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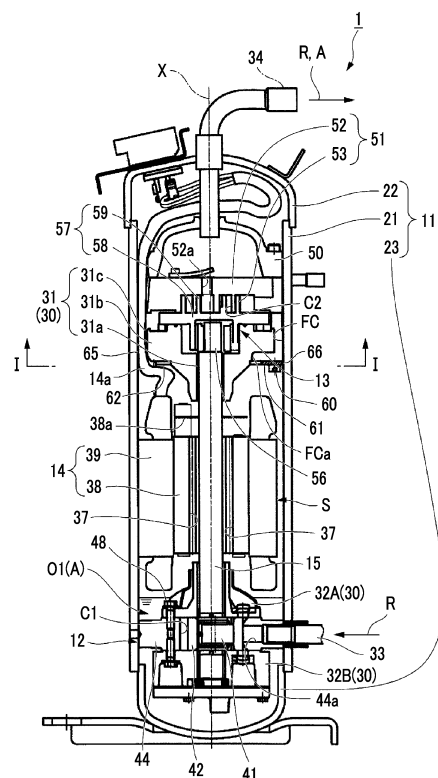
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(54) **HERMETIC TWO-STAGE COMPRESSOR**

(57) A hermetic two-stage compressor is equipped with a scroll compressor (13) that further compresses a refrigerant (R) discharged from a rotary compressor (12), and is arranged above an upper bearing (31) having a bearing (31a) supporting a rotary shaft (15) in the upper part inside a housing (11) in the interior of which is an oil storage (01), and a bearing casing (31b) supporting the bearing (31a) in the housing (11). The bearing casing (31b) is provided with: inflow channels (FC), which are equipped with intake openings (FCa) that are provided so as to draw the refrigerant (R) into the scroll compressor (13), and that open downward; and a restricting surface (62), which is arranged between the intake openings (FCa) and an electric motor (14), and is provided from the inner surface of the housing (11) toward the inside in the radial direction, so as to restrict the flow of the refrigerant (R) to the intake openings (FCa) on the outside in the radial direction.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a hermetic two-stage compressor.

[0002] Priority is claimed on Japanese Patent Application No. 2016-081000, filed April 14, 2016, the content of which is incorporated herein by reference.

Background Art

[0003] In the related art, for example, a hermetic two-stage compressor is known, which is used for refrigeration air conditioning and includes a low stage-side compression section and a high stage-side compression section which are sealed in a housing. In addition, an example of the hermetic two-stage compressor is disclosed in PTL 1.

[0004] In the hermetic two-stage compressor of PTL 1, a rotary compressor is disposed as a low stage-side compression section, a scroll compressor is disposed as a high stage-side compression section, a gas supplied into a housing is compressed by the rotary compressor, and thereafter, the gas is further compressed by the scroll compressor to be discharged from the housing. The hermetic two-stage compressor is operated in a state where a lubricating oil of the low stage-side compression section and the high stage-side compression section is held in the housing.

[0005] Here, in the hermetic two-stage compressor disclosed in PTL 1, a bearing bracket is provided in a divided portion of an upper and lower split type housing, and an oil circulation amount (OC%) in a refrigerating cycle is reduced by allowing the gas in a central region where an oil content is small to flow into the scroll compressor while preventing the gas in an outer peripheral region inside the housing containing a lot of oil from flowing into the scroll compressor.

Citation List

Patent Literature

[0006] [PTL 1] Japanese Unexamined Patent Application Publication No. 2009-180107

Summary of Invention

Technical Problem

[0007] However, in the bearing bracket of PTL 1, in a case where a member for decreasing the oil circulation amount (OC%) in the refrigerating cycle is provided in the housing by welding, there is a possibility that strain occurs in the housing. Accordingly, it is difficult to accurately manufacture the hermetic two-stage compressor, and it takes time and labor to manufacture. In addition,

the bearing bracket of the hermetic two-stage compressor of PTL 1 receives a load from a bearing case, and thus, it is necessary to increase a thickness so as to secure strength. As a result, an internal volume of the housing decreases, which is disadvantageous when oil is separated from the gas.

[0008] Accordingly, the present invention is to provide a hermetic two-stage compressor capable of being easily manufactured and effectively separating oil from a gas.

Solution to Problem

[0009] According to a first aspect of the present invention, there is provided a hermetic two-stage compressor including: a housing which includes an oil storage inside the housing; a rotary shaft which is disposed in the housing; a motor which is disposed in the housing so as to rotate the rotary shaft and includes a stator which is provided on a radially outer side and a rotor which is provided on a radially inner side; a low stage-side compression section which is disposed on one side (a first end side) in an axial direction of the rotary shaft with respect to the motor in the housing and is connected to the rotary shaft so as to compress a gas; a bearing device which is disposed on the other side (a second end side) in the axial direction with respect to the motor in the housing and includes a bearing which supports the rotary shaft and a bearing casing which supports the bearing to the housing; and a high stage-side compression section which is disposed on the other side (the second end side) in the axial direction with respect to the bearing device and further compresses the gas discharged from the low stage-side compression section, in which the bearing casing includes a suction channel which is provided to suck the gas into the high stage-side compression section and includes a suction opening which is open to the one side (first end side) in the axial direction, and a restricting surface which is disposed between the suction opening and the motor and is provided toward the radially inner side from an inner surface of the housing so as to restrict a flow of the gas to the suction opening on the radially outer side.

[0010] In the hermetic two-stage compressor, the oil of the oil storage and the gas are compressed in the low stage-side compression section. Accordingly, the oil is contained in the gas which is discharged from the low stage-side compression section. A portion of the gas containing the oil flows out toward the motor, and thereafter, flows to the high stage-side compression section through the gap between the stator and the rotor or a through-hole provided in the rotor. In addition, when the gas passes through the motor, the oil in the gas comes into contact with the rotor or an oil separation plate provided above the rotor, and thus, a content of the oil in the gas decreases. Meanwhile, the gas which has passed through a portion between the stator and the housing does not come into contact with the rotor and flows toward the high stage-side compression section as it is. Accordingly, the gas flows toward the high stage-side compression section in a state where the content of the oil in the gas is

high. That is, the amount of the oil in the gas discharged from the low stage-side compression section decreases on the radially inner side of the housing and increases on the radially outer side thereof.

[0011] Here, in the present aspect, according to a simple method in which the restricting surface is provided in the bearing casing, the flow of the gas to the suction opening on the radially outer side can be restricted. Therefore, it is possible to prevent the gas having a high content of oil on the radially outer side flows into the suction channel through suction opening as it is, and the gas on the radially inner side having a low content of oil can flow into the suction channel through the suction opening. As a result, it is possible to supply the gas having a low content of oil to the high stage-side compression section, and it is possible to decrease the amount of the oil in the gas which is compressed by the high stage-side compression section and is discharged therefrom. Therefore, it is possible to decrease an oil circulation amount (OC%) in a system including the hermetic two-stage compressor.

[0012] In addition, if the gas on the radially outer side comes into contact with the restricting surface, the oil in the gas is attached to the restricting surface, and the gas in which the content of the oil has decreased is guided to the radially inner side by the restricting surface and flows from the suction opening into the suction channel. Accordingly, in a state where the amount of the oil in the gas is decreased by the restricting surface, the gas is supplied from the suction channel to the high stage-side compression section, and thus, it is possible to decrease the amount of the oil in the gas which is compressed by the high stage-side compression section and is discharged therefrom, and it is possible to decrease the oil circulation amount (OC%) in the system.

[0013] Moreover, in the first aspect, the hermetic two-stage compressor according to a second aspect of the present invention may further include an inflow restricting plate which is fixed to the bearing casing, is formed in a plate shape, and includes the restricting surface on the one side (first end side) of the axial direction.

[0014] In this way, the inflow restricting plate is provided in the bearing casing, and thus, it is possible to provide the restricting surface in the bearing casing. Therefore, compared to a case where a member corresponding to the inflow restricting plate is attached to the housing so as to provide the restricting surface, it is possible to very easily provide the restricting surface in the bearing casing. In addition, it is possible to easily provide the restricting surface in the existing bearing casing.

[0015] Moreover, in the hermetic two-stage compressor according to a third aspect of the present invention, in the first or second aspect, the restricting surface may include a flat surface which is provided on an end portion on the radially outer side which is an inner surface side of the housing and is perpendicular to the axis to be formed in an annular shape about the axis and an inclined surface which is inclined toward the one side (first end

side) in the axial direction from the flat surface toward the radially inner side so as to be formed in a truncated conical shape about the axis.

