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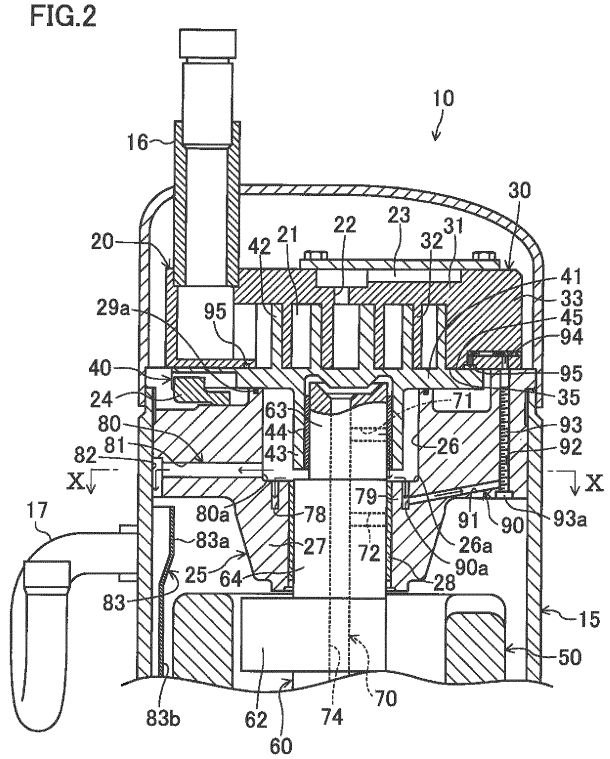
(54) **SCROLL COMPRESSOR**

(57) A housing (25) of a scroll compressor is provided with a recess (78) which is provided on a bottom (26a) of a receiving portion (26), and in which oil accumulates after lubricating a sliding portion (44) of an engaging portion (43), and an oil supply passage (70) which delivers the oil in the recess (78) to a sliding portion (35, 45) of a compression mechanism (20).

FIG.2



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Description

TECHNICAL FIELD

[0001] The present invention relates to a scroll compressor, and more particularly relates to a measure to supply oil to a sliding portion of a compression mechanism.

BACKGROUND ART

[0002] Scroll compressors having a fixed scroll and a movable scroll for compressing a fluid therebetween have been known and widely used in, e.g., a refrigerating apparatus.

[0003] Patent Document 1 discloses a scroll compressor of this type. The scroll compressor has an electric motor housed in a casing, and a drive shaft driven in rotation by the electric motor. One end of the drive shaft is engaged with an engaging portion of an end plate of the movable scroll. The rotation of the drive shaft being driven by the electric motor causes the movable scroll to rotate eccentrically relative to the fixed scroll, which gradually reduces the volume of a compression chamber between these scrolls, thereby compressing the fluid in the compression chamber.

[0004] Further, a housing which rotatably receives the drive shaft is fixed to the inner peripheral surface of the casing. The housing has a receiving chamber, arranged in its upper middle portion, for receiving the drive shaft and the engaging portion of the movable scroll. An oil pump is provided at a lower end portion of the drive shaft in order to suck up oil from an oil reservoir at the bottom of the casing. The oil sucked up by the oil pump with the rotation of the drive shaft flows upward through an oil passage in the drive shaft. The oil is then supplied to a bearing of the drive shaft and the sliding portion between the drive shaft and the engaging portion of the movable scroll, and thereafter into the receiving chamber. The oil accumulated in the receiving chamber sequentially flows through an oil passage 44a extending radially outward from the receiving chamber, and an oil passage 44b extending upward from the outlet of the oil passage 44a, and is then supplied to a sliding portion (a sliding portion of a thrust surface) of the compression mechanism. Thus, the scroll compressor of Patent Document 1 lubricates the sliding portion of the thrust surface of the compression mechanism, using the oil which has been used to lubricate the sliding portion between the drive shaft and the engaging portion of the movable scroll.

CITATION LIST

PATENT DOCUMENT

[0005] Patent Document 1: Japanese Unexamined Patent Publication No. 2001-214872

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0006] The scroll compressor disclosed in Patent Document 1 always needs to store a certain amount of oil in the receiving chamber so that the oil in the receiving chamber can be supplied to the sliding portion of the compression mechanism with reliability. However, such storage of a certain amount of oil in the receiving chamber will cause the drive shaft or engaging portion housed in the receiving chamber to be soaked in the oil. This increases a frictional resistance between the drive shaft or the engaging portion and the oil during the rotation of the drive shaft, thereby increasing churning loss and the motive energy of the electric motor.

[0007] In view of the foregoing background, it is therefore an object of the present invention to provide a scroll compressor that can reduce such oil churning loss in the receiving chamber.

SOLUTION TO THE PROBLEM

[0008] A first aspect of the invention is directed to a scroll compressor including: a casing (15); an electric motor (50) housed in the casing (15); a drive shaft (60) driven by the electric motor (50); a compression mechanism (20) which has a movable scroll (40) and a fixed scroll (30), the movable scroll (40) having an engaging portion (43), with which one end of the drive shaft (60) engages, and rotating eccentrically relative to the drive shaft (60); a housing (25) including a bearing (28) which supports the drive shaft (60), and a receiving portion (26) which receives the engaging portion (43); and an oil transfer mechanism (75) which transfers oil in an oil reservoir (18) of the casing (15). The drive shaft (60) is provided with an oil supply passage (70) which supplies the oil transferred by the oil transfer mechanism (75) to a sliding portion (44) of the engaging portion (43). In this scroll compressor, the housing (25) is provided with a recess (78) which is provided on a bottom (26a) of the receiving portion (26), and in which the oil accumulates after lubricating the sliding portion (44) of the engaging portion (43), and an oil supply channel (90) which delivers the oil in the recess (78) to a sliding portion (35, 45) of the compression mechanism (20).

[0009] In the first aspect of the invention, one end of the drive shaft (60) engages with the engaging portion (43) of the movable scroll (40), thereby coupling the drive shaft (60) and the movable scroll (40). Rotation of the drive shaft (60) being driven by the electric motor (50) causes the movable scroll (40) to rotate eccentrically relative to the fixed scroll (30), which reduces the volume of a compression chamber between the fixed scroll (30) and the movable scroll (40), thereby compressing the fluid in the compression chamber.

[0010] The oil transfer mechanism (75) supplies the oil in the oil reservoir (18) of the casing (15) to the sliding portion (44) between the drive shaft (60) and the engaging portion (43) via the oil supply passage (70). As a result, the sliding portion (44) is lubricated with the oil to cause a decrease in sliding friction. The oil used to lubricate the sliding portion (44) of the engaging portion (43) flows into the receiving portion (26) that receives the engaging portion (43). Since the present invention provides a recess (78) on the bottom of the receiving portion (26), the oil which has flowed out falls down into the recess (78). This reduces the possibility of the oil accumulating in the receiving portion (26) so much as to reach the vicinity of the engaging portion (43). As a result, the oil churning loss is reduced at the engaging portion (43) during its rotation.

[0011] The oil which has fallen down into the recess (78) is led to the sliding portion (35, 45) of the compression mechanism (20) through the oil supply channel (90). Since the recess (78) is located at a lower level than the bottom of the receiving portion (26), the oil in the receiving portion (26) is successively supplied into the recess (78). This allows for a reliable supply of the oil in the recess (78) to the sliding portion (35, 45) of the compression mechanism (20).

[0012] A second aspect of the invention is an embodiment of the first aspect of the invention. In the second aspect, the recess (78) is configured as an annular groove (78) surrounding an entire periphery of the bearing (28).

[0013] The recess of the second aspect is configured as an annular groove (78) surrounding an entire periphery of the bearing (28) of the drive shaft (60). The annular groove surrounding the entire periphery of the bearing (28) decreases the elastic modulus of a portion of the housing (25) between the annular groove (78) and the bearing (28). Thus, this portion is easily deformed along the outer peripheral surface of the drive shaft (60) even if the axial center of the drive shaft (60) inclines during the rotation of the drive shaft (60). This prevents the outer peripheral surface of the drive shaft (60) from partially contacting with the bearing (28), thereby reducing bearing load on the bearing (28).

[0014] A third aspect of the invention is an embodiment of the first or second aspect of the invention. In the third aspect, the housing (25) is provided with an oil exhaust channel (80) which delivers the oil in the receiving portion (26) to the oil reservoir (18).

[0015] In the third aspect of the invention, part of the oil which has fallen down into the receiving portion (26) after lubricating the sliding portion (44) of the engaging portion (43) returns to the oil reservoir (18) through the oil exhaust channel (80). This prevents a shortage of oil in the oil reservoir (18). Further, a rise in the oil level of the receiving portion (26) is prevented by returning the oil in the receiving portion (26) to the oil reservoir (18) through the oil exhaust channel (80). Thus, the engaging portion (43) is prevented from being soaked in the oil, which reduces the oil churning loss at the engaging portion (43) during its rotation.

