(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 705 380 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
26.04.2000 Bulletin 2000/17

(21) Application number: **93917765.5**

(22) Date of filing: **06.08.1993**

(51) Int. Cl.[7]: **F01B 3/02**, F01B 3/00, F02B 75/26

(86) International application number:
PCT/EP93/02106

(87) International publication number:
WO 94/03708 (17.02.1994 Gazette 1994/05)

(54) **AXIAL PISTON MACHINE, IN PARTICULAR AN AXIAL PISTON PUMP OR AN AXIAL PISTON MOTOR**

AXIALKOLBENMASCHINE, INSBESONDERE FÜR EINE AXIALKOLBENPUMPE ODER EINEN AXIALKOLBENMOTOR

MACHINE A PISTONS AXIAUX, NOTAMMENT POMPE OU MOTEUR A PISTONS AXIAUX

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **06.08.1992 CH 256692**

(43) Date of publication of application:
10.04.1996 Bulletin 1996/15

(73) Proprietor:
Hydrowatt Systems Limited
London WC1B 3RJ (GB)

(72) Inventor: **FREY, Bernhard**
CH-8200 Schaffhausen (CH)

(74) Representative:
Fiedler, Otto Karl, Dipl.-Ing.
Patentanwalt
Freistrasse 2
8200 Schaffhausen (CH)

(56) References cited:

FR-A- 2 027 236	**FR-A- 2 044 182**
FR-A- 2 588 617	**US-A- 1 910 054**
US-A- 2 424 660	**US-A- 2 737 895**
US-A- 2 868 443	**US-A- 3 486 335**
US-A- 3 514 223	**US-A- 4 041 703**
US-A- 4 281 971	**US-A- 4 858 480**

EP 0 705 380 B1

Description

[0001] The invention concerns a hydraulic axial pump according to the preamble of the claim 1. Such pumps are known in the art from the US-A-4 041 703 and the US-A-3 486 335, which disclose hydraulic closed loop pump/motor transmission systems with operating liquids having lubricating properties like oil. So-called "charge pumps" provided there only for the function of leakage-replenishing the hydraulic system.

[0002] In contrast thereto, it is an objective of the present invention to create a pump suitable for operation with non-lubricant and corrosive liquids and, therefore, having sufficient inherent lubrication means for the cylinder-piston units, and this with a comparatively simple and rugged construction. The solution to this problem according to the present invention is defined by the combined features of the claim 1. This allows for an effective and sufficiently vibration-free as well as equally distributed lubrication of the cylinder-piston units, which are provided usually in a plurality around the central axis of the axial pump.

[0003] The invention will be explained now further with reference to the example of a swash-plate axial piston pump illustrated in the enclosed drawings by an axial section. The Figures 1 and 2 are showing two coaxially coherent parts of the pump. The common radial plane of both parts has been marked by 0-0.

[0004] As illustrated first of all in the Fig.2, there is a first subassembly 1 comprised of a plurality of, for example five, cylinder-piston units 2, which units are arranged at a radial distance from and parallel to a central longitudinal axis 3 as well as being circumferentially offset, relative to each other around the central axis by an appropriate angle, for example 72°. Each cylinder-piston unit is comprised of a piston 4 slidably arranged in a cylinder 5 with piston 4 and cylinder 5 being shown in axial sections only over a part of their axial length. Specific design details of cylinder 5 and piston 4 are only of minimal interest in the present context, since cylinder-piston units 2 may be of any type well known in the art.

[0005] A pretensioned return coil or compression spring 6 surrounds cylinder 5 and acts through a sleeve 7 against a radially projecting bottom flange 8 of piston 4, thus tending to push piston 4 in its restoring or cylinder-filling direction (in the Figures from the left to the right). The inner (in Fig. 2 the left) end of spring 6 abuts on the right end face of a support sleeve 9 fixedly retained in an axial bore of a machine housing 10. Support sleeve 9, on its right side, is fixedly secured to the left end portion of cylinder 5.

