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(71) Applicant: **FLOTRONICS AG**
Chamerstrasse 52
CH-6300 Zug(CH)

(72) Inventor: **Marchant, Derek Noel**
11 Wolstonbury Close
Hurstpierpoint Sussex(GB)

(74) Representative: **Brooke-Smith, Fred et al,**
STEVENS, HEWLETT & PERKINS 5 Quality Court
Chancery Lane
London WC2A 1HZ(GB)

(54) Diaphragm or piston pump.

(57) A double diaphragm pump has a casing 10, 11, 12 internally divided axially by a central partition member 14 and each of the two compartments thus formed accommodates a diaphragm 16, 17. A push rod 22 slidably mounted in the partition member abuts both diaphragms. The spaces 19 on the outer sides of the diaphragms constitute motor chambers receiving compressed air alternately to drive the pump. The spaces 20 between the two diaphragms and the partition member 14 constitute pumping chambers. The partition member has an inlet passage 25 for the pumped fluid which passage is bifurcated to form two branch passages leading to the two pumping chambers 20 respectively, and two further passages in the partition member lead from the respective pumping chambers 20 to a common outlet 26. Each branch passage incorporates a non-return valve permitting flow in a direction from the inlet towards the outlet only. The end members of the casing carry pilot valve members 34 which when contacted by the diaphragms actuate operation of a changeover valve 39 to reverse the connections of the chambers 19 to pressure air supply and exhaust, to drive the diaphragms 16, 17 and push rod 22 in the opposite direction.

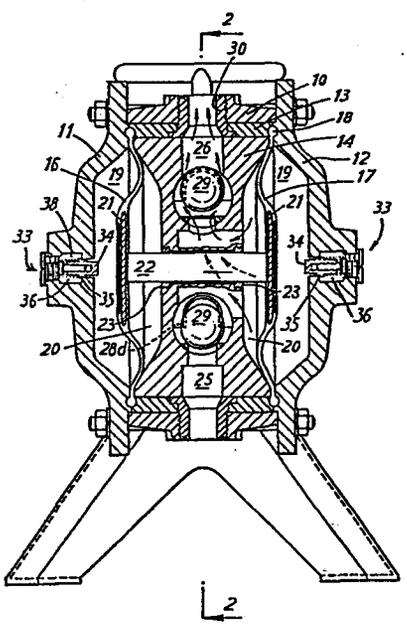

FIG. 1

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IMPROVEMENTS RELATING TO PUMPS

The invention relates to pumps and has a particularly useful but not exclusive application in pumps of the kind known as double diaphragm pumps.

According to this invention there is provided a pump comprising a hollow casing closed at its ends, two diaphragms or pistons disposed within the casing and generally parallel to each other adjacent the respective end portions of the casing, each diaphragm or piston forming with its adjacent end portion of the casing a closed first chamber, a fixed internal partition member disposed between the diaphragm or pistons and forming two closed second chambers with the respective diaphragms or pistons, said second chambers having inlets thereto controlled by respective valves and outlets therefrom controlled by respective valves, a push rod extending in a sealing manner through the partition member to transmit axial displacing forces between the diaphragms or pistons, and valve means actuated in dependence on the position of the diaphragms and adapted to open passages for connecting each of the two first chambers alternately to a source of pressure fluid and to exhaust, thereby to cause the push rod and diaphragms or pistons to reciprocate in unison and to cause the diaphragms or pistons to operate the second chambers as pumping chambers.

Preferably inlet passages providing the inlets to said second chambers and outlet passages providing the outlets from said second chambers are formed in the partition chamber.

In preferred arrangements according to the invention said inlet passages are constituted by

branch passages extending from a common inlet opening in the casing, said outlet passages providing the outlets from said second chambers are constituted by branch passages extending from a common outlet opening in the casing, the valves associated with second chambers being mounted in the branch passages.

The two ends of said push rod may advantageously be in abutting relationship with the two diaphragms or pistons respectively and are not necessarily connected to the diaphragms.

