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

(11) EP 2 947 321 A1

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

(43) Date of publication:
25.11.2015 Bulletin 2015/48

(21) Application number: **14774791.9**

(22) Date of filing: **13.03.2014**

(51) Int Cl.:
F04C 23/00 (2006.01) ***F04C 18/356*** (2006.01)
F04C 29/00 (2006.01)

(86) International application number:
PCT/JP2014/056650

(87) International publication number:
WO 2014/156679 (02.10.2014 Gazette 2014/40)

(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

(30) Priority: **29.03.2013 JP 2013073093**

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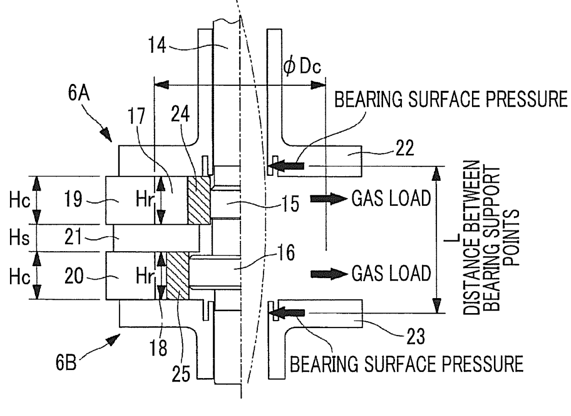
(54) MULTI-CYLINDER ROTARY COMPRESSOR

(57) In this multi-cylinder rotary compressor, a motor, and a compression mechanism driven by the motor are provided inside a sealed container. The compression mechanism is formed from rotary compression mechanisms (6A, 6B) provided with: a plurality of cylinders (17, 18); a partition plate (21) which forms a partition between the plurality of cylinders (17, 18); blades which partition the insides of the cylinders (17, 18) into intake sides and discharge sides; and rotors (24, 25) which rotate inside the cylinders (17, 18). When ΦMo represents the core diameter of the motor, ΦDc represents the internal diameter of each of the cylinders (17, 18), Hc represents the width of each of the cylinders (17, 18), and Hs represents the width of the partition plate (21), $Hs/Hc \leq 0.35$ is satisfied under conditions in which $\phi Dc/\phi Mo \geq 0.49$.

FIG. 3



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Description

Technical Field

[0001] The present invention relates to a sealed type multi-cylinder rotary compressor in which it is possible to increase the capacity (the displacement) of the compressor without increasing a motor core diameter.

Background Art

[0002] In a case of increasing the capacity of a sealed type rotary compressor, usually, a mechanical load such as bearing surface pressure or blade side surface pressure simply increases, and therefore, coping with this is performed by increasing a motor core diameter (shell diameter) or a journal diameter by one level by using a proportional design. However, an increase of the motor core diameter (shell diameter) or the journal diameter is restricted by a manufacturing facility, and therefore, design is performed by selection from a limited lineup. However, in a case of not having a compressor having a motor core diameter (shell diameter) one level higher, great capital investment is required.

[0003] Therefore, PTL 1 discloses a technique of allowing the displacement (the capacity) of a compressor to be made to have a larger capacity without changing a motor core diameter, in other words, without changing the external dimensions of the compressor. This is a technique in which in a sealed type multi-cylinder rotary compressor, a crankshaft is made to have a structure in which a plurality of portions are connected, whereby an increase in capacity is performed by reducing an opening provided in a partition plate separating a plurality of cylinders, providing a bearing for supporting a connection portion in the opening portion, accordingly reducing the external diameters of rotors rotating in the cylinders, and increasing the eccentricity of an eccentric shaft portion (making a blade stroke be a longer stroke), thereby increasing the effective capacity (displacement) in the cylinders.

Citation List

Patent Literature

[0004] [PTL 1] Japanese Patent No. 4365729

Summary of Invention

Technical Problem

[0005] However, in the technique disclosed in PTL 1 described above, a structure in which the crankshaft is separated into a plurality of portions and the portions are then assembled has to be made, and therefore, the number of parts increases, and thus there is a problem such as the number of processing steps or the number of assembly steps increasing and complication of a configuration or higher cost being inevitable.

[0006] On the other hand, it is conceivable that a compressor having a displacement one level higher could be manufactured by making a blade stroke be a longer stroke by increasing the internal diameter of a cylinder, as a method of increasing capacity (displacement) without changing a motor core diameter. However, in this case, as described above, a mechanical load such as bearing surface pressure or a blade side surface pressure increases, and therefore, there is a technical problem such as measures to suppress an increase in the mechanical load becoming essential.

[0007] The present invention has been made in view of such circumstances and has an object to provide a sealed type multi-cylinder rotary compressor in which it is possible to manufacture a compressor having a displacement one level higher by suppressing a mechanical load even if an increase in capacity is performed by increasing a cylinder internal diameter with the existing motor core diameter maintained, without increasing a motor core diameter.

Solution to Problem

[0008] In order to solve the above-described problems, a multi-cylinder rotary compressor according to the present invention adopts the following means.

