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(54) VANE COMPRESSOR

(57) To provide a vane-type compressor capable of effectively avoiding abnormal pressure increase in back pressure chambers due to compression of liquid stored in the back pressure chambers at bottom parts of vane grooves. Back-pressure suppression concave portions 42 and 52 are formed in back-pressure closed regions in which the back pressure chamber 5a does not communicate with back-pressure introducing concave portions 41 and 51 on respective surfaces of a pair of side block forming portions 13 and 21 blocking both ends in an axial direction of a cylinder forming portion 12 that houses a rotor 3, which face end surfaces of the rotor 3. One of the back-pressure suppression concave portions 42 and 52 is allowed to communicate with a high-pressure fluid housing space (high pressure space 35) through a relief passage 44 to allow one of the back-pressure suppression concave portions to function as an oil releasing chamber and to allow the other to function as an oil damper chamber. Preferably, a volume of the back-pressure suppression concave portion 42 to which the relief passage 44 is not connected is larger than a volume of the back-pressure suppression concave portion 42 to which the relief passage 44 is connected.

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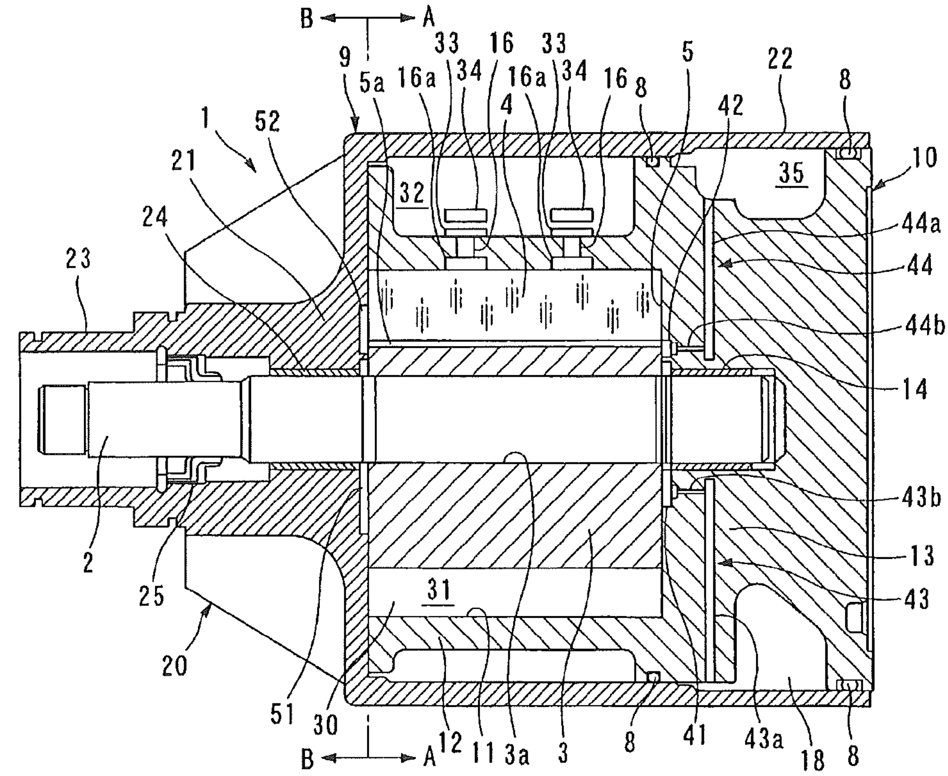
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Fig.1A

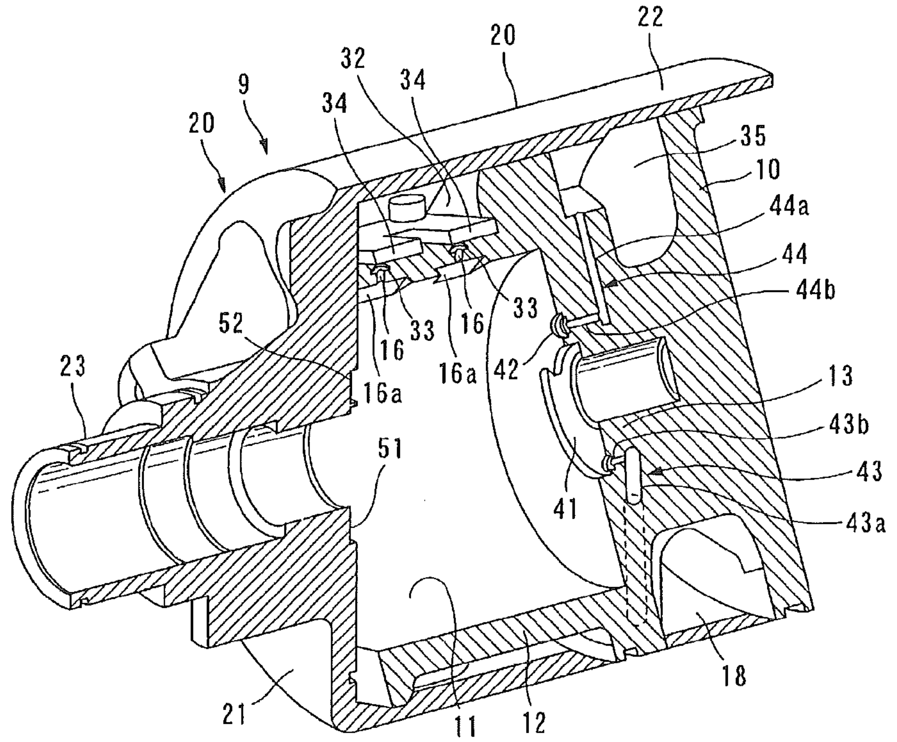
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Fig.1B

Description

Technical Field

[0001] The present invention relates to a vane-type compressor, and particularly relates to a vane-type compressor having a structure useful for coping with the inconvenience occurring when oil stored in back pressure chambers in bottom parts of vane grooves is compressed.

Background Art

[0002] A vane-type compressor is generally configured by including a cylinder in which a cam surface is formed, side blocks that block both ends of the cylinder in an axial direction, a rotor rotatably supported inside the cylinder, vane grooves formed from an outer peripheral surface of the rotor toward the inside and vanes housed in the vane grooves so as to project and retract. The back pressure chambers are provided in the bottom parts of the vane grooves, and the vanes are biased toward the cam surface of the cylinder by supplying the pressure introduced from a discharge pressure region to the back pressure chambers.

[0003] The pressure is supplied to the back pressure chambers through back-pressure introducing concave portions formed in the side blocks. The back-pressure introducing concave portions are provided so as to correspond to a rotation locus of the back pressure cambers in the rotating rotor on end surfaces of the side blocks that face the rotor so that the pressure can be supplied to the back pressure chambers in the rotor. An oil reservoir chamber in the discharge pressure region communicates with at least one of the back-pressure introducing concave portions through an oil introducing passage. The oil introducing passage has a throttle with a narrowed area thereinside. Accordingly, the pressure in the oil reservoir chamber is reduced and introduced into the back-pressure introducing concave portion, and then, supplied to the back pressure chambers of the rotating rotor.

[0004] However, there is a case in the above compressor where the pressure in a compression chamber becomes higher than the pressure in the back pressure chamber at the end of a compression stroke in an initial stage of starting the compressor when the pressure of the back pressure chamber is not sufficiently increased. In such case, it is known that a so-called chattering occurs, in which the vane is separated from the cam surface and contacts the cam surface of the cylinder again to generate collision noise.