According to a preferred feature of the invention said end portions of the casing are formed by respective end members which are detachably secured to the partition member, and the two diaphragms or pistons are respectively removably attached at their peripheries to the adjacent end members.

Where diaphragms are employed they may have a reinforcing plate embedded in the central region thereof.

One embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows a pump according to the invention in axial section,

Figure 2 is a sectional end view on the line 2-2 of Figure 1, and

Figures 3A to 3F show the sequence of operations of the pump diagrammatically.

Referring to the drawings the pump has an external casing formed by a hollow cylindrical support ring 10 to opposite ends of which end covers 11, 12 are secured by tie bolts or, where frequent cleaning of the pump is necessary, quick-release clamps. A cylindrical diaphragm ring 13 of the same axial

length as the support ring 10 enclosed within the support ring and a transverse partition member 14 is in turn enclosed within the diaphragm ring. Two diaphragms 16, 17 having a peripheral bead 18 are respectively clamped between opposite axial ends of the support ring 13 and partition member 14 at one side and the two end covers 11, 12 at the other side. The bead 18 itself is accommodated in channel section grooves in the support ring and the end cover. The groove in the end cover may have a dovetail section (not shown) and the bead may have a correspondly shaped portion which engages in the groove and serves to attach the diaphragm removably to the adjacent end cover. Each diaphragm 16, 17 divides the space between the adjacent end cover 11, 12 and the partition member 14 into two chambers 19, 20. The two axially outer chambers 19 constitute motor chambers and the two axially inner chambers 20 constitute pumping chambers.

Each diaphragm has its central region stiffened by a reinforcing disc 21 embedded in the diaphragm material and a push rod 22 which is a sliding sealing fit in two sealing rings 23 in the partition member has its ends in abutment with the two diaphragms respectively in operation of the pump. A bush extending over the full axial length of the aperture in the partition member may be used instead of rings 23 if desired.

The partition member has formed in it two bifurcated passages 25, 26 serving respectively as inlets and outlets respectively for the pumped fluid, and each of the branches of each passage incorporates a non-return valve. The two branches of the inlet passage are shown at 25a and 25b and extend from a common inlet at the outer periphery of the partition

member 14 to the two pumping chambers 20 respectively. Each of the branches has mounted in it a valve seating element 28 and a captive ball 29 together constituting the non-return valve. Similarly the two branches 26a, 26b of the outlet passage extend from the respective pumping chambers 20 to a common outlet at the periphery of the partition member, and each branch incorporates a valve seating element 28 and a captive ball 29 constituting the non-return valve. In the illustrated construction the partition member 14 is made in one piece from a plastics material such as PTFE and each seating element 28 is pressed into place through a chordal aperture 28a in the member 14 and comprises a portion 28b which blanks off the aperture 28a and a portion 28c which provides a seat for the captive ball 29. The inner face of portion 28b has an arch-like projecting rib 28d the limbs of which serve with the opposite wall of the passage to guide the ball for rectilinear movement. In an alternative construction, not illustrated, the partition member is made in two halves which are clamped together axially between end covers and valve seating rings are located in grooves on the axially inner surfaces of the two halves.

The partition member is located with the common inlet and the common outlet in circumferential alignment with radial apertures in the diaphragm ring 13 by two axial pins 13a, and a liner in the form of a hollow bolt 30 extends through each of these apertures and an aligned aperture in the support ring 10, the head of the bolt being countersunk in the diaphragm ring 13 and the shank of the bolt being in screw-threaded engagement in the aperture in the support ring. A jointing boss extends about the outer end

of each of these apertures in the support ring 10.

An air-supply/exhaust passage 40 shown in Figure 3A is formed in each end cover 11, 12 through which compressed air is admitted to and exhausted from the associated motor chamber 19 by way of a servo valve 39.

