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(71) Applicant: **BLAGDON-DURHAM LIMITED**
2 Lambert Road
Washington Tyne & Wear NE37 1QP(GB)

(72) Inventor: **Chicken, Michael**
34 Atkinson Road Chester-le-Street
Co. Durham(GB)

(74) Representative: **Gura, Henry Alan et al**
MEWBURN ELLIS & CO. 2/3 Cursitor Street
London EC4A 1BQ(GB)

(54) Diaphragm pump.

(57) A gas-operated, double diaphragm pump comprises a pair of diaphragms (6,8) secured to, to be movable with, a shaft (4) under the control of a valve (18) which supplies gas under pressure alternately to the diaphragms (6,8) whereby the diaphragms (6,8) create a pumping action. The control valve (18) includes a hollow chamber (22) having an inlet (24), first and second outlets (34,38) feeding to the diaphragms (6,8) and an exhaust outlet (36), a control member (40) movable within the chamber (22), and a bearing member (54) mounted in, to be movable with, the control member (40) and urged into sealing contact with the inner wall of the chamber (22). The arrangement is such that, on movement of the control member (40) and the bearing member (54), the gas inlet (24) is alternately interconnected with the first and second outlets (34,38) while the gas outlet not being supplied by the inlet (24) is interconnected with the exhaust outlet (36), the bearing member (54) sealing the gas outlet being supplied by the inlet (24) from the exhaust outlet (36) and from the other gas outlet.

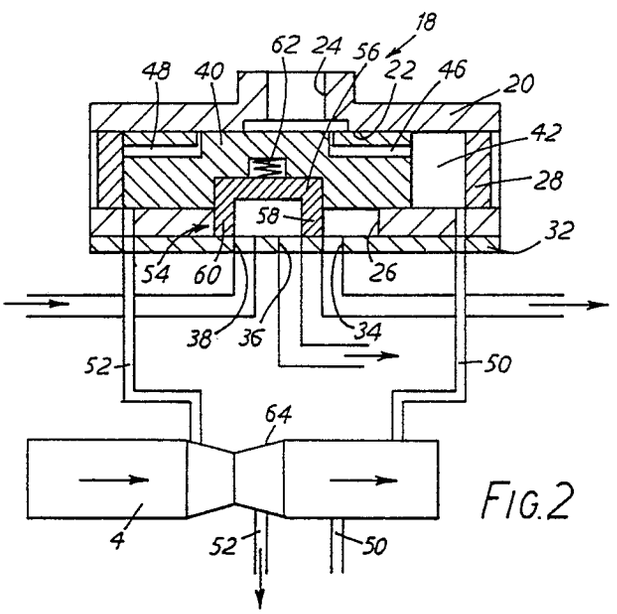

FIG.2

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PUMP

This invention relates to pumps and more particularly to gas-operated double diaphragm pumps.

Conventional air-operated double diaphragm pumps comprise an axially movable shaft to which are attached a pair of elastomer diaphragms each having a rear surface forming part of the defining walls of an air chamber to receive air under pressure and a front surface forming part of the defining walls of a liquid chamber containing liquid to be pumped. Compressed air is supplied alternately to the rear surfaces of the two diaphragms whereby, with one air chamber pressurised, fluid is pumped by the associated diaphragm out of the associated liquid chamber while, at the same time, the other diaphragm is pulled in by the shaft to draw liquid into the other liquid chamber. When the pressurised diaphragm reaches the limit of its stroke, an air control valve shifts the supply of compressed air to the air chamber of the other diaphragm and liquid is then pumped out of the other liquid chamber.

It is well-established practice for such air-operated double diaphragm pumps to incorporate one-piece moving valves as the control means for the compressed air supply to the diaphragms. Such valves have the advantage of comprising a minimum number of parts, being simple to understand and maintain and being cheap to manufacture.

However, a major disadvantage of such valves is that efficient operation thereof is very dependent upon close tolerances, while the known valves are prone to stalling at low cycle rates and to leak air slightly on stall.

More particularly, these valves comprise a spool valve member of generally cylindrical shape movable backwards and forwards in a cylindrical chamber in a valve block under the influence of compressed air applied alternately to the opposed ends of the spool valve member. The valve block has a series of apertures therein communicating with the two air chambers of the pump and with the atmosphere, while the spool valve member itself is recessed in such a manner that, on said backwards and forwards movement thereof, the various apertures in the valve block are interconnected with and disconnected from the source of compressed air and the atmosphere as required.

