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**ENGINEERING. (INCL. MACHINE SHOP MAG-
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Description

This invention relates to an aggressive liquid pump for transferring and dosing.

Several kinds of membrane pumps for pumping aggressive liquids are known. One type is a membrane piston pump powered by an electric motor. Such pumps comprise a single leaf membrane, which is directly connected via a connecting rod with the electric motor. The pump may or may not be provided with a speed reducing means. The frequency of the pumps without the reducing means is equal to the number of cycles of the electric motor, and the aggressive liquids flow rate is controlled by a degree to which an eccentric moves the connecting rod and therefore the membrane.

The frequency of the pump provided with the speed reducing means is less than the number of cycles of the electric motor. Therefore the pump speed reduction results in easier flow rate control. The use of reducing means is on the other hand disadvantageous because those pumps are considerably larger than the pumps without it. This is due to the fact, that the design and production of the pumps provided with the reducing means are much more complex. Both designs are presently considered to be obsolete.

Another type is a pneumatic operated membrane pump as for example disclosed in the EP0 315 264. The pump of the European patent application is constructed for transferring beer or carbonated beverages and not for aggressive liquids, but it is a good example to demonstrate the basic principles of this kind of pumps.

These pumps comprise usually two membranes opposite one to another. The pumps are powered by pressurized air and the aggressive liquid flow rate is controlled by controlling the flow of the air. In such pumps, one membrane draws the aggressive liquid into its respective chamber, while the other one forces aggressive liquid out and vice versa. Such pumps for pumping aggressive liquids are produced for example by ASTI Company of France (models PCS-O, PCS-1 and PCS-2).

Each chamber is provided with a separate liquid distributing means. Connecting the two separate distributing means by pipes is therefore required, in order to obtain a single intake and exhaust, which makes the design complex and enlarges the number of parts necessary, in particular the number of sealings. The complexity of the design makes assembling and disassembling more difficult, which has an adverse effect on the complete sealing.

Another type of pneumatically operated aggressive liquid pumps is disclosed in Engineering,

Volume 223, No. 12, December 1983, London GB, Page 994. This pump is of the single chamber type with only one inlet valve and an outlet valve to fill and empty the chamber. The pump body is completely machined from a solid block of PTFE. To allow a more or less continuous flow, two chambers have to be operated alternatively in parallel.

Bellows are mounted on the side of the body at a position between a suction and an exhaust valve. The valve members are operated by a pressure force of the liquid originating from the movement of pressured air driven bellows. The pressure force of the liquid acts opposite to a retaining force of the valve members that is generated by bar magnets completely embedded in the PTFE of the valve members. Because of the magnets, springs, that could be corroded by the aggressive liquid are avoided.

Each chamber has a compact design, however, the necessary size is increased by using two pumps alternatively operated to obtain a more continuous flow of liquid.

The problem of the invention is to provide a new design for an aggressive liquids pump that allows to build pumps smaller than known from the state of the art with good flow control and sealing capabilities.

The problem is solved by an aggressive liquid pump for transferring and dosing with a housing made of Koterm (R) and comprising two opposite cylinders, each divided by a movable membrane into two chambers, one for the liquid and the other for a driving gas, and both membranes being fastened to each other by a rod movable in a central boring within the housing, comprising two further cylindrical borings, each one parallel to the connecting rod, with openings at both ends into the chambers of the cylinders provided for the liquid, and each containing two valve elements, i.e., two exhaust valve elements in one boring and two suction valve elements in the other boring, the valve elements being also made completely of non-corrosive material and having completely embedded bar magnets, each situated in the end of each valve element, which is facing the other valve element in the same boring, the bar magnets in the suction valve elements facing each other with different poles and the bar magnets in the exhaust valve elements facing each other with matching poles.

The pump according to the invention is of the two chamber type as described already above. It has a compact design, is easy to produce and to disassemble because of the special construction of the housing and the valve elements being placed in borings of the housing. In the valve elements bar magnets are embedded, generating a retaining force, directed opposite to the force due to the

pressure difference generated by the motion of the members introduced by a pneumatic drive. If the pressure of the pneumatic drive completely drops, the magnetic force is able to seal the valves properly, thus allowing proper pumping even under low pressure. Fine regulation of the aggressive liquid pumping speed is therefore also possible.

The invention will be described in greater detail with reference to the drawings by an embodiment serving as example. It is shown in

- Fig. 1 a view of a pump according to the invention in three projections;
- Fig. 2 a cross section along line I-I of Fig. 1;
- Fig. 3 a pneumatic scheme of the pump according to Fig. 1;
- Fig. 4 a view of the distribution means body in three projections;
- Fig 5 a valve element for the inlet valve;
- Fig. 6 a plug to seal a permanent magnet in the inlet valve element;
- Fig. 7 a valve element for the exhaust valve;
- Fig. 8 a detailed view of a microswitch shown in Fig. 2.