[0009] According to a first aspect of the present invention, there is provided a multi-cylinder rotary compressor including: a motor provided in a sealed container; and a compression mechanism which is provided in the sealed container and driven by the motor, in which the compression mechanism is a rotary compression mechanism provided with a plurality of cylinders, a partition plate which separates the plurality of cylinders, a blade which partitions the inside of each of the cylinders into an intake side and a discharge side, and a rotor which rotates in each of the cylinders, and when a core diameter of the motor is set to be ϕMo, an internal diameter of each of the cylinders is set to be ϕDc, a width of each of the cylinders is set to Hc, and a width of the partition plate is set to Hs, the relationship of $Hs/Hc \leq 0.35$ is satisfied under a condition of $\phi Dc/\phi Mo \geq 0.49$.

[0010] According to the first aspect of the present invention, in the sealed type multi-cylinder rotary compressor, it is possible to make the displacement of the compressor have a larger capacity (an increased displacement) by making a blade stroke be a longer stroke without changing the motor core diameter ϕMo and without much increasing a gas load (a compression load), by making the ratio of the width Hs of the partition plate to the width Hc of each cylinder be set to be 0.35 or less under a condition in which the ratio of the internal diameter ϕDc of each cylinder to the core diameter ϕMo of the motor is set to be 0.49 or more, and it is possible to suppress a rise in bearing surface pressure by reducing a distance between support points of an upper bearing and a lower bearing by making the width Hs of the partition plate as small as possible with respect to the width Hc of the cylinder. Therefore, it is possible to manufacture a sealed type multi-cylinder rotary compressor having a displacement one level higher with the existing motor core diameter maintained, and thus it is possible to attain the expansion of a product lineup without performing great capital investment.

[0011] In the multi-cylinder rotary compressor according to a second aspect of the present invention, the partition plate is made of a material having a Young's modulus of 160 [GPa] or more.

[0012] According to the second aspect of the present invention, the partition plate is configured with a material having a Young's modulus of 160 [GPa] or more, and therefore, even if the width Hs of the partition plate is reduced to 0.35 or less of the cylinder width Hc, by using a material having a Young's modulus of 160 [GPa] or more which is high compared to a sintered alloy or cast iron having a Young's modulus of 160 [GPa] or less, it is possible to reduce the distance between support points of the bearings while suppressing the deformation of the partition plate. Therefore, it is possible to suppress an increase of a mechanical load such as bearing surface pressure, and thus it is possible to easily increase the displacement of the compressor to a capacity one level higher without changing the motor core diameter.

[0013] In the multi-cylinder rotary compressor according to a third aspect of the present invention, the partition plate is made of carbon steel or alloy steel.

[0014] According to the third aspect of the present invention, the partition plate is made of carbon steel or alloy steel having a Young's modulus of 160 [GPa] or more, and therefore, by using carbon steel or alloy steel having higher rigidity than a sintered alloy or cast iron, it is possible to secure a Young's modulus of 160 [GPa] or more and suppress deformation while reducing the width of the partition plate simply by the selection of an appropriate material. Therefore, it is possible to suppress an increase of a mechanical load such as bearing surface pressure, and thus it is possible to easily increase the displacement of the compressor to a capacity one level higher without changing the motor core diameter.

[0015] In the multi-cylinder rotary compressor according to a fourth aspect of the present invention, the blade is a blade with a hard coating such as a PVD film of CrN type or the like or a DLC film applied to the surface thereof.

[0016] According to the fourth aspect of the present invention, the blade is a blade with a hard coating such as a PVD film of CrN type or the like or a DLC film applied to the surface thereof, and therefore, although blade side surface pressure rises due to an increase in a blade stroke, the hard coating is applied to the blade surface, whereby it is also possible to sufficiently cope with abnormal wear or the like due to a rise in surface pressure. Therefore, it is possible to easily increase the displacement of the compressor to a capacity one level higher without performing capital investment, by increasing the cylinder internal diameter without changing the motor core diameter.

[0017] In the multi-cylinder rotary compressor according to a fifth aspect of the present invention, refrigerant oil which is filled into a bottom portion in the sealed container is refrigerant oil with an extreme pressure agent added thereto.

[0018] According to the fifth aspect of the present invention, the refrigerant oil which is filled into the bottom portion in the sealed container is refrigerant oil with an extreme pressure agent added thereto, and therefore, although some increase of the mechanical load such as the bearing surface pressure or the blade side surface pressure according to an increase in the capacity of the compressor is inevitable and it becomes easy for an extreme pressure lubrication state to occur in the sliding portions, the extreme pressure agent which is effective under a high load is added to the refrigerant oil, whereby it is possible to maintain high lubricity on a sliding surface, thereby preventing seizure, wear, or scuffing. Therefore, it is also possible to effectively cope with an increase of a mechanical load according to an increase in the capacity of the compressor.