In such an arrangement, the backwards and forwards movement of the spool valve member, which may be up to 700 cycles per minute, of necessity results in wear between the spool valve member and the valve block whereby a small gap is formed therebetween. Thus, when the compressed air flows into the recessed spool valve member during passage of the air to one or other of the air chambers, there is a leakage path to atmosphere available to said air between the spool valve member and the block whereby air can escape and reduce the efficiency of the pump.

It would be desirable to provide a gas-operated double diaphragm pump incorporating a gas-control valve less prone to leakage than the above-detailed known arrangement.

According to the present invention there is provided a gas-operated double diaphragm pump comprising a pair of diaphragms, preferably of an elastomer material, secured to, for movement with, a shaft, and a control valve for supply gas under pressure alternately to said diaphragms such that said diaphragms are extended alternately and a consequential pumping action is provided thereby, said control valve including a hollow substantially cylindrical chamber having an inlet for a supply of gas under pressure, a first outlet for supplying gas under pressure to the first diaphragm, a second outlet for supply gas under pressure to the second diaphragm and an exhaust outlet, a control member within said chamber movable such that the gas inlet is interconnected alternately with the first and second outlets, and such that the outlet not being supplied with gas under pressure is interconnected with the exhaust outlet, the control valve further including a bearing member mounted in, to be movable with, the control member and urged into sealing contact with the inner wall of the hollow chamber such as to seal the outlet being supplied with gas under pressure from the exhaust outlet and from the other gas outlet.

In a preferred pump, the bearing member is recessed to define a hollow interior therein bounded by free edges, said free edges of the bearing member making sealing contact with the inner wall of the hollow chamber, the outlet from the chamber being located such that, with the control member and the bearing member in a first operative position, the first gas outlet and the exhaust outlet are interconnected with one another by way of said hollow interior with gas under pressure being supplied to the second gas outlet, and, with the control member and the bearing member in a second operative position, the second gas outlet and the exhaust outlet are interconnected with one another by way of said hollow interior with gas under pressure being supplied to the first gas outlet.

Conveniently the bearing member is of a hard-wearing, self-lubricating material such as carbon-filled ptfe, while it is preferred that the free edges of the bearing member are resiliently urged into

sealing contact with the inner wall of the chamber, for example by means of a coil spring reacting between the control member and the bearing member.

By way of example only an embodiment of the invention will now be described in greater detail with reference to the accompanying drawings of which:

Figs. 1 a and 1b show the principle of operation of a pump according to the invention, and

Figs. 2 to 4 show part of a pump according to the invention, and in particular the control valve thereof, in three different operating conditions.

Referring to the drawings and in particular to Figs. 1a and 1 b, the illustrated pump includes a housing 2 in which is mounted an axially-movable shaft 4 to each end of which is secured the central regions of a flexible diaphragm 6,8 of an elastomer material, the rear surface of each diaphragm 6,8 forming part of the defining walls of an associated air chamber 10,12 and the front surface of each diaphragm 6,8 forming part of the defining walls of an associated liquid chamber 14,16 containing liquid to be pumped.

The pump according to the invention operates in conventional manner in that a source of compressed air is fed alternately to the two air chambers 10,12 whereby the diaphragms 6,8 are alternately extended to pump liquid from the associated liquid chambers 14,16. As with established air-operated double diaphragm pumps, the two diaphragms 6,8 and the shaft 4 move in unison such that, as one diaphragm is extended to draw the shaft 4 with it and to pump liquid from the liquid chamber, the other diaphragm is pulled in by the shaft 4 to create a suction effect in the other liquid chamber whereby liquid is drawn into that chamber for subsequent pumping therefrom.

The invention resides in the means for controlling the flow of compressed air to the two air chambers 10,12 such that the leakage inherent in the known arrangements is eliminated.

Referring in particular to Figs. 2 to 4, the air control valve of the illustrated pump is indicated generally at 18 and comprises a valve block 20, for example of brass or gun metal, in which is formed a substantially cylindrical chamber 22, the block 20 having an inlet 24 thereto and an opposed outlet port 26 therefrom. The ends of the chamber 22 are defined by walls 28,30.

