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

(11) EP 0 947 696 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.10.1999 Bulletin 1999/40

(51) Int. Cl.[6]: **F04B 27/18**, F04B 27/08

(21) Application number: **99106701.8**

(22) Date of filing: **01.04.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **03.04.1998 JP 9156498**

(71) Applicant: **Sanden Corporation**
Isesaki-shi, Gunma 372-8502 (JP)

(72) Inventors:
- **Hasegawa, Yutaka,**
  c/o Sanden Corporation
  Isesaki-shi, Gunma 372-8502 (JP)
- **Shimizu, Shigemi,**
  c/o Sanden Corporation
  Isesaki-shi, Gunma 372-8502 (JP)

(74) Representative:
Prüfer, Lutz H., Dipl.-Phys. et al
PRÜFER & PARTNER GbR,
Patentanwälte,
Harthauser Strasse 25d
81545 München (DE)

(54) Swash plate compressor in which pressure in a crank chamber can be readily and rapidly adjusted

(57) In a swash plate compressor in which a compressor casing or a cylinder block (11) defines a crank chamber (16) and rotatably supports a drive shaft (17), pressure in the crank chamber being controlled by passage of refrigerant gas through a clearance portion left between the drive shaft and the cylinder block and through a path portion communicating the crank chamber with the clearance portion, the path portion consists of at least one groove 42 that is formed on the crank chamber-facing surface of the cylinder block to which a thrust bearing 36 contacts, the groove 42 having function of widening the communication.

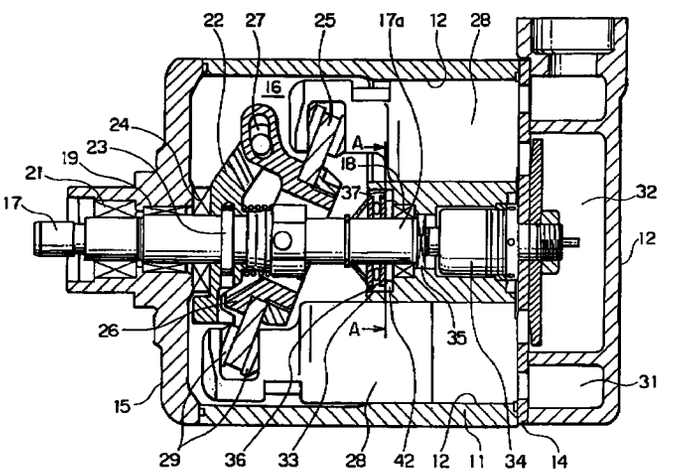

FIG. 1

EP 0 947 696 A1

Description

Background of the Invention:

[0001] The present invention relates to a swash plate compressor which is used in, for example, an air conditioner for a vehicle, an automobile, or general use.

[0002] A conventional swash plate compressor comprises a compressor casing defining a crank chamber and including a cylinder block defining a cylinder bore. A drive shaft is rotatably supported by the compressor casing via bearings and driven by, for example, an engine of the automobile. The drive shaft has an end portion rotatably supported by the cylinder block. A swash plate is mounted on the drive shaft in the crank chamber and has rotation caused by the drive shaft. In accordance with the rotation of the swash plate, a piston is reciprocated in the cylinder bore to cause compression of a gaseous fluid such as a refrigerant gas.

[0003] In the manner which will presently be described, such a swash plate compressor may be divided into a variable displacement type and a fixed displacement type.

[0004] In the variable displacement type, the swash plate has an angle controlled under pressure in the crank chamber. In accordance with the angle of the swash plate, displacement of the swash plate compressor is determined. Therefore, it is necessary to control pressure in the crank chamber.

[0005] For controlling the pressure in the crank chamber, the conventional swash plate compressor of the variable displacement type further comprises a pressure control arrangement which comprises a clearance portion left between the end portion of the drive shaft and the cylinder block and a path portion communicating the crank chamber with the clearance portion.

