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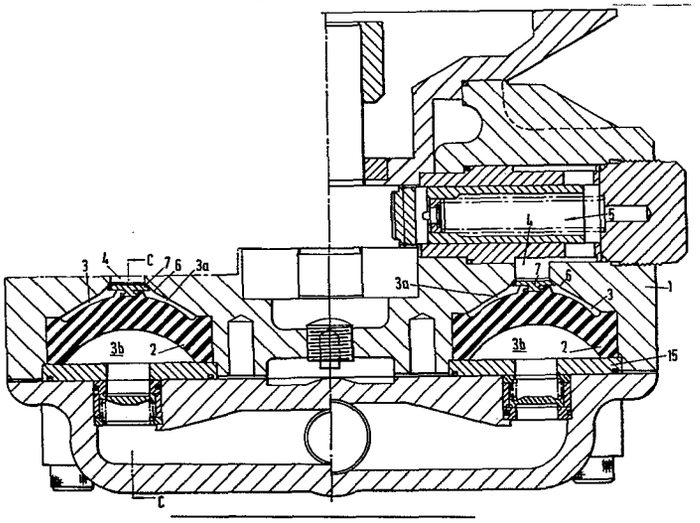
(54) High pressure diaphragm pump.

(57) A high pressure diaphragm pump has a diaphragm 2 which carries a valve poppet 7 on its upper surface. The valve poppet 7 fits into a flared portion 6 of a passage 4 for hydraulic fluid. When the diaphragm 2 restores to the position shown in Figure 1, the valve poppet 7 closes the passage 4 and prevents the diaphragm being punched back into the passage by excessive fluid pressure on the opposite side of the diaphragm. The diaphragm is made with flat edges 10, 11, 12 so that it can easily be mounted in a housing by means of three easily formed components 13, 14, 15. A small axial compression between components 14 and 15 is all that is necessary to keep the diaphragm in place during operation.



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"HIGH PRESSURE DIAPHRAGM PUMP"

This invention relates to a high pressure diaphragm pump comprising a housing containing at least one self-restoring diaphragm, the or each diaphragm being arranged within the housing so as to separate a space for receiving hydraulic fluid from a space for receiving fluid to be pumped, the space for receiving hydraulic fluid communicating with a hydraulic fluid supply via a passage. Such a pump is disclosed in our U.S. Patent Specification 4 116 590.

Experience with the pumps previously disclosed has shown that the diaphragms are at risk if the outlet, or discharge, valves fail. If a discharge valve fails, the entry of the fluid to be pumped punches the diaphragm back against the wall of the hydraulic fluid space. Hydraulic fluid enters this space through open passages, and if the diaphragm is punched back against the edges of the openings, it will wear. Under such conditions, the diaphragm may eventually rupture.

To overcome this disadvantage, it has been proposed to mount a circular component in the wall of the hydraulic fluid space, so that an annular gap is left around the edges of the circular component through which the hydraulic fluid enters the space. The edges of the component and the adjacent edges of the housing are of

course rounded, but this alternative is not particularly satisfactory in that it requires an extra component of some size to be fixed in the housing and it does still leave a channel in the wall of the hydraulic space which the diaphragm can enter if it is punched back.

The invention intends to overcome this disadvantage in a pump as set forth above, and to this end the diaphragm carries a closure member on its side facing the hydraulic fluid space for closing the passage when the diaphragm reaches the end of its intake movement.

Preferably, the passage enters the hydraulic fluid space via a flared passage portion, and the closure member is a poppet which fits into the flared portion to close the passage. The passage is preferably closed when there is still some hydraulic fluid remaining within the hydraulic fluid space, to act as a cushion in the event of high pressures occurring on the opposite side of the diaphragm, to prevent the central part of the diaphragm from touching any parts of the housing.

The angle of the flared passage portion and of the edges of the poppet may be 45°. This ensures that there is no chance of the poppet jamming in the passage portion when the diaphragm is required to carry out a pumping movement. The poppet does not have to form a fluid-tight seal in the flared passage portion.

The diaphragm may be formed with an undercut recess which receives a flange of the poppet. No further fixing means are necessary.

The passage for supplying hydraulic fluid preferably enteres the hydraulic fluid space in the centre thereof, and the closure member will then be in the centre of the diaphragm.

The or each diaphragm may have a thickness to diameter ratio of at least 1:5, and the peripheral edge

of the or each diaphragm may be a right cylindrical surface, and flat annular surfaces may adjoin the cylindrical surface at the top and bottom of the peripheral edge. Such a diaphragm can be mounted in the housing within a cylindrical housing portion of diameter equal to or slightly less than the diameter of the right cylindrical surface, and be confined by surfaces exerting an axial compression on said top and bottom annular surfaces.

