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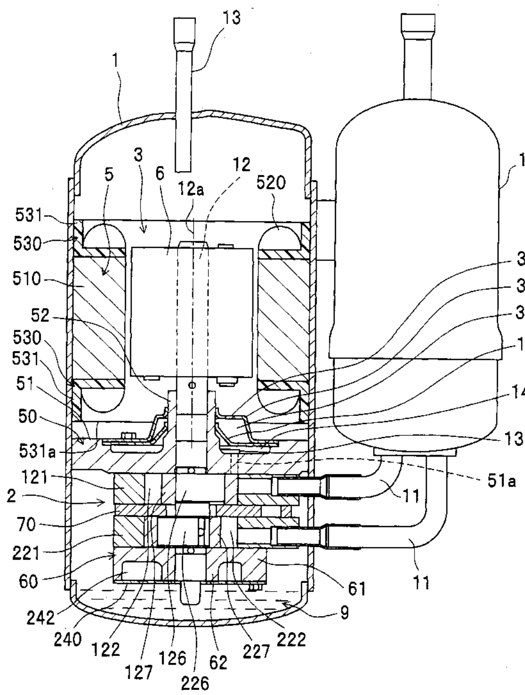
(54) **COMPRESSOR**

(57) A discharge port 340a of a compression element 2 is positioned inside an outer circumferential surface of a stator 5, as seen looking in a direction of a rotation axis 12a of a shaft 12, and overlaps the stator 5, as seen looking in a direction orthogonal to the rotation axis 12a of the shaft 12. Accordingly, refrigerant gas discharged from the compression element 2 can be made to flow mainly into spaces inside the outer circumferential surface of the stator 5.

Fig.1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a compressor that is used, for example, in an air conditioner, a refrigerator, and the like.

BACKGROUND ART

[0002] A conventional compressor has a sealed casing, a compression element placed in the sealed casing, and a motor that is placed in the sealed casing and that drives the compression element through a shaft. The compression element has a bearing for supporting the shaft, and the bearing has an oil discharge port for discharging lubricating oil supplied into between the bearing and the shaft, to outside of the bearing. The motor has a rotor and a stator placed on radial outside of the rotor (see JP H10-153188 A).

[0003] In the conventional compressor, however, the lubricating oil discharged from the oil discharge port of the bearing, together with refrigerant gas discharged from the compression element into the sealed casing, flows through spaces (outer passage) between the stator and the sealed casing and through spaces (inner passage) between the stator and the rotor.

[0004] Accordingly, the lubricating oil having flowed together with the refrigerant gas to downstream side of the motor (upper side of the compressor) is impeded by the refrigerant gas and thereby becomes hard to pass through the outer passage and the inner passage and to return to upstream side of the motor (lower side of the compressor).

[0005] It is a primary object of the invention to provide a compressor by which lubricating oil having flowed together with refrigerant gas to downstream side of the motor can efficiently be returned to upstream side of the motor.

DISCLOSURE OF THE INVENTION

[0006] In order to achieve the above object, there is provided a compressor comprising:

a sealed casing,
a compression element placed in the sealed casing, and
a motor that is placed in the sealed casing and that is for driving the compression element through a shaft,
the motor comprising a rotor and a stator placed on radial outside of the rotor,
spaces on radial inside of the stator being used as a delivery passage through which refrigerant gas discharged from the compression element into the sealed casing and lubricating oil in the sealed casing flow in a direction opposite to the compression element with respect to the motor,
spaces on radial outside of the stator being used as a return passage through which the lubricating oil in the sealed casing is returned toward the compression element with respect to the motor.

[0007] In the compressor of the invention, the spaces on radial inside of the stator are used as the delivery passage for refrigerant gas and lubricating oil, while the spaces on radial outside of the stator are used as the return passage for lubricating oil in the sealed casing, and thus lubricating oil having flowed together with refrigerant gas to downstream side of the motor can efficiently be returned to upstream side of the motor.

[0008] In one embodiment of the invention, the compression element comprises a discharge port for discharging the refrigerant gas from the compression element into the sealed casing, and
wherein the discharge port of the compression element is positioned inside an outer circumferential surface of the stator as seen looking in a direction of a rotation axis of the shaft and overlaps the stator as seen looking in a direction orthogonal to the rotation axis of the shaft.

[0009] In the compressor of the embodiment, the discharge port of the compression element is positioned inside the outer circumferential surface of the stator as seen looking in the direction of the rotation axis of the shaft and overlaps the stator as seen looking in the direction orthogonal to the rotation axis of the shaft, so that refrigerant gas discharged from the compression element can be made to flow mainly into the spaces inside the outer circumferential surface of the stator. That is, the spaces inside the outer circumferential surface of the stator can be used as a passage exclusive to flow of refrigerant gas, while the spaces outside the outer circumferential surface of the stator can be used as a passage exclusive to return of lubricating oil.

[0010] Accordingly, lubricating oil having flowed together with refrigerant gas to downstream side of the motor (upper side of the compressor) can efficiently be returned to upstream side of the motor (lower side of the compressor) and the lubricating oil can be separated from the refrigerant gas. Besides, heat generating parts of the stator, the rotor and the like can efficiently be cooled by the refrigerant gas.

[0011] In one embodiment of the invention, the stator comprises:

a stator body including a plurality of teeth that protrude inward radially and that are arranged along a circumferential direction, and
coils each of which is wound on corresponding one of the teeth without being wound on a plurality of teeth.

[0012] In the compressor of the embodiment, the coils of the stator are formed by so-called concentrated winding, and thus can easily be wound on the teeth. Besides, the stator can efficiently be cooled with refrigerant gas being passed through between the adjoining coils.

[0013] In one embodiment of the invention, the compression element comprises a support part for supporting the shaft, the support part comprising an oil discharge port for discharging the lubricating oil supplied into between the support part and the shaft, to outside of the support part,

wherein the stator comprises a stator core, coils wound on the stator core, and guide parts placed on radial outside of the coils, and

wherein the guide parts guide, toward radial inside of the stator, the lubricating oil discharged from the oil discharge port of the support part and the refrigerant gas discharged from the compression element into the sealed casing.

[0014] In the compressor of the embodiment, the guide parts guide, toward radial inside of the stator, lubricating oil discharged from the oil discharge port of the support part, together with refrigerant gas discharged from the compression element into the sealed casing, and thus the lubricating oil discharged from the oil discharge port and the refrigerant gas can be made to flow into the spaces on radial inside of the stator. That is, the spaces on radial inside of the stator can be used as the passage exclusive to delivery of lubricating oil and refrigerant gas, while the spaces on radial outside of the stator can be used as the passage exclusive to return of lubricating oil.

[0015] Accordingly, lubricating oil having flowed together with refrigerant gas to downstream side of the motor (upper side of the compressor) can efficiently be returned to upstream side of the motor (lower side of the compressor), so that oil shortage in an oil sump on upstream side (lower side) of the motor can be prevented. Besides, heat generating parts of the stator, the rotor and the like can efficiently be cooled by lubricating oil flowing along radial inside of the stator.

[0016] In one embodiment of the invention, the guide parts are positioned on radial outside of the oil discharge port of the support part as seen looking in a direction of a rotation axis of the shaft and extend farther from the stator core than the oil discharge port of the support part as seen looking in a direction orthogonal to the rotation axis of the shaft.

[0017] In the compressor of the embodiment, the guide parts are positioned on radial outside of the oil discharge port as seen looking in the direction of the rotation axis of the shaft, and extend farther from the stator core than the oil discharge port as seen looking in the direction orthogonal to the rotation axis of the shaft, so that lubricating oil discharged from the oil discharge port and refrigerant gas can reliably be made to flow into the spaces on radial inside of the stator.

[0018] In one embodiment of the invention, the guide parts are part of insulators interposed and held between the coils and the stator core.

