(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 978 755 A1

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

(43) Date of publication:
06.04.2022 Bulletin 2022/14

(21) Application number: **20836373.9**

(22) Date of filing: **22.05.2020**

(51) International Patent Classification (IPC):
F04C 18/02 *(2006.01)* ***F04C 29/02*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F04C 18/02; F04C 29/02

(86) International application number:
PCT/JP2020/020279

(87) International publication number:
WO 2021/005895 (14.01.2021 Gazette 2021/02)

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

(30) Priority: **10.07.2019 JP 2019128815**

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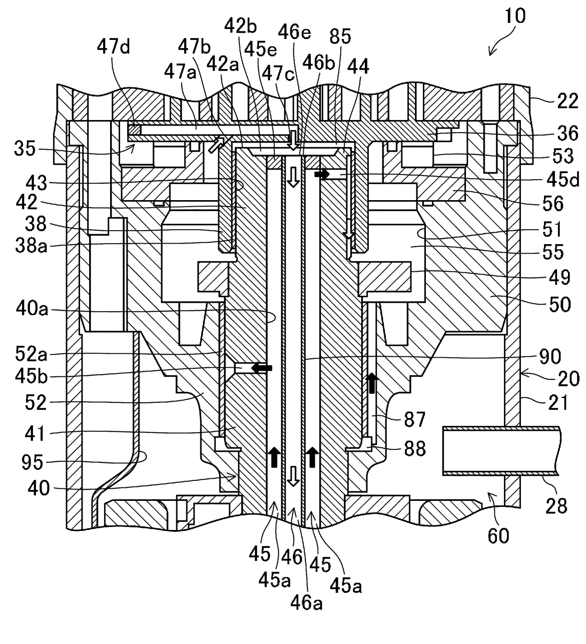
(54) SCROLL COMPRESSOR

(57) A drive shaft (40) is provided with a first oil flow passage (46) that extends on the shaft center of a main shaft (41) in the axial direction of the drive shaft (40) and that has an inflow hole (46b) opening in an upper end surface (42a) of an eccentric shaft (42), and a second oil flow passage (45a) that extends at the periphery of the first oil flow passage (46) in the axial direction and that has an annular cross-section. The second oil flow passage (45a) constitutes an oil supply path in which oil that has been transported by a pump (80) is supplied to a sliding portion (43) between the boss portion (38) and the eccentric shaft (42). A third oil flow passage (47) in which oil that has flowed out from the sliding portion (43) to a chamber (55) is sent to the inflow hole (46b) of the first oil flow passage (46) is included. The first oil flow passage (46) constitutes an oil drainage path in which oil that has flowed in through the inflow hole (46b) is returned to a storage portion (26).

FIG.2



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Description

Technical Field

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

Background Art

[0002] A scroll compressor has been known as a compressor that compresses sucked fluid (for example, refrigerant) and discharges the fluid. In the scroll compressor, a compression chamber is formed by a fixed scroll and a movable scroll meshing with each other. The scroll compressor includes a drive shaft extending in the up-down direction in the compressor. PTL 1 discloses a scroll compressor in which an in-shaft oil supply passage and an in-shaft oil drainage passage are formed in the inside of the drive shaft.

Citation List

Patent Literature

[0003] PTL 1: Japanese Unexamined Patent Application Publication No. 2018-21493

Summary of Invention

Technical Problem

[0004] In the scroll compressor of PTL 1 mentioned above, the in-shaft oil supply passage and the in-shaft oil drainage passage are formed to extend from the upper end to the lower end in the drive shaft in the axial direction. An inflow port of the in-shaft oil drainage passage opens at a position that deviates from the shaft center of the drive shaft outwardly in the radial direction. Therefore, there is a problem that, when the drive shaft rotates, oil is moved to the outer side of the inflow port due to the centrifugal force thereof, and the oil does not easily enter the in-shaft oil drainage passage.

[0005] An object of the present disclosure is to cause oil to easily enter an in-shaft oil drainage passage.

Solution to Problem

[0006] A first aspect of the present disclosure is directed to a scroll compressor and characterized by the following configurations. This scroll compressor (10) includes a casing (20), an electric motor (60) accommodated in the casing (20), a drive shaft (40) configured to be driven by the electric motor (60), a compression mechanism (30) coupled to the drive shaft (40), and a housing (50) disposed below the compression mechanism (30) and fixed to the casing (20). A bottom portion of the casing (20) is provided with a storage portion (26) configured to store oil. The drive shaft (40) has a main shaft (41) and an eccentric shaft (42) provided at an upper end of the main shaft (41). The compression mechanism (30) has a movable scroll (35) that has a boss portion (38) to which the eccentric shaft (42) is fitted and a fixed scroll (31) that meshes with the movable scroll (35). The housing (50) includes a chamber (55) that accommodates the boss portion (38). A lower end of the main shaft (41) is provided with a pump (80) configured to transport the oil of the storage portion (26).

[0007] The drive shaft (40) is provided with a first oil flow passage (46) that extends on a shaft center of the main shaft (41) in an axial direction of the drive shaft and that has an inflow hole (46b) opening in an upper end surface (42a) of the eccentric shaft (42), and a second oil flow passage (45a) that extends at a periphery of the first oil flow passage (46) in the axial direction and that has an annular cross-section. The second oil flow passage (45a) constitutes an oil supply path in which oil that has been transported by the pump (80) is supplied to at least a sliding portion (43) between the boss portion (38) and the eccentric shaft (42). A third oil flow passage (47) in which oil that has flowed out from the sliding portion (43) to the chamber (55) is sent to the inflow hole (46b) of the first oil flow passage (46) is further included. The first oil flow passage (46) constitutes an oil drainage path in which oil that has flowed in through the inflow hole (46b) is returned to the storage portion (26).

[0008] In the first aspect, the first oil flow passage (46) and the inflow hole (46b) thereof are present on the shaft center of the drive shaft (40). Consequently, a centrifugal force along with the rotation of the drive shaft (40) does not easily act on the oil near the inflow hole (46b). Therefore, according to this aspect, it is possible to cause oil to easily enter the inflow hole (46b) of the first oil flow passage (46).

[0009] A second aspect of the present disclosure is the first aspect in which the drive shaft (40) has a vertical hole (40a) that extends in the axial direction and that opens at at least an upper end of the drive shaft (40), a pipe (90) that is disposed on a shaft center of the drive shaft (40) in the vertical hole (40a) and that extends in the axial direction is included, the first oil flow passage (46) is formed in an inside of the pipe (90), and the second oil flow passage (45a) is formed between an inner peripheral surface of the vertical hole (40a) and an outer peripheral surface of the pipe (90).

[0010] In the second aspect, it is possible, by providing the pipe (90) disposed on the shaft center of the drive shaft (40) in the vertical hole (40a) formed in the drive shaft (40), to easily form the first oil flow passage (46) and the second oil flow passage (45a).

[0011] A third aspect of the present disclosure is the second aspect in which an annular upper cover (45e) that closes a gap between an inner peripheral surface of an upper end portion of the vertical hole (40a) and an outer peripheral surface of an upper end portion of the pipe (90) is included.

[0012] In the third aspect, due to the upper end portion of the second oil flow passage (45a) being closed by the annular upper cover (45e), it is possible to suppress oil leakage in the second oil flow passage (45a).

[0013] A fourth aspect of the present disclosure is the second or third aspect in which the vertical hole (40a) passes through the drive shaft (40) in the axial direction, a lower cover (45f) that closes a lower end of the vertical hole (40a) is included, and the lower cover (45f) includes a through passage (45i) that causes a discharge side of the pump (80) and the second oil flow passage (45a) to be in communication with each other.

[0014] In the fourth aspect, due to the vertical hole (40a) being formed to pass through the drive shaft (40) with the lower end of the vertical hole (40a) being closed by the lower cover (45f), it is possible to send oil that has been transported by the pump (80) to the second oil flow passage (45a) via the through passage (45i) of the lower cover (45f) .

[0015] A fifth aspect of the present disclosure is any one of the second to fourth aspects in which a connection member (100) that has a connecting port (101) and an internal flow passage (102) is included, the connecting port (101) being connected to a lower end of the pipe (90), the internal flow passage (102) extending from the connecting port (101) outwardly in a radial direction, and an outflow hole (40c) in communication with the internal flow passage (102) is formed in a peripheral wall (40b) of the vertical hole (40a) in the drive shaft (40).

[0016] In the fifth aspect, the oil that has flowed in the first oil flow passage (46) passes through the connecting port (101) of the connection member (100) and flows into the internal flow passage (102). The internal flow passage (102) extends outwardly in the radial direction. Therefore, when a centrifugal force acts on the oil in the internal flow passage (102) along with the rotation of the drive shaft (40), the oil in the internal flow passage (102) is moved outwardly in the radial direction and drained through the outflow hole (40c). Consequently, it is possible to transfer the oil of the first oil flow passage (46) to the storage portion (26) by using the centrifugal force of the drive shaft (40).

[0017] A sixth aspect of the present disclosure is any one of the first to fifth aspects in which the housing (50) is provided with a first bearing (52a) that supports the main shaft (41), and the drive shaft (40) is provided with a first oil supply hole (45b) extending from the second oil flow passage (45a) outwardly in a radial direction and through which oil is supplied to the first bearing (52a).

[0018] In the sixth aspect, it is possible to supply the oil in the second oil flow passage (45a) to the first bearing (52a) through the first oil supply hole (45b) by using a centrifugal force. Since the second oil flow passage (45a) is a flow passage having an annular cross-section, the first oil supply hole (45b) can be provided at any position in the circumferential direction of the drive shaft (40).

[0019] A seventh aspect of the present disclosure is the sixth aspect in which a support (70) having a second bearing (72a) that supports a lower portion of the main shaft (41) is included, and the drive shaft (40) is provided with a second oil supply hole (45c) extending from the second oil flow passage (45a) outwardly in the radial direction and through which oil is supplied to the second bearing (72a).

[0020] In the seventh aspect, it is possible to supply the oil in the second oil flow passage (45a) to the second bearing (72a) through the second oil supply hole (45c) by using a centrifugal force. Since the second oil flow passage (45a) is a flow passage having an annular cross-section, the second oil supply hole (45c) can be provided at any position in the circumferential direction of the drive shaft (40).

[0021] An eighth aspect of the present disclosure is any one of the first to seventh aspects in which the third oil flow passage (47) is formed in an inside of the movable scroll (35), and an outflow port (47c) of the third oil flow passage (47) and the inflow hole (46b) of the first oil flow passage (46) overlap each other in the axial direction.

[0022] In the eighth aspect, it is possible to cause the oil that has flowed out downwardly through the outflow port (47c) of the third oil flow passage (47) to easily enter the inflow hole (46b) of the first oil flow passage (46).

[0023] A ninth aspect of the present disclosure is any one of the first to eighth aspects in which a concave portion (42b) is formed on an upper end surface of the eccentric shaft (42), and the inflow hole (46b) of the first oil flow passage (46) is formed at a bottom of the concave portion (42b) .

[0024] In the ninth aspect, the oil that has flowed out from the third oil flow passage (47) can be caught in the concave portion (42b). The oil caught in the concave portion (42b) flows into the first oil flow passage (46) through the inflow hole (46b).