[0006] It should also be understood that, instead of an arrangement of cylinders 5 in parallel to axis 3, a design may be adopted with the cylinder axes being arranged at an acute angle, e.g. between 5° and 10°, relative to axis 3. This may be advantageous in view of the space available between the cylinders for auxiliary elements or units.

[0007] The left end face of housing 10 is tightly connected, e.g. by means of highly pretensioned axial screws 11, with a head-subassembly 12, which among other parts houses a valve assembly 13 and a filler or feed pump 14 attached to a section 15 of a drive shaft 16 (Fig.1). Drive shaft section 15 is coupled, by means of a toothed-clutch 17, to a central drive shaft section 18. Filler pump 14 serves to enhance the input hydraulic pressure for the cylinder-piston units 2 to a value sufficient for avoiding cavitation. Drive shaft section 18 also drives a lubricant pump 19, which in turn feeds a lubricant channel system 20 via a lubricant filter 21.

[0008] Coaxially attached to each cylinder-piston unit 2 is a combined inlet-outlet valve 22 having an inlet side 23 connected, via an inlet channel system 24, to the output 25 of filler pump 14. Pump 14 e.g. is of the well-known "side-channel" type and will not be described in detail here since it is not material for the essence or function of the invention. Filler pump 14 is connected, via an input 26, to a non-illustrated external low-pressure hydraulic feed system. Inlet/outlet valve 22 further has an output side 27, connected through an output channel system 28, to a non-illustrated external high-pressure hydraulic system. Valve 22 has substantially coaxial internal flow channel systems and spring-loaded check valve members for both flow directions, i.e. to and from the corresponding cylinder-piston unit 2. The internal structure of valve 22 is of no specific interest for the invention and thus will not be described in further detail. In principle, instead of the noted example of the combined inlet/outlet valve 22 described here, other conventional and well-known valve types may be used.

[0009] In Fig. 1, a second subassembly 29 is rotatably arranged relative to first subassembly 1. Subassembly 29 is in force-transmitting connection with cylinder-piston units 2 within the range of a coupling plane 30, arranged at least approximately right-angled or perpendicular to the central longitudinal axis 3, so as to absorb the oscillating drive forces produced by cylinder-piston units 2. Subassembly 29 is constructed as a driving subassembly that is rotatably arranged in housing 10 and coupled with a main section 31 of drive shaft 16. Drive shaft sections 18 and 31 are coupled by means of any type of a conventional clutch.

[0010] It should also be mentioned that different design modes or types of subassembly 29 may be utilized. Thus, cylinder-piston subassembly 2 may be designed as a rotating drum, i.e. in the sense of previously-noted machine types II. and III. In the latter case, this subassembly would be a substantially torqueless rotating unit.

[0011] Driving subassembly 29 includes a bearing assembly comprising two first bearings 33, 34, which act at least substantially in the radial direction and are arranged at a predetermined axial distance or spacing from each other, and a swivel-joint or pivot-type second bearing 35 acting both axially and radially. In the noted example, bearings 33 and 34 may take the form of axi-

ally movably cylindrical roller bearings, while bearing 35 may be a mainly axially acting spherical roller bearing.

[0012] The swivel or pivot center 36 of second bearing 35 is located at about the axial mid-point (center-to-center distance) 37 between the mid-points 38, of the bearing axial width 39, of axially spaced first bearings 33, 34.

[0013] Subassemblies 1 and 29 are arranged so as to be rotatable, in relation to each other, around their common central axis 3. Only one of these subassemblies, here subassembly 29, is arranged to be rotatable in housing 10 and functions as a driving subassembly, coupled with the drive shaft 16. However, as already noted earlier, a design according to machine type III. may also be utilized.