Secured to the valve block 20 is a valve plate 32, for example of nickel-plated steel, in which are formed a first air outlet 34, an exhaust outlet 36 and a second air outlet 38 all in communication with said port 26 in the valve block. The air outlet 34 is connected to the aforementioned air chamber 10 of the pump, the air outlet 38 is connected to the air chamber 12, and the exhaust outlet 36 feeds to the atmosphere.

Mounted in the chamber 22 is a valve carrier member 40 preferably of anodised aluminium and of generally cylindrical shape to be a close sliding fit in the chamber 22 and being axially movable between the first and second extreme positions shown in Figs. 2 and 4 in which cylindrical volumes 42,44 are defined within the chamber 22 between the ends of the carrier member 40 and the end walls 28,30 of the valve block 20.

The valve carrier member 40 is provided with passageways 46,48 therein whereby the volumes 42,44 can be interconnected with the inlet 24 with the carrier member 40 in its first and second extreme positions respectively. The valve block 20 is machined such that the inlet 24 is in communication with the outlet port 26, the arrangement therefore being such that the passageways 46,48 are in communication with the associated ends of the outlet port 26 of the block 20, by way of the inlet 24, when the carrier member 40 is in its first and second extreme positions respectively.

The valve block 20 and the plate 32 are each provided with aligned bores communicating into the end regions of the cylindrical volumes 42,44 and to which are connected pilot exhaust lines 50,52 respectively the paths to atmosphere of which include the shaft 4 as will be described in more detail below.

The control valve further includes a bearing member 54 in the form of a hollow slide-valve including a base portion 56 and surrounding sidewalls opposed parts of which are shown at 58,60, said base portion and sidewalls defining a hollow, open-faced interior to the slide-valve. The carrier member 40 is recessed to receive therein, as a close fit therein, the base portion 56 of the slide-valve, the free edges of the sidewalls of the slide-valve making sealing contact with the inner surface of the plate 32. The member 40 is preferably of a hard-wearing, self lubricating material such as carbon-filled ptfe, and may be resiliently urged into engagement with the plate 32 by means of a coil spring 62 reacting between the carrier member 40 and the base portion 56 of the slide-valve.

The bearing member 54 is axially movable with the carrier member 40, and, in the first extreme position of the carrier member 40, the hollow interior of the slide-valve interconnects the outlets 36 and 38, but seals the outlet 34 from said outlets 36 and 38, while, in the second extreme position of the carrier member 40, the hollow interior of the slide-valve interconnects the outlets 34 and 36, but seals the outlet 38 from said outlets 34 and 36.

The described valve operates as follows. Referring to Fig. 2, compressed air is supplied to the valve through the inlet 24 and into the volume 42 by way of passageway 46 whereby the carrier member 40 is in its first extreme position and the shaft 4 is about to move to the right as seen in Fig. 2 from its leftmost position. In this position of the shaft 4 and carrier member 40, the pilot line 52 is connected to atmosphere by way of a cut-out 64 in the shaft 4 whereby volume 44 within the chamber 22 is vented and the outlets 36 and 38 are interconnected and whereby the air chamber 12 associated with the second diaphragm 8 is vented. The air pressure in the volume 42 holds the carrier member 40 in its first extreme position, said air pressure being fed by way of the outlet 34 to the first air chamber 10. The first diaphragm 6 is therefore extended to pump liquid from the associated liquid chamber 14 and to draw with it the shaft 4.

As the shaft is drawn to the right as viewed in Fig. 2, the second diaphragm 8 is drawn therewith to create a suction effect in the second liquid chamber 16 and to draw liquid into that chamber 16, while the air from the second air chamber 12 is exhausted through outlets 38 and 36 as detailed above.

Referring to Fig. 3, the shaft 4 has reached its mid-way position and the cut-out 64 is now out of the path of the two pilot exhaust lines 50,52 which are both therefore sealed, the volume 44 of the chamber 22 having been fully exhausted.

Fig. 4 shows the shaft 4 in its extreme right-hand position associated with the fully-displaced position of the first diaphragm. In this position of the shaft 4, the pilot exhaust line 50 is opened to atmosphere by way of the cut-out 64 in the shaft 4 and the volume 42 is vented to atmosphere. As this venting occurs, a suction effect is created in the volume 42 which draws the carrier member 40 towards its second extreme position and whereby the inlet 24 is brought into communication with the volume 44 by means of the passageway 48. Thus compressed air is now fed by way of outlet 38 to the second air chamber 12, while the carrier member 40 is held in its second extreme position in which the outlets 34 and 36 are interconnected and whereby the first air chamber 10 is vented to atmosphere. The pilot line 52 is sealed to maintain the pressure within the volume 44.