[0019] In the compressor of the embodiment, the guide parts are part of the insulators interposed and held between the coils and the stator core, and the insulators can be doubled as the guide parts, so that number of components can be reduced.

[0020] In a compressor according to one embodiment, the stator core has a plurality of teeth that protrude inward radially and that are arranged along a circumferential direction, and each of the coils is wound on corresponding one of the teeth without being wound on a plurality of teeth.

[0021] In the compressor of the embodiment, the coils of the stator are formed by so-called concentrated winding, and thus can easily be wound on the teeth. Besides, the stator can efficiently be cooled with lubricating oil, along with refrigerant gas, being passed through between the adjoining coils.

[0022] In the compressor of the invention, the spaces on radial inside of the stator are used as the delivery passage for refrigerant gas and lubricating oil, while the spaces on radial outside of the stator are used as the return passage for lubricating oil in the sealed casing, and thus lubricating oil having flowed together with refrigerant gas to downstream side of the motor can efficiently be returned to upstream side of the motor.

[0023] In the compressor of the embodiment, the discharge port of the compression element is positioned inside the outer circumferential surface of the stator as seen looking in the direction of the rotation axis of the shaft and overlaps the stator as seen looking in the direction orthogonal to the rotation axis of the shaft, so that lubricating oil can be separated and so that the motor can efficiently be cooled.

[0024] In the compressor of the invention, the guide parts guide, toward radial inside of the stator, lubricating oil discharged from the oil discharge port of the support part, together with refrigerant gas discharged from the compression element into the sealed casing, and thus oil shortage in the oil sump can be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025]

Fig. 1 is a longitudinal section showing a first embodiment of a compressor of the invention;

Fig. 2 is a cross section of vicinity of a motor of the compressor;

Fig. 3 is a plan view of main parts of the compressor;

Fig. 4 is a longitudinal section showing a second embodiment of a compressor of the invention;

Fig. 5 is a plan view of main parts of the compressor; and

Fig. 6 is a cross section of vicinity of a motor of the compressor.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Embodiments of the invention will now be described in detail with reference to embodiments shown in the accompanying drawings.

(First Embodiment)

[0027] Fig. 1 shows a longitudinal section of a first embodiment of a compressor of the invention. The compressor has a sealed casing 1, a compression element 2 placed in the sealed casing 1, and a motor 3 that is placed in the sealed casing 1 and that drives the compression element 2 through a shaft 12. The compressor is a rotary compressor of so-called high-pressure dome type, having the compression element 2 placed on lower side and the motor 3 placed on upper side in the sealed casing 1.

[0028] Suction pipes 11 for intake of refrigerant gas are fixed to the sealed casing 1, and an accumulator 10 is connected to the suction pipes 11. That is, the compression element 2 sucks in refrigerant gas from the accumulator 10 through the suction pipes 11.

[0029] The refrigerant gas is obtained from controling over the compressor along with a condenser, an expansion mechanism, and an evaporator that are not shown and that form an air conditioner as an example of refrigeration system. The refrigerant gas is carbon dioxide, R410A, or R22, for example.

[0030] The compressor discharges compressed discharge gas having high temperature and high pressure from the compression element 2, fills inside of the sealed casing 1 with the gas, thereby cools the motor 3, and thereafter discharges the gas through a discharge pipe 13 to outside. Lubricating oil 9 is accumulated in lower part of a high-pressure section in the sealed casing 1.

[0031] As shown in Figs. 1 and 2, the motor 3 has a rotor 6 and a stator 5 that is placed on radial outside of the rotor 6 with an air gap between.

[0032] The rotor 6 has a rotor body 610 and magnets 620 embedded in the rotor body 610. The rotor body 610 is shaped like a cylinder and is composed of, e.g., laminated electrical steel plates. The shaft 12 is fixed into a center bore of the rotor body 610. The magnets 620 are permanent magnets shaped like flat plates. The six magnets 620 are arranged at equal intervals with equal central angles along a circumferential direction of the rotor body 610.

[0033] The stator 5 has a stator body 510 and coils 520 wound on the stator body 510. In Fig. 2, the coils 520 are depicted with some part thereof omitted.

[0034] The stator body 510 is made of, e.g., iron and is fitted into the sealed casing 1 by shrinkage fit or the like. The stator body 510 has an annular part 511 and nine teeth 512 that protrude inward radially from an inner circumferential surface of the annular part 511 and that are arranged at equal intervals along the circumferential direction.

[0035] The coils 520 are formed by so-called concentrated winding, that is, each of them is wound on corresponding one of the teeth 512 without being wound on a plurality of teeth 512.

[0036] To the stator body 510 are fixed insulators 530. The insulators 530 are placed on both axial end surfaces of the stator body 510, and the coils 520 are wound on the insulators 530 as well as the stator body 510. Fig. 2 is depicted with the insulators 530 omitted.

[0037] The insulators 530 are made of resin material having satisfactory thermal resistance, such as liquid crystal polymer (LCP), polybutylene terephthalate (PBT), polyphenylene sulfide (PPS), polyimide and polyester. The insulators 530 have circumferential walls 531 placed on radial outside of the coils 520, as seen looking in a direction of an axis 12a of the shaft 12. For example, the circumferential walls 531 are shaped like rings having cutouts at given intervals along the circumferential direction.

[0038] End faces of the circumferential walls 531 extend farther from the stator body 510 in the direction of the rotation axis 12a than end faces of the coils 520 (i.e., coil ends).

[0039] In the motor 3, the rotor 6 is rotated along with the shaft 12 by an electromagnetic force that is produced in the stator 5 by currents flowing through the coils 520, so that the compression element 2 is driven through the shaft 12.

[0040] The motor 3 is a so-called 6-pole 9-slot motor. The rotor 6 is rotated along with the shaft 12 by the electromagnetic force that is produced in the stator 5 by the currents flowing through the coils 520.

[0041] The compression element 2 has an upper end plate member 50, a first cylinder 121, an intermediate end plate member 70, a second cylinder 221, and a lower end plate member 60, in this order from upper side to lower side along the rotation axis of the shaft 12.

[0042] The upper end plate member 50 and the intermediate end plate member 70 are mounted on upper and lower opening ends of the first cylinder 121, respectively. The intermediate end plate member 70 and the lower end plate member 60 are mounted on upper and lower opening ends of the second cylinder 221, respectively.

[0043] A first cylinder chamber 122 is defined by the first cylinder 121, the upper end plate member 50, and the intermediate end plate member 70. A second cylinder chamber 222 is defined by the second cylinder 221, the lower end plate member 60, and the intermediate end plate member 70.

[0044] The upper end plate member 50 has a disc-like main body 51, and a boss 52 that is provided so as to extend upward from center of the main body 51. The main body 51 and the boss 52 are penetrated by the shaft 12. In the main body 51 is provided a discharge port 51a communicating with the first cylinder chamber 122.

[0045] On the main body 51, a discharge valve 131 is mounted so as to be positioned opposite to the first cylinder 121 with respect to the main body 51. The discharge valve 131, which is, for example, a reed valve, opens and closes the discharge port 51a.

[0046] On the main body 51, a cup-like first muffler cover 140 is mounted opposite to the first cylinder 121 so as to cover the discharge valve 131. The first muffler cover 140 is fixed onto the main body 51 by fixation members (such as bolts). The first muffler cover 140 is penetrated by the boss 52.

[0047] A first muffler chamber 142 is defined by the first muffler cover 140 and the upper end plate member 50. The first muffler chamber 142 and the first cylinder chamber 122 communicate with each other through the discharge port 51a.

[0048] The lower end plate member 60 has a disc-like main body 61, and a boss 62 that is provided so as to extend downward from center of the main body 61. The main body 61 and the boss 62 are penetrated by the shaft 12. In the main body 61 is provided a discharge port (not shown) communicating with the second cylinder chamber 222.

[0049] A discharge valve (not shown) is mounted on the main body 61 so as to be positioned opposite to the second cylinder 221 with respect to the main body 61, and opens and closes the discharge port.

