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(54) Reciprocating diaphragm pump

(57) A reciprocating pump (1) comprises a plurality of reciprocating pistons (2a,2b,2c) extending along respective longitudinal axes (X-X) parallel to each other and lying in a plane (Φ), a plurality of pumping work chambers (5a,5b,5c), and a plurality of diaphragms (7a,7b,7c), each arranged in a respective pumping work chamber (5a,5b,5c). In particular, the diaphragms (7a,7b,7c) are arranged coplanar in a plane (Δ) perpendicular to the axes (X-X) of the reciprocating pistons (2a,2b,2c), and the diaphragm of at least one reciprocating piston is offset with respect to the diaphragm of the adjacent reciprocating piston, in the direction (Y-Y) perpendicular to the plane (Φ) defined by the axes (X-X) of the reciprocating pistons (2a,2b,2c).

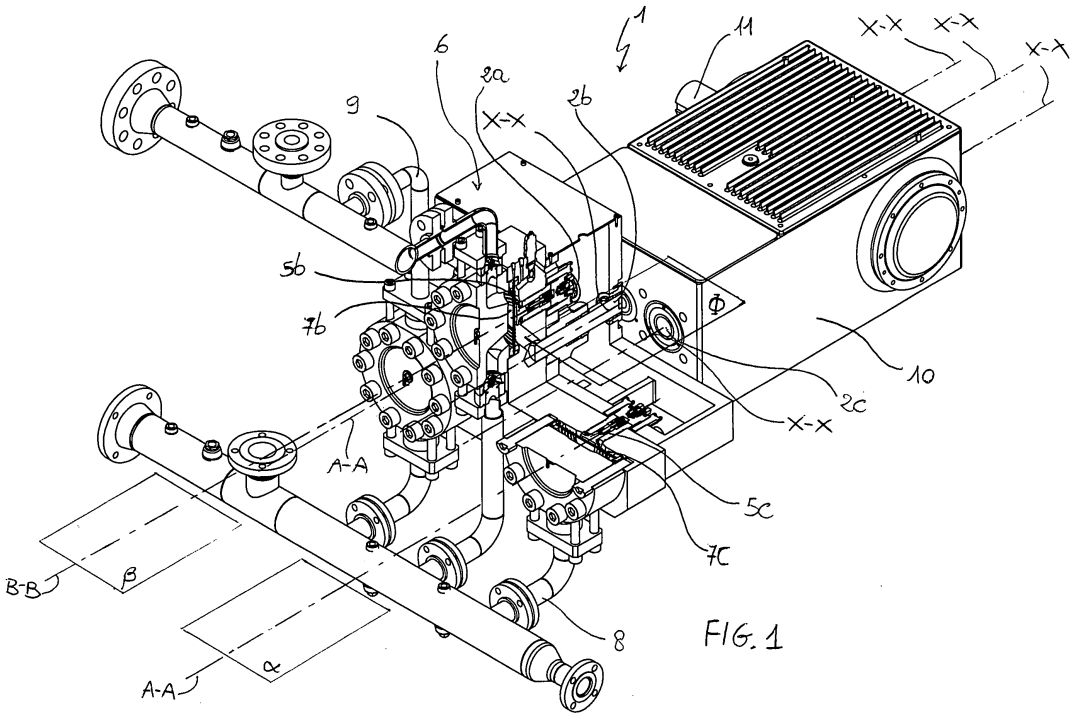

FIG. 1

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Description

[0001] The present invention relates to a reciprocating diaphragm pump in accordance with the preamble of Claim 1.

[0002] Reciprocating diaphragm pumps are known according to the state of the art.

[0003] A reciprocating diaphragm pump comprises, typically, a series of pistons housed inside cylinders which are arranged adjacent to one another and define piston stroke work chambers. The pump also comprises pumping work chambers intended to be closed and opened by means of intake valves, on the intake side, and to be opened and closed by means of delivery valves, on the delivery side.

[0004] The pumping work chambers and the piston stroke work chambers are separated from each other by diaphragms which receive, transmitted to them via the fluid present inside the piston stroke work chambers, the work performed by the stroke of the piston during its reciprocating movement inside the cylinder.