[0005] As a countermeasure against the chattering, it is known that communication between the back pressure chamber and the back-pressure introducing concave portion is cut off at the end of the compression stroke to thereby increase the pressure in the back pressure chamber (refer to Patent Literature 1) . Specifically, a back-pressure closed region in which the back-pressure introducing concave portion is not formed is provided in an area facing the back pressure chamber at the end of the compression stroke in the end surfaces of the side blocks that face the rotor. Accordingly, the back pressure chamber is an independent closed space at the end of the compression stroke, and when the vane is pushed into the vane groove along the cam surface of the cylinder, fluid in the back pressure chamber is compressed and the back pressure is sufficiently increased.

[0006] Incidentally, liquid such as oil exists in the back-pressure introducing concave portion, and a medium with a high liquid content may be introduced into the back pressure chamber. However, the back pressure chamber is completely blocked at the end of the compression stroke in the vane-type compressor described in Patent Literature 1, therefore, the liquid medium confined in the back pressure chamber is compressed when the vane enters the vane groove. Accordingly, an abnormally high back pressure may act on the vane and a load generated when a tip end of the vane abuts on the cam surface may be increased, which may increase the degree of abrasion on the cam surface of the cylinder.

[0007] In order to prevent such danger, there is proposed a structure in which a blind hole for a damper is provided in the back-pressure closed region in which the back-pressure introducing concave portion is not formed on the end surface of the side block facing the rotor, and the pressure in the back pressure chamber is released to the blind hole for the damper to thereby avoid abnormal pressure increase in the back pressure chamber (refer to Patent Literature 2).

Citation List

Patent Literature

[0008]

Patent Literature 1: JP-A-57-26293
Patent Literature 2: JP-UM-B-02-20478

Summary of Invention

Technical Problem

[0009] However, the size of the blind hole for the damper which can be secured is limited in the above proposed structure, therefore, it is difficult to sufficiently reduce the abnormally high pressure in the back pressure chamber when a space of the blind hole is filled with liquid such as oil.

[0010] The present invention has been made in view of the above circumstances and an object thereof is to provide a vane-type compressor capable of effectively avoiding abnormal pressure increase in the back pressure chamber due to the compression of liquid stored in the back pressure chamber in the bottom parts of vane groove.

Solution to Problem

[0011] In order to solve the above problems, a vane-type compressor according to present invention includes a housing, a cylinder forming portion in which a cam surface is formed and which configures part of the housing, a pair of side block forming portions blocking both ends of the cylinder forming portion in an axial direction and configuring part of the housing, a drive shaft supported in the pair of side block forming portions so as to rotate freely, a rotor fixed to the drive shaft and rotatably housed inside the cylinder forming portion, a plurality of vane grooves formed in the rotor, a plurality of vanes inserting into the vane grooves so as to slide freely, tip end portions of which project and retract from the vane grooves to slide on the cam surface, back pressure chambers demarcated by the vane grooves and the vanes, compression chambers demarcated by the rotor and the vanes in a space blocked by the cylinder forming portion and the pair of side block forming portions, a high-pressure fluid housing space housing fluid discharged from the compression chambers, and an oil reservoir chamber for storing oil in a discharge pressure region, in which back-pressure introducing concave portions capable of communicating with the back pressure chamber over a given angle range centering around a support portion of the drive shaft are formed on surfaces of the pair of side block forming portions which face end surfaces of the rotor, at least one of the back-pressure introducing concave portions is allowed to communicate with the oil reservoir chamber through an oil introducing passage, back-pressure suppression concave portions capable of communicating with the back pressure chamber are formed in back pressure closed regions in which the back-pressure introducing concave portion is not formed on respective surfaces of the pair of side block forming portions which face end surfaces of the rotor, and one of the back-pressure suppression concave portions and the high-pressure fluid housing space are allowed to communicate with each other through a relief passage.

[0012] Therefore, even when a liquid medium such as oil is confined in the back pressure chamber and compressed due to entering of the vane, high pressure due to liquid compression inside the back pressure chamber is released to the back-pressure suppression concave portions formed in both of the pair of side block forming portions, thereby suppressing abnormal pressure increase in the back pressure chambers. As one of the back-pressure suppression concave portions communicates with the high-pressure fluid housing space through the relief passage, the compressed liquid is allowed to escape to the high-pressure fluid housing space through the relief passage even when the other back-pressure suppression concave portion is filled with liquid, which can suppress abnormal pressure increase in the back pressure chamber.

[0013] It is preferable that a volume of the back-pressure suppression concave portion to which the relief passage is not connected is set to be larger than a volume of the back-pressure suppression concave portion to which the relief passage is connected.

[0014] According to the above configuration, high pressure due to liquid compression in the back pressure chamber can be discharged by using the discharge from the relief passage on one hand, and can be absorbed by the back-pressure suppression concave portion having the enough volume on the other hand, therefore, abnormally high pressure can be suppressed with good balance.

[0015] It is preferable that the back-pressure suppression concave portions are capable of changing the volume by changing the area of the surface of the side block forming portion which faces the end surface of the rotor.

[0016] Though it is possible to adjust a depth of the back-pressure introducing concave portion for changing the volume, in a case where the volume is increased by changing the depth, the back-pressure introducing concave portion is easily filled with liquid such as oil and it is difficult to sufficiently obtain the effect due to increase in volume. Accordingly, concerning the volume of the back-pressure suppression concave portion, it is preferable that a ratio of housing a gas is increased by changing the area of the surface facing the end surface of the rotor to thereby increase the damper effect.

[0017] It is also preferable that the back-pressure suppression concave portion to which the relief passage is connected and the back-pressure introducing concave portion on the side where the back-pressure suppression concave portion is provided are not allowed to communicate with each other through the back pressure chamber.

[0018] According to the above, it is possible to eliminate a danger that a high-pressure gas in the high-pressure fluid housing space flows reversely to the back-pressure introducing concave portion through the back pressure chamber after passing through the relief passage and the back-pressure suppression concave portion to which the relief passage is connected to affect the performance of the compressor.

[0019] It is further preferable that the back-pressure suppression concave portion to which the relief passage is not connected and the back-pressure introducing concave portion on the side where the back-pressure suppression concave portion is provided are capable of communicating with each other through the back pressure chamber.

[0020] According to the above, the back-pressure suppression concave portion to which the relief passage is not connected is allowed to breathe through the back pressure, which can eliminate the danger that the back-pressure introducing concave portion is filled with oil to impair the damper function. Moreover, the back-pressure suppression concave portion is not connected to the high-pressure fluid housing space through the relief passage, therefore, there is no danger that the high-pressure fluid in the high-pressure fluid housing space flows into the back-pressure introducing concave portion and flows reversely to the back-pressure suppression concave portion through the back pressure chamber.

Advantageous Effects of Invention

[0021] As described above, according to the present invention, back-pressure suppression concave portions capable of communicating with the back pressure chambers are formed in back pressure closed regions in which the back pressure chamber does not communicate with the back-pressure introducing concave portion on surfaces of the pair of side block forming portions blocking both ends of the cylinder forming portion in the axial direction, which face the end surface of the rotor. The relief passage communicating with the high-pressure fluid housing space is connected to one of the back-pressure suppression concave portions, therefore, the high pressure due to liquid compression can be absorbed by the damper function in the back-pressure suppression concave portion even when liquid confined in the back pressure chamber is compressed with the entering of the vane. Even when the back-pressure suppression concave portion is filled with liquid, the compressed liquid is allowed to escape to the high-pressure fluid housing space through the relief passage due to the back-pressure suppression concave portion to which the relief passage is connected, which can suppress abnormal pressure increase in the back pressure chamber.