[0050] On the main body 61, a second muffler cover 240 shaped like a linear flat plate is mounted opposite to the second cylinder 221 so as to cover the discharge valve. The second muffler cover 240 is fixed onto the main body 61 by fixation members (such as bolts). The second muffler cover 240 is penetrated by the boss 62.

[0051] A second muffler chamber 242 is defined by the second muffler cover 240 and the lower end plate member 60. The second muffler chamber 242 and the second cylinder chamber 222 communicate with each other through the discharge port.

[0052] On the first muffler cover 140, a cup-like third muffler cover 340 is mounted opposite to the upper end plate member 50 so as to cover the first muffler cover 140. A third muffler chamber 342 is defined by the first muffler cover 140 and the third muffler cover 340.

[0053] The first muffler chamber 142 and the third muffler chamber 342 communicate with each other through an aperture part (not shown) formed in the first muffler cover 140.

[0054] The second muffler chamber 242 and the third muffler chamber 342 communicate with each other through an aperture part (not shown) formed in the lower end plate member 60, the second cylinder 221, the intermediate end plate member 70, the first cylinder 121, and the upper end plate member 50.

[0055] The third muffler chamber 342 and outside of the third muffler cover 340 communicate with each other through a discharge port 340a formed on the third muffler cover 340. That is, the compression element 2 discharges refrigerant gas through the discharge port 340a into the sealed casing 1.

[0056] The discharge port 340a is positioned inside an outer circumferential surface of the stator 5 as seen looking in the direction of the rotation axis 12a of the shaft 12, and overlaps the stator 5 as seen looking in a direction orthogonal to the rotation axis 12a of the shaft 12. That is, the discharge port 340a resides inside, in radial directions, and above a lower end face 531a of the circumferential wall 531 of the insulator 530.

[0057] The end plate members 50, 60, 70, the cylinders 121, 221, and the muffler covers 140, 240, 340 are fixed as one unit by fixation members such as bolts. The upper end plate member 50 of the compression element 2 is fixed to the sealed casing 1 by welding or the like.

[0058] One end portion of the shaft 12 is supported by the upper end plate member 50 and the lower end plate member 60. That is, the shaft 12 is a cantilever. The one end portion (support end side) of the shaft 12 extends into the first cylinder chamber 122 and the second cylinder chamber 222.

[0059] On the shaft 12, a first eccentric pin 126 is provided so as to be positioned in the first cylinder chamber 122. The first eccentric pin 126 is fitted in a first roller 127. The first roller 127 is placed so as to be capable of making an orbital motion around a central axis of the first cylinder chamber 122 in the first cylinder chamber 122, and a compression operation is carried out by the orbital motion of the first roller 127.

[0060] On the shaft 12, a second eccentric pin 226 is provided so as to be positioned in the second cylinder chamber 222. The second eccentric pin 226 is fitted in a second roller 227. The second roller 227 is placed so as to be capable of making an orbital motion around a central axis of the second cylinder chamber 222 in the second cylinder chamber 222, and a compression operation is carried out by the orbital motion of the second roller 227.

[0061] The first eccentric pin 126 and the second eccentric pin 226 are in positions shifted 180° with respect to the rotation axis of the shaft 12.

[0062] Hereinbelow will be described the compression operation in the first cylinder chamber 122.

[0063] As shown in Fig. 3, the first cylinder chamber 122 is partitioned by a blade 128 provided integrally with the first roller 127. That is, a chamber on right side of the blade 128 in which one of the suction pipes 11 opens on an inner surface of the first cylinder chamber 122 forms a suction chamber (low-pressure chamber) 123 for refrigerant gas. On the other hand, a chamber on left side of the blade 128 in which the discharge port 51a (shown in Fig. 1) opens on the inner surface of the first cylinder chamber 122 forms a discharge chamber (high-pressure chamber) 124 for refrigerant gas.

[0064] Semicylindrical bushes 125, 125 are in intimate contact with both surfaces of the blade 128 so as to effect sealing. The bushes 125, 125 are held by the first cylinder 121. That is, the blade 128 is supported by the first cylinder 121. Lubrication with the lubricating oil 9 is performed between the blade 128 and the bushes 125, 125 and between the bushes 125 and the first cylinder 121.

[0065] The first eccentric pin 126 eccentrically rotates together with the shaft 12, so that the first roller 127 fitted on the first eccentric pin 126 makes the orbital motion with an outer circumferential surface of the first roller 127 being in contact with the inner circumferential surface of the first cylinder chamber 122.

[0066] With the orbital motion of the first roller 127 in the first cylinder chamber 122, the blade 128 reciprocates with both the side surfaces of the blade 128 held by the bushes 125, 125. Accordingly, refrigerant gas having a low pressure is sucked from the suction pipe 11 into the suction chamber 123, is then compressed in the discharge chamber 124 so as to have a high pressure, and the refrigerant gas having the high pressure is thereafter discharged from the discharge port 51a (shown in Fig. 1).

[0067] As shown in Fig. 1, subsequently, the refrigerant gas discharged from the discharge port 51a passes the first muffler chamber 142 and the third muffler chamber 342 and is then discharged through the discharge port 340a to outside of the third muffler cover 340.

[0068] On the other hand, the compression operation in the second cylinder chamber 222 is similar to that in the first cylinder chamber 122. That is, refrigerant gas having a low pressure is sucked from the other suction pipe 11 into the second cylinder chamber 222, is compressed by the orbital motion of the second roller 227 in the second cylinder chamber 222, and the refrigerant gas having a high pressure is discharged via the second muffler chamber 242 and the third muffler chamber 342 to outside of the third muffler cover 340.

[0069] The compression operation in the first cylinder chamber 122 and the compression operation in the second cylinder chamber 222 are shifted 180° in phase with each other.

[0070] In the compressor having above configuration, the discharge port 340a of the compression element 2 is positioned inside the outer circumferential surface of the stator 5 as seen looking in the direction of the rotation axis 12a of the shaft 12, and overlaps the stator 5 as seen looking in the direction orthogonal to the rotation axis 12a of the shaft 12. As a result, refrigerant gas discharged from the compression element 2 can be made to flow mainly into spaces inside the outer circumferential surface of the stator 5.

[0071] That is, the spaces (which will be referred to as inner passage, hereinbelow) inside the outer circumferential surface of the stator 5 can be used as a passage exclusive to delivery of the refrigerant gas and the lubricating oil 9, while spaces (which will be referred to as outer passage, hereinbelow) outside the outer circumferential surface of the stator 5 can be used as a passage exclusive to return of the lubricating oil 9. In short, the spaces on radial inside of the stator 5 are used as the delivery passage through which the refrigerant gas discharged from the compression element 2 into the sealed casing 1 and the lubricating oil in the sealed casing 1 flow in a direction opposite to the compression element 2 with respect to the motor 3, while the spaces on radial outside of the stator 5 are used as the return passage through which the lubricating oil in the sealed casing 1 is returned toward the compression element 2 with respect to the motor 3.

[0072] Accordingly, the lubricating oil 9 having flowed together with the refrigerant gas to downstream side of the motor 3 (upper side of the compressor) can efficiently be returned to upstream side of the motor 3 (lower side of the compressor) through the outer passage and thus the lubricating oil 9 can be separated from the refrigerant gas. Besides, heat generating parts of the stator 5, the rotor 6 and the like can efficiently be cooled by the refrigerant gas flowing through the inner passage.

[0073] Furthermore, the circumferential walls 531 are part of the insulators 530, therefore the flow of the refrigerant gas discharged from the compression element 2 can be guided by the insulators 530, and thus necessity of new components and an increase in number of components can be prevented.

[0074] The coils 520 of the stator 5 are formed by so-called concentrated winding, and thus can easily be wound on the teeth 512. Besides, the stator 5 can efficiently be cooled with the refrigerant gas being passed through between the adjoining coils 520, 520.