It has surprisingly been found that this method of fixing the diaphragm in position is quite adequate to prevent movement of the diaphragm in use. Only a small axial compression need be applied.

With this method of fixing, the housing construction can be greatly simplified because the diaphragm can be mounted within a circular bore in a plate, and the axial compression can be applied by two flat plates mounted respectively above and below the diaphragm, and pulled together by bolts.

The diaphragm is also in a shape which is easier to make than the shape shown in our prior U.S. Patent Specification.

The diaphragm may also be constructed with a step at the edge of its side which faces the space for receiving fluid to be pumped. When, in the prior art constructions, the underside of the diaphragm follows a continuous curve down to the bottom plate in which the inlet and discharge valves are formed, it is found that, on flattening the diaphragm, contact first occurs between the metal and the diaphragm at positions close to the edges of the diaphragm. Any contact between the moving part of the diaphragm and a metal surface should be avoided, since this leads to wear. The provision of the step prevents this contact.

The invention will now be further described, by way of example, with reference to the accompanying

drawings, in which:

Figure 1 is a sectional elevation through part of a high pressure pump in accordance with the invention, the lefthand half of Figure 1 being a section on line A-A of Figure 2, the righthand half of Figure 1 being a section on line B-B of Figure 2;

Figure 2 is a section on line C-C of the left-hand half of Figure 1;

Figure 3 is a cross-section through a diaphragm; and

Figure 4 shows a closure member in the form of a poppet, on a larger scale, for use with the diaphragm of Figure 3.

In general, the pump shown in Figure 1 possesses the same features as the pump disclosed in our previous U.S. Patent Specification 4,116,590, and only the parts which are particularly relevant to the present application will be described in detail.

The pump housing 1 contains two diaphragms 2 each contained in a chamber 3. Above each diaphragm 2 there is a space 3a for receiving hydraulic fluid, and below each diaphragm there is a space 3b for receiving fluid to be pumped. The hydraulic fluid, which flattens the diaphragm to produce a pumping movement, enters the chamber 3 through a passage 4 from a piston unit 5 operating in its own chamber. The lower end of the passage 4 is flared outwardly at 6 to form a seat for a poppet 7. The poppet 7 is connected to the diaphragm 2 and will move up and down with the diaphragm as the diaphragm flexes.

A diaphragm 2 is shown on a larger scale in Figure 3. It will be seen that the top face of the diaphragm has an undercut recess 8 for receiving the poppet 7. The poppet itself is shown on a larger scale in Figure 4, and it will be seen that this has a flange

9 which is received in the recess 8. No additional fixing means are required. The flange 9 is retained in place by the lips of the undercut recess 8.

The edges of the diaphragm 2 have a right circular surface 10, and top and bottom flat annular surfaces 11 and 12. As shown in the righthand half of Figure 3, the diaphragm can easily be clamped in place by three easily machined housing components. The central component 13 has a cylindrical bore, and the top and bottom components 14 and 15 just have flat surfaces which contact the flat surfaces 11 and 12. The components 14 and 15 are drawn together by, for example, bolts to provide an axial compression in the edge bead of the diaphragm.

The poppet 7 has angled faces 16 which correspond to the angle of the outwardly flared passage portion 6. The angle of the faces 16 and the portion 6 may be, for example, 45° to the axis of the passage and the axis of the diaphragm movement.

The underside of the diaphragm has a step 17. This is to prevent the area 18 of the diaphragm from touching the metal plate 15 when the diaphragm is flattened.

CLAIMS:

1. A high pressure diaphragm pump comprising a housing (1) containing at least one self-restoring diaphragm (2), the or each diaphragm being arranged within the housing so as to separate a space (3a) for receiving hydraulic fluid from a space (3b) for receiving fluid to be pumped, the space for receiving hydraulic fluid communicating with a hydraulic fluid supply via a passage (4), characterised in that the diaphragm (2) carries a closure member (7) on its side facing the hydraulic fluid space (3a), for closing the passage (4) when the diaphragm reaches the end of its intake movement.

2. A pump according to claim 1, characterised in that the passage (4) enters the hydraulic fluid space (3a) via a flared passage portion (6), and the closure member is a poppet (7) which fits into the flared portion (6) to close the passage (4).

3. A pump according to claim 2, characterised in that the diaphragm (2) is formed with an undercut recess (8) which receives a flange (9) of the poppet (7).

4. A pump according to any preceding claim, characterised in that the closure member (7) is arranged to close the passage (4) when there is still some hydraulic fluid remaining within the hydraulic fluid space (3a).

5. A pump according to any preceding claim, characterised in that the passage (4) enters the hydraulic fluid space (3a) in the centre thereof, and the closure member (7) is in the centre of the diaphragm (2).