[0016] A fourth aspect of the invention is an embodiment of the third aspect of the invention. In the fourth aspect, an inlet port (80a) of the oil exhaust channel (80) is opened to an inner space of the receiving portion (26) so as to be level with the bottom (26a) of the receiving portion (26).

[0017] In the fourth aspect of the invention, the inlet port (80a) of the oil exhaust channel (80) is arranged to be level with the bottom (26a) of the receiving portion (26). Thus, the oil which has overflowed from the recess (78) is immediately introduced to the oil exhaust channel (80). The rise in the oil level in the receiving portion (26) is therefore prevented with reliability.

[0018] A fifth aspect of the invention is an embodiment of the third aspect of the invention. In the fifth aspect, an inlet port (80a) of the oil exhaust channel (80) is opened to inside of the recess (78).

[0019] In the fifth aspect of the invention, part of the oil which has fallen down into the recess (78) from the receiving portion (26) returns to the oil reservoir (18) through the oil exhaust channel (80). Thus, the oil in the recess (78) is prevented from overflowing into the receiving portion (26), thereby preventing the rise in the oil level in the receiving portion (26) with reliability.

[0020] A sixth aspect of the invention is an embodiment of the fifth aspect of the invention. In the sixth aspect, the inside of the recess (78) is partitioned, by a partition member (100) extending from a bottom of the recess (78) to an open end of the recess (78), into a first space (S1) which communicates with an inlet port (90a) of the oil supply channel (90), and a second space (S2) which communicates with the inlet port (80a) of the oil exhaust channel (80), and the first space (S1) has a larger volume than the second space (S2).

[0021] In the sixth aspect of the invention, the inside of the recess (78) is partitioned into a first space (S1) and a second space (S2) by a partition member (100). The volume of the first space (S1) that communicates with the oil supply channel (90) is larger than the volume of the second space (S2) that communicates with the oil exhaust channel (80). This means that the amount of the oil falling down into the recess (78) after having been used to lubricate the sliding portion (44) of the engaging portion (43) is greater in the first space (S1) than in the second space (S2). Thus, the present invention allows for storing a sufficient amount of oil to be supplied to the sliding portion (35, 45) of the compression mechanism (20) through the oil supply channel (90).

[0022] A seventh aspect of the invention is an embodiment of any one of the third to sixth aspects of the invention. In the seventh aspect, the inlet port (90a) of the oil supply channel (90) is located at a lower level than the inlet port (80a) of the oil exhaust channel (80).

[0023] In the seventh aspect of the invention, the inlet port (90a) of the oil supply channel (90) is located at a lower level than the inlet port (80a) of the oil exhaust channel (80). Thus, if the oil level is between the inlet port (90a) of the oil supply channel (90) and the inlet port

(80a) of the oil exhaust channel (80), this oil is led only to the oil supply channel (90). On the other hand, if the oil level is higher than the inlet port (80a) of the oil exhaust channel (80), this oil is led to both of the oil supply channel (90) and the oil exhaust channel (80). That is, according to the present invention, the oil which has flowed out into the receiving portion (26) is supplied preferentially to the oil supply channel (90) rather than to the oil exhaust channel (80). This allows for reliable lubrication of the sliding portion (35, 45) of the compression mechanism (20).

ADVANTAGES OF THE INVENTION

[0024] According to the present invention, the recess (78) is provided on the bottom (26a) of the receiving portion (26). This allows for delivering the oil used to lubricate the sliding portion (44) of the engaging portion (43) to the recess (78). As a result, the possibility of the engaging portion (43) being soaked in the oil is reduced in the receiving portion (26), thereby reducing the oil churning loss at the engaging portion (43) during its rotation.

[0025] If the oil were agitated by the engaging portion (43), a compressed fluid could be mixed with this oil, or the oil might turn into a mist. As a result, it would be difficult for the oil to return to the oil reservoir (18) due to its own weight, causing a shortage of oil in the oil reservoir (18). On the other hand, in the present invention, the possibility of the engaging portion (43) being soaked in the oil is reduced as mentioned above, which therefore prevents the compressed fluid from being mixed with the oil, and also prevents the oil from turning into a mist. Thus, the oil used to lubricate the sliding portion (44) can immediately return to the oil reservoir (18), and so-called oil shortage can be prevented.

[0026] According to the second aspect of the invention, the recess is configured as an annular groove (78). This prevents partial contact between the drive shaft (60) and the bearing (28). That is, in the present invention, the annular groove (78) functions not only as a recess (78) for accumulating the oil but also as a so-called elastic groove. This allows for simplifying the device structure.

[0027] According to the third aspect of the invention, the oil which has flowed out into the receiving portion (26) returns to the oil reservoir (18) via the oil exhaust channel (80). This prevents the engaging portion (43) from being soaked in the oil, thereby reducing the possibility of the oil being agitated by the engaging portion (43). In particular, according to the fourth aspect of the invention, the inlet port (80a) of the oil exhaust channel (80) is level with the bottom (26a) of the receiving portion (26). Thus, the oil in the receiving portion (26) can be immediately discharged. Further, according to the fifth aspect of the invention, the inlet port (80a) of the oil exhaust channel (80) is opened to the inside of the recess (78). This prevents the oil in the recess (78) from overflowing into the receiving portion (26). As a result, according to the fourth and fifth aspects of the invention, the rise in the oil level of the receiving portion (26) is effectively prevented, thereby reducing the possibility of the oil being agitated by the engaging portion (43) with reliability.

[0028] According to the sixth aspect of the invention, the inside of the recess (78) is partitioned into a first space (S1) and the second space (S2) by a partition member (100), and the first space (S1) communicating with the oil supply channel (90) has a larger volume than the second space (S2). This prevents a shortage of the oil to be supplied from the oil supply channel (90) to the sliding portion (35, 45) of the compression mechanism (20). As a result, the sliding portion (35, 45) of the compression mechanism (20) is lubricated successfully, and the reliability of the scroll compressor is improved eventually.

[0029] According to the seventh aspect of the invention, the inlet port (90a) of the oil supply channel (90) is located at a lower level than the inlet port (80a) of the oil exhaust channel (80). This prevents a shortage of the oil to be supplied from the oil supply channel (90) to the sliding portion (35, 45) of the compression mechanism (20). As a result, the sliding portion (35, 45) of the compression mechanism (20) is lubricated as intended, and the reliability of the scroll compressor is improved eventually.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

[FIG. 1] FIG. 1 is a vertical cross-sectional view illustrating the general configuration of a scroll compressor according to an embodiment.

[FIG. 2] FIG. 2 is a vertical cross-sectional view illustrating, on a larger scale, main parts of a compression mechanism and housing according to an embodiment.

[FIG. 3] FIG. 3 is a horizontal cross-sectional view illustrating the internal structure of the compression mechanism.

[FIG. 4] FIG. 4 is a cross-sectional view taken along the plane X-X of FIG. 2.

[FIG. 5] FIG. 5 illustrates a scroll compressor of a first variation and corresponds to FIG. 2.

[FIG. 6] FIG. 6 is a perspective view illustrating an internal structure of a central recess in a scroll compressor of a second variation.

[FIG. 7] FIG. 7 is a horizontal cross-sectional view illustrating the internal structure of the central recess in the scroll compressor of the second variation.

DESCRIPTION OF EMBODIMENTS

[0031] An embodiment of the present invention will now be described in detail with reference to the drawings. The following embodiment is an only preferred example in nature, and is not intended to limit the scope, applications, and use of the invention.

[0032] An embodiment of the present invention will be described. A scroll compressor (10) of the present embodiment is a hermetically sealed compressor. The scroll compressor (10) is connected to a refrigerant circuit, which performs a refrigeration cycle, to suck and compress a refrigerant in the refrigerant circuit.

<General Configuration for Scroll Compressor>

[0033] As illustrated in FIG. 1, the scroll compressor (10) has a casing (15) which houses, in its inner space, a compression mechanism (20), an electric motor (50), a lower bearing member (55), and a drive shaft (60). The casing (15) is a vertically elongated cylindrical hermetic container. The compression mechanism (20), the electric motor (50), and the lower bearing member (55) are arranged in this order from top to bottom in the inner space of the casing (15). The drive shaft (60) is arranged such that its axial direction is parallel to the height direction of the casing (15). The structure of the compression mechanism (20) will be described later in detail.

[0034] A suction pipe (16) and a discharge pipe (17) are attached to the casing (15). Both of the suction pipe (16) and the discharge pipe (17) pass through the casing (15). The suction pipe (16) is connected to the compression mechanism (20). The discharge pipe (17) is opened to the inner space of the casing (15) between the electric motor (50) and the compression mechanism (20).

[0035] The lower bearing member (55) has a central cylindrical portion (56) and an arm portion (57). Although FIG. 1 illustrates only one arm portion (57), the lower bearing member (55) actually has three arm portions (57). The central cylindrical portion (56) has an approximately cylindrical shape. Each of the arm portions (57) extends outward from the outer peripheral surface of the central cylindrical portion (56). The three arm portions (57) of the lower bearing member (55) are spaced apart from each other at substantially equal angles. Projecting ends of the respective arm portions (57) are fixed to the casing (15). A bearing metal (58) is inserted in the vicinity of an upper end portion of the central cylindrical portion (56). An auxiliary journal (67) of the drive shaft (60) to be described later is inserted in, and passes through, this bearing metal (58). The central cylindrical portion (56) functions as a journal bearing which supports the auxiliary journal (67).