[0075] The invention is not limited to the embodiment described above. For example, the compression element 2 may be of rotary type in which rollers and blades are separate from each other. As the compression element 2, scroll type, reciprocating type or the like may be used rather than the rotary type.

[0076] The compression element 2 may be of one-cylinder type having one cylinder chamber. There may be used a single stage muffler where the third muffler cover 340 is omitted. In this configuration, the discharge port of the compression element 2 has only to be positioned above the lower end face of the stator 5.

[0077] The circumferential walls 531 may be formed as part of members other than the insulators 530 or may be formed integrally with the stator core 510.

[0078] The coils 520 may be formed by so-called distributed winding, that is, each coil may be wound on the plurality of teeth 512. The teeth 512 and the magnets 620 may freely be increased or decreased in number.

(Second Embodiment)

[0079] Fig. 4 shows a longitudinal section of a second embodiment of a compressor of the invention. The compressor has a sealed casing 1001, a compression element 1002 placed in the sealed casing 1001, and a motor 1003 that is placed in the sealed casing 1001 and that drives the compression element 1002 through a shaft 1012.

[0080] The compressor is a rotary compressor of so-called high-pressure dome type, having the compression element 1002 placed on lower side and the motor 1003 placed on upper side in the sealed casing 1001. The compression element 1002 is driven through the shaft 1012 by a rotor 1006 of the motor 1003.

[0081] The compression element 1002 sucks in refrigerant gas from an accumulator 1010 through a suction pipe 1011. The refrigerant gas is obtained from controling over the compressor along with a condenser, an expansion mechanism, and an evaporator that are not shown and that form an air conditioner as an example of refrigeration system. The refrigerant gas is carbon dioxide, R410A, or R22, for example.

[0082] The compressor discharges compressed refrigerant gas having high temperature and high pressure from the compression element 1002, fills inside of the sealed casing 1001 with the gas, cools the motor 1003 by passing the gas through a gap between the stator 1005 and the rotor 1006 of the motor 1003, and thereafter discharges the gas to outside through a discharge pipe 1013 provided above the motor 1003.

[0083] In lower part of a high-pressure section in the sealed casing 1001 is formed an oil sump 1009 in which lubricating oil is accumulated. The lubricating oil travels from the oil sump 1009 through an oil passage (not shown) provided on or in the shaft 1012 to sliding parts such as bearings of the compression element 1002 and the motor 1003, which parts are thereby lubricated. The lubricating oil is polyalkylene glycol oil (such as polyethylene glycol and polypropylene glycol), ether oil, ester oil, or mineral oil, for example. The oil passage is spiral grooves provided on an outer circumferential surface of the shaft 1012, bores provided in the shaft 1012 or the like.

[0084] The compression element 1002 has a cylinder 1021 fixed to an inner surface of the sealed casing 1001, and has an upper end plate member 1050 and a lower end plate member 1060 mounted on upper and lower opening ends of the cylinder 1021, respectively. A cylinder chamber 1022 is defined by the cylinder 1021, the upper end plate member 1050, and the lower end plate member 1060.

[0085] The upper end plate member 1050 has a disc-like main body 1051, and a boss 52 that is provided so as to extend upward from center of the main body 1051. The main body 1051 and the boss 1052 are penetrated by the shaft 1012.

[0086] The upper end plate member 1050 is an example of a support part for supporting the shaft 1012. The upper end plate member 1050 has an oil discharge port 1050a. The oil discharge port 1050a discharges the lubricating oil supplied through the oil passage (not shown) into between the end plate member 1050 and the shaft 1012, to outside of the end plate member 1050. Specifically, the oil discharge port 1050a is a space formed on an upper end face of the boss 1052 and between the outer circumferential surface of the shaft 1012 and an inner circumferential surface of the boss 1052.

[0087] In the main body 1051 is provided a discharge port 1051a communicating with the cylinder chamber 1022. On the main body 1051, a discharge valve 1031 is mounted so as to be positioned opposite to the cylinder 1021 with respect to the main body 1051. The discharge valve 1031, which is, for example, a reed valve, opens and closes the discharge port 1051a.

[0088] On the main body 1051, a cup-like muffler cover 1040 is mounted opposite to the cylinder 1021 so as to cover the discharge valve 1031. The muffler cover 1040 is fixed onto the main body 1051 by fixation members 1035 (such as bolts). The muffler cover 1040 is penetrated by the boss 1052.

[0089] A muffler chamber 1042 is defined by the muffler cover 1040 and the upper end plate member 1050. The muffler chamber 1042 and the cylinder chamber 1022 communicate with each other through the discharge port 1051a.

[0090] The muffler cover 1040 has an aperture 1043. The aperture 1043 provides communication between the muffler chamber 1042 and outside of the muffler cover 1040.

[0091] The lower end plate member 1060 has a disc-like main body 1061, and a boss 1062 that is provided so as to extend downward from center of the main body 1061. The main body 1061 and the boss 1062 are penetrated by the shaft 1012.

[0092] That is, one end portion of the shaft 1012 is supported by the upper end plate member 1050 and the lower end plate member 1060. That is, the shaft 1012 is a cantilever. The one end portion (support end side) of the shaft 1012 extends into the cylinder chamber 1022.

[0093] On support end side of the shaft 1012, an eccentric pin 1026 is provided so as to be positioned in the cylinder chamber 1022 on side of the compression element 1002. The eccentric pin 1026 is fitted in a roller 1027. The roller 1027 is placed so as to be capable of making an orbital motion in the cylinder chamber 1022, and a compression operation is carried out by the orbital motion of the roller 1027.

[0094] In other words, the one end portion of the shaft 1012 is supported by a housing 1007 of the compression element 1002 on both sides of the eccentric pin 1026. The housing 1007 includes the upper end plate member 1050 and the lower end plate member 1060.

[0095] Hereinbelow will be described the compression operation in the cylinder chamber 1022.

[0096] As shown in Fig. 5, the cylinder chamber 1022 is partitioned by a blade 1028 provided integrally with the roller 1027. That is, a chamber on right side of the blade 1028 in which one of the suction pipes 1011 opens on an inner surface of the cylinder chamber 1022 forms a suction chamber (low-pressure chamber) 1022a. On the other hand, a chamber on left side of the blade 1028 in which the discharge port 1051a (shown in Fig. 4) opens on the inner surface of the cylinder chamber 1022 forms a discharge chamber (high-pressure chamber) 1022b.

[0097] Semicylindrical bushes 1025, 1025 are in intimate contact with both surfaces of the blade 1028 so as to effect sealing. Lubrication with the lubricating oil is performed between the blade 1028 and the bushes 1025, 1025.

[0098] The eccentric pin 1026 eccentrically rotates together with the shaft 1012, so that the roller 1027 fitted on the eccentric pin 1026 makes the orbital motion with an outer circumferential surface of the roller 1027 being in contact with the inner circumferential surface of the cylinder chamber 1022.

[0099] With the orbital motion of the roller 1027 in the cylinder chamber 1022, the blade 1028 reciprocates with both the side surfaces of the blade 1028 held by the bushes 1025, 1025. Accordingly, refrigerant gas having a low pressure is sucked from the suction pipe 1011 into the suction chamber 1022a, is then compressed in the discharge chamber 1022b so as to have a high pressure, and the refrigerant gas having the high pressure is thereafter discharged from the discharge port 1051a (shown in Fig. 4).

[0100] As shown in Fig. 4, subsequently, the refrigerant gas discharged from the discharge port 1051a passes the muffler chamber 1042 and is then discharged to outside of the muffler cover 1040.

[0101] As shown in Figs. 4 and 6, the motor 1003 has the rotor 1006 and the stator 1005 that is placed on radial outside of the rotor 1006 with an air gap between.