Advantageous Effects of Invention

[0019] According to the present invention, it is possible to make the displacement of the compressor have a larger capacity (an increased displacement) by making the blade stroke be a longer stroke without changing the motor core diameter ϕMo and without much increasing the gas load (the compression load), and it is possible to suppress a rise in bearing surface pressure by reducing the distance between support points of the upper bearing and the lower bearing by making the width Hs of the partition plate as small as possible with respect to the width Hc of the cylinder. For this reason, it is possible to manufacture a sealed type multi-cylinder rotary compressor having a displacement one level higher with the existing motor core diameter maintained, and thus it is possible to attain the expansion of a product lineup without performing great capital investment.

Brief Description of the Drawings

[0020]

Fig. 1 is a longitudinal sectional view of a multi-cylinder rotary compressor according to an embodiment of the present invention.

Fig. 2 is a cross-sectional view showing the specifications of a compression mechanism section of the multi-cylinder rotary compressor.

Fig. 3 is a longitudinal sectional view showing the specifications of the compression mechanism section of the multi-cylinder rotary compressor.

Fig. 4 is a graph showing the relationship between the ratio between a motor core diameter and a cylinder internal diameter of the multi-cylinder rotary compressor and a gas load.

Fig. 5 is a graph showing the relationship between the ratio between a partition plate width and a cylinder width of the multi-cylinder rotary compressor and bearing surface pressure.

Fig. 6 is a graph showing the relationship between the ratio between the partition plate width and the cylinder width of the multi-cylinder rotary compressor and the ratio between the motor core diameter and the cylinder internal diameter.

Description of Embodiments

[0021] Hereinafter, an embodiment of the present invention will be described with reference to Figs. 1 to 6.

[0022] In Fig. 1, a longitudinal sectional view of a multi-cylinder rotary compressor according to an embodiment of the present invention is shown, and in Fig. 2, a cross-sectional view showing the specifications of a compression mechanism section thereof is shown, and in Fig. 3, a longitudinal sectional view showing the specifications of the compression mechanism section is shown.

[0023] A multi-cylinder rotary compressor 1 according to this embodiment is a sealed type multi-cylinder rotary compressor 1 which is provided with a cylindrical sealed container 2 in which an upper portion and a lower portion are hermetically sealed by an upper cover 3 and a lower cover 4, a motor 5 is installed at a higher part in the inside thereof, and a compression mechanism (a rotary compressor mechanism) 6 which is driven by the motor 5 is installed at a lower part thereof.

[0024] A mounting leg 7 is provided at the outer periphery of the lower portion of the sealed container 2. Further, a discharge pipe 8 penetrating the upper cover 3 is provided in the upper portion of the sealed container 2, and thus a configuration is made in which high-pressure refrigerant gas compressed in the multi-cylinder rotary compressor 1 is discharged to the refrigeration cycle side. In addition, an accumulator 9 is integrally assembled to an outer peripheral portion of the sealed container 2, and thus a configuration is made in which a liquid component such as oil or a liquid refrigerant which is contained in low-pressure refrigerant gas which returns from the refrigeration cycle side is separated out and only a gaseous component is sucked into the compression mechanism 6 through suction pipes 10 and 11.

[0025] The motor 5 is provided with a stator 12 and a rotor 13, and the stator 12 is installed by being fixed to the inner peripheral surface of the sealed container 2 by press fitting or the like. A crankshaft 14 is integrally coupled to the rotor 13, whereby a rotational driving force of the rotor 13 can be transmitted to the compression mechanism 6 through the crankshaft 14. Further, at a lower part of the crankshaft 14, a first eccentric portion 15 and a second eccentric portion 16 are provided corresponding to a first rotor 24 and a second rotor 25 of the rotary compression mechanism 6 which will be described later.

[0026] The rotary compression mechanism 6 is of, in this embodiment, a two-cylinder type. First and second rotary compression mechanisms 6A and 6B thereof are provided with a first cylinder main body 19 and a second cylinder main body 20 which have a first cylinder chamber 17 and a second cylinder chamber 18 (there is also a case of being hereinafter referred to simply as cylinders 17 and 18) formed therein and are fixedly installed in the sealed container 2 to correspond to the first eccentric portion 15 and the second eccentric portion 16 of the crankshaft 14, a partition plate (a separator plate) 21 which is interposed between the first cylinder main body 19 and the second cylinder main body 20, thereby separating the first cylinder chamber 17 and the second cylinder chamber 18, an upper bearing 22 which is provided on the upper surface of the first cylinder main body 19, thereby defining the first cylinder chamber 17 and supporting the crankshaft 14, and a lower bearing 23 which is provided on the lower surface of the second cylinder main body 20, thereby defining the second cylinder chamber 18 and supporting the crankshaft 14.

[0027] Further, the first and second rotary compression mechanisms 6A and 6B are provided with the first rotor 24 and the second rotor 25 which are rotatably fitted to the first eccentric portion 15 and the second eccentric portion 16 and are rotated in the first cylinder chamber 17 and the second cylinder chamber 18, and blades 28 and 29 (refer to Fig. 2) which are slidably fitted into blade grooves 26 and 27 (refer to Fig. 2) provided in the first cylinder main body 19 and the second cylinder main body 20 and partition the insides of the first cylinder chamber 17 and the second cylinder chamber 18 into intake chamber sides and discharge chamber sides.

