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(54) **SCROLL COMPRESSOR**

(57) Provided is a scroll compressor with which it is possible to reduce damage in sliding sections, even under circumstances in which lubricating oil in a lower oil reservoir part has been depleted. This scroll compressor (1) has a volumetric pump (79) adapted to feed a lubricating oil to an oil feed passage (17a), in order to supply sliding sections above with lubricating oil stored in a lower oil reservoir part (P), via the oil feed passage (17a), which is disposed in a crankshaft (17). An oil retention space (90) is formed extending in an axial direction in the interior of the crankshaft (17), separately from the oil feed passage (17a).

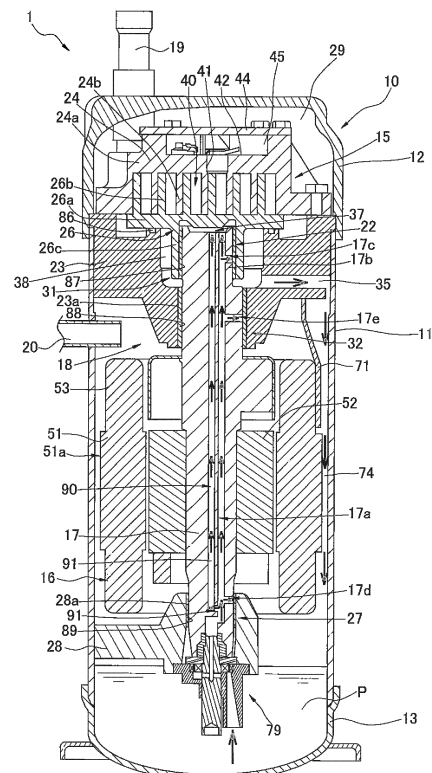


FIG. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to a scroll compressor.

BACKGROUND ART

[0002] A scroll compressor that has a crankshaft extending in a vertical direction, and that is designed to retain a lubricating oil (freezer oil) in a bottom section inside a casing, such as the compressor disclosed in Patent Document 1 (Japanese Laid-open Patent Application 2011-137523) for example, has been described in the prior art.

[0003] In a scroll compressor of this design, lubricating oil is suctioned up through an opening provided at a bottom end of the crankshaft, and flows into an oil feed passage that extends vertically inside the crankshaft. The flow of lubricating oil fed into the oil feed passage inside the crankshaft then branches into each of three branch passages, whereby oil is supplied to sliding members, such as the periphery of bearing metal of a bottom bearing, the periphery of bearing metal provided in a central expanded portion of the housing, the periphery of bearing metal provided to the cylindrical part of a rotating scroll, and the like.

SUMMARY OF THE INVENTION

<Technical Problem>

[0004] A scroll compressor such as the one disclosed in the aforementioned Patent Document 1 (Japanese Laid-open Patent Application 2011-137523) is configured so that lubricating oil retained in the bottom section of the housing is suctioned up; however, depending on the state of operation of a refrigeration device, there may be cases in which the lubricant in the bottom section becomes temporarily depleted.

[0005] In such cases, there will be an insufficient amount of lubricating oil supplied to the sliding sections, which, though temporary, poses a risk that seizing and/or abnormal friction will occur in the sliding sections and/or periphery thereof, causing damage to the sections in question.

[0006] With the foregoing in view, it is an object of the present invention to provide a scroll compressor with which it is possible to reduce damage in sliding sections, even under conditions in which the lubricating oil in the lower oil reservoir part has been depleted.

<Solution to Problem>

[0007] The scroll compressor according to a first aspect of the present invention is provided with a casing, a compression mechanism part, a crankshaft, a motor, an

oil feed pump, a lower oil reservoir part, an oil feed passage, and an oil retention space. The compression mechanism part is accommodated within the casing, and has a stationary scroll, and a moveable scroll forming a compression chamber in relation to the stationary scroll. The crankshaft is linked to the moveable scroll. The motor rotatably drives the crankshaft. The oil feed pump feeds lubricating oil upward. The lower oil reservoir part is disposed in a space below the oil feed pump, and holds the lubricating oil. The oil feed passage is formed so as to extend in the axial direction within the interior of the crankshaft, and communicates at a lower end with a discharge side of the oil feed pump. The oil retention space is formed so as to extend in an axial direction within the crankshaft interior separately from the oil feed passage, and communicates with the oil feed passage.

[0008] In this scroll compressor, the bottom end of the oil feed passage communicates with the discharge side of the oil feed pump, whereby under conditions in which the oil feed pump is being driven and lubricating oil is present in the lower oil reservoir part, the lubricating oil will be fed upward in the axial direction through the crankshaft interior. The lubricating oil fed upwardly through the oil feed passage is fed as far as the outer periphery of the crankshaft, and oil can be supplied to the sliding sections. In contrast to this, it is possible for the oil retention space to retain lubricating oil within the internal space thereof.

[0009] In cases in which oil can no longer be fed to the oil feed passage via the oil feed pump, as may occur under abnormal circumstances such as when the lubricating oil in the lower oil reservoir part has been depleted, the lubricating oil retained within the oil retention space is fed into the oil feed passage, thereby making it possible to supply oil on a temporary basis via the oil feed passage.

[0010] A scroll compressor according to a second aspect of the present invention is the scroll compressor according to the first aspect of the present invention, wherein the oil feed passage and the oil retention space communicate via a communicating passage disposed in the interior of the crankshaft.

[0011] In this scroll compressor, lubricating oil can be easily fed to the oil feed passage from the oil retention space via the communicating passage provided to the interior of the crankshaft.

[0012] A scroll compressor according to a third aspect of the present invention is the scroll compressor according to the first or second aspect of the present invention, wherein the oil retention space communicates with the discharge side of the oil feed pump via a space within the oil feed passage, without communicating directly with the discharge side of the oil feed pump.

[0013] In this scroll compressor, because the oil retention space communicates with the discharge side of the oil feed pump via a space within the oil feed passage, the lubricating oil being fed upwardly by the oil feed pump is first fed preferentially into the oil feed passage. A portion of the rising lubricating oil fed into the oil feed passage

is then fed towards the oil retention space side. Then, in cases in which oil can no longer be fed to the oil feed passage via the oil feed pump, as may occur under abnormal circumstances such as when the lubricating oil in the lower oil reservoir part has been depleted, rather than lubricating oil being fed into the oil retention space, the lubricating oil retained within the oil retention space flows down and is fed into the oil feed passage via the section thereof that communicates with the oil feed passage. In so doing, the lubricating oil held within the oil retention space can be fed to into the oil feed passage in a more reliable fashion, even under abnormal circumstances such as when the lubricating oil in the lower oil reservoir part has been depleted.

[0014] A scroll compressor according to a fourth aspect of the present invention is the scroll compressor according to any of the first to third aspects of the present invention, wherein the oil feed passage, the crankshaft, and the oil retention space are each cylindrical in shape. The axial center of the oil retention space is disposed at a location closer to the axial center of the crankshaft with respect to the outer periphery thereof, than is the location of the axial center of the oil feed passage.

[0015] In this scroll compressor, the axial center of the oil retention space is arranged closer to the axial center of the outer periphery of the crankshaft, than is the axial center of the oil feed passage. For this reason, even at times of rotational driving of the crankshaft, the lubricating oil retained in the oil retention space is less susceptible to the action of centrifugal force, as compared with the lubricating oil inside the oil feed passage. It is therefore possible for the lubricating oil to be retained more easily in the interior.

[0016] A scroll compressor according to a fifth aspect of the present invention is the scroll compressor according to the fourth aspect of the present invention, wherein the axial center of the oil retention space is disposed at an identical location to the location of the axial center of the crankshaft with respect to the outer periphery thereof.

[0017] With this scroll compressor, centrifugal force acting on the lubricating oil retained within the oil retention space can be held to an even lower level, even while the crankshaft is rotating. For this reason, even while the crankshaft is rotating, the lubricating oil is easily fed to the oil feed passage below via the section communicating with the oil feed passage. Additionally, because the oil retention space is disposed at the axial center of the crankshaft, decline in strength of the crankshaft can be minimized.

[0018] A scroll compressor according to a sixth aspect of the present invention is the scroll compressor according to any of the first to fifth aspects of the present invention, further provided with a supply path disposed such that it is possible to supply lubricating oil towards the outer periphery of the crankshaft from the interior of the oil feed passage.

[0019] There are no particular limitations as to the supply passage, which may be configured, for example, by

a hole shape penetrating between the interior of the oil feed passage and the outer periphery of the crankshaft, or configured by a shape produced by partial cutting of the outer peripheral surface of the crankshaft so that lubricating oil may be supplied from the oil feed passage to the vicinity of an upper end of the crankshaft via the upper end section of the crankshaft.

[0020] With this scroll compressor, it is possible for the vicinity of the outer periphery of the crankshaft to be supplied with lubricating oil via a supply passage extending from the interior of the oil feed passage.

[0021] A scroll compressor according to a seventh aspect of the present invention is the scroll compressor according to the sixth aspect of the present invention, wherein the supply passage is a horizontal oil-feed hole disposed so as to pass between the interior of the oil feed passage and the outer periphery of the crankshaft in the crankshaft interior.

[0022] This scroll compressor has a horizontal oil-feed hole disposed so as to pass through the crankshaft interior, between the interior of the oil feed passage and the outer periphery of the crankshaft. It is therefore possible for lubricating oil to be supplied to the outer peripheral section of the crankshaft by branching off the flow thereof midway along the oil feed passage, even without the oil being fed as far as the upper end of the oil feed passage.

[0023] A scroll compressor according to an eighth aspect of the present invention is the scroll compressor according to the seventh aspect of the present invention, wherein the oil retention space either lacks an opening that penetrates as far as the outer periphery of the crankshaft, or is provided with a hole that extends so as to penetrate from the interior to the outer periphery of the crankshaft and has a smaller passage cross-sectional area than that of the horizontal oil-feed hole.

[0024] With this scroll compressor, the oil retention space either is not provided with an opening that penetrates as far as the outer periphery of the crankshaft, or the provided hole has a smaller passage cross-sectional area than the horizontal oil-feed hole. Therefore, leakage of lubricating oil to the outside from inside the oil retention space can be minimized, making it possible for the lubricating oil to be easily retained in a space in the interior of the oil retention space.

[0025] A scroll compressor according to a ninth aspect of the present invention is the scroll compressor according to the seventh or eighth aspect of the present invention, further provided with an upper bearing part and a lower bearing part. The upper bearing part supports the crankshaft from a circumferential direction. The lower bearing part supports the crankshaft from a circumferential direction, at a point below the upper bearing part. The horizontal oil-feed hole has a lower bearing horizontal oil-feed hole that extends towards the lower bearing part from within the oil feed passage. The oil retention space and the oil feed passage communicate at a location below the location at which the lower bearing horizontal oil-feed hole branches from the oil feed passage.

[0026] This scroll compressor is configured such that the location at which the oil retention space and the oil feed passage communicate is a location below the location at which the lower bearing horizontal oil-feed hole branches off from the oil feed passage. Therefore, even under abnormal circumstances such as when the lubricating oil in the lower oil reservoir part has been depleted, the lubricating oil retained within the oil retention space can be fed, via the communicating section, to the oil feed passage interior and move to a location at which centrifugal force acts more readily, and to thereby ascend due to centrifugal force and be fed as far as the section where the lower bearing horizontal oil-feed hole branches off from the oil feed passage. In so doing, it is possible to minimize friction in the sliding section between the lower bearing part and the crankshaft, even under abnormal circumstances such as when the lubricating oil in the lower oil reservoir part has been depleted.

[0027] A scroll compressor according to a tenth aspect of the present invention is the scroll compressor according to the ninth aspect of the present invention, further provided with an upper communicating passage. The upper communicating passage provides communication between the interior of the oil feed passage and the interior of the oil retention space. The oil retention space and the oil feed passage communicate at a location below the upper communicating passage.

[0028] With this scroll compressor, the upper communicating passage causes the interior of the oil feed passage and the interior of the oil retention space to communicate, at a location above the location at which the oil retention space and the oil feed passage communicate. Therefore, a portion of the lubricating oil retained in the interior of the oil retention space is fed into the oil feed passage via the upper communicating passage, not via the location at which the oil retention space and the oil feed passage communicate. Therefore, it is possible to shorten the interval from the point in time that the lubricating oil in the lower oil reservoir part is depleted, until lubricating oil can be supplied to sliding sections in the upper part of the crankshaft.

[0029] A scroll compressor according to an eleventh aspect of the present invention is the scroll compressor according to the seventh aspect of the present invention, further provided with an upper bearing part and a lower bearing part. The upper bearing part supports the crankshaft from a circumferential direction. The lower bearing part supports the crankshaft from a circumferential direction, at a point below the upper bearing part. The horizontal oil-feed hole has an upper bearing horizontal oil-feed hole that extends towards the inner peripheral surface of the upper bearing part from within the oil feed passage.

[0030] With this scroll compressor, it is possible to minimize friction in sliding sections between the upper bearing part and the crankshaft, even under abnormal circumstances such as when the lubricating oil in the lower oil reservoir part has been depleted.

[0031] A scroll compressor according to a twelfth aspect of the present invention is the scroll compressor according to the seventh aspect of the present invention, wherein the moveable scroll has a cylindrical part for covering the upper end of the crankshaft from the circumferential direction. The horizontal oil-feed hole has an upper horizontal oil-feed hole that extends towards the inner peripheral surface of the cylindrical part from within the oil feed passage.

[0032] With this scroll compressor, it is possible to minimize friction in sliding sections between the cylindrical part of the moveable scroll and the crankshaft, even under abnormal circumstances such as when the lubricating oil in the lower oil reservoir part has been depleted.

[0033] A scroll compressor according to a thirteenth aspect of the present invention is the scroll compressor according to the fourth or fifth aspect of the present invention, wherein the inside diameter of the oil retention space is 0.5-2.0 times the inside diameter of the oil feed passage.

[0034] With this scroll compressor, because the inside diameter of the oil retention space is 0.5-2.0 times the inside diameter of the oil feed passage, it is possible for an ample quantity of lubricating oil to be retained within the oil retention space.