[0102] The rotor 1006 has a rotor body 1610 and magnets 1620 embedded in the rotor body 1610. The rotor body 1610 is shaped like a cylinder and is composed of, e.g., laminated electrical steel plates. The shaft 1012 is fixed into a center bore of the rotor body 1610. The magnets 1620 are permanent magnets shaped like flat plates. The six magnets 1620 are arranged at equal intervals with equal central angles along a circumferential direction of the rotor body 1610.

[0103] The stator 1005 has a stator core 1510, coils 1520 wound on the stator core 1510, and guide parts 1500 placed on radial outside of the coils 1520. Fig. 6 is depicted with some part of the coils 1520 omitted and with the guides 1500 omitted.

[0104] The stator core 1510 is composed of a plurality of laminated steel plates and is fitted into the sealed casing 1001 by shrinkage fit or the like. The stator body 510 has an annular part 1511 and nine teeth 1512 that protrude inward radially from an inner circumferential surface of the annular part 1511 and that are arranged at equal intervals along the circumferential direction.

[0105] The coils 1520 are formed by so-called concentrated winding, that is, each of them is wound on corresponding one of the teeth 1512 without being wound on the plurality of teeth 1512. The motor 1003 is a so-called 6-pole 9-slot motor. The rotor 1006 is rotated along with the shaft 1012 by an electromagnetic force that is produced in the stator 1005 by currents flowing through the coils 1520.

[0106] The guide parts 1500 are part of insulators 1530 interposed and held between the coils 1520 and the stator core 1510. The insulators 1530 are placed on both axial end surfaces of the stator core 1510, and the coils 1520 are wound on the insulators 1530 as well as the stator core 1510. Fig. 6 is depicted with the insulators 1530 omitted.

[0107] The insulators 1530 are made of resin material having satisfactory thermal resistance, such as liquid crystal polymer (LCP), polybutylene terephthalate (PBT), polyphenylene sulfide (PPS), polyimide and polyester. The insulators 1530 have circumferential walls 1531 placed on radial outside of the coils 1520, as seen looking in a direction of a rotation axis 1012a of the shaft 1012. For example, the circumferential walls 1531 are shaped like rings having cutouts at given intervals along the circumferential direction. That is, the guide parts 1500 represent the circumferential walls 1531.

[0108] The guide parts 1500 are positioned on radial outside of the oil discharge port 1050a of the end plate member 1050, as seen looking in the direction of the rotation axis 1012a of the shaft 1012, and extend farther from the stator core 1510 than the oil discharge port 1050a of the end plate member 1050, as seen looking in a direction orthogonal to the rotation axis 1012a of the shaft 1012.

[0109] That is, a lower end face 1531a of the circumferential walls 1531 resides outside, in the radial direction, and below the oil discharge port 1050a. Besides, the lower end face 1531a of the circumferential walls 1531 resides below a lower end face of the coils 1520 (i.e., coil end) .

[0110] The guide parts 1500 (the circumferential walls 1531) guide, toward radial inside of the stator 1005, the lubricating oil discharged from the oil discharge port 1050a of the end plate member 1050 and the refrigerant gas discharged from the compression element 1002 into the sealed casing 1001, so as to make the oil and the gas flow through spaces on radial inside of the stator 1005.

[0111] That is, the spaces (which will be referred to as inner passage, hereinbelow) on radial inside of the stator 1005 can be used as a passage exclusive to delivery of the lubricating oil and the refrigerant gas, while the spaces (which will be referred to as outer passage, hereinbelow) on radial outside of the stator 1005 can be used as a passage exclusive to return of the lubricating oil. In short, the spaces on radial inside the stator 1005 are used as the delivery passage through which the refrigerant gas discharged from the compression element 1002 into the sealed casing 1001 and the lubricating oil in the sealed casing 1001 flow in a direction opposite to the compression element 1002 with respect to the motor 1003, while the spaces on radial outside of the stator 1005 are used as the return passage through which the lubricating oil in the sealed casing 1001 is returned toward the compression element 1002 with respect to the motor 1003.

[0112] Herein, the inner passage refers to the air gap between the stator 1005 and the rotor 1006, spaces between the adjoining coils 1520, 1520, and the like. The outer passage refers to spaces between core cuts, i.e., recessed grooves, D-cut surfaces, and the like, provided on the outer circumferential surface of the stator core 1510 and an inner circumferential surface of the sealed casing 1001.

[0113] Accordingly, the lubricating oil on upstream side of the motor 1003 (lower side of the compressor) is made to flow, together with the refrigerant gas, through the inner passage to downstream side of the motor 1003 (upper side of the compressor), as shown by arrows A in Fig. 4, and the lubricating oil having flowed to downstream side of the motor (upper side of the compressor) is returned through the outer passage to upstream side of the motor (lower side of the compressor), as shown by arrows B in Fig. 4, so that oil shortage in the oil sump 1009 on upstream side of the motor (lower side of the compressor) can be prevented.

[0114] The prevention of oil shortage makes it possible to effectively deliver the lubricating oil in the oil sump 1009 through the shaft 1012 to the compression element 1002, the motor 1003 and the like and improves reliability of the compressor.

[0115] Besides, the coils 1520, i.e., heat generating parts of the stator 1005, heat generating parts of the rotor 1006 and the like can efficiently be cooled by the lubricating oil flowing through the inner passage.

[0116] Furthermore, the guide parts 1500 are part of the insulators 1530, and thus the insulators 1530 can be doubled as the guide parts 1500, so that number of components can be reduced.

[0117] The coils 1520 of the stator 1005 are formed by so-called concentrated winding, and thus can easily be wound on the teeth 1512. Besides, the stator 1005 can efficiently be cooled with the refrigerant gas being passed through between the adjoining coils 1520, 1520.

[0118] The invention is not limited to the embodiment described above. For example, the compression element 1002 may be of rotary type in which rollers and blades are separate from each other. As the compression element 1002, scroll type, reciprocating type or the like may be used rather than the rotary type.

[0119] The compression element 1002 may be of two-cylinder type having two cylinder chambers. The coils 1520 may be formed by so-called distributed winding, that is, each coil may be wound on the plurality of teeth 1512.

[0120] The upper end plate member 1050 as the support part for supporting the shaft 1012 may be formed integrally with the cylinder 1021, instead of being separate from the cylinder 1021. Furthermore, the guide parts 1500 may be members other than the circumferential walls 1531 of the insulators 1530 or may be formed integrally with the stator core 1510.

[0121] The compression element 1002 may be positioned on upper side and the motor 1003 may be positioned on lower side. Instead of the oil passage provided in or on the shaft 1012, spiral grooves may be provided on an inner surface of the end plate member 1050.

Claims

1. A compressor comprising:

a sealed casing (1, 1001),
a compression element (2, 1002) placed in the sealed casing (1, 1001), and
a motor (3, 1003) that is placed in the sealed casing (1, 1001) to drive the compression element (2, 1002) through a shaft (12),
the motor (3, 1003) comprising a rotor (6, 1006) and a stator (5, 1005) placed on radial outside of the rotor (6, 1006),
spaces on radial inside of the stator (5, 1005) being used as a delivery passage through which refrigerant gas discharged from the compression element (2, 1002) into the sealed casing (1, 1001) and lubricating oil in the sealed casing (1, 1001) flow in a direction opposite to the compression element (2, 1002) with respect to the motor (3, 1003),
spaces on radial outside of the stator (5, 1005) being used as a return passage through which the lubricating oil in the sealed casing (1, 1001) is returned toward the compression element (2, 1002) with respect to the motor (3, 1003) .

2. A compressor as claimed in Claim 1,
wherein the compression element (2) comprises a discharge port (340a) for discharging the refrigerant gas from the compression element (2) into the sealed casing (1), and
wherein the discharge port (340a) of the compression element (2) is positioned inside an outer circumferential surface of the stator (5) as seen looking in a direction of a rotation axis (12a) of the shaft (12) and overlaps the stator (5) as seen looking in a direction orthogonal to the rotation axis (12a) of the shaft (12).

