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(71) Applicant: **RIVA CALZONI S.p.A.**
Bologna (IT)

(72) Inventor:
Breveglieri, Alessandro
Casalecchio di Reno (Bologna) (IT)

(74) Representative:
Raimondi, Alfredo, Dott. Ing. Prof.
Dott. Ing. Prof. RAIMONDI ALFREDO S.r.l.
Piazzale Cadorna 15
20123 Milano (IT)

(54) Hydraulic motor with propulsion members having their longitudinal axis inclined both with respect to the other propulsors and with respect to the axis of the drive shaft

(57) Hydraulic motor comprising a drive shaft (12), propulsion members (20), an element (15) which is coaxial with the drive shaft and integral with the latter and which is acted on by said propulsion members and an eccentric body (30) for reaction to the thrust of said propulsion members, wherein each propulsion member (20) has a longitudinal axis inclined both with respect to the longitudinal axis of the other propulsion members (20) and with respect to the axis of the drive shaft (12).

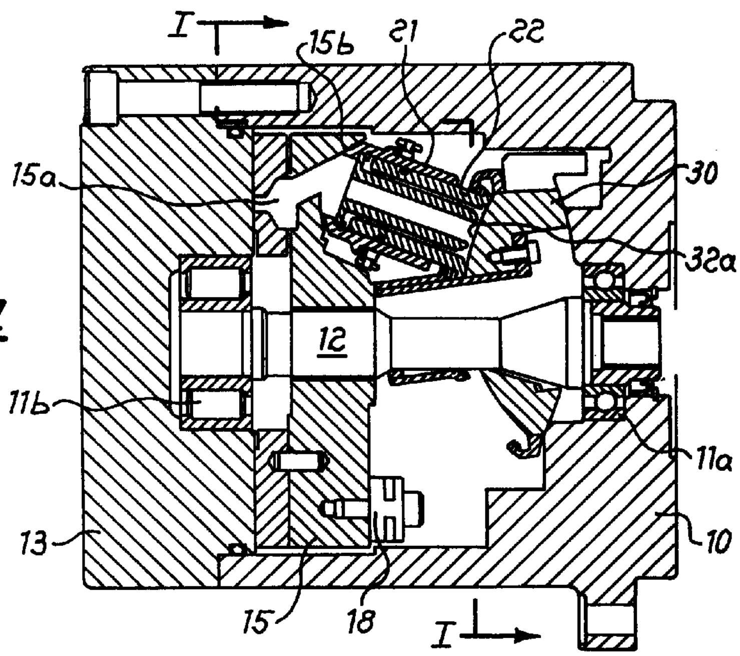

Fig.2

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Description

The present invention relates to a hydraulic motor, the propulsion members of which are arranged with their axis inclined both with respect to the longitudinal axis of the other propulsion members and with respect to the axis of the drive shaft.

In the sector relating to the construction of hydraulic motors used for various industrial applications such as, for example, earth-moving machinery and plastics injection machines, it is known of the possibility of arranging the propulsion members of said motors in a substantially radial direction (radial motors) or substantially parallel direction (axial motors) with respect to the axis of the drive shaft in order to cause rotary operation of the latter.

It is also known of motors in which the propulsion members are arranged inside a body arranged with its axis inclined with respect to the axis of the drive shaft, although the propulsion members are arranged inside said body parallel to one other.

Although functional, these motors of the known type have some limitations due mainly to the fact that they generate limited starting torques, in particular when there is a reduction in the inclination of the element which is integral with the drive shaft and which is acted on by the propulsion members in order to cause rotation of the latter, or, for the same inclination of said element, the inclination of the propulsion members with respect to the latter becomes minimal.

The technical problem which is posed, therefore, is that of providing a hydraulic motor which is able to overcome the abovementioned limitations.

In addition to the above, it is required that the motor should be able to be made indifferently with the cylinder capacity fixed or variable so as to be adaptable to the most varied applicational requirements and be able to operate with the same efficiency both as a motor and as a pump.

Within the scope of this problem a further requirement is that said propulsion members should be retained against the respective contact and reaction surfaces via associated means which also ensure a seal against the thrusting fluid and allow the dead volumes of the fluid itself during the cycle to be reduced.

These technical problems are resolved according to the present invention by a hydraulic motor comprising a drive shaft, propulsion members, an element which is coaxial with the drive shaft and integral with the latter and which is acted on by said propulsion members and an eccentric body for reaction to the thrust of said propulsion members, wherein each propulsion member has a longitudinal axis inclined both with respect to the longitudinal axis of the other propulsion members and with respect to the axis of the drive shaft.

