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

(11) **EP 3 779 200 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
18.09.2024 Bulletin 2024/38

(21) Application number: **18912376.3**

(22) Date of filing: **17.10.2018**

(51) International Patent Classification (IPC):
F04C 29/02 *(2006.01)* ***F04C 18/356*** *(2006.01)*
F04C 23/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F04C 18/3564; F04C 23/001; F04C 23/008; F04C 29/028

(86) International application number:
PCT/JP2018/038727

(87) International publication number:
WO 2019/187272 (03.10.2019 Gazette 2019/40)

(54) ROTARY COMPRESSOR

ROTATIONSVERDICHTER

COMPRESSEUR ROTATIF

(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

(30) Priority: **29.03.2018 JP 2018063470**

(43) Date of publication of application:
17.02.2021 Bulletin 2021/07

(73) Proprietor: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

(72) Inventor: **OGASAWARA Hirotsugu**
Osaka-shi, Osaka 540-6207 (JP)

(74) Representative: **Eisenführ Speiser**
Patentanwälte Rechtsanwälte PartGmbB
Postfach 31 02 60
80102 München (DE)

(56) References cited:
EP-A1- 1 462 656
EP-A2- 1 522 733
JP-A- 2004 293 330

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 3 779 200 B1

Description

Technical Field

[0001] The present invention relates to a rotary compressor, and in particular to a rotary compressor of an internal intermediate pressure multi-stage (two stages) rotary compressor comprising first and second rotary compression elements in a sealed container.

Background Art

[0002] Heretofore, for example, an internal intermediate pressure multi-stage (two stages) compression rotary compressor comprising first and second rotary compression elements has been known.

[0003] Such a rotary compressor has a configuration including, in a sealed container, a drive motor and first and second rotary compression mechanisms that are driven with this drive motor. Refrigerant gas is taken into a low pressure chamber side of a cylinder through an intake port of the first rotary compression mechanism, and compressed by an operation of a roller and a vane to obtain an intermediate pressure, and the gas is discharged from a high pressure chamber side of the cylinder through a discharge port and a discharge muffler into the sealed container. The intermediate pressure refrigerant gas in this sealed container is taken into a low pressure chamber side of the cylinder through an intake port of the second rotary compression mechanism, and subjected to second stage compression by an operation of a roller and a vane. Resulting high-temperature high-pressure refrigerant gas is discharged from the high pressure chamber side to the outside. This technology is disclosed.

[0004] In the rotary compressor in which such two-stage compression is performed, a compressed refrigerant is discharged from a second stage compression chamber directly to the outside of the rotary compressor, and hence the refrigerant and oil cannot be separated. Consequently, a mainstream lies in a mechanism on which an oil separator is externally mounted and in which oil is returned in a system circuit.

[0005] Therefore, for example, a conventional technology is disclosed in which oil separation means for reducing discharge of oil to the outside of a sealed container by centrifugal separation is used, so that the oil can be separated in the rotary compressor (e.g., see Patent Literature 1).

[0006] Patent Literature 2 relates to a so-called internal intermediate pressure multistage compression type rotary compressor making it possible to prevent the pressure inside a roller from inconveniently increasing and also to permit smooth and reliable supply of oil into a cylinder of a second rotary compressing element. A lubrication groove for providing communication between an oil bore and a low-pressure chamber in the cylinder is formed in a surface of an intermediate partitioner that is adjacent to the cylinder of the second rotary compressing element. Furthermore, a through bore for providing communication between a hermetically sealed vessel and the inside of the roller is formed in the intermediate partitioner.

[0007] Patent Literature 3 relates to a rotary compressor comprising an electric element, and first and second rotary compression elements driven by the electric element. These components are provided in a hermetically sealed container. Gas compressed by the first rotary compression element is discharged into the hermetically sealed container, and the discharged gas of intermediate pressure is further compressed by the second rotary compression element wherein cylinders constitute the respective rotary compression elements. An intermediate diaphragm is provided between the cylinders to partition each rotary compression element. A support member is adapted to seal an opening surface of each cylinder and is provided with a bearing of a rotary shaft and an oil hole formed in the rotary shaft wherein the intermediate diaphragm includes an oil supply path for communicating the oil hole with a suction side of the second rotary compression element.

Citation List

Patent Literature

[0008]

Patent Literature 1: Japanese Patent Laid-Open No. 2012-072716;
Patent Literature 2: European Patent Application No. 1 462 656;
Patent Literature 3: European Patent Application No. 1 522 733.

Summary of Invention

Technical Problem

[0009] In a technology of Patent Literature 1, however, there is a problem that performance loss due to pressure bypass is generated in a process of returning oil separated in a rotary compressor. Generally, in the rotary compressor of a two-stage compression direct discharge specification, intermediate pressure oil in a sealed container is always supplied into compression chambers for improvement of sealability in a second stage compression chamber.

[0010] Therefore, there is a problem that an amount of oil to be discharged from the second stage compression chamber definitely increases. Furthermore, there is also a situation where it is difficult to decrease an amount of oil to be supplied to the second stage compression chamber due to manufacturing process constraint such as processing accuracy.