[0022] In order to increase the damper function particularly in the back-pressure suppression concave portion to which the relief passage is not connected, the volume of the back-pressure suppression concave portion is preferably larger than the volume of the back-pressure suppression concave portion to which the relief passage is connected. According to the configuration, pressure increase in the back pressure chamber on the side where the relief passage is not connected can be suppressed to the same degree as in the side where the relief passage is connected.

Brief Description of Drawings

[0023]

Fig. 1 is a view showing a vane-type compressor according to the present invention, in which (a) is a cross-sectional side view and (b) is a cross-sectional perspective view showing a first housing member and a second housing member of the vane-type compressor shown in (a).

Fig. 2 (a) is a perspective view showing the first housing member of the vane-type compressor shown in Fig. 1, and Fig. 2(b) is a cross-sectional view taken along A-A line of Fig. 1.

Fig. 3 (a) is a perspective view showing the second housing member of the vane-type compressor shown in Fig. 1, and Fig. 3(b) is a cross-sectional view taken along B-B line of Fig. 1.

Fig. 4 (a) is a view for explaining a relationship between a back-pressure introducing concave portion and a back-pressure suppression concave portion on the front side of the vane-type compressor according to the present invention, and Fig. 4 (b) is a view for explaining a relationship between a back-pressure introducing concave portion and a back-pressure suppression concave portion on the rear side of the vane-type compressor according to the present invention.

Fig. 5 (a) is a timing chart showing the timing when back pressure chamber communicates with the back-pressure introducing concave portion and the back-pressure suppression concave portion on the front side respectively, and Fig. 5 (b) is a timing chart showing the timing when the back pressure chamber communicates with the back-pressure introducing concave portion and the back-pressure suppression concave portion on the rear side, respectively.

Description of Embodiments

[0024] Hereinafter, a vane-type compressor according to the present invention will be explained with reference to the drawings.

[0025] In Fig. 1, a vane-type compressor suitable for a refrigerating cycle using a refrigerant as a working fluid is shown. A vane-type compressor 1 is configured by including a drive shaft 2, a rotor 3 fixed to the drive shaft 2 and rotating with the rotational motion of the drive shaft 2, vanes 4 attached to the rotor 3 and a housing 9 supporting the drive shaft 9 so as to rotate freely and housing the rotor 3 and the vanes 4. In Fig. 1, the left side is the front side and the right side is the rear side.

[0026] The housing 9 is configured by combining two members which are a first housing member 10 and a second housing member 20. The first housing member 10 includes a cylinder forming portion 12 in which the rotor 3 is housed and a cam surface 11 is formed on an inner peripheral surface and a first side block forming portion 13 integrally formed so as to block one end side (rear side) of the cylinder forming portion 12 in the axial direction also as shown in Fig. 2. The inner peripheral surface (cam surface 11) of the cylinder forming portion 12 is formed to have a perfect circle in cross section so that a length in the axial direction is approximately equal to a length of the later-described rotor 3 in the axial direction.

[0027] The second housing member 20 is configured by including a second side block forming portion 21 abutting on an end surface of the other end side (front side) of the cylinder forming portion 12 in the axial direction to block this other end side and a shell forming portion 22 integrally formed with the second side block forming portion 21 also as shown in Fig. 3. The shell forming portion 22 is extended in the axial direction of the drive shaft 2 and formed so as to surround outer peripheral surfaces of the cylinder forming portion 12 and the first side block forming portion 13.

[0028] Moreover, the first housing member 10 and the second housing member 20 are fastened in the axial direction through not-shown connecting fittings such as bolts. A sealing member 8 such as an O-ring is interposed between the first side block forming portion 13 of the first housing member 10 and the shell forming portion 22 of the second housing member 20 to seal the space therebetween with good airtightness.

[0029] Furthermore, a boss portion 23 extended from the second side block forming portion 21 toward the front side is integrally formed in the second housing member 20. A pulley (not shown) transmitting rotational power to the drive shaft 2 is fitted onto the boss portion 23 so as to rotate freely, and the rotational power is transmitted from the pulley to the drive shaft 2 through a not-shown electromagnetic clutch.

[0030] The drive shaft 2 is supported by the first side block forming portion 13 and the second side block forming portion 21 so as to rotate freely through bearings 14 and 24. A tip end portion of the drive shaft 2 protrudes inside the boss portion 23 of the second housing member 20, and a space between the drive shaft 2 and the boss portion 23 is sealed with good airtightness by a sealing member 25 provided between the drive shaft 2 and the boss portion 23.

[0031] The rotor 3 is formed to have a perfect circle shape in cross section, in which the drive shaft 2 is inserted into an insertion hole 3a provided in an axial center thereof so as to be fixed to the drive shaft 2 so that their axial centers coincide with each other. An axial center O' of the cylinder forming portion 12 and an axial center O of the rotor 3 (drive shaft 2) are provided so as to be shifted (provided so as to be shifted by 1/2 of a difference between an inner diameter of the cylinder forming portion 12 and an outer diameter of the rotor 3) so that an outer peripheral surface of the rotor 3 and an inner peripheral surface (cam surface 11) of the cylinder forming portion 12 abut on each other at a place in a circumferential direction. In a space blocked by the cylinder forming portion 12, the first side block forming portion 13 and the second side block forming portion 21, a compression space 30 is demarcated between the inner peripheral surface (cam surface 11) of the cylinder forming portion 12 and the outer peripheral surface of the rotor 3.

[0032] In the second housing member 20, a suction opening for sucking a working fluid (refrigerant gas) from the outside and a discharge opening for discharging the working fluid to the outside are formed though not shown. In the cylinder forming portion 12 of the first housing member 10, a suction port 15 communicating with the suction opening is formed in the vicinity of the front side in a rotation direction of the rotor 3 with respect to a portion (hereinafter, a radial sealing portion 40) where the outer peripheral surface of the rotor 3 is close to the inner peripheral surface (cam surface 11) of the cylinder forming portion 12. Also, discharge ports 16 communicating with the discharge opening are formed closest to the rear side in the rotation direction of the rotor 3. In Fig. 2 and Fig. 3, 36 denotes screws holes into which connecting fittings are screwed. In Fig. 3, 37 denotes a low-pressure space for allowing the suction opening to communicate with the suction port 15.

[0033] The discharge ports 16 include counterbores 16a which are recessed in a curved shape along the circumferential direction at opening ends with respect to the inner surface (cam surface 11) of the cylinder forming portion 12. A compressed gas is discharged through the counterbores 16a. A discharge chamber 32 is formed between the cylinder forming portion 12 of the first housing member 10 and the shell forming portion 22 of the second housing member 20. The discharge ports 16 open to the discharge chamber 32 and are blocked by discharge valves 33 provided in the discharge chamber 32 so as to be opened/closed. Note that 34 denotes retainers for regulating movement of the discharge valves 33.