Fig. 1 shows the general design of an embodiment of a pump according to the invention. The pump 1 is fixed on a housing 2 of the pneumatic elements. For operation the pressured air to drive the pump is supplied via a connector 3, situated in the housing. Before the air is led to the pump 1 it flows through a 3/2 distributor 4 that can be operated from outside. In addition to the distributor 4 a muffler 5 can be regulated from the front panel of the housing 2 for the pneumatic elements. The muffler serves to regulate the air flow, thus regulating the flow of the pumped aggressive liquid. Detailed description of its function will be given below in reference to Fig. 3.

The pump 1 is fixed on the housing for the pneumatic elements by a screw 6 made of brass. The pump 1 consists mainly out of liquid distributions means 7 in the center and two cylinders 8 at each side of the distribution means 7. The cylinders are made of Koterm. At the end of each cylinder 8 opposite to its end not engaging with the liquid distribution means 7, switch housings 9 are fixed containing microswitches that will be described later. The switch housings 9, the cylinders 8, and the distribution means 7 are fastened together by flanges 10 made out of duraluminium, bolts 11 made of steel, nuts 12 and washers 13. Additionally air pumping means 14 are visible in Fig. 1, delivering pressured air from the housing 2 to the pump 1.

The function and the interior construction of the pump can be seen more easily from a sectional drawing along the lines I-I of Fig. 2. This figure shows in particular the inside structure of the liquid distribution means 7 sandwiched by the both cyl-

inders 8 and the switch housings 9. The liquid distribution means 7 comprises a housing 15 made of Koterm (R), which is shown in Fig. 4 in detail. The housing 15 is cylindrical and has a center boring 16 and two borings offset from the center, used as exhaust chamber 17 and inlet chamber 18 for pumping the aggressive liquid. The exhaust chamber 17 contains two exhaust valve elements 19, and the inlet chamber 18 two suction valve elements 20. Both chambers contain corresponding valve seats 21 and 22 for the respective valve elements 19 and 20 as well. All these parts are made of Koterm (R).

While the suction valve seats 22 in the inlet chamber 18 are fixed central inside the liquid distribution means 7, the exhaust valve seats 21 in the exhaust chamber 19 are positioned at its ends.

The pressure in the chambers 17 and 18 to move the valve elements 21, 22 is generated by membranes 23 made of teflon (R), moved by pressured air in the cylinders 8. Both membranes 23 are connected via a connecting rod 24 made of stainless steel. The connecting rod is fixed at the membranes 23 with screws 25, also made of stainless steel.

When the membrane 23 on the left side of Fig. 2 is moving to the left, an underpressure is generated, which pulls the left suction valve element 20 and exhaust valve element 19 to the left and opens the entrance for the aggressive liquid which is pulled into the inlet chamber 18 by the same pressure. Because the both membranes are rigidly connected by the connecting rod 24 the right membrane 23 moves to the left as well. Therefore it presses liquid, present in the exhaust chamber 17 by moving the right exhaust valve element 19 to the left, while the right suction valve element 20 is sealing on its seat 22 and does not allow liquid to exit on the spot. At the end of the movement the membrane 23 switches a microswitch 26 in the switch housing 9. By use of an additional pressure circuit that will be described later in reference to Fig. 3 the switching of the microswitch 26 results in a reversal of the air pressure so that the right membrane 23 then moves to the right until it actuates the right microswitch 26. This again reverses the air pressure and this way periodic pumping cycles are provided.

The inlet chamber 19 is closed on both sides with special screws 27 made of teflon, having a central boring allowing the pressure generated by the movement of the membranes 23 to act on the suction valve elements 20. Similarly the center boring 16, bearing the connecting rod 24 is closed with special screws 28 made of teflon (R).

Each of the suction valve elements 20 and the exhaust valve elements 19 incorporate magnets 29 and 30 respectively. The magnets 29 generate a

force between the both suction valve elements 20 that seals the intake when the air pressure is very low. The magnets 30 generate a repulsive force between the exhaust valve elements 19 to open the exhaust when the air pressure drops. This way the magnets allow even a proper function of the pump under low pressure.

All the magnets 29, 30 are embedded completely in the valve elements 19, 20 as will be described later in detail in reference to Fig. 5 to Fig. 7.

A pneumatic scheme to drive the pump is shown in Fig. 3. Air under pressure of 2.5 to 5.0 bars enters at the 3/2 distributor 4, flows through the muffler 5 to a 5/2 distributor 31 and further to one of the membranes 23 and widens it. Because of the connection of the both membranes 23 with the connection rod 24 the movement of one membrane 23 is transferred to the other. For a better understanding of the pumping scheme assume that the right membrane 23 moves to the left. Then the air from the inside part of the left membrane 23 freely leaves into the atmosphere through the 5/2 distributor 31, the same time the left membrane generates the underpressure in the left chamber, sucking the aggressive liquid in the way it was described before. When the inside part of the left membrane 23 actuates the microswitch 26 air flows through it, resulting in a command pulse, that switches the 5/2 air distributor 31. The 5/2 air distributor 31 then changes the direction of air streaming. Now the air enters the inside of the left membrane and exits freely into atmosphere from the right membrane 23. The aggressive liquid, which is already sucked in, is pushed out of the left chamber and additionally the aggressive liquid is sucked into the right chamber until the inside part of the right membrane 23 actuates the microswitch 26, changing again the direction of movement. That way the liquid is continuously sucked into one chamber and pushed out from the other chamber and vice versa.