Further details may be obtained from the following description of a non-limiting example of embodiment of the invention provided with reference to the accompanying drawings, in which:

Figure 1 shows a schematic cross-sectional view, along the plane indicated by I-I in Fig. 2, of the motor according to the invention with a fixed cylinder capacity;

Figure 2 shows a schematic cross-sectional view along the plane indicated by II-II in Fig. 1;

Figure 3 shows a partial cross-section illustrating in detail the arrangement of the propulsion members and the eccentric cam of the motor according to Fig. 1;

Figure 4 shows a cross-sectional view, similar to that of Fig. 2, of a motor according to the invention with a variable cylinder capacity in the configuration for maximum cylinder capacity;

Figure 5 shows the motor according to Fig. 4 in the configuration for minimum cylinder capacity.

As can be seen from Figures 1, 2 and 3, the motor according to the invention comprises a body 10 which supports by means of a bearing 11a one end of the drive shaft 12, the other end of which is supported by an additional bearing 11b integral with a cover 13 closing the body 10 of the motor.

The middle part of the drive shaft 12, including the body 10 and the cover 13, has keyed onto it a disc 15 which is made to rotate by the propulsion members 20 described further below and which therefore forms the element for operating the drive shaft itself.

Said disc 15 has formed in it the ducts 15a for distribution of the fluid operating the propulsion members and on its surface opposite that of the cover 13 there are formed spherical seats 15b inside each of which one of the two ends of the propulsion members 20 is received.

Said propulsion members 20 consist of a cylinder 21, one of the two end edges of which is in abutment against the associated spherical seat 15b formed in the disc 15, and a piston 22, telescopically slidable inside the cylinder 21 and having one of the two end edges in abutment against the surface 32a of a body 30 which is eccentric with respect to the drive shaft 12.

The bearing edge of said cylinder 21 and said piston 22 against the associated sliding-contact surfaces 15b and 32a, respectively, of the disc 15 and the eccentric cam 30, essentially consists (Fig. 3) of an annular edge 21a, 22a having a contact surface 21b, 22b parallel to the surface of the eccentric cam, and a tooth 21c,22c extending outwards and designed to engage with retaining means 40 described below.

The eccentric body (Fig. 3) is essentially composed of a bell-piece 30, the narrowest part of which is formed by a tube 31 designed to allow the drive shaft 12 to pass through and be arranged, with a limited part of its end edge 31a, in abutment against the disc 15.

The widest part 32 of the bell-piece is shaped with two opposite spherical convex surfaces 32a and 32b forming, respectively, the reaction surface of the piston

22 and the abutment surface of the eccentric cam 30 against the body 10, so that the said cam 30 is prevented from performing movements in a direction parallel to that of the drive shaft.

In the zone of contact between the piston 21 and the eccentric cam 30 (Fig. 3), said retaining and locking means 40 consist of a sliding piece 43 having a hole 43a with a diameter slightly greater than the external diameter of the piston 21 so as to allow the latter to pass through.

Said sliding piece 43 has an upper surface 43b designed to form an engaging seat for a bowl-shaped element 45 comprising a hollow cylindrical part 45a coaxial with the tube 31 of the eccentric cam 30 and a bowl-shaped part 45b with a turned-back edge for allowing engagement with the eccentric cam 30.

The bowl-shaped part 45b has moreover openings 45d designed to allow the propulsion member 20 to pass through. In this way, the bowl 45, once engaged with the eccentric cam 30, presses against each edge 43c of all the sliding pieces 43 arranged around each cylinder 21, sliding pieces which, in turn, keep the associated cylinder 21 in abutment against the eccentric cam 30 during rotation thereof.

In order to ensure adherence between the sliding piece 43 and the edge 21a of the cylinder 21, a resilient element is arranged between them, said resilient element in the example consisting of a wave spring 46, designed to impart a force of relative contact between the sliding-contact surfaces, which is constant and independent of the working phases of the propulsion member and compatible with the spatial position assumed by the eccentric cam 30.

In the zone of contact between the piston 22 and the disc 15, the retaining elements 40 again consist of a sliding piece 48 pushed in abutment against the shoulder 21c of the cylinder by a ring 47, which is coaxial with the cylinder 21 and associated with two pins 49, the axis of which lies on the radial axis of the cylinder and which are both fastened to the disc 15 by means of a support 18.