[0005] In order to simplify the connections between the pumping work chambers, piston stroke work chambers and the diaphragms, the pumping chambers are arranged axially aligned with the piston stroke chambers.

[0006] This relative arrangement of the pumping and piston stroke work chambers has, however, certain drawbacks. It must be pointed out, in fact, that the cross-sectional dimension of the pumping work chambers and the piston stroke work chambers in the region of the diaphragms are significantly greater than the cross-sectional dimension of the pistons. For this reason, the pumping work chambers may be arranged in the configuration axially aligned with the respective piston stroke work chambers only if the cylinders are kept sufficiently spaced from each other.

[0007] Therefore, an increase in the number of cylinders and associated diaphragms and/or an increase in the cross-section of the diaphragms requires a corresponding increase in the distance between the cylinders or the centre distance of the pump. On the other hand, an increase in the distance between the cylinders requires a corresponding adaptation of the piston actuating systems, with a consequent increase in the costs, and results in an increase in the dimensions of the end of the pump and the overall dimensions of the pump.

[0008] A solution to this problem has been proposed in the document EP 380 922 which describes a reciprocating diaphragm pump having a plurality of cylinders arranged adjacent to one another in a row so as to define work chambers for the stroke of an associated piston.

[0009] In accordance with this prior art, the pumping work chambers associated with the adjacent piston stroke work chambers are arranged on different sides of the row of cylinders. In particular, in the case of a three-cylinder pump, the pumping work chamber associated with the central chamber is arranged as an extension of the central cylinder, while the pumping chambers associated with the two side cylinders are arranged laterally with respect to the axis of the central cylinder. The aforementioned solution, while reducing the problems encountered in the previously known pumps, has significant drawbacks and gives rise to a series of problems relating to the interchangeability of the pistons.

[0010] In fact, the particular arrangement of the diaphragms proposed in the document EP 380 922 requires the use of pistons with different lengths, with the consequent impossibility of interchanging the pistons, and creates different spaces which are prejudicial for the two lateral cylinders in relation to the central cylinder, with a consequent overall imbalance of the pump. It must also be noted that the presence of pumping chambers and associated lateral diaphragms produces stresses and therefore vibrations in the direction transverse to the movement of the pistons.

[0011] From above, it is clear that ther's a need to provide a reciprocating pump with in-line cylinders which allows the distance between the cylinders to be kept constant and which allows interchangeability of the pistons with an increase in the size of the diaphragms and/or the number of cylinders.

[0012] The object of the present invention is therefore to provide a reciprocating pump which has structural and functional characteristics such as to satisfy the above-mentioned requirements and overcome at the same time the drawbacks encountered with reference to the prior art.

[0013] This object is achieved by a reciprocating pump according to Claim 1.

[0014] Further characteristic features and advantages of the reciprocating pump according to the present invention will emerge from the description below of a preferred example of embodiment, provided by way of a non-limiting example, with reference to the accompanying figures in which:

- Figure 1 shows a partially sectioned, schematic, perspective view of a reciprocating pump according to the invention;
- Figure 2 shows a front view of the reciprocating pump according to Figure 1;
- Figure 3 shows a cross-sectional side view of the reciprocating pump of Figure 1 along the cross-sectional line III-III of Figure 2; and
- Figure 4 shows a cross-sectional view of the front part of the reciprocating pump of Figure 1 along the cross-sectional line IV-IV of Figure 3.

With reference to the accompanying figures, 1 denotes in its entirety a reciprocating pump.

The pump 1 comprises a stationary base body 10, a driving shaft 11 and a plurality of reciprocating pistons

- indicated overall by 2 - which extend along respective longitudinal axes - indicated by X-X - which are parallel to each other and lie in a common plane Φ.

[0015] The reciprocating pistons 2 are housed inside corresponding cylinders 3 which are arranged adjacent to each other and define a corresponding plurality of stroke work chambers 4 arranged alongside each other for the said pistons 2.