[0035] A scroll compressor according to a fourteenth aspect of the present invention is the scroll compressor according to any of the first to thirteenth aspects of the present invention, wherein the oil retention space is open at the upper end.

[0036] With this scroll compressor, because the upper end of the oil retention space is open, lubricating oil that, of the lubricating oil fed upwardly from the oil feed passage, represents surplus oil present above the crankshaft may be easily retained. In so doing, it is possible for lubricating oil for use in abnormal circumstances to be retained within the oil retention space in a more reliable manner.

[0037] A scroll compressor according to a fifteenth aspect of the present invention is the scroll compressor according to any of the first to fourteenth aspects of the present invention, further provided with a member arranged in the interior of the oil retention space, for limiting the descent speed of the lubricating oil within the oil retention space.

[0038] With this scroll compressor, the speed of descent of the lubricating oil in the oil retention space can be limited. In so doing, the time required from the point in time at which the lubricating oil in the lower oil reservoir part is depleted until the lubricating oil in the oil retention space is also depleted can be extended. In so doing, it is possible to continuously supply oil to sliding sections of the crankshaft for a longer period, starting at the point in time at which the lubricating oil in the lower oil reservoir part is depleted.

<Advantageous Effects of Invention>

[0039] With the scroll compressor according to the first aspect of the present invention, under abnormal circumstances such as when the lubricating oil in the lower oil reservoir part has been depleted, it is possible for oil to be supplied on a temporary basis via the oil feed passage, by feeding the lubricating oil retained within the oil retention space to the oil feed passage.

[0040] With the scroll compressor according to the second aspect of the present invention, the oil feed passage can be easily fed lubricating oil from the oil retention space.

[0041] With the scroll compressor according to the third aspect of the present invention, even under abnormal circumstances such as when the lubricating oil in the lower oil reservoir part has been depleted, the lubricating oil retained in the oil retention space can be fed into the oil feed passage in a more reliable manner.

[0042] With the scroll compressor according to the fourth aspect of the present invention, it is possible for the lubricating oil to be easily retained in the interior.

[0043] With the scroll compressor according to the fifth aspect of the present invention, the lubricating oil can be easily fed to the oil feed passage even when the crankshaft is rotating, and decline in the strength of the crankshaft can be minimized.

[0044] With the scroll compressor according to the sixth aspect of the present invention, it is possible for the vicinity of the outer periphery of the crankshaft to be supplied with lubricating oil via the supply passage extending from the interior of the oil feed passage.

[0045] With the scroll compressor according to the seventh aspect of the present invention, it is possible to induce the flow of lubricating oil to branch into the horizontal oil-feed hole at a point midway along the oil feed passage and supplied to outer peripheral sections of the crankshaft, without being fed as far as the upper end of the oil feed passage.

[0046] With the scroll compressor according to the eighth aspect of the present invention, it is possible to minimize leakage of lubricating oil to the outside from inside the oil retention space, and to easily retain the lubricating oil in a space in the interior of the oil retention space.

[0047] With the scroll compressor according to the ninth aspect of the present invention, it is possible to minimize friction in the sliding section between the lower bearing part and the crankshaft.

[0048] With the scroll compressor according to the tenth aspect of the present invention, it is possible to shorten the interval from the point in time that the lubricating oil in the lower oil reservoir part is depleted, until lubricating oil can be supplied to a sliding section above the crankshaft.

[0049] With the scroll compressor according to the eleventh aspect of the present invention, it is possible to minimize friction in sliding sections between the upper

bearing part and the crankshaft.

[0050] With the scroll compressor according to the twelfth aspect of the present invention, it is possible to minimize friction in sliding sections between the cylindrical part of the moveable scroll and the crankshaft.

[0051] With the scroll compressor according to the thirteenth aspect of the present invention, it is possible for an ample quantity of lubricating oil to be retained within the oil retention space.

[0052] With the scroll compressor according to the fourteenth aspect of the present invention, it is possible for lubricating oil for use in abnormal circumstances to be retained within the oil retention space in a more reliable manner.

[0053] With the scroll compressor according to the fifteenth aspect of the present invention, it is possible to continuously supply oil to sliding sections of the crankshaft for a longer period, starting at the point in time at which the lubricating oil in the lower oil reservoir part is depleted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0054]

[FIG. 1] A longitudinal cross-sectional view of a scroll compressor according to a first embodiment, depicting a normal condition.

[FIG. 2] A longitudinal cross-sectional view of the scroll compressor according to the first embodiment, depicting depletion.

[FIG. 3] A fragmentary enlarged cross-sectional view of section X of FIG. 2.

[FIG. 4] A schematic diagram showing a structure in the vicinity of the crankshaft bottom end.

[FIG. 5] A fragmentary enlarged cross-sectional view according to another embodiment (5-1).

[FIG. 6] A fragmentary enlarged cross-sectional view of a scroll compressor according to another embodiment (5-2).

[FIG. 7] A fragmentary enlarged cross-sectional view of a scroll compressor according to another embodiment (5-3).

[FIG. 8] A fragmentary enlarged cross-sectional view of a scroll compressor according to another embodiment (5-4).

[FIG. 9] A fragmentary enlarged cross-sectional view of a scroll compressor according to another embodiment (5-5).

[FIG. 10] A fragmentary enlarged cross-sectional view of a scroll compressor according to another embodiment (5-6).

[FIG. 11] A fragmentary enlarged cross-sectional view of a scroll compressor according to another embodiment (5-7).

DESCRIPTION OF EMBODIMENTS

[0055] An embodiment of the scroll compressor will be described below, while referring to the drawings.

(1) First Embodiment

[0056] FIG. 1 shows a longitudinal cross-sectional view of a scroll compressor 1 during normal operation. FIG. 2 shows a longitudinal cross-sectional view of the scroll compressor 1 when depleted. FIG. 3 shows a fragmentary enlarged cross-sectional view of section X of FIG. 2. FIG 4 shows a schematic diagram of a structure in the vicinity of the crankshaft bottom end.

[0057] The scroll compressor 1 is a scroll compressor of high-low pressure dome type, and together with an evaporator, a condenser, an expansion mechanism, and the like, makes up a refrigerant circuit. This scroll compressor 1 performs the role of compressing a refrigerant gas in the refrigerant circuit.

[0058] The scroll compressor 1 is configured mainly from a sealed dome type casing 10 of vertically elongated cylindrical shape, a pin bearing part 22, an upper bearing part 32, a lower bearing part 27, a motor 16, a volumetric pump 79, an intake pipe 19, a discharge pipe 20, a compression mechanism part 15, a crankshaft 17 that functions as a drive shaft, and an oil return guide 71. These constituent components of the scroll compressor 1 are each described in detail below.

(1-1) Casing

[0059] The casing 10 is a vertically elongated sealed container, and has a generally cylindrical-shaped barrel casing part 11, a bowl-shaped upper wall part 12 welded airtightly to an upper end part of the barrel casing part 11, and a bowl-shaped lower wall part 13 welded airtightly to a lower end part of the barrel casing part 11. The casing 10 mainly accommodates the compression mechanism part 15, which compresses the refrigerant gas, and the motor 16, which is arranged below the compression mechanism part 15. The compression mechanism part 15 and the motor 16 are linked by the crankshaft 17, which is arranged extending in a vertical direction within the casing 10. Between the compression mechanism part 15 and the motor 16 is a high-pressure space 18.

(1-2) Pin bearing part

[0060] The pin bearing part 22 supports a pin shaft part 17b at the upper end of the crankshaft 17, from the outside in a diametrical direction. The pin bearing part 22 is constituted by a boss part 26c that extends in a cylindrical profile axially downward from the vicinity of the center of a moveable scroll 26, discussed below, and pin shaft bearing metal 87 fitted against the inner peripheral surface to the diametrical inside of the boss part 26c, and is disposed such that the inner peripheral surface of the

pin shaft bearing metal 87 contacts the outer peripheral surface of the pin shaft part 17b of the crankshaft 17.

(1-3) Upper bearing part

[0061] The upper bearing part 32 is located somewhat above the center within the casing 10, and supports a section of the crankshaft 17 below the pin shaft part 17b from the outside in a diametrical direction. The upper bearing part 32 is configured from an upper inner peripheral section 23a situated at the diametrical inside of an upper bearing housing 23, discussed below, and upper bearing metal 88 fitted against the inner peripheral surface at the diametrical inside of the upper bearing part 32. The inner peripheral surface of the upper bearing metal 88 is disposed so as to contact the outer peripheral surface the crankshaft 17 in a section thereof that lies below the pin shaft part 17b. The relationship of the upper bearing part 32 to the upper bearing housing 23 is discussed below.

(1-4) Lower bearing part

[0062] The lower bearing part 27 is located in a lower part within the casing 10, and supports a lower section of the crankshaft 17 from the outside in a diametrical direction. The lower bearing part 27 is configured from a lower inner peripheral section 28a situated to the diametrical inside of the lower bearing housing 28, and lower bearing metal 89 that fits against the inner peripheral surface at the diametrical inside of the lower inner peripheral section 28a; and is moreover disposed such that the inner peripheral surface of the lower bearing metal 89 contacts the outer peripheral surface of the lower section of the crankshaft 17. The lower bearing housing 28 is arranged in a lower space below the motor 16. This lower bearing housing 28 is fixed at a diametrical outside end part thereof to an inner peripheral section of the barrel casing part 11.

(1-5) Motor

[0063] The motor 16 is configured mainly from a ring-shaped stator 51 fixed to an inner wall surface of the casing 10, and a rotor 52 accommodated rotatably to the inside of the stator 51, with a slight gap (air gap passage) therebetween.

[0064] Copper wire is wound about the stator 51 at top and bottom, forming a coil end 53. An upper end of the coil end 53 of the stator 51 is arranged such that the heightwise position is substantially the same as that of the bottom end of the upper bearing part 32 of the upper bearing housing 23, discussed below. The outer peripheral surface of the stator 51 is provided at several locations, spaced apart by prescribed distances in the circumferential direction, with groove-shaped core cut parts 51a that extend in a plumb vertical direction from an upper end surface to a lower end surface of the stator 51. These

core cut parts 51a are configured as motor cooling passages that extend in the vertical direction between the inner peripheral side of the barrel casing part 11 and the outer peripheral side of the stator 51. As shown in FIG. 1, an oil return flow channel 74 through which it is possible for the lubricating oil to descend is formed between the outer peripheral side of the stator 51 and the inner peripheral side of the main casing 10.

[0065] The rotor 52 is drive-coupled to the moveable scroll 26 of the compression mechanism part 15 via the crankshaft 17, which is arranged at the axial center of the barrel casing part 11 so as to extend in the vertical direction.

(1-6) Volumetric pump

[0066] The volumetric pump 79 for suctioning up the lubricating oil in a lower oil reservoir part P into an oil feed passage 17a of the crankshaft 17 is disposed at the lower end of the crankshaft 17. In the present first embodiment, a "trochoid pump" is employed as the volumetric pump 79. This trochoid pump is configured to suction up the lubricating oil through changes in volume brought about by rotary operation of rotors or gears to produce suctioning/discharge action of the lubricating oil in the lower oil reservoir part P.

[0067] As shown in FIG. 4, the discharge side of this volumetric pump 79 is arranged so as to communicate with the lower end of the crankshaft 17. A space communicating with the discharge side of the volumetric pump 79 at the lower end of the crankshaft 17 communicates in a diametrical direction with a lower end section of the oil feed passage 17a, and is configured to suction up the lubricating oil by rotating in tandem with the crankshaft 17.

[0068] By employing a volumetric pump, rather than a pressure differential pump or the like, as the pump for supplying the lubricating oil to the sliding sections in this manner, it is possible for oil to be supplied more easily to the sliding sections of the lower bearing part 27. Specifically, by drawing up the lubricating oil in the lower oil reservoir part P with the volumetric pump 79 in a manner free of limitation to a state of driving by the compression mechanism part 15 in order to produce a pressure differential between an oil feed source and an oil feed destination, a more reliable feed of oil to the sliding sections of the lower bearing part 27 via the oil feed passage 17a of the crankshaft 17 and the oil retention space 90 is possible.

(1-7) Intake pipe

[0069] The intake pipe 19 is a line for guiding the refrigerant of the refrigerant circuit to the compression mechanism part 15, and is fitted airtightly into the upper wall part 12 of the casing 10. The intake pipe 19 passes in the vertical direction through a low-pressure space 29 which is a space at the top of the casing 10 interior, and

a bottom end part thereof is fitted into a stationary scroll 24.

(1-8) Discharge pipe

[0070] The discharge pipe 20 is a line for discharging the refrigerant within the casing 10 to outside the casing 10, and is fitted airtightly into the barrel casing part 11 of the casing 10. An end of this discharge pipe 20 is disposed at a location so as to protrude further to the inside from the inner peripheral surface of the barrel casing part 11.

(1-9) Compression mechanism part

[0071] As shown in FIG 1, the compression mechanism part 15 is configured mainly from the stationary scroll 24 which is arranged airtightly above the upper bearing housing 23, discussed below, and the moveable scroll 26 which is interleaved with the stationary scroll 24.

[0072] Each of the constituent parts of this compression mechanism part 15 will be described in detail below.

(1-9-1) Stationary scroll

[0073] As shown in FIG 1, the stationary scroll 24 has a flat plate-shaped end plate 24a, and a lap 24b of spiral shape (involute shape) viewed from the bottom surface, formed extending downward from the bottom surface of the end plate 24a.

[0074] The end plate 24a is perforated in an axial direction by a discharge port 41 at the approximate axial center of the top surface side. This discharge port 41 communicates with a compression chamber 40, discussed below. The discharge port 41 is formed so as to extend in the vertical direction.

[0075] In a portion further towards the top from the discharge port 41 at the upper surface side of the end plate 24a is formed an expanded recess part 42 that extends upward and expands further in a horizontal direction than the upper end opening section of the discharge port 41. A cover 44 is affixed to the expanded recess part 42 so as to provide closure from above. A space enclosed in the vertical direction by the expanded recess part 42 and the cover 44 forms a muffler space 45. This muffler space 45 functions as an expansion chamber for silencing operating noise of the compression mechanism part 15. A seal structure is employed between the stationary scroll 24 and the cover 44, to provide intimate contact through the agency of a gasket, not illustrated.