Said pins 49 therefore allow rotation of the cylinder 21 about its radial axis.

In this case also, a wave spring 46 is arranged between sliding piece 48 and annular edge 21a so as to ensure constant adherence of the sliding-contact surfaces during the various working phases of the propulsion member 20.

Since the ring 47 in turn allows rotation of the cylinder 21 about a radial axis, the cylinder 21 is essentially as a whole designed to rotate about a centre point arranged on its longitudinal axis, so as to follow spherical trajectories during rotation of the drive shaft; this ensures that the propulsion member 20 does not lose its adherence against the associated contact surfaces of the disc 15 and the body 30 during rotation of the latter.

As illustrated in Figs. 4 and 5, the motor according to the invention may also be realized with a variable cylinder capacity: in this case the eccentric body 30 may be made to rotate along an arc with a circumference having its centre on the centre of the spherical surface of contact between the cover-piece 30 and the body 10.

Said rotation is performed by means of a cylinder 50 which is radially integral with the casing of the motor 10 and the piston 51 of which acts on a radial surface of the eccentric body 30.

As illustrated in Fig. 4, the free end of the piston 51 consists of a flat flange 51a which prevents rotation of the eccentric cam 30 about its longitudinal axis, interfering with a corresponding lug 33 of the eccentric bell-piece 30.

By causing the piston 51 to emerge from the cylinder 50 (Fig. 5), the eccentric bell-piece 30 rotates so as to be arranged with its longitudinal axis at an angle, with respect to the motor axis, which is smaller than the preceding one; in this way each propulsor 20 performs (Fig. 5) a smaller compression and expansion stroke than the preceding one (Fig. 2), causing an actual reduction in the cylinder capacity of the motor.

Said displacement of the eccentric cover-piece 30 which causes the variation in eccentricity with respect to the drive shaft is not linear, but is performed along an arc, the centre of which is the centre of the surface 32b, making it possible to obtain significant variations in the cylinder capacity with very small dimensions and with minimum sliding of the spherical surface 32a of the eccentric cam 30 with respect to the contact surface of the pistons 22.

It is therefore obvious how, in the motor according to the invention, the propulsors are located at an angle both with respect to the axis of rotation of the drive shaft and with respect to one another and, during each cycle, follow a trajectory of the conoidal type, the vertex of which is the centre of the spherical cover-piece 30 forming the eccentric cam of the motor and the base of which is defined by the circular trajectory of the spherical seats 16a of the disc 16.

In addition to this it pointed out how the systems for constraining the propulsor members 20 respectively to the seats 15a of the disc 15 and to the surface 32a of the eccentric bell-piece 30 are such as to constrain respectively the cylinder 21 and the piston 22 at a fixed distance from its centre of rotation, allowing the cylinder to assume the most varied positions relative to the spherical surface and allowing the piston to assume the most varied spatial positions.

In addition it is obvious how the solution described, which provides systems for engagement with the spherical surfaces 32a and 15b, allows the cylinders 20 to perform fluid suction functions without the loss of adherence to the associated sliding-contact surfaces, thus making it possible for the motor to operate as a pump by simply providing movement to the drive shaft.

Claims

1. Hydraulic motor comprising a drive shaft (12), propulsion members (20), an element (15) which is coaxial with the drive shaft and integral with the latter and which is acted on by said propulsion members and an eccentric body (30) for reaction to the thrust of said propulsion members, characterized in that each propulsion member (20) has a longitudinal axis inclined both with respect to the longitudinal axis of the other propulsion members (20) and with respect to the axis of the drive shaft (12).

2. Motor according to Claim 1, characterized in that the longitudinal axes of the propulsion members form an acute relative angle with respect to the axis of the drive shaft.

3. Motor according to Claim 1, characterized in that said eccentric body consists of a bell-piece (30), the narrowest part of which forms a hollow tube (31) and the widest part (32) of which has two opposite convex surfaces (32a, 32b) forming respectively the reaction surface of the piston (22) and the abutment surface of the eccentric cam (30) against a corresponding internal surface of the body (10).

4. Motor according to Claim 4, characterized in that said convex surfaces (32a, 32b) are spherical surfaces.

5. Motor according to Claim 4, characterized in that said convex surface (32a) is spherical and said convex surface (32b) is cylindrical.