[0014] In addition, a disk-like coupling member 40 is rotatably connected to second subassembly 29 around a swash axis 41, which is arranged at an angle relative to the central axis 3. Coupling member 40 is further connected to first subassembly 1 in a manner so as to be blocked against continuous rotation around central axis 3, and is connected in a force-transmitting manner with the cylinder-piston units 2 within the range of coupling plane 30. Coupling plane 30 is arranged at least approximately right-angled or perpendicularly to swash axis 41. Thus, coupling member 40 takes over or absorbs the substantially axial, oscillating drive forces produced by cylinder-piston units 2 and transmits such forces to second subassembly 29. It should be understood that coupling member 40 can also be regarded as a part of second subassembly 29.

[0015] The noted rotation-blocking connection between coupling member 40 and first subassembly 1 is accomplished by means of a positively-acting holding device 42. In the illustrated embodiment, holding device 42 is a cardan type of device comprising a cardan ring 43, which extends along the external perimeter of coupling member 40 and which is connected with each of coupling members 40 and subassembly 1 by means of a pair of diametrical pivots 44. In view of first subassembly 1 being fixedly arranged in machine housing 10, cardan ring 43 is fixed to housing 10 by means of a further pair of non-illustrated diametrical pivots. In the illustrated embodiment, double-jointed rods 45, preferably double ball-jointed rods, are provided for the force transmission between cylinder-piston units 2 and coupling member 40. Each of double-jointed rods 45 is connected by means of a first joint 46 to a corresponding piston 2 and by means of a second joint 47 to a corresponding junction assembly 48 of coupling member 40.

[0016] As already previously noted, in the illustrated embodiment, drive shaft 16 is comprised of three rotationally coupled sections 31, 18 and 15. Drive shaft 16 extends coaxially with central axis 3 from its drive input end 49 through a corresponding central opening of first subassembly 1 and of housing 10 to head-subassembly 12 with feed pump 14 and valve assembly 13.

[0017] Obviously, the mode of design according to the invention, as specifically depicted in the illustrated embodiment, can also be utilized for axial piston motors. Of course, the valve assembly then must be positively coupled to and synchronized with the rotation of the drive shaft, which then functions as a power output shaft. The filler pump can be omitted or replaced by other useful auxiliary units.

[0018] While there are shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto, but may be otherwise variously embodied and practiced within the scope of the following claims and the reasonably equivalent structures thereto.

[0019] In particular it is to be understood that the angle between the swash axis and the central axis may be predetermined so as to be of a fixed acute angle value or so as to be variably adjustable in operation between 0° and a maximum acute angle value, and this with angle variation to both sides of the zero angle value if desired for purposes of hydraulic flow direction reversal. Such variation obviously entails a corresponding variation of the angle between the coupling plane and the central axis, which is the complementary angle to the one between the swash axis and the central axis and determinative for the magnitude of the piston stroke. This type of of swash plate axial piston machines with variable swash-angle is well known in the art per se. Thus the realization of the subject of the present invention for such variable-swash-angle machines can be established by usual structures near at hand and needs no further explanation.

Claims

1. A hydraulic axial pump, in particular a high pressure pump, comprising:

a) a first subassembly (1) including a plurality of cylinder-piston units (2), said cylinder-piston units being arranged at a distance from, and in parallel or at an acute angle to a central axis (3) as well as being circumferentially offset, relative to each other, around said central axis by a predetermined angle;

b) a second subassembly (29) being coaxially with and arranged rotationally around said central axis on a drive shaft (16), said second subassembly further having a force-transmitting connection with said cylinder-piston units so as to receive oscillating drive forces of said cylinder-piston units;

c) said drive shaft extending coaxially to said central axis from a drive input end (49) through a corresponding central opening of said first subassembly to a head-subassembly (12);

characterized by:

d) said first subassembly including a lubricant pump (19) being positioned in a vicinity of said

central axis (3) and within a radial space between said cylinder-piston units (2) so as to extend over an axial length which is covered by an axial length of said cylinder-piston units;

e) said lubricant pump (19) being connected to at least one substantially radially extending lubricant channel;

f) said drive shaft including at least two rotationally coupled longitudinal sections, and said lubricant pump being arranged on one (18) of said sections and in a rotational drive connection therewith.