[0076] The refrigerant discharged from the discharge port 41 of the compression mechanism part 15 passes through the muffler space 45, passes downward through an access passage (not illustrated) which is formed near the outer periphery of the upper bearing housing 23 and which is formed to penetrate therethrough in the vertical direction, whereupon a portion of the flow is split off and directed into a gas guide (not illustrated), passes down-

ward through a specific one of the core cuts 51a until reaching a space near the underside of the motor 16, and thereafter passes upward through a passage such as a different one of the core cuts 51 a, and thereby fed into the high-pressure space 18. Another portion, with the lubricating oil separated by centrifugal force, is fed to the high-pressure space 18 via a hole provided in the gas guide (not illustrated).

(1-9-2) Moveable scroll

[0077] As shown in FIG. 1, the moveable scroll 26 has an end plate 26a; a lap 26b of spiral shape (involute shape) viewed from the top surface, formed extending to the upper surface side of the end plate 26a; and a boss part 26c which configures a pin bearing part for receiving the upper end of the crankshaft 17, and which is formed so as to extend in a cylindrical profile to the lower surface side of the end plate 26a.

[0078] While there is no particular limitation as to the type of the moveable scroll 26, the present embodiment employs an inner drive moveable scroll. The boss part 26c of the moveable scroll 26 covers from the outside in the diametrical direction the pin shaft part 17b which configures the proximity of the upper end of the crankshaft 17. In this way, the moveable scroll 26 and the crankshaft 17 are rotatably linked.

[0079] The lap 26b, which extends upward from the moveable scroll 26, is interleaved from the vertical direction with the lap 24b which extends downward from the stationary scroll 24, in such a way that the scrolls overlap in the diametrical direction. Here, the lap 24b of the stationary scroll 24 and the lap 26b of the moveable scroll 26 are interleaved in such a way that the compression chamber 40 is formed between the contacting sections.

[0080] The moveable scroll 26 is supported by the upper surface of the upper bearing housing 23, in such a way as to prevent rotational motion. As mentioned above, the pin shaft part 17b at the upper end of the crankshaft 17 is inserted into the boss part 26c, to the inside thereof in the diametrical direction.

[0081] Through rotary driving of the crankshaft 17, the boss part 26c, which is linked to the pin shaft part 17b in such a way that rotary driving force is transmitted thereto, is acted upon by the force of the crankshaft 17, and the moveable scroll 26 orbits without rotating within the upper bearing housing 23. In the process, in association with the orbiting of the moveable scroll 26, the compression chamber 40 formed by the lap 24b of the stationary scroll 24 and the lap 26b of the moveable scroll 26 becomes shorter in distance in the diametrical direction from the discharge port 41, while advancing in the rotational advance direction, thereby contracting while the volume faces the center. In the scroll compressor 1 according to the present embodiment, the refrigerant gas is compressed in this manner.

[0082] Due to the above structure, the lubricating oil which has been pressurized by the volumetric pump 79

ascends through the oil feed passage 17a which penetrates the crankshaft 17 interior in the axial direction, feeding oil to the lower bearing part 27, the upper bearing part 32, and the pin bearing part 22, respectively, and is fed into a pin shaft headspace 37 at the upper end of the crankshaft 17, which is part of a linking space to the inside of the inner peripheral surface of the boss part 26c of the moveable scroll 26.

10 (1-10) Upper bearing housing

[0083] The upper bearing housing 23 is affixed, along the entire outer peripheral surface thereof in the circumferential direction, against the inner peripheral surface of the barrel casing part 11 by pressure fitting. In so doing, the diametrical inside of the barrel casing part 11 and the diametrical outside of the upper bearing housing 23 are disposed in airtight intimate contact about their entire circumference. The interior of the casing 10 is thereby partitioned into the high-pressure space 18 below the upper bearing housing 23, and the low-pressure space 29 above the upper bearing housing 23. The stationary scroll 24 is affixed by fastening with a bolt (not illustrated) to the upper bearing housing 23, so that the upper end surface of the latter is disposed in intimate contact against the lower end surface of the stationary scroll 24.

[0084] This upper bearing housing 23 has a downwardly-recessed crank chamber 31 at the center of the upper surface. A lower section of the upper bearing housing 23 is formed such that the diametrical length at the outer periphery thereof increases moving upwards from the lower end, while the inner periphery is formed to cylindrical shape, the axial direction of which is aligned with the plumb vertical direction. The upper inner peripheral section 23a, which is part of the upper bearing part 32, is a section that corresponds to this cylindrical shape. This upper inner peripheral section 23a, and the round cylindrical upper bearing metal 88 which is fitted into the diametrical inside thereof and shares the same axial direction, together configure the upper bearing part 32. The inner peripheral surface of this upper bearing metal 88 rotatably supports a section of the crankshaft 17 below the pin shaft part 17b, from the outside in the diametrical direction.

[0085] In the upper bearing housing 23 there is formed a diametrical oil passage 35 that extends diametrically outside through to reach the outer peripheral surface from the vicinity of the lower end of the crank chamber 31. Lubricating oil which has been supplied into the crank chamber 31 passes through this diametrical oil passage 35 and descends between the oil return guide 71, discussed below, and the casing 10, descends through the gap between the barrel casing part 11 and the stator 51, and is returned to the lower oil reservoir part P in the lower part of the casing 10.

[0086] Further, in a section of the upper surface of the upper bearing housing 23 situated diametrically to outside the crank chamber 31, there is provided an annular

sealing ring 86 for sealing off the section of high pressure to the inside in the area below the moveable scroll 26 and the section of low pressure to the outside in the area below the moveable scroll 26, in order to maintain high pressure in the crank chamber 31 interior.

(1-11) Other

[0087] As mentioned above, the refrigerant discharged from the discharge port 41 of the compression mechanism part 15 passes through the muffler space 45, a portion thereof passes downward through specific one of the core cuts 51a until reaching the space near the underside of the motor 16, and thereafter passes upward through a passage such as a different one of the core cuts 51a, and is thereby fed to the high-pressure space 18. Another portion passes through a hole in the gas guide (not illustrated), and is fed to the high-pressure space 18. The refrigerant gas fed to the high-pressure space 18 is discharged to outside the casing 10 from the discharge pipe 20.

(1-12) Crankshaft

[0088] The crankshaft 17 is a drive shaft for transmitting the drive force of the motor 16 to the compression mechanism part 15.

[0089] The crankshaft 17 is rotatably supported inside the casing 10 by the upper bearing part 32 of the upper bearing housing 23, and the lower bearing part 27. A medial section of the crankshaft 17 is linked concentrically to the rotor 52 of the motor 16.

[0090] The pin shaft part 17b is disposed at the upper end of the crankshaft 17, and positioned eccentrically from the medial section of the crankshaft 17. The pin shaft part 17b is inserted towards an inner peripheral space of the boss part 26c of the moveable scroll 26. In so doing, it is possible for the moveable scroll 26 to undergo revolutionary movement, through rotation of the crankshaft 17 by the drive force of the motor 16.

[0091] In the interior of the crankshaft 17 are formed the oil feed passage 17a extending in the axial direction of the crankshaft 17, and the oil retention space 90 which is provided separately from the oil feed passage 17a but which likewise extends in the axial direction of the crankshaft 17. In the pin shaft part 17b of the crankshaft 17, there is formed a pin bearing horizontal oil-feed hole 17c which branches to extend out diametrically towards the outside from a point midway along the oil feed passage 17a, and communicates in a diametrical direction with the pin shaft part 17b. Via this the pin bearing horizontal oil-feed hole 17c, lubricating oil is supplied to sliding sections between the inner peripheral surface of the boss part 26c of the moveable scroll 26 and the outer peripheral surface of the pin shaft part 17b.

[0092] The discharge side of the volumetric pump 79 communicates with the lower end of the oil feed passage 17a. Specifically, as shown in FIG. 4, a space that com-

municates with the discharge side of the volumetric pump 79 at the lower end of the crankshaft 17 communicates in a diametrical direction with a lower end section of the oil feed passage 17a. As shown in FIG. 3, the upper end of the oil feed passage 17a extends as far as the upper end section of the crankshaft 17, and the upper end section is open vertically. In the aforescribed manner, the interior of the pin shaft part 17b of the crankshaft 17, there is formed the pin bearing horizontal oil-feed hole 17c which branches to extend out diametrically towards the outside from a point midway along the oil feed passage 17a, and communicates as far as the near side of the inner peripheral surface of the pin shaft bearing metal 87 situated at the outside. The lubricating oil is supplied, via this pin bearing horizontal oil-feed hole 17c, to the sliding sections between the outer peripheral surface of the pin shaft part 17b and the inner peripheral surface of the pin shaft bearing metal 87 disposed inside the boss part 26c of the moveable scroll 26.

[0093] In a section of the crankshaft 17 that is supported by the lower bearing part 27, there is formed a lower bearing horizontal oil-feed hole 17d which branches and extends towards the outside in a diametrical direction from a point midway along the oil feed passage 17a, and extends to penetrate as far as the near side of the inner peripheral surface of the lower bearing metal 89 situated at the outside. Sliding sections between the inner peripheral surface of the lower bearing metal 89 of the lower bearing part 27 and outer peripheral surface in the vicinity of the lower end of the crankshaft 17 are supplied with oil via this lower bearing horizontal oil-feed hole 17d.

[0094] In a section of the crankshaft 17 that is supported by the upper bearing part 32, there is formed an upper bearing horizontal oil-feed hole 17e which branches and extends towards the outside in a diametrical direction from a point midway along the oil feed passage 17a, and extends to penetrate as far as the near side of the inner peripheral surface of the upper bearing metal 88 situated at the outside. Sliding sections between the inner peripheral surface of the upper bearing metal 88 of the upper bearing part 32 and the lower outer peripheral surface of the pin shaft part 17b of the crankshaft 17 are supplied with oil via this upper bearing horizontal oil-feed hole 17e.

[0095] The axial center of the oil feed passage 17a is arranged at a different location than the axial center of the outer peripheral surface of the crankshaft 17. Specifically, the axial center of the oil feed passage 17a is eccentric in relation to the axial center with respect to the outer periphery of the crankshaft 17. In so doing, during rotation of the crankshaft 17, centrifugal force readily acts on the lubricating oil within the oil feed passage 17a, and the oil is easily supplied upward.

[0096] The oil retention space 90, like the oil feed passage 17a, is cylindrical in shape, and the axial center thereof is arranged at the same location as the axial center of the outside peripheral surface of the crankshaft 17. Specifically, the axial center of the oil retention space 90 is arranged closer to the axial center of the outer periph-

eral surface of the crankshaft 17 than is the axial center of the oil feed passage 17a. In so doing, even during drive rotation of the crankshaft 17, the lubricating oil present inside the oil retention space 90 is largely unaffected by the action of centrifugal force, and therefore readily descends downward due to the weight of the lubricating oil itself. The lower end of the oil retention space 90 does not communicate directly with the discharge side of the volumetric pump 79, but rather communicates with the discharge side of the volumetric pump 79 via a space inside the oil feed passage 17a. In this way, the vicinity of the lower end of the oil retention space 90 is connected, via a communicating passage 91 extending in the diametrical direction, to the vicinity of the lower end of the oil feed passage 17a. As shown in FIG. 4, a communication location B at which the communicating passage 91 and the oil feed passage 17a communicate is located below the section where the lower bearing horizontal oil-feed hole 17d branches off from the oil feed passage 17a. Unlike the oil feed passage 17a, the oil retention space 90 of the present embodiment lacks a horizontal oil-feed hole configured to penetrate as far as the outer peripheral surface of the crankshaft 17. Therefore, when the lubricating oil is fed towards the bottom of the oil feed passage 17a from the volumetric pump 79 through rotary driving of the crankshaft 17, the lubricating oil collects within the oil retention space 90 via the communicating passage 91. As shown in FIG. 3, the upper end of the oil retention space 90 extends as far as the upper end section of the crankshaft 17, and the upper end section opens vertically, to a size about equal to the inside diameter of the cylindrical section. In the present embodiment, the inside diameter of the oil retention space 90 is formed to an inside diameter equal to the inside diameter of the oil feed passage 17a.

[0097] As shown in FIG. 1, the pin shaft headspace 37, which is a space lying between the upper end surface of the pin shaft part 17b of the distal end of the crankshaft 17 and the lower surface of the end plate 26a of the moveable scroll 26, and a pin shaft circumferential space 38 (part of the crank chamber 31), which is a space lying between the outer peripheral surface of the pin shaft part 17b of the distal end of the crankshaft 17 and the inner peripheral surface of the pin shaft bearing metal 87 disposed inside the boss part 26c of the moveable scroll 26, are respectively formed in the interior of the boss part 26c of the moveable scroll 26. A portion of the lubricating oil supplied via the oil feed passage 17a in the crankshaft 17 interior is supplied between the moveable scroll 26 and the stationary scroll 24, via the pin shaft headspace 37. The pin shaft circumferential space 38 is formed such that a diametrical width of about several tens of microns extends in the vertical direction.

(1-13) Oil return guide

[0098] As shown in FIG 1, the oil return guide 71 is a member of thin metal plate shape, arranged below the

diametrical outside of the upper bearing housing 23 in a space above the motor 16, and is affixed to the barrel casing part 11, forming a flow channel in relation to the inner peripheral face of the barrel casing part 11.

[0099] This oil return guide 71 guides the lubricating oil which has passed through the diametrical oil passage 35 formed in the upper bearing housing 23, and extends in the diametrical direction into an upper end section of the oil return flow channel 74 situated between the outer peripheral surface of the stator 51 and the inner peripheral surface of the barrel casing part 11.

[0100] The lubricating oil guided into the upper end section of the oil return flow channel 74 then descends through the oil return flow channel 74, and collects in the lower oil reservoir part P in the lower part of the casing 10.

(2) Operating behavior of scroll compressor during normal operation

[0101] Next, the operating behavior of the scroll compressor 1 will be briefly described, while referring to FIG 1.

[0102] First, when driving of the motor 16 starts, the crankshaft 17 rotates, and the moveable scroll 26 performs orbiting operation without rotating.