6. Motor according to Claim 1, characterized in that it has a variable cylinder capacity.

7. Motor according to Claims 1 and 6, characterized in that it has means (50) for causing rotation of the eccentric cover-piece (30) about the centre of the spherical surface of contact between cover-piece (30) itself and body (10), said rotation being designed to cause a variation in the cylinder capacity of the motor.

8. Motor according to Claim 7, characterized in that said means (50) for causing rotation of the eccentric cam (30) consist of a cylinder (50), the piston (51) of which acts in a substantially radial direction with respect to the drive shaft (12) on a side surface of the eccentric cam itself.

9. Motor according to Claim 1, characterized in that the free end of said piston (51) has a flat flange designed to co-operate with a corresponding extension (33) of the eccentric cam (30) so as to prevent rotation thereof about its longitudinal axis.

10. Motor according to Claim 1, characterized in that said propulsion members (20) comprise a cylinder (21) and a piston (22) which are telescopically coupled and free to perform self-alignment on the lines joining the centres of the thrusting and reaction surfaces.

11. Motor according to Claim 1, characterized in that one end of the cylinder (21) is kept in abutment against a corresponding seat of the acting element (15) integral with the drive shaft (12).

12. Motor according to Claim 1 and 11, characterized in that said cylinder (21) is kept at a constant distance from its centre of rotation.

13. Motor according to Claim 1, characterized in that said piston (22) is kept at a constant distance from its centre of rotation.

14. Motor according to Claim 1, characterized in that the trajectory of the movement of the propulsion members (20) lies inside a cone having its vertex in the centre of the eccentric cover-piece (30) and base in the circle described by the centres of the spherical surfaces of the cylinders (21b).