[0034] Furthermore, a high-pressure space 35 to which the discharge opening is connected is formed between the first side block forming portion 13 of the first housing member 10 and the shell forming portion 22 of the second housing member 20. The discharge chamber 32 communicates with the high-pressure space 35 through a not-shown oil separator. A high-pressure fluid housing space for housing the fluid discharged from the discharge ports 16 is formed by the discharge chamber 32 and the high-pressure space 35. Moreover, an oil reservoir chamber 18 for storing oil separated from the working fluid by the not-shown oil separator is formed between a lower part of the first side block forming portion 13 of the first housing member 10 and a lower part of the shell forming portion 22 of the second housing member 20. The discharge chamber 32, the high-pressure chamber 35 and the oil reservoir chamber are included in a discharge pressure region.

[0035] Plural vane grooves 5 are formed on the outer peripheral surface of the rotor 3 along the axial direction of the rotor 3, and vanes 4 are inserted into the respective vane grooves 5 so as to slide freely. The vane grooves 5 open not only to the outer peripheral surface of the rotor 3 but also to end surfaces facing the first side block forming portion 13 and the second side block forming portion 21, and back surface chambers 5a are formed on bottom parts with respect to the vanes 4. A plurality of vane grooves 5 are formed in the circumferential direction at equal intervals so as to be parallel with each other at two places where phases are different by 180 degrees in this example.

[0036] The vanes 4 are formed so that widths along the axial direction of the drive shaft 2 are equal to lengths of the rotor 3 in the axial direction. Lengths in the insertion direction (sliding direction) with respect to the vane grooves 5 are approximately equal to lengths of the vane grooves 5 in the same direction. The vanes 4 protrude from the vane grooves 5 due to the back pressure supplied to the back pressure chambers 5a of the vane grooves 5 so that tip end portions can abut on the inner peripheral surface (cam surface 11) of the cylinder forming portion 12.

[0037] Therefore, the compression space 30 is partitioned into plural compression chambers 31 by the vanes 4 inserted into the vane grooves 5 so as to slide freely. Volumes of respective compression chambers 31 are changed by rotation of the rotor 3.

[0038] On a surface of the first side block forming portion 13 which faces the end surface of the rotor 3 in the axial direction, a first back-pressure introducing concave portion 41 and a first back-pressure suppression concave portion 42 which can communicate with the back-pressure chambers 5a provided on the bottom parts of the vane grooves 5 are formed. Here, "can communicate" means that the back-pressure chamber 5a rotates around the axial center O of the rotor 3 with the rotation of the rotor 3 and passes in front of the first back-pressure introducing concave portion 41 or the first back-pressure suppression concave portion 42 to communicate with the first back-pressure introducing concave portion 41 or the first back-pressure suppression concave portion 42 momentarily. Also in the following description, "can communicate" indicates the momentary communication with respect to the back pressure chamber 5a with the rotation of the rotor 3.

[0039] The first back-pressure introducing concave portion 41 corresponds to a rotation locus of the bottom part (back-pressure chamber 5a) of the vane groove 5 in which the vane 4 demarcating the compression chamber is housed, which is formed so as to communicate with the back-pressure chamber 5a while the compression chamber moves from the start of a suction stroke to the beginning of the end of the compression stroke. Specifically, the first back-pressure introducing concave portion 41 is formed so as to communicate with the bottom part of the vane groove 5 (back-pressure chamber 5a) over a range where a tip end portion of the vane 4 moves from a part coming close to the suction port 15 to a part before coming close to the discharge ports 16 (before coming close to the counterbores 16a).

[0040] On the other hand, the first back-pressure suppression concave portion 42 is provided in a region where the first back-pressure introducing concave portion 41 is not provided (back-pressure closed region α), which is formed so as to communicate with the bottom part of the vane groove 5 (back pressure chamber 5a) over a range where the tip end portion of the vane 4 moves from a position close to the discharge ports 16a (position close to the couterbores 16a) to a part before the radial sealing portion 40.

[0041] The first back-pressure suppression concave portion 42 is formed so as to be separated from the first back-pressure introducing concave portion 41 by a size equal to or larger than a size of the back-pressure chamber 5a in the circumferential direction so as not to communicate with the first back-pressure introducing concave portion 41 by the bottom part (back-pressure chamber 5a) as shown in Fig. 4 (a) .

[0042] That is, when considering variations in communicating area between the back-pressure chamber 5a and the first back-pressure introducing concave portion 41 as well as the first back-pressure suppression concave portion 42 by changing a rotation angle of the rotor 3, the position and the size of the first back-pressure suppression concave portion 42 are set so that regions where the back-pressure chamber 5a does not communicate with any of the first back-pressure introducing concave portion 41 and the first back-pressure suppression concave portion 42 are formed as shown in Fig. 5 (a).

[0043] In the first side block forming portion 13 where the first back-pressure introducing concave portion 41 and the first back-pressure suppression concave portion 42 are formed, an oil introducing passage 43 for allowing the first back-pressure introducing concave portion 41 to communicate with the oil reservoir chamber 18 and a relief passage 44 for allowing the first back-pressure suppression concave portion 42 to communicate with the high-pressure space 35 are formed.

[0044] The oil introducing passage 43 is configured by including an oil suction passage 43a drilled from the oil reservoir chamber 18 to the radial direction of the first side block forming portion 13 and an orifice passage 43b one end of which opens to the oil suction passage 43a and the other end of which opens to the first back-pressure introducing concave portion 41.

[0045] The relief passage 44 is configured by including a radial direction passage 44a drilled from the high-pressure space 35 to the radial direction of the first side block forming portion 13 and an orifice passage 44b one end of which opens to the radial direction passage 52a and the other end of which opens to the second concave portion 42.

[0046] Throttles are formed in the oil introducing passage 43 and the relief passage 44 due to the orifice passages 43b and 44b.

[0047] Accordingly, when the bottom part (back pressure chamber 5a) of the vane groove 5 communicates with the first concave portion 41, the oil stored in the oil reservoir chamber 18 in the discharge pressure region is introduced into the first back-pressure introducing concave portion 41 through the oil suction passage 44a and the orifice passage 44b and fed into the back pressure chamber 5a through the first back-pressure introducing concave portion 41. After that, the bottom part (back pressure chamber 5) of the vane groove 5 enters the back pressure closed region α where the first back-pressure introducing concave portion 41 is not formed by the rotation of the rotor 3, the back pressure chamber 5a becomes an independent closed space and fluid in the back pressure chamber is compressed and the pressure in the chamber is increased due to the entering of the vane 4. However, when the rotor 3 further rotates, the back pressure chamber 5a communicates with the first back-pressure suppression concave portion 42 to thereby release the pressure generated by the fluid in the back pressure chamber being compressed due to the entering of the vane from the first back-pressure suppression concave portion 42 to the high pressure space 35 through the relief passage 44.

[0048] On the other hand, on an end surface of the second side block forming portion 21 which faces the end surface of the rotor 3 in the axial direction, a second back-pressure introducing concave portion 51 and a second back-pressure suppression concave portion 52 which can communicate with the back pressure chambers 5a are formed.

[0049] The second back-pressure introducing concave portion 51 is formed so as to communicate with the bottom part of the vane groove 5 (back-pressure chamber 5a) over a range where the tip end portion of the vane 4 moves from a part coming close to the suction port 15 to a part before coming close to the discharge ports 16 (before coming close to the counterbores 16a). The second back-pressure introducing concave portion 51 is formed so as to be plane-symmetrical to the first back-pressure introducing concave portion 41 with respect to a plane perpendicular to the drive shaft 2.