6. A pump according to any preceding claim, characterised in that the peripheral edge of the diaphragm (2) is a right cylindrical surface (10) with

flat annular surfaces (11, 12) adjoining the cylindrical surface at the top and bottom of the peripheral edge; the diaphragm being mounted in the housing (1) within a cylindrical housing portion (13) of diameter equal to or slightly less than the diameter of the cylindrical surface (10), and being confined by surfaces (14, 15) exerting an axial compression on said annular surfaces (11, 12).

7. A pump according to any preceding claim, characterised in that the diaphragm (2) has a step (17) at the edge of its side which faces the space (3b) for receiving fluid to be pumped.

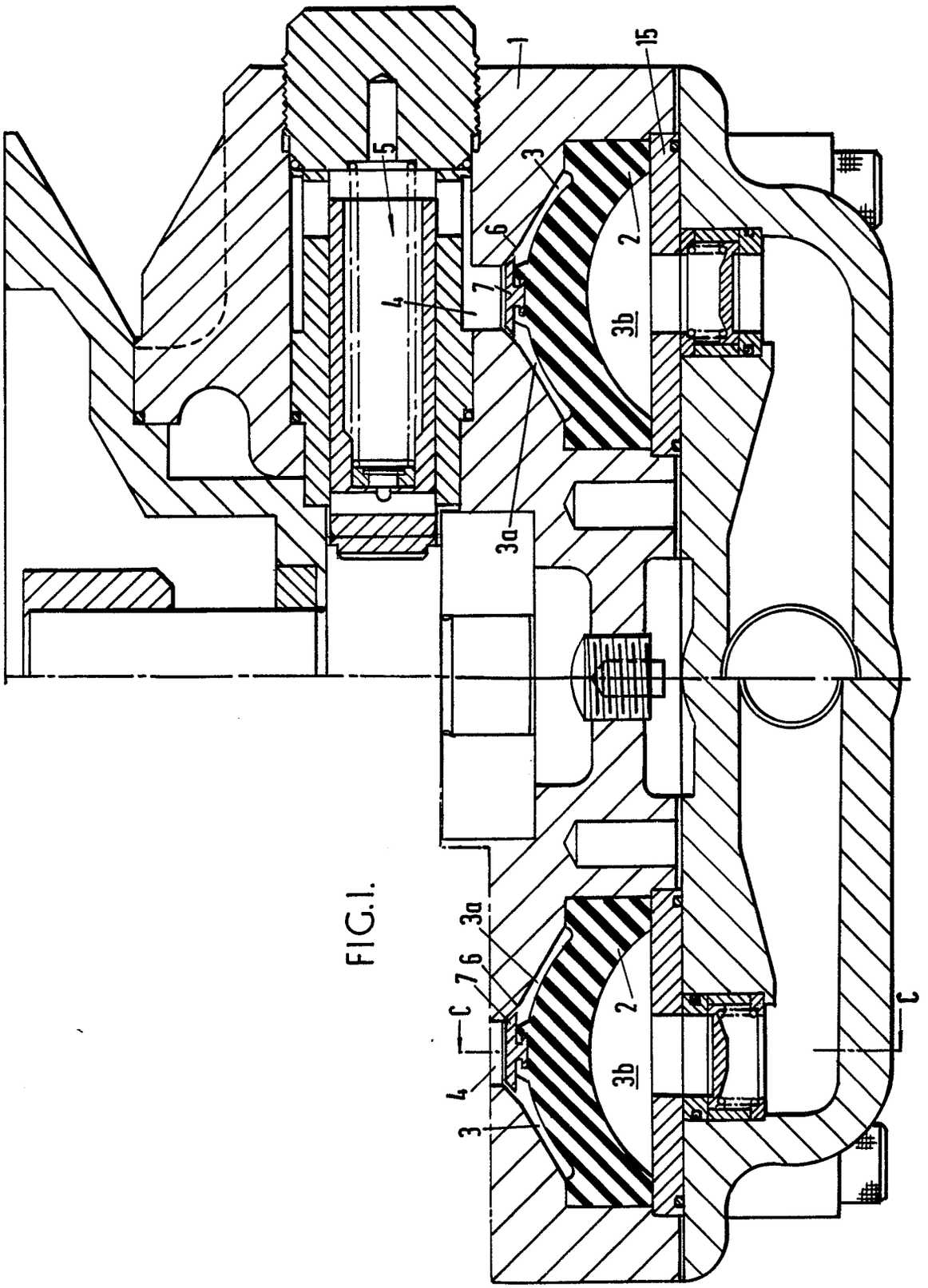

FIG.1.