[0016] The pistons 2 are intended to move with a reciprocating motion along the respective longitudinal axes X-X following the rotational actuation of the driving shaft 11. In order to actuate rotationally the driving shaft 11, the pump 1 comprises, in a manner known per se, suitable actuating means (not shown in the figures).

[0017] In the example shown in the accompanying figures, the pistons 2 are three in number and are indicated by 2a,2b and 2c, more specifically a central piston 2b and two lateral pistons 2a,2c.

[0018] The pistons 2a,2b,2c are housed inside corresponding cylinders 3a,3b,3c which define the stroke work chambers 4a,4b,4c of the pistons 2a,2b,2c, respectively.

[0019] A corresponding plurality of pumping work chambers 5, in the example the chambers 5a,5b,5c, are situated at the end 6 of the pump 1. The pumping work chambers 5a,5b,5c are intended to communicate, by means of the intake and delivery valves arranged in between, with a corresponding intake header 8 and delivery header 9.

[0020] The pumping work chambers 5a,5b,5c and the stroke work chambers 4a,4b,4c of the pistons 2a,2b,2c are separated from each other by diaphragms 7a,7b,7c which receive, transmitted to them via the fluid present inside the stroke work chambers 4a, 4b, 4c of the pistons 2a,2b,2c, the work performed by the stroke of the pistons 2a,2b,2c during their reciprocating movement inside the cylinders 3a,3b,3c.

[0021] The diaphragms 7a,7b,7c are each arranged inside a respective pumping work chamber 5a,5b,5c, for allowing the entry of fluid into the pumping work chambers 5a,5b,5c and the outflow of fluid from the pumping work chambers 5a,5b,5c via the intake and delivery valves, respectively, following the reciprocating movement of the pistons 2a,2b,2c. Respective ducts 12a,12b, 12c are envisaged for connecting the pumping work chambers 5a,5b,5c to the corresponding stroke work chambers 4a,4b,4c of the pistons 2a,2b,2c.

[0022] The diaphragms 7a,7b,7c, when considered in the rest condition, extend perpendicularly to the axes X-X of the pistons 2a,2b,2c and have respective longitudinal axes perpendicular to their plane and parallel to each other.

[0023] Advantageously, the diaphragms 7a,7b,7c are arranged coplanar in a plane Δ perpendicular to the axes X-X of the pistons 2a,2b,2c and the diaphragm of at least one piston is offset with respect to the diaphragm of the adjacent piston, in the direction Y-Y perpendicular to the plane Φ defined by the longitudinal axes X-X of the pistons 2a,2b,2c.

[0024] In the example shown in the accompanying figures, the diaphragm 7b of the central piston 2b is offset with respect to the diaphragms 7a,7c of the lateral pistons 2a,2c, in the vertical direction Y-Y perpendicular to the plane Φ defined by the axes X-X of the pistons 2a,2b,2c.

[0025] This arrangement of the diaphragms 7a,7b,7c allows the number of pistons and/or the size of the diaphragms to be increased, keeping constant the distance L between the axes X-X of the pistons, thus limiting the overall dimensions of the end of the pump 1.

[0026] Owing to the fact that the diaphragms 7a,7b,7c are all coplanar in the plane Δ there are no transverse stresses acting on the said diaphragms and therefore an optimum hydraulic equilibrium is achieved. This characteristic, together with the particular arrangement of at least one diaphragm with respect to the adjacent diaphragms, allows optimum use of the space available on the front surface of the end 6 of the pump 1, keeping the stresses which are transmitted to the supporting structure 10 in substantial equilibrium with each other and along the axes X-X of the pistons.

[0027] Advantageously, where the axes X-X of the pistons 2a,2b,2c are arranged parallel to each other in the plane Φ, the axis of at least one of the diaphragms 7a, 7b,7c is arranged in a separate plane parallel to the plane in which the axes of the other diaphragms lie. In the example shown in the Figures, the axes A-A of the diaphragms 7c, 7c lie in the same plane α, while the axis B-B of the diaphragm 7b lies in a separate plane β parallel to the plane α.

[0028] Advantageously, moreover, the planes α, P in which the axes A-A, B-B of the diaphragms 7a,7b,7c lie are separate and parallel to the plane Φ in which the axes X-X of the pistons 2a,2b,2c lie.