Brief Description of Drawings

[0025]

[Fig. 1] Fig. 1 is a longitudinal sectional view illustrating a configuration of a scroll compressor according to Embodiment 1 of the present disclosure.

[Fig. 2] Fig. 2 is a partially enlarged sectional view of the periphery of a housing of the scroll compressor in Fig. 1.

[Fig. 3] Fig. 3 is a partially enlarged sectional view of the periphery of a lower portion support of the scroll compressor in Fig. 1.

[Fig. 4] Fig. 4 is a perspective view of a drive shaft.

[Fig. 5] Fig. 5 is a perspective view of a pipe.

[Fig. 6] Fig. 6 is a perspective view of a movable scroll as viewed from the back surface (bottom surface).

[Fig. 7] Fig. 7 is a perspective view illustrating a state of assembly of a drive shaft.

[Fig. 8] Fig. 8 is a view illustrating Modification 1 and corresponding to Fig. 3.

[Fig. 9] Fig. 9 is a view illustrating Modification 2 and corresponding to Fig. 3.

[Fig. 10] Fig. 10 is a perspective view of a lower cover in Modification 2.

Description of Embodiments

<<Embodiment 1>>

Embodiment 1 will be described.

[0026] A scroll compressor (10) is connected to, for example, a vapor compression refrigerant circuit (not illustrated). In such a refrigerant circuit, a cycle in which refrigerant (fluid) compressed and discharged by the scroll compressor (10) releases heat at a condenser (radiator), is decompressed at a decompression mechanism, thereafter evaporates at an evaporator, is sucked and compressed by the scroll compressor (10) is repeated.

- Scroll Compressor -

[0027] As illustrated in Fig. 1, the scroll compressor (10) includes a casing (20), a compression mechanism (30), a drive shaft (40), a housing (50), an electric motor (60), a support (70), and a pump (80). In the casing (20), the compression mechanism (30), the housing (50), the electric motor (60), the support (70), and the pump (80) are disposed in this order from up to down.

<Casing>

[0028] The casing (20) is constituted by a vertically elongated cylindrical airtight container. Specifically, the casing (20) has a barrel portion (21), a first panel portion (22), a second panel portion (23), and a leg portion (24). The barrel portion (21) is formed in a cylindrical shape that opens at both ends in the axial direction. The first panel portion (22) closes one end (upper end) of the barrel portion (21) in the axial direction. The second panel portion (23) closes the other end (lower end) of the barrel portion (21) in the axial direction. The leg portion (24) is provided on the lower side of the second panel portion (23) and supports the casing (20).

[0029] A suction pipe (27) and a discharge pipe (28) are connected to the casing (20). The suction pipe (27) passes through the first panel portion (22) of the casing (20) in the axial direction and is in communication with a compression chamber (C) of the compression mechanism (30) via an auxiliary suction hole (not illustrated). The discharge pipe (28) passes through the barrel portion (21) of the casing (20) in the radial direction and is in communication with a lower space (25) (more specifically, a space between the housing (50) and the electric motor (60)) of the housing (50).

[0030] A storage portion (26) is provided at the bottom portion of the casing (20). The storage portion (26) stores a lubrication oil for lubricating each sliding portion in the inside of the scroll compressor (10).

<Compression Mechanism>

[0031] The compression mechanism (30) is provided in the casing (20) and compresses fluid (for example, refrigerant and the like). The compression mechanism (30) includes a fixed scroll (31) and a movable scroll (35) that meshes with the fixed scroll (31).

[0032] The fixed scroll (31) has a fixed-side panel portion (32), a fixed-side lap (33), and an outer peripheral wall portion (34). The fixed-side panel portion (32) is formed in a disc shape. The fixed-side lap (33) is formed in a spiral wall shape having an involute curve and protrudes from the front surface (lower surface) of the fixed-side panel portion (32). The outer peripheral wall portion (34) is formed to surround the outer peripheral side of the fixed-side lap (33) and protrudes from the front surface (lower surface) of the fixed-side panel portion (32). An end surface (lower surface) of the outer peripheral wall portion (34) is flush with an end surface of the fixed-side lap (33) .

[0033] The movable scroll (35) has a movable-side panel portion (36), a movable-side lap (37), and a boss portion (38). The movable-side panel portion (36) is formed in a disc shape. The movable-side lap (37) is formed in a spiral wall shape having an involute curve and protrudes from the front surface (upper surface) of the movable-side panel portion (36). The boss portion (38) is formed in a cylindrical shape and is disposed at a center portion of the back surface (lower surface) of the movable-side panel portion (36). A slide bearing (38a) is fitted to the inner periphery of the boss portion (38).

[0034] In the compression mechanism (30), the movable-side lap (37) of the movable scroll (35) meshes with the fixed-side lap (33) of the fixed scroll (31). Consequently, a compression chamber (the compression chamber (C) for compressing fluid) that is surrounded by the fixed-side panel portion (32) and the fixed-side lap (33) of the fixed scroll (31) and the movable-side panel portion (36) and the movable-side lap (37) of the movable scroll (35) is constituted.

[0035] A discharge port (P) and a discharge chamber (S) are formed in the fixed-side panel portion (32) of the fixed scroll (31). The discharge port (P) passes through a center portion of the fixed-side panel portion (32) in the axial direction and is in communication with the compression chamber (C). The discharge chamber (S) is formed at the back surface (upper surface) of the fixed-side panel portion (32) and is in communication with the discharge port (P). The discharge chamber (S) is in communication with the lower space (25) of the housing (50) through a discharge passage (39) formed in the fixed scroll (31) and the housing (50). The lower space (25) of the housing (50) constitutes a high-pressure space filled with high-pressure fluid (for example, discharged refrigerant having a high pressure).

<Drive Shaft>

[0036] The drive shaft (40) extends in the casing (20) in the up-down direction. Specifically, the drive shaft (40) extends in the axial direction (up-down direction) of the casing (20) from the upper end of the barrel portion (21) of the casing (20) to the bottom portion (storage portion (26)) of the casing (20). In this example, the drive shaft (40) has a main shaft (41) and an eccentric shaft (42). The main shaft (41) extends in the axial direction (up-down direction) of the casing (20). The eccentric shaft (42) is provided at the upper end of the main shaft (41). The outer diameter of the eccentric shaft (42) is formed to be smaller than the outer diameter of the main shaft (41), and the shaft center of the eccentric shaft (42) deviates from the shaft center of the main shaft (41) by a predetermined distance.

[0037] The upper end portion (eccentric shaft (42)) of the drive shaft (40) is slidably coupled to the boss portion (38) of the movable scroll (35). In this example, the eccentric shaft (42) of the drive shaft (40) is rotatably supported by the boss portion (38) of the movable scroll (35) via the slide bearing (38a).

[0038] As illustrated in Fig. 2, a vertical hole (40a) is formed in the inside of the drive shaft (40). The vertical hole (40a) extends in the axial direction (up-down direction) of the drive shaft (40). The vertical hole (40a) is formed to be coaxial with the main shaft (41) of the drive shaft (40). In this example, the vertical hole (40a) is formed to extend from the upper end to the lower end of the drive shaft (40). The vertical hole (40a) passes through the drive shaft (40) in the axial direction thereof.

[0039] A cylindrical pipe (90) is disposed in the inside of the vertical hole (40a). This pipe (90) is disposed on the shaft center of the main shaft (41) and extends in the axial direction of the drive shaft (40). In this example, the pipe (90) is disposed to be coaxial with the main shaft (41). An in-shaft oil drainage passage (46) (first oil flow passage) is formed in the inside of the pipe (90). Between the outer peripheral surface of the pipe (90) and the inner peripheral surface of the vertical hole (40a), a main oil supply passage (45a) (second oil flow passage) of an in-shaft oil supply passage (45) is formed. The in-shaft oil supply passage (45) is formed to surround the periphery of a main oil drainage passage (46a) of the in-shaft oil drainage passage (46). The in-shaft oil supply passage (45) and the in-shaft oil drainage passage (46) will be described later in detail.

[0040] As illustrated in Fig. 3 and Fig. 5, the lower end of the pipe (90) is provided with a connection member (100). The upper end of the connection member (100) is provided with a connecting port (101) connected to the lower end of the pipe (90). In the inside of the connection member (100), an internal flow passage (102) extending from the connecting port (101) outwardly in the radial direction is formed.

[0041] An outflow hole (40c) is formed in a lower portion of a peripheral wall (40b) of the vertical hole (40a) of the drive shaft (40). The outflow hole (40c) is in communication with the outflow end of the internal flow passage (102) of the connection member (100). The outflow hole (40c) opens in the internal space of a lower concave portion (71) of the support (70).

[0042] As illustrated in Fig. 4, an upper portion of the drive shaft (40) is provided with an upper cover (45e). The upper cover (45e) is formed in an annular shape that closes a gap between the inner peripheral surface of the upper end portion of the vertical hole (40a) and the outer peripheral surface of the upper end portion of the pipe (90).

[0043] As illustrated in Fig. 3, a lower portion of the drive shaft (40) is provided with a lower cover (45f) that closes the lower end of the vertical hole (40a). The lower cover (45f) is constituted by an upper stage portion (45g) and a lower stage portion (45h). The lower cover (45f) is formed in a cylindrical shape in which the outer diameter of the upper stage portion (45g) and the outer diameter of the lower stage portion (45h) differ from each other. Specifically, the outer diameter of the upper stage portion (45g) of the lower cover (45f) is substantially identical to the inner diameter of the lower end portion of the drive shaft (40). The outer diameter of the lower stage portion (45h) of the lower cover (45f) is substantially identical to the outer diameter of the lower end portion of the drive shaft (40). The outer diameter of the upper stage portion (45g) is formed to be smaller than the outer diameter of the lower stage portion (45h).

[0044] The upper stage portion (45g) of the lower cover (45f) is inserted into the lower end of the vertical hole (40a) in the drive shaft (40). A through passage (45i) that passes through in the axial direction of the drive shaft (40) is formed in the inside of the lower cover (45f). This through passage (45i) is formed to pass through the shaft center of the lower cover (45f). The cross-section of the through passage (45i) at the lower stage portion (45h) of the lower cover (45f) is formed in a substantially regular hexagonal shape. Here, the cross-section of the outer periphery of an upper projecting portion (83) of the pump (80) is formed in a substantially regular hexagonal shape. The upper projecting portion (83) of the pump (80) is fitted to the through passage (45i) at the lower stage portion (45h) of the lower cover (45f). Consequently, when the drive shaft (40) rotates, the rotational force thereof is transmitted to the upper projecting portion (83) of the pump (80) via the lower cover (45f), and the pump (80) is operated. The through passage (45i) causes the discharge side of the pump (80) and the main oil supply passage (45a) to be in communication with each other. The oil supplied from the pump (80) flows into the through passage (45i) in the lower cover (45f) via the inside of the upper projecting portion (83) of the pump (80). The oil that has passed through the through passage (45i) flows out to the in-shaft oil supply passage (45) in the drive shaft (40).

[0045] A concave portion (42b) is formed on an upper end surface (42a) of the eccentric shaft (42) of the drive shaft (40). The center of the concave portion (42b) is located at a position substantially identical to the position of the shaft center of the eccentric shaft (42). The center of the concave portion (42b) deviates from the shaft center of the main shaft (41) by a predetermined distance. The inner diameter of the concave portion (42b) is larger than the outer diameter of the upper cover (45e).