[0036] The electric motor (50) has a stator (51) and a rotor (52). The stator (51) is fixed to the casing (15). The rotor (52) is arranged coaxially with the stator (51). A main shaft portion (61) of the drive shaft (60) to be described later is inserted in, and passes through, this rotor (52). A plurality of core cuts (51a) extending between both ends of the stator (51) in its axial direction are formed in the outer peripheral surface of the stator (51) in order to allow a refrigerant and oil to flow therethrough.

[0037] The drive shaft (60) includes the main shaft portion (61), a balance weight portion (62), and an eccentric portion (63). The balance weight portion (62) is disposed at a halfway point in the axial direction of the main shaft portion (61). A portion of the main shaft portion (61) under the balance weight portion (62) passes through the rotor (52) of the electric motor (50). Another portion of the main shaft portion (61) over the balance weight portion (62) functions as a main journal (64), and still another portion of the main shaft portion (61) under the portion passing through the rotor (52) functions as the auxiliary journal (67). The main journal (64) is inserted in, and passes through, a bearing metal (28) provided inside a central expansion (27) of a housing (25). The auxiliary journal (67) is inserted in, and passes through, the bearing metal (58) provided inside the central cylindrical portion (56) of the lower bearing member (55).

[0038] The eccentric portion (63) is arranged at the upper end of the drive shaft (60). The eccentric portion (63) has a columnar shape with a smaller diameter than the main journal (64), and projects from the upper end surface of the main journal (64). The axial center of the eccentric portion (63) is parallel to the axial center of the main journal (64) (i.e., the axial center of the main shaft portion (61)), and is eccentric with the axial center of the main journal (64). The eccentric portion (63) in inserted in a bearing metal (44) provided inside a cylindrical portion (43) of the movable scroll (40). The cylindrical portion (43) of the movable scroll (40) functions as an engaging portion with which the eccentric portion (63) rotatably engages.

[0039] The drive shaft (60) is provided with an oil supply passage (70). The oil supply passage (70) has one main passage (74) and three branch passages (71-73). The main passage (74) extends along the axial center of the drive shaft (60). One end of the main passage (74) is opened to the bottom end of the main shaft portion (61), and the other end thereof is opened to the upper end surface of the eccentric portion (63). A first branch passage (71) is provided for the eccentric portion (63). The first branch passage (71) extends outward from the main passage (74) in the radial direction of the eccentric portion (63), and is opened to the outer peripheral surface of the eccentric portion (63). A second branch passage (72) is provided for the main journal (64). The second branch passage (72) extends outward from the main passage (74) in the radial direction of the main journal (64), and is opened to the outer peripheral surface of the main journal (64). A third branch passage (73) is provided for the auxiliary journal (67). The third branch passage (73) extends outward from the main passage (74) in the radial direction of the auxiliary journal (67), and is opened to the outer peripheral surface of the auxiliary journal (67).

[0040] An oil supply pump (75), which functions as an oil transfer mechanism, is attached to the lower end of the drive shaft (60). The oil supply pump (75) is a trochoid pump driven by the drive shaft (60). The oil supply pump (75) is arranged near the starting end of the main passage (74) of the oil supply passage (70). Further, the oil supply pump (75) is provided with an inlet port (76), opened downward at its lower end, for sucking up the refrigeration oil, which is a lubricating oil. The oil supply pump (75) does not have to be the trochoid pump but may also be any positive displacement pump driven by the drive shaft (60). Thus, the oil supply pump (75) may be a gear pump, for example.

[0041] The refrigeration oil, which is a lubricating oil, is accumulated at the bottom of the casing (15). That is, an oil reservoir (18) is provided at the bottom of the casing (15). As the drive shaft (60) rotates, the oil supply pump (75) sucks up the refrigeration oil from the oil reservoir (18) and discharges that refrigeration oil, which then flows through the main passage (74). The refrigeration oil flowing through the main passage (74) is supplied to the lower bearing member (55) and the sliding portion between the compression mechanism (20) and the drive shaft (60). Since the oil supply pump (75) is a positive displacement pump, the flow rate of the refrigeration oil in the main passage (74) is proportional to the rotational speed of the drive shaft (60).

[0042] As also illustrated in FIG. 2, in the casing (15), a housing (25) is provided above the electric motor (50). The housing (25) has a thick disk-like shape, with its outer peripheral edge fixed to the casing (15). The housing (25) is provided, at its central portion, with a central recess (26) and an annular projection (29). The central recess (26) is a columnar depression opened on the upper surface of the housing (25). The central recess (26) functions as a receiving portion which receives the cylindrical portion (43) of the movable scroll (40) and the eccentric portion (63) of the drive shaft (60). The annular projection (29) surrounds the outer periphery of the central recess (26), and projects from the upper surface of the housing (25). The projecting end surface of the annular projection (29) is a flat surface. The projecting end surface of the annular projection (29) is provided with a ring-like recessed groove along its circumferential direction. A seal member (29a) is fitted in this recessed groove.

[0043] The housing (25) has the central expansion (27). The central expansion (27) is located under the central recess (26) and expands downward. The central expansion (27) has a through hole which vertically runs through the central expansion (27), and into which the bearing metal (28) is inserted. The main journal (64) of the drive shaft (60) is inserted in, and passes through, the bearing metal (28) of the central expansion (27). The central expansion (27) serves as a journal bearing which supports the main journal (64).

<Configuration for Compression Mechanism>

[0044] As also illustrated in FIG. 2, the compression mechanism (20) includes the fixed scroll (30) and the movable scroll (40). The compression mechanism (20) is further provided with an Oldham coupling (24) for regulating the rotational movement of the movable scroll (40).

[0045] The fixed scroll (30) and the movable scroll (40) are mounted on the housing (25). The fixed scroll (30) is fixed to the housing (25) with, e.g., a bolt. On the other hand, the movable scroll (40) engages with the housing (25) via the Oldham coupling (24), and is relatively movable with respect to the housing (25). The movable scroll (40) engages with the drive shaft (60) and rotates eccentrically.

[0046] The movable scroll (40) is a member comprised of a movable end plate (41), a movable lap (42), and the cylindrical portion (43) which are formed integrally with each other. The movable end plate (41) has a disk shape. The movable lap (42) has a spiral wall shape, and protrudes from the front surface (the upper surface in FIGS. 1 and 2) of the movable end plate (41). The cylindrical portion (43) has a cylindrical shape, and protrudes from the back surface (the lower surface in FIGS. 1 and 2) of the movable end plate (41).

[0047] The back surface of the movable end plate (41) of the movable scroll (40) is in sliding contact with the seal member (29a) provided on the annular projection (29) of the housing (25). On the other hand, the cylindrical portion (43) of the movable scroll (40) is inserted in the central recess (26) of the housing (25) from over the recess (26). The bearing metal (44) is inserted in the cylindrical portion (43), and functions as a sliding portion with which the eccentric portion (63) comes into sliding contact. The eccentric portion (63) of the drive shaft (60) to be described later is inserted in the bearing metal (44) of the cylindrical portion (43) from under the bearing metal (44). The cylindrical portion (43) functions as a journal bearing which slides against the eccentric portion (63).

[0048] The fixed scroll (30) is a member comprised of a fixed end plate (31), a fixed lap (32), and an outer peripheral portion (33) which are formed integrally with each other. The fixed end plate (31) has a disk shape. The fixed lap (32) has a spiral wall shape, and protrudes from the front surface (the lower surface in FIGS. 1 and 2) of the fixed end plate (31). The outer peripheral portion (33) has a thick ring-like shape extending downward from the fixed end plate (31), and surrounds the fixed lap (32).

[0049] The fixed end plate (31) is provided with a discharge port (22). The discharge port (22) is a through hole provided around the center of the fixed end plate (31), and runs through the fixed end plate (31) in the thickness direction. Further, the suction pipe (16) is inserted in a portion of the fixed end plate (31) around its the outer periphery.

[0050] The compression mechanism (20) is provided with a discharge gas passage (23). The starting end of the discharge gas passage (23) communicates with the discharge port (22). Although not shown, the discharge gas passage (23) extends from the fixed scroll (30) to the housing (25), and the other end thereof is opened to the lower surface of the housing (25).

[0051] In the compression mechanism (20), the fixed scroll (30) and the movable scroll (40) are arranged such that the front surface of the fixed end plate (31) and the front surface of the movable end plate (41) face each other, and that the fixed lap (32) and the movable lap (42) engage with each other. Such engagement between the fixed lap (32) and the movable lap (42) forms a plurality of compression chambers (21) in the compression mechanism (20).