[0028] A configuration is made such that the low-pressure refrigerant gas is sucked from the suction pipes 10 and 11 into the first cylinder chamber 17 and the second cylinder chamber 18 of the first and second rotary compression mechanisms 6A and 6B through suction ports 30 and 31, is compressed by the rotation of the first rotor 24 and the second rotor 25, thereafter, is discharged into discharge chambers 32 and 33 through discharge ports and discharge valves (not shown), is discharged from the discharge chambers 32 and 33 into the sealed container 2, and thereafter, is sent out to the refrigeration cycle through the discharge pipe 8.

[0029] The first cylinder main body 19 and the second cylinder main body 20, the partition plate 21, the upper bearing 22, and the lower bearing 23 configuring the rotary compression mechanism 6 are integrally fastened and fixed to each other through bolts. Further, refrigerant oil 34 such as PAG oil or POE oil is filled in a bottom portion in the sealed container 2 and can be fed to lubrication sites in the compression mechanism 6, as is known, through an oil feed hole or the like provided in the crankshaft 14. An extreme pressure agent adapted to each of the oils is added to the refrigerant oil 34 in an appropriate amount.

[0030] In the multi-cylinder rotary compressor 1 described above, in order to increase a displacement (capacity) thereof to a capacity one level higher by increasing the internal diameter of each of the first cylinder chamber 17 and the second cylinder chamber 18, that is, a cylinder internal diameter ϕDc, without changing a core diameter (a shell diameter or an eternal diameter) ϕMo of the motor 5 which is already used in a compressor in production, when a motor core diameter is set to be ϕMo and the cylinder internal diameter of each of the first cylinder chamber 17 and the second cylinder chamber 18 is set to be ϕDc, the cylinder internal diameter ϕDc is set so as to satisfy the relationship of $\phi Dc/\phi Mo \geq 0.49$.

[0031] This is because in a rotary compressor during production in a current situation, $\phi Dc/\phi Mo$ which is the ratio between the motor core diameter ϕMo and the cylinder internal diameter ϕDc generally mostly falls within a range of 0.35 to 0.45 and is 0.48 at a maximum, as shown in Fig. 6. On the other hand, the relationship between a gas load (a compression load) which becomes a mechanical load of a rotary compressor and $\phi Dc/\phi Mo$ forms a rightward and downward-sloping curve in a case where displacement is constant, as shown in Fig. 4, and for this reason, it is found that even if the value of $\phi Dc/\phi Mo$ is increased by increasing the cylinder internal diameter ϕDc, the gas load (refer to Fig. 3) does not increase and the mechanical load does not increase.

[0032] That is, it is apparent from Figs. 4 and 6 that even if in order to increase the displacement of the rotary compressor 1 to a certain value, a blade stroke (a sliding stroke of each of the blades 28 and 29) is made to be a longer stroke by increasing the cylinder internal diameter ϕDc without changing the motor core diameter ϕMo, thereby making $\phi Dc/\phi Mo$ which is the ratio therebetween be 0.49 or more, the gas load (the compression load) which is determined from a frontal projected area of a rotor, which is the product of a rotor external diameter ϕDr and a rotor width Hr, is restricted to a predetermined value or less with the frontal projected area of a rotor restricted.

[0033] Knowledge that if the gas load which determines the mechanical load can be restricted to a certain value or less under the above-described conditions, the displacement can be made to have a larger capacity by increasing the cylinder internal diameter ϕDc without changing the motor core diameter ϕMo was obtained. That is, if the displacement is made to have a larger capacity, as shown in Fig. 3, the gas load which is the mechanical load increases, and thus the deformation amount of the crankshaft 14 increases, and therefore, it becomes necessary to suppress the deformation of the crankshaft 14. If the deformation amount of the crankshaft 14 increases, the degree of partial contact of the shaft with the bearing increases, and thus bearing surface pressure increases. The deformation amount of the crankshaft 14 depends on a distance between bearing support points L between the upper bearing 22 and the lower bearing 23, and therefore, it is found that making the distance between bearing support points L as small as possible is effective in suppressing the bearing surface pressure.

[0034] In order to make the distance between bearing support points L small, it is favorable if a width Hc of each of the first cylinder chamber 17 and the second cylinder chambers 18 (hereinafter referred to as a cylinder width Hc) and a width Hs of the partition plate (the separator plate) 21 (hereinafter referred to as a partition plate width Hs) are reduced. However, in increasing the displacement, it is difficult to reduce the cylinder width Hc. Therefore, the partition plate width Hs is reduced. However, as a result of the analysis of the relationship between the partition plate width Hs and the cylinder width Hc, and the bearing surface pressure, when a graph with Hs/Hc as the horizontal axis and the bearing surface pressure as the vertical axis is made, as shown in Fig. 5, an rightward and upward-sloping curve is obtained, and it is found that if Hs/Hc is set to be less than or equal to a predetermined value, it is possible to make the bearing surface pressure be less than or equal to an allowable value.