15. Motor according to Claim 1, characterized in that it may be operated as a pump.

Fig.1

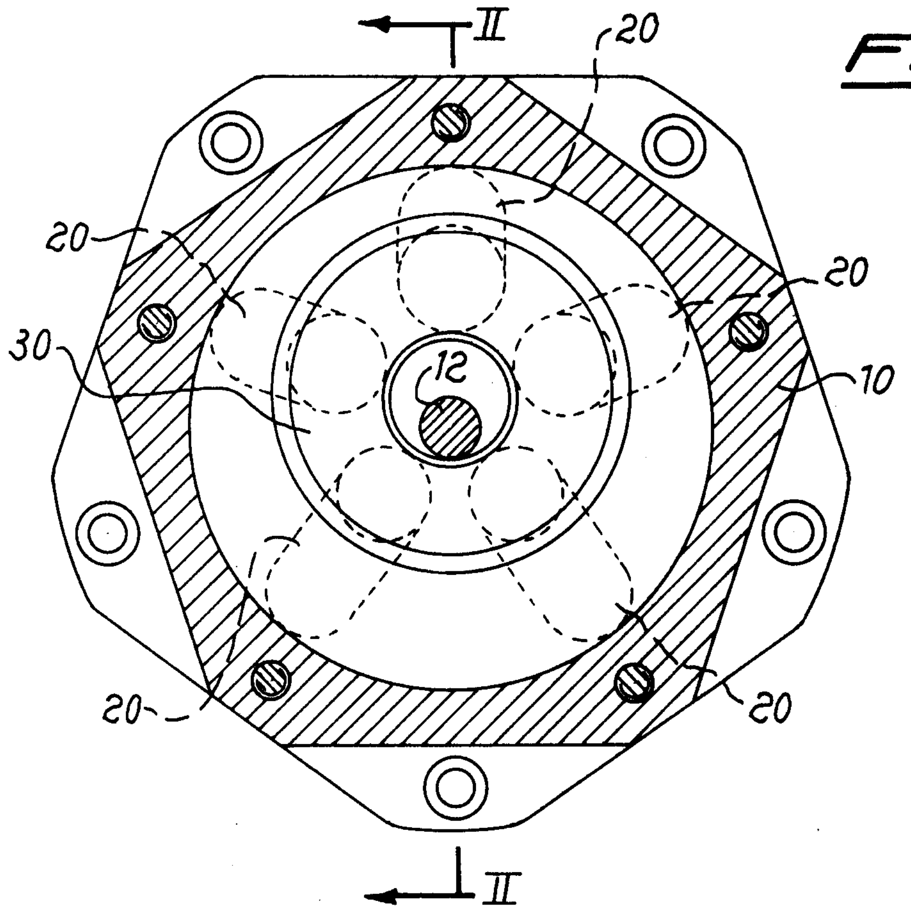

II
20
20
20
30
12
10
20
20
II

Fig.2

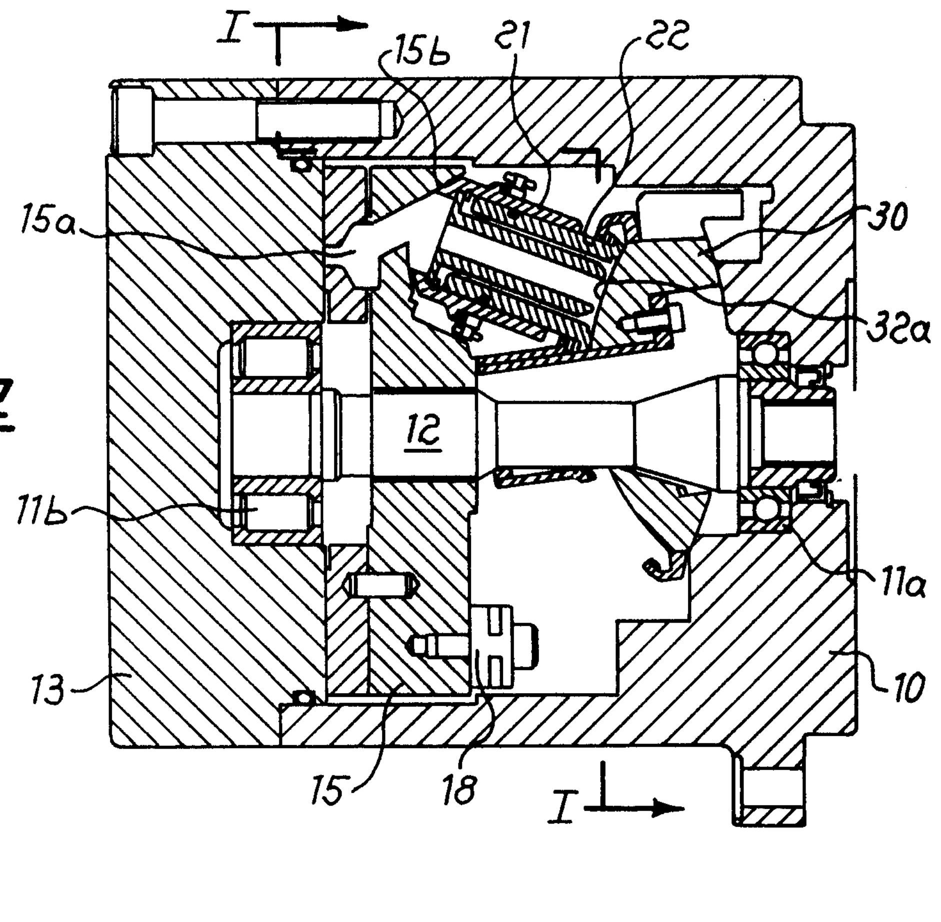
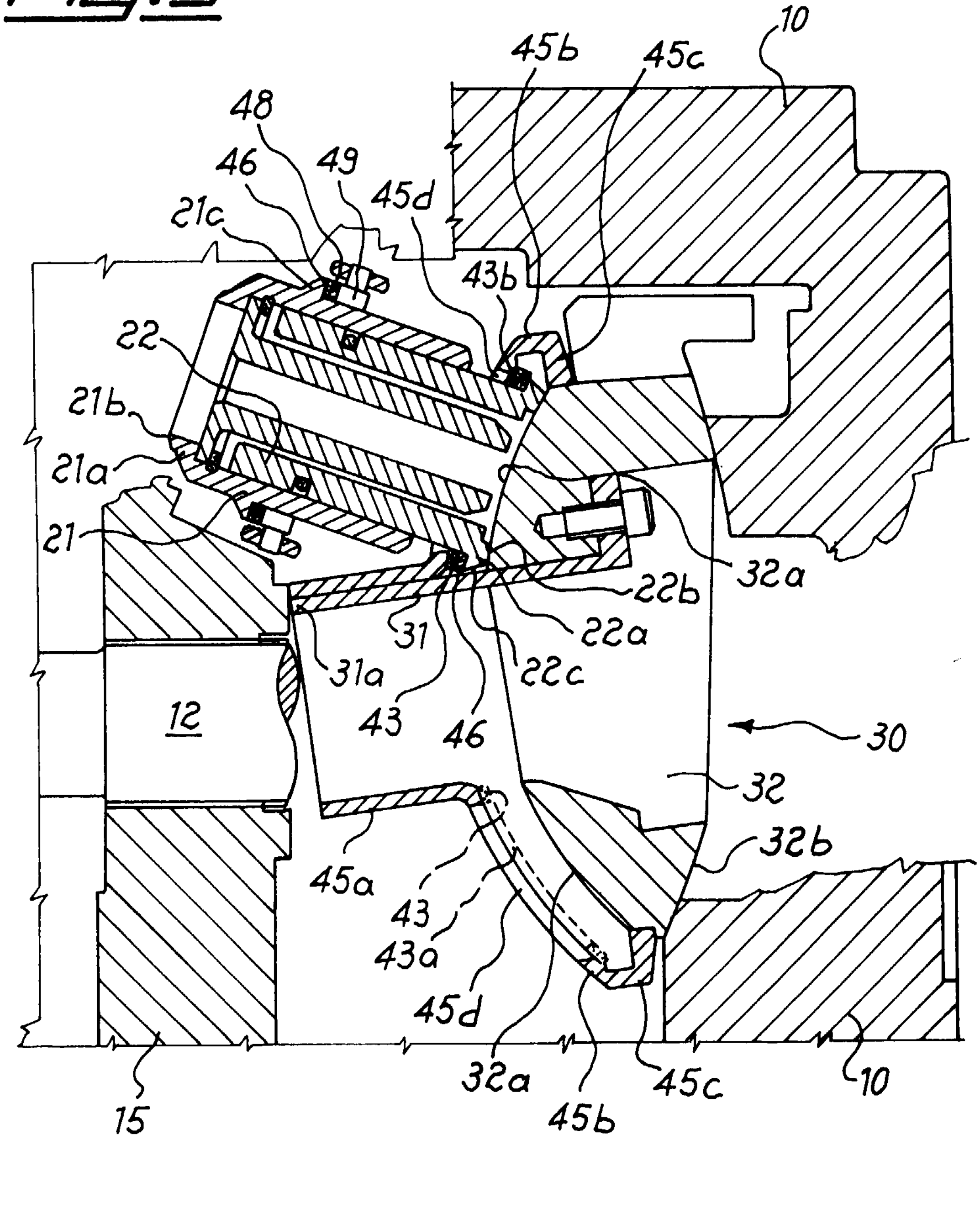