In the outer end of a bore extending centrally through each end cover is secured a pilot valve unit 33 which is screw-threaded into the end cover and which carries a pilot valve member 34 loaded lightly into sealing engagement with a valve seat 35 by a compression spring 36. An intermediate enlarged portion of the bore forms a chamber 38 about the unit and each of the chambers communicates through a passage 41 with an associated pilot chamber 37 of a pneumatic servo changeover valve 39. This valve (see Figure 3A) is of the kind comprising a valve body 42 having a bore in which a valve spool 44 is slidably mounted. The chambers 37 at opposite ends of the spool are in permanently open but restricted communication with a source of compressed air through passages 45,

The operation of the pump is illuatrated in Figures 3A to 3F to which reference is now made. Compressed air supplied to the left hand chamber 19 causes the diaphragm 16 to move to the right as shown in Figure 3A, pushing the push rod 22 and diaphragm 17 to the right also. In this stroke, fluid in the left hand chamber 20 is expelled through the non-return valve 28c, 29 in the passage 26a, fluid is drawn into the right hand chamber 20 through the non-return valve in passage 25b. The right hand air chamber 19 is open to exhaust via its inlet/exhaust passage shown at 40 and an exhaust port 48

in the servo valve 39. When the diaphragm 17 contacts the adjacent pilot valve member 34 (Figure 3B), the member is lifted away from the seat 35 and allows compressed air in the chamber 38 of the bore to flow into the adjoining chamber 19 and thence to exhaust through passage 40. The reduction of pressure in the corresponding end chamber 37 of the servo valve 39 causes the valve spool 44 to be moved to that end of its stroke by the air pressure in the other end chamber 37 (Figure 3C) and to reverse the connection of the air supply port 50 and exhaust ports 48 to chambers 19, so that air under pressure is supplied to the right hand chamber 19, and the left hand chamber 19 is connected to exhaust. During the resulting leftward movement (Figure 3D) of the diaphragms 16 and 17 and push rod 22 , the fluid drawn into the right hand chamber 20 in the previous stroke is discharged through the non-return valve in passage 26b and a fresh charge of fluid is drawn into the left hand chamber 20 through the non-return valve in passage 25a. A similar cycle of events takes place when the left hand diaphragm contacts its adjacent pilot valve member (Figure 3E), setting in train (Figure 3F) the next rightward movement of the diaphragm and the push rod.

Electric solenoid devices may be provided which control movements of the spool valve member in both directions independently, similarly electric solenoid devices may be provided which control movements of the spool valve in both directions independently and which are also capable of moving the spool valve member into either of its end positions from a central position into which it is urged by centralising springs provided in the end chambers; in this case, the valve ports and lands are arranged so that both motor chambers 19 are connected to exhaust when the spool valve member is in its central position.

The ends of the push rod 22 are flat but may be suitably domed and profiled to avoid pressing sharp edges against the diaphragms whatever the attitude of the latter. The diaphragms themselves may be made from any suitable materials, including PTFE, rubber, neoprene, viton and PTFE-faced rubber, and may be reinforced locally or across the full face of the diaphragm if required. The diaphragms may be of the tandem or double-skin type with a liquid held captive between the two skins to transmit the pressures from one skin to the other, and a device responsive to the pressure of the liquid and/or to a change in the composition of the liquid may be provided to indicate rupture of one of the skins.

In an alternative construction, not shown, the diaphragms 16, 17 are secured to the ends of the push rod 22.

The partition member and the bolts 30 may be made from stainless steel, plastics, glass, wood or any material suitably resistant to corrosive properties of the fluid to be pumped, and it will be apparent that the diaphragms 16, 17 prevent leakage of the pumped fluid between the partition member 14 and the bolts 30, so that these five components jointly confine the pumped fluid during the whole of its passage through the pump.

Flap valves may be employed in place of the ball valves and may advantageously be arranged so as to enable the pumped fluid to enter by the top passage 26 and be delivered through the bottom passage 25.

A major advantage of the illustrated pump is that it enables dangerous or unpleasantr fluids to be pumped

with relative safety in that the partition member 14 can be made of plastics, glass or wood or any other material which in itself is relatively fragile but which is appropriately resistant to the effects of the fluid, because the partition member is protected by the support ring and the end covers against accicental damage. In addition, there is no external pipework connecting the pumping chambers and requiring joints and seals which are potentially sources of leakage.