[0011] The present invention has been developed in

view of the above described respects, and an object of the present invention is to provide a rotary compressor in which an amount of oil to be supplied through an oil supply hole can be properly adjusted with a simple configuration.

Solution to Problem

[0012] To achieve the above object, according to the present invention, provided is a rotary compressor as defined in claim 1 comprising, i.a. a sealed container, a drive motor, a first stage rotary compression mechanism and a second stage rotary compression mechanism that are rotated and driven by rotation of the drive motor, and an intermediate partition plate provided between the first stage rotary compression mechanism and the second stage rotary compression mechanism, wherein in the intermediate partition plate, an oil supply passage that extends from a center of the sealed container toward outside is provided, an oil supply hole that communicates between the oil supply passage and a second compression chamber of the second stage rotary compression mechanism is formed, and the oil supply hole is formed at a position to be opened where a second roller of the second stage rotary compression mechanism is at a position other than a compression stroke.

[0013] Consequently, the oil supply hole to be opened where the second roller is at the position other than the compression stroke is provided, and hence the oil supply hole can be held in an opened state or a closed state in accordance with a crank angle of the second roller. This makes it possible to adjust an amount of oil to be supplied through the oil supply hole.

Advantageous Effect of Invention

[0014] According to the present invention, an oil supply hole is provided to be opened where a second roller is at a position other than a compression stroke, and hence the oil supply hole can be held in an opened state or a closed state in accordance with a crank angle of the second roller. This makes it possible to adjust an amount of oil to be supplied through the oil supply hole with a simple configuration.

Brief Description of Drawings

[0015]

[Figure 1] Fig. 1 is a schematic vertical cross-sectional view showing an embodiment of a rotary compressor according to the present invention.

[Figure 2] Fig. 2 is an enlarged view of the rotary compressor of the present embodiment.

[Figure 3] Fig. 3 is a view showing an example where an oil supply hole of the present embodiment is formed at a position having a distance of 20 mm from a center of a rotary shaft and an angle of 120° from a second vane.

[Figure 4] Fig. 4 is a view showing an example where the oil supply hole of the present embodiment is formed at a position having a distance of 19.2 mm from the center of the rotary shaft and an angle of 120° from the second vane.

Description of Embodiment

[0016] According to the invention, a rotary compressor comprises, in a sealed container, a drive motor, a first stage rotary compression mechanism and a second stage rotary compression mechanism that are rotated and driven by rotation of the drive motor, and an intermediate partition plate provided between the first stage rotary compression mechanism and the second stage rotary compression mechanism, wherein in the intermediate partition plate, an oil supply passage that extends from a center of the sealed container toward outside is provided, an oil supply hole that communicates between the oil supply passage and a second compression chamber of the second stage rotary compression mechanism is formed, and the oil supply hole is formed at a position to be opened where a second roller of the second stage rotary compression mechanism is at a position other than a compression stroke.

[0017] Consequently, the oil supply hole to be opened where the second roller is at the position other than the compression stroke is provided, and hence the oil supply hole can be held in an opened state or a closed state in accordance with a crank angle of the second roller. This makes it possible to adjust an amount of oil to be supplied through the oil supply hole with a simple configuration.

[0018] In an example, the oil supply hole is provided in a range from 0° to 120° on a suction passage side from a position of a second vane of the second stage rotary compression mechanism so that the oil supply hole communicates at a crank angle of the second roller in a range from 60° to 350°.

[0019] Consequently, the oil supply hole is provided in the range from 0° to 120° on the suction passage side from the position of the second vane of the second stage rotary compression mechanism so that the oil supply hole communicates at the crank angle of the second roller in the range from 60° to 350°. Therefore, when the second roller is at the position other than the compression stroke, the oil supply hole can be opened. This makes it possible to adjust the amount of the oil to be supplied through the oil supply hole.

[0020] Hereinafter, description will be made as to an embodiment of the present invention with reference to the drawings.

[0021] Fig. 1 is a schematic vertical cross-sectional view showing the embodiment of a rotary compressor of the present invention. Fig. 2 is an enlarged view of the rotary compressor.

[0022] As shown in Fig. 1 and Fig. 2, a rotary compressor 1 comprises a vertical cylindrical sealed container 10

made of a steel plate, and a lid body 11 is attached to an upper part of the sealed container 10. In an upper part of an interior of the sealed container 10, a drive motor 20 is contained.

[0023] A terminal 12 is attached to a center of an upper surface of the lid body 11, to supply power to the drive motor 20.

[0024] The drive motor 20 comprises an annular stator 21 attached along an inner peripheral surface of an upper space of the sealed container 10, and a rotor 22 inserted and disposed inside the stator 21 with a gap. A rotary shaft 23 that extends in an axial direction of the sealed container 10 is attached to a center of the rotor 22.

[0025] The stator 21 comprises a laminate body 24 made of laminated annular electromagnetic steel plates, and a stator coil 25 wound around the laminate body 24. Furthermore, the rotor 22 comprises a laminate body 26 made of laminated electromagnetic steel plates, and a permanent magnet 27 disposed in the laminate body 26.

[0026] In a lower part of the interior of the sealed container 10, a first stage rotary compression mechanism 30 rotated and driven by the rotary shaft 23 of the drive motor 20 and a second stage rotary compression mechanism 31 located on an upper side are arranged. An intermediate partition plate 32 is disposed between the first stage rotary compression mechanism 30 and the second stage rotary compression mechanism 31.