2. A hydraulic axial pump according to claim 1, including a head-subassembly (12) with a filler pump (14) coupled with said drive shaft, a flow path of said filler pump being connected in series with a main flow path of the hydraulic axial discharge pump to deliver substantially an entire admission flow at an enhanced input pressure to said cylinder-piston units sufficient for avoiding cavitation.

3. A hydraulic axial pump according to claim 2, wherein said head-subassembly further includes a valve assembly (13) coupled in the main flow path of the hydraulic axial pump and wherein said filler pump (14) is situated axially in front of said valve assembly with at least one output port (25) of said filler pump adjacent to said input valve assembly (13).

4. A hydraulic axial pump according to claim 3, wherein said filler pump (14) is of the side channel type and arranged with a side channel and at least one output port (25) adjacent to said input valve assembly.

5. A hydraulic axial pump according to anyone of claims 2 to 4, wherein said lubricant pump (19) and said filler pump (14) are arranged on separate ones (15, 18) of said longitudinal drive shaft sections, these drive shaft sections being coaxially arranged and coupled in drive connection with each other.

Patentansprüche

1. Axialpumpe, insbesondere Hochdruckpumpe, umfassend:

a) eine erste Baugruppe (1) mit einer Mehrzahl von Zylinder-Kolbeneinheiten (2), die mit Abstand von und parallel oder unter einem spitzen Winkel zu einer Zentralachse (3) sowie gegeneinander um diese Zentralachse unter einem vorgegebenen Winkel in Umfangsrichtung versetzt angeordnet sind;

b) eine koaxial mit der Zentralachse und um diese drehbar auf einer Antriebswelle (16) angeordnete zweite Baugruppe (29), die derart in kraftübertragender Verbindung mit den Zylinder-Kolbeneinheiten steht, dass sie deren oszillierende Antriebskräfte aufnimmt;

c) wobei sich die Antriebswelle koaxial mit der Zentralachse von einem Antriebs-Eingangsende (49) durch eine entsprechende Zentralöffnung der ersten Baugruppe zu einer Koptbaugruppe (12) erstreckt;

gekennzeichnet dadurch,

d) dass die erste Baugruppe eine Schmierpumpe (19) aufweist, die angrenzend an die Zentralachse (3) und in einem radialen Raum zwisehen den Zylinder-Kolbeneinheiten (2) derart angeordnet ist, dass sie sich über eine von einer Axiallänge der Zylinder-Kolbeneinheiten bedeckte Axiallänge erstreckt;

e) dass die Schmierpumpe (19) mit wenigstend einem sich im wesentlichen radial erstreckenden Schmierkanal verbunden ist;

f) dass die Antriebswelle wenigstens zwei drehgekuppelte Längsabschnitte aufweist und dass die Schmierpumpe auf einem (18) dieser Absehnitte und in Dreh-Antriebsverbindung mit diesem angeordnet ist.

2. Hydraulische Axialpumpe gemäss Anspruch 1, umfassend eine Kopfbaugruppe (12) mit einer mit der Antriebswelle gekuppelten Vorfüllpumpe (14), wobei ein Strömungspfad dieser Vorfüllpumpe in Reihe mit einem Hauptströmungspfad der hydraulischen Axial-Förderpumpe angeordnet ist, um den Zylinder-Kolbeneinheiten im wesentlichen einen vollständigen Zufluss unter einem erhöhten, zur Vermeidung von Kavitation ausreichenden Eingangsdruck zu liefern.

3. Hydraulische Axialpumpe gemäss Anspruch 2, worin die Kopfbaugruppe des weiteren eine in den Hauptströmungspfad. der hydraulischen Axialpumpe eingeschaltete Ventilanordnung (13) aufweist und worin sich die Vorfüllpumpe (14) axial vor dieser Ventilanordnung befindet, wobei sich wenigstens ein Auslass (25) der Vorfüllpumpe zunächst der Einlassventilanordnung (13) befindet.

4. Hydraulische Axialpumpe gemäss Anspruch 3, worin die Vorfüllpumpe (14) vom Seitenkanal-Typ ist und sich mit einem Seitenkanal sowie mindestens einem Auslass (25) zunächst der Einlassvenmtilanordnung befindet.