In conventional double diaphragm pumps, the pumping chambers are at opposite ends of the pump and the air chambers are adjacent each other, and a pneumatic switching mechanism is disposed between the diaphragm and is consequently difficult of access, but in the illustrated pump the pneumatic switching mechanism can be conveniently mounted on the casing to be readily accessible and removable for servicing. Furthermore, since the air chambers are at the ends of the pump, the rod 22 extending between the diaphragm is never in tension so that it is in many cases unnecessary to connect the rod to the diaphragms. Thus the diaphragms can be unperforated and the simple abutment contact between the rod and the diaphragm allows the latter to find their natural position during pumping. The previously mentioned optional attachment of the diaphragms to the end covers and the simple abutment of the diaphragms against the push rod enables the diaphragms to be removed and replaced easily without extensive dismantling of the pump; moreover the

attachment of the diaphragms to the end covers serves to protect the diaphragms against accidental damage during servicing of the pump.

The length of the working stroke can be adjusted by altering the length of the pilot valve member 38 projecting into the cylinder.

In some cases, particularly where the fluid to be pumped is likely to cause heavy wear on a guide or supporting sealing rings for the push rod, the guide or rings may be omitted and the push rod attached to the diaphragms, a small clearance being left round the push rod where it passes through the partition member. The clearance is determined having regard to the viscosity of the pumped fluid such that there is no significant leakage between the two axially inner chambers.

Although the invention has been described principally as applied to a diaphragm pump, it will be apparent that the diaphragms can be replaced by pistons.

CLAIMS

1. A pump comprising a hollow casing closed at its ends, two diaphragms or pistons disposed within the casing and generally parallel to each other adjacent the respective end portions of the casing, each diaphragm or piston forming with its adjacent end portion of the casing a closed first chamber, a fixed internal partition member disposed between the diaphragms or pistons and forming two closed second chambers with the respective diaphragms or pistons, said second chambers having inlets thereto controlled by respective valves and outlets therefrom controlled by respective valves, a push rod extending in a sealing manner through the partition member to transmit axial displacing forces between the diaphragms or pistons, and valve means actuated in dependence on the position of the diaphragms and adapted to open passages for connecting each of the two first chambers alternately to a source of pressure fluid and to exhaust, thereby to cause the push rod and diaphragms or pistons to reciprocate in unison and to cause the diaphragms or pistons to operate the second chambers as pumping chambers.

2. A pump as claimed in claim 1, wherein inlet passages providing the inlets to said second chambers and outlet passages providing the outlets from said second chambers are formed in the partition chamber.

3. A pump as claimed in claim 2, wherein said inlet passages are constituted by branch passages extending from a common inlet opening in the casing, said outlet passages providing the outlets from said second chambers are constituted by branch passages extending from a common outlet opening in the casing, the valves associated with second chambers being mounted in the branch passages.

4. A pump as claimed in any one of claims 1 to 3, wherein where diaphragms are provided, the two ends of the push rod are in abutting relationship with but are not connected to the diaphragms.

5. A pumps as claimed in any one of claims 1 to 4, wherein said end portions of the casing are formed by respective end members which are detachably secured to the partition member, and the two diaphragms or pistons are respectively removably attached at their peripheries to the adjacent end members.

6. A pump as claimed in any one of claims 1 to 5, wherein the internal partition member is formed in two halves which abut each other axially.

7. A pump as claimed in any one of claims 1 to 6, wherein each of said valves comprises a ball mounted for free but guided rectilinear movement into and out of engagement with an annular valve seat so as to operate as a non-return valve.

8. A pump as claimed in claim 7 in conjunction with claim 6, wherein said valve seats are constituted by annular inserts disposed between the two halves of the partition member.