[0035] From the above, even if the relationship of $\phi Dc/\phi Mo \geq 0.49$ is satisfied by increasing the cylinder internal diameter ϕDc without changing the motor core diameter ϕMo affecting a manufacturing facility (the motor core diameter is restricted by a manufacturing facility, and thus if the motor core diameter is increased, new capital investment is required), if Hs/Hc is limited to the relationship of $Hs/Hc \leq 0.35$, it becomes possible to make the displacement of the rotary compressor 1 have a larger capacity by suppressing an increase in the bearing surface pressure which is the mechanical load. That is, it becomes possible to easily manufacture the rotary compressor 1 having a displacement one level higher by using an existing facility without new capital investment, with the core diameter ϕMo of the motor 5 being the existing core diameter ϕMo in a hatching area shown in Fig. 6.

[0036] In addition, as described above, if a partition plate made of sintered metal or cast iron which has been used for the partition plate 21 in the past is used as it is by reducing the width Hs of the partition plate 21, since these materials have a low Young's modulus of 160 [GPa] or less, there is a possibility that deformation due to a reduction in width may become a problem. Therefore, it is desirable that the partition plate 21 is configured with a material having a Young's modulus of 160 [GPa] or more, and it is favorable if, for example, carbon steel or alloy steel having a Young's modulus of about 200 [GPa] is used.

[0037] Further, if the cylinder internal diameter ϕDc is increased, the stroke of each of the blades 28 and 29 is increased according to this, thereby having to become a longer stroke, and due to the blade stroke becoming a longer stroke, pressure which is applied to the side surface of each of the blades 28 and 29 increases, and thus so-called blade side surface pressure rises. In order to cope with this, it is desirable to apply a hard coating such as a PVD film (a Physical Vapor Deposition film) of CrN type or the like or a DLC film (a DiamondLike Carbon film), for example, to both side surfaces of each of the blades 28 and 29 so as to be able to cope with abnormal wear or the like due to a surface pressure rise.

[0038] In addition, although an attempt to suppress an increase in the mechanical load due to making the displacement of the compressor have a larger capacity, as much as possible, is made, some increase of the mechanical load such as the bearing surface pressure or the blade side surface pressure is inevitable and it becomes easy for an extreme pressure lubrication state to occur in sliding portions such as the bearings 22 and 23, the blades 28 and 29, or the rotors 24 and 25. In order to cope with this, it is desirable that the extreme pressure agent which is effective under a high load, as described above, is added to the refrigerant oil 34 filled in the bottom portion in the sealed container 2, in an appropriate amount.

[0039] Due to the configuration described above, according to this embodiment, the following operation and effects are exhibited.

[0040] In the rotary compressor 1, if the internal diameter of each of the first cylinder chamber 17 and the second cylinder chamber 18, that is, the cylinder internal diameter ϕDc, is increased, a cylinder volume increases, and therefore, it is possible to make the displacement of the compressor have a larger capacity by increasing the eccentricities of the first eccentric portion 15 and the second eccentric portion 16, thereby increasing the strokes of the blades 28 and 29.

[0041] Further, when manufacturing the rotary compressor 1, the core diameter ϕMo of the motor 5 is restricted by a manufacturing facility, and therefore, if the motor core diameter ϕMo is increased, new capital investment is required. However, if an increase in capacity is performed by increasing the cylinder internal diameter ϕDc with the core diameter ϕMo of the motor 5 set to be that in the existing rotary compressor 1, it is possible to manufacture the rotary compressor 1 having a displacement one level higher by using the existing facility without performing capital investment.

[0042] Thus, in this embodiment, in the sealed type multi-cylinder rotary compressor 1 in which the motor 5 and the compression mechanism 6 which is driven by the motor 5 are provided in the sealed container 2 and the compression mechanism 6 includes the rotary compression mechanisms 6A and 6B provided with the plurality of cylinders 17 and 18, the partition plate 21 which separates the plurality of cylinders 17 and 18, the blades 28 and 29, each of which partitions the inside of each of the cylinders 17 and 18 into an intake side and a discharge side, and the rotors 24 and 25 which respectively rotate in the cylinders 17 and 18, a configuration is made in which when the core diameter of the motor 5 is set to be ϕMo, the internal diameter of each of the cylinders 17 and 18 is set to be ϕDc, the width of each of the cylinders 17 and 18 is set to Hc, and the width of the partition plate 21 is set to Hs, the relationship of $Hs/Hc \leq 0.35$ is satisfied under a condition of $\phi Dc/\phi Mo \geq 0.49$.

[0043] In this way, it is possible to make the displacement of the multi-cylinder rotary compressor 1 have a larger capacity (an increased displacement) by making the stroke of each of the blades 28 and 29 be a longer stroke without changing the motor core diameter ϕMo and without increasing the gas load (the compression load), and it is possible to suppress a rise in bearing surface pressure by reducing the distance L between support points of the upper bearing 22 and the lower bearing 23 by making the width Hs of the partition plate as small as possible with respect to the cylinder width Hc. Therefore, it is possible to manufacture the sealed type multi-cylinder rotary compressor 1 having a displacement one level higher with the existing motor core diameter ϕMo maintained, and thus it is possible to attain the expansion of a product lineup without performing great capital investment.