By regulating the air flow with the muffler 5, the speed of the membrane movement is regulated which also regulates the flow of the aggressive liquid. The flow of aggressive liquid changes linearly dependent on the number of cycles of the membrane per minute.

Therefore also the flow of aggressive liquid is linearly dependant on the number of cycles in a minute.

The best way for economic use of the invention is

- the number of cycles is between 10 to 60 cycles per minute;
- the flow of the pump is between 20 l/h with 10 cycles/min. to 300 l/h with 60 cycles/min.;
- the optimum working condition of the pump is 10 cycles/min. up to 50 cycles/min.

Fig. 4 shows the housing 15 of the distribution means 7 made of Koterm. It is of cylindrical shape 86 mm long with a diameter of 70 mm. The center boring 16 is 10.5 mm in diameter, giving enough tolerance for the movement of the rod, that is cylindrical with 10 mm diameter. The borings used for the exhaust chamber 17 and the inlet chamber 18 are each 14.5 mm wide. Fig. 4 shows in addition a radial extending hole 32 with an M10 thread for fixing the screw 6.

Fig. 5 and 6 show how the suction valve elements 20 are shaped and in particular how the magnets 29 are embedded in the material. The suction valve element 20 is made of Koterm with a maximum outer diameter of 14.5 mm. In the center a hole 33 with a diameter of 4.5 mm is provided to fix a cylindrical magnet 29 of 4.5 mm diameter.

After introducing the magnet 29 in the hole 33 of the valve element 20 it is sealed with a plug 34 as shown in Fig. 6. It has two cylindrical sections 35 and 36 with a conical section 37 between them. The cylindrical section 35 is 4.4 mm in diameter so that the plug 34 fits well in the hole 33 of the inlet valve element 20. The conical section 37 seals the hole 33 after introduction of the magnet. Because the plug 34 and the suction valve element 20 is made of Koterm the whole valve element resists against aggressive liquids. The magnets are completely embedded inside the valve element 20 and secured.

Fig. 7 shows the shape of the exhaust valve elements 19. It comprises also a central hole 38 to include the magnet 30 that is fixed with a plug similar to that in Fig. 6.

Fig. 8 shows the details of the microswitch 26 used to reverse together with the 5/2 distributor 31 the flow of pressured air from one membrane 23 to the other. The membranes 23 act on an actuator 39 of the microswitch 26 made of brass. The actuator 39 is held in position relative to the housing 40 made of brass by a spring 41 made of spring iron wire. The spring 41 is acting on a ball housing including a ball 43 that is secured with another spring 41.

In addition, there are two openings 44 and 45 as inlet and outlet for pressured air. The inside part of the membrane 23 moves the actuator 39 and closes the opening 45 before the other end of the actuator 39 moves the ball 43 and makes it possible for air under pressure to pass by the ball 43 through the opening 44. Air under pressure works on the part marked by the arrow with the reference number 46.

The described embodiment of the invention showed excellent properties in transporting aggressive liquids, fine-regulating aggressive liquids and it has a simple construction allowing easy disassem-

bling and assembling of the pump.

Claims

1. Aggressive liquids pump for transferring and dosing with a housing (15) made of Koterm (R) and comprising two opposite cylinders (8), each divided by a movable membrane (23) into two chambers, one for the liquid and the other for a driving gas, and both membranes (23) being fastened to each other by a rod (24) movable in a central boring (24) within the housing (15), comprising two further cylindrical borings (17, 18), each one parallel to the connecting rod, with openings at both ends into the chambers of the cylinders provided for the liquid, and each containing two valve elements, i.e., two exhaust valve elements (19) in one boring (17) and two suction valve elements (20) in the other boring (18), the valve elements being also made completely of Koterm (R) and having completely embedded bar magnets (29, 30), each situated in the end of each valve element (19, 20), which is facing the other valve element (19, 20) in the same boring, the bar magnets (29) in the suction valve elements (20) facing each other with different poles and the bar magnets (30) in the exhaust valve elements (19) facing each other with matching poles. 5 10 15 20 25 30
2. Pump according to claim 1, characterized in that micro-switches (26) are situated within the chambers of the cylinders provided for the driving gas, each micro-switch (26) being activated by each of the membranes (23) in the cylinders. 35