[0016] In this way, the inclined surface which is formed in a truncated conical shape is provided as the restricting surface, and thus, it is possible to form the opening portion which is formed in an annular shape about the axis so as to extend from the suction opening to the one side (first end side) in the axial direction. Accordingly, the opening portion extending from the suction opening can be formed in an annular shape, and thus, an opening area can be secured, and it is possible to secure a flow rate of the gas flowing from the inside of the housing into the suction channel. In addition, the gas having a high content of oil in the radially outer side region flows to the radially inner side along the flat surface of the restricting surface, and thereafter, collides with the inclined surface, and thus, the oil can be attached to the inclined surface. Accordingly, the gas flows into the suction channel in a state where the content of the oil in the gas further decreases, and thus, it is possible to decrease the amount of the oil in the gas supplied to the high stage-side compression section, and it is possible to decrease the amount of the oil in the gas which is compressed by the high stage-side compression section and is discharged therefrom. Accordingly, it is possible to further decrease the oil circulation amount (OC%) in the system.

[0017] Moreover, in the hermetic two-stage compressor according to a fourth aspect of the present invention, in any one of the first to third aspects, an inner edge portion on the radially inner side of the restricting surface may be disposed at a position on the radially inner side of the stator, and the restricting surface may close a portion of the suction opening so as to secure an intake amount of the gas required in the high stage-side compression section.

[0018] In this way, the inner edge portion of the restricting surface is positioned on the radially inner side from the stator, and thus, the restricting surface extends to the position of the rotor. Accordingly, the gas which comes into contact with the rotor so as to sufficiently decrease the amount of the oil can flow from the suction opening into the suction channel. Therefore, it is possible to further decrease the amount of the oil in the gas which is compressed by the high stage-side compression section and is discharged therefrom, and it is possible to further decrease the oil circulation amount (OC%) in the system. Moreover, at this case, it is possible to secure an intake amount of the gas required in the high stage-side compression section, and it is possible to prevent compression efficiency in the high stage-side compression section from decreasing.

[0019] In addition, in any one of the first to fourth aspects, the hermetic two-stage compressor according to a fifth aspect of the present invention may further include a seal member which is provided in a gap between an outer edge portion on the radially outer side of the restricting surface and the inner surface of the housing.

[0020] The gas having a high content of oil which has passed through a portion between the housing and the stator in the radially outer side region in the housing can be prevented from flowing from the portion between the restricting surface and the housing into the high stage-side compression section as it is, by the seal member. Accordingly, it is possible to further decrease the amount of the oil in the gas which is compressed by the high stage-side compression section and is discharged therefrom, and it is possible to further decrease the oil circulation amount (OC%) in the system.

[0021] In addition, in any one of the first to fifth aspects, the hermetic two-stage compressor according to a sixth aspect of the present invention may further include an oil return section which is provided at a position of an end portion on the radially outer side in the bearing casing and causes the high stage-side compression section and the one side (first end side) in the axial direction from the bearing casing in the housing to communicate with each other such that oil from the high stage-side compression section can flow through the oil return section.

[0022] The oil return section is provided, and thus, the oil used for lubricating in the high stage-side compression section is returned into the housing through the oil return section. Accordingly, it is possible to further decrease the amount of the oil in the gas which is compressed by the high stage-side compression section and is discharged therefrom, and it is possible to further decrease the oil circulation amount (OC%) in the system.

[0023] In addition, the oil return section is provided on the end portion on the radially outer side of the bearing casing, and thus, the oil return section is provided at a position separated from the suction opening which is open to the radially inner side. Therefore, the oil which is returned from the oil return section to the housing can be prevented from flowing from the suction opening into the suction channel as it is. Accordingly, it is possible to further decrease the amount of the oil in the gas which is compressed by the high stage-side compression section and is discharged therefrom, and it is possible to further decrease the oil circulation amount (OC%) in the system.

[0024] Moreover, in the hermetic two-stage compressor according to a seventh aspect of the present invention, in any one of the first to sixth aspects, an accommodation portion which extends in the axial direction and through which a wire of the motor can be inserted may be provided in the bearing casing, and the hermetic two-stage compressor may further include a seal member which is provided in a gap between the restricting surface and the wire of the motor.

[0025] Even when the accommodation portion into which the wire of the motor is inserted is formed in the bearing casing, the gap between the restricting surface and the wire of the motor can be sealed by the seal member. Accordingly, it is possible to prevent the gas containing the oil from being supplied to the high stage-side compression section through the gap as it is.

Advantageous Effects of Invention

[0026] According to the hermetic two-stage compressor, the method of providing the restricting surface in the bearing casing is used, and thus, it is possible to easily manufacture the hermetic two-stage compressor, and it is possible to effectively separate the oil in the gas by the restricting surface.

Brief Description of Drawings

[0027]

Fig. 1 is a longitudinal sectional view showing a hermetic two-stage compressor according to a first embodiment of the present invention.

Fig. 2 shows the hermetic two-stage compressor according to the first embodiment of the present invention and is a longitudinal sectional view at a sectional position from the sectional position of Fig. 1 in a circumferential direction.

Fig. 3 is a view showing a bearing casing and an inflow restricting plate of the hermetic two-stage compressor according to the first embodiment of the present invention and shows a cross section taken along line I-I of Fig. 1.

Fig. 4 is a longitudinal sectional view showing a hermetic two-stage compressor according to a second embodiment of the present invention.

Fig. 5 is a view showing a bearing casing and an inflow restricting plate of the hermetic two-stage compressor according to the second embodiment of the present invention and shows a cross section taken along line IV-IV of Fig. 4.

Fig. 6 is a view showing a bearing casing and an inflow restricting plate of a hermetic two-stage compressor according to a modification example of the embodiment of the present invention.

Description of Embodiments

[First Embodiment]

[0028] Hereinafter, a hermetic two-stage compressor 1 (hereinafter, referred to as a two-stage compressor 1) according to a first embodiment of the present invention will be described.

[0029] As shown in Figs. 1 and 2, for example, the two-stage compressor 1 compresses a refrigerant R which is a gas such as carbon dioxide. The two-stage compressor 1 includes a housing 11, a rotary compressor (low stage-side compression section) 12, a scroll compressor (high stage-side compression section) 13, an electric motor 14, a rotary shaft 15, and a bearing device 30 which are provided inside the housing 11, and an inflow restricting plate 61 which is fixed to the bearing device 30.

[0030] The housing 11 includes a main body portion 21 which is formed in a cylindrical shape, and an upper

cover portion 22 and a lower cover portion 23 which close an upper opening and a lower opening of the main body portion 21. In addition, a space inside the housing 11 is sealed.

[0031] The rotary shaft 15 is disposed to extend vertically inside the housing 11.

[0032] The electric motor 14 is disposed on an outer peripheral side of the rotary shaft 15 and rotates the rotary shaft 15 around an axis X. That is, the electric motor 14 includes a rotor 38 which is fixed to an outer peripheral surface of the rotary shaft 15, and a stator 39 which radially faces the rotor 38 with a gap between the stator 39 and the outer peripheral surface of the rotor 38 and is fixed to an inner surface of the main body portion 21 of the housing 11.

[0033] The electric motor 14 is connected to a power source (not shown) via a wire 14a and rotates the rotary shaft 15 by power from the power source. A portion of the stator 39 in a circumferential direction is fixed to the inner surface of the housing 11, and in portions other than the portion fixed to the inner surface of the housing 11, the inner surface of the housing 11 and the stator 39 are disposed with a gap S in a radial direction.

[0034] The rotary compressor 12 is disposed at a position adjacent to the lower cover portion 23 at a lower portion which is one in a direction of the axis X of the electric motor 14 inside the housing 11. The rotary compressor 12 includes an eccentric shaft portion 41 which is provided on the rotary shaft 15, a piston rotor 42 which is fixed to the eccentric shaft portion 41 and is eccentrically rotated about the axis X according to a rotation of the rotary shaft 15, and a cylinder 44 which includes a compression chamber C1 accommodating the piston rotor 42 is formed inside the cylinder 44.

[0035] A suction hole 44a through which the refrigerant R can flow into the cylinder 44 is formed in the cylinder 44. A suction pipe 33 which is provided to penetrate the main body portion 21 of the housing 11 is connected to the suction hole 44a and the refrigerant R is supplied through the suction pipe 33 from the outside of the housing 11. In addition, a discharge hole (not shown) is formed in the cylinder 44, and the refrigerant R compressed by the rotary compressor 12 is discharged from the discharge hole to a region in the housing 11 in which the electric motor 14 is provided.