[0027] An upper support member 33 that closes an upper surface opening of the second stage rotary compression mechanism 31 is disposed above the second stage rotary compression mechanism 31, and a lower support member 34 that closes a lower surface opening of the first stage rotary compression mechanism 30 is disposed below the first stage rotary compression mechanism 30.

[0028] The first stage rotary compression mechanism 30 comprises a first cylinder 41 including a first compression chamber 40 to compress a refrigerant therein, a first eccentric member 42 provided in the first cylinder 41, a first roller 43 fitted in the first eccentric member 42 to be eccentrically rotated, and a first vane that abuts on an outer peripheral surface of the first roller 43 to divide the first compression chamber 40 in the first cylinder 41 into a low pressure chamber side and a high pressure chamber side.

[0029] Similarly, the second stage rotary compression mechanism 31 comprises a second cylinder 51 including a second compression chamber 50 to compress the refrigerant therein, a second eccentric member 52 provided in the second cylinder 51, a second roller 53 fitted in the second eccentric member 52 to be eccentrically rotated, and a second vane 54 that abuts on an outer peripheral surface of the second roller 53 to divide the second compression chamber 50 in the second cylinder 51 into a low pressure chamber side and a high pressure chamber side.

[0030] In the upper support member 33 and the lower support member 34, a suction passage (not shown) that communicates with interiors of the second cylinder 51 and first cylinder 41 in an unshown suction port is provided, and an upper cover 35 and a lower cover 36 are provided on an upper surface of the upper support member 33 and a lower surface of the lower support member 34, respectively. In the lower surface of the lower support member 34, an intermediate pressure first stage discharge muffler 37, partially formed in a recess shape, is provided. Furthermore, in the upper surface of the upper support member 33, a high pressure second stage discharge muffler 38, partially formed in a recess shape, is provided.

[0031] Furthermore, in the second stage rotary compression mechanism 31, a suction passage 60 is provided to communicate from the second compression chamber 50 to the interior of the sealed container 10.

[0032] Additionally, in the intermediate partition plate 32, an oil supply passage 61 is formed to extend from a center of the sealed container 10 toward outside, and intermediate pressure oil is supplied to the oil supply passage 61. In the oil supply passage 61, an oil supply hole 62 is formed to be opened in the second compression chamber 50 of the second stage rotary compression mechanism 31.

[0033] The oil supply hole 62 is formed at a position to be opened where the second roller 53 is at a position other than a compression stroke. Specifically, as an example that does not fall under the scope of the claim, when a position of the second vane 54 is set to 0° so that the oil supply hole communicates at a crank angle of the second roller 53 in a range from 60° to 350°, the oil supply hole 62 is provided in a range from 10° to 120° on a suction passage 60 side from the second vane 54. Furthermore, a distance of the oil supply hole 62 from a center of the rotary shaft 23 is also appropriately set.

[0034] Here, the oil supply hole 62 is formed at the position to be opened where the second roller 53 is at the position other than the compression stroke, because there is concern that the oil flows backward due to pressure of compression, if the oil supply hole 62 opens where the second roller 53 is at a position of the compression stroke.

[0035] Thus, the angle of the oil supply hole 62 from the second vane 54 and the distance of the hole from the center of the rotary shaft 23 are set, so that even in a case where an eccentric amount of the second roller 53 varies, it is possible to set a period in which the oil supply hole 62 is opened while the second roller 53 rotates once.

[0036] Note that in the present example, the oil supply hole 62 is provided in the range from 10° to 120° on the suction passage 60 side from the second vane 54, but this is not restrictive. That is, the oil supply hole is provided from 10° on the suction passage 60 side from the second vane 54, because in consideration of a width dimension of the second vane 54, the oil supply hole 62 cannot be formed at a position that overlaps with the second vane 54. Consequently, the position of the oil supply hole 62 may be set to a range from 0° to 10° in accordance with the width dimension of the second vane 54.

[0037] Fig. 3 is a view showing an example where the oil supply hole 62 is formed at a position having a distance of 20 mm from the center of the rotary shaft 23 and an angle of 120° from the second vane 54. Fig. 4 is a view showing an example where the oil supply hole 62 is formed at a position having a distance of 19.2 mm from the center of the rotary shaft 23 and an angle of 120° from the second vane 54.

[0038] As shown in Fig. 3, in a case where the oil supply hole 62 is formed at the position having the distance of 20 mm from the center of the rotary shaft 23 and the angle of 120° from the second vane 54 and in a case where the crank angle of the second roller 53 is 0°, the oil supply hole 62 is closed. Even if the second roller 53 rotates to the crank angle of 180°, the oil supply hole 62 is closed.

[0039] Then, when the crank angle of the second roller 53 reaches 245°, the oil supply hole 62 starts opening, and when the crank angle of the second roller 53 is 350°, the oil supply hole 62 finishes opening.