[0103] In so doing, in the compression mechanism part 15 which receives rotational force from the crankshaft 17, the low-pressure refrigerant gas is suctioned through the intake pipe 19 and into the compression chamber 40 from the peripheral edge side of the compression chamber 40, and is compressed in association with the changing volume of the compression chamber 40, becoming transformed to high-pressure refrigerant gas.

[0104] This high-pressure refrigerant gas is discharged from a center part of the compression chamber 40 into the muffler space 45 through the discharge port 41, and thereafter flows downward through the access passage (not illustrated) of the upper bearing housing 23, whereupon a portion of the flow is split off, flows in a circumferential direction along the inner peripheral surface of the barrel casing part 11, and is fed into the high-pressure space 18 through a hole in the gas guide (not illustrated). At this time, lubricating oil admixed into the refrigerant gas is separated, and is retained in the lower oil reservoir part P. Another portion of the divided flow of refrigerant gas passes downward through a specific one of the core cuts 51a formed in the rotor 52 until reaching the space near the underside of the motor 16, and thereafter reverses course and passes upward through an air-gap passage between a different one of the core cuts 51a, the stator 51, and the rotor 52, and is thereby fed to the high-pressure space 18. The converged flow of the refrigerant gas fed into the high-pressure space 18 is discharged to outside the casing 10 through the discharge pipe 20.

[0105] The refrigerant gas discharged to outside the casing 10 is then circulated through the refrigerant circuit, and thereafter is again sucked into the compression mechanism part 15 through the intake pipe 19, and com-

pressed.

[0106] During driving of the scroll compressor 1, the lubricating oil of lower oil reservoir part P in the casing 10 interior is drawn up by the pumping action of the volumetric pump 79, whereby the lubricating oil ascends through the oil feed passage 17a of the crankshaft 17. In the process, a portion of the lubricating oil is branched off via the communicating passage 91 and is stored in the interior of the oil retention space 90 (see the arrows in FIG. 1). Some of the lubricating oil ascending through the oil feed passage 17a is supplied to the sliding section of the lower bearing part 27 via the lower bearing horizontal oil-feed hole 17d. The lubricating oil ascending further up through the oil feed passage 17a is supplied to the sliding section of the upper bearing part 32 via the upper bearing horizontal oil-feed hole 17e. The lubricating oil ascending further up through the oil feed passage 17a is supplied to the sliding section of the pin bearing part 22 through the pin bearing horizontal oil-feed hole 17c. In the event that extra space is remaining within the oil retention space 90, surplus oil in the pin shaft head-space 37 collects in the oil retention space 90 interior, from the open section at the upper end of the oil retention space 90.

(3) Operating behavior of scroll compressor during an abnormal condition

[0107] During normal operation in the above manner, within the space inside the casing 10 of the scroll compressor 1, the refrigerant and the lubricating oil are separated, and the separated lubricating oil descends, to become stored in the lower oil reservoir part P.

[0108] Depending on the operating status of the refrigeration cycle, there may be instances in which separation of the lubricating oil is insufficient, and lubricating oil, entrained by the refrigerant passing through the discharge pipe 20, flows to the outside of the casing 10. In such cases, the amount of lubricating oil stored in the lower oil reservoir part P will progressively decrease. In the event that the lubricating oil in the lower oil reservoir part P becomes depleted, the volumetric pump 79 will no longer be able to draw up lubricating oil.

[0109] When this occurs, the system goes from a state of normal operation in which the lubricating oil is pushed towards the oil retention space 90 side from the oil feed passage 17a side within the communicating passage 91, to an abnormal state in which this pushing flow ceases.

[0110] In this abnormal state, there is no flow of lubricating oil into the oil retention space 90 through the communicating passage 91; moreover, because the axial center of the oil retention space 90 is at the same location as the axial center of the outer periphery of the crankshaft 17, and the lubricating oil within the oil retention space 90 is largely unaffected by centrifugal force produced during rotary driving of the crankshaft 17, the lubricating oil within the oil retention space 90 starts to descend under its own weight. The lubricating oil having descended

within the oil retention space 90 in this manner moves towards the oil feed passage 17a side through the communicating passage 91, whereby the lubricating oil is supplied to the oil feed passage 17a (see the arrows in FIG. 2). The lubricating oil within the oil feed passage 17a now becomes susceptible to the action of centrifugal force produced by rotary driving of the crankshaft 17, and therefore ascends within the oil feed passage 17a. The lubricating oil ascending within the oil feed passage 17a is thereby supplied in respective fashion to the sliding section of the lower bearing part 27 via the lower bearing horizontal oil-feed hole 17d, to the sliding section of the upper bearing part 32 via the upper bearing horizontal oil-feed hole 17e, and to the sliding section of the pin bearing part 22 via the pin bearing horizontal oil-feed hole 17c.

(4) Characteristics of first embodiment

[0111] With the scroll compressor 1 according to the first embodiment, during normal operation when the motor 16 is driven and the crankshaft 17 is rotatably driven, the volumetric pump 79 is driven, whereby the lubricating oil stored in the lower oil reservoir part P is fed upward via the oil feed passage 17a, and in so doing is supplied to the sliding section of the lower bearing part 27, the sliding section of the upper bearing part 32, the sliding section of the pin bearing part 22, and the sliding section near the compression mechanism part 15 at the top, preventing seizing and the like of these sliding sections.

[0112] Additionally, during normal operation, lubricating oil can be stored to the oil retention space 90.

[0113] Further, during abnormal circumstances in which the lubricating oil in the lower oil reservoir part P is depleted, the lubricating oil being stored in the oil retention space 90 can be utilized to supply the sliding section of the lower bearing part 27, the sliding section of the upper bearing part 32, the sliding section of the pin bearing part 22, and the sliding section near the compression mechanism part 15 at the top. In so doing, even during abnormal circumstances in which the lubricating oil in the lower oil reservoir part P is depleted, it is possible for the sliding parts to be supplied continuously until no oil is left within the oil retention space 90, so that a shortage of lubricating oil is unlikely to occur even under during abnormal circumstances, making it possible to minimize problems such as seizing and the like.

(5) Other embodiments

[0114] In the preceding first embodiment, one embodiment of the present invention was described as an example.

[0115] However, the present invention is not limited to this embodiment, and other embodiments resulting from appropriate modifications within the spirit of the present invention are included within the scope thereof. In the following embodiments, elements indicated by identical

symbols are not described.

(5-1)

[0116] The preceding first embodiment described an example of a case in which the upper end of the oil retention space 90 opens vertically.

[0117] However, there is no limitation of the embodiments to this particular arrangement, it being acceptable for a scroll compressor 201 to have a crankshaft 217 formed so as to be provided with a diametrical section 96, as shown in FIG 5 for example.

[0118] This diametrical section 96 is produced by extending an upper section of the oil retention space 90 near the pin shaft part 17b, so as to pass through the pin shaft part 17b towards the outside in a diametrical direction, as far as an outside peripheral section thereof. This scroll compressor 201 affords working effects like those of the preceding embodiment.

(5-2)

[0119] The preceding first embodiment described an example of a case in which the oil retention space 90 and the oil feed passage 17a in the crankshaft 17 lack a communicating section in any section besides the communicating passage 91.

[0120] However, there is no limitation of the embodiments to this particular arrangement; it being acceptable for a scroll compressor 301 to be provided, for example, with a first internal passage 317s and a second internal passage 317t through which the oil retention space 90 and the oil feed passage 17a communicate with one another at locations above the communicating passage 91, as shown in FIG. 6.

[0121] This first internal passage 317s is disposed at a location at the same height as the pin bearing horizontal oil-feed hole 17c, so as to pass through between the oil retention space 90 and the oil feed passage 17a. The second internal passage 317t is disposed at a location at the same height as the upper bearing horizontal oil-feed hole 17e, so as to pass through between the oil retention space 90 and the oil feed passage 17a.

[0122] In so doing, in the event that the lubricating oil in the lower oil reservoir part P has been depleted, the lubricating oil retained within the oil retention space 90 is fed to the oil feed passage 17a via the first internal passage 317s and/or the second internal passage 317t, rather than via the communicating passage 91 through which the oil retention space 90 and the oil feed passage 17a communicate at a point further down, and can thereby be supplied to the sliding section of the pin bearing part 22 and/or the sliding section of the upper bearing part 32. In so doing, the interval from the point in time that the lubricating oil in the lower oil reservoir part P is depleted until lubricating oil can be supplied to sliding sections in the upper part of the crankshaft 17 is shortened.

[0123] The heightwise location of the end of the first internal passage 317s at the oil feed passage 17a side thereof may be a location lower than the heightwise location of the pin bearing horizontal oil-feed hole 17c and higher than the heightwise location of the upper bearing horizontal oil-feed hole 17e, rather than the same as the heightwise location of the pin bearing horizontal oil-feed hole 17c. In so doing, the lubricating oil that has been fed into the oil feed passage 17a via the first internal passage 317s can ascend somewhat within the oil feed passage 17a, and be fed as far as the pin bearing horizontal oil-feed hole 17c.

[0124] Moreover, the heightwise location of the end of the second internal passage 317t at the oil feed passage 17a side thereof may be a location above the heightwise location of the lower bearing horizontal oil-feed hole 17d and below the heightwise location of the upper bearing horizontal oil-feed hole 17e, rather than the same as the heightwise location of the upper bearing horizontal oil-feed hole 17e. In so doing, the lubricating oil that has been fed into the oil feed passage 17a via the second internal passage 317t can ascend somewhat within the oil feed passage 17a, and be fed as far as the upper bearing horizontal oil-feed hole 17e.

[0125] The passage cross-sectional area of the first internal passage 317s (the smallest area among areas perpendicular to the direction of passage in the case where the lubricating oil passes from the oil retention space 90 to the oil feed passage 17a) may be configured to be smaller than the passage cross-sectional area of the pin bearing horizontal oil-feed hole 17c. In so doing, the extent to which the lubricating oil in the oil retention space 90 interior leaks to the outside via the first internal passage 317s can be minimized, and the lubricating oil can be easily retained within the oil retention space 90.

[0126] The passage cross-sectional area of the second internal passage 317t (the smallest area among areas perpendicular to the direction of passage in the case where the lubricating oil passes from the oil retention space 90 to the oil feed passage 17a) may be configured to be smaller than the passage cross-sectional area of the upper bearing horizontal oil-feed hole 17e. In so doing, the extent to which the lubricating oil in the oil retention space 90 interior leaks to the outside via the second internal passage 317t can be minimized, and the lubricating oil can be easily retained within the oil retention space 90.

(5-3)

[0127] The first embodiment described an example of a case in which the crankshaft 17 lacks a hole for communication between the interior of the oil retention space 90 and the outside of the crankshaft 17.

[0128] However, there is no limitation of the embodiments to this particular arrangement, and a scroll compressor 401 could, for example, be provided with a crankshaft 417 having a first outer passage 417s and a second

outer passage 417t through which the oil retention space 90 and the outside of the crankshaft 417 communicate with one another at locations above the communicating passage 91, as shown in FIG. 7.

[0129] This first outer passage 417s extends to pass through from the interior of the oil retention space 90 to the outside of the crankshaft 417, at the same heightwise location as the pin bearing horizontal oil-feed hole 17c. The second outer passage 417t extends to pass through from the interior of the oil retention space 90 to the outside of the crankshaft 417, at the same heightwise location as the upper bearing horizontal oil-feed hole 17e.

[0130] The passage cross-sectional area of the first outer passage 417s (in the case where the lubricating oil passes from the oil retention space 90 to the outside of the crankshaft 417, the smallest area among areas perpendicular to the direction of passage) may be configured to be smaller than the passage cross-sectional area of the pin bearing horizontal oil-feed hole 17c. In so doing, the extent to which the lubricating oil in the oil retention space 90 interior leaks to the outside via the first outer passage 417s can be minimized, and the lubricating oil can be easily retained within the oil retention space 90.

[0131] The passage cross-sectional area of the second outer passage 417t (in the case where the lubricating oil passes from the oil retention space 90 to the outside of the crankshaft 417, the smallest area among areas perpendicular to the direction of passage) may be configured to be smaller than the passage cross-sectional area of the upper bearing horizontal oil-feed hole 17e. In so doing, the extent to which the lubricating oil in the oil retention space 90 interior leaks to the outside via the second outer passage 417t can be minimized, and the lubricating oil can be easily retained within the oil retention space 90.

[0132] By means of the above configuration, in cases in which the lubricating oil in the lower oil reservoir part P has been depleted, the lubricating oil retained in the oil retention space 90 can be supplied to the sliding section of the pin bearing part 22 and/or the sliding section of the upper bearing part 32 via the first outer passage 417s and the second outer passage 417t, instead of via the communicating passage 91 through which the oil feed passage 17a and the oil retention space 90 communicate further towards the bottom. In so doing, the interval from the point in time that the lubricating oil in the lower oil reservoir part P is depleted until lubricating oil can be supplied to sliding sections in the upper part of the crankshaft 417 is shortened.

(5-4)

[0133] The preceding embodiment described an example of a case in which the interior of the oil retention space 90 of the crankshaft 17 is a hollow space.

[0134] However, there is no limitation of the embodiments to this particular arrangement; for example, also it being acceptable for a scroll compressor 501 provided

with a crankshaft 517 in which the interior of the oil retention space 90 is filled with a porous substance 590x, as shown in FIG. 8.

[0135] With the oil retention space 90 of this crankshaft 517, the porous substance 590x retains the lubricating oil to a greater degree than in the case of a hollow space, and therefore the speed of descent of the lubricating oil is slower. There are no particular limitations as to the material of the porous substance 590x; e.g., polyethylene or polypropylene could be used. Moreover, there is no limitation as to the form of the porous substance 590x, but a sponge-like form is preferred.

[0136] By disposing the porous substance 590x in this manner, a low flow rate of lubricating oil flowing through the communicating passage 91 from the oil retention space 90 to the oil feed passage 17a can be maintained, making it possible to extend the time over which the lubricating oil retained in the oil retention space 90 is continuously supplied, starting at the point in time when the lubricating oil in the lower oil reservoir part P is depleted. In so doing, even when the lubricating oil in the lower oil reservoir part P is depleted, the feed of oil to the sliding sections via the lower bearing horizontal oil-feed hole 17d and/or the upper bearing horizontal oil-feed hole 17e and/or the pin bearing horizontal oil-feed hole 17c is readily maintained until the refrigerant flowing through the refrigerant circuit and entraining the lubricating oil is returned to within the scroll compressor 501.

