



(11) **EP 3 015 711 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
04.05.2016 Bulletin 2016/18

(51) Int Cl.:
F04C 18/344 (2006.01) **F04C 29/00** (2006.01)
F04C 29/12 (2006.01)

(21) Application number: **14818134.0**

(86) International application number:
PCT/JP2014/065988

(22) Date of filing: **17.06.2014**

(87) International publication number:
WO 2014/208398 (31.12.2014 Gazette 2014/53)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

- **TERAYA, Takanori**
Kumagaya-shi
Saitama 360-0193 (JP)
- **OSAWA, Jin**
Kumagaya-shi
Saitama 360-0193 (JP)

(30) Priority: **27.06.2013 JP 2013134474**

(74) Representative: **Metz, Gaëlle**
Valeo Systemes Thermiques
Propriété Industrielle
8, rue Louis Lormand
La Verrière
78320 Le Mesnil Saint-Denis (FR)

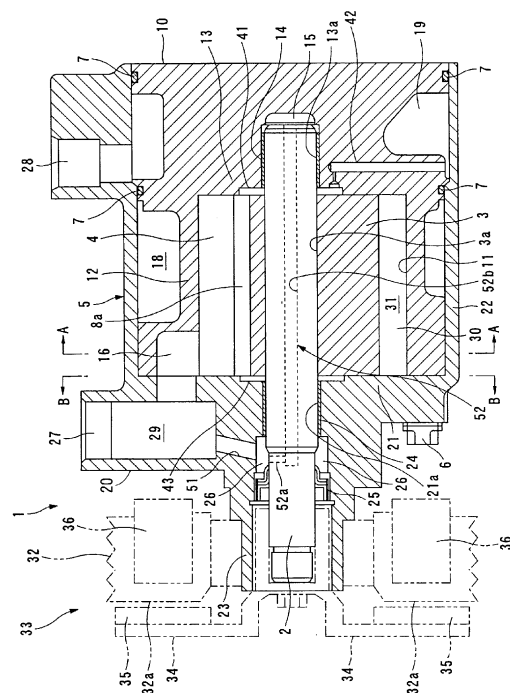
(71) Applicant: **Valeo Japan Co., Ltd.**
Saitama 360-0193 (JP)

(72) Inventors:
• **TAKAHASHI, Tomoyasu**
Kumagaya-shi
Saitama 360-0193 (JP)

(54) **VANE COMPRESSOR**

(57) To provide a vane type compressor that can appropriately keep the allocation of the clearances at the front and rear ends in the axial direction of the rotor by balancing the forces applied to the front and rear sides of the drive shaft. The clearances at the front and rear ends in the axial direction of a rotor 3 are appropriately allocated by providing, in a drive shaft 2, a passage 52 communicating between a low-pressure space 26 communicating with a suction chamber 29 and a shaft end space 15 partitioned by a rear side block 13 and the end of the drive shaft 2 and balancing the forces applied to the front and rear sides of the drive shaft 2. This prevents the compression efficiency from reducing while ensuring the smooth rotation of the rotor 3.

[図1]



EP 3 015 711 A1

Description

Technical Field

[0001] The present invention relates to a vane type compressor and, more particularly, to a vane type compressor having a structure useful for appropriately keeping the allocation of the clearances at the front and rear ends of a rotor.

Background Art

[0002] There are various structures for vane type compressors used for the refrigeration cycle or the like of an in-vehicle air conditioner (see the patent gazettes below). For example, as typified by the structure in Fig. 3, a vane type compressor comprises a cylinder 12, formed in a housing 5, that has a cam surface 11 on the inner periphery surface, a pair of side blocks (a rear side block 13, a front side block 21) that close both ends in the axial direction of the cylinder 12, a drive shaft 2 rotatably supported by the pair of side blocks, a rotor 3, fixed to the drive shaft 2, that is rotatably accommodated in the cylinder, a vane groove 8 formed inward from the outer periphery surface of the rotor 3, and a vane 4 retractably accommodated in the vane groove 8. The vane 4 is in contact with and supported by the inner periphery surface (the cam surface 11) of the cylinder 12 through the centrifugal force by rotation of the rotor 3 and the back pressure from a back pressure chamber 8a provided on the bottom of the vane groove 8. Then, in the space closed by the cylinder 12 and the pair of side blocks 13 and 21, a compression chamber 31 is partitioned by the rotor 3 and the vane 4, so that the fluid sucked into the compression chamber 31 is compressed in accordance with the rotation of the rotor 3.

[0003] In such a vane type compressor, to ensure the smooth rotation of the rotor 3 and prevent the reduction in the compression efficiency, the dimensions of the rotor 3 are controlled so that appropriate clearances are formed between the front and rear end surfaces in the axial direction of the rotor 3 and the side blocks 13 and 21.