<Housing>

[0046] The housing (50) is formed in a cylindrical shape extending in the axial direction (up-down direction) of the casing (20) and is provided below the movable scroll (35) in the casing (20). At the inner periphery of the housing (50), the drive shaft (40) is inserted. In this example, the housing (50) is formed such that the outer diameter of the upper-side part thereof is larger than the outer diameter of the lower-side part. The outer peripheral surface of the housing (50) at the upper-side part is fixed to the inner peripheral surface of the barrel portion (21) of the casing (20). Consequently, the internal space of the housing (50) is divided into an upper space and the lower space (25) of the housing (50).

[0047] The housing (50) is formed such that the inner diameter of the upper-side part thereof is larger than the inner diameter of the lower-side part thereof. The boss portion (38) of the movable scroll (35) is accommodated at the inner periphery of the upper-side part of the housing (50). The main shaft (41) of the drive shaft (40) is rotatably supported by the inner periphery of the lower-side part of the housing (50). A concave portion (51) that is recessed downward is formed at the upper-side part of the housing (50), and the concave portion (51) constitutes a crank chamber (55) that accommodates the boss portion (38) of the movable scroll (35). A main bearing portion (52) that passes through the housing (50) in the axial direction and that is in communication with the crank chamber (55) is formed at the lower-side part of the housing (50). This main bearing portion (52) rotatably supports the main shaft (41) of the drive shaft (40). Note that, in this example, a slide bearing (52a) (first bearing) is fitted to the inner periphery of the main bearing portion (52), and the main bearing portion (52) rotatably supports the main shaft (41) of the drive shaft (40) via this slide bearing (52a).

[0048] The upper surface of the housing (50) is provided with a self-rotation inhibition member (53) for inhibiting self-rotation of the movable scroll (35). The self-rotation inhibition member (53) is slidably fitted to the movable-side panel portion (36) of the movable scroll (35) and a movable panel support (56) of the housing (50). For example, the self-rotation inhibition member (53) is constituted by an Oldham coupling. The outer peripheral wall portion (34) of the fixed scroll (31) is fixed to the upper surface of the housing (50).

<Electric Motor>

[0049] The electric motor (60) is provided below the housing (50) in the casing (20). The electric motor (60) has a stator (61) and a rotor (62). The stator (61) is formed in a cylindrical shape and fixed in the casing (20). A core cut (61a) that passes through the stator (61) in the axial direction is formed in the outer peripheral surface of the stator (61). The rotor (62) is formed in a cylindrical shape and rotatably inserted at the inner periphery of the stator (61). The drive shaft (40) is inserted and fixed at the inner periphery of the rotor (62).

<Support>

[0050] The support (70) is formed in a cylindrical shape extending in the axial direction (up-down direction) of the casing (20) and is provided between the electric motor (60) and the bottom portion (storage portion (26)) of the casing (20) in the casing (20). The drive shaft (40) is inserted at the inner periphery of the support (70). In this embodiment, the outer peripheral surface of a portion of the support (70) protrudes outwardly in the radial direction and is fixed to the inner peripheral surface of the barrel portion (21) of the casing (20).

[0051] The support (70) is formed such that the inner diameter of the upper-side part thereof is smaller than the inner diameter of the lower-side part thereof. The main shaft (41) of the drive shaft (40) is rotatably supported by the inner periphery of the upper-side part thereof, and the lower end portion of the main shaft (41) of the drive shaft (40) is accommodated at the inner periphery of the lower-side part thereof. The upwardly recessed lower concave portion (71) is formed at the lower-side part of the support (70), and the lower end portion of the main shaft (41) of the drive shaft (40) is accommodated in the lower concave portion (71).

[0052] A lower bearing portion (72) that passes through the support (70) in the axial direction and that is in communication with the internal space of the lower concave portion (71) is formed at the upper-side part of the support (70), and the lower bearing portion (72) rotatably supports the main shaft (41) of the drive shaft (40). Note that, in this example, a slide bearing (72a) (second bearing) is fitted to the inner periphery of the lower bearing portion (72), and the lower bearing portion (72) rotatably supports the main shaft (41) of the drive shaft (40) via this slide bearing (72a).

<Pump>

[0053] The pump (80) is provided at the lower end portion of the drive shaft (40) via the lower cover (45f) and mounted to the lower surface of the support (70) to close the lower concave portion (71) of the support (70). The pump (80) is configured to transport oil from the storage portion (26) to the in-shaft oil supply passage (45) and transport oil from the in-shaft oil drainage passage (46) to the storage portion (26). In this embodiment, the pump (80) is constituted by so-called positive displacement twin trochoid pumps. The lower-side part thereof constitutes an oil supply pump portion (81), and the upper-side part thereof constitutes an oil drainage pump portion (82). The oil supply pump portion (81) discharges oil that is sucked from the storage portion (26) to the in-shaft oil supply passage (45). The oil drainage pump portion (82) discharges oil that is sucked from the in-shaft oil drainage passage (46) via the lower concave portion (71) of the support (70) to the storage portion (26).

<In-Shaft Oil Drainage Passage>

[0054] The in-shaft oil drainage passage (46) is an oil passage for draining oil that has flowed into the crank chamber (55) to the storage portion (26). The in-shaft oil drainage passage (46) is formed in the inside of the drive shaft (40). The in-shaft oil drainage passage (46) has the main oil drainage passage (46a) and the inflow hole (46b) at the upper end of the main oil drainage passage (46a).

[0055] The main oil drainage passage (46a) extends on the shaft center of the main shaft (41) in the axial direction (up-down direction) of the drive shaft (40). In this example, the main oil drainage passage (46a) is formed to be coaxial with the main shaft (41). The main oil drainage passage (46a) extends from the upper end of the drive shaft (40) to a portion before the lower end. The cross-section of the main oil drainage passage (46a) is formed in a circular shape. In the present embodiment, the main oil drainage passage (46a) is formed in the inside of the pipe (90).

[0056] The inflow hole (46b) is formed in the upper end portion of the main oil drainage passage (46a). This inflow hole (46b) is formed at the bottom of the concave portion (42b) on the upper end surface (42a) of the eccentric shaft (42) .

<In-Shaft Oil Supply Passage>

[0057] The in-shaft oil supply passage (45) is an oil passage for supplying the oil stored in the storage portion (26) to each sliding portion. The in-shaft oil supply passage (45) is formed in the inside of the drive shaft (40). The in-shaft oil supply passage (45) includes the main oil supply passage (45a), an upper-side outflow passage (45b) (first oil supply hole), a lower-side outflow passage (45c) (second oil supply hole), and an oil-supply-side communication passage (45d) (refer to Fig. 2) that is in communication with the sliding portion (43) from the main oil supply passage (45a).

[0058] The main oil supply passage (45a) extends on the shaft center of the main shaft (41) in the axial direction (up-down direction) of the drive shaft (40). In this example, the main oil supply passage (45a) is formed to be coaxial with the main shaft (41). The main oil supply passage (45a) extends from the lower end to the upper end of the drive shaft (40). The inner diameter of the main oil supply passage (45a) is formed to be larger than the inner diameter of the main oil drainage passage (46a). The main oil supply passage (45a) is formed to surround the periphery of the main oil drainage passage (46a). The cross-section of the main oil supply passage (45a) is formed in an annular shape. The inflow end of the main oil supply passage (45a) opens in the lower end surface of the main shaft (41) of the drive shaft (40). The upper end of the main oil supply passage (45a) is closed by the upper cover (45e).

[0059] The upper-side outflow passage (45b) is for supplying oil to the slide bearing (52a). The upper-side outflow passage (45b) extends from the main oil supply passage (45a) outwardly in the radial direction. The inflow end of the upper-side outflow passage (45b) is in communication with the main oil supply passage (45a), and the outflow end of the upper-side outflow passage (45b) opens in the main bearing portion (52) of the housing (50). The upper-side outflow passage (45b) is in communication with a sliding portion between the main bearing portion (52) of the housing (50) and the main shaft (41) of the drive shaft (40).

[0060] The lower-side outflow passage (45c) is for supplying oil to the slide bearing (72a). The lower-side outflow passage (45c) extends from the main oil supply passage (45a) outwardly in the radial direction. The inflow end of the lower-side outflow passage (45c) is in communication with the main oil supply passage (45a), and the outflow end of the lower-side outflow passage (45c) opens in the lower bearing portion (72) of the support (70). The lower-side outflow passage (45c) is in communication with a sliding portion between the lower bearing portion (72) of the support (70) and the main shaft (41) of the drive shaft (40). The lower-side outflow passage (45c) opens at a location shifted from the upper-side outflow passage (45b) in the circumferential direction by about 180°.

[0061] The oil-supply-side communication passage (45d) is for supplying oil to the slide bearing (38a). The oil-supply-side communication passage (45d) extends from the main oil supply passage (45a) outwardly in the radial direction. The inflow end of the oil-supply-side communication passage (45d) is in communication with the main oil supply passage (45a), and the outflow end of the oil-supply-side communication passage (45d) opens in the boss portion (38) of the movable scroll (35). The oil-supply-side communication passage (45d) is in communication with the sliding portion (43) between the boss portion (38) of the movable scroll (35) and the eccentric shaft (42) of the drive shaft (40).

[0062] As illustrated in Fig. 2, an oil connection chamber (85) is constituted between the upper end surface (the upper end surface of the eccentric shaft (42)) of the drive shaft (40) and the back surface (lower surface) of the movable-side panel portion (36) (refer to Fig. 2). A gap between the upper end surface of the drive shaft (40) and the back surface of the movable-side panel portion (36) constitutes the oil connection chamber (85).

<Oil-Drainage-Side Communication Passage>

[0063] As illustrated in Fig. 6, at the movable-side panel portion (36) of the movable scroll (35), an oil-drainage-side communication passage (47) (third oil flow passage) that is a passage passing through the inside of the movable-side panel portion (36) is formed. The oil-drainage-side communication passage (47) is for sending oil that has flowed out to the crank chamber (55) from the sliding portion (43), to the inflow hole (46b) of the in-shaft oil drainage passage (46). This oil-drainage-side communication passage (47) has a communication passage (47a) that is in communication from the outer edge of the movable-side panel portion (36) to the center of the boss portion (38) in the radial direction, an inflow port (47b) that opens toward the crank chamber (55), an outflow port (47c) that opens in the lower surface of the movable-side panel portion (36) at the center of the boss portion (38), and a plug (47d) that closes an end portion of the communication passage (47a) on the outer side in the radial direction. The outflow port (47c) is formed to overlap the inflow hole (46b) of the in-shaft oil drainage passage (46) in the axial direction of the drive shaft (40). Specifically, the outflow port (47c) of the oil-drainage-side communication passage (47) performs, along with turning of the movable scroll (35), a turning movement by an amount of eccentricity (that is, turning radius) between the shaft center of the main shaft (41) and the shaft center of the eccentric shaft (42). The inflow hole (46b) of the in-shaft oil drainage passage (46) is present on the shaft center of the main shaft (41). The inflow hole (46b) thus does not perform a turning movement even when the movable scroll (35) turns. In a predetermined eccentric angle range during turning of the movable scroll (35), the outflow port (47c) and the inflow hole (46b) of the in-shaft oil drainage passage (46) overlap each other in the axial direction.