Thus the second diaphragm 8 is extended and the shaft 4 is drawn to the left as viewed in the drawings to complete the full stroke sequence, which is then repeated.

It will be appreciated that the provision of the bearing member 54 with the free edges of the sidewalls thereof in continual sealing engagement with the plate 32 ensures that the exhaust outlet 36 is at all times totally disconnected from the pressurised air, thereby eliminating any leakage of compressed air to the atmosphere. Further, the mounting of the slide-valve 54 within the carrier member 40 is such that the compressed air supplied to either of the volumes 42 or 44 serves to supplement the sealing of the member 54 with the plate 32 by acting on the surface of the member 54 remote from the interior thereof and urging said member 54 into sealing contact with the plate 32. With such an arrangement, the more the valve is used the more the bearing member wears into the plate 32 and the better is the seal therebetween.

Clearly the precise construction of the valve 18, and in particular the bearing member 54, can be varied from that described and illustrated without departing from the scope of the invention claimed. The cut-out 64 in the shaft 4 for controlling the venting of the pilot lines 50,52 to atmosphere may be replaced by, for example, a hollow chamber formed in the shaft 4 in the region of said cut-out 64 the defining walls of which are provided with two axially-spaced series of circumferentially-spaced ports located to connect and/or disconnect the pilot lines 50,52 to atmosphere in the manner of the cut-out 64.

Thus there is provided an air operated, double diaphragm pump incorporating a control valve of relatively simple construction, that is easy and cheap to manufacture and which totally eliminates the leakage that is inherent in established valves, the sealing effect of the slide-valve in fact improving with use of the control valve.

Claims

1. A gas-operated double diaphragm pump comprising a pair of diaphragms (6,8) secured to, for movement with, a shaft (4), and a control valve (18) for supplying gas under pressure alternately to said diaphragms (6,8) such that said diaphragms (6,8) are extended alternately and a consequential pumping action is provided thereby, said control valve (18) including a hollow, substantially cylindrical chamber (22) having an inlet (24) for a supply of gas under pressure, a first outlet (34) for supplying gas under pressure to the first daphragm (6), a second outlet (38) for supplying gas under pressure to the second diaphragm (8) and an exhaust outlet (36), a control member (40) within said chamber (22) movable such that the gas inlet (24) is interconnected alternately with the first and second outlets (34,38), and such that the outlet not being supplied with gas under pressure is interconnected with the exhaust outlet (36), characterised in that the control valve (18) further includes a bearing member (54) mounted in, to be movable with, the control member (40) and urged into sealing contact

with the inner wall of the hollow chamber (22) such as to seal the outlet (34,38) being supplied with gas under pressure from the exhaust outlet (36) and from the other gas outlet (38,34).

2. A pump as claimed in claim 1 in which the bearing member (54) is recessed to define a hollow interior therein bounded by free edges (58,60), said free edges (58,60) of the bearing member (54) making sealing contact with the inner wall of the hollow chamber (22), the outlets (34,36,38) from the chamber (22) being located such that, with the control member (40) and the bearing member (54) in a first operative position, the first gas outlet (34) and the exhaust outlet (36) are interconnected with one another by way of said hollow interior with gas under pressure being supplied to the second gas outlet (38), and with the control member (40) and the bearing member (54) in a second operative position, the second gas outlet (38) and the exhaust outlet (36) are interconnected with one another by way of said hollow interior with gas under pressure being supplied to the first gas outlet (34).

3. A pump as claimed in claim 1 or claim 2 in which the bearing member (54) is of a hard-wearing, self-lubricating material and is resiliently urged into sealing contact with the inner wall of the chamber (22).

4. A pump as claimed in claim 3 in which the bearing member (54) is of carbon filled ptfe and is resiliently urged into sealing contact with the inner wall of the chamber (22) by means of a coil spring (62) reacting between the control member (40) and the bearing member (54).