Patentansprüche

1. Pumpe zur Förderung und Dosierung aggressiver Flüssigkeiten mit einem Gehäuse (15) aus Koterm (R) und zwei gegenüberliegenden Zylindern (8), deren jeder von einer beweglichen Membran (23) in zwei Kammern, eine für die Flüssigkeit und die andere für ein Treibgas, unterteilt ist, wobei beide Membranen (23) mittels einer Stange (24) aneinander befestigt sind, die in einer zentralen Bohrung (24) im Gehäuse (15) beweglich ist, und mit zwei weiteren zylindrischen Bohrungen (17, 18), deren jede parallel zur Verbindungs-Stange verläuft und die an beiden Enden Öffnungen in die Zylinderkammern, die für die Flüssigkeit vorgesehen sind, sowie jeweils zwei Ventilelemente aufweisen, d.h., zwei Auslaßventilelemente (19) in einer Bohrung (17) und zwei Ansaugventilelemente (20) in der anderen Bohrung 40 45 50 55

(18), wobei die Ventilelemente ebenfalls vollständig aus Koterm (R) bestehen und vollständig eingebettete Stabmagneten (29, 30) aufweisen, deren jeder am Ende jedes Ventilelementes (19, 20) angeordnet ist, das dem anderen Ventilelement (19, 20) in derselben Bohrung gegenüberliegt, wobei sich die Stabmagneten (29) in den Ansaugventilelementen (20) mit verschiedenen Polen und die Stabmagneten (30) in den Auslaßventilelementen (19) mit übereinstimmenden Polen gegenüberliegen.

2. Pumpe nach Anspruch 1, dadurch gekennzeichnet, daß Mikro-Schalter (26) in den für das Treibgas vorgesehenen Zylinderkammern angeordnet sind, wobei jeder Mikro-Schalter (26) durch jede der Membranen (23) in den Zylindern aktiviert wird.

Revendications

1. Pompe pour transferer et doser des liquides agressifs comportant un carter (15) réalisé en Koterm (R) et comprenant deux cylindres opposés (8) divisés chacun par une membrane mobile (23) en deux chambres, l'une pour le liquide et l'autre pour un gaz d'entraînement, les deux membranes (23) étant fixées l'une à l'autre par une tige (24) mobile dans un perçage central (16) à l'intérieur d'un carter (15), comprenant deux autres perçages cylindriques (17-18), chacun parallèle à la tige de liaison, débouchant à leurs deux extrémités dans les chambres des cylindres prévues pour le liquide, et contenant chacun deux éléments de soupape, à savoir deux éléments de soupape d'échappement (19) dans le perçage (17) et deux éléments de soupape d'aspiration (20) dans l'autre perçage (18), les éléments de soupape étant également réalisés en Koterm (R) et contenant, complètement noyés à l'intérieur, des barreaux magnétiques (29-30) dont chacun est situé à l'extrémité de chaque élément de soupape (19,20) qui fait face à l'autre élément de soupape (19,20) dans le même perçage, les barreaux magnétiques (29) dans les éléments de soupape d'aspiration (20) se faisant face avec des pôles différents et les barreaux magnétiques (30) dans les éléments de soupape de refoulement (19) se faisant face avec des pôles correspondants. 40 45 50 55
2. Pompe selon la revendication 1, caractérisée en ce que des micro-interrupteurs (26) sont disposés à l'intérieur des chambres des cylindres prévus pour le gaz d'entraînement chaque micro-interrupteur (26) étant actionné par chacune des membranes (23) se

trouvant dans les cylindres.