[0006] However, the pressure control arrangement is insufficient for rapidly controlling the pressure in the crank chamber. This is because it is difficult to widely make the path portion in the manner known in the art. For example, the path portion may be prevented by a mechanism which is for supporting the drive shaft. This results in deterioration of responsibility at a time when the displacement of the swash plate compressor is changed.

[0007] Also in the fixed displacement type, it is necessary to control the pressure in the crank chamber. This is because a blow-by gas increases the pressure in the crank chamber in the manner known in the art

Summary of the Invention:

[0008] It is therefore an object of the present invention to provide a swash plate compressor in which pressure in a crank chamber can be readily and rapidly adjusted.

[0009] It is another object of the present invention to provide a swash plate compressor of a variable displacement type, In which responsibility is improved as regards a change of the displacement thereof.

[0010] It is still another object of the present invention to provide a swash plate compressor of a fixed displacement type, in which improvement is made about the life of a bearing supporting a drive shaft.

[0011] Other objects of the present invention will become clear as the description proceeds.

[0012] According to an aspect of the present invention, there is provided a swash plate compressor which comprises a compressor casing defining a crank chamber and including a cylinder block defining a cylinder bore, a drive shaft having an end portion rotatably supported by the cylinder block, a swash plate placed in the crank chamber and having rotation caused by the drive shaft, a piston inserted in the cylinder bore and reciprocated in accordance with the rotation of the swash plate, and pressure control means for controlling pressure in the crank chamber. The pressure control means comprises a clearance portion left between the end portion of the drive shaft and the cylinder block and a path portion communicating the crank chamber with the clearance portion. In the swash plate compressor, the pressure control means further comprises at least one groove portion made to the cylinder block to widen the path portion.

Brief Description of the Drawing:

[0013]

Fig. 1 is a longitudinal sectional view of a swash plate compressor according to a first embodiment of the present invention;

Fig. 2 is a partial enlarged sectional view taken along the line A-A in Fig. 1;

Fig. 3 is a sectional view taken along the line B-B in Fig. 2; and

Fig. 4 is a longitudinal sectional view of a swash plate compressor according to a second embodiment of the present invention.

Description of the Preferred Embodiments:

[0014] With reference to Fig. 1, description will be made as regards a swash plate compressor according to a first embodiment of the present invention. The swash plate compressor is of a variable displacement type and comprises a cylinder block 11 having a plurality of cylinder bores 12 each extending in a predetermined direction, a cylinder head 13 fixed to an end of the cylinder block 11 in the predetermined direction through a valve plate 14, and a front housing 15 fixed to the other end of the cylinder block 11 in the predetermined direction. A combination of the cylinder block 11 and the front housing 15 is referred to as a compressor casing and defines a crank chamber 16.

[0015] A drive shaft 17 is rotatably supported by the cylinder block 11 and the front housing 15 via a rear

radial bearing 18 and two front radial bearings 19 and 21. The drive shaft 17 is driven by, for example, an engine of an automobile. It is to be noted that the drive shaft 17 has a rear end portion 17a rotatably supported by the cylinder block 11 via the rear radial bearing 18.

[0016] A rotor 22 is fixed to the drive shaft 17 by a pin member 23 in the crank chamber 16. A thrust bearing 24 is interposed between the rotor 22 and the front housing 15. A swash plate 25 is placed in the crank chamber 16 and coupled to the rotor 22 through a plate boss 26 and a hinge mechanism 27. The hinge mechanism 27 makes the swash plate 25 have an angle which is variable in the manner known in the art. It is a matter of course that the swash plate 25 is rotated together with the drive shaft 17 and the rotor 22.

[0017] A plurality of pistons 28 are slidably inserted in the cylinder bores 12, respectively. Each of the pistons 28 is engaged with a peripheral portion of the swash plate 25 via shoes 29 in the predetermined direction. In accordance with the rotation of the swash plate 25, a plurality of pistons 28 are driven via the shoes 29 in the cylinder bores 12, respectively. As a result, each of the pistons 28 is reciprocated to cause compression of a gaseous fluid such as a refrigerant gas. In other words, the gaseous fluid is displaced from a suction chamber 31 to a discharge chamber 32 through the cylinder bores 12 in response to reciprocation of each of the pistons 28.