[0052] Further, in the compression mechanism (20), the movable end plate (41) of the movable scroll (40) and the outer peripheral portion (33) of the fixed scroll (30) are in sliding contact with each other. More particularly, a portion of the front surface (the upper surface in FIGS. 1 and 2) of the movable end plate (41) outside the movable lap (42) is a sliding portion (45) of a movable thrust surface which comes into sliding contact with the fixed scroll (30). On the other hand, the projecting end surface (the lower surface in FIGS. 1 and 2) of the outer peripheral portion (33) of the fixed scroll (30) comes into sliding contact with the sliding portion (45) of the movable thrust surface of the movable scroll (40). A portion of the projecting end surface of the outer peripheral portion (33) which is in sliding contact with the sliding portion (45) of the movable thrust surface is a sliding portion (35) of a fixed thrust surface. That is, the sliding portion (35) of the fixed thrust surface and the sliding portion (45) of the movable thrust surface form a sliding portion of the compression mechanism (20).

[0053] As illustrated in FIGS. 2 and 4, the bottom (26a) of the above-described central recess (26) is provided with an annular groove (78). The annular groove (78) is configured as a recess opened upward. The center of the annular groove (78) substantially coincides with the axial center of the main journal (64), and the annular groove (78) surrounds entirely the bearing metal (28), which is a bearing. The annular groove (78) may be implemented as a so-called "elastic groove". That is, the housing (25) is provided with a cylindrical projection (79) projecting upward between the annular groove (78) and the bearing metal (28). When the main journal (64) warps radially outward during rotation of the drive shaft (60), the cylindrical projection (79) elastically deforms along the main journal (64). This prevents the main journal (64) from making line contact with the bearing metal (28), i.e., so-called partial contact, thereby reducing bearing load on the bearing metal (28).

[0054] The oil used to lubricate the bearing metal (28) of the main journal (64) flows through the oil supply passage (70) into the central recess (26) of the housing (25). The housing (25) is provided with an oil exhaust channel (80) for delivering the oil which has flowed out into the central recess (26) to the oil reservoir (18), and an oil supply channel (90) for delivering this oil to the sliding portion (that is, the sliding portion (35) of the fixed thrust surface and the sliding portion (45) of the movable thrust surface) of the compression mechanism (20).

[0055] The oil exhaust channel (80) of the present embodiment is provided for the annular projection (29) of the housing (25). The oil exhaust channel (80) is comprised of a horizontal hole (81) which runs radially through a lower end portion of the annular projection (29), and a vertical hole (82) which extends downward from the outflow end of the horizontal hole (81). An inlet port (80a) of the oil exhaust channel (80) is opened to the inside of the central recess (26). The lower portion of the inlet port (80a) of the oil exhaust channel (80) is substantially level with the bottom (26a) of the central recess (26). That is, the inlet port (80a) of the oil exhaust channel (80) is continuous with the bottom (26a) of the central recess (26).

[0056] An oil catch plate (83) is arranged under the vertical hole (82) of the oil exhaust channel (80). The oil catch plate (83) has an increased-width portion (83a), of which the width increases upward, and a lower nozzle portion (83b) extending downward from the increased-width portion (83a). The outflow end (i.e., the lower end) of the lower nozzle portion (83b) is located in a core cut (51a) of the stator (51).

[0057] The oil supply channel (90) extends from the central expansion (27) to the annular projection (29) of the housing (25). The oil supply channel (90) is comprised of a first oil supply hole (91) and a second oil supply hole (92). The first oil supply hole (91) is formed in the housing (25), and extends radially outward, and obliquely upward, from the annular groove (78). An inlet port (91a) of the first oil supply hole (91) is opened to the inside of the annular groove (78). The inlet port (91a) of the first oil supply hole (91) is located at a lower level than the inlet port (80a) of the oil exhaust channel (80). Further, the inlet port (91a) of the first oil supply hole (91) is located at a higher level than the bottom of the annular groove (78). This structure prevents waste or any other foreign substances collected at the bottom of the annular groove (78) from entering the oil supply channel (90) through the inlet port (91a), and eventually prevents the oil supply channel (90) from being clogged with such waste or any other substances.

[0058] The second oil supply hole (92) runs through the annular projection (29) of the housing (25) in the axial direction so as to communicate with the outflow end of the first oil supply hole (91). A screw member (93) is inserted in, and passes through, the second oil supply hole (92). The head (93a) of the screw member (93) closes the lower end of the second oil supply hole (92). The screw member (93) narrows the flow path of the oil in the second oil supply hole (92). That is, the screw member (93) functions as a pressure-reducing mechanism (a throttle mechanism) that reduces the pressure of the oil flowing through the second oil supply hole (92).

[0059] As illustrated in FIGS. 2 and 3, the outer peripheral portion (33) of the fixed scroll (30) is provided with an oil communication passage (94) which communicates with the second oil supply hole (92), and an oil groove (95) which communicates with the oil communication passage (94). The inflow end of the oil communication passage (94) is connected to the second oil supply hole (92) inside the housing (25). The outflow end of the oil communication passage (94) is opened to the sliding portion (45) of the movable thrust surface of the movable scroll (40). The oil groove (95) is a recessed groove provided on the sliding portion (35) of the fixed thrust surface of the outer peripheral portion (33), and has a ring-like shape surrounding the fixed lap (32). The oil groove (95) communicates with the outflow end of the oil communication passage (94).

-Operation-

[0060] Operation of the scroll compressor (10) will be described.

<Operation of Compressing Refrigerant>

[0061] In the scroll compressor (10), the energization of the electric motor (50) causes the drive shaft (60) to rotate the movable scroll (40). Since the Oldham coupling (24) regulates the rotational movement of the movable scroll (40), the movable scroll (40) does not rotate on its own axis but only revolves around.

[0062] When the movable scroll (40) revolves around, a low-pressure gas refrigerant which has flowed into the compression mechanism (20) through the suction pipe (16) is sucked into the compression chamber (21) from around outer peripheral edges of the fixed lap (32) and the movable lap (42). Further revolution of the movable scroll (40) disconnects the compression chamber (21) from the suction pipe (16), thereby closing the compression chamber (21). The compression chamber (21) then moves along the fixed lap (32) and the movable lap (42) toward their inner peripheral edges. In the course of this movement, the volume of the compression chamber (21) gradually decreases, thus compressing the gas refrigerant in the compression chamber (21).

[0063] As the volume of the compression chamber (21) gradually decreases with the movement of the movable scroll (40), the compression chamber (21) comes to communicate with the discharge port (22) in the end. The refrigerant compressed in the compression chamber (21) (that is, a high-pressure gas refrigerant) flows into the discharge gas passage (23) through the discharge port (22), and is then discharged into the inner space of the casing (15). In the inner space of the casing (15), the high-pressure gas refrigerant discharged from the compression mechanism (20) is once guided to below the stator (51) of the electric motor (50), and then flows upward through a gap between the rotor (52) and the stator (51) and other regions. Thereafter, the high-pressure gas refrigerant flows out of the casing (15) through the discharge pipe (17).

[0064] The high-pressure gas refrigerant discharged from the compression mechanism (20) circulates through the inner space of the casing (15) under the housing (25), where the pressure is substantially equal to the pressure of the high-pressure gas refrigerant. This means that the pressure of the refrigeration oil accumulated in the oil reservoir (18) in the casing (15), too, is substantially equal to that of the high-pressure gas refrigerant.

[0065] On the other hand, although not shown, the inner space of the casing (15) over the housing (25) communicates with the suction pipe (16), and has almost as much pressure as the low-pressure gas refrigerant to be sucked into the compression mechanism (20). This means that in the compression mechanism (20), a space around the outer periphery of the movable end plate (41) of the movable scroll (40), too, has almost as much pressure as the low-pressure gas refrigerant.

<Oil Supply Operation at Sliding Portion>

[0066] During the operation of the scroll compressor (10), the rotating drive shaft (60) drives the oil supply pump (75), thereby sucking up the refrigeration oil accumulated at the bottom of the casing (15) to the main passage (74) of the oil supply passage (70). Part of the refrigeration oil flowing through the main passage (74) flows into the branch passages (71-73), and the rest flows out of the main passage (74) through its upper end. The oil (the refrigeration oil) which has flowed into the third branch passage (73) is supplied to a gap between the auxiliary journal (67) and the bearing metal (58), and is used to lubricate and cool the auxiliary journal (67) and the bearing metal (58). The oil which has flowed into the second branch passage (72) is supplied to a gap between the main journal (64) and the bearing metal (28), and is used to lubricate and cool the main journal (64) and the bearing metal (28).

[0067] The oil which has flowed into the first branch passage (71) is supplied to a gap between the eccentric portion (63) and the bearing metal (44), and is used to lubricate and cool the eccentric portion (63) and the bearing metal (44). The oil used to lubricate the bearing metal (44) flows out into the central recess (26).