5. Hydraulische Axialpumpe gemäss einem der Ansprüche 2 bis 4, worin die Schmierpumpe (19) und die Vorfüllpumpe (14) auf gesonderten Längsabschnitten (15, 18) der Antriebswelle angeordnet sind, wobei diese Antriebswellenabschnitte koaxial angeordnet und miteinander in Antriebsverbindung

gekuppelt sind.

Revendications

1. Pompe hydraulique axiale, en particulier pompe à pression élevée, comprenant :

   a) un premier sous-ensemble (1) incluant une pluralité d'unités à piston et à cylindre (2), lesdites unités à piston et à cylindre étant disposées à une distance de, et parallèlement ou selon un angle aigu à un axe central (3) et sont décalées circonférentiellement, les unes par rapport aux autres, autour dudit axe central selon un angle prédéterminé;
   b) un second sous-ensemble (29) coaxialement avec et disposé d'une manière rotative autour dudit axe central sur un arbre d'entraînement (16), ledit second sous-ensemble ayant en outre une connexion de transmission des forces avec lesdites unités à piston et à cylindre de manière à recevoir des forces d'entraînement oscillantes desdites unités à piston et à cylindre;
   c) ledit arbre d'entraînement s'étendant coaxialement audit axe central depuis une extrémité d'entraînement d'entrée (49) à travers une ouverture centrale correspondante dudit premier sous-ensemble à un sous-ensemble principal (12);
   caractérisée par:
   d) ledit premier sous-ensemble incluant une pompe de lubrifiant (19) positionnée au voisinage dudit axe central (3) et dans un espace radial entre lesdites unités à piston et à cylindre (2) de manière à s'étendre sur une longueur axiale qui est couverte par une longueur axiale desdites unités à piston et à cylindre;
   e) ladite pompe de lubrifiant (19) étant connectée à au moins un canal de lubrifiant s'étendant sensiblement radialement;
   f) ledit arbre d'entraînement incluant au moins deux sections longitudinales accouplées en rotation, et ladite pompe de lubrifiant étant agencée sur l'une (18) desdites sections et en une connexion d'entraînement en rotation avec celle-ci.

2. Pompe hydraulique axiale selon la revendication 1, incluant un sous-ensemble principal (12) avec une pompe de remplissage (14) accouplée audit arbre d'entraînement, un trajet d'écoulement de ladite pompe de remplissage étant connecté en série avec un trajet d'écoulement principal de la pompe d'évacuation hydraulique axiale pour transmettre sensiblement un écoulement d'admission entier à une pression d'entrée augmentée auxdites unités à piston et à cylindre suffisant pour éviter une cavitation.

3. Pompe hydraulique axiale selon la revendication 2, où ledit sous-ensemble principal comporte en outre un ensemble de vanne (13) accouplé dans le trajet d'écoulement principal de la pompe axiale hydraulique, et où ladite pompe de remplissage (14) est située axialement devant ledit ensemble de vanne, au moins un orifice de sortie (25) de ladite pompe de remplissage étant adjacent audit ensemble de vanne d'entrée (13).

4. Pompe hydraulique axiale selon la revendication 3, où ladite pompe de remplissage (14) est du type à canal latéral et agencé avec un canal latéral et au moins un orifice de sortie (25) adjacent audit ensemble de vanne d'entrée.

5. Pompe hydraulique axiale selon l'une des revendications 2 à 4, où ladite pompe de lubrifiant (19) et ladite pompe de remplissage (14) sont agencées sur des sections séparées (15, 18) desdites sections d'arbre d'entraînement longitudinal, ces sections d'arbre d'entraînement étant agencées coaxialement et accouplées en connextion d'entraînement les unes avec les autres.