Citation List

Patent Literature

[0004]

PTL 1: JP-A-2013-050038

PTL 2: JP-A-2007-064163

Summary of Invention

Technical Problem

[0005] However, one end (front end) of the drive shaft 2 to which the rotor 3 is fixed passes through one side

block (front side block 21) because the front end of the drive shaft 2 needs to be coupled directly to a driving source or the power transfer member (such as a pulley and an electromagnetic clutch) for transferring the power of the driving source needs to be fixed to the front end.

[0006] Accordingly, when one end of the drive shaft 2 passes through one side block (front side block 21) and projects outside the housing, the atmospheric pressure is applied to one end of the drive shaft 2 and, in response to this, a relatively high pressure in the compressor is applied to the other end (the side supported by the rear side block 13) of the drive shaft 2. Accordingly, the drive shaft 2 is biased toward one end (front side) projecting through the side block due to the difference between the pressures applied to the front and rear sides in the axial direction, the position in the axial direction of the rotor 3 becomes close toward the side block (front side block 21) through which the drive shaft 2 passes, and the clearance between the front end of the rotor 3 and the front side block 21 becomes relatively smaller. In contrast, the clearance between the rear end of the rotor 3 and the rear side block 13 becomes relatively larger. Accordingly, on the rear side (toward the rear side block 13) where the clearance becomes larger, the fluid leaks between adjacent compression chambers via the clearance (oil sealing degrades), thereby reducing the compression efficiency.

[0007] As illustrated by the dot-dash line in Fig. 3, when an electromagnetic clutch 33 is provided on the drive shaft 2 as a power transfer member, during attraction of the electromagnetic clutch 33 in which power is transferred to the rotor 3, the spring force by a blade spring included in the clutch biases the rotor 3 backward (toward the rear side block 13) via the drive shaft 2. Accordingly, the position in the axial direction of the rotor 3 is determined by the difference between the pressures applied to the front and rear sides in the axial direction of the drive shaft 2 and the spring force of the electromagnetic clutch 33.

[0008] However, a vane type compressor is generally small and the spring force of an electromagnetic clutch is not large enough to cancel the difference between the pressures applied to the front and rear ends of the drive shaft 2. Accordingly, even when the electromagnetic clutch 33 is provided, it is impossible to eliminate the state in which the clearance (clearance between the rotor 3 and the rear side block 13) at the rear of the rotor 3 is larger than the clearance (clearance between the rotor 3 and the front side block 21) at the front of the rotor 3, so reduction in the compression efficiency still remains.

[0009] Therefore, there is a conventional method in which the total clearance (the sum of the clearances at the front and rear ends of the rotor) at the front and rear ends in the axial direction of the rotor is prevented from becoming too large so that the clearance on the rear side of the rotor falls within a permissible range. However, such a control method complicates the control process and reduces the productivity.

[0010] The invention addresses the above problems with a main object of providing a vane type compressor that can appropriately keep the allocation of clearances at the front and rear ends in the axial direction of the rotor by balancing the forces applied to the front and rear sides of the drive shaft.

Solution to Problem

[0011] To solve the above problems, a vane type compressor according to the present invention comprises a housing, a cylinder in which a cam surface is formed, the cylinder being provided in the housing, a pair of side blocks closing both ends in an axial direction of the cylinder, the pair of side blocks being provided in the housing, a drive shaft rotatably supported by the pair of side blocks, a rotor fixed to the drive shaft, the rotor being rotatably accommodated in the cylinder, a plurality of vane grooves formed in the rotor, a plurality of vanes slidably inserted into the vane grooves, the vanes each having an end protruding or retracting from one of the vane grooves and sliding on the cam surface, a compression chamber formed by the rotor and the vanes in a space closed by the cylinder and the pair of side blocks, a suction chamber provided adjacently to a front side block of the pair of side blocks, a fluid before compression being introduced to the suction chamber, a seal member provided between the front side block and the drive shaft, a low-pressure space provided closer to a rear side in an axial direction of the drive shaft than the seal member, the low-pressure space communicating with the suction chamber, and a shaft end space partitioned by a rear side block of the pair of side blocks and an end of the drive shaft, in which a passage communicating between the low-pressure space and the shaft end space is provided in the drive shaft.

[0012] Since the drive shaft is provided with the passage communicating between the low-pressure space and the shaft end space, the pressure in the shaft end space of the drive shaft is equivalent to the suction pressure and the difference between the pressures applied to both ends of the drive shaft can be reduced. Accordingly, it is possible to appropriately allocate the clearances (the clearance between one end surface of the rotor and the side block facing the one end surface and the clearance between the other end surface of the rotor and the side block facing the other end surface) at the front and rear ends in the axial direction of the rotor by balancing the force applied in the axial direction of the rotor.

[0013] The above structure of the side block is effective in adjusting imbalance in the allocation of clearances caused by the difference between the pressures of the low-pressure space of the drive shaft or the side projecting outside and the side disposed inside the housing of the compressor when the space housing an electric motor is relatively low in pressure or when the drive shaft passes through the front side block and projects outside the housing specially in the electric compressor in which

the drive shaft passes through the front side block and directly connects to the shaft of the electric motor.