[0040] Furthermore, as shown in Fig. 4, in a case where the oil supply hole 62 is formed at the position having the distance of 19.2 mm from the center of the rotary shaft 23 and the angle of 120° from the second vane 54 and in a case where the crank angle of the second roller 53 is 0°, the oil supply hole 62 is closed. Even when the second roller 53 rotates to the crank angle of 180°, the oil supply hole 62 is closed, and when the crank angle of the second roller 53 is 285°, the oil supply hole 62 starts opening. Then, when the crank angle of the second roller 53 is 320°, the oil supply hole 62 finishes opening.

[0041] Next, an operation of the present embodiment will be described.

[0042] Upon driving of the drive motor 20, the rotor 22 is rotated, and the rotary shaft 23 is rotated and driven, so that the first roller 43 and the second roller 53 are eccentrically rotated.

[0043] Consequently, low pressure refrigerant gas taken into the first cylinder 41 is compressed by an operation of the first roller 43 and the first vane to obtain an intermediate pressure, and is discharged from the first cylinder 41 into the sealed container 10. In consequence, the gas obtains the intermediate pressure in the sealed container 10.

[0044] Then, the intermediate pressure refrigerant gas in the sealed container 10 is taken into the second cylinder 51, the taken intermediate pressure refrigerant gas is subjected to second stage compression by an operation of the second roller 53 and the second vane 54, and the resulting high-temperature high-pressure refrigerant gas is discharged.

[0045] At this time, the oil mixed in the refrigerant gas flows into the oil supply passage 61 of the intermediate partition plate 32, and flows through the oil supply hole 62 into the second cylinder 51.

[0046] As described above, the oil supply hole 62 is held in the opened state or a closed state in accordance with the crank angle of the second roller 53. Consequently, the oil supply hole 62 is not always opened, and hence an amount of oil to be supplied through the oil supply hole 62 can be properly adjusted.

[0047] As described above, in the present embodiment, the rotary compressor comprises, in the sealed container 10, the drive motor 20, the first stage rotary compression mechanism 30 and the second stage rotary compression mechanism 31 that are rotated and driven by rotation of the drive motor 20, and the intermediate partition plate 32 provided between the first stage rotary compression mechanism 30 and the second stage rotary compression mechanism 31, wherein in the intermediate partition plate 32, the oil supply passage 61 that extends from the center of the sealed container 10 toward outside is provided, the oil supply hole 62 that communicates between the oil supply passage 61 and the second compression chamber 50 of the second stage rotary compression mechanism 31 is formed, and the oil supply hole 62 is formed at the position to be opened where the second roller 53 of the second stage rotary compression mechanism 31 is at the position other than the compression stroke.

[0048] Consequently, the oil supply hole 62 to be opened where the second roller 53 is at the position other than the compression stroke is provided, and hence the oil supply hole 62 can be held in the opened state or the closed state in accordance with the crank angle of the second roller 53. This makes it possible to adjust the amount of the oil to be supplied through the oil supply hole 62.

[0049] Furthermore, in an example, the oil supply hole 62 is provided in a range from 0° to 120° on a suction passage 60 side from a position of the second vane 54 of the second stage rotary compression mechanism 31 so that the oil supply hole communicates at the crank angle of the second roller 53 in a range from 60° to 350°.

[0050] Consequently, the oil supply hole 62 is provided in the range from 0° to 120° on the suction passage 60 side from the position of the second vane 54 of the second stage rotary compression mechanism 31 so that the oil supply hole communicates at the crank angle of the second roller 53 in the range from 60° to 350°. Therefore, when the second roller 53 is at the position other than the compression stroke, the oil supply hole 62 can be opened. This makes it possible to adjust the amount of the oil to be supplied through the oil supply hole 62.

[0051] Note that the embodiment of the present invention has been described with reference to the drawings, but the present invention is not limited to the above embodiment, and can be modified without departing from the scope of the invention.

Industrial Applicability

[0052] As described above, according to the present invention, an oil supply hole can be held in an opened state or a closed state in accordance with a crank angle of a second roller, and an amount of oil to be supplied

through the oil supply hole can be adjusted with a simple configuration. Consequently, the invention is suitable as a rotary compressor.

Reference Signs List

[0053]

1	rotary compressor
10	sealed container
20	drive motor
23	rotary shaft
30	first stage rotary compression mechanism
31	second stage rotary compression mechanism
32	intermediate partition plate
40	first compression chamber
41	first cylinder
42	first eccentric member
43	first roller
50	second compression chamber
51	second cylinder
52	second eccentric member
53	second roller
54	second vane
60	suction passage
61	oil supply passage
62	oil supply hole

Claims

1. A rotary compressor comprising

a sealed container (10),
a drive motor (20),
a first stage rotary compression mechanism (30) having a first roller (43) and a first vane (44), and a second stage rotary compression mechanism (31) having a second roller (53) and a second vane (54), that are rotated and driven by rotation of the drive motor, and
an intermediate partition plate (32) provided between the first stage rotary compression mechanism and the second stage rotary compression mechanism,
wherein in the intermediate partition plate, an oil supply (61) passage that extends from a center of the sealed container toward outside is provided, an oil supply hole (62) that communicates between the oil supply passage and a second compression chamber (50) of the second stage rotary compression mechanism is formed,
the oil supply hole (62) is formed at a position to be opened where the second roller (53) of the second stage rotary compression mechanism (31) is at a position other than a compression stroke,
characterized in that
the oil supply hole (62) is provided at a position of 120° on a suction passage side from a position of the second vane (54) of the second stage rotary compression mechanism (31) so that the oil supply hole (62) communicates at a crank angle of the second roller (53) in a range from 245° to 350°.