[0044] Further, the possibility of the deformation of the partition plate 21 arises due to reducing the width Hs of the partition plate 21 so as to satisfy the relationship of $Hs/Hc \leq 0.35$. However, the partition plate 21 is configured with a material such as carbon steel or alloy steel, for example, having a Young's modulus of 160 [GPa] or more, whereby even if the width Hs of the partition plate 21 is reduced to 0.35 or less of the cylinder width Hc, it is possible to suppress the deformation of the partition plate 21. Therefore, it is possible to suppress an increase of mechanical load such as bearing surface pressure, and thus it is possible to easily increase the displacement of the multi-cylinder rotary compressor 1 to a capacity one level higher by increasing the cylinder internal diameter ϕDc without changing the motor core diameter ϕMo.

[0045] In addition, capacity is increased by increasing the cylinder internal diameter ϕDc, whereby the stroke of each of the blades 28 and 29 is made to be a longer stroke, and thus the blade side surface pressure rises. However, the hard coating such as the PVD film of CrN type or the like or the DLC film is applied to the blade surface, whereby it is also possible to sufficiently cope with abnormal wear or the like due to a rise in blade side surface pressure. For this reason, it is possible to easily increase the displacement of the multi-cylinder rotary compressor 1 to a capacity one level higher without performing capital investment, by increasing the cylinder internal diameter ϕDc without changing the core diameter ϕMo of the motor 5.

[0046] Further, since the extreme pressure agent is added to the refrigerant oil 34 which is filled into the bottom portion of the sealed container 2, although some increase of the mechanical load such as the bearing surface pressure or the blade side surface pressure according to an increase in the capacity of the compressor is inevitable and it becomes easy for an extreme pressure lubrication state to occur in the sliding portions, the extreme pressure agent which is effective under a high load is added to the refrigerant oil, whereby it is possible to maintain high lubricity on a sliding surface, thereby preventing seizure, wear, or scuffing. Accordingly, it is also possible to effectively cope with an increase in mechanical load according to an increase in the capacity of the rotary compressor 1.

[0047] In addition, the present invention is not limited to an invention related to the above-described embodiment and modifications can be appropriately made within a scope which does not depart from the gist thereof. For example, it goes without saying that in the above-described embodiment, the first rotary compression mechanism 6A and the second rotary compression mechanism 6B may be provided with phases shifted by 180 degrees from each other. Further, of course, the discharge chambers 32 and 33 may be configured such that high-pressure gas discharged to the discharge chamber 33 joins in the discharge chamber 32 and is then discharged into the sealed container 2. In addition, the widths Hc of the first cylinder chamber 17 and the second cylinder chamber 18 need not necessarily be the same and may be different widths, and in this case, it is favorable if the cylinder chamber a larger width Hc is used as a reference.

Reference Signs List

[0048]

1:	multi-cylinder rotary compressor
2:	sealed container
5:	motor
6:	compression mechanism (rotary compression mechanism)
6A:	first rotary compression mechanism
6B:	second rotary compression mechanism
14:	crankshaft
15:	first eccentric portion
16:	second eccentric portion
17:	first cylinder chamber (cylinder)
18:	second cylinder chamber (cylinder)
19:	first cylinder main body
20:	second cylinder main body
21:	partition plate
24:	first rotor
25:	second rotor
28, 29:	blade
34:	refrigerant oil
ϕMo:	motor core diameter
ϕDc:	cylinder internal diameter
Hc:	cylinder width
Hs:	partition plate width

Claims

1. A multi-cylinder rotary compressor comprising:

   a motor provided in a sealed container; and
   a compression mechanism which is provided in the sealed container and driven by the motor,
   wherein the compression mechanism is a rotary compression mechanism provided with a plurality of cylinders, a partition plate which separates the plurality of cylinders, a blade which partitions the inside of each of the cylinders into an intake side and a discharge side, and a rotor which rotates in each of the cylinders, and
   when a core diameter of the motor is set to be ϕMo, an internal diameter of each of the cylinders is set to be ϕDc, a width of each of the cylinders is set to Hc, and a width of the partition plate is set to Hs, the relationship of $Hs/Hc \leq 0.35$ is satisfied under a condition of $\phi Dc/\phi Mo \geq 0.49$.

2. The multi-cylinder rotary compressor according to Claim 1, wherein the partition plate is made of a material having a Young's modulus of 160 [GPa] or more.

3. The multi-cylinder rotary compressor according to Claim 2, wherein the partition plate is made of carbon steel or alloy steel.

4. The multi-cylinder rotary compressor according to any one of Claims 1 to 3, wherein the blade is a blade with a hard coating such as a PVD film of CrN type or the like or a DLC film applied to the surface thereof.

5. The multi-cylinder rotary compressor according to any one of Claims 1 to 4, wherein refrigerant oil which is filled into a bottom portion in the sealed container is refrigerant oil with an extreme pressure agent added thereto.