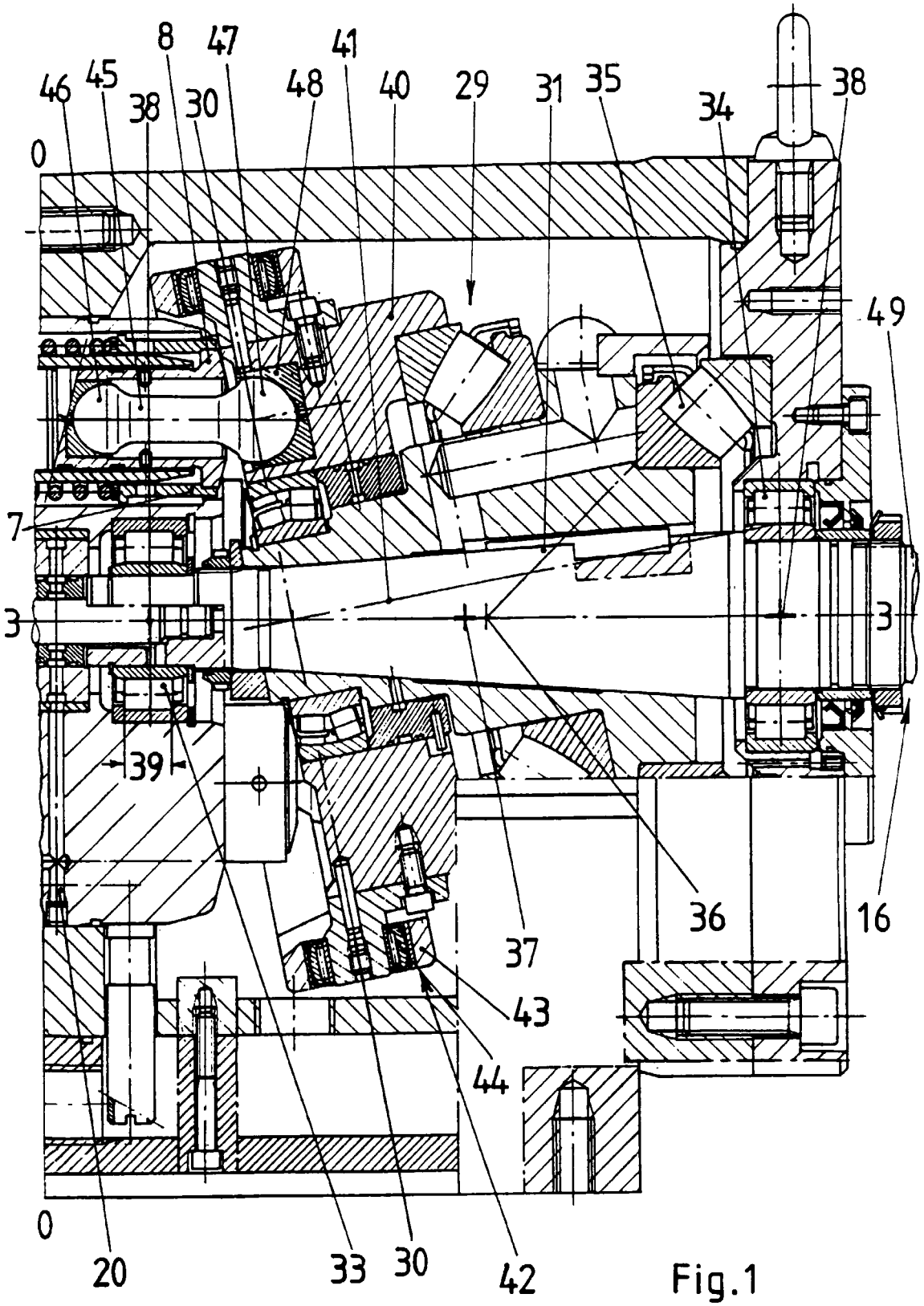
8
47
41
46
45
38
30
48
40
29
31
35
34
38
0
49
7
3
3
39
36
16
37
43
44
0
20
33
30
42