[0068] If this oil used to lubricate the bearing metal (44) is accumulated in the central recess (26), the cylindrical portion (43) of the movable scroll (40) may be soaked in the oil. If the cylindrical portion (43) performs the eccentric rotational movement a number of times in such a state, the oil in the central recess (26) constitutes a resistance to the cylindrical portion (43), and so-called oil churning loss increases. This leads to an increase in motive energy of the electric motor (50). Further, if the oil in the central recess (26) is agitated by the cylindrical portion (43), the high-pressure gas refrigerant in the casing (15) may be mixed with the oil, or the oil may turn into a fine mist. As a result, after all, it becomes difficult for the oil agitated in the central recess (26) to go back to the oil reservoir (18) due to its own weight. This causes a shortage of oil in the oil reservoir (18). The present embodiment therefore provides the annular groove (78) on the bottom (26a) of the central recess (26) to prevent the oil in the central recess (26) from being agitated by the cylindrical portion (43).

[0069] More particularly, the refrigerant which has been used to lubricate the bearing metal (44) and flowed into the central recess (26) falls down into the annular groove (78) from the bottom (26a) of the central recess (26). When the oil level in the annular groove (78) exceeds the level of the inlet port (90a) of the first oil supply hole (91), the oil in the annular groove (78) flows into the first oil supply hole (91). This oil passes through the first oil supply hole (91), and then flows upward through the second oil supply hole (92). In the course of this flow, the high-pressure oil is decompressed in the second oil supply hole (92) by the screw member (93). The oil which has passed through the second oil supply hole (92) flows into the oil groove (95) via the oil communication passage (94) inside the fixed scroll (30). As a result, the sliding portion of the compression mechanism (20) between the sliding portion (35) of the fixed thrust surface and the sliding portion (45) of the movable thrust surface is lubricated with the oil.

[0070] As described above, the oil which has flowed out into the central recess (26) is appropriately supplied to the sliding portion of the compression mechanism (20) through the annular groove (78) and the oil supply channel (90). As a result, the rise in the oil level in the central recess (26) is prevented, thereby reducing the area of the cylindrical portion (43) of the movable scroll (40) to be soaked in the oil.

[0071] Further, if the oil level in the annular groove (78) rises so much as to make the oil overflow from the annular groove (78) into the central recess (26), this oil flows into the oil exhaust channel (80). In the oil exhaust channel (80), the oil sequentially flows through the horizontal hole (81), the vertical hole (82), and the oil catch plate (83) to be guided into the core cut (51 a). The oil in the core cut (51a) further flows down along the inner peripheral surface of the casing (15), and is delivered to the oil reservoir (18) in the end.

[0072] In this manner, the oil which has overflowed from the annular groove (78) returns directly to the oil reservoir (18) through the oil exhaust channel (80). Thus, the rise in the oil level in the central recess (26) is prevented, thereby reducing the area of the cylindrical portion (43) of the movable scroll (40) to be soaked in the oil.

-Advantages of Embodiment-

[0073] In the embodiment described above, the annular groove (78) is provided on the bottom (26a) of the central recess (26) of the housing (25), which allows the annular groove (78) to catch the oil used to lubricate the bearing metal (44). This reduces the possibility of the cylindrical portion (43) of the movable scroll (40) being soaked in the oil in the central recess (26), thereby reducing the oil churning loss at the cylindrical portion (43) during its rotation. As a result, the motive energy of the electric motor (50) is reduced, which contributes to energy saving more effectively.

[0074] In addition, since this structure prevents the cylindrical portion (43) from agitating the oil in this manner, it also prevents a compressed fluid from being mixed with the oil, and further prevents the oil from turning into a mist. Thus, the oil used to lubricate the bearing metal (44) can immediately return to the oil reservoir (18), and therefore so-called oil shortage is eliminated.

[0075] Furthermore, in the embodiment described above, the annular groove (78) is provided around the bearing metal (28) of the main journal (64), which allows for providing the cylindrical projection (79) between the annular groove (78) and the bearing metal (28). This structure allows the cylindrical projection (79) to be elastically deformed along the main journal (64) even if the main journal (64) inclines with respect to the axial center. Thus, the main journal (64) is prevented from partially contacting with the bearing metal (28), thereby reducing bearing load on the main journal (64). The annular groove (78) functions not only as a groove which catches and delivers the oil to the oil supply channel (90) but also as a so-called elastic groove. This allows for simplifying the structure of the housing (25).

[0076] On top of that, according to the embodiment described above, part of the oil which has flowed out into the central recess (26) returns directly to the oil reservoir (18) through the oil exhaust channel (80). This prevents the cylindrical portion (43) from being soaked in the oil. In particular, according to the present embodiment, the inlet port (80a) of the oil exhaust channel (80) is arranged to be level with the bottom (26a) of the central recess (26). Thus, even when the oil overflows from the annular groove (78), this oil can be immediately introduced to the oil exhaust channel (80).

[0077] Furthermore, according to the embodiment described above, the inlet port (90a) of the oil supply channel (90) is opened to the inside of the annular groove (78), and the inlet port (80a) of the oil exhaust channel (80) is opened to the inside of the central recess (26). That is, the inlet port (90a) of the oil supply channel (90) is located at a lower level than the inlet port (80a) of the oil exhaust channel (80). Thus, the oil which has flowed out into the central recess (26) is introduced to the oil supply channel (90) earlier than to the oil exhaust channel (80). This allows for supplying the oil to the sliding portions (35, 45) of the compression mechanism (20) successfully, and increases reliability of the scroll compressor (10).

<First Variation of Embodiment>

[0078] The scroll compressor (10) according to a first variation illustrated in FIG. 5 is different from the above embodiment in the configuration of the oil exhaust channel (80). Specifically, the inlet port (80a) of the oil exhaust channel (80) of the first variation is opened to the inside of the annular groove (78). More particularly, the oil exhaust channel (80) has a horizontal hole (81) which extends radially outward from inside the annular groove (78), and a vertical hole (82) which extends downward from the radially outer end of the horizontal hole (81). In the annular groove (78), the inlet port (90a) of the oil supply channel (90) is located at a lower level than the inlet port (80a) of the oil exhaust channel (80).

[0079] In the first variation, the oil is introduced to the oil supply channel (90) preferentially if the oil level in the annular groove (78) is located at a level between the inlet port (90a) of the oil supply channel (90) and the inlet port (80a) of the oil exhaust channel (80). However, when the oil level in the annular groove (78) reaches the level of the inlet port (80a) of the oil exhaust channel (80), the oil is introduced to both of the oil supply channel (90) and the oil exhaust channel (80). Thus, in the first variation, too, the oil which has flowed out into the central recess (26) is introduced to the oil supply channel (90) earlier than to the oil exhaust channel (80). This allows the oil to be supplied to the sliding portions (35, 45) of the compression mechanism (20) successfully, and increases the reliability of the scroll compressor (10).

[0080] Further, in the first variation, the oil in the annular groove (78) is prevented from overflowing into the central recess (26), since the oil in the annular groove (78) is delivered to both of the oil supply channel (90) and the oil exhaust channel (80). As a result, the cylindrical portion (43) of the movable scroll (40) is more reliably prevented from being soaked in the oil.

[0081] The other functions and effects of the first variation are the same as those of the embodiment described above.

<Second Variation of Embodiment>

[0082] The second variation illustrated in FIGS. 6 and 7 includes a housing (25) which has a similar configuration to the counterpart of the first variation but which includes a partition member (100) in the annular groove (78). The partition member (100) extends from a lower bottom of the annular groove (78) to an upper open end of the annular groove (78) in the axial direction of the annular groove (78). The partition member (100) has an approximately U-shaped cross-section on a plane perpendicular to the axial direction of the annular groove (78), and is fitted in the annular groove (78).

[0083] The partition member (100) has an arc-shaped vertical wall (100a) which is curved along the inner peripheral surface of the annular groove (78), and a pair of sidewalls (100b) which are located at both ends of the vertical wall (100a) in its circumferential direction. The vertical wall (100a) is arranged to face the inlet port (80a) of the oil exhaust channel (80). Each of the sidewalls (100b) extends in a radial direction from the inner peripheral surface to the outer peripheral surface of the annular groove (78). This partition member (100) partitions the inside of the annular groove (78) into a first space (S1) outside the partition member (100), and a second space inside the partition member (100). The inlet port (90a) of the oil supply channel (90) communicates with the first space (S1). The inlet port (80a) of the oil exhaust channel (80) communicates with the second space (S2).

[0084] In the second variation, the opening area of the upper end of the first space (S1) is larger than the opening area of the upper end of the second space (S2). That is, the volume of the first space (S1) is larger than the volume of the second space (S2) inside the annular groove (78). Thus, in the second variation, the oil which has flowed out into the central recess (26) flows down more into the first space (S1) than into the second space (S2), thus making it possible to store a sufficient amount of oil in the first space (S1). This allows the oil to be supplied to the sliding portions (35, 45) of the compression mechanism (20) via the first space (S1) and the oil supply channel (90) successfully, and increases the reliability of the scroll compressor (10).

[0085] The other functions and effects of the second variation are the same as those of the above embodiment.

«Other Embodiments»

[0086] The embodiment described above may be modified to have the following configurations.