Patentansprüche

1. Rotationsverdichter, umfassend

einen abgedichteten Behälter (10),
einen Antriebsmotor (20),
einen Rotationsverdichtungsmechanismus der ersten Stufe (30) mit einer ersten Walze (43) und einem ersten Schieber (44), und
einen Rotationsverdichtungsmechanismus der zweiten Stufe (31) mit einer zweiten Walze (53) und einem zweiten Schieber (54), die durch Drehung des Antriebsmotors gedreht und angetrieben werden, und
eine Zwischenunterteilungsplatte (32), die zwischen dem Rotationsverdichtungsmechanismus der ersten Stufe und dem Rotationsverdichtungsmechanismus der zweiten Stufe vorgesehen ist,
wobei in der Zwischenunterteilungsplatte ein Ölzuführkanal (61), der von einer Mitte des abgedichteten Behälters nach außen verläuft, vorgesehen ist, eine Ölzuführbohrung (62) ausgebildet ist, die eine Verbindung zwischen dem Ölzuführkanal und einer zweiten Verdichtungskammer (50) des Rotationsverdichtungsmechanismus der zweiten Stufe herstellt,
die Ölzuführbohrung (62) an einer zu öffnenden Stelle ausgebildet ist, wo sich die zweite Walze (53) des Rotationsverdichtungsmechanismus der zweiten Stufe (31) an einer anderen Position als einem Verdichtungshub befindet,
dadurch gekennzeichnet, dass
die Ölzuführbohrung (62) an einer Position von 120° auf einer Saugkanalseite von einer Position des zweiten Trennschiebers (54) des Rotationsverdichtungsmechanismus der zweiten Stufe (31) vorgesehen ist, sodass die Ölzuführbohrung (62) bei einem Kurbelwinkel der zweiten Walze (53) im Bereich von 245° bis 350° eine Verbindung herstellt.

Revendications

1. Compresseur rotatif comprenant

un récipient étanche (10),
un moteur d'entraînement (20),

un mécanisme de compression rotatif de premier étage (30) présentant un premier rouleau (43) et une première aube (44) et
un mécanisme de compression rotatif de second étage (31) présentant un second rouleau (53) et une seconde aube (54), qui sont mis en rotation et entraînés par la rotation du moteur d'entraînement et
une plaque de séparation intermédiaire (32) disposée entre le mécanisme de compression rotatif de premier étage et le mécanisme de compression rotatif de second étage,
un passage d'alimentation en huile (61) qui s'étend à partir d'un centre du récipient étanche vers l'extérieur étant disposé dans la plaque de séparation intermédiaire, un trou d'alimentation en huile (62) qui communique entre le passage d'alimentation en huile et une seconde chambre de compression (50) du mécanisme de compression rotatif de second étage étant formé,
le trou d'alimentation en huile (62) étant formé en une position à ouvrir où le second rouleau (53) du mécanisme de compression rotatif de second étage (31) est en une position autre qu'une course de compression,
caractérisé en ce que
le trou d'alimentation en huile (62) est disposé en une position de 120° sur un côté de passage d'aspiration à partir d'une position de la seconde aube (54) du mécanisme de compression rotatif de second étage (31) de telle sorte que le trou d'alimentation en huile (62) communique à un angle de manivelle du second rouleau (53) dans une plage de 245° à 350°.