[0064] The drive shaft (40) is provided with a seal portion (44) for suppressing oil leakage.

[0065] The seal portion (44) is provided at the upper end of the sliding portion (43) between the boss portion (38) of the movable scroll (35) and the eccentric shaft (42) of the upper end portion of the drive shaft (40).

[0066] A balance weight (49) is mounted to the drive shaft (40). The balance weight (49) is constituted by an annular portion (49a) fitted and fixed to the drive shaft (40), and an arc-shaped peripheral wall portion (49b) formed integrally with the annular portion (49a).

[0067] A main bearing oil drainage passage (87) is formed in the housing (50). The main bearing oil drainage passage (87) is an oil passage for draining the oil of a sliding portion between the slide bearing (52a) of the main bearing portion (52) and the main shaft (41) of the drive shaft (40) to the crank chamber (55). In this embodiment, an outer peripheral groove (88) is formed at, of the main shaft (41) of the drive shaft (40), a part that corresponds to the lower end portion of the slide bearing (52a) of the main bearing portion (52). The main bearing oil drainage passage (87) extends along the slide bearing (52a) of the main bearing portion (52) in the up-down direction in the housing (50). The inflow end of the main bearing oil drainage passage (87) is in communication with the outer peripheral groove (88), and the outflow end thereof opens in the crank chamber (55).

[0068] A guide plate (95) is provided below the outflow end of the discharge passage (39). The guide plate (95) is configured to guide the refrigerant that has flowed out from the outflow end of the discharge passage (39) and part of oil to the core cut (61a) of the stator (61). The guide plate (95) is also configured to cause the remaining refrigerant and oil to flow out in the circumferential direction in the lower space (25) of the housing (50).

- Operation Action -

[0069] Next, operation action of the scroll compressor (10) will be described. When the electric motor (60) is started, the drive shaft (40) rotates, and the movable scroll (35) of the compression mechanism (30) is driven. The movable scroll (35) revolves around the shaft center of the drive shaft (40) in a state in which self-rotation is restricted by the self-rotation inhibition member (53). Consequently, low-pressure fluid (for example, low-pressure gas refrigerant) is sucked from the suction pipe (27) into the compression chamber (C) through an auxiliary suction hole (not illustrated) of the compression mechanism (30) and compressed. The fluid (high-pressure fluid) compressed in the compression chamber (C) is discharged to the discharge chamber (S) through the discharge port (P) of the fixed scroll (31). The high-pressure fluid (for example, high-pressure gas refrigerant) that has flowed into the discharge chamber (S) flows out through the discharge passage (39) formed in the fixed scroll (31) and the housing (50) into the lower space (25) of the housing (50). The high-pressure fluid that has flowed into the lower space (25) is discharged through the discharge pipe (28) to the outside (for example, the condenser of the refrigerant circuit) of the casing (20).

[0070] Next, an oil supplying/draining operation in the scroll compressor (10) will be described. When the electric motor (60) is started, the drive shaft (40) rotates, and the pump (80) is driven. In the pump (80), the oil stored in the storage portion (26) is sucked by the oil supply pump portion (81), and the oil sucked by the oil supply pump portion (81) is discharged to the main oil supply passage (45a) of the in-shaft oil supply passage (45). Part of the oil discharged from the oil supply pump portion (81) to the main oil supply passage (45a) is supplied to the lower bearing portion (72) through the lower-side outflow passage (45c), and the remaining portion thereof goes upward in the main oil supply passage (45a) toward the upper end of the main oil supply passage (45a).

[0071] The oil supplied to the lower bearing portion (72) through the lower-side outflow passage (45c) is supplied to a sliding portion between the slide bearing (72a) of the lower bearing portion (72) and the main shaft (41) of the drive shaft (40). Consequently, the sliding portion between the slide bearing (72a) of the lower bearing portion (72) and the main shaft (41) of the drive shaft (40) is lubricated. Part of this oil is drained to a lower space (29) of the electric motor (60) from the upper end of the sliding portion between the slide bearing (72a) of the lower bearing portion (72) and the main shaft (41) of the drive shaft (40). The remaining portion of the oil is drained to the lower concave portion (71) of the support (70) from the lower end of a sliding portion between the slide bearing (72a) of the lower bearing portion (72) and the main shaft (41) of the drive shaft (40).

[0072] Part of the oil that goes upward in the main oil supply passage (45a) without flowing into the lower-side outflow passage (45c) is supplied to the main bearing portion (52) through the upper-side outflow passage (45b), and the remaining portion thereof goes upward in the main oil supply passage (45a) toward the upper end of the main oil supply passage (45a).

[0073] The oil supplied to the main bearing portion (52) through the upper-side outflow passage (45b) is supplied to a sliding portion between the slide bearing (52a) of the main bearing portion (52) and the main shaft (41) of the drive shaft (40). Consequently, the sliding portion between the slide bearing (52a) of the main bearing portion (52) and the main shaft (41) of the drive shaft (40) is lubricated. Part of this oil is drained directly to the crank chamber (55) of the housing (50) from the upper end of the sliding portion between the slide bearing (52a) of the main bearing portion (52) and the main shaft (41) of the drive shaft (40). The remaining portion of the oil is drained to the crank chamber (55) of the housing (50) from the lower end of the sliding portion between the slide bearing (52a) of the main bearing portion (52) and the main shaft (41) of the drive shaft (40) by passing through the outer peripheral groove (88) of the main shaft (41) and the main bearing oil drainage passage (87) successively.

[0074] The oil that goes upward in the main oil supply passage (45a) without flowing into the upper-side outflow passage (45b) is supplied to the sliding portion (43) from the oil-supply-side communication passage (45d) in communication with the main oil supply passage (45a). Consequently, the sliding portion (43) between the slide bearing (38a) of the boss portion (38) and the eccentric shaft (42) of the drive shaft (40) is lubricated. This oil is drained to the crank chamber (55) of the housing (50) from the sliding portion (43) between the slide bearing (38a) of the boss portion (38) and the eccentric shaft (42) of the drive shaft (40).

[0075] Part of the oil of the crank chamber (55) is supplied to a sliding portion between the fixed scroll (31) and the movable scroll (35) through an oil supply path, whose details are omitted. The oil of the crank chamber (55) is drained to the main oil drainage passage (46a) through the oil-drainage-side communication passage (47) formed in the movable scroll (35). The oil drained to the main oil drainage passage (46a) goes downward in the main oil drainage passage (46a) from the upper end toward the lower end of the main oil drainage passage (46a). The oil that goes downward in the main oil drainage passage (46a) is drained via the internal flow passage (102) of the connection member (100) to the lower concave portion (71) of the support (70) through the outflow hole (40c). In the pump (80), the oil drained to the lower concave portion (71) of the support (70) is sucked by the oil drainage pump portion (82), and the oil sucked by the oil drainage pump portion (82) is discharged to the storage portion (26).

- Method of Manufacturing Drive Shaft -

[0076] Hereinafter, a method of manufacturing the drive shaft (40) of the scroll compressor (10) that is configured as described above will be described.

[0077] First, the drive shaft (40) that has the main shaft (41) and the eccentric shaft (42) provided at one end of the main shaft (41), and an elongated pipe (90) are prepared. Next, the vertical hole (40a) is drilled over both ends of the drive shaft (40) in the axial direction. The shaft center of the vertical hole (40a) is made to be coaxial with the shaft center of the main shaft (41). Next, the upper cover (45e) is mounted to one end of the pipe (90), and the connection member (100) is mounted to the other end. Next, the pipe (90) in this state is inserted into the vertical hole (40a). At this time, the outflow end of the internal flow passage (102) of the connection member (100) and the outflow hole (40c) formed in the peripheral wall (40b) of the vertical hole (40a) in the drive shaft (40) are made to be in communication with each other. In addition, the shaft center of the vertical hole (40a) and the shaft center of the pipe (90) are disposed to be coaxial with each other. Through the above steps, the in-shaft oil drainage passage (46) (first oil flow passage) can be formed in the inside of the pipe (90). The main oil supply passage (45a) (second oil flow passage) can be formed between the inner peripheral surface of the vertical hole (40a) and the outer peripheral surface of the pipe (90).

- Effects of Embodiment 1 -

[0078] In the present embodiment, the scroll compressor (10) includes the casing (20), the electric motor (60) that is accommodated in the casing (20), the drive shaft (40) that is driven by the electric motor (60), the compression mechanism (30) that is coupled to the drive shaft (40), and the housing (50) that is disposed below the compression mechanism (30) and fixed to the casing (20). The bottom portion of the casing (20) is provided with the storage portion (26) in which oil is stored. The drive shaft (40) has the main shaft (41) and the eccentric shaft (42) provided at the upper end of the main shaft (41). The compression mechanism (30) has the movable scroll (35) having the boss portion (38) to which the eccentric shaft (42) is fitted and the fixed scroll (31) that meshes with the movable scroll (35). The crank chamber (55) that accommodates the boss portion (38) is formed in the housing (50). The pump (80) that transports the oil of the storage portion (26) is provided at the lower end of the main shaft (41) .

[0079] The drive shaft (40) is provided with the in-shaft oil drainage passage (46) extending on the shaft center of the main shaft (41) in the axial direction of the drive shaft and having the inflow hole (46b) that opens in the upper end surface (42a) of the eccentric shaft (42), and the main oil supply passage (45a) having an annular cross-section and extending at the periphery of the in-shaft oil drainage passage (46) in the axial direction. The main oil supply passage (45a) constitutes an oil supply path in which the oil that has been transported by the pump (80) is supplied to, at least, the sliding portion (43) between the boss portion (38) and the eccentric shaft (42). The oil-drainage-side communication passage (47) in which the oil that has flowed out from the sliding portion (43) to the crank chamber (55) is sent to the inflow hole (46b) of the in-shaft oil drainage passage (46) is further included. The in-shaft oil drainage passage (46) constitutes an oil drainage path in which the oil that has flowed in through the inflow hole (46b) is returned to the storage portion (26).

[0080] Therefore, the in-shaft oil drainage passage (46) and the inflow hole (46b) thereof are present on the shaft center of the drive shaft (40). Consequently, a centrifugal force along with the rotation of the drive shaft (40) does not easily act on the oil near the inflow hole (46b). Thus, according to this aspect, it is possible to cause oil to easily enter the inflow hole (46b) of the in-shaft oil drainage passage (46) and possible to return the oil that has been used for lubrication to the storage portion (26) quickly.

[0081] As described above, by increasing the oil drainage capacity in the drive shaft (40), oil is prevented from being stored excessively in the crank chamber (55). It is thus possible to suppress a pressure increase in the crank chamber (55) and possible to reduce the load of the pump (80). Consequently, it is also possible to increase the reliability of the pump (80).

[0082] In addition, by increasing the oil drainage capacity in the drive shaft (40), oil does not easily flow out from the lower end of the housing (50) to the lower space (25). Therefore, oil does not easily flow out from the discharge pipe (28) to the outside of the scroll compressor (10), and it is possible to reduce oil loss from the scroll compressor.