[0029] As can be appreciated from that described, with the reciprocating pump according to the invention it is possible to satisfy the requirements mentioned in the introductory part of the present description and overcome the drawbacks of the reciprocating diaphragm pump of the

prior art.

[0030] Obviously, a person skilled in the art, for the purpose of satisfying contingent and specific requirements, may make numerous modifications and variations to the pump according to the invention described above, all of which, however, are contained within the scope of protection of the invention as defined by the following claims.

Claims

1. Reciprocating diaphragm pump (1) comprising:

- a plurality of pistons (2a,2b,2c) extending along respective longitudinal axes (X-X) parallel to each other and lying in a first plane (Φ), the pistons of said plurality of pistons (2a,2b,2c) being arranged adjacent to one another and being in-

tended to move with a reciprocating motion along said axes (X-X);
- a plurality of pumping work chambers (5a,5b, 5c), each chamber of said plurality of pumping work chambers (5a,5b,5c) being associated with a respective piston of said plurality of pistons (2a,2b,2c);
- a plurality of diaphragms (7a,7b,7c), each diaphragm of said plurality of diaphragms (7a,7b, 7c) being arranged in a respective pumping work chamber of said plurality of pumping work chambers (5a,5b,5c) and being associated with a respective piston (2a,2b,2c);

characterized in that

- the diaphragms of said plurality of diaphragms (7a,7b,7c) are arranged coplanar in a second plane (Δ) perpendicular to said longitudinal axes (X-X); and
- the diaphragm associated with at least one piston of said pistons is offset with respect to the diaphragm associated with the adjacent piston, in a direction (Y-Y) perpendicular to said first plane (Φ).

2. Reciprocating pump (1) according to Claim 1, in which said reciprocating pistons comprise a central reciprocating piston (2b) and two lateral reciprocating pistons (2a,2c), each adjacent to the central reciprocating piston (2b), the diaphragm (7b) associated with the central reciprocating piston (2b) being positioned offset with respect to the diaphragms (7a, 7c) of the lateral reciprocating pistons (2a,2c), in said direction (Y-Y) perpendicular to said first plane (Φ).

3. Reciprocating pump (1) according to Claims 1 or 2, in which said diaphragms (7a,7b,7c), considered in the rest condition, extend perpendicularly with respect to said longitudinal axes (X-X) of the reciprocating pistons (2a,2b,2c) and have respective longitudinal axes perpendicular to their plane and parallel to each other.

4. Reciprocating pump (1) according to Claim 3, in which the longitudinal axis (A-A) of at least one diaphragm (7b) of said diaphragms (7a,7b,7c) is arranged in a third plane (α) distinct from a fourth plane (β) in which the longitudinal axes (B-B) of the adjacent diaphragms (7a,7c) lie, said third plane (α) and fourth plane (β) being parallel to said first plane (Φ).

5. Reciprocating pump according to any one of Claims 1 to 4, in which said reciprocating pistons (2a,2b,2c) are housed in corresponding cylinders (3a,3b,3c) which are arranged adjacent to one another and define a corresponding plurality of stroke work chambers (4a,4b,4c) of the reciprocating pistons (2a,2b, 2c).

6. Reciprocating pump (1) according to Claim 6, in which said pumping work chambers (5a,5b,5c) and said stroke work chambers (4a,4b,4c) are separated from each other by said diaphragms (7a,7b,7c).