3. A compressor as claimed in Claim 2,
wherein the stator (5) comprises:

a stator body (510) including a plurality of teeth (512) that protrude inward radially and that are arranged along a circumferential direction, and
coils (520) each of which is wound on corresponding one of the teeth (512) without being wound on a plurality of teeth (512).

4. A compressor as claimed in Claim 1,
wherein the compression element (1002) comprises a support part (1050) for supporting the shaft (1012), the support part (1050) comprising an oil discharge port (1050a) for discharging the lubricating oil supplied into between the support part (1050) and the shaft (1012), to outside of the support part (1050),
wherein the stator (1005) comprises a stator core (1510), coils (1520) wound on the stator core (1510), and guide parts (1500) placed on radial outside of the coils (1520), and
wherein the guide parts (1500) guide, toward radial inside of the stator (1005), the lubricating oil discharged from the oil discharge port (1050a) of the support part (1050) and the refrigerant gas discharged from the compression element (1002) into

the sealed casing (1001).

5. A compressor as claimed in Claim 4, wherein the guide parts (1500) are positioned on radial outside of the oil discharge port (1050a) of the support part (1050) as seen looking in a direction of a rotation axis (1012a) of the shaft (1012) and extend farther from the stator core (1510) than the oil discharge port (1050a) of the support part (1050) as seen looking in a direction orthogonal to the rotation axis (1012a) of the shaft (1012).

6. A compressor as claimed in Claim 4, wherein the guide parts (1500) are part of insulators (1530) interposed and held between the coils (1520) and the stator core (1510).

Fig. 1

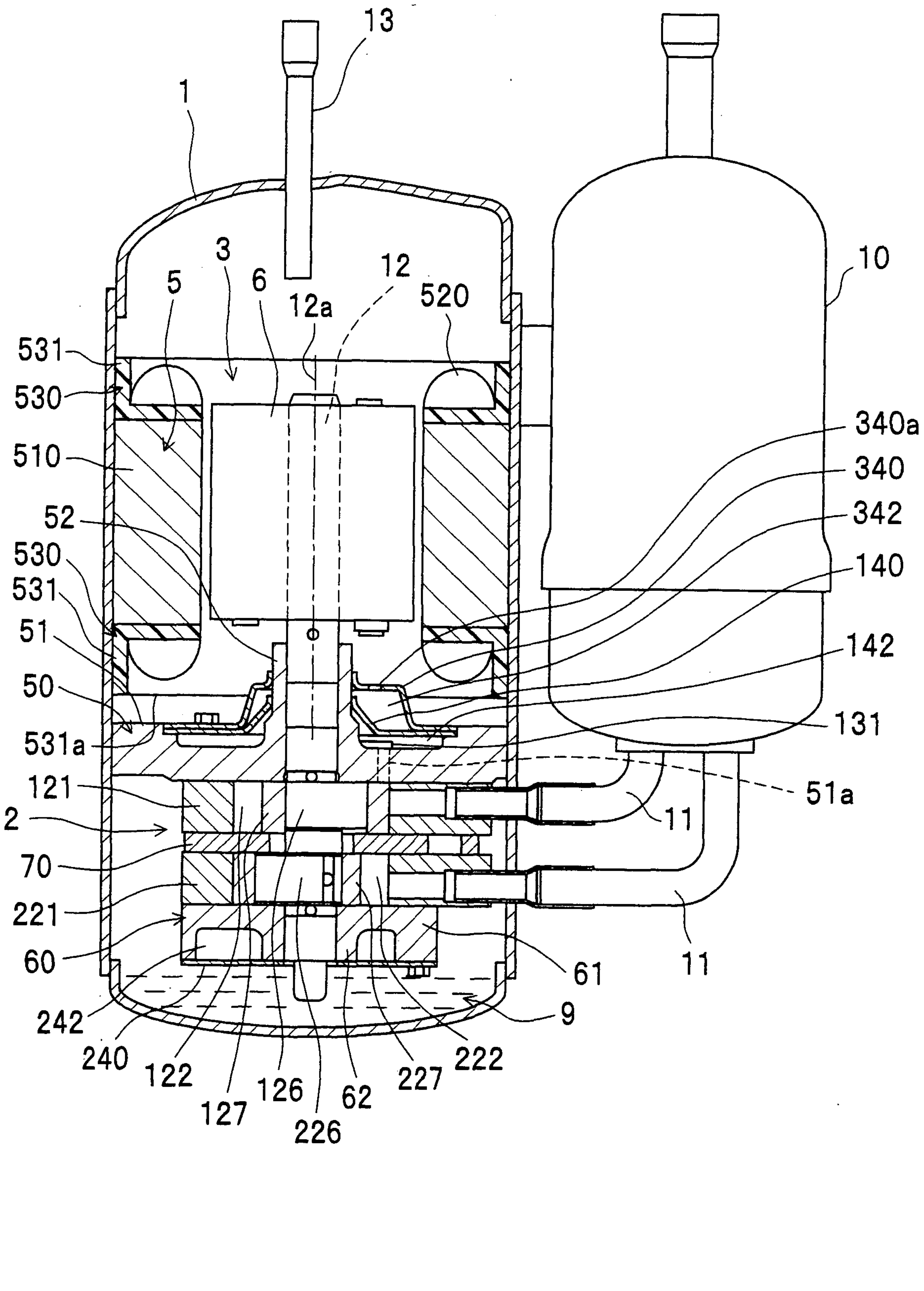
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Fig.2