[0083] Further, in the scroll compressor (10) of the present embodiment, the vertical hole (40a) extending in the axial direction and opening at at least the upper end of the drive shaft (40) is formed in the drive shaft (40), the pipe (90) disposed on the shaft center of the drive shaft (40) in the vertical hole (40a) and extending in the axial direction is included, the first oil flow passage (46) is formed in the inside of the pipe (90), and the main oil supply passage (45a) is formed between the inner peripheral surface of the vertical hole (40a) and the outer peripheral surface of the pipe (90).

[0084] Therefore, by providing the pipe (90) disposed on the shaft center of the drive shaft (40) in the vertical hole (40a) formed in the drive shaft (40), the in-shaft oil drainage passage (46) and the main oil supply passage (45a) can be easily formed.

[0085] It is also possible to form the in-shaft oil drainage passage (46) and the main oil supply passage (45a) by hollow drilling, not deep-hole drilling, and it is thus possible to reduce manufacturing costs.

[0086] Further, in the scroll compressor (10) of the present embodiment, the annular upper cover (45e) that closes the gap between the inner peripheral surface of the upper end portion of the vertical hole (40a) and the outer peripheral surface of the upper end portion of the pipe (90) is included.

[0087] Therefore, the upper end portion of the main oil supply passage (45a) is closed by the annular upper cover (45e), and it is thus possible to suppress oil leakage in the main oil supply passage (45a).

[0088] Further, in the scroll compressor (10) of the present embodiment, the vertical hole (40a) passes through the drive shaft (40) in the axial direction, the lower cover (45f) that closes the lower end of the vertical hole (40a) is included, and the through passage (45i) that causes the discharge side of the pump (80) and the main oil supply passage (45a) to be in communication with each other is formed in the lower cover (45f).

[0089] Therefore, by forming the vertical hole (40a) to pass through the drive shaft (40) and closing the lower end of the vertical hole (40a) by the lower cover (45f), it is possible to send the oil that has been transported by the pump (80), to the main oil supply passage (45a) via the through passage (45i) of the lower cover (45f).

[0090] Due to the lower cover (45f) being included, it is possible to mount the pump (80) via the lower cover (45f), without performing processing directly for mounting the pump (80) to the drive shaft (40). It is thus possible to ease the processing of drive shaft (40).

[0091] Further, in the scroll compressor (10) of the present embodiment, the connection member (100) having the connecting port (101) and the internal flow passage (102) is included, the connecting port (101) being connected to the lower end of the pipe (90), the internal flow passage (102) extending from the connecting port (101) outwardly in the radial direction, and the outflow hole (40c) in communication with the internal flow passage (102) is formed in the peripheral wall (40b) of the vertical hole (40a) of the drive shaft (40).

[0092] Therefore, the oil that has flowed in the in-shaft oil drainage passage (46) passes through the connecting port (101) of the connection member (100) and flows into the internal flow passage (102). The internal flow passage (102) extends outwardly in the radial direction. Therefore, when a centrifugal force acts on the oil in the internal flow passage (102) along with the rotation of the drive shaft (40), the oil in the internal flow passage (102) is moved outwardly in the radial direction and drained through the outflow hole (40c). Consequently, it is possible to transfer the oil of the main oil drainage passage (46a) to the storage portion (26) by using the centrifugal force of the drive shaft (40).

[0093] In particular, the inflow end of the internal flow passage (102) is present on the shaft center of the main shaft (41) in the present embodiment. Since a distance from the inflow end of the internal flow passage (102) to the outflow hole (40c) of the drive shaft (40) is maximum, the centrifugal force that acts, along with the rotation of the drive shaft (40), on the oil that flows in the internal flow passage (102) is maximum. Consequently, it is possible to increase the oil drainage capacity.

[0094] Further, in the scroll compressor (10) of the present embodiment, the housing (50) is provided with the slide bearing (52a) that supports the main shaft (41), and the drive shaft (40) is provided with the upper-side outflow passage (45b) extending from the main oil supply passage (45a) outwardly in the radial direction and in which oil is supplied to the slide bearing (52a).

[0095] Therefore, it is possible to supply the oil in the main oil supply passage (45a) to the slide bearing (52a) from the upper-side outflow passage (45b) by using a centrifugal force. The main oil supply passage (45a) is a flow path having an annular cross-section. It is thus possible to provide the upper-side outflow passage (45b) at any position in the circumferential direction of the drive shaft (40).

[0096] Further, in the scroll compressor (10) of the present embodiment, the support (70) having the bearing (72a) that supports the lower portion of the main shaft (41) is included, and the drive shaft (40) is provided with the lower-side outflow passage (45c) extending from the main oil supply passage (45a) outwardly in the radial direction and in which oil is supplied to the slide bearing (72a).

[0097] Therefore, it is possible to supply the oil in the main oil supply passage (45a) to the slide bearing (72a) from the lower-side outflow passage (45c) by using a centrifugal force. The main oil supply passage (45a) is a flow path having an annular cross-section. It is thus possible to provide the lower-side outflow passage (45c) at any position in the circumferential direction of the drive shaft (40).

[0098] Since the main oil supply passage (45a) is a flow path having an annular cross-section, it is possible to supply oil to each slide bearing (52a, 72a) via the upper-side outflow passage (45b) and the lower-side outflow passage (45c) that are in communication with one oil supply passage.

[0099] Here, the direction of the load applied to the slide bearing (52a) and the direction of the load applied to the slide bearing (72a) in the rotation of the drive shaft (40) tend to be shifted from each other in the circumferential direction by about 180°. In the present embodiment, the main oil supply passage (45a) is an annular flow passage. It is thus possible to shift a relative angle between the lower-side outflow passage (45c) and the upper-side outflow passage (45b) easily by 180° in the circumferential direction. Therefore, it is possible to supply sufficient oil to each sliding portion.

[0100] Further, in the scroll compressor (10) of the present embodiment, the oil-drainage-side communication passage (47) is formed in the inside of the movable scroll (35), and the outflow port (47c) of the oil-drainage-side communication passage (47) and the inflow hole (46b) of the in-shaft oil drainage passage (46) overlap each other in the axial direction. Specifically, the outflow port (47c) of the oil-drainage-side communication passage (47) performs a turning movement of an amount of eccentricity (that is, turning radius) between the shaft center of the main shaft (41) and the shaft center of the eccentric shaft (42). In this turning movement, the outflow port (47c) of the oil-drainage-side communication passage (47) and the inflow hole (46b) of the in-shaft oil drainage passage (46) overlap each other in the axial direction in a range of a predetermined eccentric angle.

[0101] Accordingly, it is possible to cause the oil that has flowed out downwardly through the outflow port (47c) of the oil-drainage-side communication passage (47) to enter the inflow hole (46b) of the in-shaft oil drainage passage (46) easily and possible to increase the oil drainage capacity.

[0102] Further, by forming a plurality of the communication passages (47a), the inflow ports (47b), and the plugs (47d) of the oil-drainage-side communication passage (47), it is possible to further ease the entrance of the oil.

[0103] Further, in the scroll compressor (10) of the present embodiment, the concave portion (42b) is formed on the upper end surface of the eccentric shaft (42), and the inflow hole (46b) of the in-shaft oil drainage passage (46) is formed at the bottom of the concave portion (42b).

[0104] Therefore, the oil that has flowed out from the oil-drainage-side communication passage (47) can be caught in the concave portion (42b), and the oil of the concave portion (42b) can enter the inflow hole (46b). Thus, it is possible to improve the oil drainage capacity in the drive shaft (40).

- Modifications of Embodiment 1 -

<Modification 1>

[0105] As illustrated in Fig. 8, the lower cover (45f) that closes the vertical hole (40a) of the drive shaft (40) is constituted by an upper stage portion (45k), an intermediate state portion (451), and a lower stage portion (45m) in Modification 1 of the present embodiment.

[0106] The upper stage portion (45k) and the intermediate stage portion (451) of the lower cover (45f) are formed in cylindrical shapes having outer diameters that differ from each other. Specifically, the outer diameter of the upper stage portion (45k) is smaller than the outer diameter of the intermediate stage portion (451). The cross-section of the outer periphery of the lower stage portion (45m) is formed in a D-shape. Here, the pump

(80) has an internal gear (84a) and an external gear (84b). The cross-section of the inner periphery of the internal gear (84a) is formed in a D-shape. The lower stage portion (45m) of the lower cover (45f) meshes with the inner peripheral surface of the internal gear (84a). Consequently, when the drive shaft (40) rotates, the rotational force thereof is transmitted to the internal gear (84a) of the pump (80) via the lower cover (45f). Then, the transmitted rotational force is transmitted to the external gear (84b) that meshes with the internal gear (84a), the pump (80) is operated, and oil is transported.

[0107] The through passage (45i) that passes through in the axial direction of the drive shaft (40) is formed in the inside of the lower cover (45f). As the pump (80) of Modification 1, a single trochoid pump is used. The oil supplied from the pump (80) passes through the through passage (45i) of the lower cover (45f) and is drained through an outflow port formed in the upper end surface of the lower cover (45f) to the in-shaft oil supply passage (45) in the drive shaft (40).

<Modification 2>

[0108] As illustrated in Fig. 9 and Fig. 10, the lower cover (45f) and the connection member (100) are formed integrally in Modification 2 of the present embodiment. An oil supply path and an oil drainage path are included in the inside of the lower cover (45f). Specifically, in contrast to Modification 1, the upper end surface of the upper stage portion (45k) of the lower cover (45f) is located above the outflow hole (40c) of the drive shaft (40). The connecting port (101) connected to the lower end of the pipe (90) is formed in the upper end surface of the lower cover (45f). The internal flow passage (102) connected to the outflow hole (40c) of the drive shaft (40) is formed in the inside of the upper stage portion (45k) of the lower cover (45f). This internal flow passage (102) constitutes part of the oil drainage path.

[0109] An oil supply passage (45n) extending in the radial direction of the drive shaft (40) is formed below the internal flow passage (102) in the inside of the lower cover (45f). The outflow end of the through passage (45i) of the lower cover (45f) is in communication with the oil supply passage (45n). This through passage (45i) and the oil supply passage (45n) constitute part of the oil supply path.

[0110] According to this modification, the drive shaft (40) can be constituted by a small number of components. It is thus possible to obtain the scroll compressor (10) easily.

<<Other Embodiments>>

[0111] Regarding the aforementioned embodiment, following configurations may be employed.

[0112] In the scroll compressor (10) of the aforementioned embodiment, the pump (80) may have a different pump structure. For example, the oil supply pump portion (81) of the pump (80) may be constituted by a differential pressure pump and may be constituted by a centrifugal pump.

[0113] In the method of manufacturing the drive shaft (40) of the aforementioned embodiment, the vertical hole (40a) may be molded together when the drive shaft (40) is molded.

[0114] Although embodiments and modifications have been described above, it should be understood that various changes in the forms and the details are possible without departing from the gist and the scope of the claims. The above embodiments and modifications may be combined and replaced, as appropriate, as long as the directed functions of the present disclosure are not lost.

Industrial Applicability

[0115] As described above, the present disclosure is useful for a scroll compressor.