FIG.1

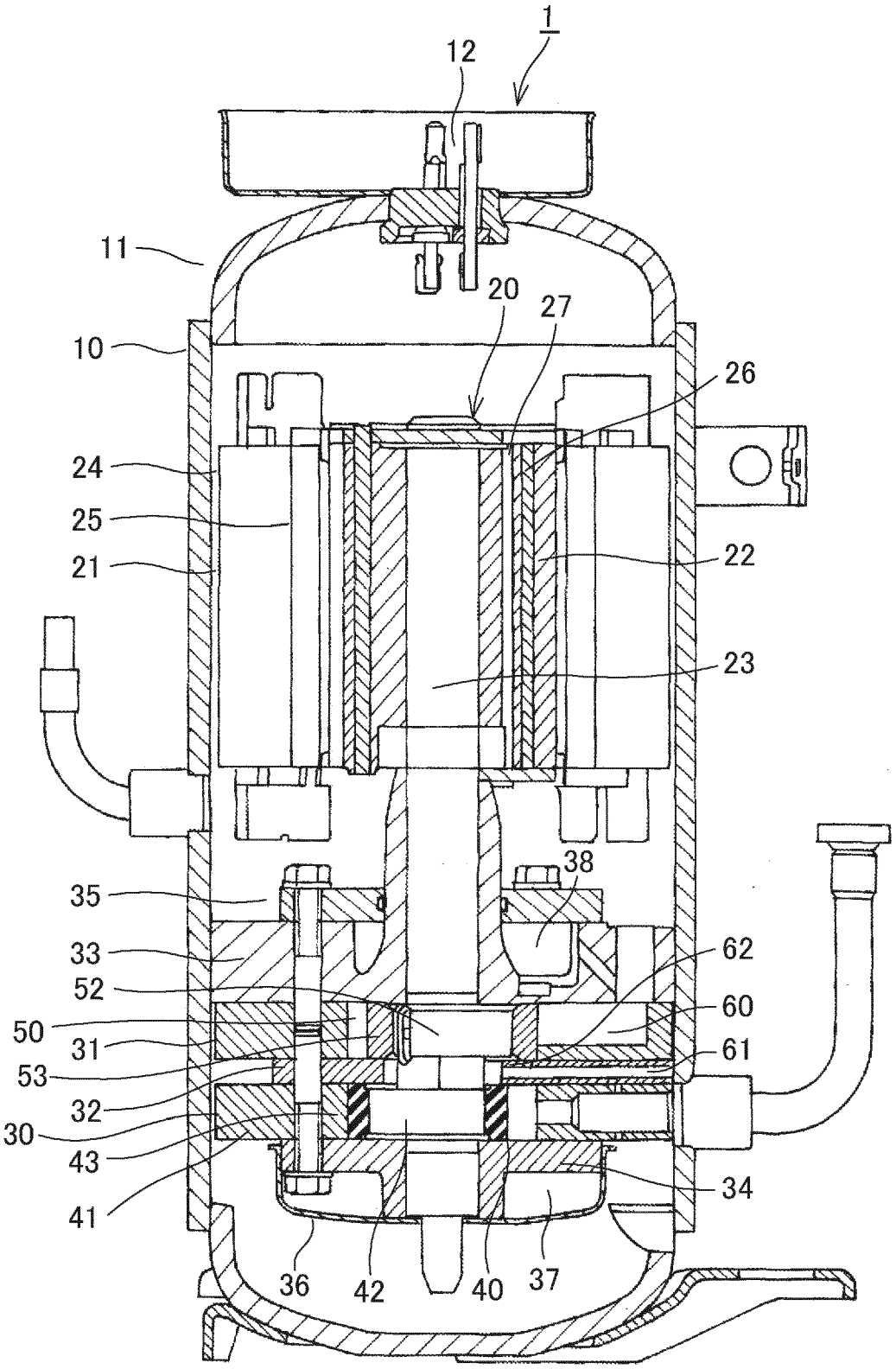

1
12
11
20
27
10
26
24
25
21
22
23
38
35
33
62
52
60
50
31
61
53
32
30
43
34
41
36
42
40
37