[0137] It would also be acceptable to use fibrous members that give rise to resistance to movement of the lubricating oil, in place of the porous substance 590x of the aforescribed embodiment.

(5-5)

[0138] In another embodiment, it being acceptable for a scroll compressor 601 provided with a crankshaft 617 like that shown in FIG. 9 for example, having a first inner passage 617s and a second inner passage 617t through which the oil retention space 90 and the oil feed passage 17a communicate with one another at a location above the communicating passage 91, and having a porous substance 690x packed into the interior of the oil retention space 90 (specifically, the porous substance 690x may be packed into the oil retention space 90 of the aforescribed embodiment of (5-2)).

[0139] In this case, as in the aforescribed embodiment of (5-2), the lubricating oil retained in the oil retention space 90 can be fed into the oil feed passage 17a through the first inner passage 617s and the second inner passage 617t, to supply the sliding parts via the pin bearing horizontal oil-feed hole 17c and/or the upper bearing horizontal oil-feed hole 17e, whereby the interval from the point in time that the lubricating oil in the lower oil reservoir part P is depleted until lubricating oil can be supplied to sliding sections in the upper part of the crankshaft 617 is shortened.

[0140] Additionally, as in the aforescribed embodi-

ment of (5-4), it will be possible to extend the time until no lubricating oil is left within the oil retention space 90.

(5-6)

[0141] In another embodiment, e.g., as shown in FIG. 10, it being acceptable for a scroll compressor 701 provided with a crankshaft 717 having a first outer passage 717s and a second outer passage 717t through which the oil retention space 90 and the outside of the crankshaft 917 communicate with one another at a location above the communicating passage 91, and having a porous substance 790x packed into the interior of the oil retention space 90 (specifically, the porous substance 790x may be packed into the oil retention space 90 of the aforescribed embodiment of (5-3)).

[0142] In this case, as in the aforescribed embodiment of (5-3), the lubricating oil retained in the oil retention space 90 can be supplied to sliding sections via the first outer passage 717s and/or the second outer passage 717t, prior to passing through the communicating passage 91 below, and then ascending within the oil feed passage 17a to be supplied to the sliding parts from the upper bearing horizontal oil-feed hole 17e and/or the pin bearing horizontal oil-feed hole 17c, thereby shortening the interval from the point in time that the lubricating oil in the lower oil reservoir part P is depleted until lubricating oil is supplied to sliding sections in the upper part of the crankshaft 717.

[0143] Additionally, as in the aforescribed embodiment of (5-4), it will be possible to extend the time until no lubricating oil is left within the oil retention space 90.

(5-7)

[0144] The aforescribed embodiment described an example in which the crankshaft 17 has the lower bearing horizontal oil-feed hole 17d, the upper bearing horizontal oil-feed hole 17e, and the pin bearing horizontal oil-feed hole 17c.

[0145] However, there is no limitation of the embodiments to this particular arrangement; e.g., as shown in FIG 11, it being acceptable for a scroll compressor 801 provided with a crankshaft 817 that lacks these horizontal oil-feed holes.

[0146] The crankshaft 817 of the scroll compressor 801, unlike the crankshaft 17 of the aforescribed first embodiment, lacks the pin bearing horizontal oil-feed hole 17c, instead having a pin shaft groove part 17x formed by cutting on the vertical a part of the outer surface of the pin shaft part 17b at the diametrical outside end part thereof. By cutting away part of an outer peripheral section in an upper end section of the pin shaft part 17b, this pin shaft groove part 17x is configured as a groove part that is recessed diametrically inward, the recessed groove part extending so as to lead downward from the upper end of the pin shaft part 17b. This scroll compressor 801 has a pin shaft supply path 817c formed between

the pin shaft groove part 17x and the inner peripheral surface of the pin shaft bearing metal 87.

[0147] Part of the lubricating oil which has been fed into the pin shaft headspace 37 via the oil feed passage 17a of the crankshaft 817 is then fed to the pin shaft supply path 817c through a gap between the inside of the boss part 26c of the moveable scroll 26 and the pin shaft part 17b of the crankshaft 817. In so doing, it is possible for the lubricating oil to easily enter the pin shaft supply path 817c, providing lubrication between the outer peripheral surface of the pin shaft part 17b and the inner peripheral surface of the pin shaft bearing metal 87.

[0148] In this way, effects comparable to those of the aforescribed embodiment can be obtained, even in the case of adopting the crankshaft 817 lacking the pin bearing horizontal oil-feed hole 17c penetrating in the diametrical direction through the pin shaft part 17b of the aforescribed first embodiment.

(5-8)

[0149] The aforescribed embodiment described an example of a case of "slide bearings," in which the three bearings, i.e., the pin bearing part 22, the upper bearing part 32, and the lower bearing part 27, are configured such that the inner peripheral surface of the pin shaft bearing metal 87, the inner peripheral surface of the upper bearing metal 88, and the inner peripheral surface of the lower bearing metal 89 contact the outer peripheral surface of the crankshaft 17 at their respective heightwise locations.

[0150] However, there is no limitation of the embodiments to this particular arrangement; e.g., a configuration in which at least any one of these three bearings is a rolling bearing would be acceptable.

[0151] Effects comparable to those of the aforescribed embodiment can be obtained with such a scroll compressor as well.

(5-9)

[0152] The aforescribed embodiment described an example of a case in which the inside diameter of the oil retention space 90 and the inside diameter of the oil feed passage 17a are equal.

[0153] However, there is no limitation of the embodiments to this particular arrangement; e.g., a range of 0.5-2.0 times the inside diameter of the oil feed passage 17a would be an acceptable range for the inside diameter of the oil retention space 90. It is preferable for the inside diameter of the oil retention space 90 to be such that the space has the capacity to retain lubricating oil in an amount necessary to compensate for a temporary abnormal condition encountered in cases of depleted lubricating oil in the lower oil reservoir part P.

(5-10)

[0154] In the aforescribed first embodiment, the size of the inside diameter of the communicating passage 91 was described as being arbitrary.

[0155] However, there is no limitation of the embodiments to this particular arrangement; for example, the channel cross-sectional area of the communicating passage 91 could be made smaller, so as to slow the descent speed of the lubricating oil within the oil retention space 90 when an abnormal condition is encountered. In so doing, it is possible to ensure a supply of lubricating oil for a prolonged period during an abnormal condition.

[0156] The size of the inside diameter of the communicating passage 91 may be determined, as appropriate, in the light of factors such as the rotation frequency of the crankshaft 17 during normal operation, and the like.

INDUSTRIAL APPLICABILITY

[0157] The scroll compressor of the present invention is particularly useful, for example, as a scroll compressor having a crankshaft that extends in the vertical direction, and in which lubricating oil is stored in a lower end part.

REFERENCE SIGNS LIST

[0158]

1, 201, 301, 401, 501, 601, 701, 801, 901: Scroll compressor
 15: Compression mechanism part
 16: Motor
 17, 217, 317, 417, 517, 617, 717, 817, 917: Crankshaft
 17a: Oil feed passage
 17b: Pin shaft part
 17c: Pin shaft bearing horizontal oil-feed hole (supply hole, horizontal oil-feed hole, upper horizontal oil-feed hole)
 17d: Lower bearing horizontal oil-feed hole (supply hole, horizontal oil-feed hole)
 17e: Upper bearing horizontal oil-feed hole (supply hole, horizontal oil-feed hole)
 24: Stationary scroll
 26: Moveable scroll
 26c: Boss part (cylindrical part)
 27: Lower bearing part
 32: Upper bearing part
 37: Pin shaft headspace
 38: Pin shaft circumferential space
 40: Compression chamber
 79: Volumetric pump
 90: Oil retention space
 91: Communicating passage
 96: Diametrical section
 317s: First inner passage (upper communicating passage)

317t: Second inner passage (upper communicating passage)

417s: First outer passage (hole of small passage cross-sectional area)

417t: Second outer passage (hole of small passage cross-sectional area)

590x: Porous substance (member for reducing lubricating oil descent speed)

617s: First inner passage (upper communicating passage)

617t: Second inner passage (upper communicating passage)

690x: Porous substance (member for reducing lubricating oil descent speed)

717s: First outer passage (hole of small passage cross-sectional area)

717t: Second outer passage (hole of small passage cross-sectional area)

790x: Porous substance (member for reducing lubricating oil descent speed)

917c: Pin shaft supply path (supply path)

B: Communication location

P: Lower oil reservoir part

25 CITATION LIST

PATENT LITERATURE

[0159] Patent Literature 1

30 Japanese Laid-open Patent Application 2011-137523

Claims

35 **1.** A scroll compressor (1,201, 301, 401, 501, 601, 701, 801, 901) comprising:

a casing (10);
 a compression mechanism part (15) accommodated within the casing, and having a stationary scroll (24), and a moveable scroll (26) for forming a compression chamber in relation to the stationary scroll;
 a crankshaft (17, 217, 317, 417, 517, 617, 717, 817, 917) linked to the moveable scroll;
 a motor (16) for rotatably driving the crankshaft;
 an oil feed pump (79) for feeding lubricating oil upward; and
 a lower oil reservoir part (P) disposed in a space below the oil feed pump, for holding the lubricating oil, wherein the scroll compressor comprises:

an oil feed passage (17a) formed so as to extend in an axial direction within the interior of the crankshaft, and communicating at a lower end with a discharge side of the oil feed pump; and

- an oil retention space (90) formed so as to extend in an axial direction within the crankshaft interior separately from the oil feed passage, and communicating with the oil feed passage.
2. The scroll compressor according to claim 1, wherein the oil feed passage (17a) and the oil retention space (90) communicate via a communicating passage (91) disposed in the interior of the crankshaft.
 3. The scroll compressor according to claim 1 or 2, wherein the oil retention space (90) communicates with the discharge side of the oil feed pump (79) via a space within the oil feed passage (17a), without communicating directly with the discharge side of the oil feed pump (79).
 4. The scroll compressor according to any of claims 1 to 3, wherein the oil feed passage (17a), the crankshaft, and the oil retention space (90) are each cylindrical in shape, and the axial center of the oil retention space (90) is disposed at a location closer to the axial center of the crankshaft with respect to the outer periphery thereof, than is the location of the axial center of the oil feed passage (17a).
 5. The scroll compressor according to claim 4, wherein the axial center of the oil retention space (90) is disposed at an identical location to the location of the axial center of the crankshaft with respect to the outer periphery thereof.
 6. The scroll compressor according to any of claims 1 to 5, further comprising a supply path (17c, 17d, 17e, 917c) disposed such that it is possible to supply lubricating oil towards the outer periphery of the crankshaft from the interior of the oil feed passage.
 7. The scroll compressor according to claim 6, wherein the supply passage is a horizontal oil-feed hole (17c, 17d, 17e) disposed so as to pass between the interior of the oil feed passage and the outer periphery of the crankshaft in the crankshaft interior.
 8. The scroll compressor according to claim 7, wherein the oil retention space (90) either lacks an opening that penetrates as far as the outer periphery of the crankshaft, or is provided with a hole (417s, 417t, 717s, 717t) that extends so as to penetrate from the interior to the outer periphery of the crankshaft and has a smaller passage cross-sectional area than that of the horizontal oil-feed hole.
 9. The scroll compressor according to claim 7 or 8, further comprising:
 - an upper bearing part (32) supporting the crankshaft from a circumferential direction; and
 - a lower bearing part (27) supporting the crankshaft from a circumferential direction, at a point below the upper bearing part,
 - the horizontal oil-feed hole having a lower bearing horizontal oil-feed hole (17d) that extends towards the lower bearing part from within the oil feed passage (17a), and
 - the oil retention space (90) and the oil feed passage (17a) communicating at a location below the location at which the lower bearing horizontal oil-feed hole (17d) branches from the oil feed passage.
 10. The scroll compressor according to claim 9, further comprising an upper communicating passage (317s, 317t, 617s, 617t) providing communication between the interior of the oil feed passage (17a) and the interior of the oil retention space (90), the oil retention space (90) and the oil feed passage (17a) communicating at a location below the upper communicating passage (317s, 317t, 617s, 617t).
 11. The scroll compressor according to claim 7, further comprising:
 - an upper bearing part (32) supporting the crankshaft from a circumferential direction; and
 - a lower bearing part (27) supporting the crankshaft from a circumferential direction, at a point below the upper bearing part,
 - the horizontal oil-feed hole having an upper bearing horizontal oil-feed hole (17e) that extends towards the inner peripheral surface of the upper bearing part from within the oil feed passage (17a).
 12. The scroll compressor according to claim 7, wherein the moveable scroll has a cylindrical part (26c) for covering an upper end of the crankshaft from the circumferential direction, and the horizontal oil-feed hole has an upper horizontal oil-feed hole (17c) that extends towards the inner peripheral surface of the cylindrical part from within the oil feed passage (17a).
 13. The scroll compressor according to any of claims 4 or 5, wherein the inside diameter of the oil retention space (90) is 0.5-2.0 times the inside diameter of the oil feed passage (17a).
 14. The scroll compressor according to any of claims 1 to 13, wherein the oil retention space (90) is open at an upper end.
 15. The scroll compressor according to any of claims 1

to 14, further comprising
a member (590x, 690x, 790x) arranged in the interior
of the oil retention space (90), for limiting the descent
speed of the lubricating oil within the oil retention
space (90).