Reference Signs List

[0116]

10	scroll compressor
20	casing
26	storage portion
30	compression mechanism
31	fixed scroll
35	movable scroll
38	boss portion
40	drive shaft
40a	vertical hole
40b	peripheral wall
40c	outflow hole
41	main shaft
42	eccentric shaft
42a	upper end surface
42b	concave portion
43	sliding portion
45	in-shaft oil supply passage
45a	main oil supply passage (second oil flow passage)
45b	upper-side outflow passage (first oil supply hole)
45c	lower-side outflow passage (second oil supply hole)
45e	upper cover
45f	lower cover
46	in-shaft oil drainage passage (first oil flow passage)
46b	inflow hole
47	oil-drainage-side communication passage (third oil flow passage)
47c	outflow port
50	housing
52a	bearing (first bearing)
55	chamber

60	electric motor
70	support
72a	bearing (second bearing)
80	pump
90	pipe
100	connection member
101	connecting port
102	internal flow passage

Claims

1. A scroll compressor comprising: a casing (20), an electric motor (60) accommodated in the casing (20), a drive shaft (40) configured to be driven by the electric motor (60), a compression mechanism (30) coupled to the drive shaft (40), and a housing (50) disposed below the compression mechanism (30) and fixed to the casing (20),

    wherein a bottom portion of the casing (20) is provided with a storage portion (26) configured to store oil,
    the drive shaft (40) has a main shaft (41) and an eccentric shaft (42) provided at an upper end of the main shaft (41),
    the compression mechanism (30) has a movable scroll (35) that has a boss portion (38) to which the eccentric shaft (42) is fitted and a fixed scroll (31) that meshes with the movable scroll (35),
    the housing (50) includes a chamber (55) that accommodates the boss portion (38),
    a lower end of the main shaft (41) is provided with a pump (80) configured to transport oil of the storage portion (26),
    the drive shaft (40) is provided with

        a first oil flow passage (46) that extends on a shaft center of the main shaft (41) in an axial direction of the drive shaft (40) and that has an inflow hole (46b) opening in an upper end surface (42a) of the eccentric shaft (42), and
        a second oil flow passage (45a) that extends at a periphery of the first oil flow passage (46) in the axial direction and that has an annular cross-section,

    the second oil flow passage (45a) constitutes an oil supply path in which oil that has been transported by the pump (80) is supplied to at least a sliding portion (43) between the boss portion (38) and the eccentric shaft (42),
    a third oil flow passage (47) in which oil that has flowed out from the sliding portion (43) to the chamber (55) is sent to the inflow hole (46b) of the first oil flow passage (46) is further included, and
    the first oil flow passage (46) constitutes an oil drainage path in which oil that has flowed in through the inflow hole (46b) is returned to the storage portion (26).

2. The scroll compressor according to claim 1,

    wherein the drive shaft (40) has a vertical hole (40a) that extends in the axial direction and that opens at at least an upper end of the drive shaft (40),
    a pipe (90) that is disposed on a shaft center of the drive shaft (40) in the vertical hole (40a) and that extends in the axial direction is included,
    the first oil flow passage (46) is formed in an inside of the pipe (90), and
    the second oil flow passage (45a) is formed between an inner peripheral surface of the vertical hole (40a) and an outer peripheral surface of the pipe (90).

3. The scroll compressor according to claim 2, wherein an annular upper cover (45e) that closes a gap between an inner peripheral surface of an upper end portion of the vertical hole (40a) and an outer peripheral surface of an upper end portion of the pipe (90) is included.

4. The scroll compressor according to claim 2 or claim 3,

    wherein the vertical hole (40a) passes through the drive shaft (40) in the axial direction,
    a lower cover (45f) that closes a lower end of the vertical hole (40a) is included, and
    the lower cover (45f) includes a through passage (45i) that causes a discharge side of the pump (80) and the second oil flow passage (45a) to be in communication with each other.

5. The scroll compressor according to any one of claims 2 to 4,

    wherein a connection member (100) that has a connecting port (101) and an internal flow passage (102) is included, the connecting port (101) being connected to a lower end of the pipe (90), the internal flow passage (102) extending from the connecting port (101) outwardly in a radial direction, and
    a peripheral wall (40b) of the vertical hole (40a) in the drive shaft (40) has an outflow hole (40c) in communication with the internal flow passage (102).

6. The scroll compressor according to any one of claims 1 to 5,

wherein the housing (50) is provided with a first bearing (52a) that supports the main shaft (41), and

the drive shaft (40) is provided with a first oil supply hole (45b) extending from the second oil flow passage (45a) outwardly in a radial direction and through which oil is supplied to the first bearing (52a).

7. The scroll compressor according to claim 6,

wherein a support (70) having a second bearing (72a) that supports a lower portion of the main shaft (41) is included, and

the drive shaft (40) is provided with a second oil supply hole (45c) extending from the second oil flow passage (45a) outwardly in the radial direction and through which oil is supplied to the second bearing (72a).

8. The scroll compressor according to any one of claims 1 to 7,

wherein the third oil flow passage (47) is formed in an inside of the movable scroll (35), and

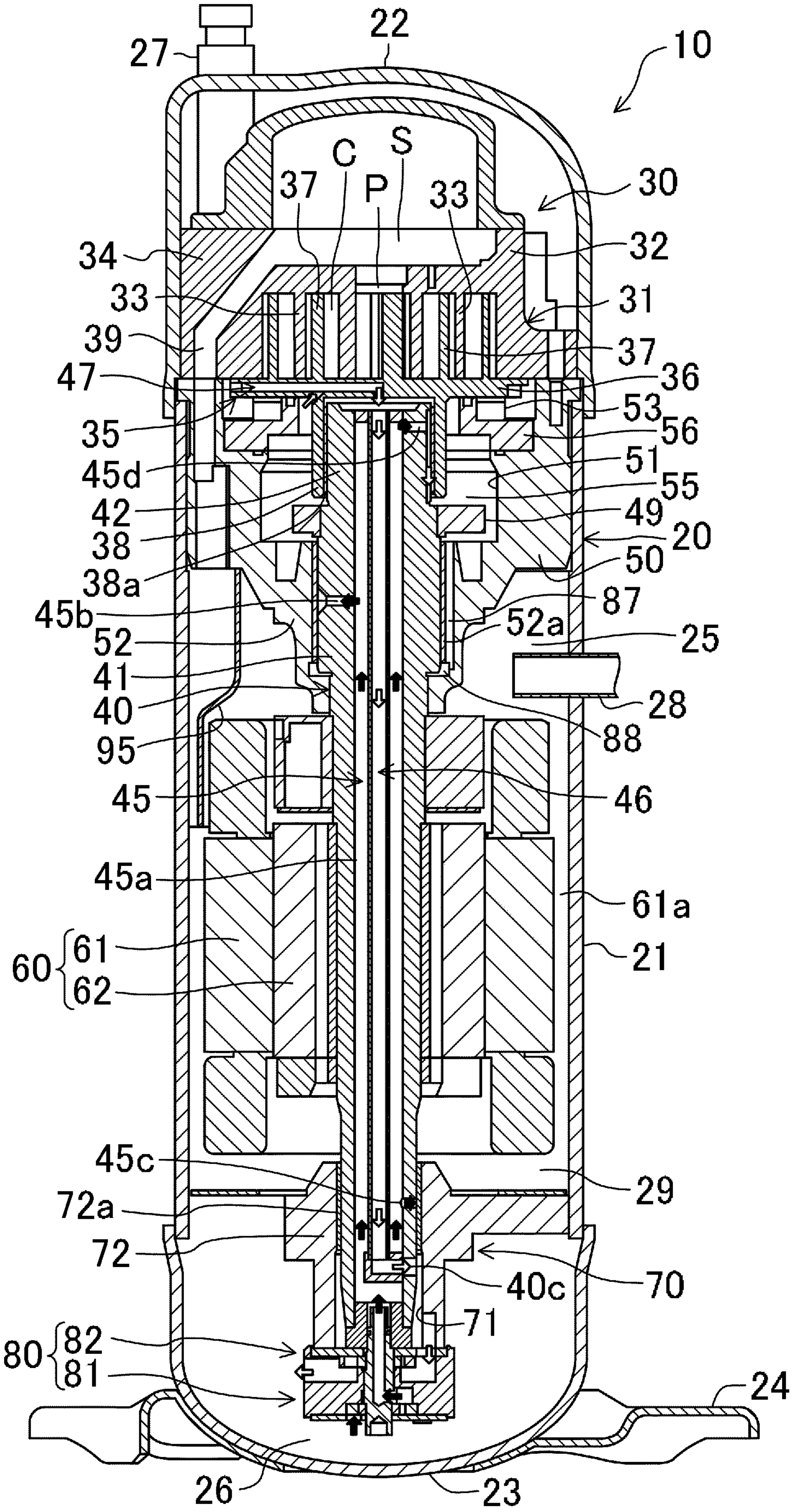
an outflow port (47c) of the third oil flow passage (47) and the inflow hole (46b) of the first oil flow passage (46) overlap each other in the axial direction.

9. The scroll compressor according to any one of claims 1 to 8,

wherein a concave portion (42b) is formed on an upper end surface (42a) of the eccentric shaft (42), and

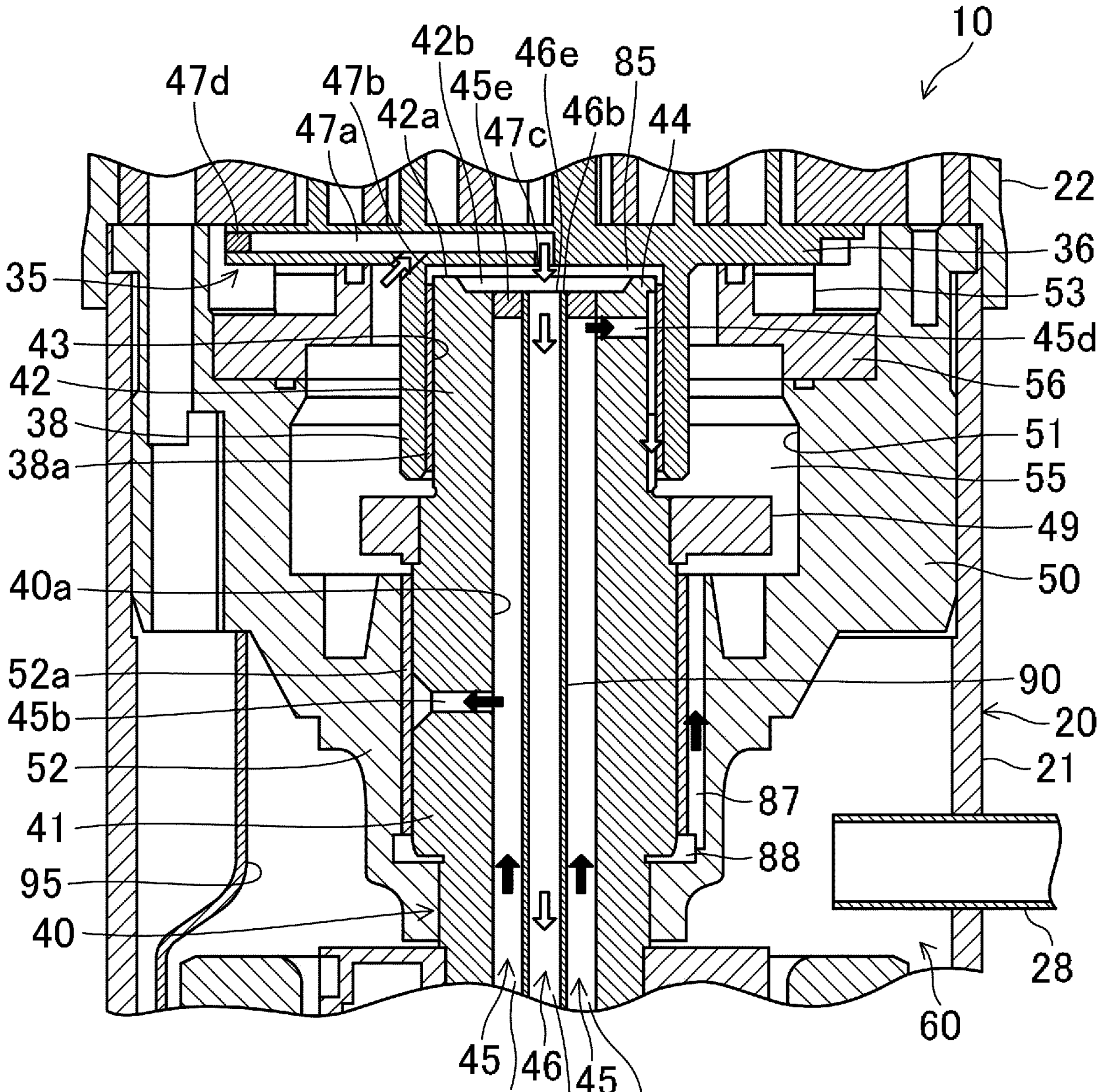
the inflow hole (46b) of the first oil flow passage (46) is formed at a bottom of the concave portion (42b).