[0018] The cylinder block 11 has a center bore 33 penetrating in the predetermined direction at a central portion thereof. A flow control valve 34 is placed in a rear portion of the center bore 33 and is for controlling a flow of the gaseous fluid between the crank chamber 16 and the suction chamber 31 in the manner known in the art.

[0019] In a front portion of the center bore 33, the rear end portion 17a of the drive shaft 17 is rotatably supported by the rear radial bearing 18. In the manner known in the art, the rear end portion 17a and the rear radial bearing 18 define a clearance portion therebetween.

[0020] The drive shaft 17 has a rear end surface received by a rear thrust bearing 35 placed in a middle portion of the center bore 33. It is a matter of course that the rear thrust bearing 35 has a communication space which communicates the clearance portion with the flow control valve 34.

[0021] A middle thrust bearing 36 is placed around the drive shaft 17. The middle thrust bearing 36 is engaged between the drive shaft 17 and an axial receiving surface 37 in the front portion of the central bore 33 to prevent the drive shaft 17 from being moved towards the flow control valve 34.

[0022] Referring to Figs. 2 and 3 in addition, the description will be proceeded. The middle thrust bearing 36 comprises a rear race 36a, a front race 36b, and rolling elements 36c between the rear and the front races 36a and 36b. The rear race 36a is in contact with the axial receiving surface 37. A spring 38 like a belleville spring is interposed between the front race 36b and a stopper ring 39 fixed to the drive shaft 17. It is to be noted that a circular gap 41 is left between the middle thrust bearing 36 and a cylindrical surface of the center bore 33.

[0023] Four grooves 42 are formed at the axial receiving surface 37 of the cylinder block 11. The grooves 42 extend in a radial direction to make an angle of 45° with one another. A combination of the grooves 42 and the circular gap 41 is referred to as a path portion which communicates the crank chamber with the above-mentioned clearance portion. It is to be noted that the grooves 42 widen the path portion.

[0024] In addition, four slits or grooves 43 are formed at a rear surface of the rear race 36a of the middle thrust bearing 36 in one-to-one correspondence of the grooves 42. The slits 43 further widen the path portion in cooperation with the grooves 42. Therefore, the flow of the gaseous fluid with a less loss can be established. In other words, the gaseous fluid flows from the crank chamber 16 to the flow control valve 34 through the path portion, the clearance portion, and the above-mentioned communication space, thereby reducing the pressure in the crank chamber 16.

[0025] The angle of the swash plate 25 varies in response to a change of the pressure in the crank chamber 16. Each of the pistons 28 has a stroke determined in accordance with the angle of the swash plate 25. Therefore, the swash plate compressor has a displacement which is variable in response to the pressure in the crank chamber 16.

[0026] Since the responsibility is improved, so that the responding operation of the tilt angle of the swash plate becomes rapid, a displacement controllability is improved, and a cooling performance is enhanced.

[0027] With reference to Fig. 4, the description will be made as regards a swash plate compressor according to a second embodiment of the present invention. The swash plate compressor is of a fixed displacement type and comprises similar parts designated by like reference numerals.

[0028] In the swash plate compressor, the swash plate 25 is fixed to the drive shaft 17 by a pin member 51 to have an angle fixed relative to the drive shaft 17. The center bore 33 of the cylinder block 11 is not provided with the flow control valve 34 and the rear thrust bearing 35 that are illustrated in Fig. 1.

[0029] The rear end portion 17a of the drive shaft 17 is rotatably supported to the cylinder block 11 via a radial bearing 52. The rear end portion 17a and the radial bearing 52 define the clearance portion therebetween.

[0030] The thrust bearing 36 is engaged between the drive shaft 17 and an axial receiving surface 54 of the cylinder block 11 to prevent the drive shaft 17 from being moved towards the discharge chamber 32.