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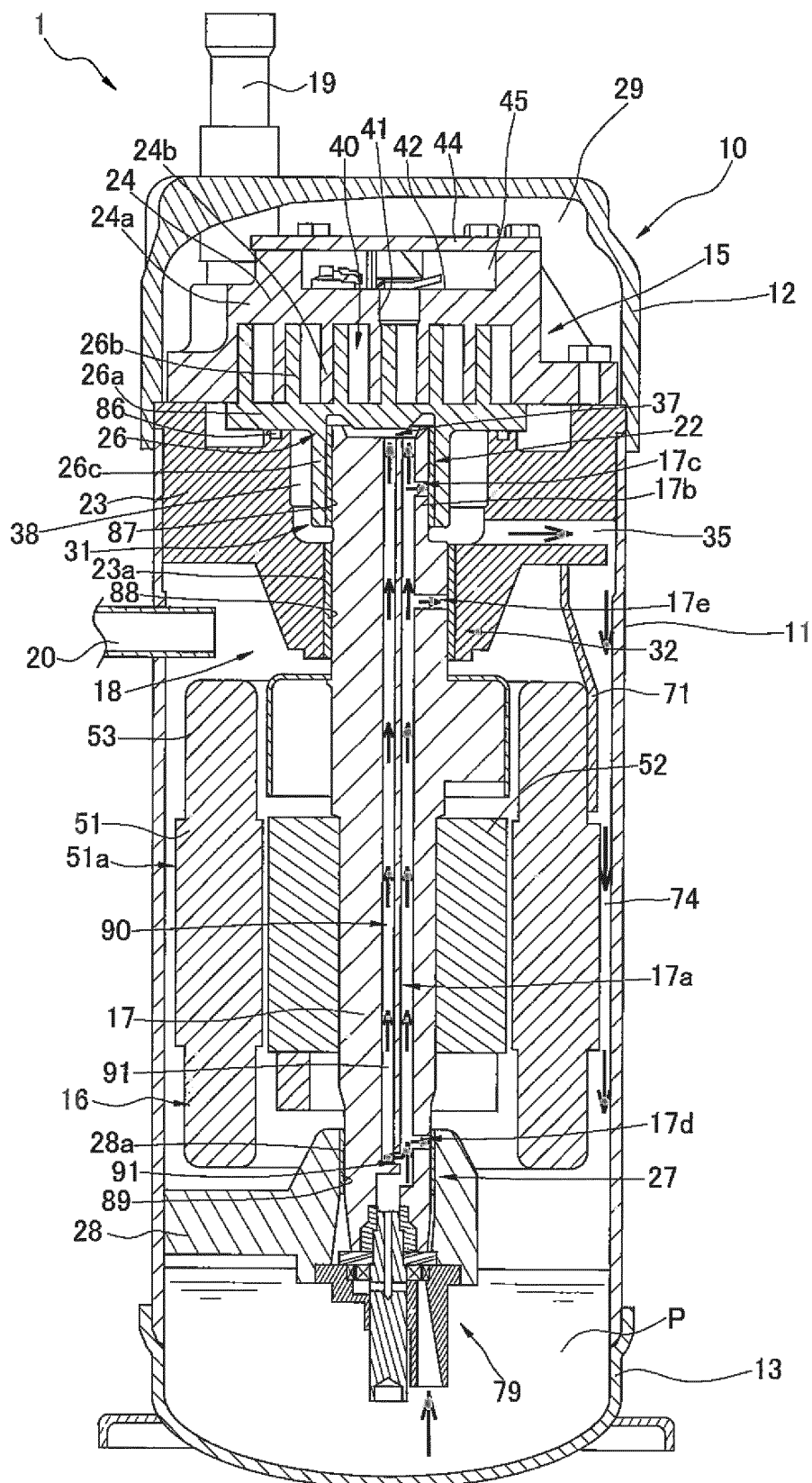