9. A pump as claimed in any one of claims 1 to 6 wherein one or more of said valves are flap valves.

10. A pump as claimed in any one of claims 1 to 9, wherein said valve means comprises a pilot valve mounted in each end portion which pilot valve is opened by abutment therewith of the adjacent diaphragm at the end of a stroke of the pump and operates to open an external servo pressure line to exhaust.

11. In combination, a pump as claimed in claim 10 and a servo valve comprising a valve spool slidably disposed in a valve housing, opposite ends of the

spool being arranged to have air under pressure supplied thereto through permanently open restricted passages and having exhaust connections controlled by the two pilot valves respectively, said housing providing inlet and exhaust ports controlled by the valve spool to supply compressed air from said inlet to said first chamber alternately and to connect to exhaust the chamber not being supplied with compressed air.

12. The combination claimed in claim 11, wherein the servo valve has electrical control means operable to delay changeover movements of the valve spool initiated by operation of the pilot valves.

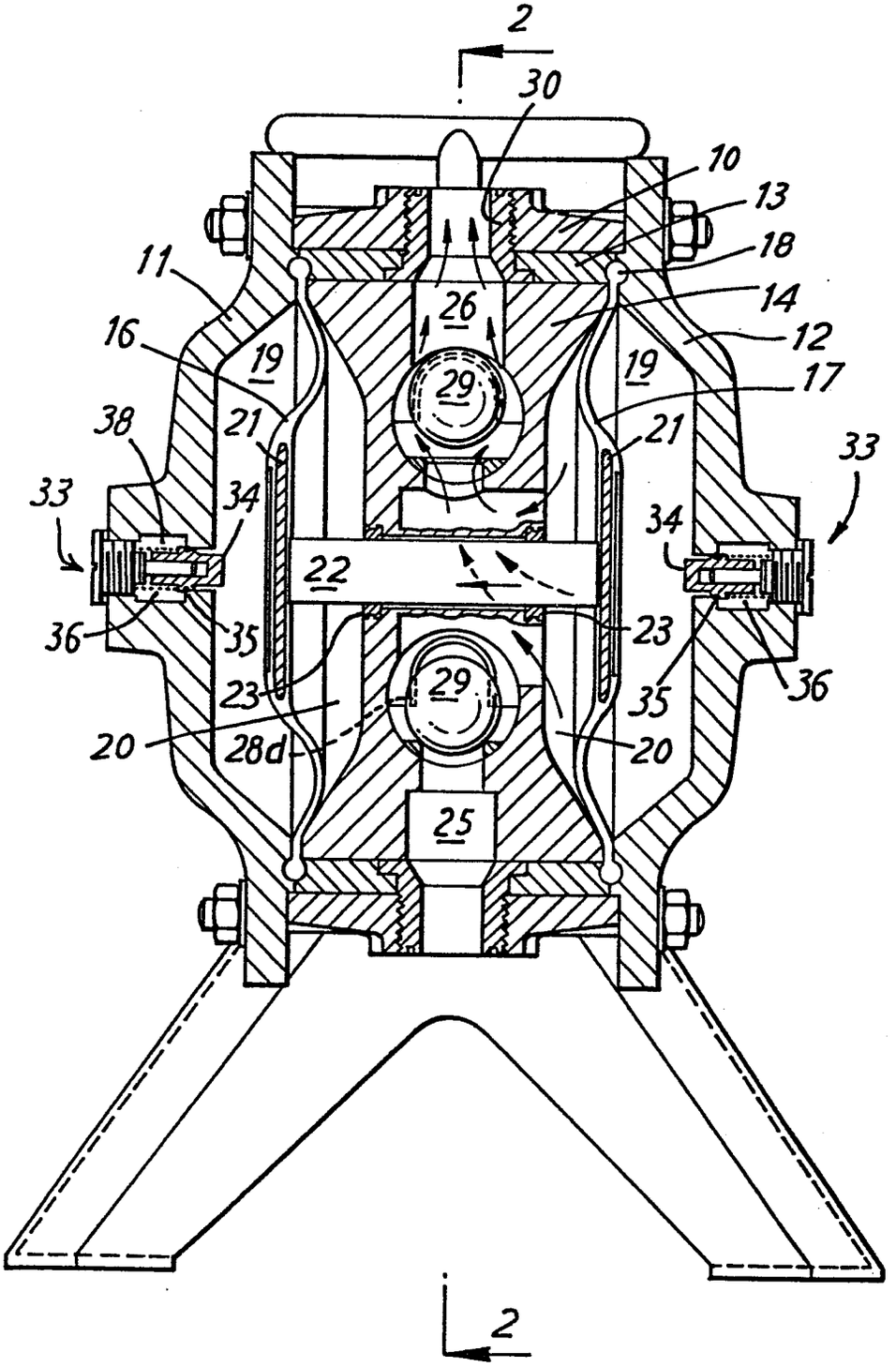
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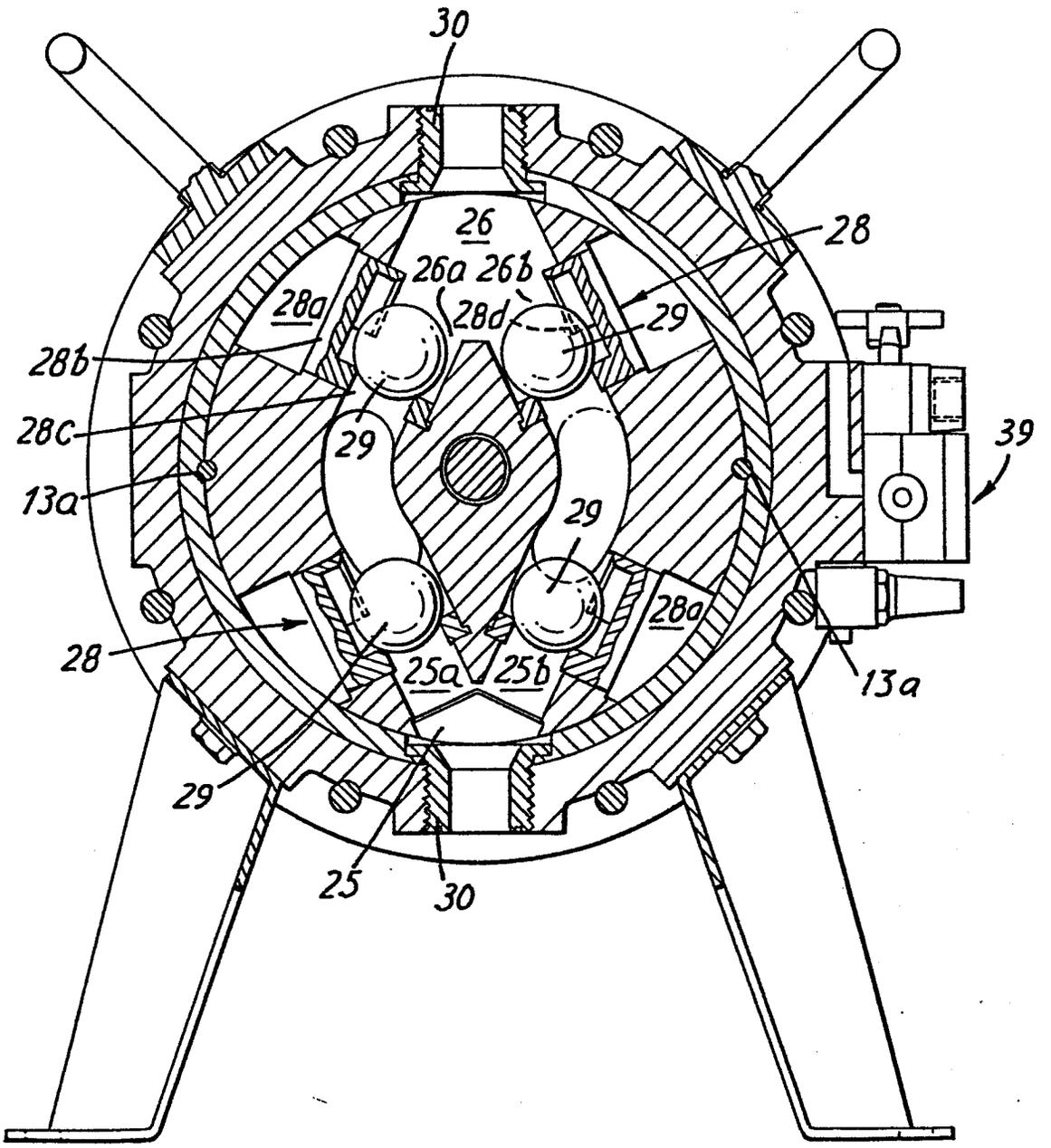
FIG. 1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28d
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FIG.2