[0031] At least one groove or notch 55 is formed at the

axial receiving surface 54 of the cylinder block 11. The groove 55 extends in a radial direction. The groove 55 is referred to as the path portion. It is to be noted that the groove 55 widens the path portion.

[0032] Further, an additional path portion 56 is made in the cylinder block 11. The additional path portion 56 is connected to the center bore 33 and the suction chamber 31. Therefore, the gaseous fluid flows from the crank chamber 16 towards the suction chamber 31 through the path portion, the clearance portion, the center bore 33, and the additional path portion. In this event, the flow of the gaseous fluid with a less loss can be established. Since the gaseous fluid flows with lubricating oil through the radial bearing 52, the lubrication operation is favorably made. This results in increasing the durability of the radial bearing 52.

[0033] Since the lubrication of the radial bearing 52 is improved, the durability is increased. A work for a balance hole which is conventionally provided and which communicates between the crank case and the inlet chamber becomes useless, so that a reduction of costs can be improved. Further, such a synergistic effect as to improve the response speed and the lubrication can be expected. The durability in the radial bearing located in the portion where the oil passes upon communicating is also increased due to the lubricating effect.

[0034] While the present invention has thus far been described in connection with a few embodiments thereof, it will readily be possible for those skilled in the art to put this invention into practice in various other manners. For example, in the swash plate compressor of Fig.1, the grooves 42 may be made to the rear race 36a of the middle thrust bearing 36 in place of the axial receiving surface 37 of the cylinder block 11. The grooves 42 may be made to both of the rear race 36a and the axial receiving surface 37. A single groove may be used in place of the grooves 42. In the swash plate compressor of Fig. 4, a plurality of grooves may be used in place of the groove or notch 55.

Claims

1. A swash plate compressor which comprises a compressor casing defining a crank chamber (16) and including a cylinder block (11) defining a cylinder bore (12), a drive shaft (17) having an end portion (17a) rotatably supported by said cylinder block (11), a swash plate (25) placed in said crank chamber (16) and having rotation caused by said drive shaft (17), a piston (28) inserted in said cylinder bore (12) and reciprocated in accordance with said rotation of said swash plate (25), and pressure control means for controlling pressure in said crank chamber (16), characterized in that

   said pressure control means comprises a clearance portion left between said end portion (17a) of said drive shaft (17) and said cylinder block (11) and a path portion (41, 42) communicating said crank chamber (16) with said clearance portion.

2. The swash plate compressor as claimed in claim 1, wherein said pressure control means further comprises at least one groove portion (42) made to said cylinder block (11) to widen said path portion (41, 42).

3. The swash plate compressor as claimed in claim 2, wherein said drive shaft (17) extends in a predetermined direction, said swash plate compressor further comprising a thrust bearing (36) placed around said drive shaft (17), said cylinder block (11) having a receiving surface (37) for receiving said thrust bearing (36) in said predetermined direction, said at least one groove portion (42) being made on said receiving surface (37).

4. The swash plate compressor as claimed in one of claims 1 to 3, further comprising a radial bearing (18) inserted between said cylinder block (11) and said end portion of said drive shaft (17), said clearance portion being defined between sai radial bearing (18) and said end portion (17a) of said drive shaft (17).

5. The swash plate compressor as claimed in one of claims 1 to 4, wherein said swash plate (25) has an angle variable in response to said pressure in said crank chamber (16), said pressure control means further comprising a flow control valve (34) connected to said clearance portion for controlling a flow of a gas through said clearance portion.

6. The swash plate compressor as claimed in one of claims 1 to 5, further comprising:

   a rotor (22) fixed to said drive shaft (17) in said crank chamber (16); and
   a hinge mechanism (27) coupling said swash plate (25) with said rotor (22) to make the angle of said swash plate (25) be variable.

7. The swash plate compressor as claimed in one of claims 1 to 6, further comprising:

   a cylinder head (13) defining a suction chamber (31) and a discharge chamber (32) therein which are connected to said cylinder bore (12); and
   an additional path portion connected between said clearance portion and said suction chamber (31),
   wherein said swash plate (25) is fixed to said drive shaft (17).