Fig.1

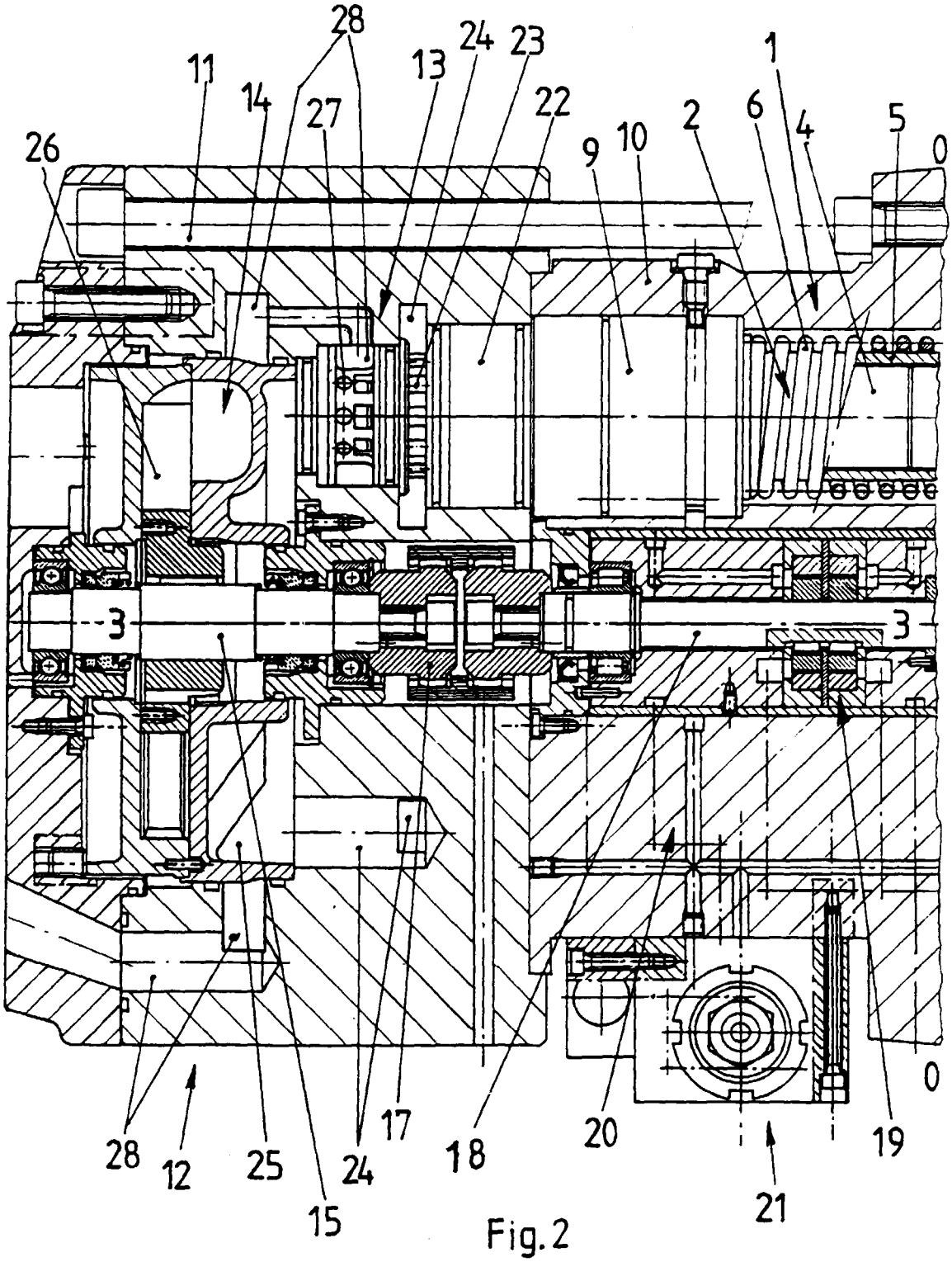
28
24
23
11
13
1
14
27
22
6
2
4
5
26
9
10
0
3
3
0
28
12
25
24
17
18
20
19
15
21

Fig. 2