[0036] In addition, oil A is stored in the bottom portion of the housing 11 and an oil storage 01 is provided in the bottom portion. When the oil A is initially sealed, a liquid surface of the oil storage 01 is positioned above the rotary compressor 12. Accordingly, the rotary compressor 12 is driven in the oil storage 01.

[0037] The scroll compressor 13 is disposed above the electric motor 14 inside the housing 11. The scroll compressor 13 includes a fixed scroll 51 which is fixed to an upper bearing 31 and an orbiting scroll 57 which is disposed to face the fixed scroll 51 below the fixed scroll 51.

[0038] The fixed scroll 51 includes an end plate 52 which is fixed to an upper surface of the upper bearing

31 and a fixed lap 53 which protrudes downward from the end plate 52. A discharge hole 52a which vertically penetrates the end plate 52 is formed at a center portion (in the vicinity of the axis X) of the end plate 52.

[0039] The orbiting scroll 57 includes an end plate 58 which is disposed to be interposed between the bearing device 30 (upper bearing 31 described below) and the end plate 52 of the fixed scroll 51 in the direction of the axis X and is fixed to the rotary shaft 15, and an orbiting lap 59 which protrudes upward from the end plate 58.

[0040] The end plate 58 is fixed to an eccentric shaft portion 56 provided on an upper end of the rotary shaft 15 and is eccentrically rotated about the axis X according to the rotation of the rotary shaft 15.

[0041] The orbiting lap 59 meshes with the fixed lap 53, and thus, a compression chamber C2 in which the refrigerant R is compressed is formed between the orbiting lap 59 and the fixed lap 53.

[0042] Here, a suction hole (not shown) is formed in the fixed scroll 51, and the refrigerant R which is compressed by the rotary compressor 12 and is discharged into the housing 11 can be sucked into the compression chamber C2 via the bearing device 30 through the suction hole. The refrigerant R compressed in the compression chamber C2 is discharged to the outside of the housing 11 from a discharge pipe 34 through the discharge hole 52a of the fixed scroll 51, and the discharge pipe 34 is open to a space surrounded by the fixed scroll 51 fixed to the upper portion of the fixed scroll 51 in the housing 11 and the discharge cover 50 and is provided to penetrate the housing 11 so as to extend the outside of the housing 11.

[0043] The bearing device 30 includes the upper bearing 31 which is provided on the upper portion of the housing 11 inside the housing 11, and lower bearings 32A and 32B which are provided on the lower portion of the housing 11 inside the housing 11.

[0044] The lower bearings 32A and 32B rotatably support the rotary shaft 15 with respect to the housing 11 at the lower portion of the housing 11. Specifically, the rotary compressor 12 is vertically disposed in the direction of the axis X between the lower bearings 32A and 32B, and the lower bearings 32A and 32B are fixed to the cylinder 44 by a bolt 48.

[0045] The upper bearing 31 includes a bearing 31a which rotatably supports the rotary shaft 15 around the axis X of the rotary shaft 15 with respect to the housing 11 and a bearing casing 31b which supports the bearing 31a on the housing 11 integrally with the bearing 31a.

[0046] As shown in Figs. 1 to 3, a plurality of suction channels FC are provided in the bearing casing 31b, and the suction channels FC extend to be parallel to the axis X over the entire region of the bearing casing 31b in the direction of the axis X with intervals to each other in the circumferential direction. In the present embodiment, each of the suction channels FC is a recessed groove having a rectangular cross section which is recessed from the outer peripheral surface of the bearing casing

31b toward the radially inner side.

[0047] In addition, a suction opening FCa is provided in the bearing casing 31b, and the suction opening FCa extends from a lower end of the suction channel FC toward the radially inner side so as to be continued to the lower side which is one side (first end side) of the axis X and is open in a fan shape downward when the bearing casing 31b is viewed.

[0048] In addition, a recessed portion (accommodation portion) 31c is provided in the bearing casing 31b, and the recessed portion 31c is recessed over the entire region in the direction of the axis X from the outer peripheral surface toward the radially inner side at a position at which the recessed portion does not interfere with the suction opening FCa. The wire 14a of the electric motor 14 is disposed inside the recessed portion. A seal member 65 is provided in a gap among the recessed portion 31c, the wire 14a, and the inner surface of the housing 11. For example, as the seal member 65, a seal material such as a resin can be used.

[0049] In addition, a bearing channel 31d (refer to Fig. 2) is formed in the bearing casing 31b, and the bearing channel 31d radially penetrates the bearing casing 31b and is open to the inside of the housing 11 at a position in the direction of the axis X at which the orbiting scroll 57 is fixed to the eccentric shaft portion 56.

[0050] In addition, an oil return pipe (oil return section) 72 is provided in the bearing casing 31b, and, at a position at which the oil return pipe 72 does not interfere with the suction opening FCa and the recessed portion 31c and a position of an end portion on the radially outer side, the oil return pipe 72 communicates with the bearing channel 31d, penetrates the bearing casing 31b toward the electric motor 14 to extend along the inner surface of the housing 11, and protrudes downward from the bearing casing 31b.

[0051] As shown in Fig. 3, the inflow restricting plate 61 is fixed to the bearing casing 31b by bolts 60 from below. The inflow restricting plate 61 is formed in an annular shape about the axis X. The inflow restricting plate 61 includes a plurality of notches 63, which are cut out from the end portion on the radially inner side toward the radially inner side, at positions corresponding to the suction openings FCa. A lower surface of the inflow restricting plate 61 becomes a restricting surface 62, and a bottom portion of each notch 63 forms an inner edge portion 62a of the restricting surface 62. The inner edge portion 62a has a curved shape formed along the circumferential direction. The inner edge portion 62a is positioned at a radially intermediate position of the suction opening FCa, and as a result, only the radially inner position of the suction opening FCa is open toward the electric motor 14 by the inflow restricting plate 61. Accordingly, a flow of the refrigerant R to the suction opening FCa on the radially outer side is restricted by the restricting surface 62.

[0052] In addition, a notch 61a is provided in the inflow restricting plate 61, and the notch 61a is recessed from

the outer edge portion 62b toward the radially inner side at a position corresponding to the position of the wire 14a so as not to interfere with the wire 14a.

[0053] As shown in Fig. 1, when viewed from a cross section including the axis X, the restricting surface 62 is provided to protrude from the inner surface of the housing 11 toward the radially inner side.

[0054] In addition, in the present embodiment, a seal member 66 is provided in a gap between the inner surface of the housing 11 and an outer edge portion 62b (an end edge on the radially outer side along the inner surface of the housing 11) of the restricting surface 62. As the seal member 66, a seal member formed of a resin, an O ring, or the like can be used.

[0055] In the two-stage compressor 1 of the above-described present embodiment, the oil A of the oil storage 01 and the refrigerant R are compressed by the rotary compressor 12. Accordingly, the oil A is included in the refrigerant R discharged from the rotary compressor 12. A portion of the refrigerant R including the oil A flows out toward the electric motor 14, and thereafter, flows toward the scroll compressor 13 through the gap between the stator 39 and the rotor 38 or the through-hole 37 provided in the rotor 38. In addition, when the refrigerant R passes through the electric motor 14, the oil A in the refrigerant R comes into contact with the rotor 38 or an oil separation plate 38a which is provided on the rotor 38 and extends in the radial direction, and thus, a content of the oil A in the refrigerant R decreases.

[0056] Meanwhile, the refrigerant R which has passed through the gap S between the stator 39 and the housing 11 does not come into contact with the rotor 38 and flows toward the scroll compressor 13 as it is. Accordingly, the refrigerant R flows toward the scroll compressor 13 in a state where the content of the oil A in the refrigerant R is high. That is, the amount of the oil A in the refrigerant R discharged from the rotary compressor 12 decreases on the radially inner side of the housing 11 and increases on the radially outer side thereof.

[0057] Here, in the present embodiment, the inflow restricting plate 61 having the restricting surface 62 is provided in the bearing casing 31b, and thus, the flow of the refrigerant R to the suction opening FCa on the radially outer side can be restricted. Accordingly, it is possible to prevent the refrigerant R having a high content of oil A on the radially outer side flows into the suction channel FC through the suction opening FCa as it is. In addition, the refrigerant R on the radially inner side having a low content of oil A can flow into the suction channel FC through the suction opening FCa.