[0087] In the above embodiment, the bottom (26a) of the central recess (26) is provided with an annular recess (78) which surrounds the main journal (64). However, this recess (78) does not necessarily have an annular shape, but may have a rectangular, linear, or dotted cross-section on a plane perpendicular to the axial direction. That is, the recess (78) may have any shape as long as it is capable of catching the oil flowing out into the central recess (26).

INDUSTRIAL APPLICABILITY

[0088] As can be seen from the foregoing description, the present invention relates to a scroll compressor, and is particularly useful for providing an effective measure to supply oil to a sliding portion of a compression mechanism.

DESCRIPTION OF REFERENCE CHARACTERS

[0089]

10	scroll compressor
15	casing
18	oil reservoir
20	compression mechanism
25	housing
26	central recess (receiving portion)
26a	bottom
28	bearing metal (bearing)
30	fixed scroll
35	sliding portion of fixed thrust surface
40	movable scroll
43	cylindrical portion (engaging portion)
44	bearing metal (sliding portion)
45	sliding portion of movable thrust surface
50	electric motor
60	drive shaft
70	oil supply passage
75	oil supply pump (oil transfer mechanism)
78	annular groove (recess)
80	oil exhaust channel

80a inlet port (on the oil exhaust channel side)
90 oil supply channel
90a inlet port (on the oil supply channel side)
100 partition member
S1 first space
S2 second space

Claims

1. A scroll compressor, comprising:

    a casing (15);
    an electric motor (50) housed in the casing (15);
    a drive shaft (60) driven by the electric motor (50);
    a compression mechanism (20) which has a movable scroll (40) and a fixed scroll (30), the movable scroll (40) having an engaging portion (43), with which one end of the drive shaft (60) engages, and rotating eccentrically relative to the drive shaft (60);
    a housing (25) including a bearing (28) which supports the drive shaft (60), and a receiving portion (26) which receives the engaging portion (43); and
    an oil transfer mechanism (75) which transfers oil in an oil reservoir (18) of the casing (15), and
    the drive shaft (60) being provided with an oil supply passage (70) which supplies the oil transferred by the oil transfer mechanism (75) to a sliding portion (44) of the engaging portion (43), wherein
    the housing (25) is provided with

        a recess (78) which is provided on a bottom (26a) of the receiving portion (26), and in which the oil accumulates after lubricating the sliding portion (44) of the engaging portion (43), and
        an oil supply channel (90) which delivers the oil in the recess (78) to a sliding portion (35, 45) of the compression mechanism (20).

2. The scroll compressor of claim 1, wherein the recess (78) is configured as an annular groove (78) surrounding an entire

3. The scroll compressor of claim 1 or 2, wherein the housing (25) is provided with an oil exhaust channel (80) which delivers the oil in the receiving portion (26) to the oil reservoir (18).

4. The scroll compressor of claim 3, wherein an inlet port (80a) of the oil exhaust channel (80) is opened to an inner space of the receiving portion (26) so as to be level with the bottom (26a) of the receiving portion (26).

5. The scroll compressor of claim 3, wherein an inlet port (80a) of the oil exhaust channel (80) is opened to inside of the recess (78).

6. The scroll compressor of claim 5, wherein the inside of the recess (78) is partitioned, by a partition member (100) extending from a bottom of the recess (78) to an open end of the recess (78), into a first space (S1) which communicates with an inlet port (90a) of the oil supply channel (90) and a second space (S2) which communicates with the inlet port (80a) of the oil exhaust channel (80), and the first space (S1) has a larger volume than the second space (S2).

7. The scroll compressor of any one of claims 3-6, wherein the inlet port (90a) of the oil supply channel (90) is located at a lower level than the inlet port (80a) of the oil exhaust channel (80).

FIG.1

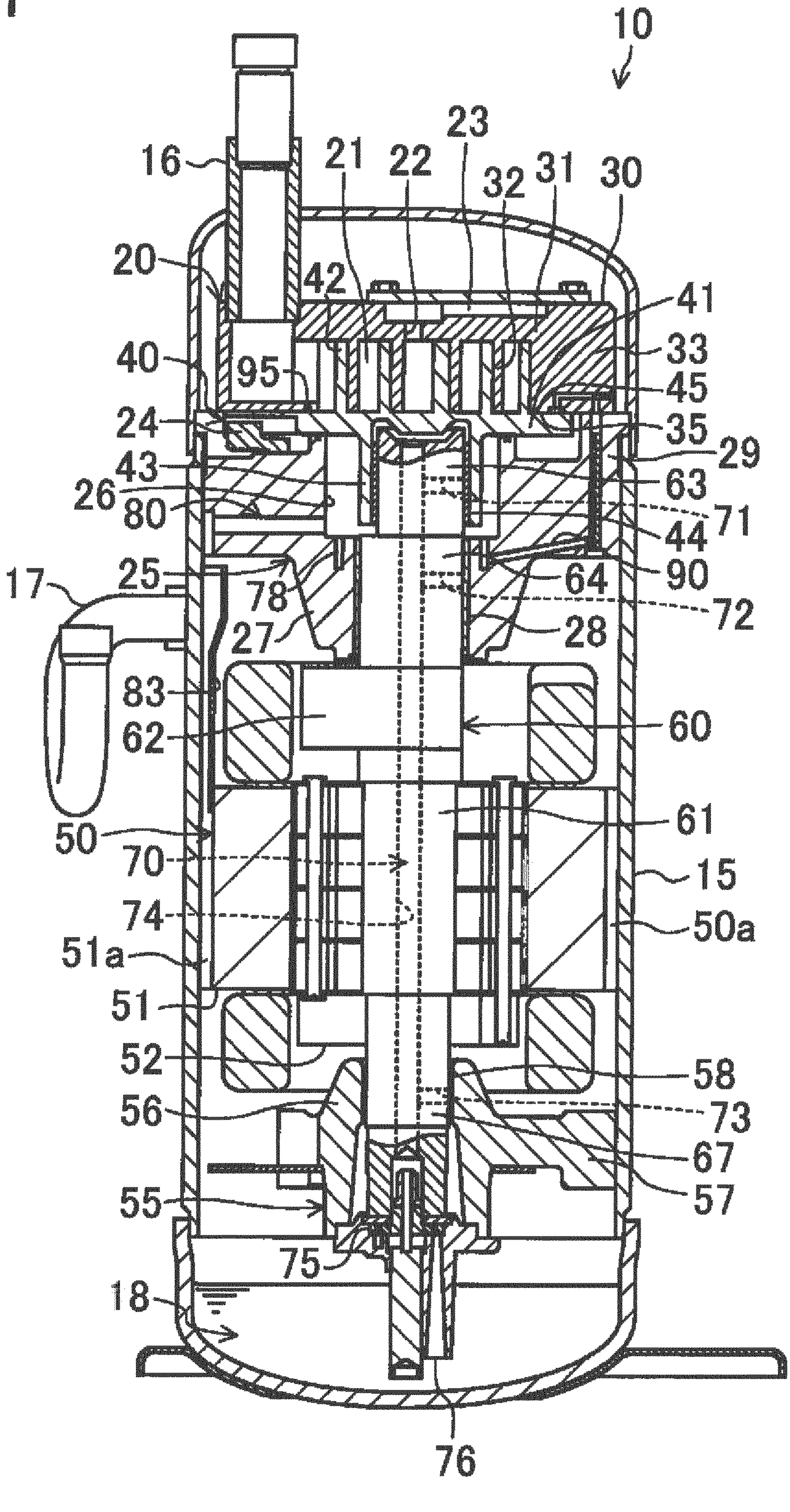
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FIG.2