[0014] The housing may be configured by combining a first housing member with a second housing member, the first housing member being configured by integrally forming the cylinder having a true-circular inner periphery surface with a first side block closing one end in the axial direction of the cylinder, the second housing member being provided with a second side block closing the other end in the axial direction of the cylinder, and the pair of the side blocks may include the first side block and the second side block.

[0015] In such a structure, for example, the first side block may be associated with the rear side block and the second side block may be associated with the front side block.

Advantageous Effects of Invention

[0016] As described above, according to the invention, since the drive shaft is provided with the passage communicating between the low-pressure space communicating with the suction chamber and the shaft end space partitioned by the rear side block and the end of the drive shaft, it is possible to appropriately keep the allocation of the clearances at the front and rear ends in the axial direction of the rotor by balancing the forces applied to the front and rear sides of the drive shaft. Accordingly, reduction in the compression efficiency is prevented while ensuring the smooth rotation of the rotor.

Brief Description of Drawings

[0017]

[Fig. 1] Fig. 1 is a cross sectional view illustrating a vane type compressor according to the present invention.

[Fig. 2A] Fig. 2A illustrates the rear part of the vane type compressor seen from line A-A in Fig. 1.

[Fig. 2B] Fig. 2B illustrates the front part of the vane type compressor seen from line B-B in Fig. 1.

[Fig. 3] Fig. 3 is a cross sectional view illustrating a conventional vane type compressor.

Description of Embodiments

[0018] A vane type compressor according to the present invention will be described with reference to the drawings.

[0019] Figs. 1, 2A and 2B illustrate a vane type compressor suited to a refrigeration cycle in which a refrigerant is used as a working fluid. A vane type compressor 1 comprises a drive shaft 2, a rotor 3, fixed to the drive shaft 2, that rotates according to the rotation of the drive shaft 2, a vane 4 attached to the rotor 3, and a housing 5, supporting the drive shaft 2 rotatably, that accommodates the rotor 3 and the vane 4. In Fig. 1 illustrating the

compressor from a side, it is assumed that the left side indicates the front side and the right side indicates the rear side.

[0020] The housing 5 is configured by combining two members, that is, a first housing member 10 and a second housing member 20.

[0021] The first housing member 10 includes a cylinder 12, accommodating the rotor 3, that has a cam surface 11 on its inner periphery surface and a rear side block 13, which is formed integrally so as to close one end (rear side) in the axial direction of the cylinder 12. The inner periphery surface (cam surface 11) of the cylinder 12 has a true-circular cross section and the length in the axial direction of the cylinder 12 is substantially the same as the length in the axial direction of the rotor 3, which will be described later.

[0022] The second housing member 20 includes a front side block 21 abutting against an end face of the other end (front side) and closing the other end in the axial direction of the cylinder 12 and a shell 22 formed integrally with the front side block 21, extending in the axial direction of the drive shaft 2, and formed so as to surround the outer periphery surfaces of the cylinder 12 and the rear side block 13.

[0023] The first housing member 10 and the second housing member 20 are coupled to each other in the axial direction via a coupling tool 6 such as a bolt, and a seal member 7 such as an O-ring is provided between the rear side block 13 of the first housing member 10 and the shell 22 of the second housing member 20 for hermetical sealing.

[0024] In addition, a boss section 23 extending from the front side block 21 toward the front is formed integrally with the second housing member 20. A pulley 32 (indicated by the dot-dash line) for transferring rotational power to the drive shaft 2 is rotatably mounted externally to the boss section 23 so that the pulley 32 can transfer rotational power to the drive shaft 2 via an electromagnetic clutch 33.

[0025] The drive shaft 2 is rotatably supported by the rear side block 13 and the front side block 21 via bearings 14 and 24. The end of the drive shaft 2 passes through the front side block 21 of the second housing member 20 and protrudes inside the boss section 23. A seal member 25 provided between the boss section 23 and the drive shaft 2 hermetically seals the boss section 23 and the drive shaft 2 with each other.

[0026] A low-pressure space 26 is formed closer to the rear in the axial direction of the drive shaft 2 than the seal member 25, that is, the periphery of the drive shaft 2 between the seal member 25 and the bearing 24 in this example (the part of the space in the boss section 23 to which the drive shaft 2 projects closer to the rear than the seal member 25).

[0027] In addition, a bearing hole 13a into which the drive shaft 2 is inserted via the bearing 14 is formed in the rear side block 13 and, at the end of the bearing hole 13a, a shaft end space 15 partitioned by the rear side

block 13 and the end of the drive shaft 2 is provided.

[0028] The electromagnetic clutch 33 is a known one. A clutch plate 35 is fixed so as to face a friction surface 32a of the pulley 32 via a blade spring 34 attached in the axial direction to the part projecting from the housing member 20 (front side block 21) of the drive shaft 2. When an excitation coil 36 included in the pulley 32 is energized, the clutch plate 35 is attracted by the pulley 32 and the rotational power from the traveling engine to be given to the pulley 32 is transferred to the drive shaft 2 via the clutch plate 35 and the blade spring 34. When the clutch plate 35 is attracted to the pulley 32 in this way, the drive shaft 2 is biased toward the rear side block 13 (rear side) by the spring force of the blade spring 34.