[0058] As a result, it is possible to supply the refrigerant R having a low content of oil A to the scroll compressor 13, and it is possible to decrease the amount of the oil A in the refrigerant R which is compressed by the scroll compressor 13 and is discharged therefrom. It is possible to decrease an oil circulation amount (OC%) in a system including the two-stage compressor 1.

[0059] In addition, if the refrigerant R on the radially

outer side comes into contact with the restricting surface 62, the oil A in the refrigerant R is attached to the restricting surface 62, and the refrigerant R in which the content of the oil A has decreased is guided to the radially inner side by the restricting surface 62 and flows from suction opening FCa into suction channel FC. Accordingly, in a state where the amount of the oil A in the refrigerant R is decreased by the restricting surface 62, the refrigerant R is supplied from the suction channel FC to the scroll compressor 13. In this way, it is possible to decrease the amount of the oil A in the refrigerant R which is compressed by the scroll compressor 13 and is discharged from the discharge pipe 34 to the outside of the housing 11, and it is possible to decrease the oil circulation amount (OC%) in the system.

[0060] In addition, the inflow restricting plate 61 is provided in the bearing casing 31b, and thus, the restricting surface 62 can be provided in the bearing casing 31b. Accordingly, compared to a case where a member corresponding to the inflow restricting plate 61 is attached to the housing 11, a welding work or the like with respect to the housing 11 is not required, and it is possible to very easily provide the restricting surface 62 in the bearing casing 31b. Accordingly, it is possible to effectively separate the oil A in the refrigerant R from the refrigerant R while easily manufacturing the two-stage compressor 1 having the restricting surface 62.

[0061] In addition, the oil return pipe 72 is provided, and thus, the oil which is used to lubricate the high stage-side compression section is returned into the housing 11 through the oil return pipe 72. Accordingly, it is possible to further decrease the amount of the oil A in the refrigerant R which is compressed by the scroll compressor 13 and is discharged therefrom. In addition, the oil return pipe 72 is provided on the end portion on the radially outer side of the bearing casing 31b, and thus, the oil return pipe 72 is provided at a position separated from the opening portion on the radially inner side in the suction opening FCa on the radially inner side. Therefore, the oil A which is returned from the oil return pipe 72 to the housing 11 can be prevented from flowing from the suction opening FCa into the suction channel FC as it is. Accordingly, it is possible to further decrease the amount of the oil A in the refrigerant R which is compressed by the scroll compressor 13 and is discharged therefrom.

[0062] In addition, the refrigerant R having a high content of oil A which has passed through the gap S between the housing 11 and the stator 39 in the region on the radially outer side inside the housing 11 can be prevented from flowing from the portion between the restricting surface 62 and the inner surface of the housing 11 into the scroll compressor 13 as it is by the seal member 66. Therefore, it is possible to further decrease the amount of the oil A in the refrigerant R which is compressed by the scroll compressor 13 and is discharged therefrom.

[0063] In addition, even when the recessed portion 31c into which the wire 14a of the electric motor 14 is inserted is formed in the bearing casing 31b, it is possible to seal

the gap among the recessed portion 31c, the wire 14a, and the inner surface of the housing 11 by the seal member 65. Accordingly, it is possible to prevent the refrigerant R including the oil A from being supplied to the scroll compressor 13 through the gap as it is.

[Second Embodiment]

[0064] Next, a two-stage compressor 80 according to a second embodiment of the present invention will be described with reference to Figs. 4 and 5. In Fig. 4, for convenience of descriptions, the wire 14a of the electric motor 14 and the oil return pipe 72 are not shown.

[0065] The same reference numerals are assigned to the components similar to those of the second embodiment, and detail descriptions.

[0066] In the two-stage compressor 80 of the present embodiment, an inflow restricting plate 81 having a restricting surface 82 is different from the inflow restricting plate 61 of the first embodiment.

[0067] The inflow restricting plate 81 includes an annular portion 83 which is disposed on the radially outer side along the inner surface of the housing 11 and is formed in an annular shape about the axis X, and a conical portion 84 which is continuous to the radially inner side of the annular portion 83 so as to be provided integrally with the annular portion 83.

[0068] A lower surface of the annular portion 83 is a flat surface 86 which is formed in an annular shape about the axis X. In addition, an outer surface of the conical portion 84 is an inclined surface 87 which is formed in a truncated conical shape about the axis X. The inclined surface 87 is inclined downward from the flat surface 86 toward the radially inner side.

[0069] In this way, the restricting surface 82 of the present embodiment includes the flat surface 86 and the inclined surface 87. An inner edge portion 87a which is an end edge on the radially inner side of the inclined surface 87 is positioned on the radially inner side from the stator 39 and on the radially outer side from the bearing casing 31b and the rotary shaft 15.

[0070] In addition, in the present embodiment, the inner edge portion 87a of the inflow restricting plate 81 is disposed at a position at which an intake amount of the refrigerant R required in the scroll compressor 13 can be secured, that is, an opening area of the suction opening FCa can be secured.

[0071] In the two-stage compressor 80 of the above-described present embodiment, the restricting surface 82 has the inclined surface 87, and thus, it is possible to form an opening portion OP which is formed in an annular shape about the axis X so as to extend downward in the direction of the axis X from the suction opening FCa. Accordingly, compared to the first embodiment, the area of the suction opening FCa which is open toward the electric motor 14 can increase. Therefore, it is possible to secure a flow rate of the refrigerant R flowing from the inside of the housing 11 into the suction channel FC.

[0072] In addition, the refrigerant R having a high content of the oil A in the radially outer side region in the housing 11 flows to the radially inner side along the flat surface 86, and thereafter, collides with the inclined surface 87, and thus, the oil A can be attached to the inclined surface 87. Accordingly, the refrigerant R can flow into the suction channel FC in a state where the content of the oil A in the refrigerant R further decreases so as to be supplied to the scroll compressor 13. As a result, it is possible to further decrease the amount of the oil A in the refrigerant R which is compressed by the scroll compressor 13 and is discharged to the outside of the housing 11 and it is possible to further decrease the oil circulation amount (OC%) in the system including the two-stage compressor 80.

[0073] In addition, in the present embodiment, the inner edge portion 87a on the radially inner side of the inclined surface 87 is positioned on the radially inner side from the stator 39, and thus, the restricting surface 82 extends to the position of the rotor 38. Accordingly, the refrigerant R flowing through the radially inner side in the housing 11 and the oil A in the refrigerant R come into contact with the rotor 38, and the refrigerant R in which the amount of the oil A is sufficiently decreased by the rotor 38 can flow from the suction opening FCa into the suction channel FC.

[0074] In addition, the inner edge portion 87a of the inflow restricting plate 81 is disposed at the position at which the intake amount of the refrigerant R required in the scroll compressor 13 can be secured, and thus, it is possible to prevent compression efficiency in the scroll compressor 13 from decreasing.

[0075] Hereinbefore, the embodiments of the present invention are described in detail with reference to the drawings. However, the respective configurations and combinations thereof in the respective embodiments are merely examples, and additions, omissions, substations, and other modifications of configurations are possible within the scope which does not depart from the gist of the present invention. In addition, the present invention is not limited to the embodiments and are limited by only claims.

[0076] For example, the bearing casing 31b and each of the inflow restricting plates 61 and 81 may be integrated with each other. That is, each of the restricting surfaces 62 and 82 may be directly provided in the bearing casing 31b.

[0077] In addition, similarly to the second embodiment, in the first embodiment, the inner edge portion 62a of the restricting surface 62 may be disposed on the radially inner side from the stator 39. In addition, in this case, the position of the inner edge portion 62a may be determined such that the intake amount of the refrigerant R required in the scroll compressor 13 can be secured.

[0078] In addition, in the bearing casing 31b, instead of the recessed portion 31c, a through-hole penetrating the bearing casing 31b in the direction of the axis X may be formed such that the wire 14a is inserted into the

through-hole so as to be disposed.

[0079] In addition, as shown in Fig. 6, an annular recessed portion 90 which is recessed upward and is formed in an annular shape about the axis X may be provided in the restricting surface 62A. According to the annular recessed portion, the refrigerant R on the radially outer side comes into contact with the restricting surface 62A, and thus, the oil A attached to the restricting surface 62A flows toward the radially inner side, and it is possible to prevent the oil A from being sucked into the suction opening FCa. The annular recessed portion 90 can be provided in any one of the restricting surface 62 of the first embodiment and the restricting surface 82 of the second embodiment.