[0050] The second back-pressure suppression concave portion 52 is provided in a region where the second back-pressure introducing concave portion 51 is not provided (back-pressure closed region β), which is formed so as to communicate with the bottom part of the vane groove 5 (back pressure chamber 5a) over a range where the tip end portion of the vane 4 moves from a position before coming close to the discharge ports 16 (position before coming close to the couterbores 16a) to a part passing the radial sealing portion 40.

[0051] Moreover, the second back-pressure suppression concave portion 52 is formed so as to be separated from the second back-pressure introducing concave portion 51 by a size equal to or smaller than the size of the back-pressure chamber 5a in the circumferential direction.

[0052] That is, when considering variations in communicating area between the back-pressure chamber 5a and the second back-pressure introducing concave portion 51 as well as the second back-pressure suppression concave portion 52 by changing the rotation angle of the rotor 3, the position and the size of the second back-pressure suppression concave portion 52 are set so that regions where the back-pressure chamber 5a communicates with both of the second back-pressure introducing concave portion 51 and the second back-pressure suppression concave portion 52 are formed as shown in Fig. 5 (b). Therefore, the second back-pressure suppression concave portion 52 is formed to be wider than the first back-pressure suppression concave portion 42 in the circumferential direction and is formed so that a volume of the second back-pressure suppression concave portion 52 is formed to be larger than a volume of the first back-pressure suppression concave portion 42.

[0053] In the above configuration, the structure in which oil is easily introduced in to the back pressure chambers 5a through the oil introducing passage 43 and the first back-pressure introducing concave portion 41 is adopted, therefore, in a case where an introduction amount of oil to the back pressure chamber 5a is large, the inside of the back pressure chamber becomes a closed space when the back pressure chamber 5a comes close to the back pressure closed regions α, β where the back-pressure introducing concave portion 41 is not formed by the rotation of the rotor 3, and the fluid inside the back pressure chamber is compressed as the vane 4 enters the vane groove 5, then, the pressure is abnormally increased. However, the first back-pressure suppression concave portion 42 is formed on the rear side and the second back-pressure suppression concave portion 52 is formed on the front side in the back pressure closed regions α, β, therefore, when the back pressure chamber 5a comes close to these back-pressure suppression concave portions 42 and 52, oil (or pressure) inside the back pressure chamber is released to the back-pressure suppression concave portions 42 and 52, which can alleviate the pressure increase in the back pressure chamber 5a.

[0054] At this time, the relief passage 44 is connected to the first back-pressure suppression concave portion 42 on the rear side, therefore, oil (or pressure) released to the first back-pressure suppression concave portion 42 is allowed to escape to the high-pressure space 35 through the relief passage 44 even when the first back-pressure suppression concave portion 42 is filled, which can suppress abnormal pressure increase in the back pressure chamber 5a. Therefore, oil (or pressure) inside the back pressure chamber is allowed to escape through the relief passage 44, therefore, it is no problem if the volume of the first back-pressure suppression concave portion 42 is small. It is also possible to form the relief passage 44 alone by eliminating the first back-pressure suppression concave portion 42.

[0055] On the front side, oil (or pressure) in the back pressure chamber 5a is allowed to escape to the second back-pressure suppression concave portion 52 when the back pressure chamber 5a communicates with the second back-pressure suppression concave portion 52, and abnormal pressure increase can be absorbed by the damper function. As the volume of the second back-pressure suppression concave portion 52 is larger than the volume of the first back-pressure suppression concave portion 42 particularly in this example, it is possible to avoid the inconvenience that the second back-pressure suppression concave portion 52 is filled with oil and the damper function is inhibited.

[0056] Accordingly, mechanisms for avoiding abnormal increase of the back pressure are provided in both ends of the rotor 3 in the axial direction in the above configuration, therefore, it is possible to equally suppress abnormal increase of the back pressure over the entire region of the back pressure chambers 5a, and the inconvenience that loads generated by tip ends of the vanes

4 abutting on the cam surface 11 are increased and the degree of abrasion of the cam surface (inner peripheral surface of the cylinder forming portion 12) is increased can be avoided.

[0057] If the mechanism for suppressing abnormally high pressure in the back pressure is configured by a mechanism with a poor damping function including the relief passage 44 alone, a passage resistance generated when oil with a high viscosity is allowed to pass through the relief passage 44 at the time of a low temperature or the like may be increased and there is a danger that the high pressure is not sufficiently alleviated. Conversely, when the damper space without the relief passage (second back-pressure suppression concave portion 52) is adopted alone, it is difficult to sufficiently alleviate abnormally high pressure due to saturation of oil when the volume of the damper space is small, and further, there is a danger that the effect of suppressing chattering to be obtained by increasing the back pressure due to the back pressure closed region at the time of normal gas compression is impaired when the damper space is too large. In the above configuration, the structure of discharging the high pressure through the relief passage 44 is combined with the structure of releasing the high pressure to the damper space (second back-pressure suppression concave portion 52) to be absorbed, thereby realizing well-balanced suppression of abnormally high pressure with high stability under various conditions.

[0058] As a method of setting the volume of the second back-pressure suppression concave portion 52 to be larger than the volume of the first back-pressure suppression concave portion 42, it is possible to consider a method of increasing a depth of the back-pressure suppression concave portion 52, however, a case where, if the depth of the back-pressure suppression concave portion is increased, the amount of oil to be stored there is increased but a region of an air layer is not increased so much can be assumed, therefore, it is preferable that the depth of the second back-pressure suppression concave portion 52 on the front side is set to be the same as the depth of the first back-pressure suppression concave portion 42 on the rear side, and that the area of the second back-pressure suppression concave portion 52 is set to be larger than the area of the first back-pressure suppression concave portion 42 as in the above configuration example to thereby secure the region of the air layer in the second back-pressure suppression concave portion 52 to be large and to increase the damper effect due to the air layer.

[0059] As the first back-pressure introducing concave portion 41 and the first back-pressure suppression concave portion 42 on the rear side do not communicate with each other through the back pressure chamber 5a, there is no inconvenience that the high pressure in the high-pressure space 35 flows reversely from the relief passage 44 and the first back-pressure suppression concave portion 42 to the first back-pressure introducing concave portion 41 through the back pressure chamber 5a, therefore, the danger of causing chattering and the inconvenience that efficiency of the compressor is reduced can be avoided.

[0060] On the other hand, the second back-pressure introducing concave portion 51 on the front side can communicate with the second back-pressure suppression concave portion 52 through the back pressure chambers 5a, however, the second back-pressure introducing concave portion 51 does not communicate with the first back-pressure suppression concave portion 42 even indirectly, therefore, the inconvenience that the high pressure flows reversely from the high-pressure space 35, and oil (or pressure) in the second back-pressure suppression concave portion 52 can be released to the second back-pressure introducing concave portion 51 through the back pressure chambers 5a, which can effectively suppress abnormal pressure increase in the back pressure chamber.

[0061] In the above configuration, the example in which the relief passage 44 communicating with the high-pressure space 35 is connected to the first back-pressure suppression concave portion 42 on the rear side, and the volume of the second back-pressure suppression concave portion 52 on the front side is set to be larger than the volume of the first back-pressure suppression concave portion 42 on the rear side is shown. It is also preferable to reverse the above relationship, and the relief passage communicating with the high-pressure space 35 may be connected to the second back-pressure suppression concave portion 52 on the front side and the volume of the first back-pressure suppression concave portion 42 on the rear side may be set to be larger than the volume of the second back-pressure suppression concave portion 52 on the front side.