[0029] The rotor 3 has a true-circular cross section, the drive shaft 2 is inserted into an insertion hole 3a provided in the center of the shaft, and the rotor 3 is fixed to the drive shaft 2 with the centers of their shafts aligned with each other. In addition, the center of the shaft of the cylinder 12 is misaligned with the center of the shaft of the rotor 3 (drive shaft 2) so that the outer periphery surface of the rotor 3 makes contact with the inner periphery surface (cam surface 11) of the cylinder 12 at one position in the circumferential direction (provided to be misaligned by one-half of the difference between the inner diameter of the cylinder 12 and the outer diameter of the rotor 3). In the space closed by the cylinder 12, the rear side block 13, and the front side block 21, a compression space 30 is partitioned between the inner periphery surface of the cylinder 12 and the outer periphery surface of the rotor 3.

[0030] A plurality of vane grooves 8 are formed in the outer periphery surface of the rotor 3 and the vane 4 is slidably inserted into each of the vane grooves 8. The vane groove 8 is opened not only in the outer periphery surface of the rotor 3, but also in the end surfaces facing the rear side block 13 and the front side block 21, and a back pressure chamber 8a is formed on the bottom. The vane grooves 8 are formed at regular intervals in the circumferential direction. In this example, the vane grooves are formed in two positions having phases different from each other by 180 degrees in parallel with each other so that the plane including the vane 4 and the plane, in parallel with the vane 4, that includes the shaft center of the drive shaft 2 are distant (offset) by a predetermined distance.

[0031] The length of the vane 4 in the axial direction of the drive shaft 2 is equal to the length of the rotor 3 in the axial direction and the length of insertion into the vane groove 8 in the insertion direction (sliding direction) is substantially equal to the length of the vane groove 8 in this insertion direction. The vane 4 projects from the vane groove 8 due to oil, which will be described later, supplied to the back pressure chamber 8a of the vane groove 8 and the end can abut against the inner periphery surface (cam surface 11) of the cylinder 12.

[0032] Accordingly, the compression space 30 is separated into a plurality of compression chambers 31 by the vane 4 slidably inserted into the vane groove 8 and

the volumes of the compression chambers 31 change depending on the rotation of the rotor 3.

[0033] The second housing member 20 is provided with a suction port 27 sucking the working fluid (refrigerant gas) from the outside and a discharge port 28 discharging the working fluid to the outside. In addition, the front side block 21 is provided with a suction chamber 29 that communicates with the suction port 27, provided adjacently to the front side block, and receives the fluid before being compressed.

[0034] In addition, the cylinder 12 of the first housing member 10 is provided with a suction port 16 that communicates with the suction chamber 29 and sucks the fluid into the compression chamber 31. The suction port 16 is formed in the vicinity of the front side in the rotation direction of the rotor 3 with respect to the part (radial sealing part 40) at which the outer periphery surface of the rotor 3 abuts against the inner periphery surface of the cylinder 12.

[0035] In addition, the first housing member 10 is provided with a discharge port 17 for discharging the fluid compressed in the compression chamber in the vicinity of the rear side in the rotation direction of the rotor 3 with respect to the radial sealing part 40. In addition, the first housing member 10 is provided with a discharge chamber 18 introducing, to the discharge port 28, the fluid discharged via the discharge port 17.

[0036] An oil separator (not illustrated) is disposed between the discharge chamber 18 and the discharge port 28. In addition, an oil chamber 19 for storing high-pressure oil separated from the fluid by the oil separator is provided between the lower part of the rear side block 13 of the first housing member 10 and the lower part of the shell 22 of the second housing member 20.

[0037] On the surface of the rear side block 13 facing the end surface of the rotor 3, an oil introducing groove 41 on the rear side is formed in the circumferential edge of the opening of the bearing hole 13a into which the drive shaft 2 is inserted via the bearing 14. The oil introducing groove 41 on the rear side is formed by recessing the circumferential edge of the opening of the bearing hole 13a so as to extend in the circumferential direction and the oil introducing groove 41 is formed in a predetermined angle range (angle range of approximately 270 degrees) from the angle position in which the radial sealing part 40 is provided to an angle position before the angle position in which the discharge port 17 is provided. In addition, the oil introducing groove 41 is connected to the oil chamber 19 via an oil communication passage 42 with a narrow section.

[0038] Accordingly, when the discharge pressure is high, the high-pressure oil stored in the oil chamber 19 is supplied via the oil communication passage 42 to the oil introducing groove 41 on the rear side formed in the rear side block 13 and, from the oil introducing groove 41 on the rear side, fed to a sliding part such as the bearing 14 or the back pressure chamber 8a of the rotor 3. The vane 4 is pressed against the inner periphery surface

(cam surface 11) of the cylinder 12 due to the oil fed to the back pressure chamber 8a, thereby ensuring stable compression.