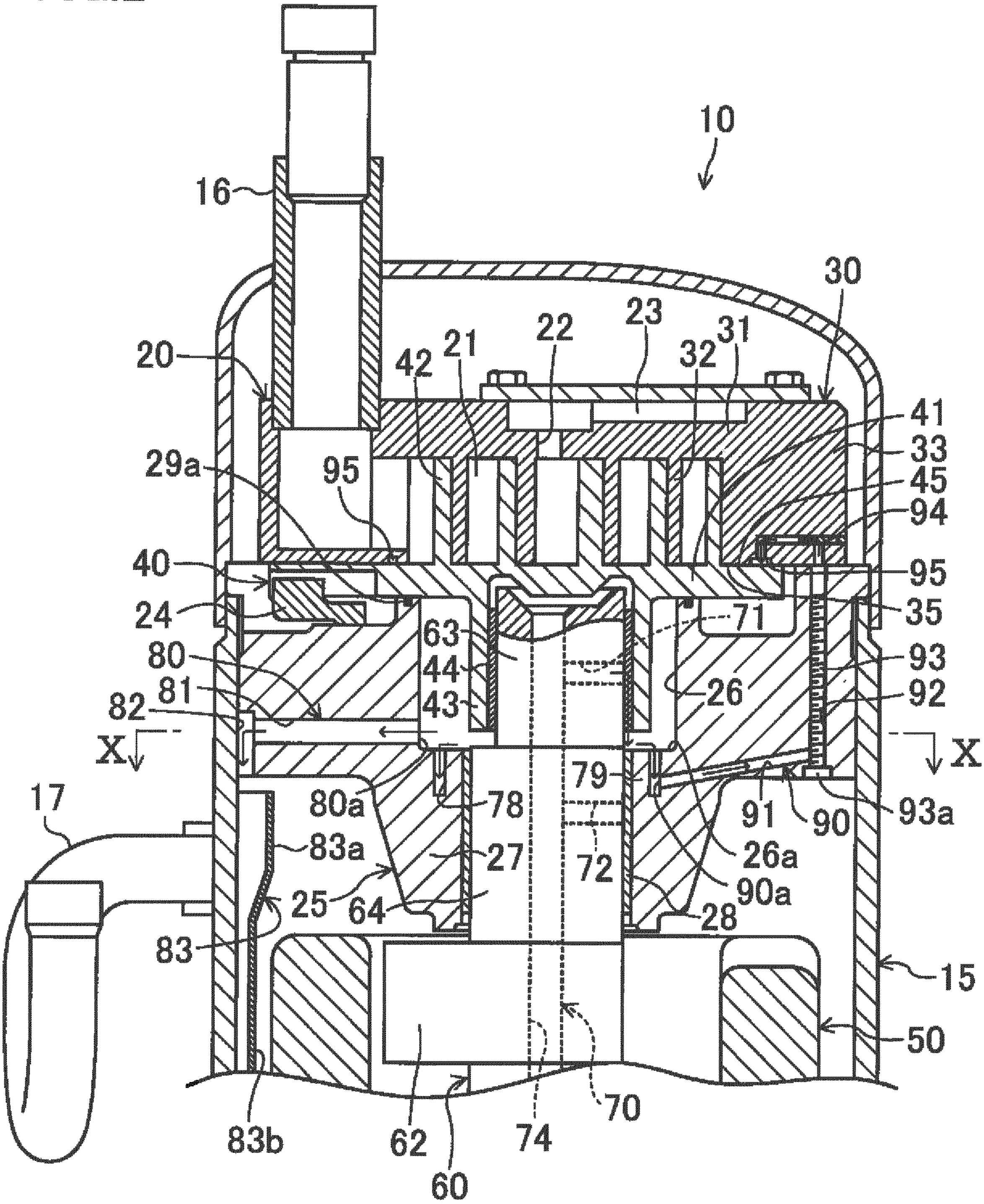
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FIG.3

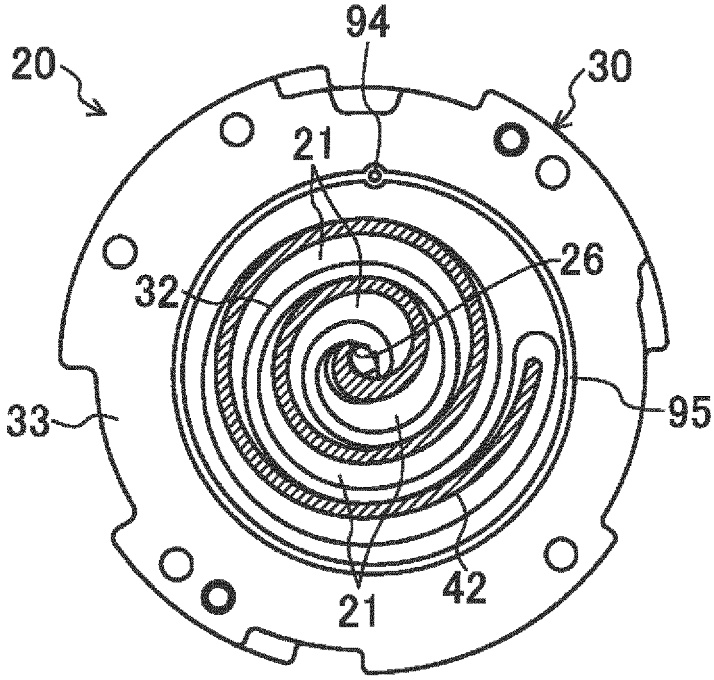


FIG.4

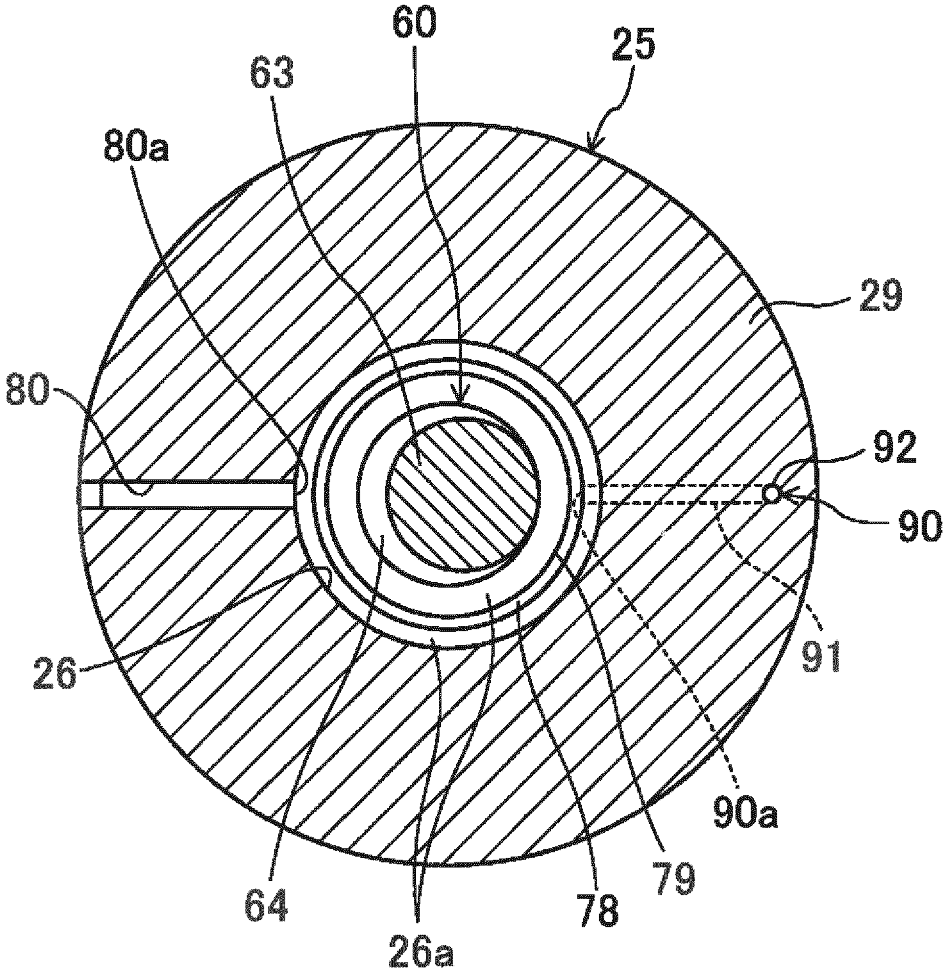
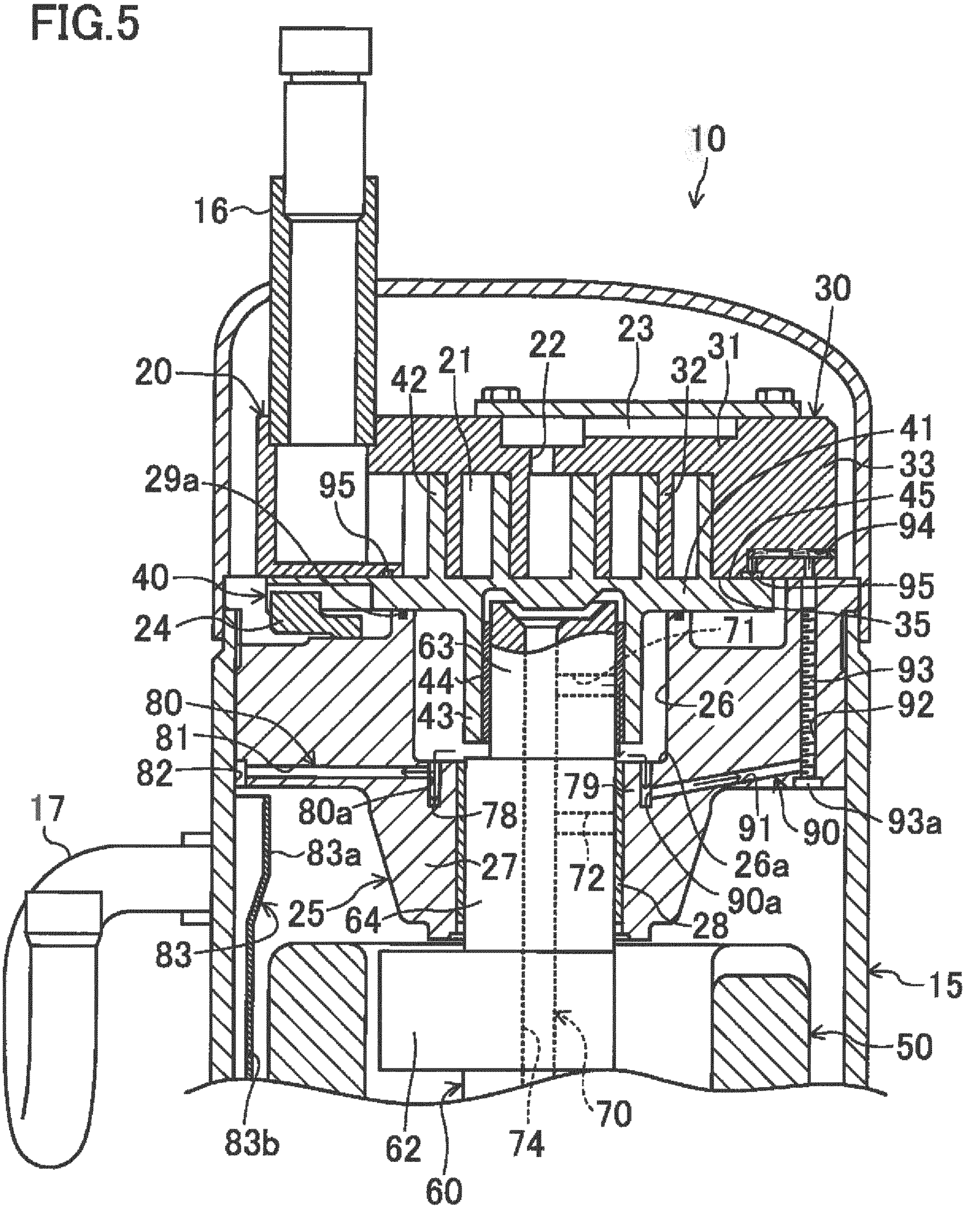