FIG. 1

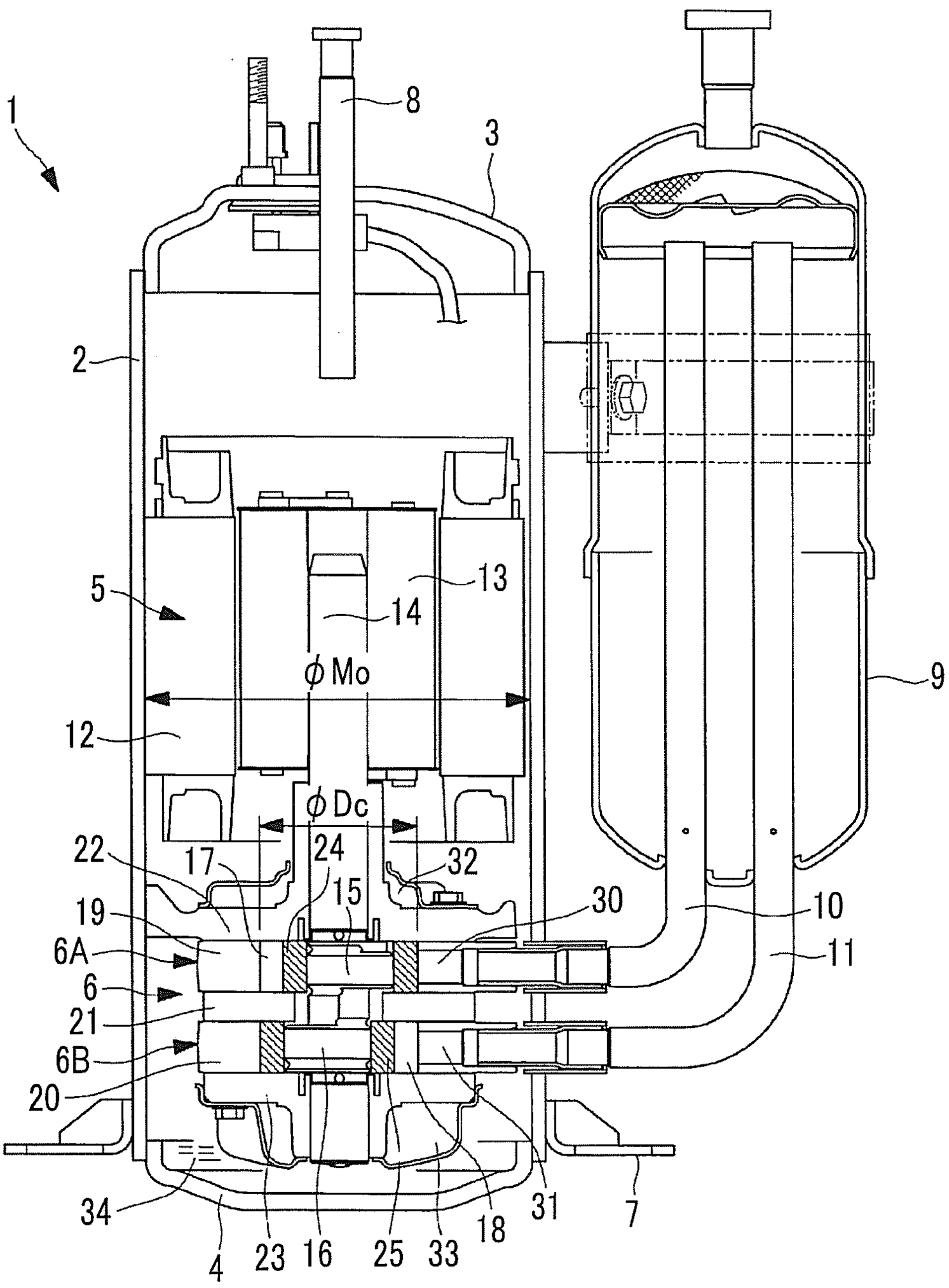

1
8
3
2
5
13
14
φ Mo
9
12
φ Dc
22
17
24
32
15
19
30
10
6A
11
6
21
6B
20
34
23
16
25
33
18
31
7
4