FIG.2

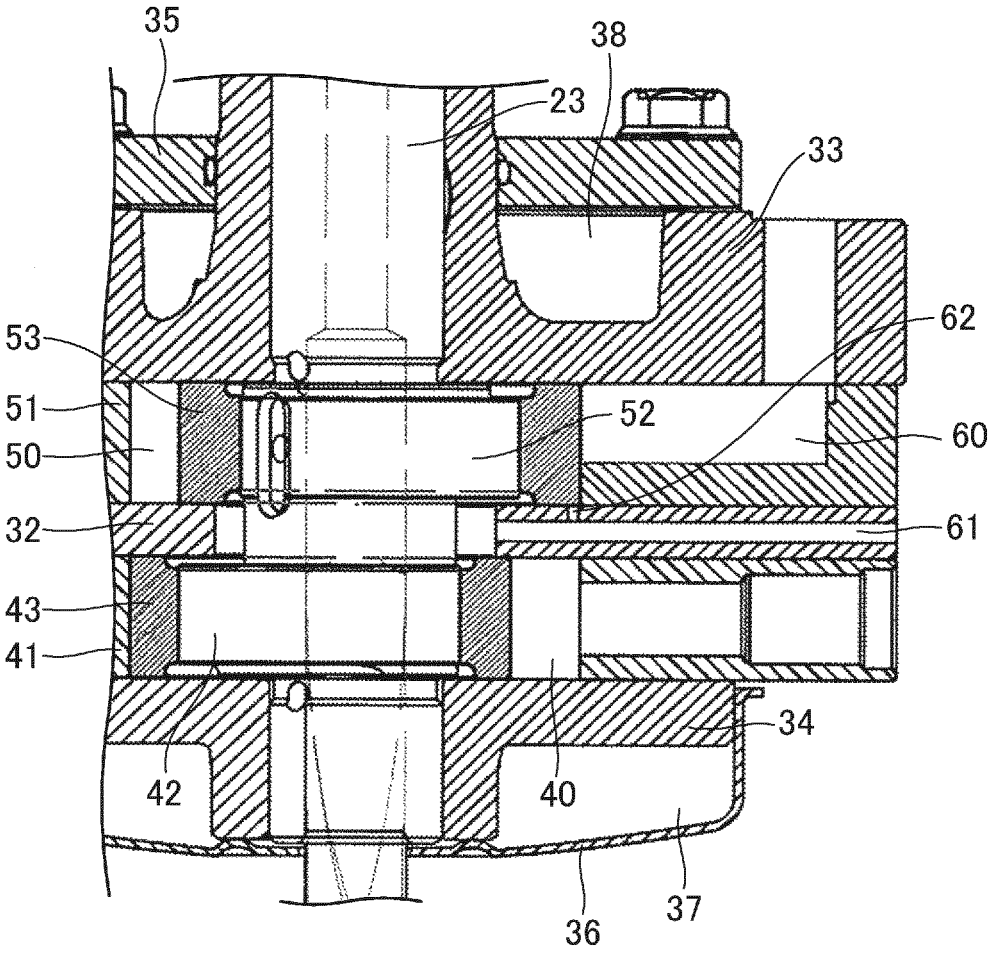
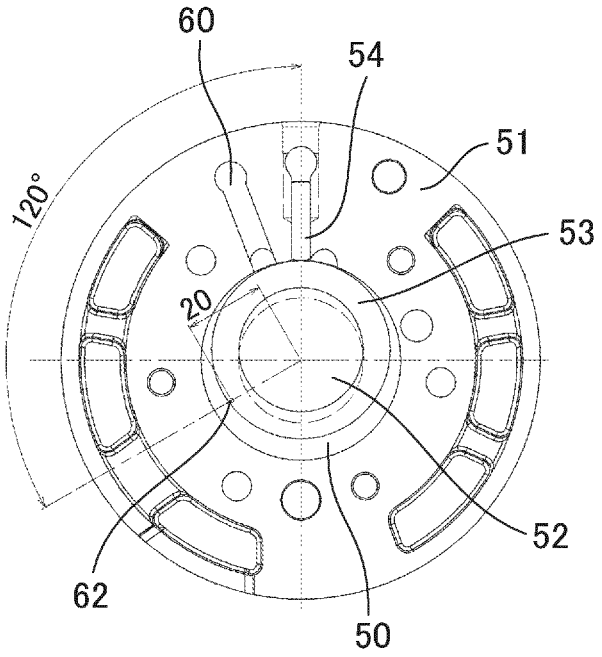
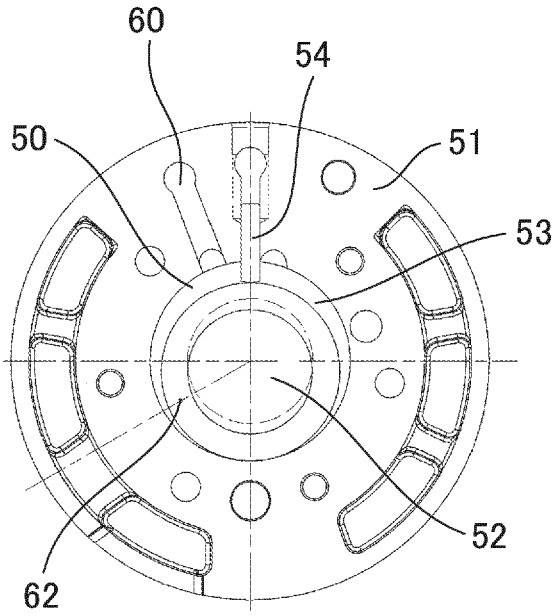


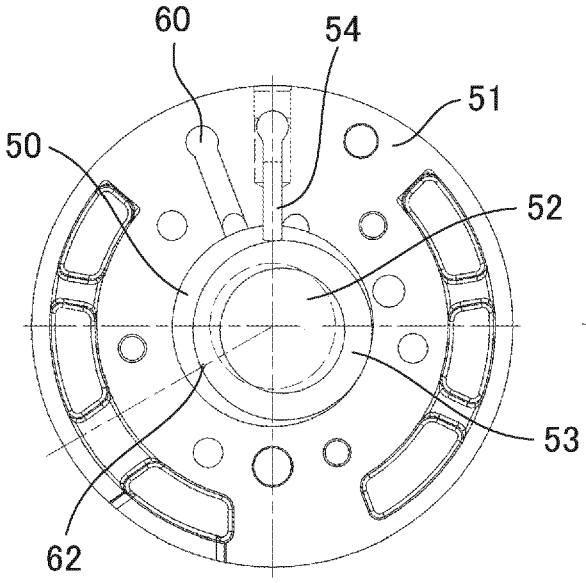
FIG.3



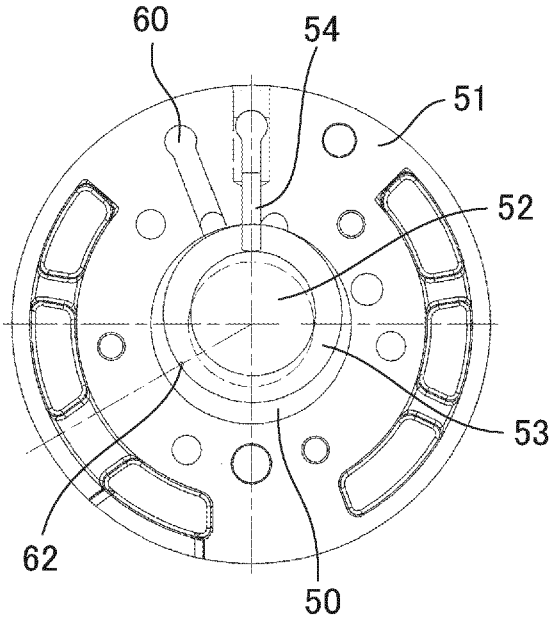
CRANK ANGLE 0 deg (BEING CLOSED)