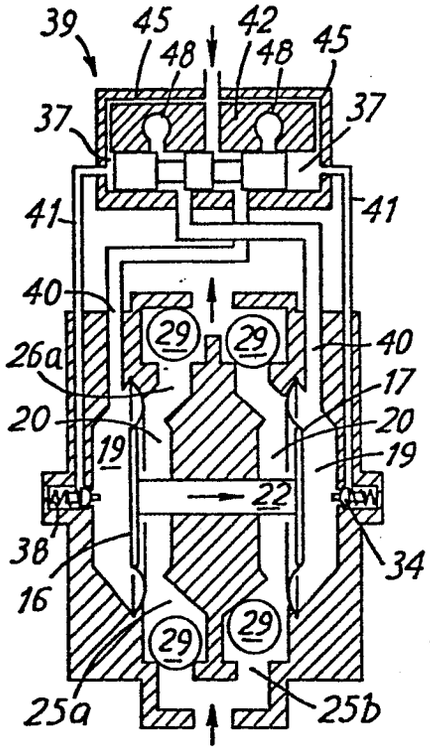

FIG. 3A

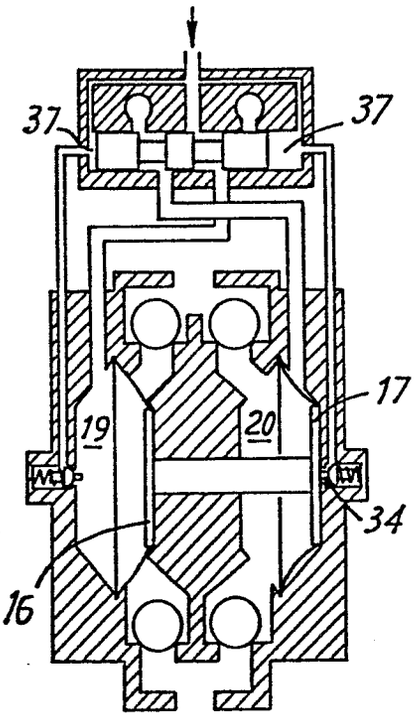

FIG. 3B

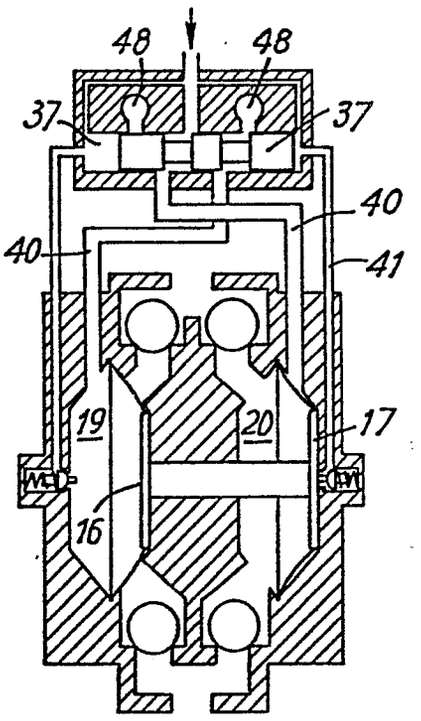

FIG. 3C

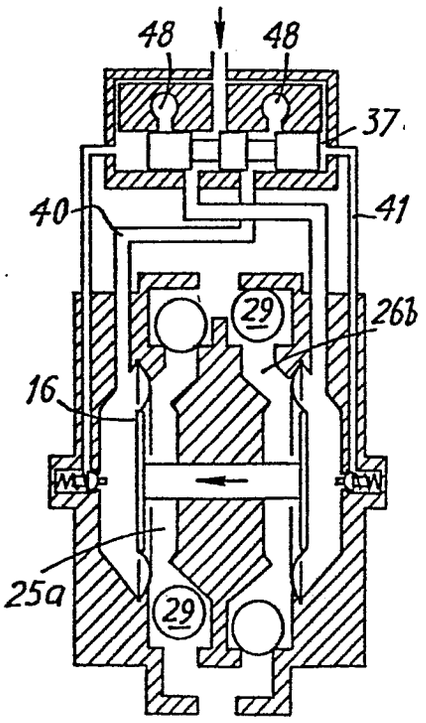

FIG. 3D

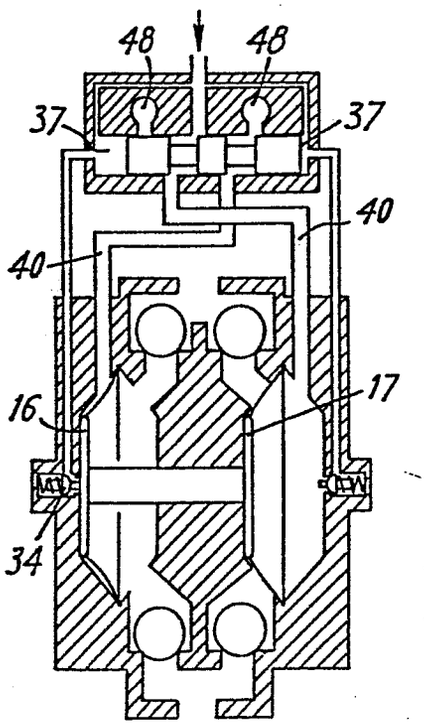

FIG. 3E

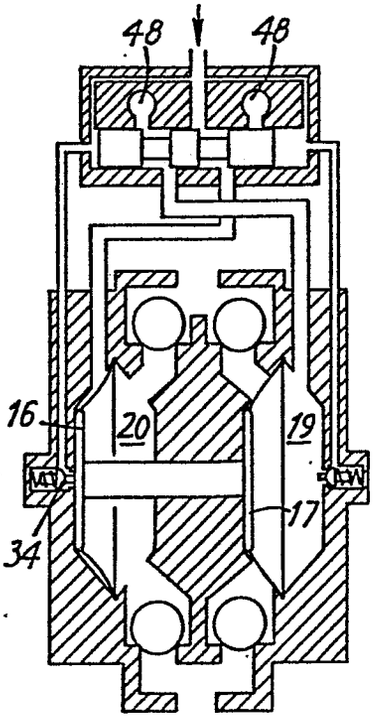

FIG. 3F

European Patent Office

EUROPEAN SEARCH REPORT

0132913
Application number

EP 84302390.4

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X	US - A - 4 334 837 (INADA) * Totality *	1-3,5,9	F 04 B 43/06
X	US - A - 1 920 014 (HORTON) * Totality *	1-3,5	
A	US - A - 2 260 306 (FERGUSON) * Page 3, left column, line 10 - page 4, left column, line 56; fig. 3,5,7,11 *	1-3,10,11	
A	GB - A - 837 737 (BUTLER & CO.) * Fig. 1 *	7	
A	GB - A - 2 085 979 (MC CANN'S ENGINEERING)		TECHNICAL FIELDS SEARCHED (Int. Cl. ³) F 04 B 9/00 F 04 B 43/00 F 04 B 45/00
A	GB - A - 481 270 (CARETTA)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	27-08-1984	WITTMANN

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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