[0080] In addition, in the housing 11, the rotary compressor 12 is provided as the low stage-side compressor and the scroll compressor 13 is provided as the high stage-side compressor. However, the present invention is not limited to this. For example, the scroll compressor 13 may be provided as the low stage-side compressor and the rotary compressor 12 may be used as the high stage-side compressor. In addition, the scroll compressor 13 may be provided on both the low stage side and the high stage side, or the rotary compressor 12 may be provided on both the low stage side and the high stage side. In addition, a compressor other than the scroll compressor 13 and the rotary compressor 12 may be provided.

[0081] Moreover, the restricting surfaces 62 and 82 may be provided in a two-stage compressor which is used in a horizontal position so that the axis of the rotary shaft extends in a horizontal direction.

Industrial Applicability

[0082] According to the hermetic two-stage compressor, the hermetic two-stage compressor can be easily manufactured, and the oil in the gas can be effectively separated. Reference Signs List

[0083]

- 1, 80: hermetic two-stage compressor
- 11: housing
- 12: rotary compressor (low stage-side compression section)
- 13: scroll compressor (high stage-side compression section)
- 14: electric motor
- 14a: wire
- 15: rotary shaft
- 21: main body portion
- 22: upper cover portion
- 23: lower cover portion
- 30: bearing device
- 31: upper bearing
- 31a: bearing
- 31b: bearing casing
- 31c: recessed portion (accommodation portion)

31d: bearing channel
 32A, 32B: lower bearing
 33: suction pipe
 34: discharge pipe
 37: through-hole 5
 38: rotor
 38a: oil separation plate
 39: stator
 41: eccentric shaft portion
 42: piston rotor 10
 44: cylinder
 44a: suction hole
 48: bolt
 50: discharge cover
 51: fixed scroll 15
 52: end plate
 52a: discharge hole
 53: fixed lap
 56: eccentric shaft portion
 57: orbiting scroll 20
 58: end plate
 59: orbiting lap
 60: bolt
 61: inflow restricting plate
 61a: notch 25
 62, 62A: restricting surface
 62a: inner edge portion
 62b: outer edge portion
 63: notch
 65: seal member 30
 66: seal member
 72: oil return pipe (oil return section)
 81: inflow restricting plate
 82: restricting surface
 83: annular portion 35
 84: conical portion
 86: flat surface
 87: inclined surface
 87a: inner edge portion
 90: annular recessed portion 40
 C1: compression chamber
 C2: compression chamber
 O1: oil storage
 R: refrigerant
 X: axis 45
 A: oil
 S: gap
 FC: suction channel
 FCa: suction opening
 OP: opening portion 50

Claims

1. A hermetic two-stage compressor comprising: 55

a housing which includes an oil storage inside the housing;

a rotary shaft which is disposed in the housing; a motor which is disposed in the housing so as to rotate the rotary shaft and includes a stator which is provided on a radially outer side and a rotor which is provided on a radially inner side; a low stage-side compression section which is disposed on one side in an axial direction of the rotary shaft with respect to the motor in the housing and is connected to the rotary shaft so as to compress a gas; a bearing device which is disposed on the other side in the axial direction with respect to the motor in the housing and includes a bearing which supports the rotary shaft and a bearing casing which supports the bearing to the housing; and a high stage-side compression section which is disposed on the other side in the axial direction with respect to the bearing device and further compresses the gas discharged from the low stage-side compression section, wherein the bearing casing includes

a suction channel which is provided to suck the gas into the high stage-side compression section and includes a suction opening which is open to the one side in the axial direction, and

a restricting surface which is disposed between the suction opening and the motor and is provided toward the radially inner side from an inner surface of the housing so as to restrict a flow of the gas to the suction opening on the radially outer side.

2. The hermetic two-stage compressor according to claim 1, further comprising: an inflow restricting plate which is fixed to the bearing casing, is formed in a plate shape, and includes the restricting surface on the one side of the axial direction. 40

3. The hermetic two-stage compressor according to claim 1 or 2, wherein the restricting surface includes 45

a flat surface which is provided on an end portion on the radially outer side which is an inner surface side of the housing and is perpendicular to the axis to be formed in an annular shape about the axis, and

an inclined surface which is inclined toward the one side in the axial direction from the flat surface toward the radially inner side so as to be formed in a truncated conical shape about the axis. 50

4. A hermetic two-stage compressor according to any one of claims 1 to 3,

wherein an inner edge portion on the radially inner side of the restricting surface is disposed at a position on the radially inner side of the stator, and wherein the restricting surface closes a portion of the suction opening so as to secure an intake amount of the gas required in the high stage-side compression section.

5. The hermetic two-stage compressor according to any one of claims 1 to 4, further comprising:
 a seal member which is provided in a gap between an outer edge portion on the radially outer side of the restricting surface and the inner surface of the housing.
6. The hermetic two-stage compressor according to any one of claims 1 to 5, further comprising:
 an oil return section which is provided at a position of an end portion on the radially outer side in the bearing casing, and causes the high stage-side compression section and the one side in the axial direction from the bearing casing in the housing to communicate with each other such that oil from the high stage-side compression section can flow through the oil return section.

Amended claims under Art. 19.1 PCT

1. (Amended) A hermetic two-stage compressor comprising:

a housing which includes an oil storage inside the housing;
 a rotary shaft which is disposed in the housing;
 a motor which is disposed in the housing so as to rotate the rotary shaft and includes a stator which is provided on a radially outer side and a rotor which is provided on a radially inner side;
 a low stage-side compression section which is disposed on one side in an axial direction of the rotary shaft with respect to the motor in the housing and is connected to the rotary shaft so as to compress a gas;
 a bearing device which is disposed on the other side in the axial direction with respect to the motor in the housing and includes a bearing which supports the rotary shaft and a bearing casing which supports the bearing to the housing; and
 a high stage-side compression section which is disposed on the other side in the axial direction with respect to the bearing device and further compresses the gas discharged from the low stage-side compression section,
 wherein the bearing casing includes

a suction channel which is provided to suck the gas into the high stage-side compression

section and includes a suction opening which is open to the one side in the axial direction, and
 a restricting surface which is disposed between the suction opening and the motor and is provided toward the radially inner side from an inner surface of the housing so as to restrict a flow of the gas to the suction opening on the radially outer side, and

wherein the restricting surface includes a plurality of notches which are cut out from an end portion on the radially inner side toward the radially inner side at a position corresponding to the suction opening and only a position on the radially inner side of the suction opening is open toward the motor.

2. The hermetic two-stage compressor according to claim 1, further comprising:
 an inflow restricting plate which is fixed to the bearing casing, is formed in a plate shape, and includes the restricting surface on the one side of the axial direction.
3. The hermetic two-stage compressor according to claim 1 or 2,
 wherein the restricting surface includes

a flat surface which is provided on an end portion on the radially outer side which is an inner surface side of the housing and is perpendicular to the axis to be formed in an annular shape about the axis, and
 an inclined surface which is inclined toward the one side in the axial direction from the flat surface toward the radially inner side so as to be formed in a truncated conical shape about the axis.

4. A hermetic two-stage compressor according to any one of claims 1 to 3,
 wherein an inner edge portion on the radially inner side of the restricting surface is disposed at a position on the radially inner side of the stator, and wherein the restricting surface closes a portion of the suction opening so as to secure an intake amount of the gas required in the high stage-side compression section.
5. The hermetic two-stage compressor according to any one of claims 1 to 4, further comprising:
 a seal member which is provided in a gap between an outer edge portion on the radially outer side of the restricting surface and the inner surface of the housing.
6. The hermetic two-stage compressor according to

any one of claims 1 to 5, further comprising:
 an oil return section which is provided at a position
 of an end portion on the radially outer side in the
 bearing casing, and causes the high stage-side com- 5
 pression section and the one side in the axial direc-
 tion from the bearing casing in the housing to com-
 municate with each other such that oil from the high
 stage-side compression section can flow through the
 oil return section. 10

Statement under Art. 19.1 PCT

In Claim 1, "the restricting surface includes a plurality
 of notches which are cut out from an end portion on the 15
 radially inner side toward the radially inner side at a po-
 sition corresponding to the suction opening and only a
 position on the radially inner side of the suction opening
 is open toward the motor" is added.

A basis of this amendment is described in Paragraph 20
 [0045] and Fig. 3 of the present specification.

According to this amendment, Claim 1 clarifies that
 it is possible to achieve an effect that "a flow of a refig-
 erant to the suction opening on the radially outer side is 25
 restricted by the restricting surface".

