used is to pump printing inks to the inking devices in printing machines, in which case it functions as a circulation pump in the circuit between the ink vats of the inking devices and a storage container for the printing ink. Other instances of purposes for which this pump is used are pumping of lacquers in lacquering machines and glue in laminating and gluing machines.

The diaphragm pump according to the invention has a pump housing with inlet and outlet valves for the passage of the liquid being pumped and a second housing connected with the pump housing along marginal portions between which there is mounted a diaphragm, one side of which borders on the pump housing chamber and the other side of which, together with the other housing defines a room which is adapted to be supplied with compressed air for operating the diaphragm, the said second housing being provided with valve means for bringing about variations in the air pressure prevailing in the room and acting on the diaphragm, thus causing its reciprocatng movements, and is characterized in that the valve means are mechanically and pneumatically guided by the reciprocating movements of the diaphragm and consist of a bore provided opposite the diaphragm in the second housing and being in communication with the atmosphere, as well as a valve body displaceable in the said bore and, in an end position, shutting the bore from the room in the second housing, the valve body being adapted to be moved to the shutting position under the action of the diaphragm itself at the stroke of the latter in one direction, and to be moved to an opening position at the stroke of the diaphragm in the other direction at a moment determined by follower means under the influence of the diaphragm.

Further objects and advantages of the invention will be described in greater detail in the following, with reference to the accompanying drawings, in which,

FIG. 1 is an axial section of an embodiment of a diaphragm pump according to the invention,

FIG. 2 is an axial section of part of another embodiment of the pump.

The diaphragm pump shown in the drawing has a pump housing 1 enclosing a chamber 2. The housing 1 consists of a box-shaped portion 3 and an annular portion 4, which are detachably connected with each other by means of a bayonet catch 5 and mutually sealed by means of a gasket 6. The box-shaped portion 3 is provided with diametrically opposite connecting pieces 7 and 8, into which hose fittings 9 and 10, respectively, are screwed. Between an

interior annular shoulder in each connecting piece 7 and 8 and the inner end of the respective hose fitting 9 and 10 there is clamped a ring 11 and 12, respectively, which serves as a valve seat. The valve seat 11 and a ball 13 resting against it on the inside form an inlet valve for the liquid to be pumped and which is supplied through a hose (not shown) connected with the fitting 9, while the valve seat 12 and a ball 14 resting against it on the outside form an outlet valve for the liquid which is discharged through a hose (not shown) connected to the fitting 10.

A second housing 15, which defines a room 16, is connected with a portion 4 of the pump housing 1 by means of marginal or flange portions and bolts 17 passing through these, only one of which is shown in the drawing. Between these marginal or flange portions there is mounted a diaphragm 18, which consequently defines the chamber 2 in the pump housing 1 on one side and a room 16 in the housing 15 on the other side. The diaphragm 18 may preferably be laminated and consists of a fabric reinforced neoprene-rubber partial diaphragm having a thickness of e.g. 2 mm. and provided on the side which faces the pump housing, and a fabric reinforced neoprene-rubber partial member having a thickness of 0.5 mm. and provided on the opposite side. On the pump housing side of the diaphragm 18 there is provided a washer 19 and on the opposite side a washer 20. These two washers are held tensioned centrally against the diaphragm by means of a bolt 21 inserted from the pump housing side and a nut 22 tensioned against the washer 20. Beneath the head of the bolt there is mounted a sealing gasket 23. The washer 19 is provided with a seat for one end of a spring 24, which rests with its other end against a seat provided on the bottom of the box-shaped portion 3 of the housing 1. The spring 24 is pretensioned and thus exerts a pressure on the diaphragm 18 in a direction away from the housing 15.

The room 16 in the housing 15 is adapted to be placed in connection with a source of compressed air through an aperture 25 in the wall of the housing at the bottom of an exterior threaded recess 26 for screwing a hose fitting (not shown) onto a hose conduit coming from the source of compressed air. Axially opposite the central point of the diaphragm 18 there is provided an inner bore in the material of the housing 15, into which there is pressed a bushing 27. To provide an outlet for the return air from the room 16 there is bored a lateral aperture 28 through the housing from the said bore to the atmosphere. In the bushing 27 there is displaceably mounted a valve member 29 which is provided with a cone 30 intended to rest in sealing engagement with that end of the bushing which faces the room 16 when the valve member is completely inserted into the bushing. A weak compression spring 31 is mounted between the bottom of the bore and the valve member 29 and thus tends to keep the cone 30 away from its seat. The end surface of the valve member 29 which faces the room 16 is ground completely plane. The valve body has a through axial passage 32, the opening of which on the said plane end surface may be kept tightly sealed by means of a fibre disk 33, which is kept pressed against the surface by the nut 22 when the diaphragm 18 is in the position shown in the drawing.

In a second interior bore 34 in the housing 15 beside the bore mentioned above there is provided a follower member 35, which consists of a tubular body which is displaceably threaded onto a pin 36 mounted in the wall of the housing 15 and projecting freely into the bore 34. The front end of the follower member 35 is kept pressed against the washer 20 on the diaphragm 18 by a spring 37, which is provided between the bottom of the bore 34 and a spring seat on the follower member. At a certain distance from its said forward end the latter has a shoulder 38 directed forward and intended to engage

with the edge of the fibre disk **33** in order to tilt it a little farther away from the end surface of the valve body **29** when the diaphragm **18** has moved so far to the left in the drawing as to permit the spring **37** to displace the follower member **35** through the required distance.