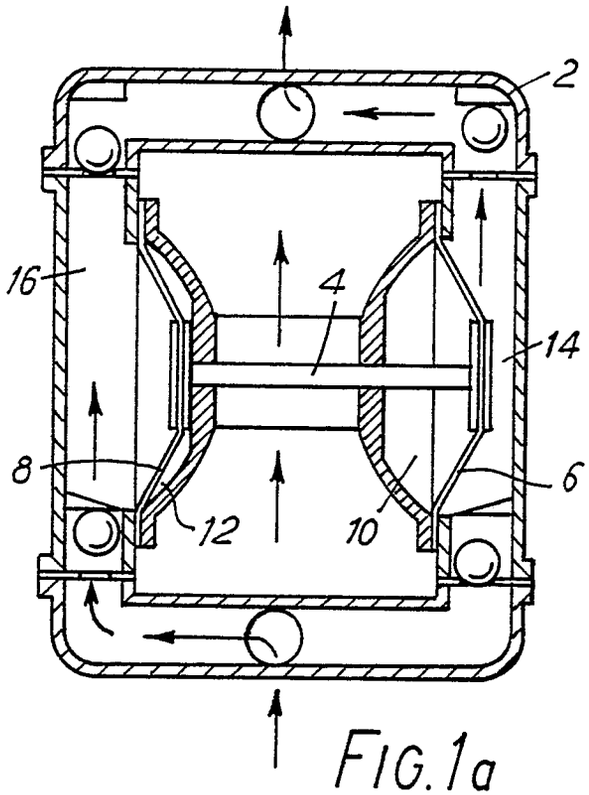

FIG.1a

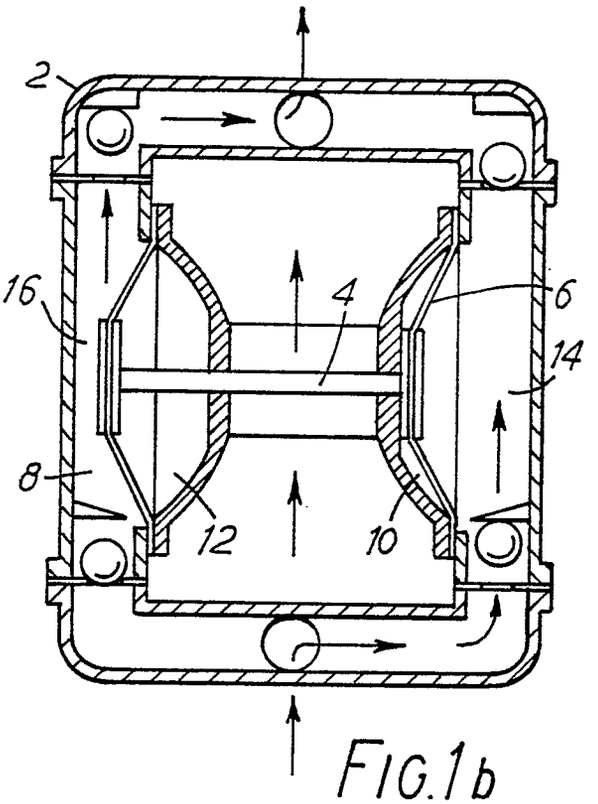

FIG.1b

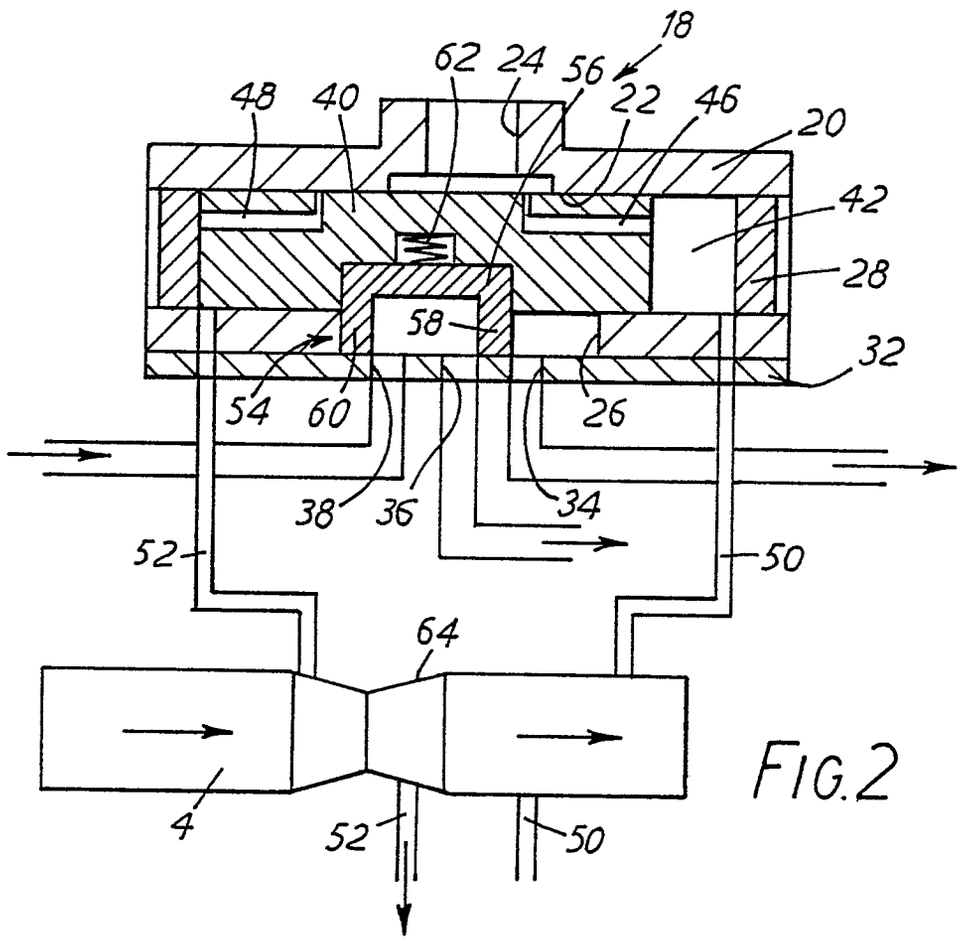