FIG.1



10
22
27
30
C
S
P
37
33
34
32
33
31
39
37
47
36
35
53
56
45d
51
55
42
49
38
20
38a
50
87
45b
52a
52
25
41
40
28
88
95
45
46
45a
61a
60
61
62
21
45c
29
72a
72
70
40c
71
80
82
81
24
26
23

FIG.2


10
47d
47b
42b
46e
85
45e
47a
42a
47c
46b
44
22
36
35
53
43
45d
42
56
38
51
38a
55
49
40a
50
52a
90
45b
20
52
21
87
41
88
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60
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46
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45a
45a
46a

FIG.3

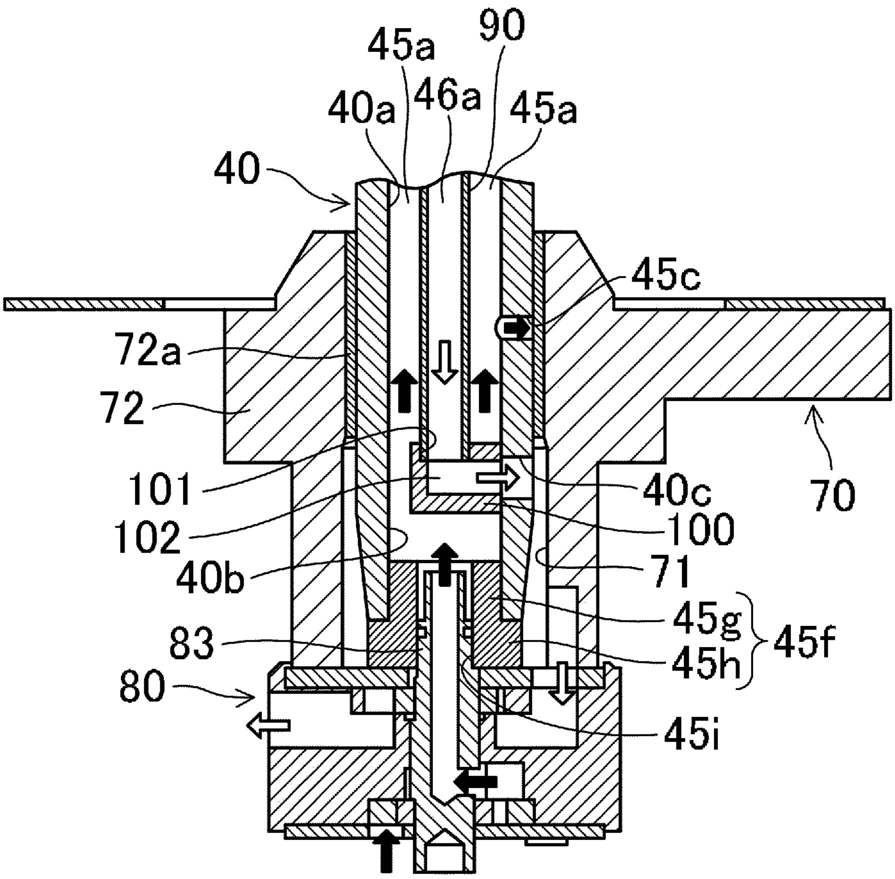

90
45a
40a
46a
45a
40
45c
72a
72
70
101
40c
102
100
40b
71
45g
45f
83
45h
80
45i

FIG.4

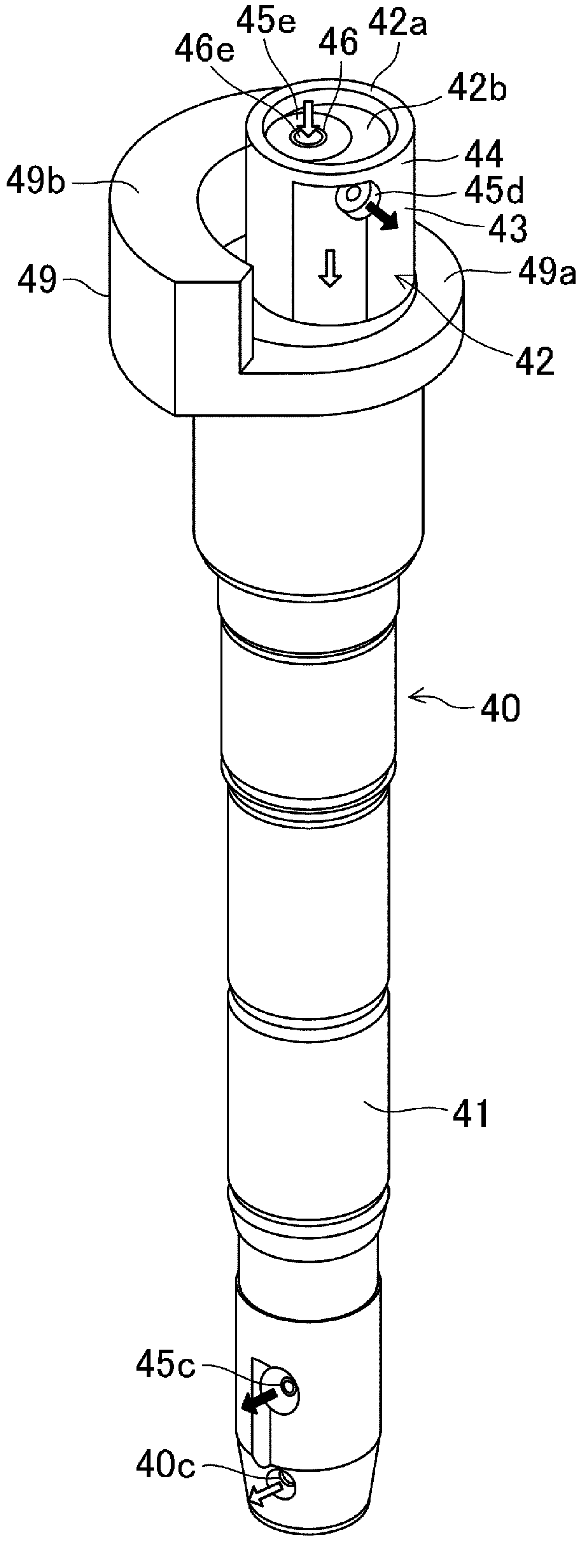


FIG.5

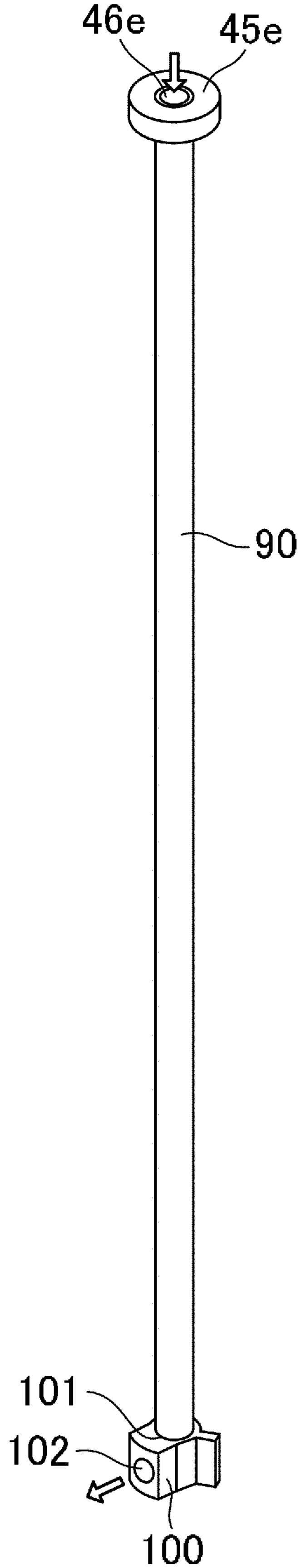


FIG.6

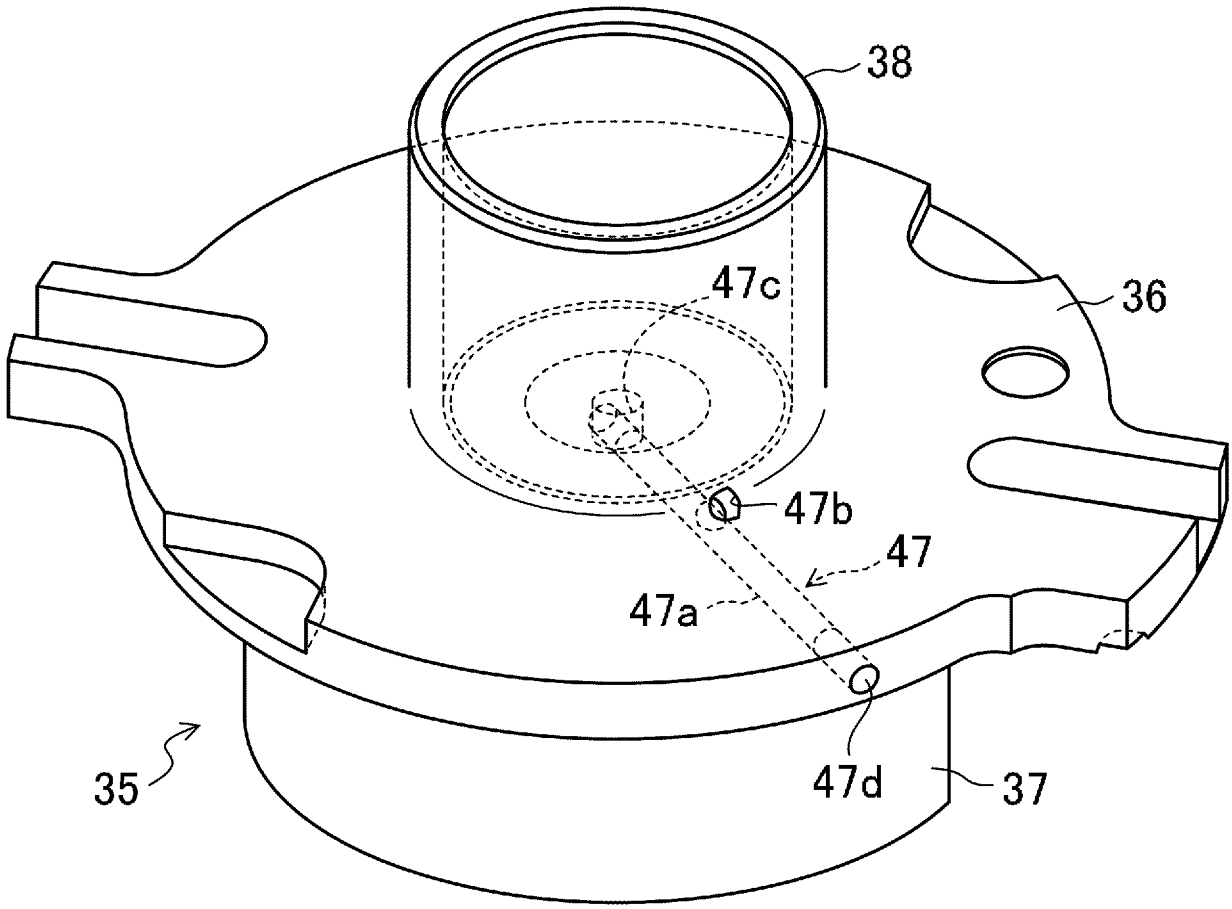


FIG.7

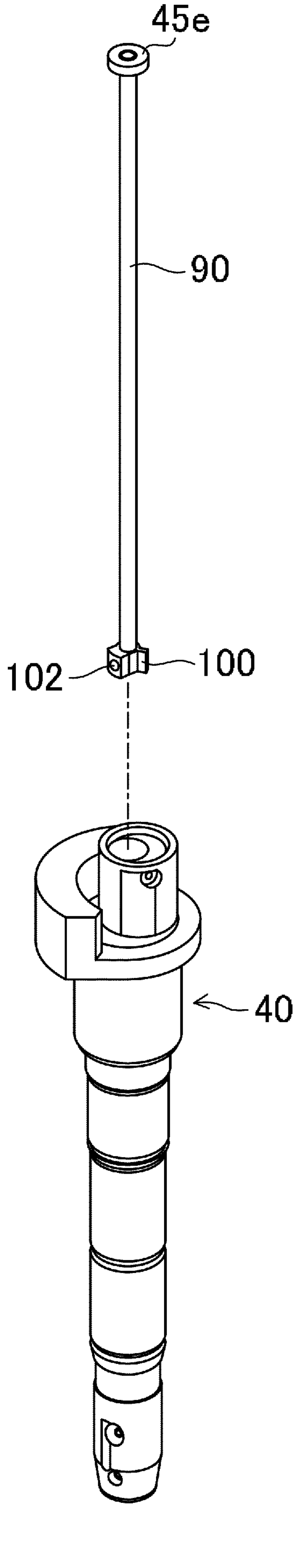
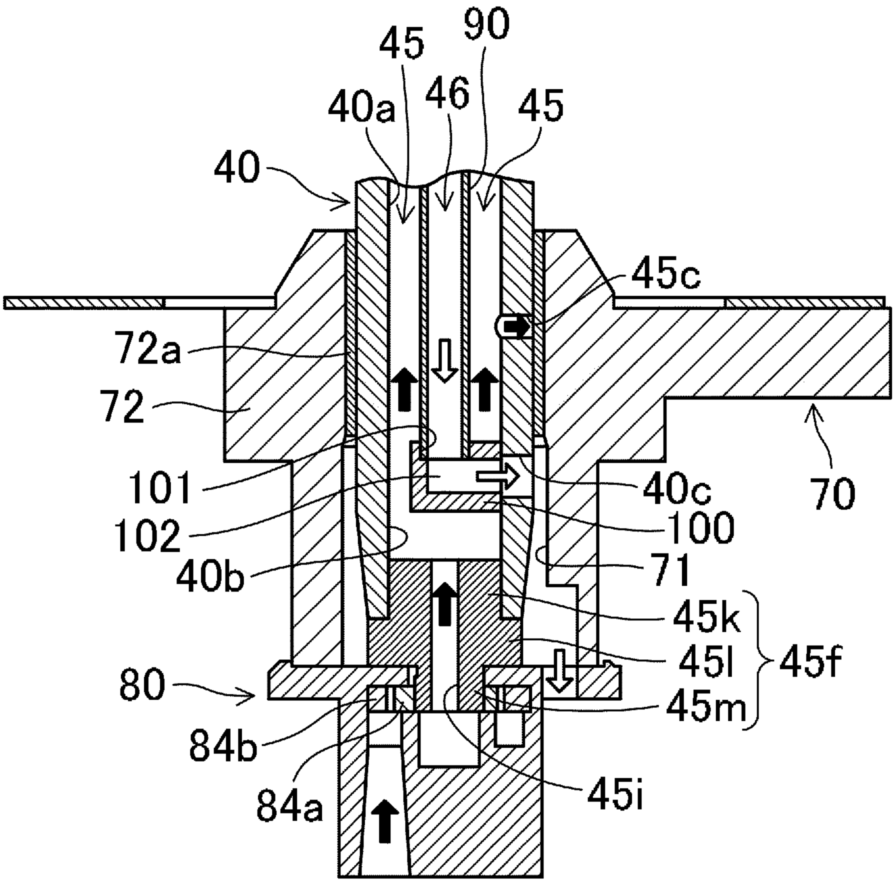


FIG.8



45
90
40a
46
45
40
45c
72a
72
70
101
40c
102
100
40b
71
45k
45l
45f
80
45m
84b
84a
45i

FIG.9

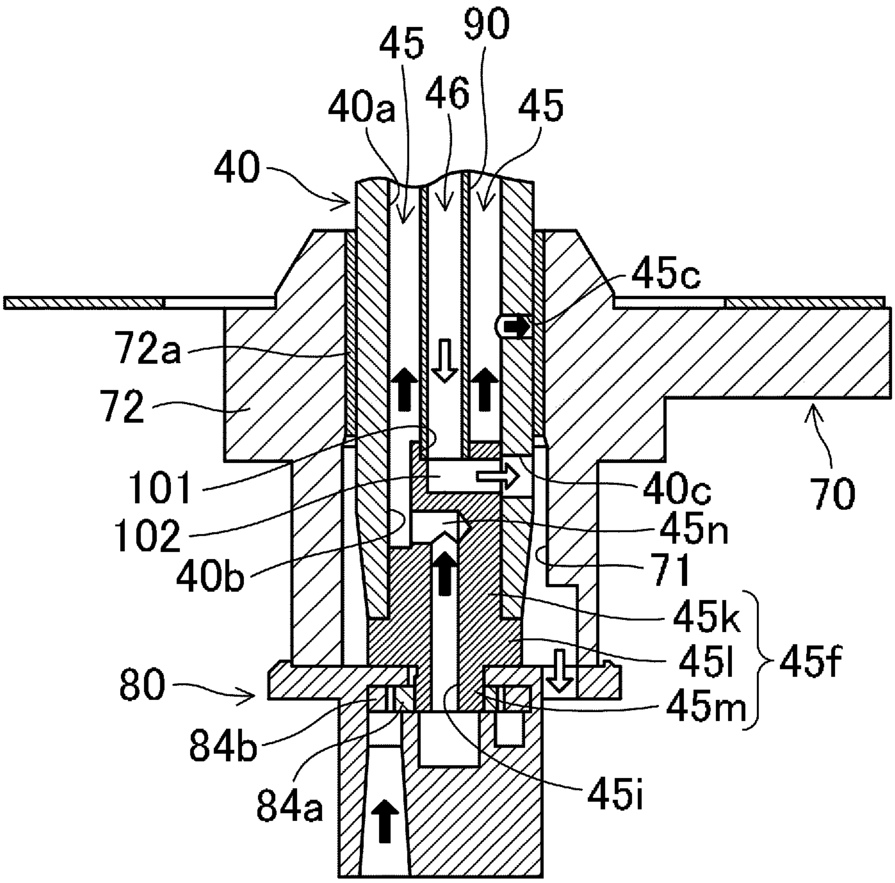
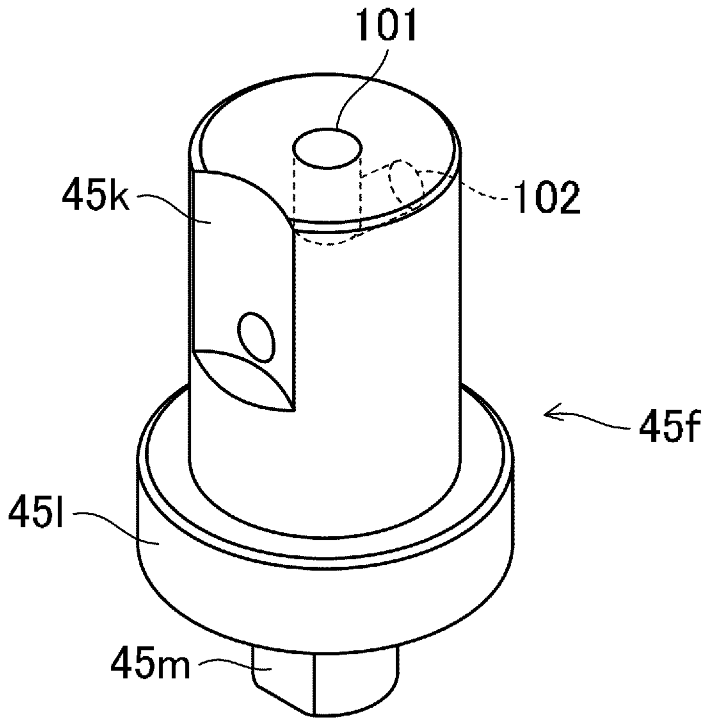

45
90
40a
46
45
40
45c
72a
72
101
40c
70
102
45n
40b
71
45k
45l
45f
80
45m
84b
45i
84a

FIG.10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/020279

A. CLASSIFICATION OF SUBJECT MATTER
F04C 18/02(2006.01)i; F04C 29/02(2006.01)i
FI: F04C18/02 311Y; F04C29/02 361A

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 4-143489 A (DAIKIN INDUSTRIES, LTD.) 18.05.1992 (1992-05-18) page 3, upper left column, line 11 to page 4, lower left column, line 17, fig. 1, 3	1-9
Y	JP 5-164079 A (TOSHIBA CORP.) 29.06.1993 (1993-06-29) paragraphs [0024]-[0046], fig. 1-2	1-9
Y	JP 2018-21493 A (DAIKIN INDUSTRIES, LTD.) 08.02.2018 (2018-02-08) paragraphs [0027]-[0079], fig. 1-7	1-9

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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
13 July 2020 (13.07.2020)	21 July 2020 (21.07.2020)

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

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/020279

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 4-143489 A	18 May 1992	(Family: none)	
JP 5-164079 A	29 Jun. 1993	(Family: none)	
JP 2018-21493 A	08 Feb. 2018	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2018021493 A **[0003]**