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FIG. 1

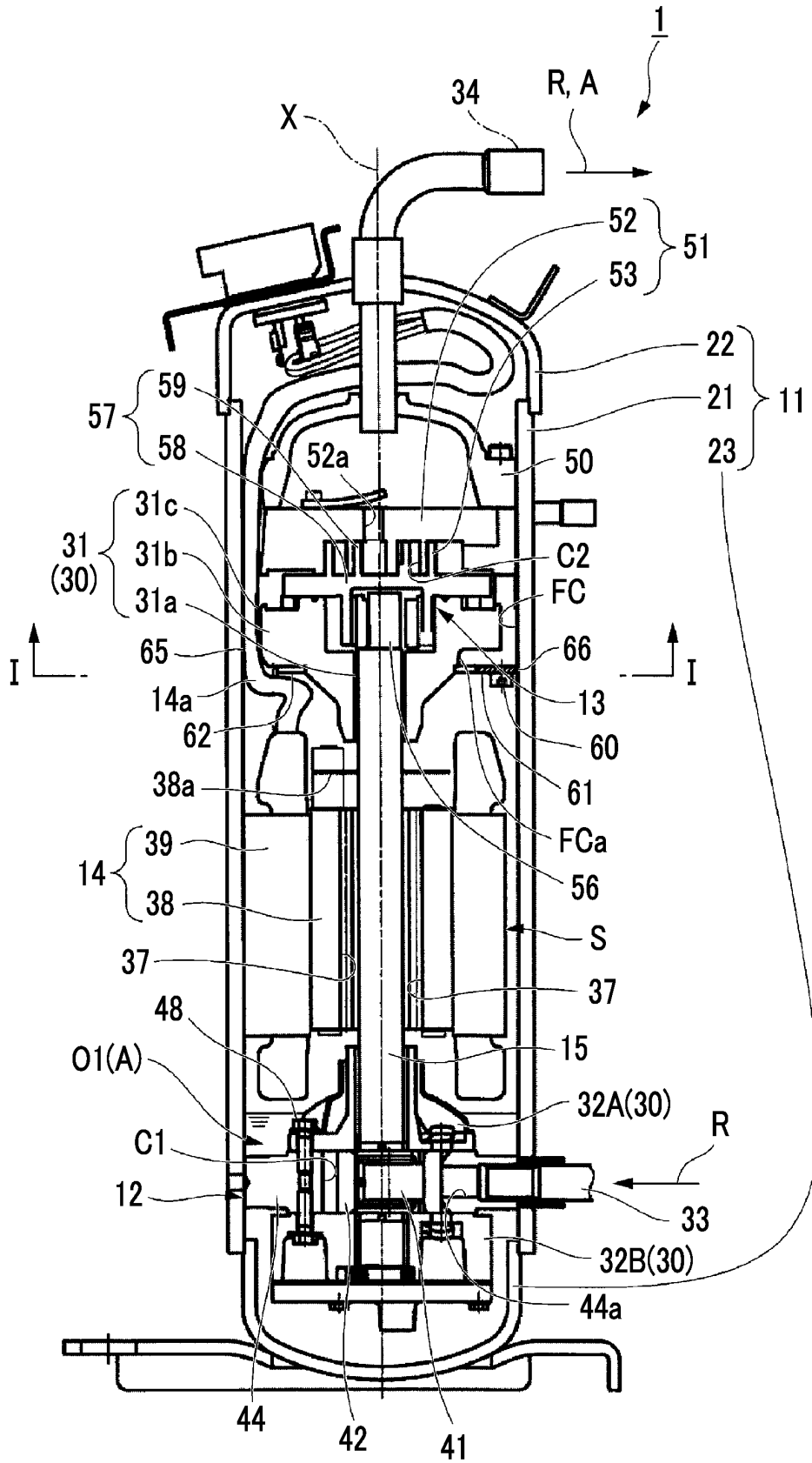


FIG. 2

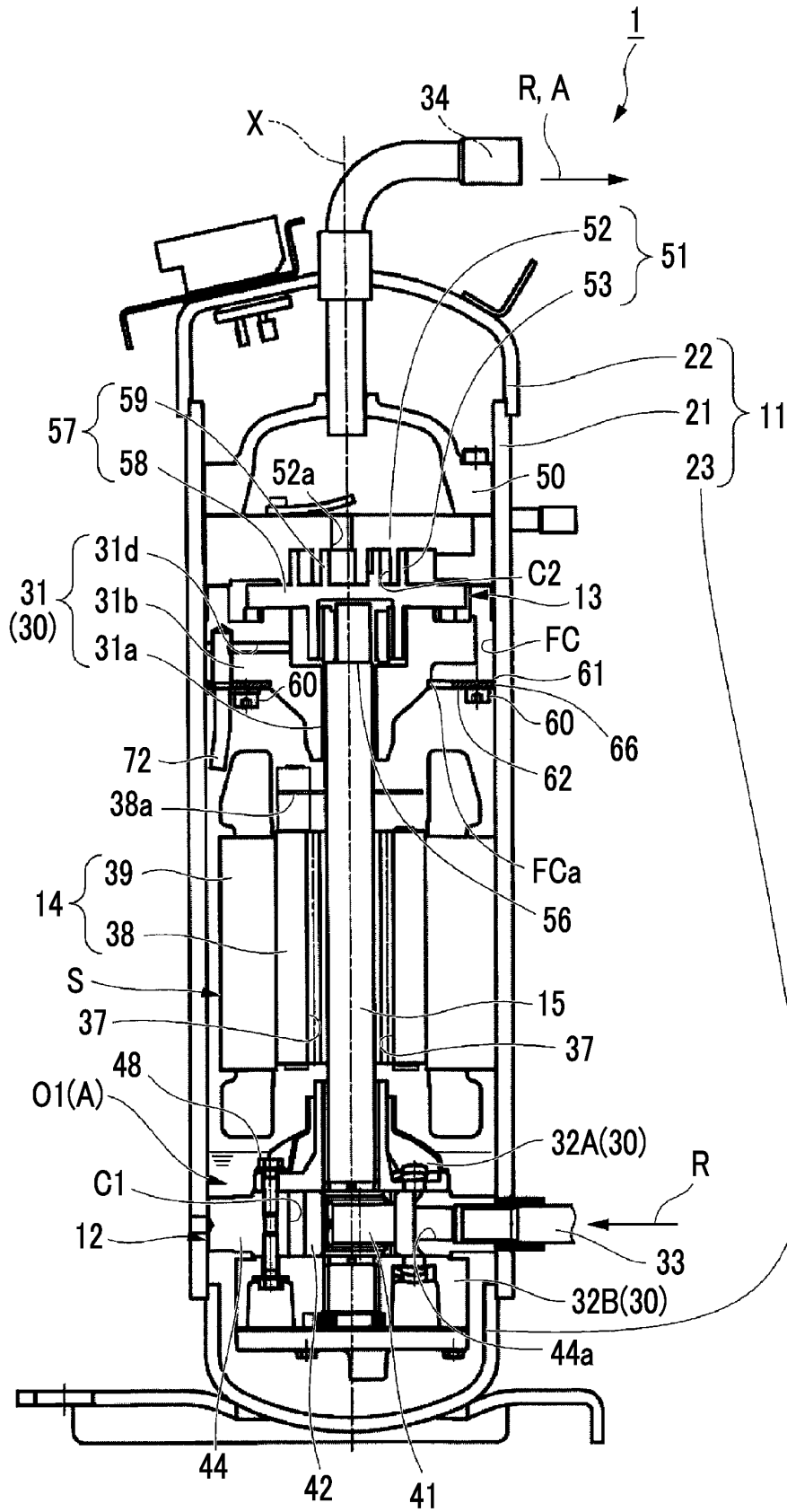


FIG. 3

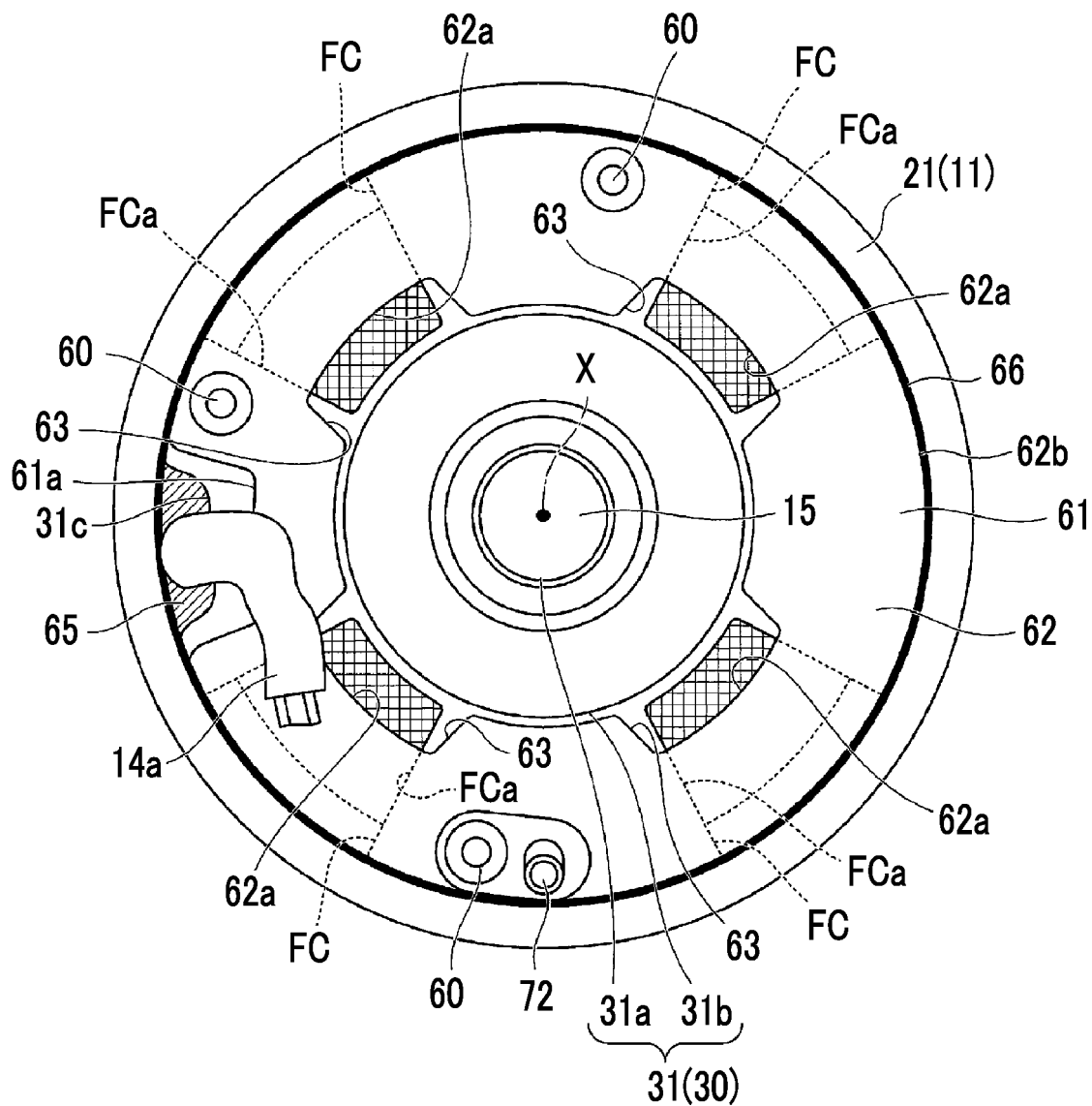


FIG. 4

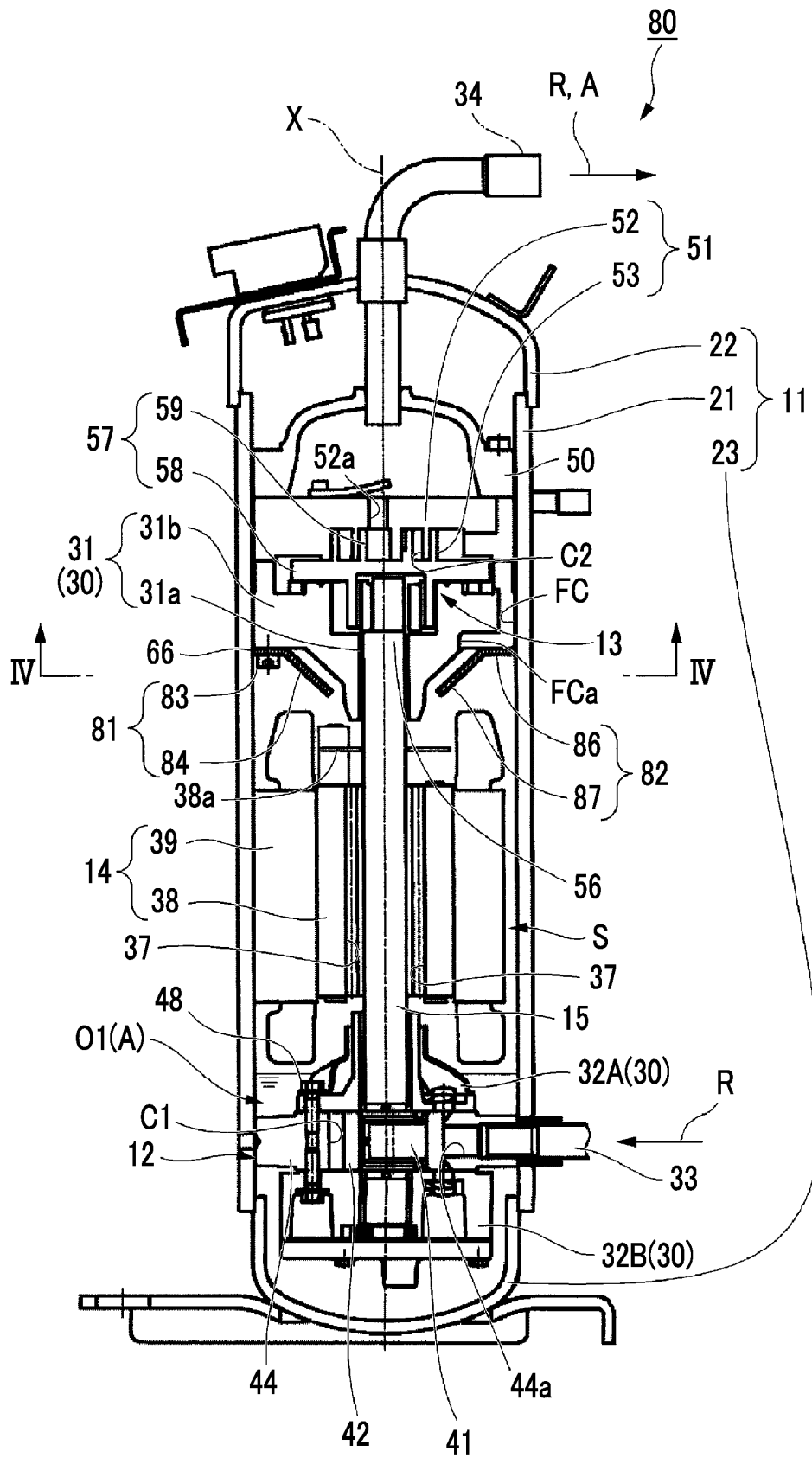


FIG. 5

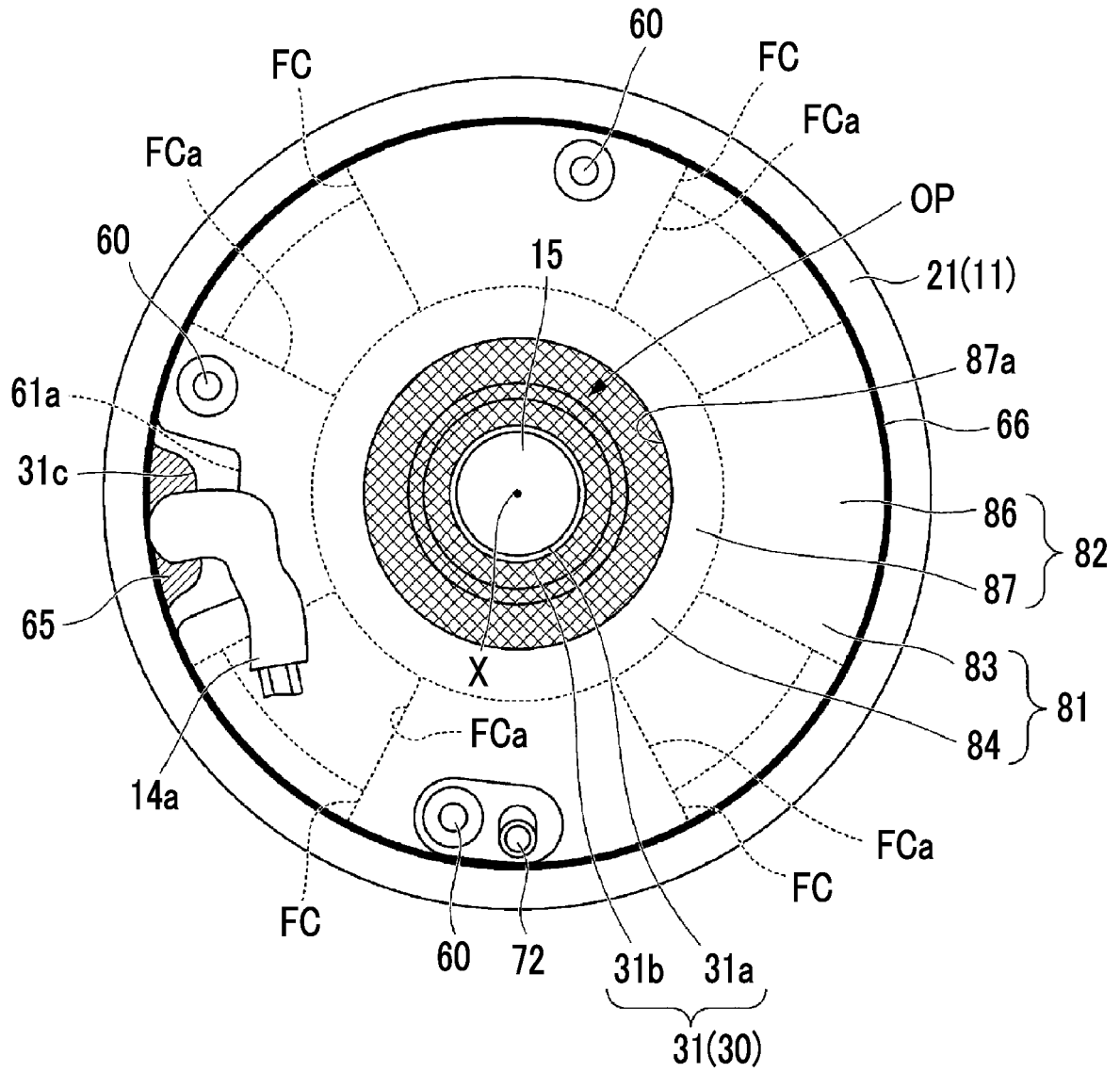
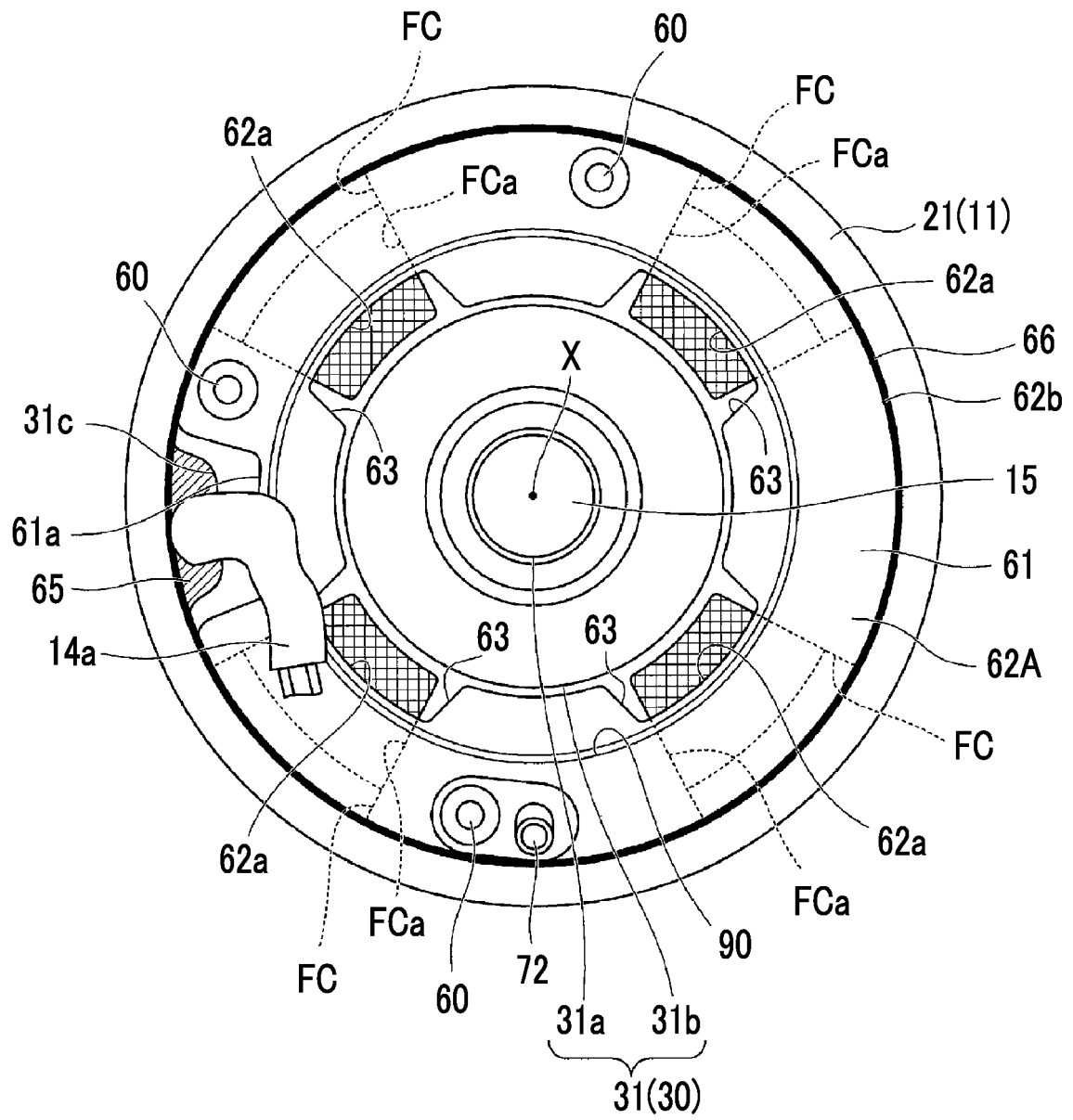


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/015333

5	A. CLASSIFICATION OF SUBJECT MATTER F04C29/00(2006.01)i, F04C18/02(2006.01)i, F04C23/00(2006.01)i, F04C29/02(2006.01)i	
	According to International Patent Classification (IPC) or to both national classification and IPC	
10	B. FIELDS SEARCHED	
	Minimum documentation searched (classification system followed by classification symbols) F04C29/00, F04C18/02, F04C23/00, F04C29/02	