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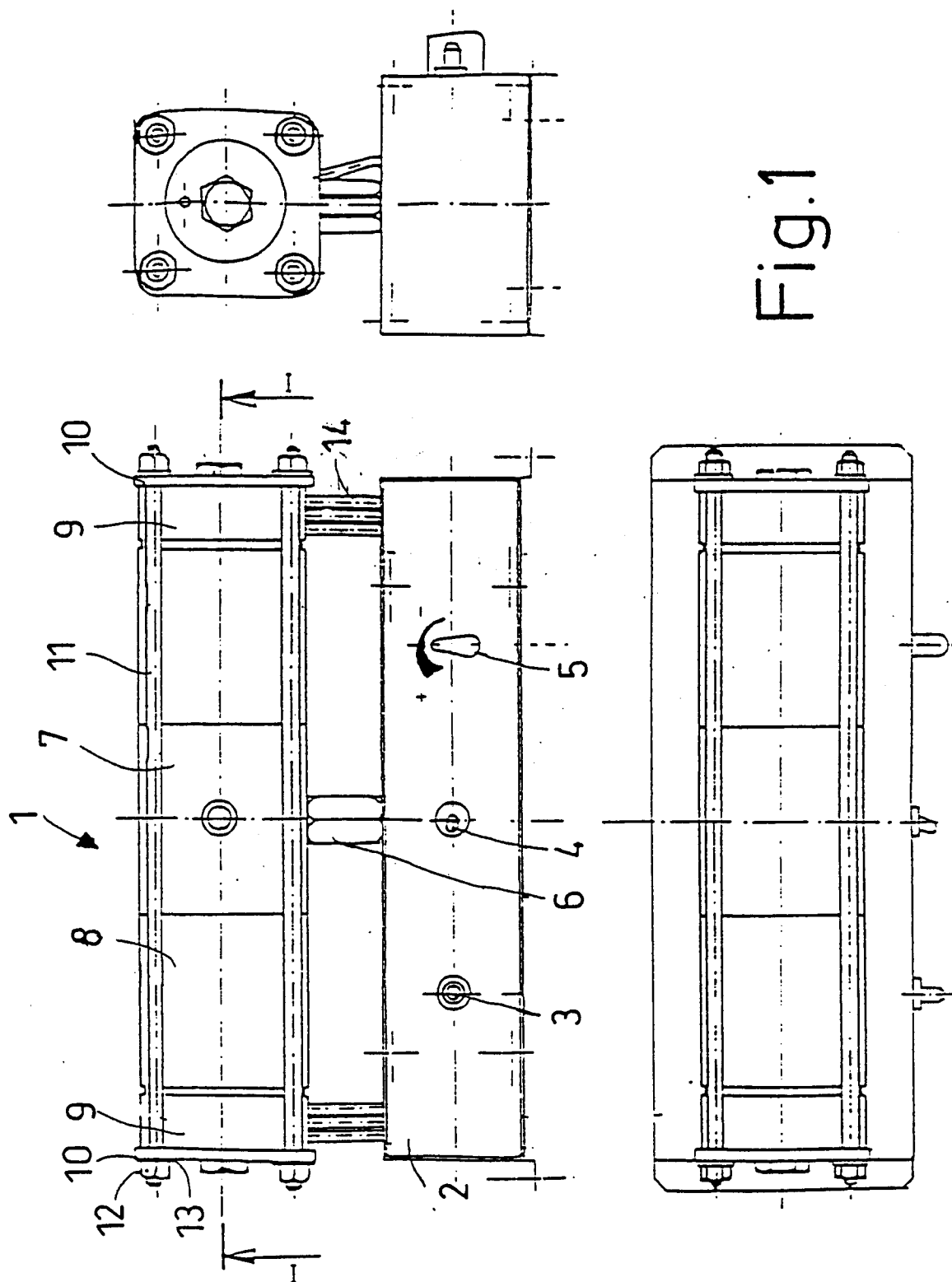