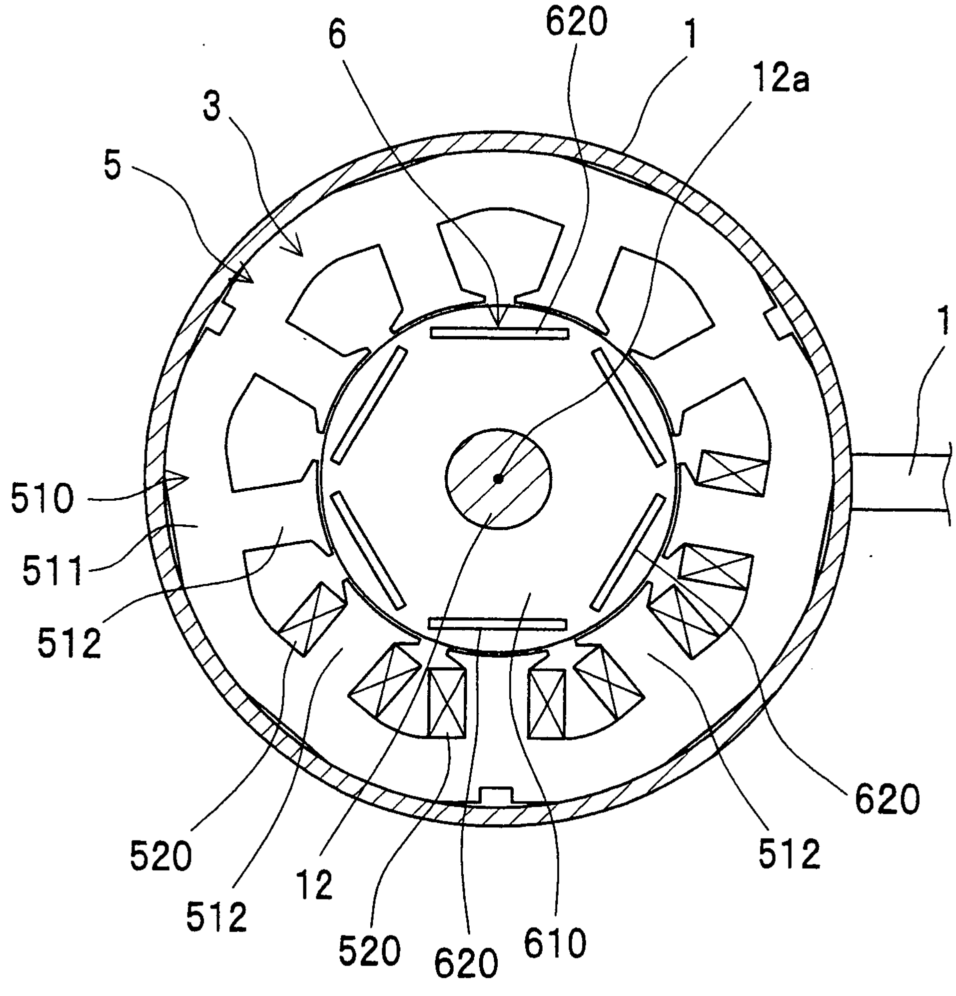


Fig.3

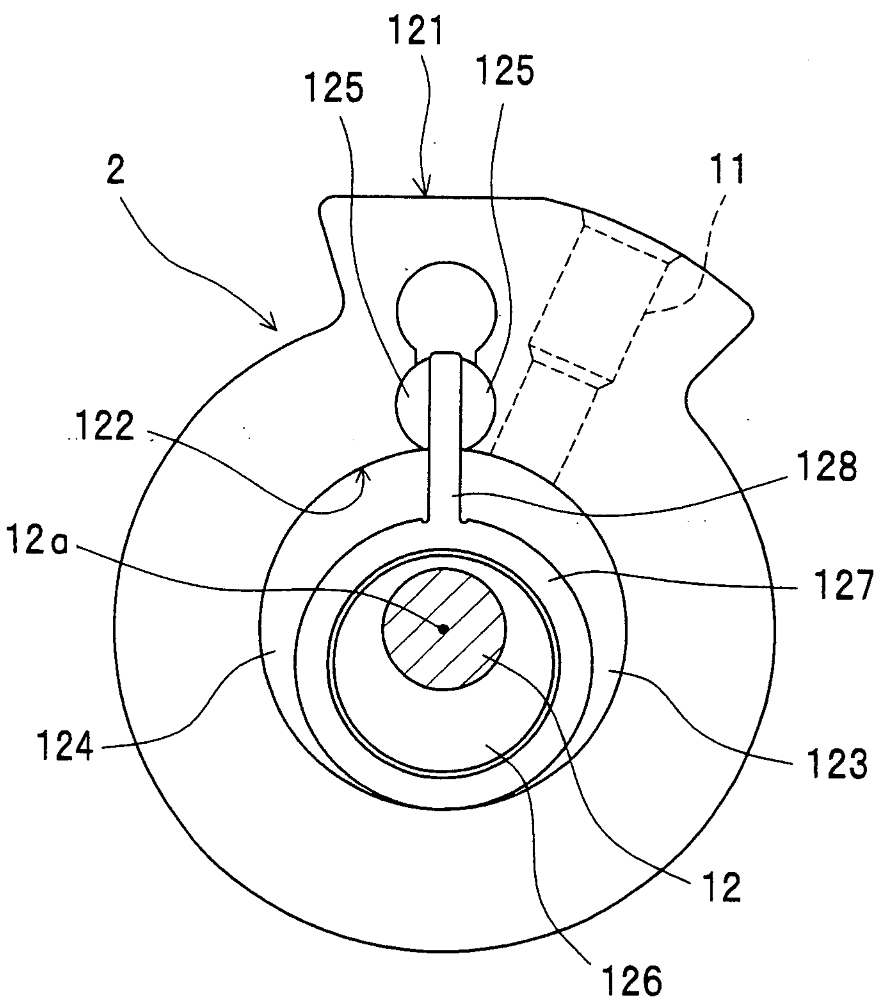
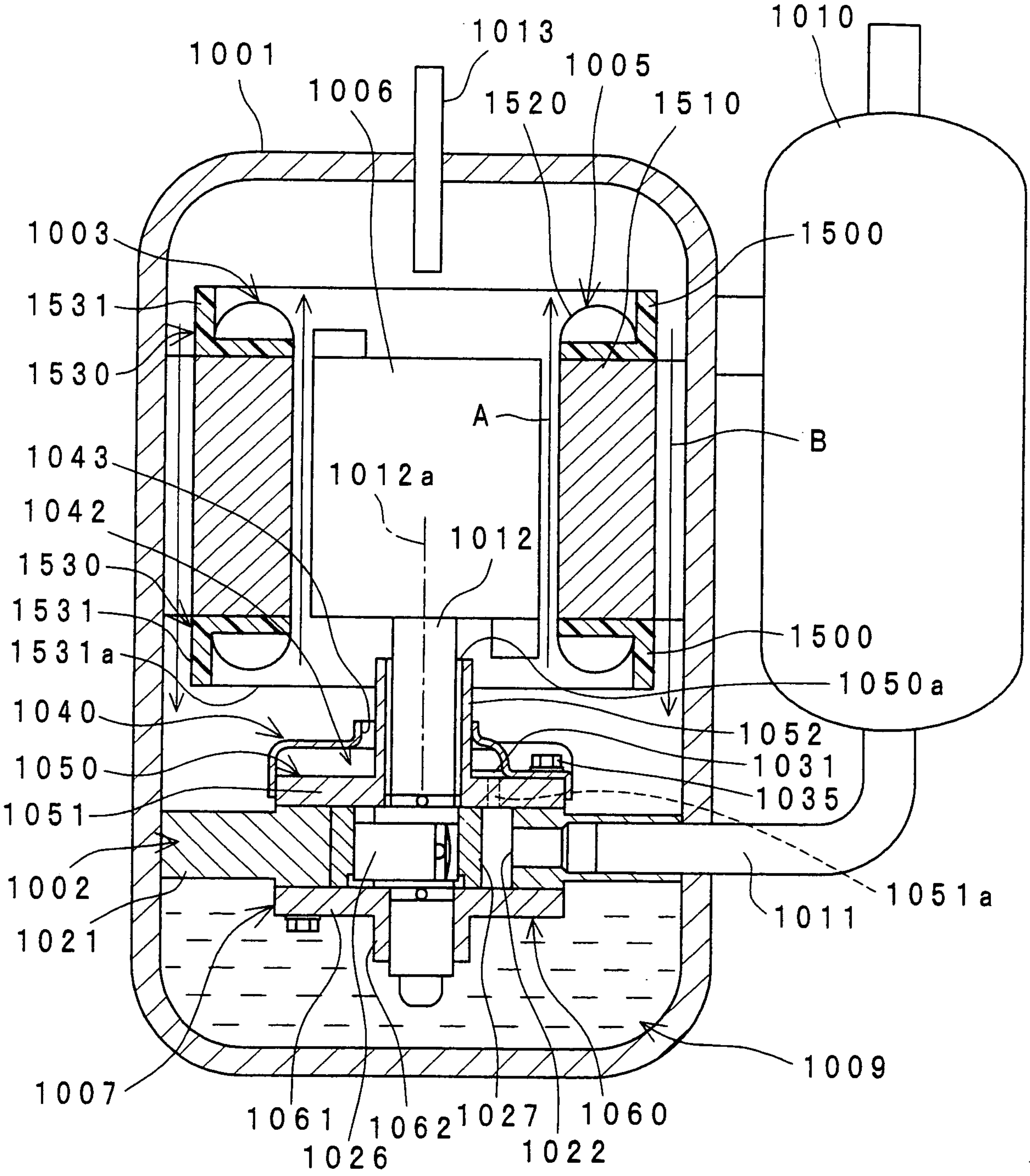


Fig.4



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1006
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1520
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1500
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1531
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Fig.5