15	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017 Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017	
	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)	
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
	Category*	Citation of document, with indication, where appropriate, of the relevant passages
25	X Y	JP 2009-47039 A (Mitsubishi Heavy Industries, Ltd.), 05 March 2009 (05.03.2009), paragraphs [0033] to [0055]; fig. 1 to 7; particularly, fig. 7 & US 2010/0083690 A1 paragraphs [0075] to [0109]; fig. 1 to 7
30	X Y	JP 2004-132353 A (Tecumseh Products Co.), 30 April 2004 (30.04.2004), paragraphs [0019] to [0050]; fig. 1 to 5 & US 2003/0228233 A1 paragraphs [0032] to [0065]; fig. 1 to 5
35		Relevant to claim No. 1-2, 4 1-6 1-4 1-6
40	<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.	
45	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
50	Date of the actual completion of the international search 13 June 2017 (13.06.17)	Date of mailing of the international search report 20 June 2017 (20.06.17)
55	Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2012-149544 A (Mitsubishi Heavy Industries, Ltd.), 09 August 2012 (09.08.2012), paragraphs [0014] to [0035]; fig. 1 to 3 (Family: none)	1-6
Y	JP 2012-202252 A (Sanyo Electric Co., Ltd.), 22 October 2012 (22.10.2012), paragraph [0020]; fig. 1 & US 2014/0037474 A1 paragraph [0029]; fig. 1	6
Y	US 2009/0148328 A1 (YEH, Chung-Hung), 11 June 2009 (11.06.2009), paragraph [0021]; fig. 4 (Family: none)	6

REFERENCES CITED IN THE DESCRIPTION

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- JP 2009180107 A [0006]