Fig. 1

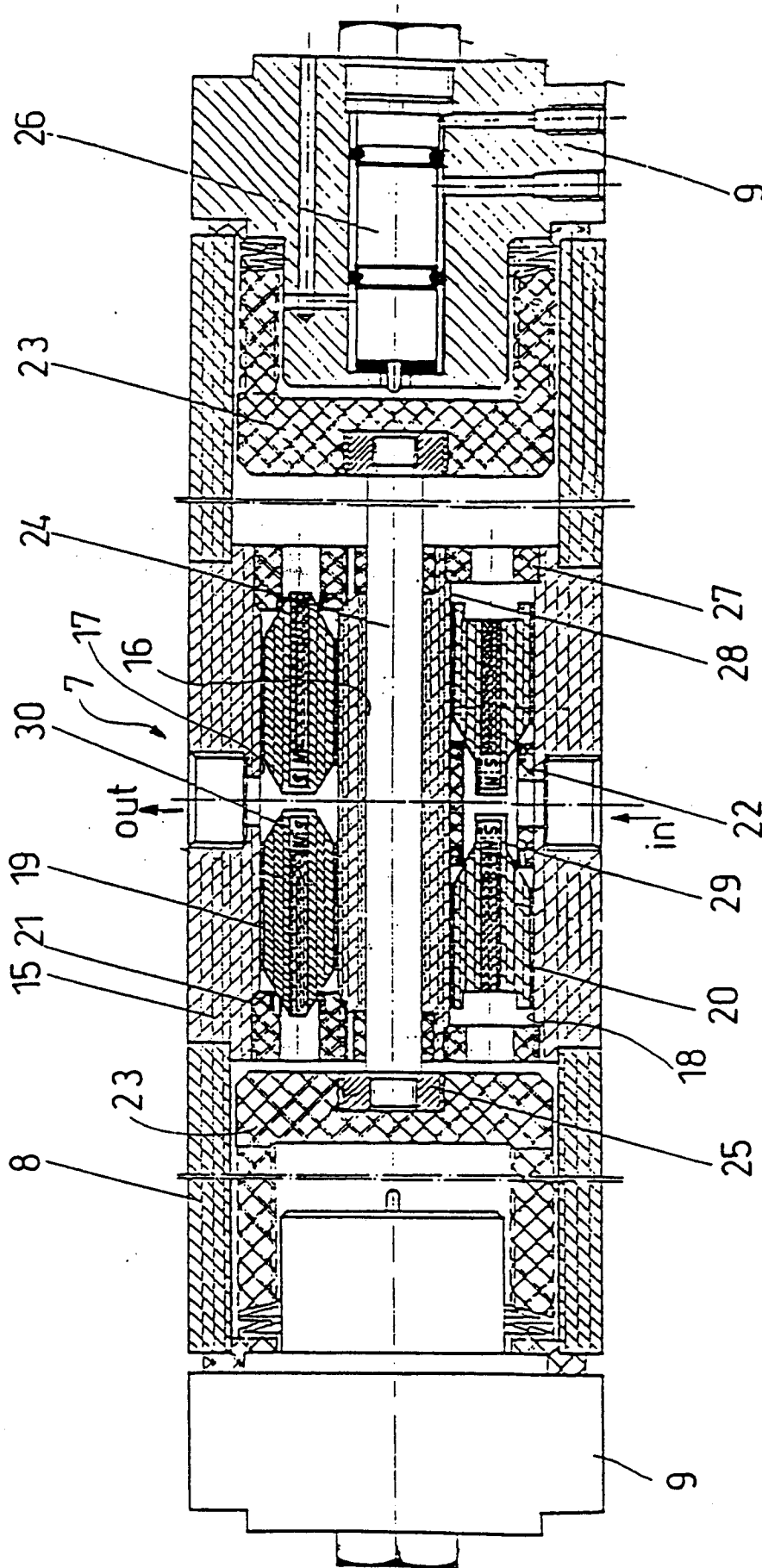


Fig.2

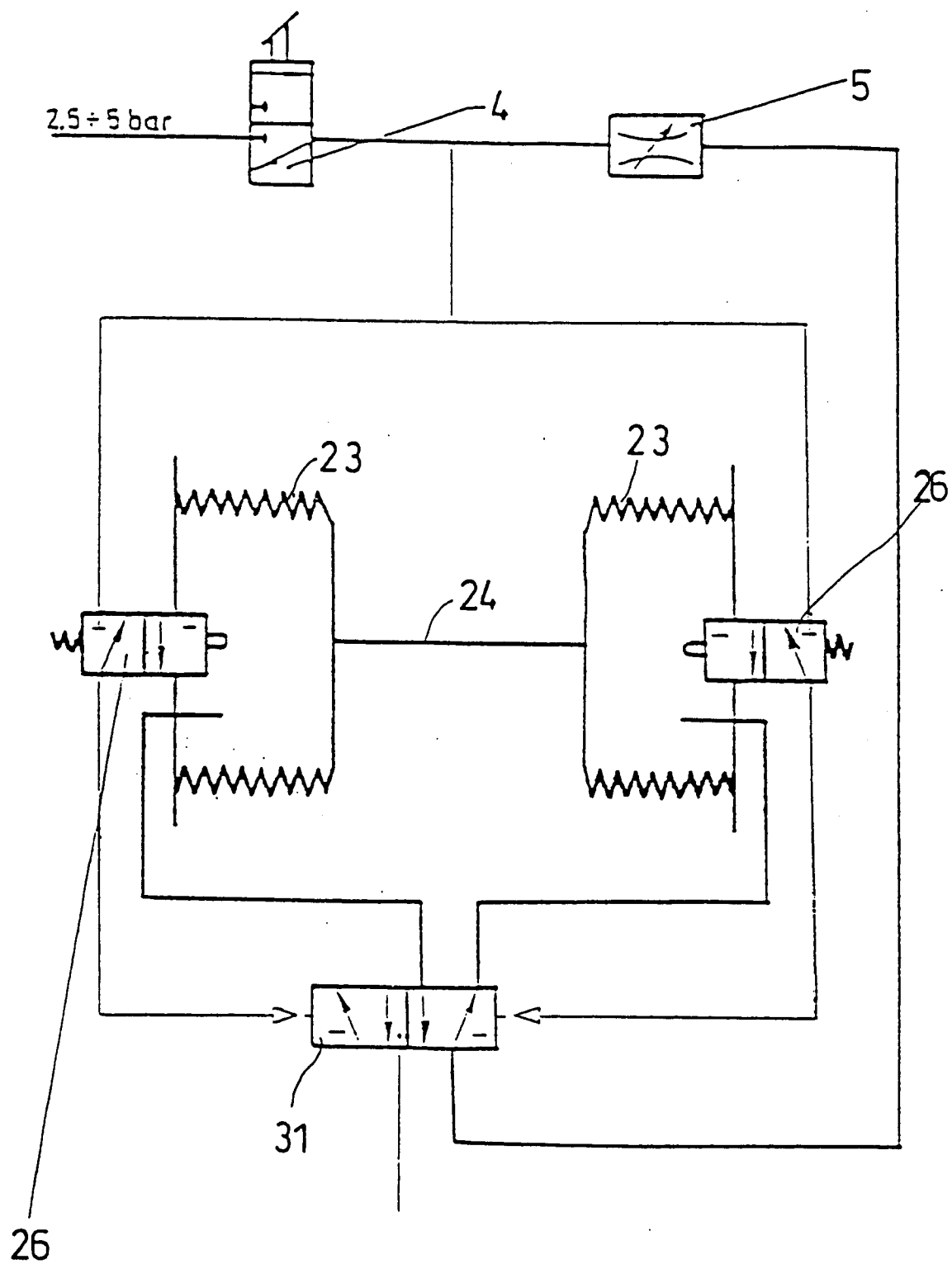


Fig.3