FIG. 1

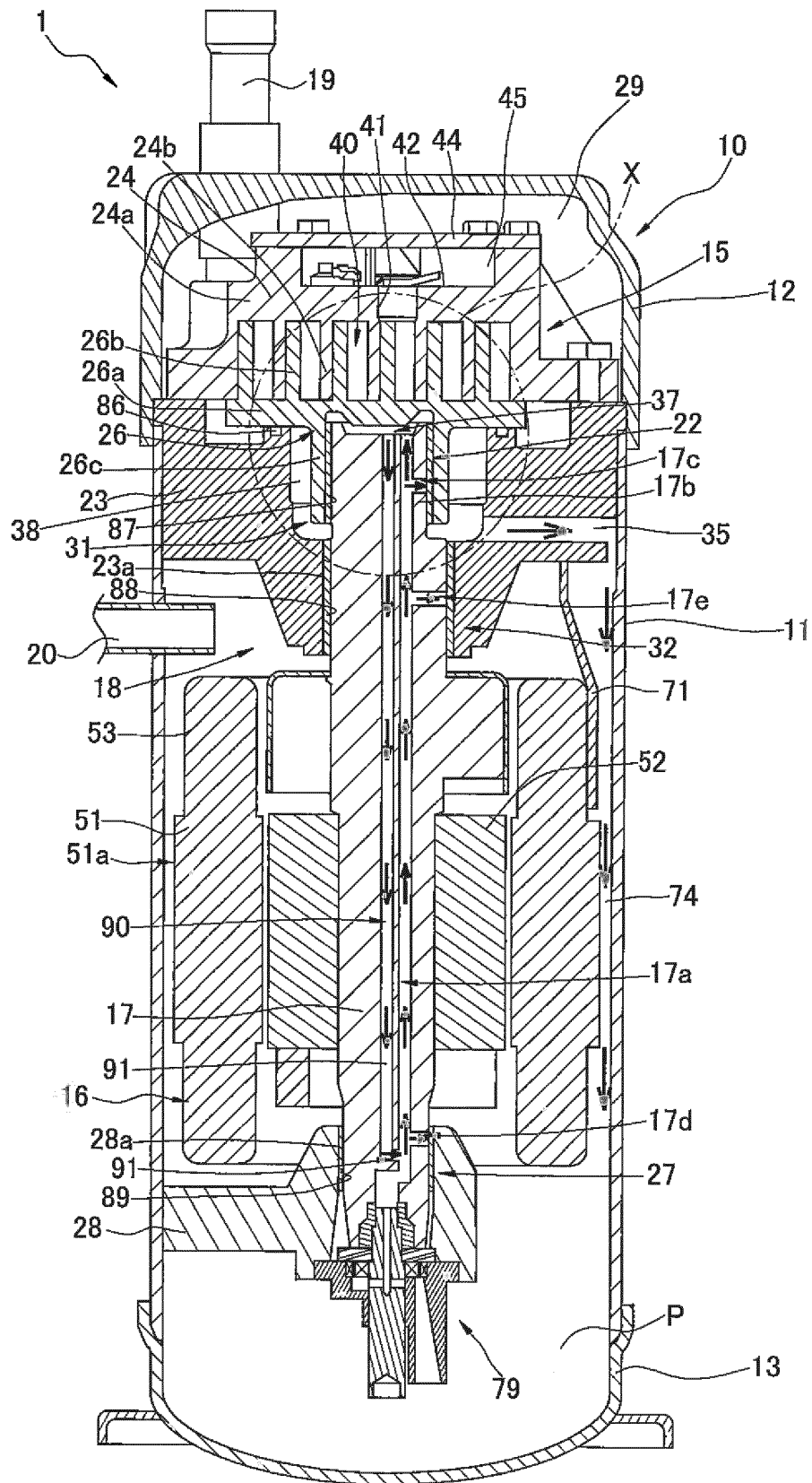


FIG. 2

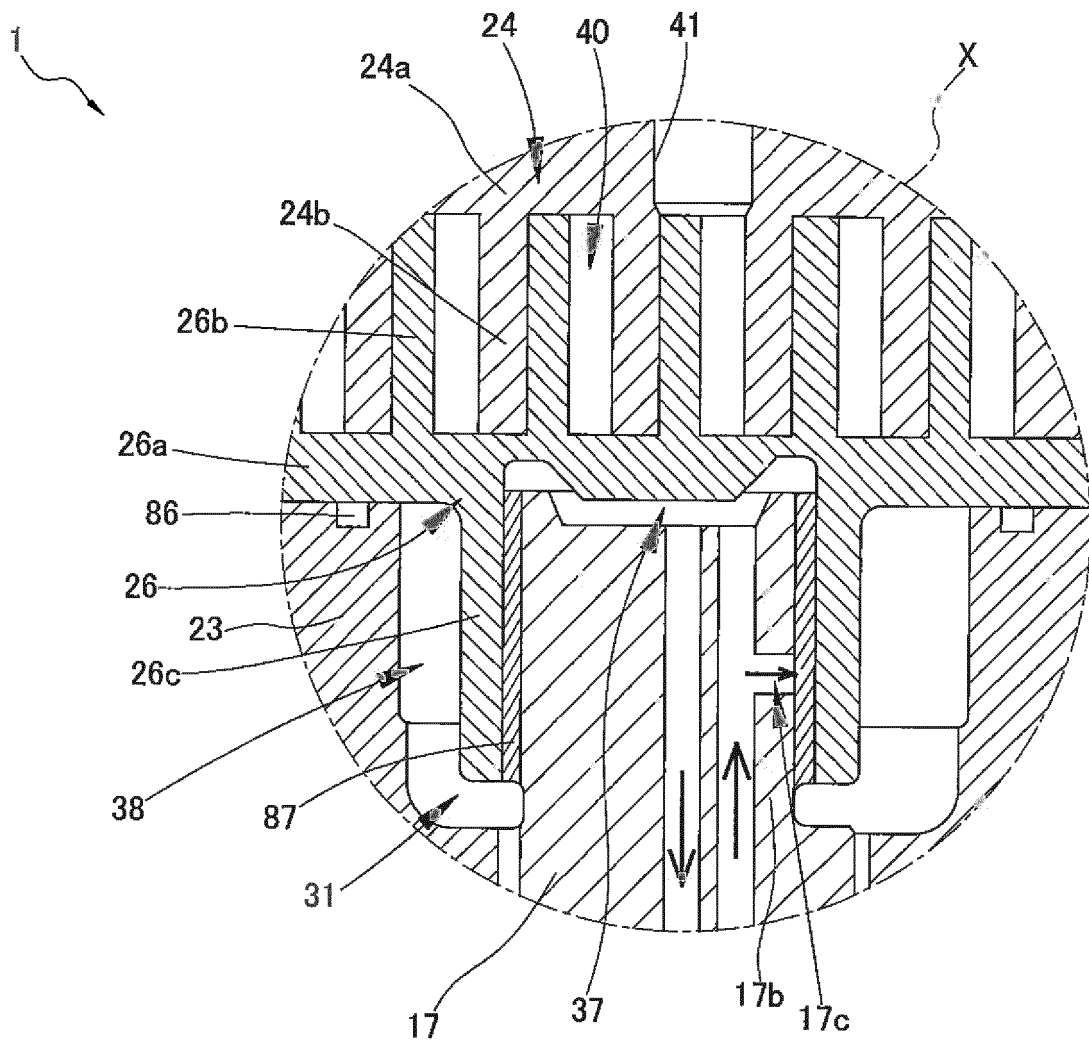


FIG. 3

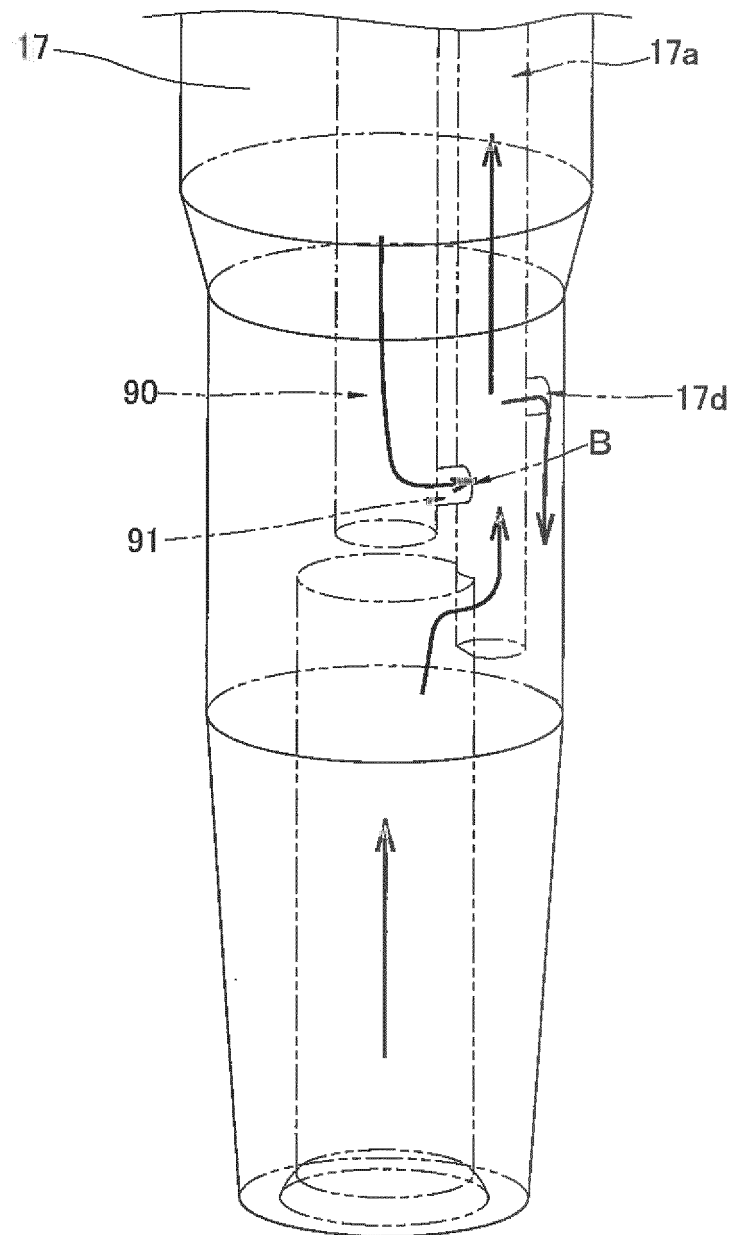


FIG. 4

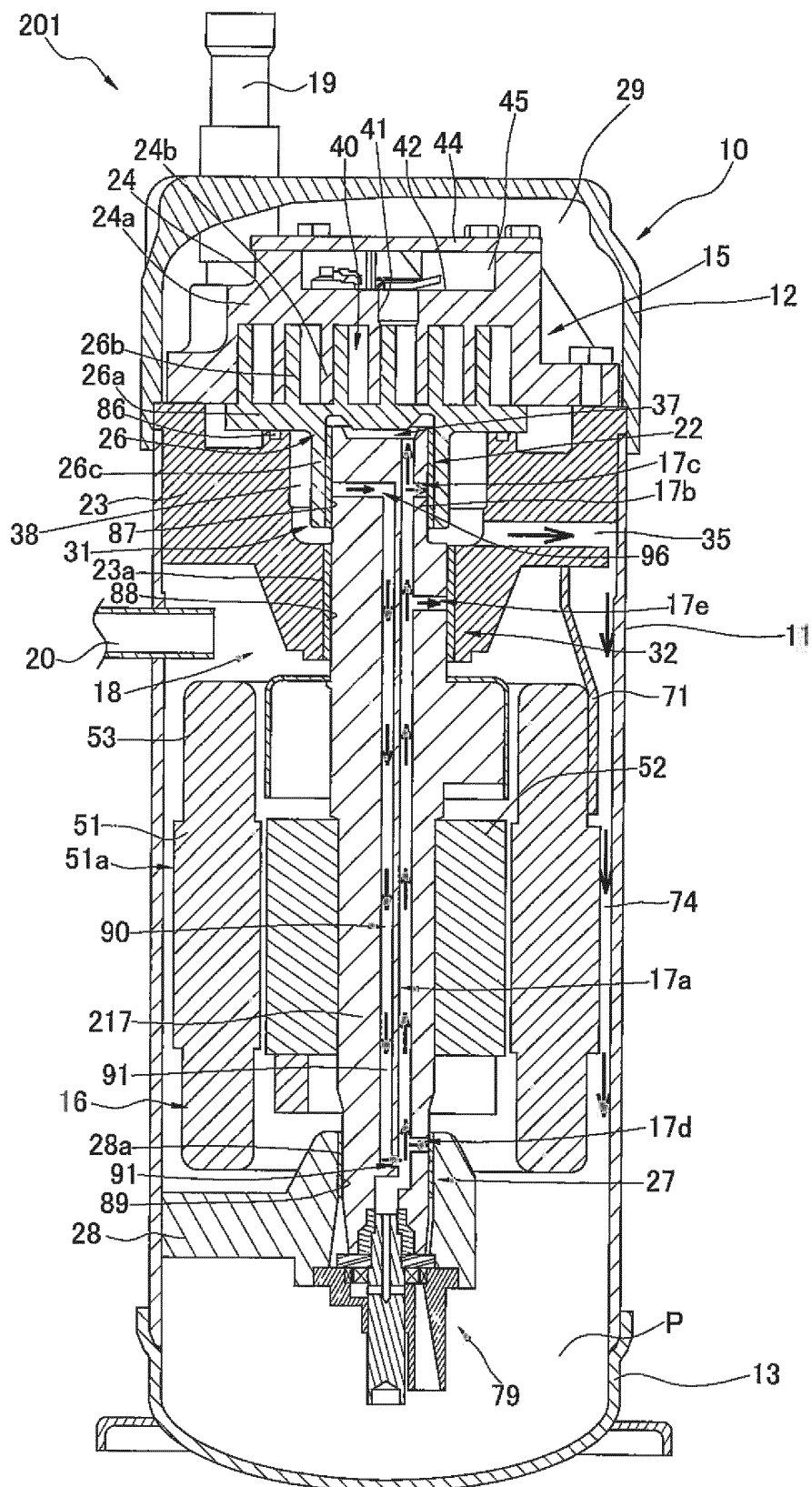


FIG. 5

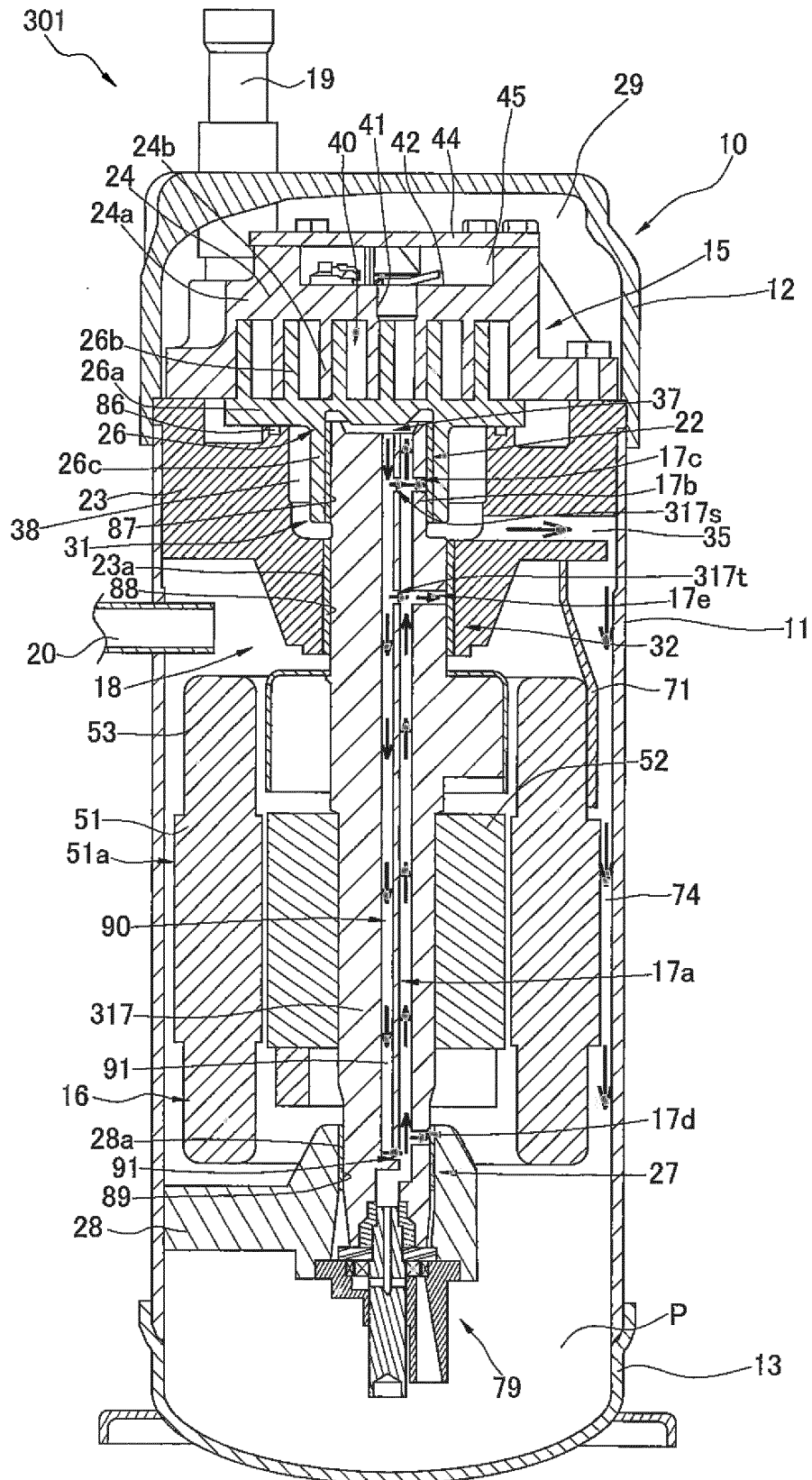


FIG. 6

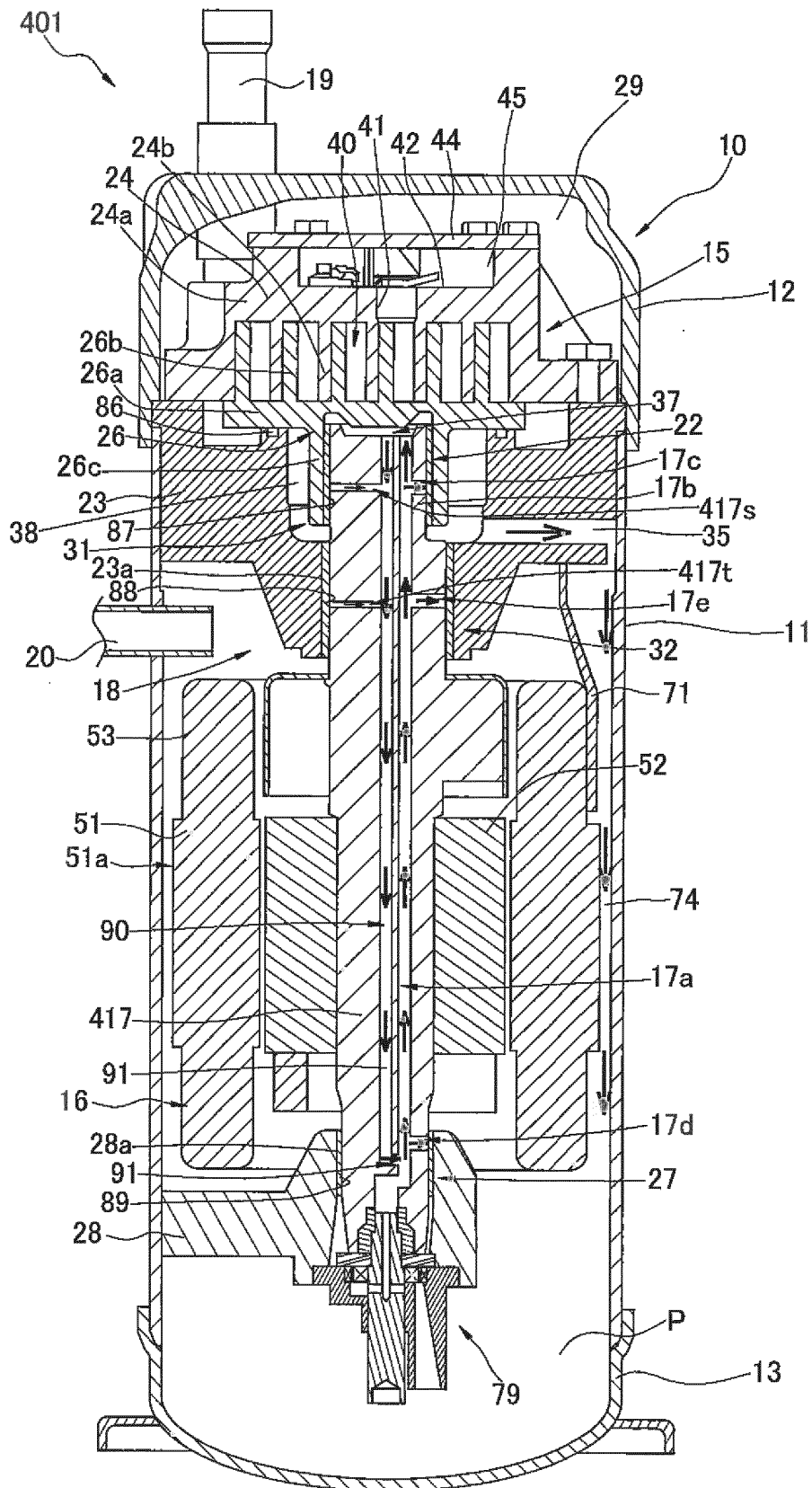


FIG. 7

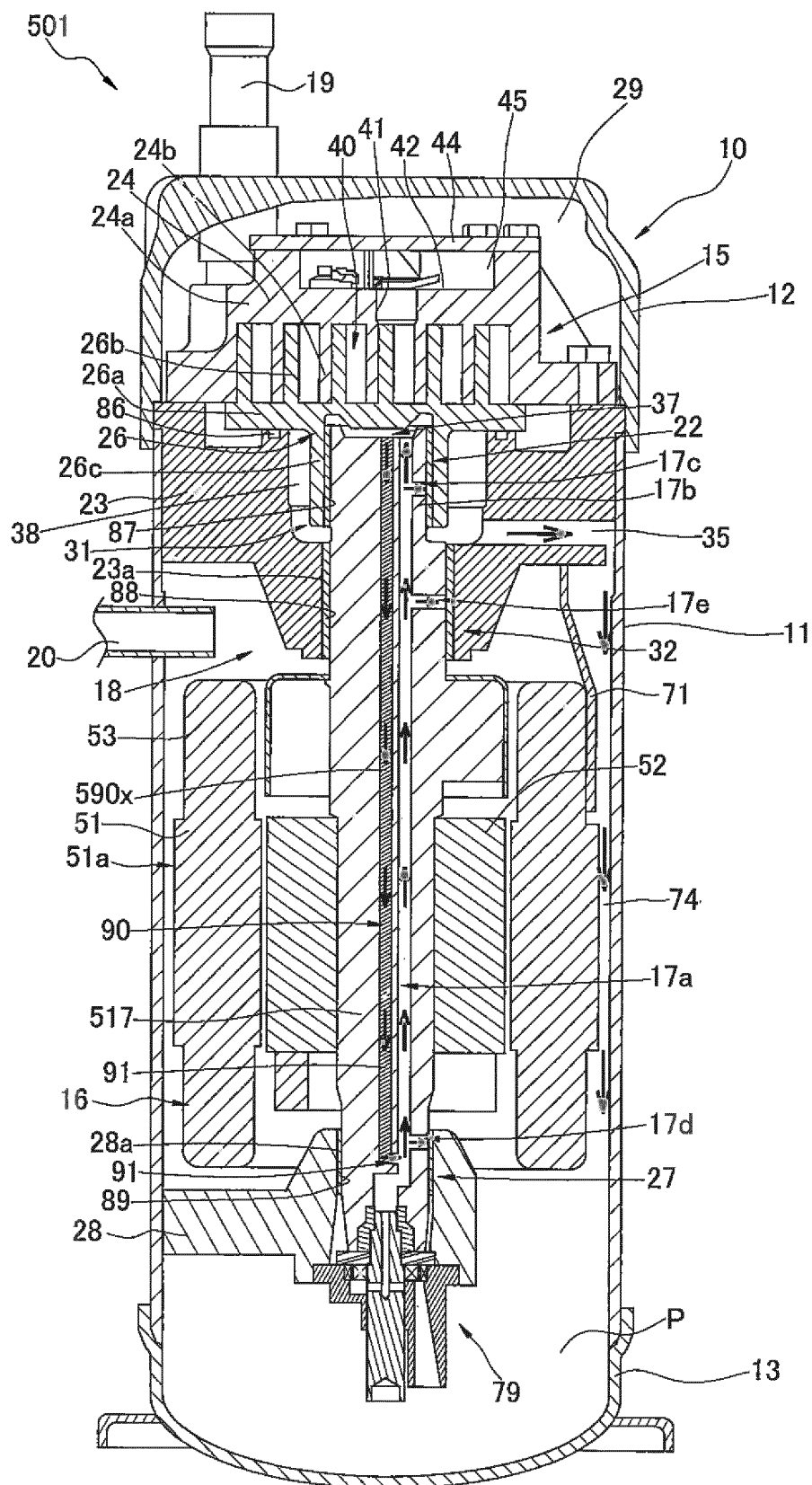


FIG. 8

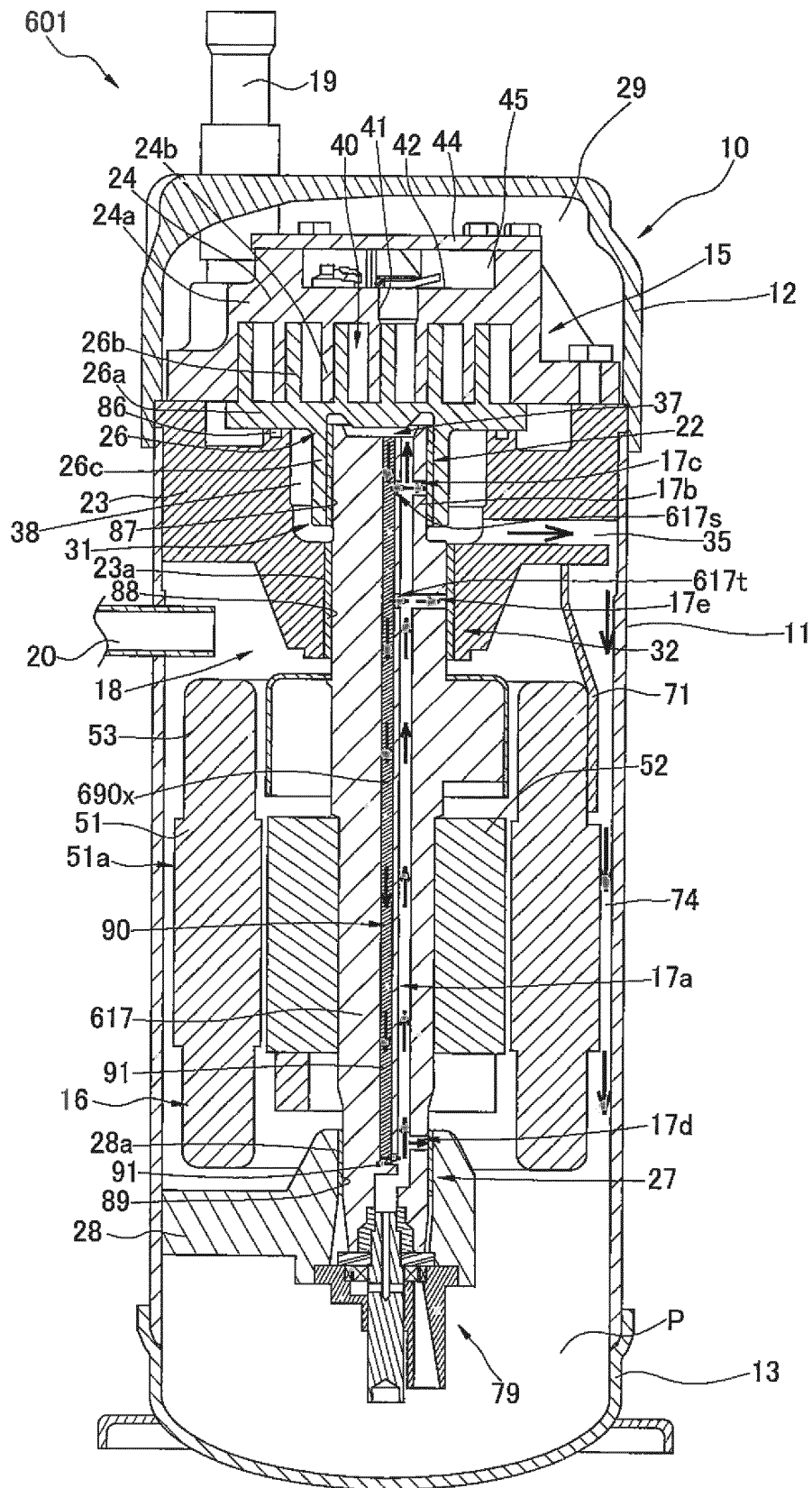


FIG. 9

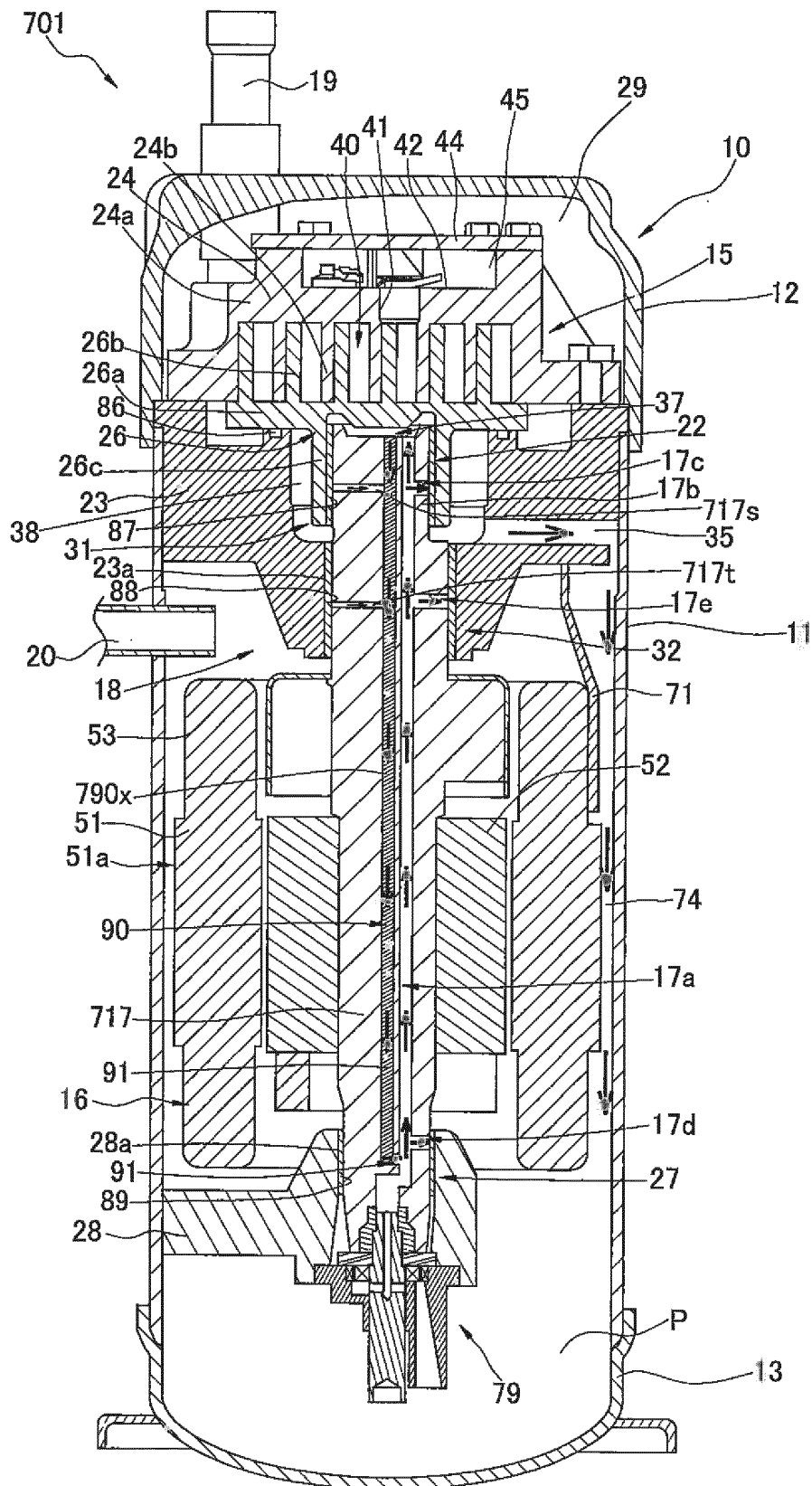


FIG. 10

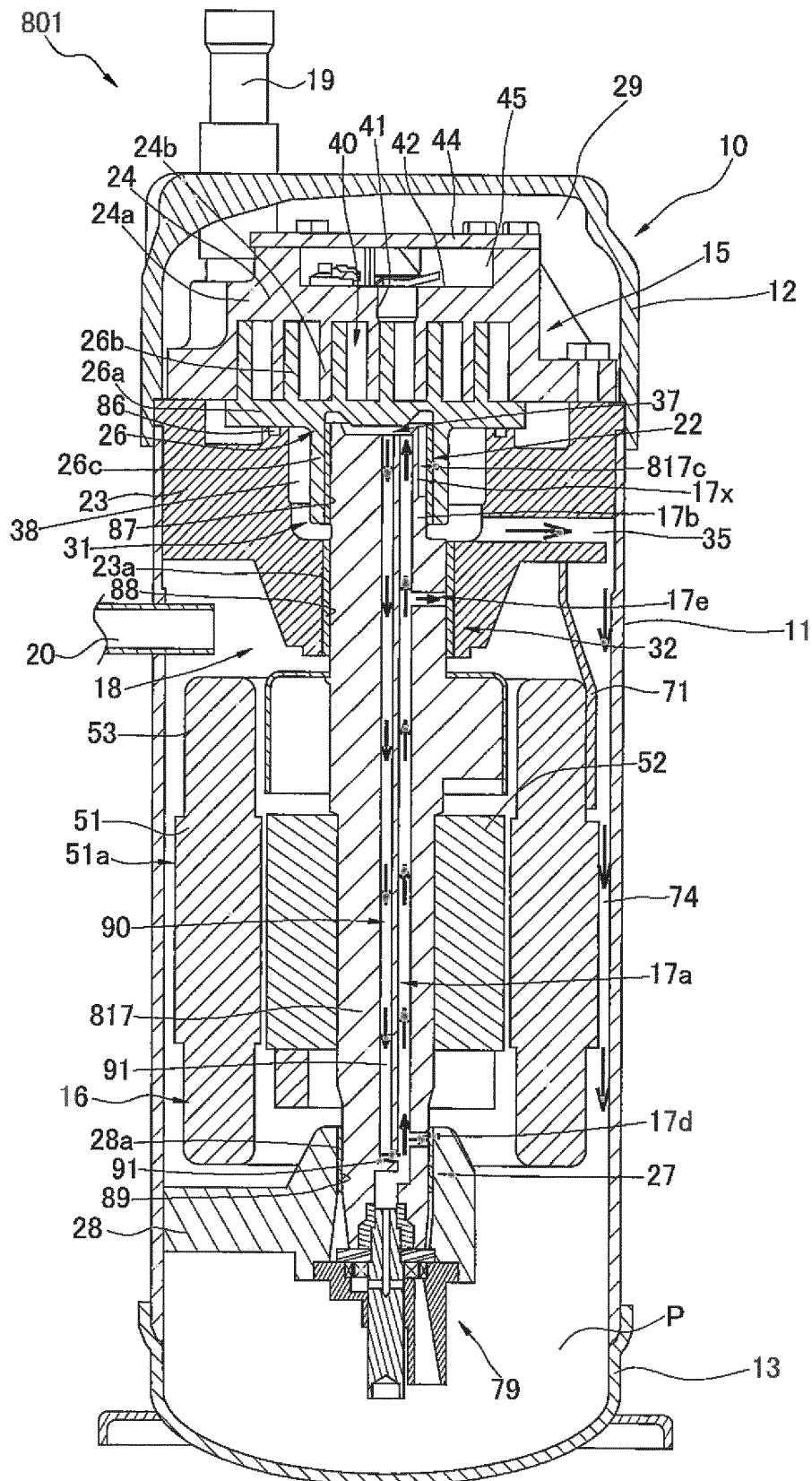


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/070476

A. CLASSIFICATION OF SUBJECT MATTER

F04C29/02(2006.01)i, F04C18/02(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)

F04C29/02, F04C18/02

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	JP 2616094 B2 (Daikin Industries, Ltd.), 04 June 1997 (04.06.1997), entire text; all drawings	1-2, 4, 6-8, 11, 13-14
Y	(Family: none)	12
A		3, 5, 9-10, 15
Y	JP 2011-137523 A (Daikin Industries, Ltd.), 14 July 2011 (14.07.2011), paragraphs [0033], [0042], [0050]; fig. 2	12
A	(Family: none)	1-11, 13-15
A	JP 3843333 B2 (Hitachi, Ltd.), 08 November 2006 (08.11.2006), entire text; all drawings & US 2004/0219048 A1	1-15

☒ 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
14 October, 2014 (14.10.14)Date of mailing of the international search report
28 October, 2014 (28.10.14)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/070476

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 3-11188 A (Toshiba Corp.), 18 January 1991 (18.01.1991), entire text; all drawings (Family: none)	1-15
A	JP 3-242487 A (Mitsubishi Electric Corp.), 29 October 1991 (29.10.1991), entire text; all drawings (Family: none)	1-15
A	JP 2013-137002 A (Daikin Industries, Ltd.), 11 July 2013 (11.07.2013), entire text; all drawings (Family: none)	1-15
A	US 5885066 A (Yoshifumi MATSUMOTO), 23 March 1999 (23.03.1999), entire text; all drawings & CN 1193080 A	1-15
A	US 2009/0035168 A1 (Pierre GINIES), 05 February 2009 (05.02.2009), entire text; all drawings & WO 2006/125909 A1 & FR 2885966 A & KR 10-2008-0011443 A & CN 101223364 A & AT 437307 T	1-15

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

REFERENCES CITED IN THE DESCRIPTION

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- JP 2011137523 A [0002] [0004] [0159]