[0062] Also in the above configuration, the oil introducing passage 43 communicating with the oil reservoir chamber 18 is connected to the first back-pressure introducing concave portion 41 on the rear side, however, it is also preferable that the oil introducing passage is connected to the second back-pressure introducing concave portion 51 on the front side instead of the above configuration or in addition to the above configuration.

[0063] Furthermore, a pair of side block forming portions 13 and 21 are formed integrally with the cylinder forming portion 12 and the shell forming portion 22 respectively in the above configuration, however, it is also preferable to form these components as separate parts.

[0064] Additionally, the above configurations can be adopted in the same manner in a vane-type compressor having three or more vanes 4. Even in the configuration of two vanes, the above configurations may be adopted in the same manner not only in the case where the vane grooves 5 (vanes 4) are provided so as to be offset but also in a case where a plane including vane 4 and a plane parallel to the vane 4 and including the axial center O of the drive shaft 2 are allowed to coincide (set an offset to "0 (zero)" as well as in a case where vanes are offset in opposite directions.

Reference Signs List

[0065]

1	vane-type compressor
2	drive shaft
3	rotor
4	vane
5	vane groove
5a	back pressure chamber
9	housing
10	first housing member
11	cam surface
12	cylinder forming portion
13	first side block forming portion
18	oil reservoir chamber
20	second housing member
21	second side block forming portion
31	compression chamber
32	discharge chamber
35	high-pressure space
41	first back-pressure introducing concave portion
42	first back-pressure suppression concave portion
43	oil introducing passage
44	relief passage
51	second back-pressure introducing concave portion
52	second back-pressure suppression concave portion
α, β	back pressure closed region

Claims

1. A vane-type compressor (1) comprising:

    a housing (9);
    a cylinder forming portion (12) in which a cam surface (11) is formed and which configures part of the housing (9);
    a pair of side block forming portions (13, 21) blocking both ends of the cylinder forming portion (12) in an axial direction and configuring part of the housing (9);
    a drive shaft (2) supported in the pair of side block forming portions (13, 21) so as to rotate freely;
    a rotor (3) fixed to the drive shaft (2) and rotatably housed inside the cylinder forming portion (12);
    a plurality of vane grooves (5) formed in the rotor (3) ;
    a plurality of vanes (4) inserting into the vane grooves (5) so as to slide freely, tip end portions of which project and retract from the vane grooves (5) to slide on the cam surface (11) ;
    back pressure chambers (5a) demarcated by the vane grooves (5) and the vanes (4);
    compression chambers (31) demarcated by the rotor (3) and the vanes (4) in a space blocked by the cylinder forming portion (12) and the pair of side block forming portions (13, 21) ;
    a high-pressure fluid housing space (32, 35) housing fluid discharged from the compression chambers (31); and
    an oil reservoir (18) chamber for storing oil in a discharge pressure region,
    wherein back-pressure introducing concave portions (41, 51) capable of communicating with the back pressure chamber (5a) over a given angle range centering around a support portion of the drive shaft (2) are formed on surfaces of the pair of side block forming portions (13, 21) which face end surfaces of the rotor (3),
    and at least one of the back-pressure introducing concave portions (41, 51) is allowed to communicate with the oil reservoir chamber (18) through an oil introducing passage (43),
    characterized in that back-pressure suppression concave portions (42, 52) capable of communicating with the back pressure chamber (5a) are formed in back pressure closed regions (α, β) in which the back-pressure introducing concave portion (41, 51) is not formed on respective surfaces of the pair of side block forming portions (13, 21) which face end surfaces of the rotor (3), and
    one of the back-pressure suppression concave portions (42, 52) and the high-pressure fluid housing space (32, 35) are allowed to communicate with each other through a relief passage (44).

2. The vane-type compressor (1) according to claim 1, wherein a volume of the back-pressure suppression concave portion (42, 52) to which the relief passage (44) is not connected is set to be larger than a volume of the back-pressure suppression concave portion (42, 52) to which the relief passage (44) is connected in the back-pressure suppression concave portions (42, 52) formed in the pair of side block forming portions (13, 21).

3. The vane-type compressor (1) according to claim 1 or 2,
wherein the back-pressure suppression concave portion (42, 52) is capable of changing the volume by changing the area of the surface of the side block forming portion (13, 21) which faces the end surface of the rotor (3).

4. The vane-type compressor (1) according to any one of claims 1 to 3,
wherein the back-pressure suppression concave portion (42, 52) to which the relief passage (44) is connected and the back-pressure introducing concave portion (41, 51) on the side where the back-

pressure suppression concave portion (42, 52) is provided are not allowed to communicate with each other through the back pressure chamber (5a).

5. The vane-type compressor (1) according to claim 4, wherein the back-pressure suppression concave portion (42, 52) to which the relief passage (44) is not connected and the back-pressure introducing concave portion (41, 51) on the side where the back-pressure suppression concave portion (42, 52) is provided are capable of communicate with each other through the back pressure chamber (5a).