CRANK ANGLE 180 deg (BEING CLOSED)

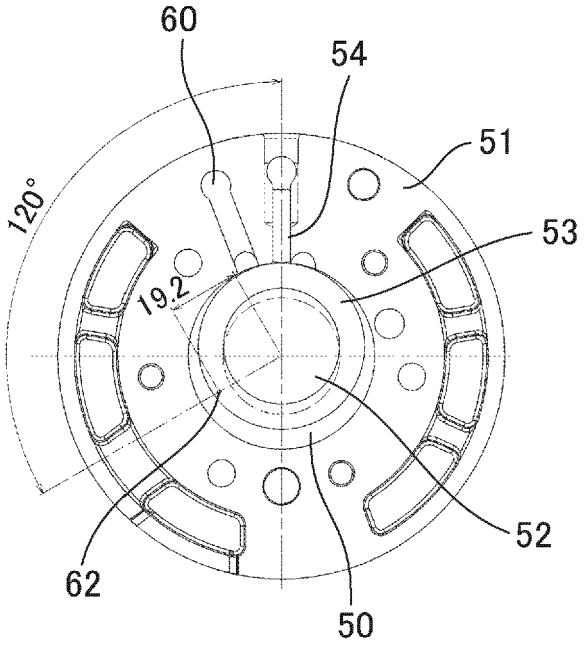


CRANK ANGLE 245 deg (START OPENING)

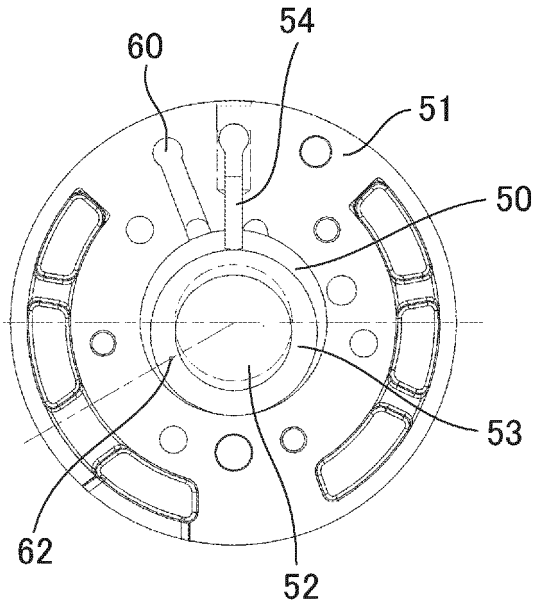


CRANK ANGLE 350 deg (FINISH OPENING)

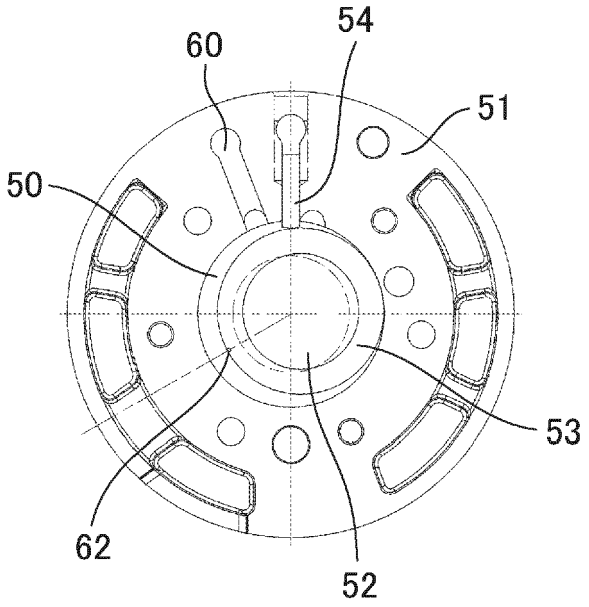
FIG.4



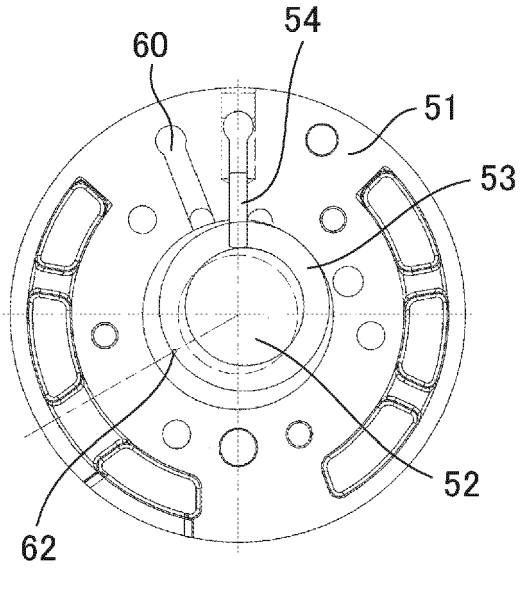
CRANK ANGLE 0 deg (BEING CLOSED)



CRANK ANGLE 180 deg (BEING CLOSED)



CRANK ANGLE 285 deg (START OPENING)



CRANK ANGLE 320 deg (FINISH OPENING)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2012072716 A **[0008]**
- EP 1462656 A **[0008]**
- EP 1522733 A **[0008]**