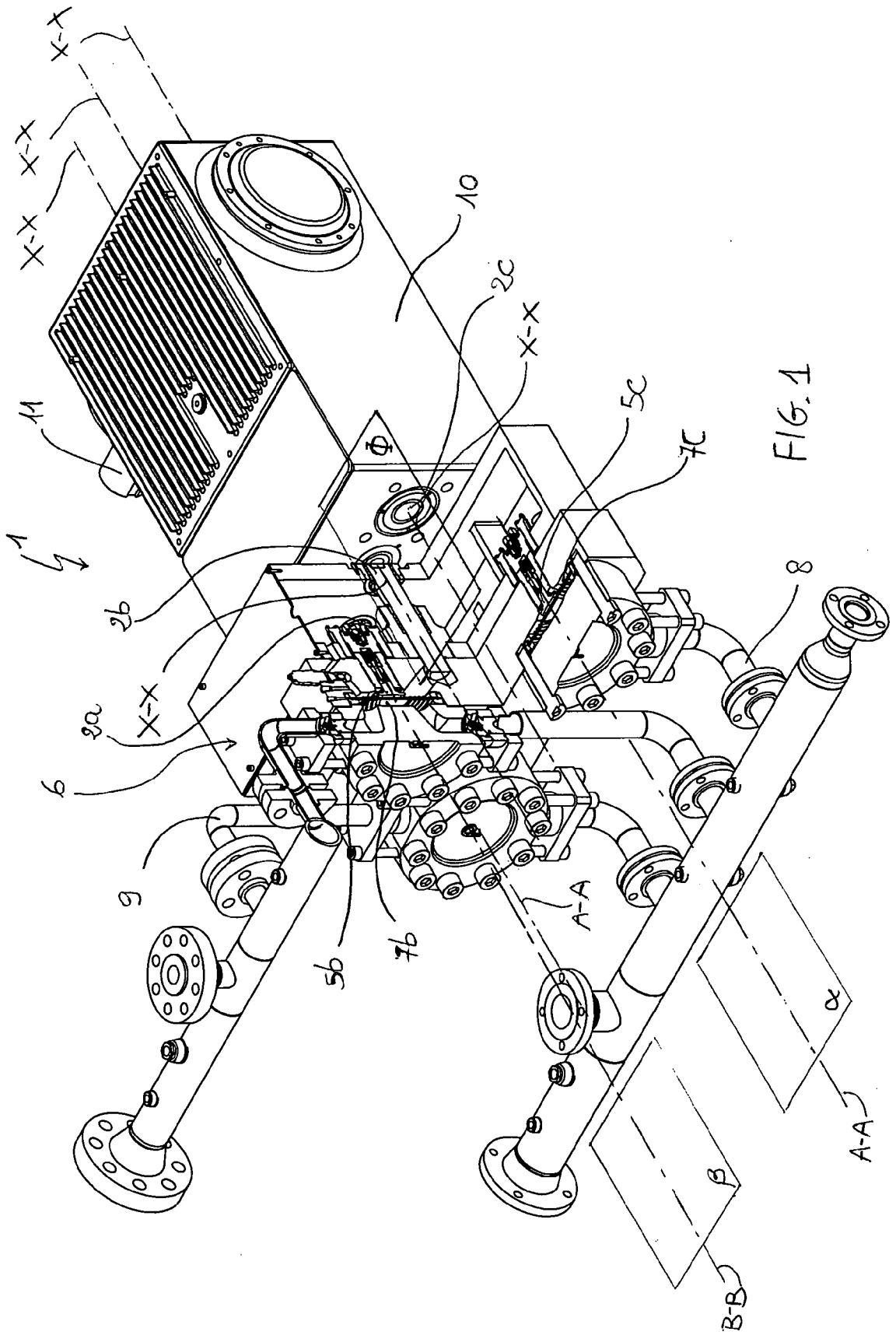

FIG. 1

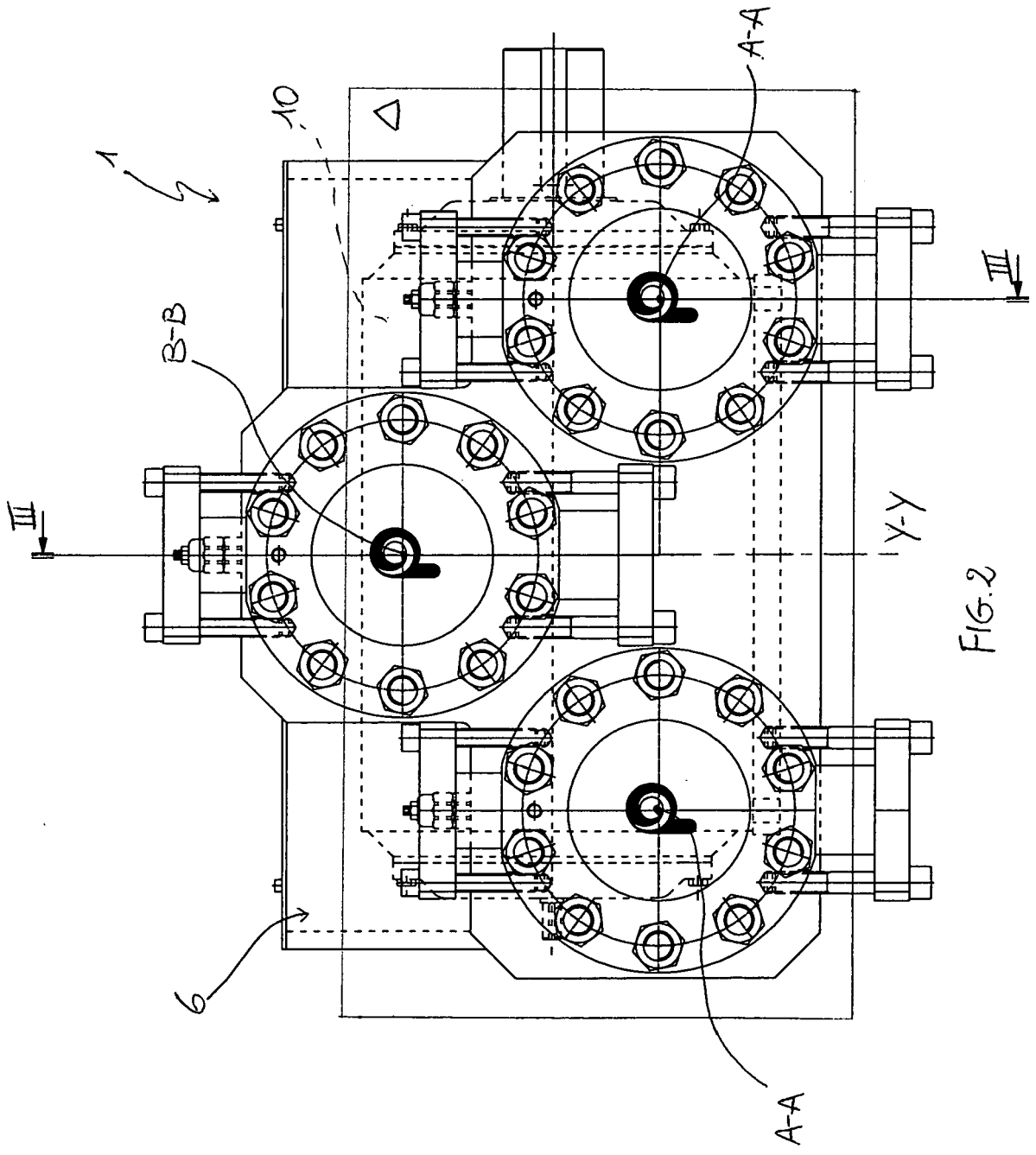

FIG.2

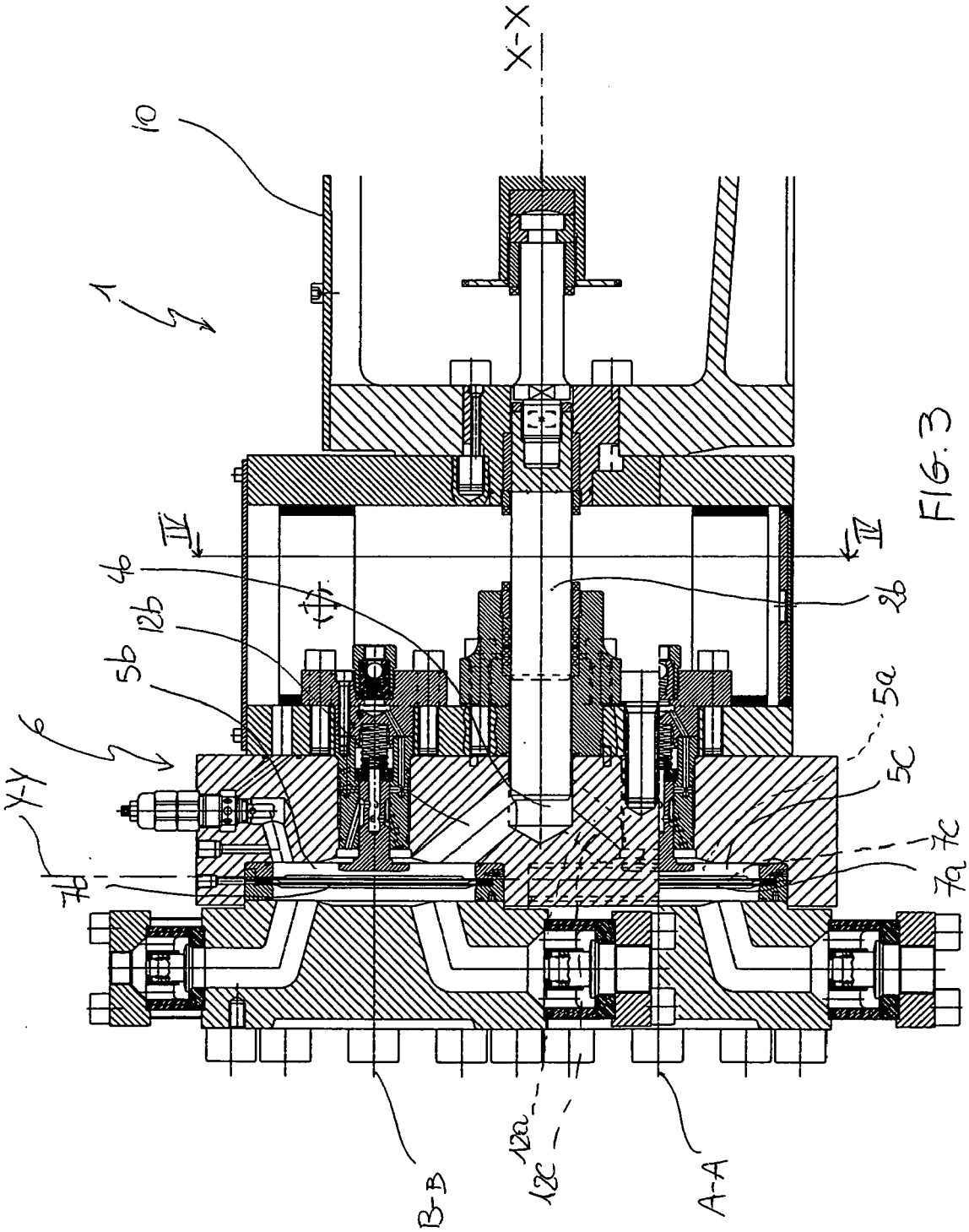

FIG. 3

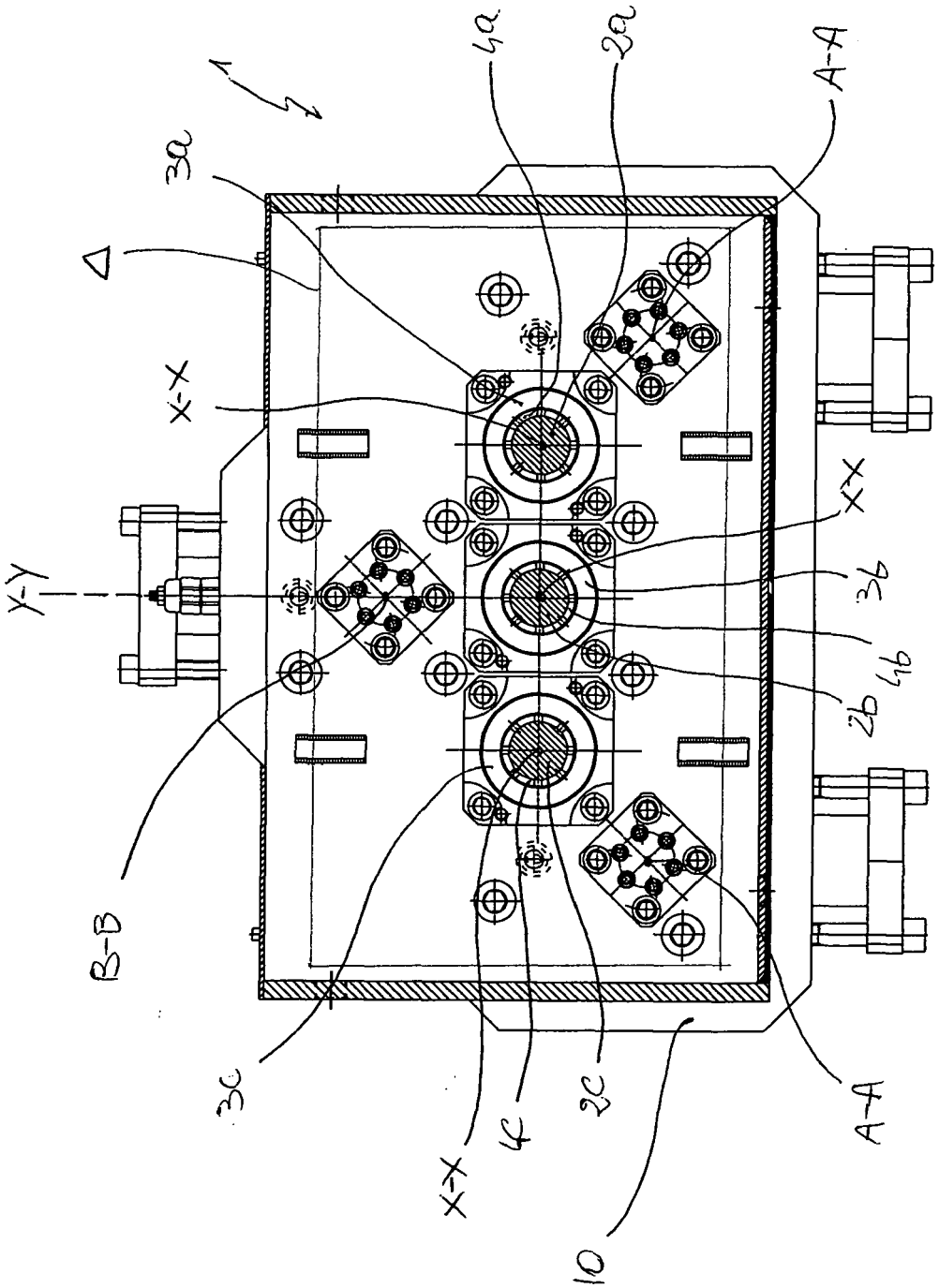

FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5060

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