I
15b
21
22
15a
30
32a
12
11b
11a
13
10
15
18
I

Fig. 3


10
45b
45c
48
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49
45d
21c
43b
22
21b
21a
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32a
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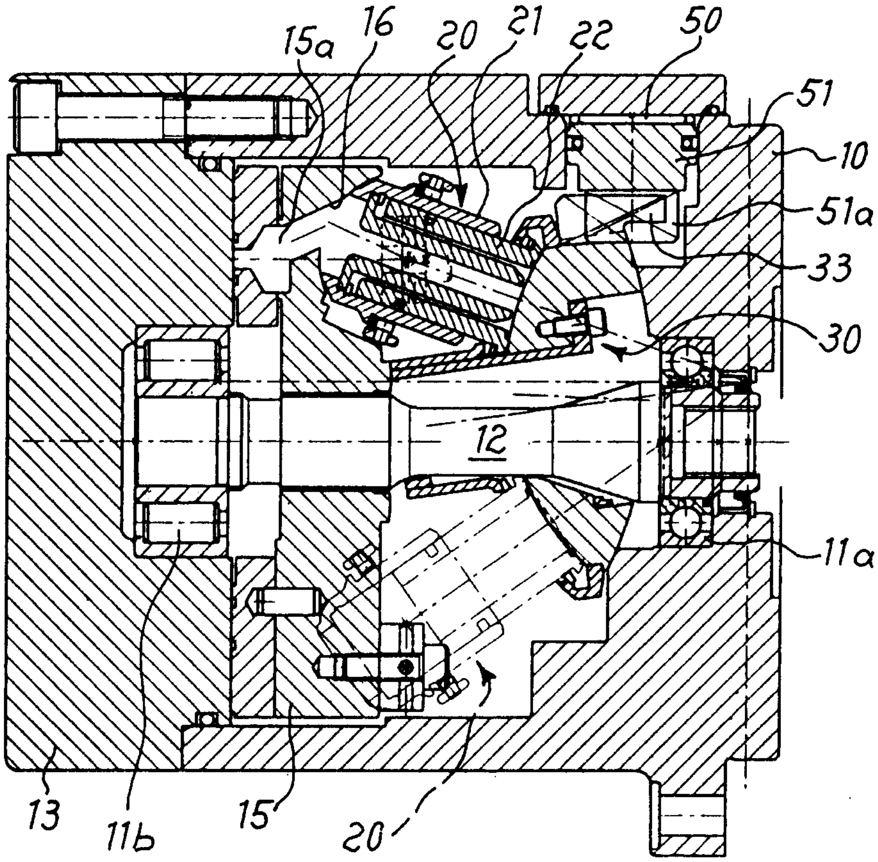
45b