[0039] In addition, on the surface of the front side block 21 facing the end surface of the rotor 3, an oil introducing groove 43 on the front side is formed in the circumferential edge of the opening of a bearing hole 21a into which the drive shaft 2 is inserted via the bearing 24. The oil introducing groove 43 on the front side is formed by recessing the circumferential edge of the opening of the bearing hole 21a so as to extend in the circumferential direction and the oil introducing groove 43 is formed in a predetermined angle range (angle range of approximately 270 degrees) from the angle position in which the radial sealing part 40 is provided to an angle position before the angle position in which the discharge port 17 is provided. In addition, the oil introducing groove 43 communicates with the bottom (back pressure chamber 8a) of the vane groove 8 when the end of the vane 4 is present in the angle range from the position at which the end of the vane 4 reaches the suction port 16 to a position immediately before the position at which the end of the vane 4 reaches the discharge port 17.

[0040] Accordingly, the oil fed to the back pressure chamber 8a is supplied to the oil introducing groove 43 on the front side in the process in which the back pressure chamber 8a communicates with the oil introducing groove 43 on the front side, and then fed to a sliding member such as a bearing via the oil introducing groove 43 on the front side.

[0041] In Fig. 2A and 2B, reference numeral 37 indicates a screw hole used to screwing the coupling tool 6.

[0042] In such a structure, the housing member on the front side is provided with a communication passage 51 communicating between the suction chamber 29 and the low-pressure space 26 and the drive shaft 2 is provided with a passage 52 communicating between the low-pressure space 26 and the shaft end space 15. Specifically, the communication passage 51 is formed by a passage bored substantially orthogonally to the drive shaft 2 from the suction chamber 29 to the low-pressure space 26. In addition, the passage 52 provided in the drive shaft 2 includes a radial direction hole 52a having one end opened to the low-pressure space 26 and the other end extending to the center of the drive shaft 2 and an axial direction hole 52b, formed in the center of the driving shaft 2 in the axial direction, that has one end communicating with the radial direction hole 52a and the other end extending to the shaft end space 15.

[0043] Accordingly, the low-pressure space 26 communicates with the suction chamber 29 via the communication passage 51 and the shaft end space 15 communicates with the low-pressure space 26 via the passage 52, so the low-pressure space 26 and the shaft end space 15 are kept at a pressure equivalent to the suction pressure.

[0044] Therefore, when the electromagnetic clutch 33 is provided, during attraction of the electromagnetic

clutch 33 in which power is transferred to the drive shaft, the position in the axial direction of the rotor 3 is the position at which the difference between the pressures applied to the front and rear sides of the drive shaft 2 is balanced with the spring force by the blade spring 34 of the electromagnetic clutch 33.

[0045] Since the front side of the drive shaft 2 projects outside the housing 5 (in the atmosphere) via the front side block 21, the atmospheric pressure is applied to the front end of the drive shaft 2 via the blade spring 34 and the spring force by the blade spring 34 of the electromagnetic clutch 33 is applied to the front end of the drive shaft 2. On the other hand, a pressure equivalent to the suction pressure is applied to the rear end of the drive shaft 2, so the biasing force toward the front side block 21 is small, thereby enabling reduction in the difference between the pressures applied to the front and rear in the axial direction. Accordingly, the forces applied to the front and rear sides of the drive shaft 2 can be balanced to appropriately keep the allocation of the clearances at the front and rear ends in the axial direction of the rotor 3.

[0046] The compressor having two vanes 4 has been described in the above structure, but the same structure can be used even when the compressor has three or more vanes. Although the vane groove 8 (vane 4) is offset and provided in the structure having two vanes, the same structure may be used to adjust the allocation of the clearances at the front and rear ends in the axial direction of the rotor 3 even when the plane including the vane 4 may coincide with the plane, disposed in parallel with the vane 4, that includes the shaft center of the drive shaft 2 (the offset is set to 0) or even when offsetting is performed in the reverse direction.

Reference Signs List

[0047]

- 1: vane type compressor
- 2: drive shaft
- 3: rotor
- 4: vane
- 5: housing
- 8: vane groove
- 8a: back pressure chamber
- 10: first housing member
- 11: cam surface
- 12: cylinder
- 13: rear side block
- 18: discharge chamber
- 20: second housing member
- 21: front side block
- 29: suction chamber
- 31: compression chamber