D,A	EP 0 380 922 A (URACA PUMPEN; URACA PUMPENFABRIK GMBH & CO. KG) 8 August 1990 (1990-08-08) * the whole document *	1-6	INV. F04B43/02 F04B43/00
A	US 4 705 461 A (CLEMENTS ET AL) 10 November 1987 (1987-11-10) * the whole document *	1-6	
A	GB 1 480 002 A (LEWA HERBERT OTT KG) 20 July 1977 (1977-07-20) * the whole document *	1-6	
A	US 3 779 669 A (SOMMER H,US) 18 December 1973 (1973-12-18) * the whole document *	1-6	

TECHNICAL FIELDS SEARCHED (IPC)

F04B

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Place of search	Date of completion of the search	Examiner
Munich	11 July 2006	Avramidis, P

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11-07-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0380922 A	08-08-1990	DE 3903049 A1	23-08-1990
		JP 2238186 A	20-09-1990
		US 5018949 A	28-05-1991
US 4705461 A	10-11-1987	NONE	
GB 1480002 A	20-07-1977	DE 2446805 A1	08-04-1976
		JP 939276 C	30-01-1979
		JP 51061003 A	27-05-1976
		JP 53017762 B	10-06-1978
US 3779669 A	18-12-1973	NONE	

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 380922 A **[0008] [0010]**