FIG.2

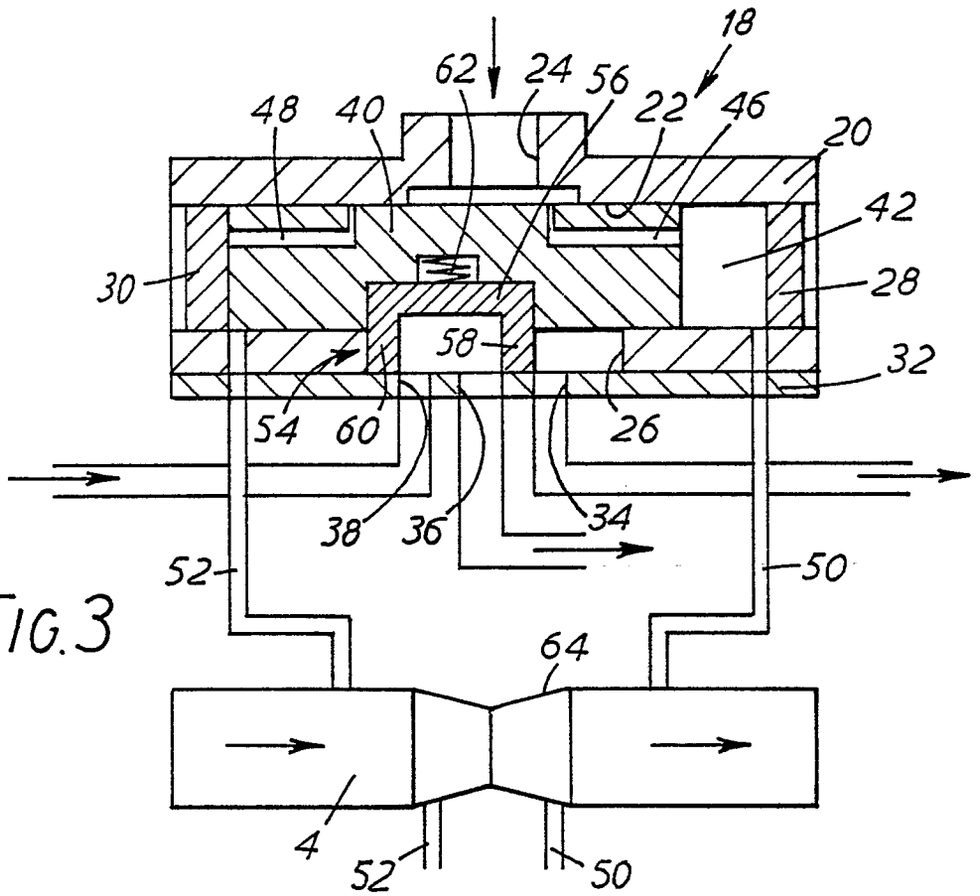
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FIG.3