15a
16
20
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51a
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11a
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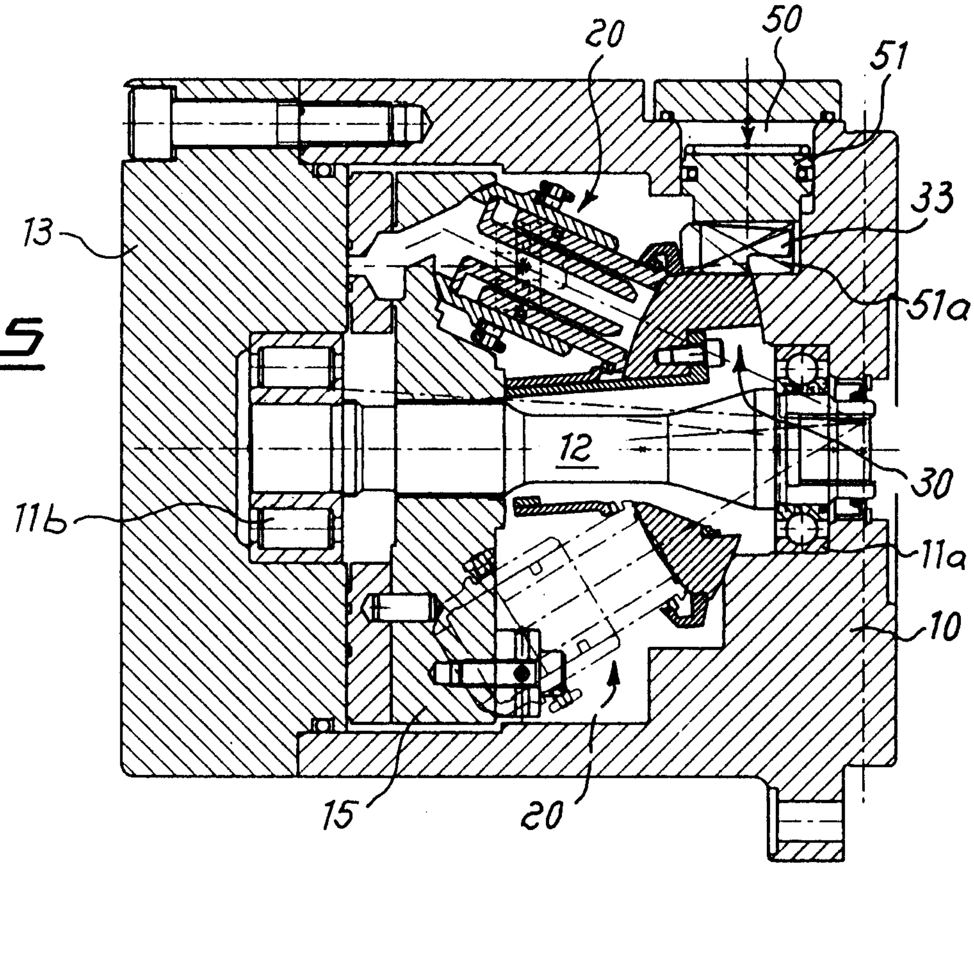
11b
15
20

Fig.4

Fig.5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EUROPEAN SEARCH REPORT

Application Number
EP 98 20 0246

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.6)
A	FR 1 548 517 A (BINHACK) 6 December 1968 * figures 1,5 * * page 2, paragraph 9 - paragraph 12 * * abstract * ---	1,2,4	F03C1/04 F03C1/06
A	US 3 885 459 A (FREESE) 27 May 1975 * figures 1,3 * * column 5, line 24 - line 33 * * abstract * -----	1-4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F03C F01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 June 1998	Wassenaar, G

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