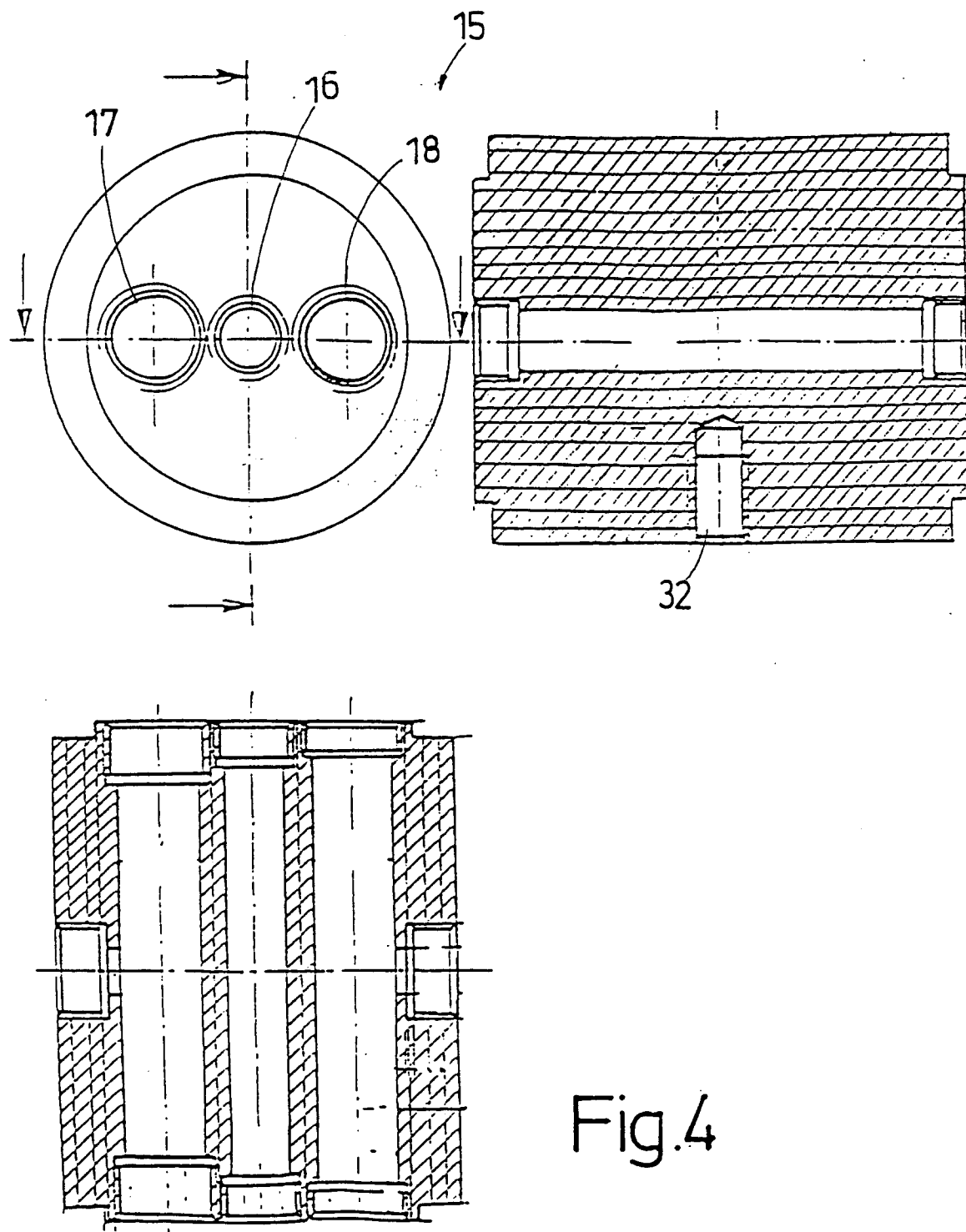


Fig.4

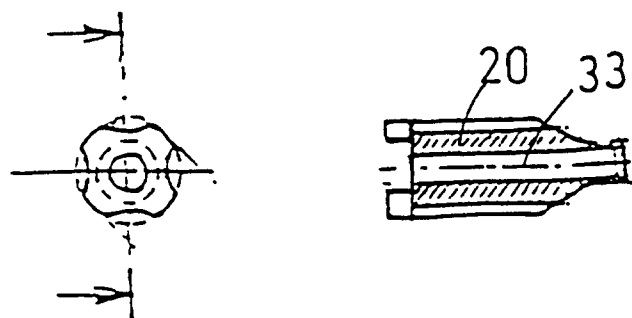


Fig.5

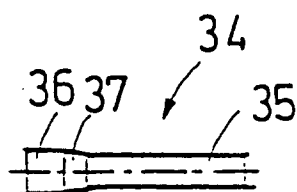