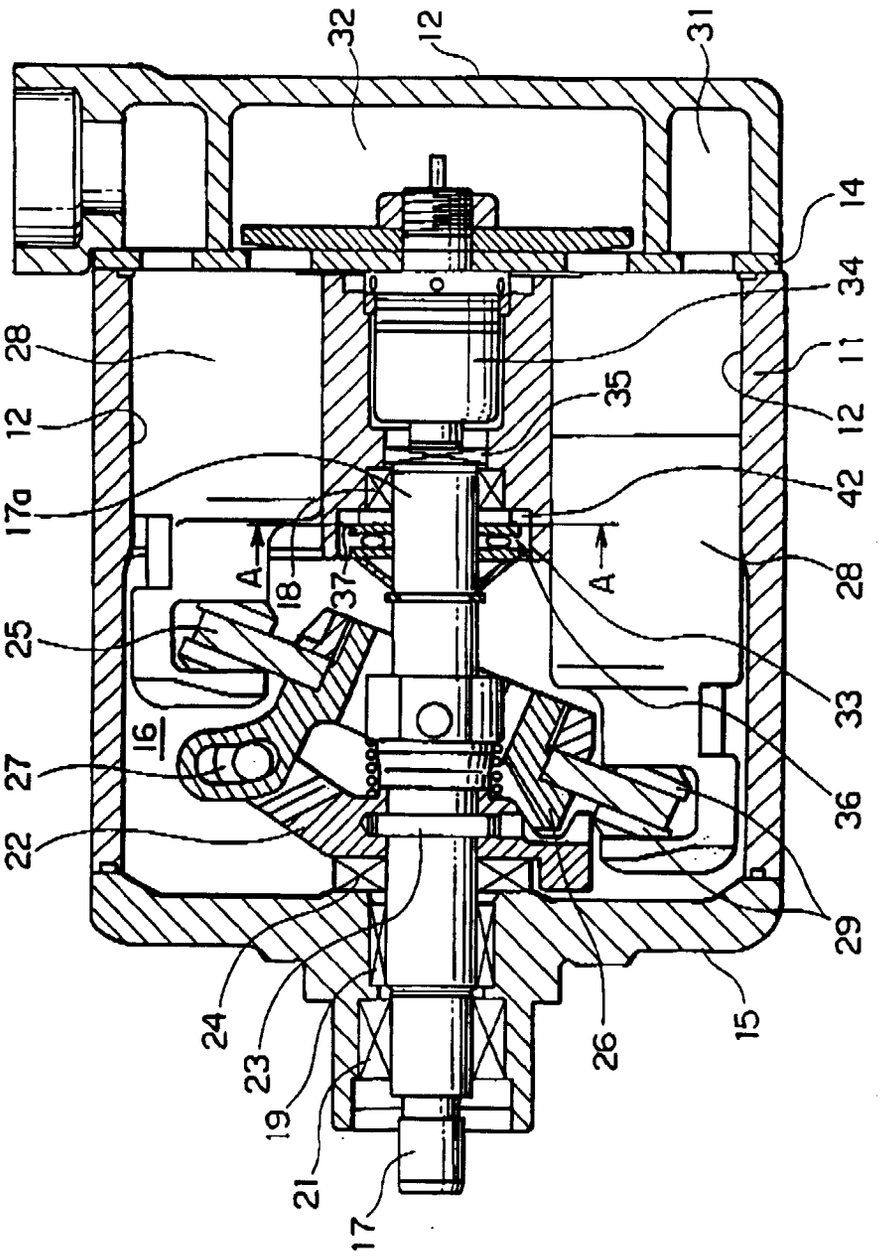
32
12
31
14
34
28
11
12
35
12
42
17a
A
18
37
A
28
25
33
16
27
36
22
29
24
23
19
21
17
26
15