For a purpose to be explained below there is mounted a ring **39** in a peripherally interior groove in the housing **15**, said ring surrounding the nut **22** freely and having at the top (as seen in FIG. 1) at **40** a bulge in the direction of the fibre disk.

The pump described above functions as follows. It is assumed that the parts of the pump occupy the position shown in the drawing from the beginning. When compressed air enters the room **16**, preferably at a pressure of 1.5 kp./cm.^{2}, the diaphragm **18** is forced towards the left in FIG. 1. The outlet for the compressed air through the aperture **28** is shut by the valve cone **30** while this takes place. The spring **37** simultaneously displaces the follower means **35** towards the left. When the shoulder **38** of the said member strikes against the edge of the fibre disk **33** and tilts it in the manner described above, the compressed air may follow through the passage **32** into the space behind the valve member **29**, thus equalizing the pressure difference acting on the valve member. Thereupon the spring **31** can displace the valve member to the left so that the outlet for the compressed air past the cone **30** is opened. The valve member **29** moves the fibre disk **33** along, but in consequence of the fact that the said disk strikes against the bulge **40** on the ring **39** it cannot lie sealingly against the end surface of the member **29** but is forced to occupy an inclined position in relation thereto. When the air pressure acting on the diaphragm **18** has sunk to such a degree that the force of the spring **24** acting on the diaphragm preponderates, the diaphragm is forced back, whereupon the nut **22** comes into contact with the fibre disk **33** and returns it to the position in which it shuts the passage **32** and forces the valve member **29** back so that the cone **30** again shuts off the outlet for the compressed air. In addition, the follower member is also forced back by the washer **20**. When this has been done, the pump has completed one work stroke, during which liquid has been forced out through the outlet valves **12**, **14** and been sucked in through the inlet valves **11**, **13**.

The pump may be fixed, preferably by means of a threaded pin **41**, in a corresponding opening in the lid of a liquid container.

The embodiment of the pump which is partly shown in FIG. 2 differs from the embodiment shown in FIG. 1 only with respect to the construction of the valve means.

The valve body **42** consists of a part provided with a cone **43** and of a part **44** having a larger outer diameter than the cone and being connected with the cone member by means of a nut **45**. The bushing **46** provided in the bore in the housing **15***a* has a portion with a relatively small inner diameter at its end which is adjacent the chamber **16***a* in the housing, against which portion the cone **43** is to rest when the valve body **42** is completely inserted into the bushing **46**, and a portion of a larger inner diameter in which the valve body part **44** moves.

When the fibre disk **33***a* is tilted in the manner described with reference to FIG. 1, the pressure difference between the ends of the valve body is equalized, and since the surface of the valve body which is exposed in this connection to a pressure directed towards the left in the figure is larger than the surface of the body which is exposed to a pressure directed to the right in the figure, the valve body will be displaced to the opening position

so that the outlet past the cone **43** is opened. In consequence hereof, the spring used in order to bring about this displacement in the embodiment according to FIG. 1 has become unnecessary, which is of advantage for the operational reliability of the valve means.

I claim:

1. A diaphragm pump comprising a housing, a diaphragm fixedly mounted at its periphery in said housing and dividing the interior thereof into first and second rooms, valve controlled inlet and outlet means communicating with said first room forming a pump chamber, means for supplying pressure fluid to said second room to operate said diaphragm, and valve means controlling the discharge of pressure fluid from said second room in order to bring about variations in the air pressure prevailing in said second room and acting on the diaphragm, thus producing reciprocating movement thereof, said valve means having a valve body reciprocable between closed and open positions in a bore in said housing, opening in said second room opposite said diaphragm and communicating with the atmosphere, said valve body being adapted to be moved to said closed position by said diaphragm when moved towards said second room and to be retained in said closed position closing said bore to said second room, by fluid pressure in said second room, a shutting member controlling communication through a passage in said valve body between the ends thereof, a follower operatively related to said diaphragm to follow the reciprocation thereof, and means on said follower engageable with said shutting member when said diaphragm is moved towards said first room, to actuate said shutting member at a moment determined by said follower under the influence of said discharge, so as to bring about communication between the ends of said valve body, equalizing pressure difference between the ends thereof, movement of said valve body to its open position thereby being initiated.

2. A diaphragm pump as claimed in claim **1**, in which the follower member is displaceably disposed in a bore in the second housing beside the bore receiving the valve body and is held with one of its ends resting against the diaphragm under the influence of a spring means, and in which the follower member has an abutment spaced a distance inside the said end for moving the shutting member aside.

3. A diaphragm pump as claimed in claim **1**, in which the diaphragm is under the action of a spring provided in the chamber of the pump housing for bringing about its stroke in the return direction when the air pressure on the opposite side of the diaphragm is reduced.

4. A diaphragm pump as claimed in claim **1**, in which when the valve body is in its shutting position and the shutting member has been moved aside, the surface of the valve body on which the pressure acts in order to press the body towards the opening position is larger than the surface on which the pressure acts in order to press the body towards the shutting position.

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ROBERT M. WALKER, *Primary Examiner.*

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