Claims

1. A vane type compressor (1) comprising:

- 5 a housing (5);
- a cylinder (12) in which a cam surface (11) is formed, the cylinder (12) being provided in the housing (5);
- 10 a pair of side blocks (13, 21) closing both ends in an axial direction of the cylinder (12), the pair of side blocks (13, 21) being provided in the housing (5);
- a drive shaft (2) rotatably supported by the pair of side blocks (13, 21);
- 15 a rotor (3) fixed to the drive shaft (2), the rotor (3) being rotatably accommodated in the cylinder (12);
- a plurality of vane grooves (8) formed in the rotor (3) ;
- 20 a plurality of vanes (4) slidably inserted into the vane grooves (8), the vanes (4) each having an end protruding or retracting from one of the vane grooves (8) and sliding on the cam surface (11);
- a compression chamber (31) formed by the rotor (3) and the vanes (4) in a space closed by the cylinder (12) and the pair of side blocks (13, 21);
- 25 a suction chamber (29) provided adjacently to a front side block (21) of the pair of side blocks (13, 21), a fluid before compression being introduced to the suction chamber (29) ;
- a seal member (25) provided between the front side block (21) and the drive shaft (2);
- a low-pressure space (26) provided closer to a rear side in an axial direction of the drive shaft (2) than the seal member (25), the low-pressure space (26) communicating with the suction chamber (29); and
- 30 a shaft end space (15) partitioned by a rear side block (13) of the pair of side blocks (13, 21) and an end of the drive shaft(2);
- wherein a passage (52) communicating between the low-pressure space (26) and the shaft end space (15) is provided in the drive shaft (2).

- 45 **2.** The vane type compressor (1) according to claim 1, wherein the drive shaft (2) passes through the front side block (21) and protrudes outside the housing (5).

- 50 **3.** The vane type compressor (1) according to claim 1 or 2, wherein the housing (5) is configured by combining a first housing member (10) with a second housing member (20), the first housing member (10) being configured by integrally forming the cylinder (12) having a true-circular inner periphery surface with the rear side block (13) closing one end in the axial direction of the cylinder (12), the second housing member (20) being provided with the front side
- 55

block (21) closing the other end in the axial direction of the cylinder (12), and the pair of side blocks (13, 21) include the rear side block (13) and the front side block (21).