FIG.5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93a
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FIG.6

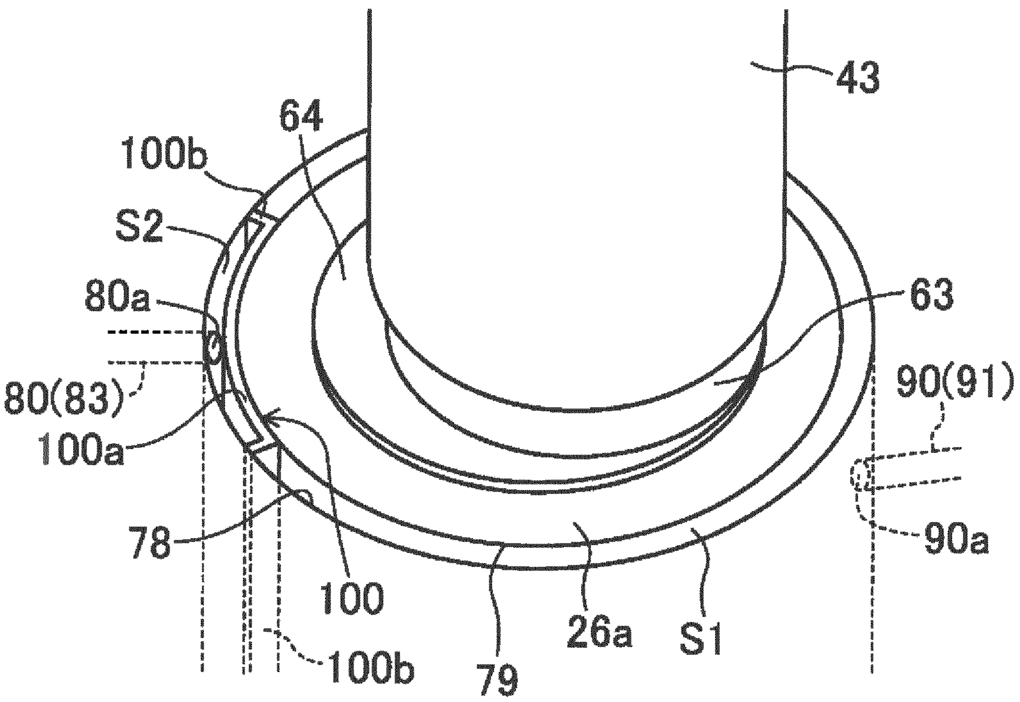
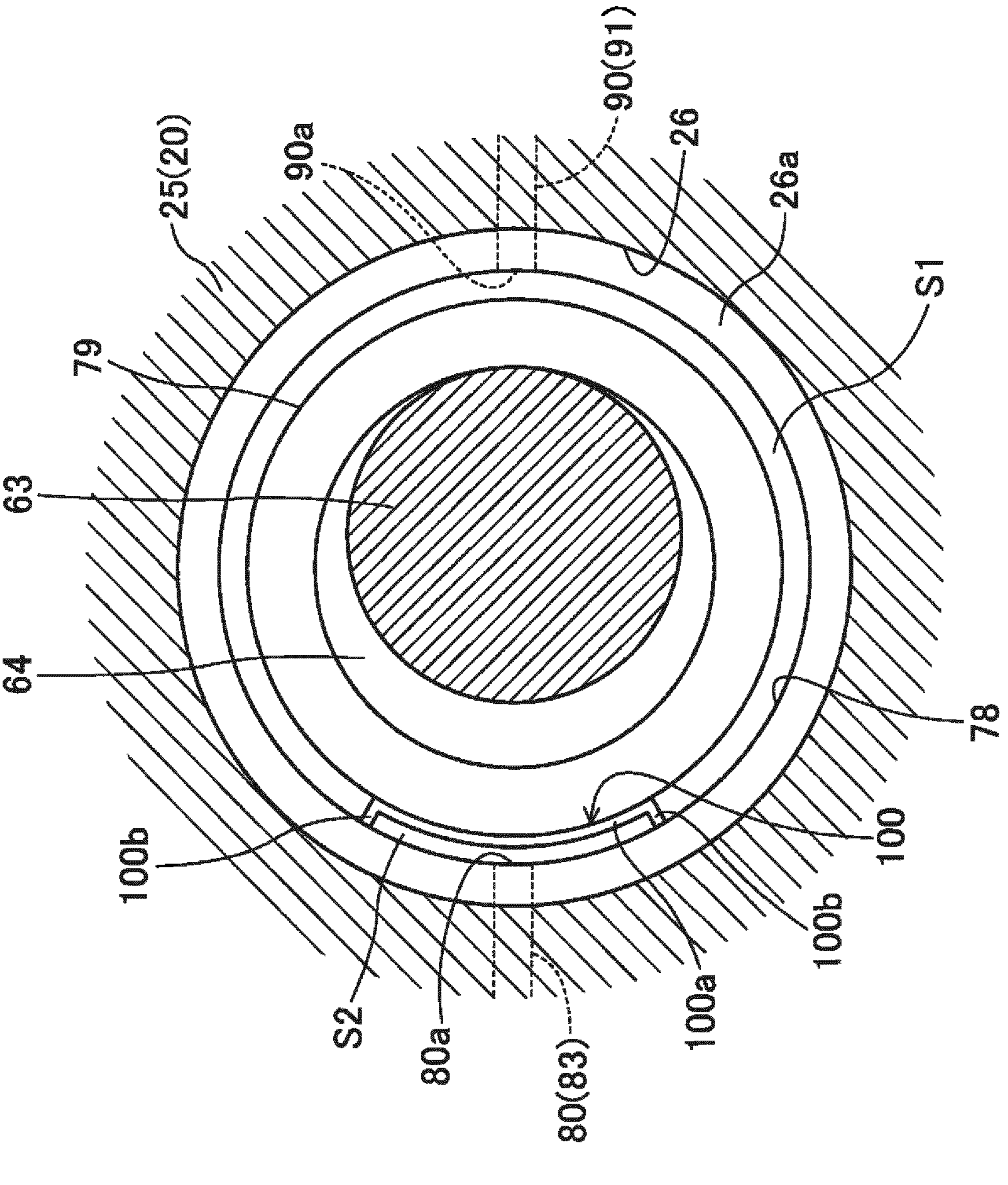


FIG.7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90(91)
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S1
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/007242

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

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 5-306689 A (Daikin Industries, Ltd.), 19 November 1993 (19.11.1993), paragraphs [0016] to [0028]; fig. 1 (Family: none)	1,3,7 4 2,5,6
Y	JP 6-58274 A (Daikin Industries, Ltd.), 01 March 1994 (01.03.1994), paragraphs [0032], [0033]; fig. 9 (Family: none)	4
A	JP 2012-97580 A (Daikin Industries, Ltd.), 24 May 2012 (24.05.2012), entire text; all drawings (Family: none)	1-7

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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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
03 March, 2014 (03.03.14)	18 March, 2014 (18.03.14)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/007242

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 8-49673 A (Daikin Industries, Ltd.), 20 February 1996 (20.02.1996), entire text; all drawings (Family: none)	1-7

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REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2001214872 A **[0005]**