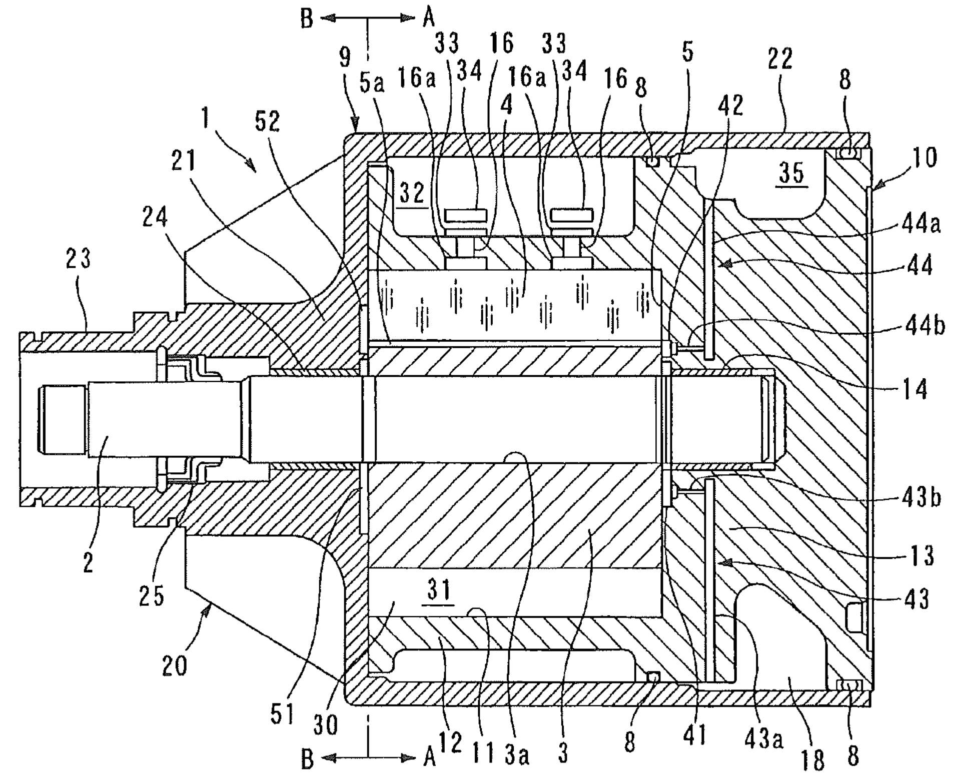
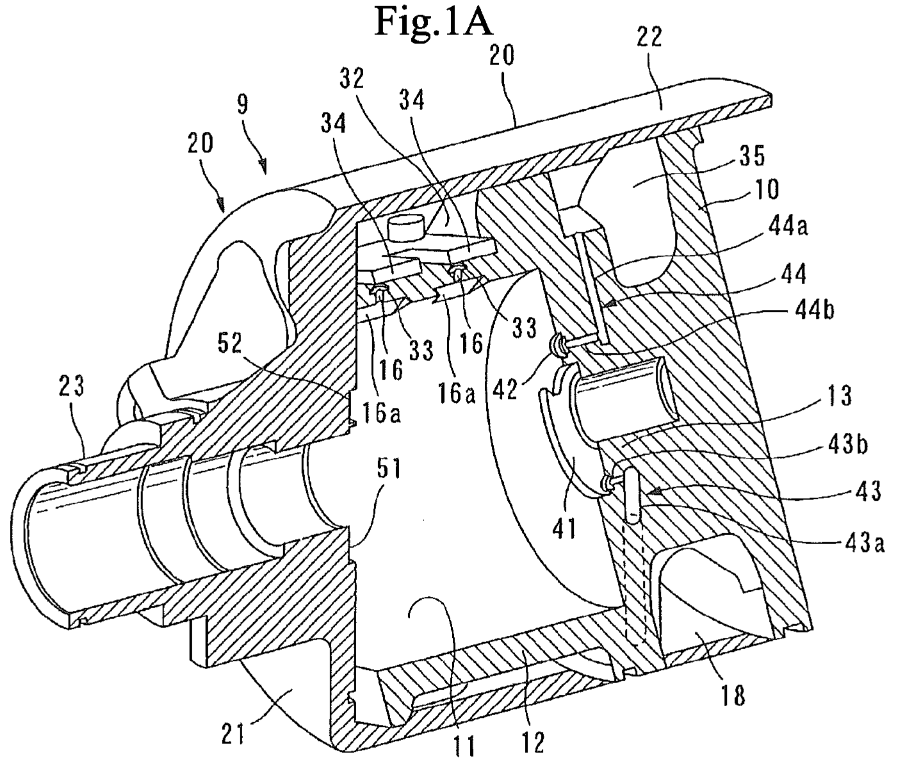

B
A
B
A
1
2
3
3a
4
5
5a
8
9
10
11
12
13
14
16
16a
18
20
21
22
23
24
25
30
31
32
33
34
35
41
42
43
43a
43b
44
44a
44b
51
52

Fig.1A


9
10
11
12
13
16
16a
18
20
21
22
23
32
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34
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41
42
43
43a
43b
44
44a
44b
51
52

Fig.1B

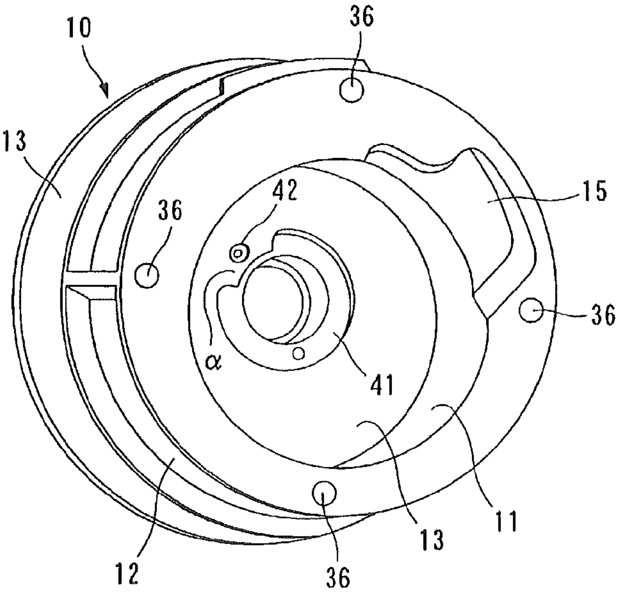
10
36
13
42
36
15
36
α
41
13
11
12
13
36

Fig.2A

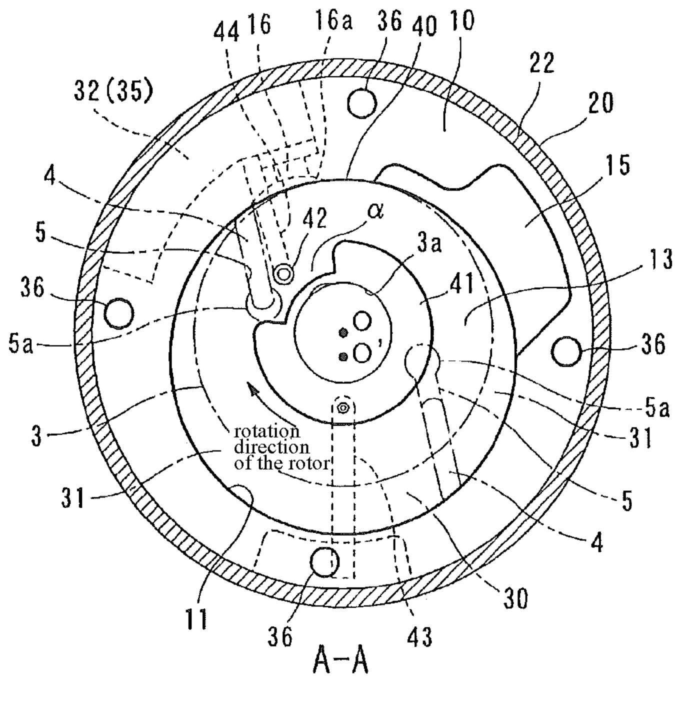
44
16
16a
36
40
10
22
20
32 (35)
15
4
42
α
3a
13
5
41
36
36
5a
5a
31
3
rotation direction of the rotor
31
5
4
11
36
43
30
A-A