FIG. 1

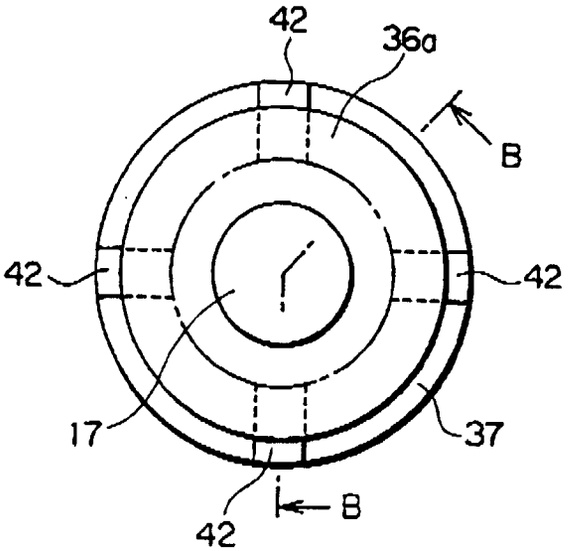

FIG. 2

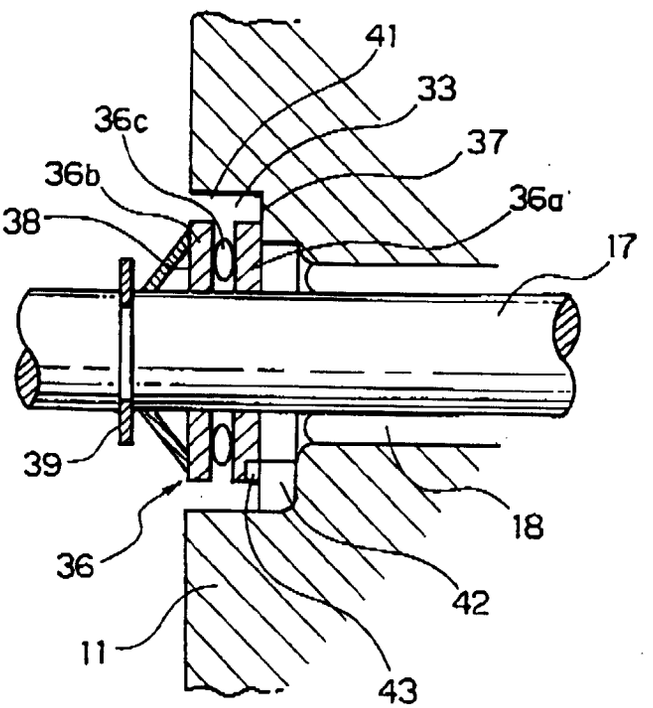

FIG. 3

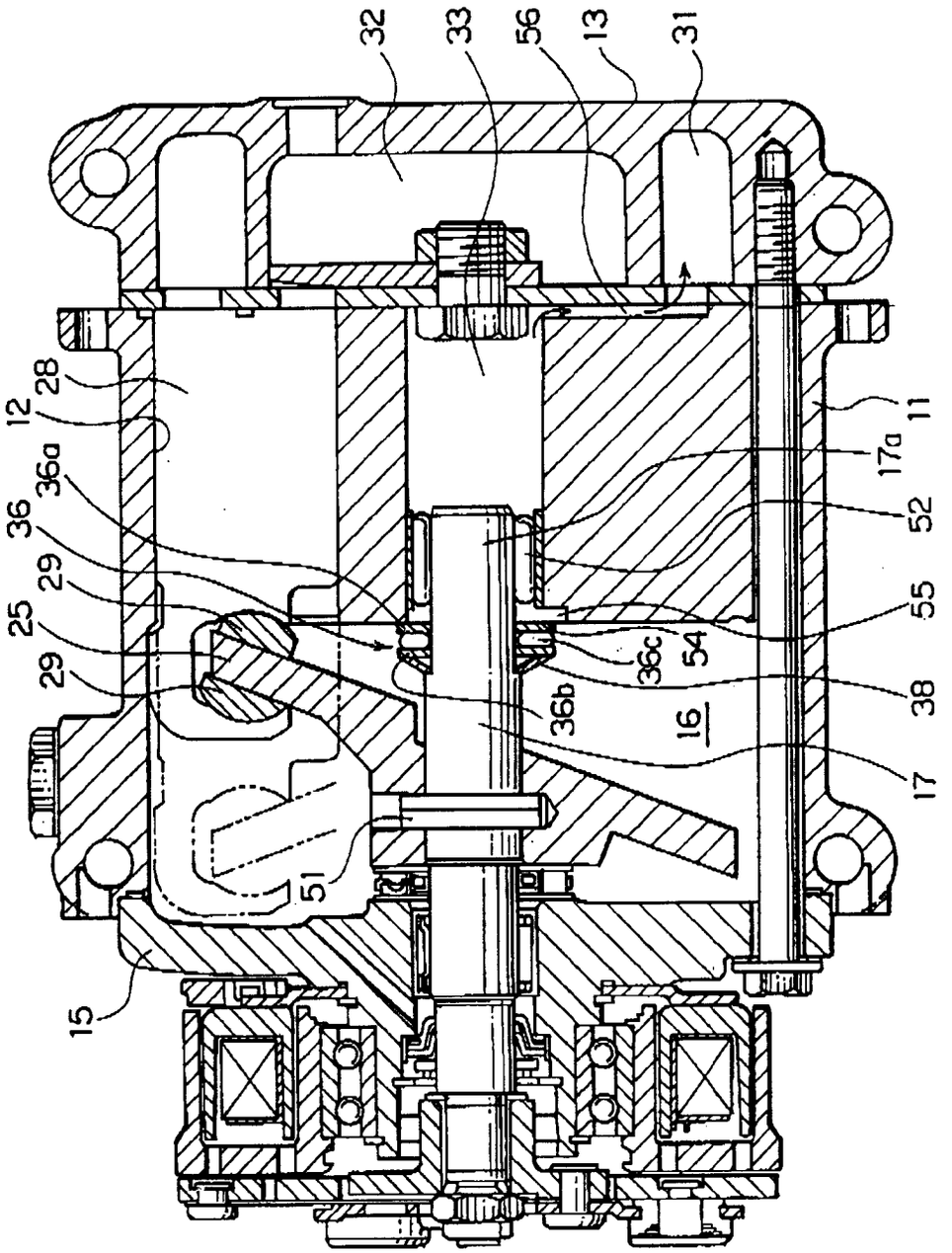
32
33
56
13
31
28
12
11
17a
36a
36
52
29
25
55
54
36c
29
38
36b
16
17
51
15

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number EP 99106701.8

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	US 4687419 A (SUZUKI et al.) 18 August 1987, the whole document, especially column 6, lines 3-16. --	1-7	F 04 B 27/18 F 04 B 27/08
A	EP 0256334 A1 (SANDEN CORP.) 24 February 1988, the whole document. --	1-7	
A	US 5094590 A (CARELLA et al.) 10 March 1992, the whole document. ----	1-7	

TECHNICAL FIELDS SEARCHED (Int. Cl. 6)

F 04 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	24-06-1999	WERDECKER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO. EP 99106701.8

This annex lists the patent family members relating to the patent documents cited in the above-mentioned search report.
The members are as contained in the EPIDOS INPADOC file on 30. 6.1999.
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US A 4687419	18-08-1987	DE A1 3545581	10-07-1986
		DE C2 3545581	26-07-1990
		JP A2 61155665	15-07-1986
		JP B4 6037874	18-05-1994
EP A1 256334	24-02-1988	AU A1 75913/87	28-01-1988
		AU B2 603367	15-11-1990
		DE C0 3760973	14-12-1989
		EP B1 256334	08-11-1989
		JP A2 63029067	06-02-1988
		US A 4780059	25-10-1988
US A 5094590	10-03-1992	none	

For more details about this annex see Official Journal of the European Patent Office, No. 12/82.