Fig.6

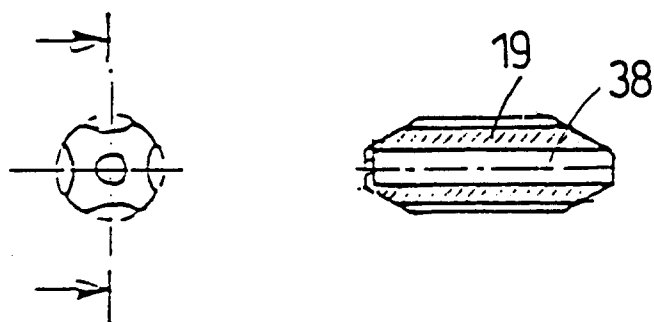


Fig.7

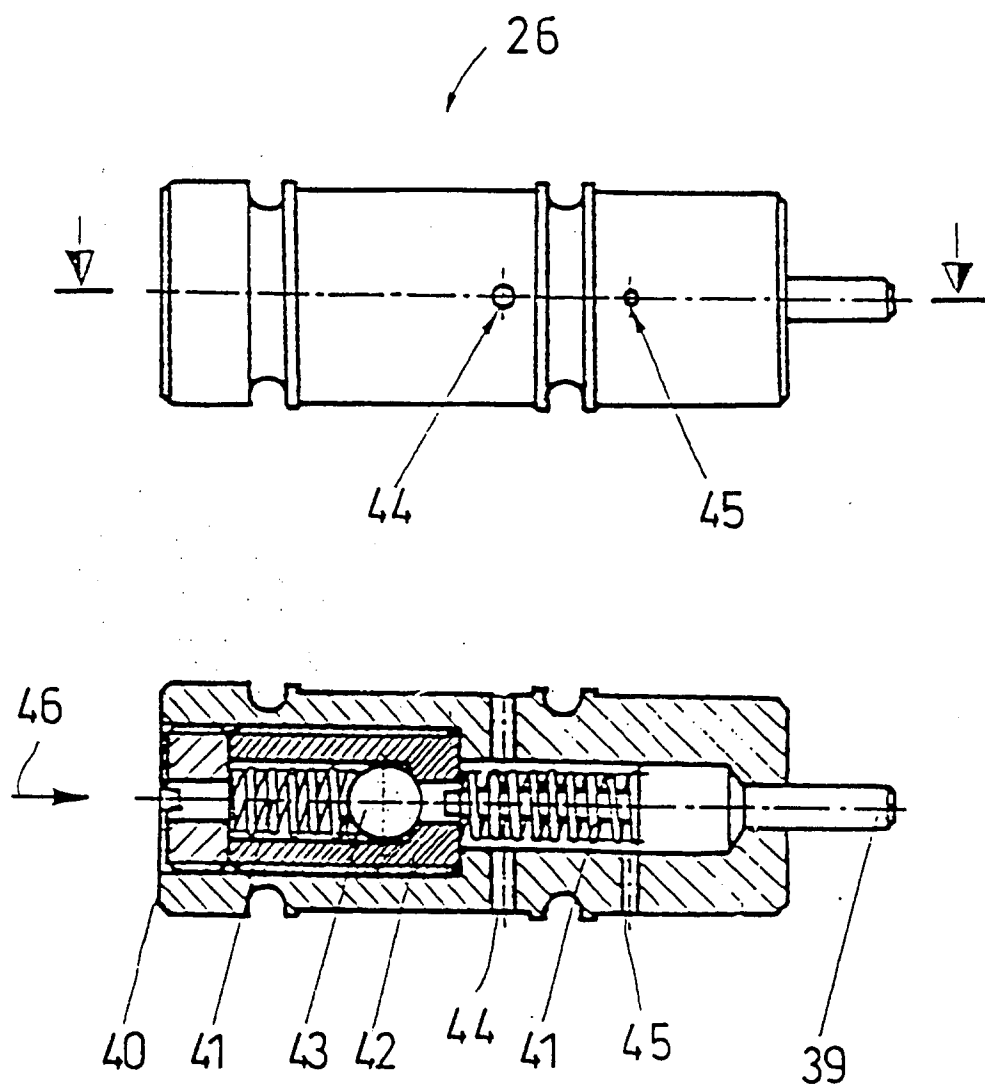


Fig.8