Fig.2B

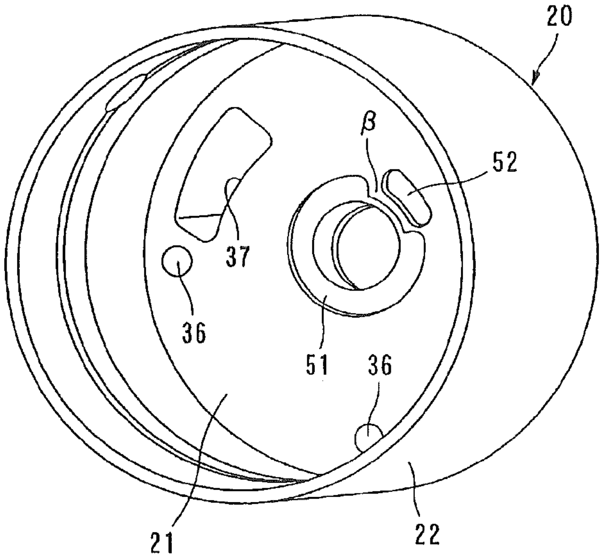
20
β
52
37
36
51
36
21
22

Fig.3A

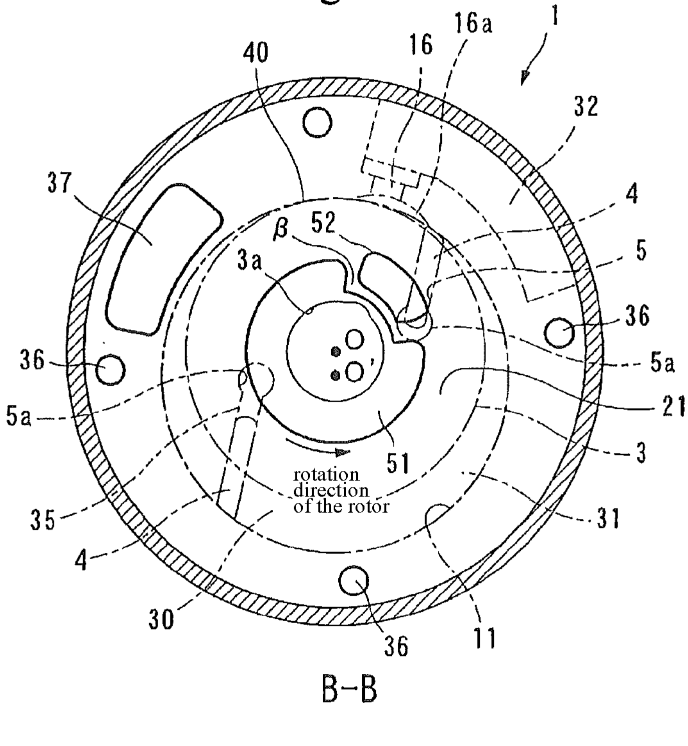
1
40
16
16a
32
37
4
β
52
5
3a
36
36
5a
5a
21
51
3
rotation
direction
of the rotor
35
31
4
30
36
11
B-B

Fig.3B

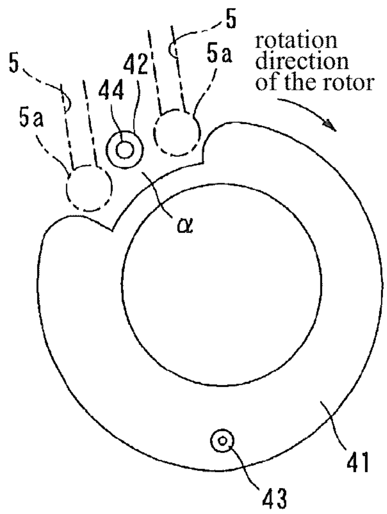

Fig.4A

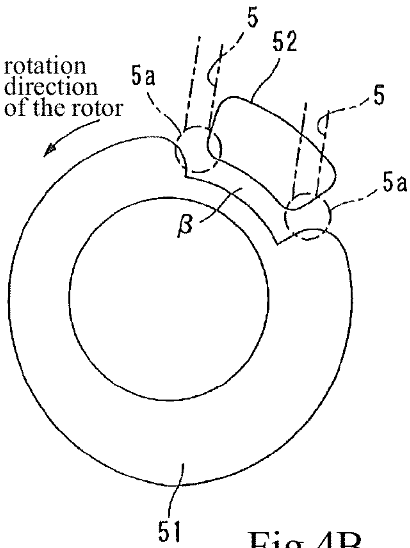

Fig.4B

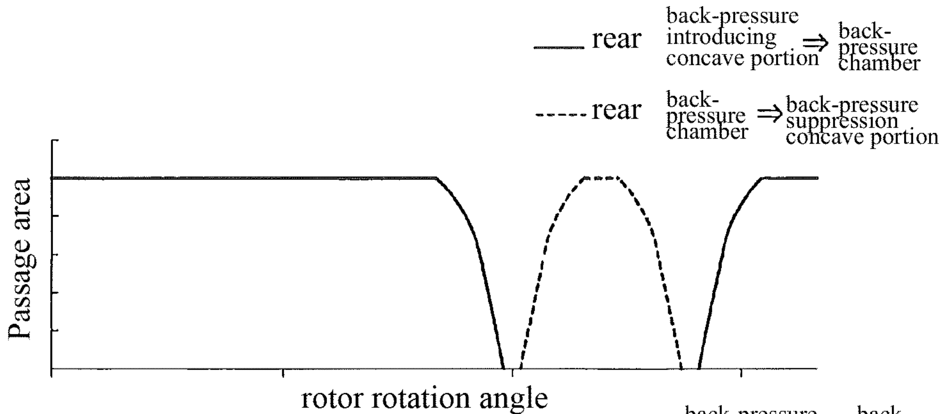

Fig.5A

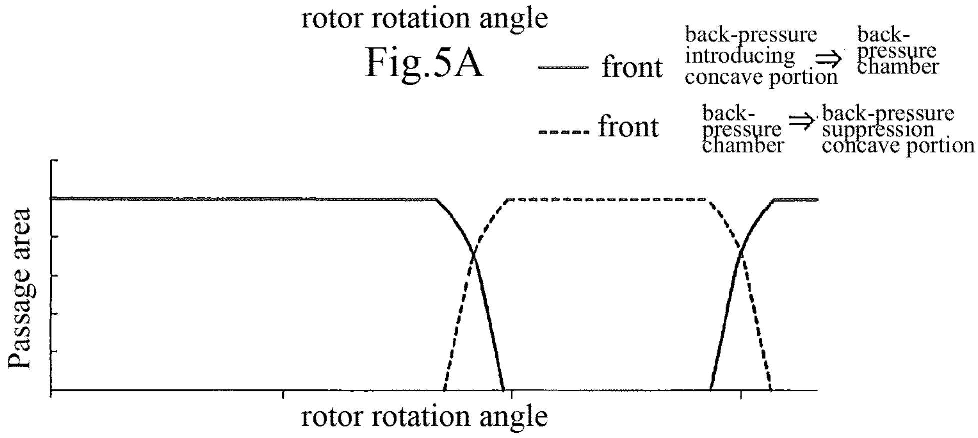

Fig.5B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/088362

A. CLASSIFICATION OF SUBJECT MATTER
F04C18/344(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

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	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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.
Y A	JP 2014-125962 A (Calsonic Kansei Corp.), 07 July 2014 (07.07.2014), paragraphs [0017] to [0030], [0062] to [0112] & WO 2014/103974 A1	1,4 2-3,5
Y A	JP 2-20478 Y2 (Diesel Kiki Co., Ltd.), 04 June 1990 (04.06.1990), column 3, line 26 to column 6, line 32; fig. 1 to 4 & US 4636153 A column 2, line 57 to column 5, line 39	1,4 2-3,5

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

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- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 March 2017 (23.03.17)	04 April 2017 (04.04.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/088362

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 59-103984 A (Toyoda Automatic Loom Works, Ltd.), 15 June 1984 (15.06.1984), page 3, lower right column, line 18 to page 4, upper left column, line 2; fig. 1 to 4 (Family: none)	4 1-3,5
A	JP 2001-165081 A (Matsushita Electric Industrial Co., Ltd.), 19 June 2001 (19.06.2001), entire text; all drawings (Family: none)	1-5
A	US 4621986 A (Yukio SUDO), 11 November 1986 (11.11.1986), entire text; all drawings (Family: none)	1-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 57026293 A **[0008]**
- JP 2020478 B **[0008]**