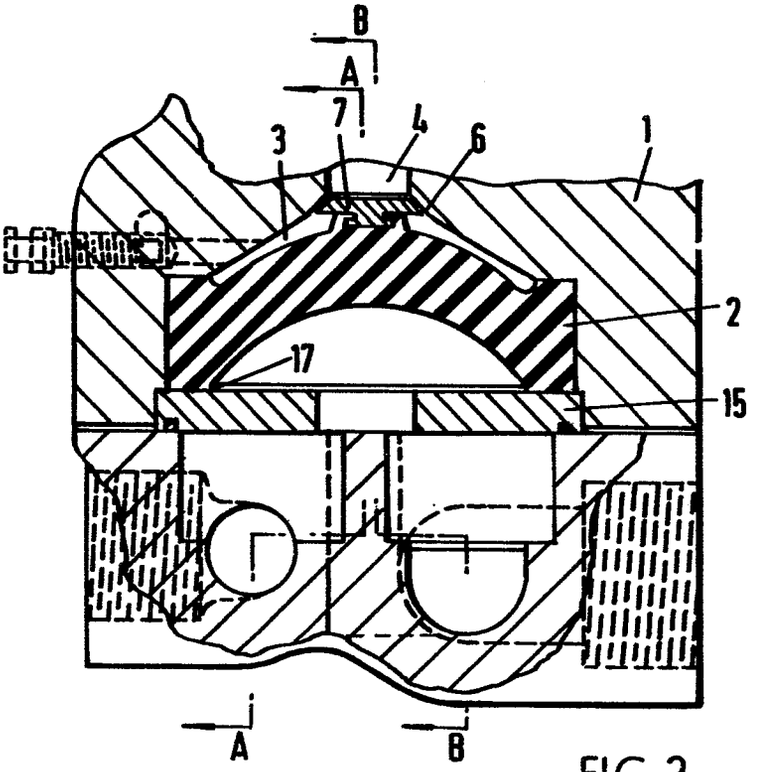

FIG. 2.

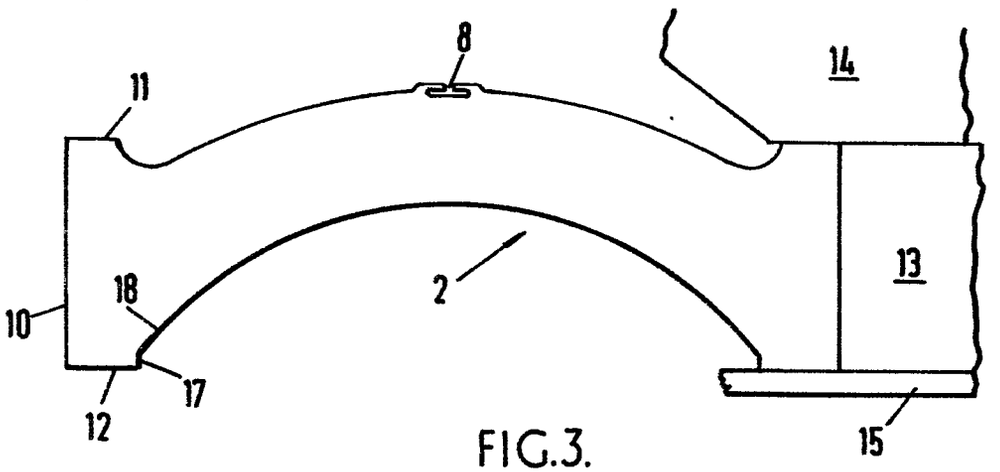

FIG. 3.

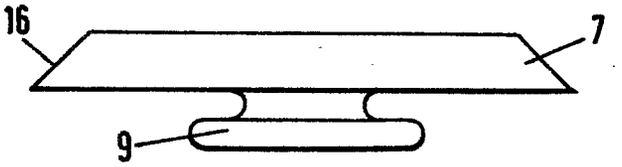

FIG. 4.

European Patent Office

EUROPEAN SEARCH REPORT

Application number 0012584

EP 79 30 2829

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	US - A - 2 948 223 (MASHINTER) * Column 4, lines 47-75; column 5, lines 1-9; column 7, lines 21-48; figures 2,6 *	1,3,4, 5,6
X	US - A - 2 970 747 (KASPAR) * Column 3, lines 23-41; figure 2 *	1,2,5
X	FR - A - 1 064 799 (BATAAFSCHE) * Page 2, left-hand column, paragraph 2; figure 1 *	1,4,5
	US - A - 2 928 426 (TAYLOR) * Column 2, lines 11-16, 33-38; figure 1 *	6
	US - A - 2 476 545 (HAYWARD) * Column 2, lines 50-55; column 3, lines 1-16; figure 2 *	1,7
	US - A - 2 474 442 (SPENDER) * Column 2, lines 47-50; figure 1 *	7
A	US - A - 2 659 310 (RYBA) * Entire document *	1

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

F 04 B 43/06

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

F 04 B

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	06-03-1980	HEINLEIN

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