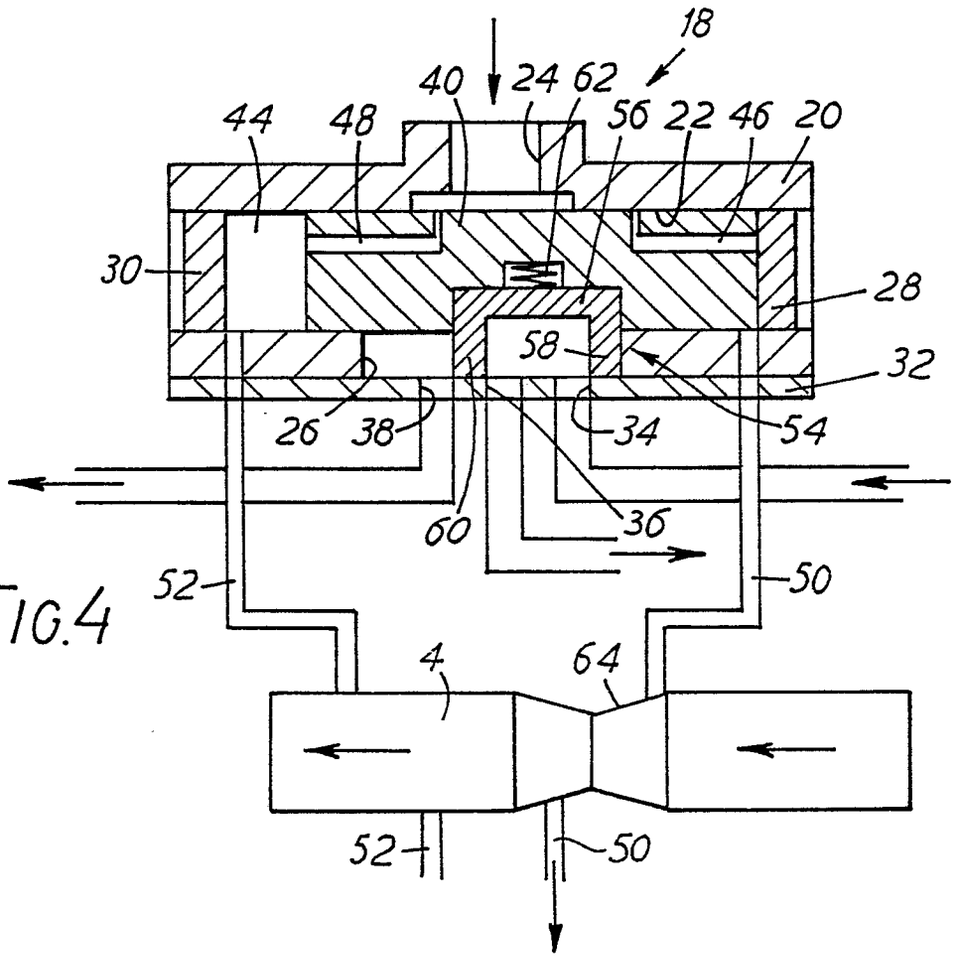
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FIG.4

European Patent Office

EUROPEAN SEARCH REPORT

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 86308888.6

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 4)
Y	GB - A - 2 144 493 (WILDEN) * Totality; especially page 2, line 112 - page 3, line 48; fig. 3,5; claims *	1-4	F 04 B 43/06 F 01 L 15/10
Y	SOVIET INVENTIONS ILLUSTRATED, sections P,Q, week 8534, October 2, 1985 DERWENT PUBLICATIONS LTD, London, Q5 * SU-1137-221-A (MOSC PNEVMOAPPARAT) *	1-4	
A	DE - B - 1 017 855 (PLEIGER) * Totality; especially columns 1-2, line 44; fig. *	1,2	
A	DE - B - 2 064 899 (KRÜGER) * Totality; especially columns 6-8; fig. *	1,2	

TECHNICAL FIELDS SEARCHED (Int Cl 4)

F 01 L 15/00
F 01 L 25/00
F 01 L 29/00
F 04 B 9/00
F 04 B 43/00
F 04 B 45/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	12-05-1987	WERDECKER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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