5

10

15

20

25

30

35

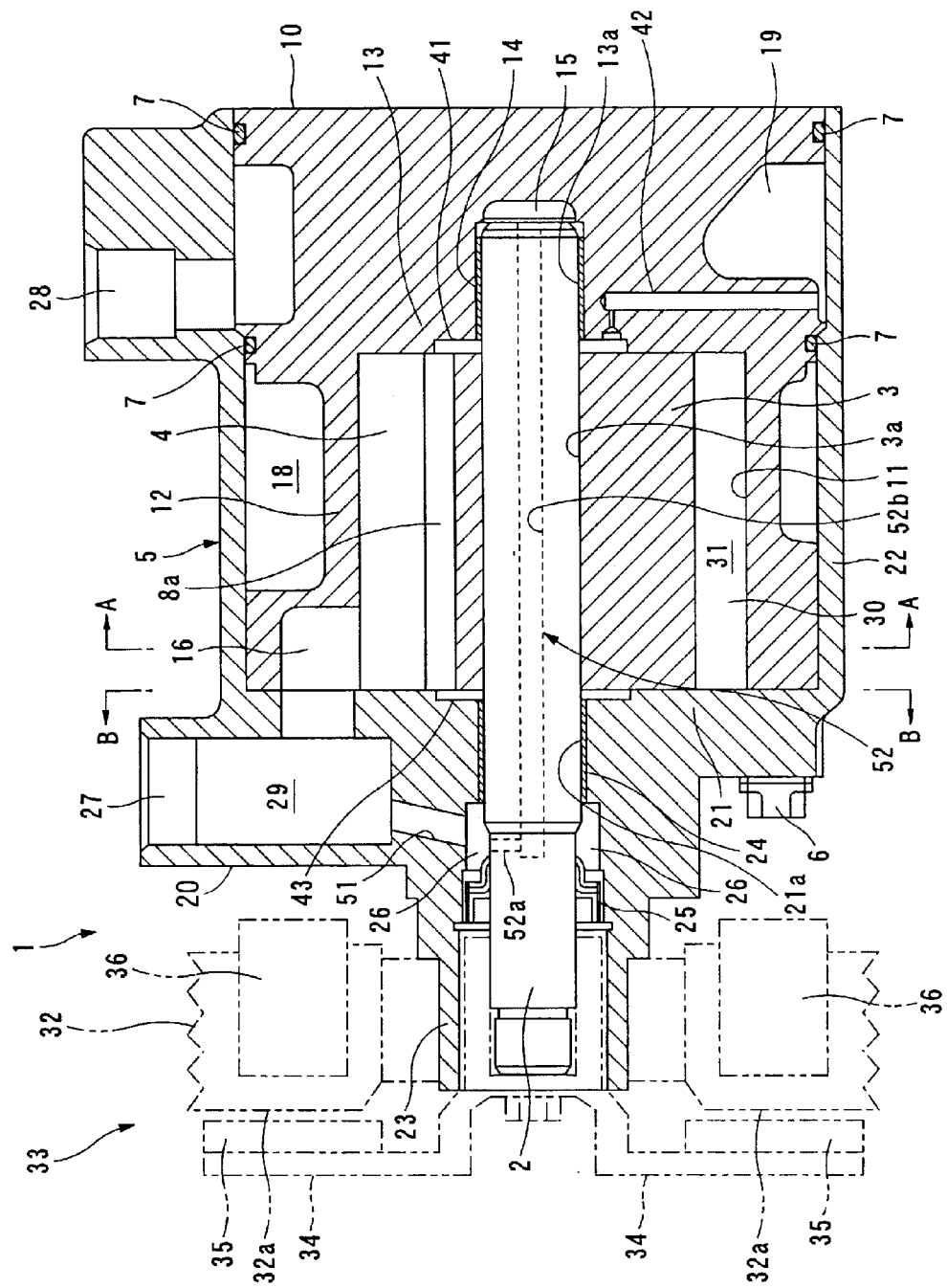
40

45

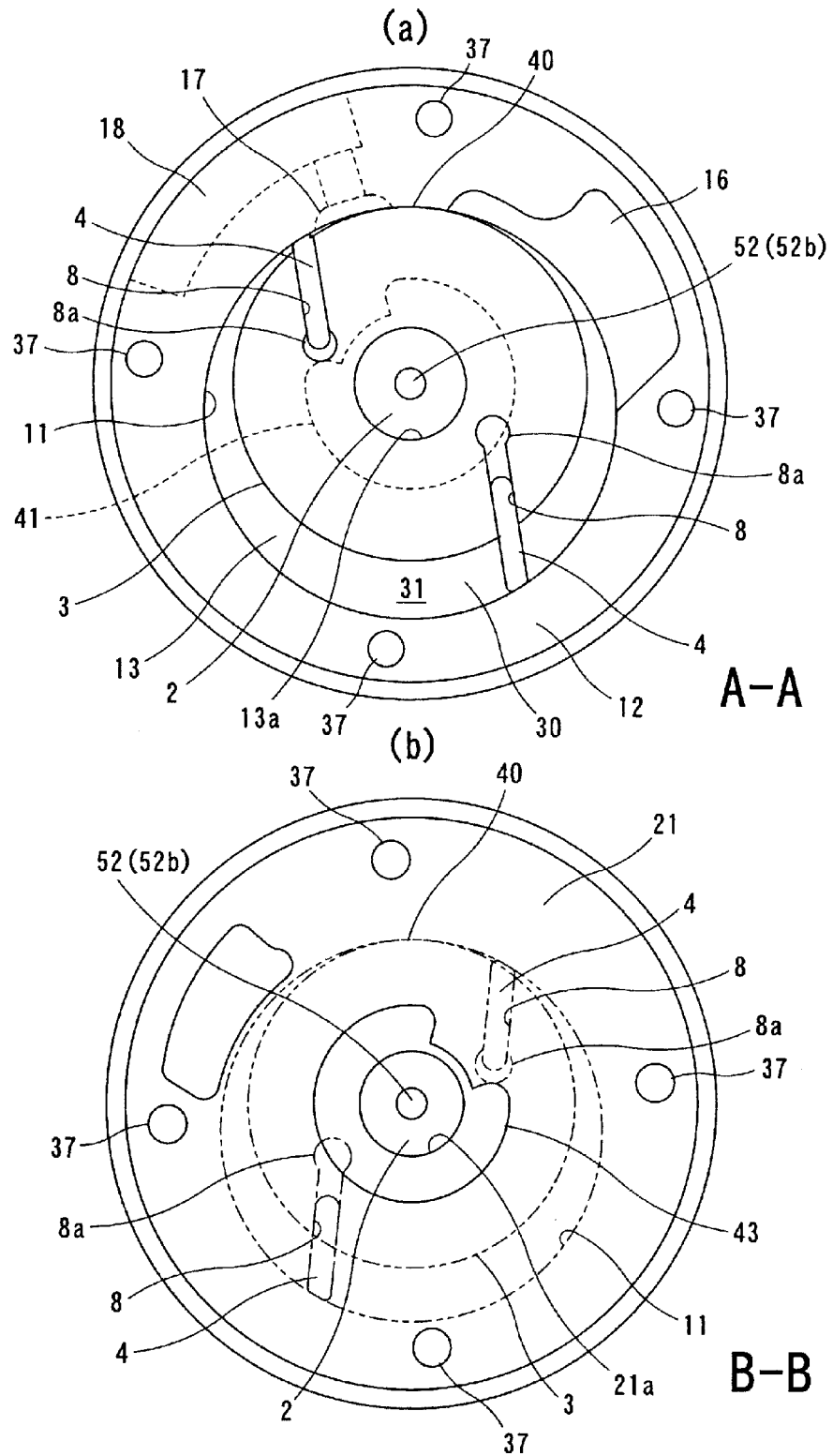
50

55

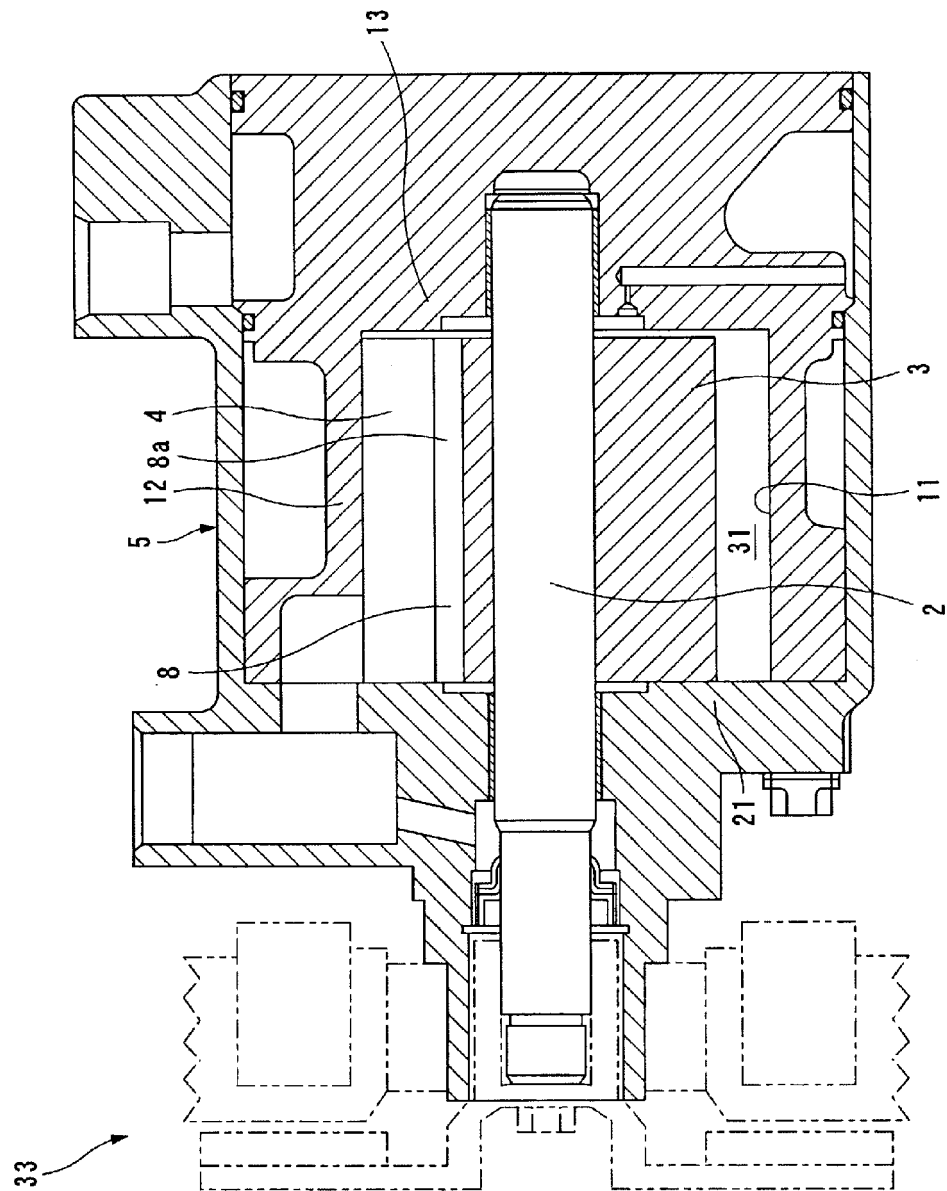
[图1]



[図2]



[圖3]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/065988

A. CLASSIFICATION OF SUBJECT MATTER

F04C18/344(2006.01)i, F04C29/00(2006.01)i, F04C29/12(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04C18/344, F04C29/00, F04C29/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2003-184770 A (Seiko Instruments Inc.), 03 July 2003 (03.07.2003), entire text; all drawings (Family: none)	1-3
A	JP 5-1663 A (Toshiba Corp.), 08 January 1993 (08.01.1993), entire text; all drawings & US 5242287 A	1-3
A	JP 57-110790 A (Toyoda Automatic Loom Works, Ltd.), 09 July 1982 (09.07.1982), entire text; all drawings (Family: none)	1-3

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
06 August, 2014 (06.08.14)Date of mailing of the international search report
19 August, 2014 (19.08.14)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/065988

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 60-164684 A (Hitachi, Ltd.), 27 August 1985 (27.08.1985), entire text; all drawings (Family: none)	1-3
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 62603/1982 (Laid-open No. 163694/1983) (Nissan Motor Co., Ltd.), 31 October 1983 (31.10.1983), entire text; all drawings (Family: none)	1-3
A	JP 2011-137426 A (Valeo Japan Co., Ltd.), 14 July 2011 (14.07.2011), entire text; all drawings (Family: none)	1-3

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2013050038 A [0004]
- JP 2007064163 A [0004]