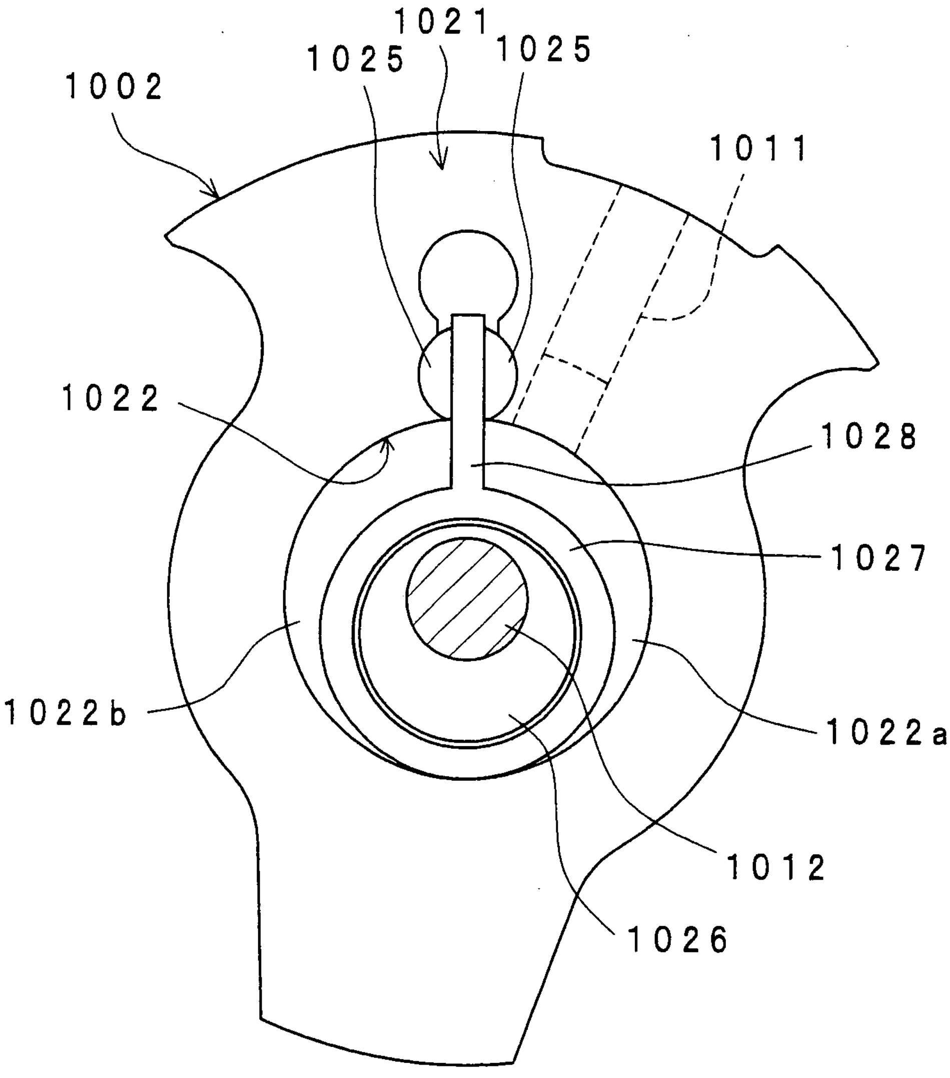
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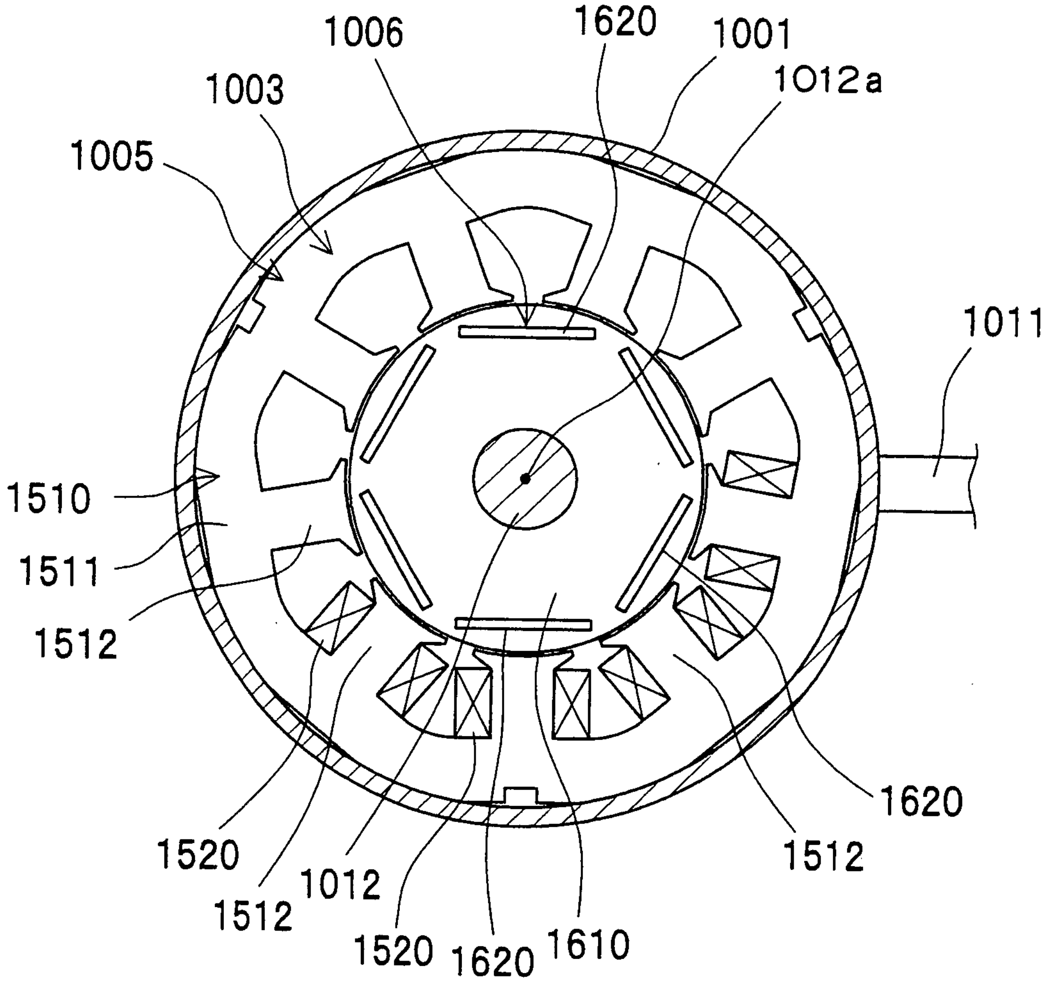
Fig.6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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2006/324743

A. CLASSIFICATION OF SUBJECT MATTER
F04C29/02(2006.01)i, *F04C18/32*(2006.01)i, *F04C29/00*(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)
F04C29/02, F04C18/32, F04C29/00

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	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

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	JP 8-65961 A (Toshiba Corp.), 08 March, 1996 (08.03.96), Par. Nos. [0023] to [0025]; Figs. 1 to 2 (Family: none)	1-6
Y	JP 3-67095 A (Toshiba Corp.), 22 March, 1991 (22.03.91), Page 3, upper right column, line 20 to lower left column, line 18; Figs. 1 to 7 (Family: none)	1-6

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

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Date of the actual completion of the international search	Date of mailing of the international search report
13 February, 2007 (13.02.07)	06 March, 2007 (06.03.07)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2006/324743

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2001-55977 A (Toshiba Carrier Corp.), 27 February, 2001 (27.02.01), Par. Nos. [0039] to [0041]; Fig. 2 & US 6623253 B1 & EP 1203159 A & WO 01/12992 A2 & AU 6474400 A & BR 13257 A & CN 1369040 A & ES 2239025 T	3
Y	JP 5-195975 A (Hitachi, Ltd.), 06 August, 1993 (06.08.93), Par. No. [0003]; Fig. 3 (Family: none)	4-6
Y	JP 2004-316500 A (Fujitsu General Ltd.), 11 November, 2004 (11.11.04), Par. No. [0011]; Figs. 1 to 2 (Family: none)	4-6

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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- JP H10153188 A **[0002]**