FIG. 2

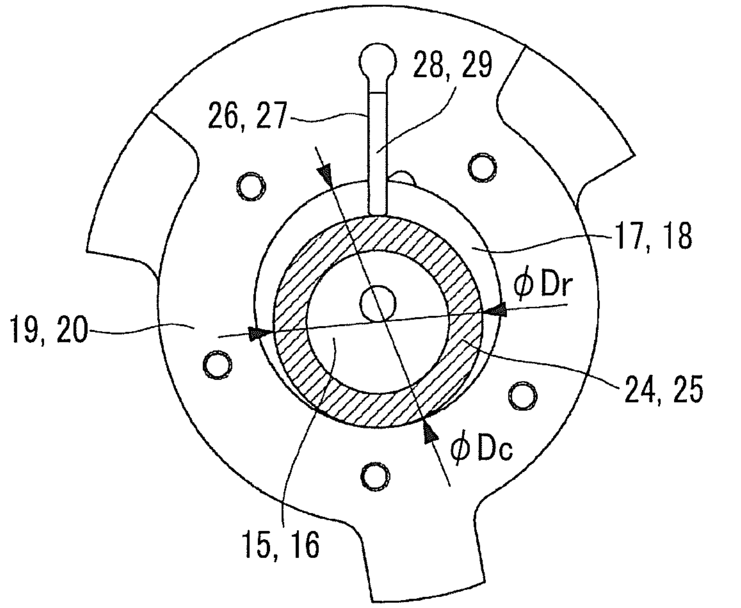

28, 29
26, 27
17, 18
ϕ Dr
19, 20
24, 25
ϕ Dc
15, 16

FIG. 3

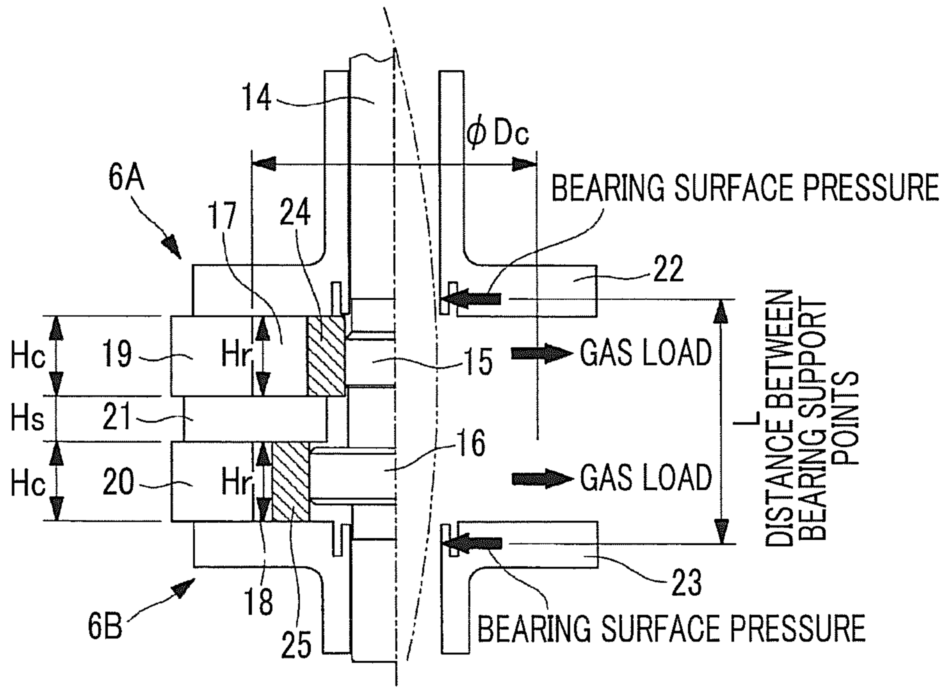

14
ϕ Dc
BEARING SURFACE PRESSURE
6A
17
24
22
Hc
19
Hr
15
GAS LOAD
Hs
21
16
Hc
20
Hr
GAS LOAD
L
DISTANCE BETWEEN BEARING SUPPORT POINTS
23
18
6B
25
BEARING SURFACE PRESSURE

FIG. 4

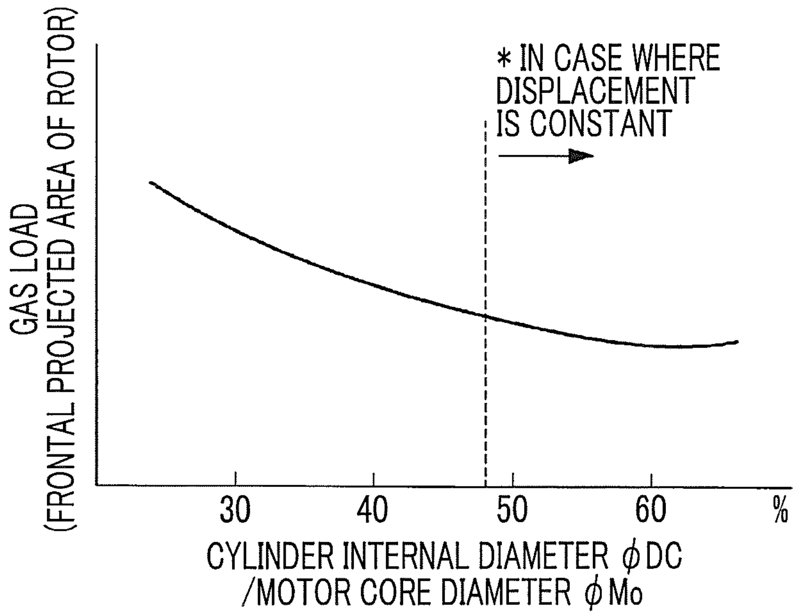

GAS LOAD
(FRONTAL PROJECTED AREA OF ROTOR)
* IN CASE WHERE DISPLACEMENT IS CONSTANT
30
40
50
60
%
CYLINDER INTERNAL DIAMETER φDC
/MOTOR CORE DIAMETER φMo

FIG. 5

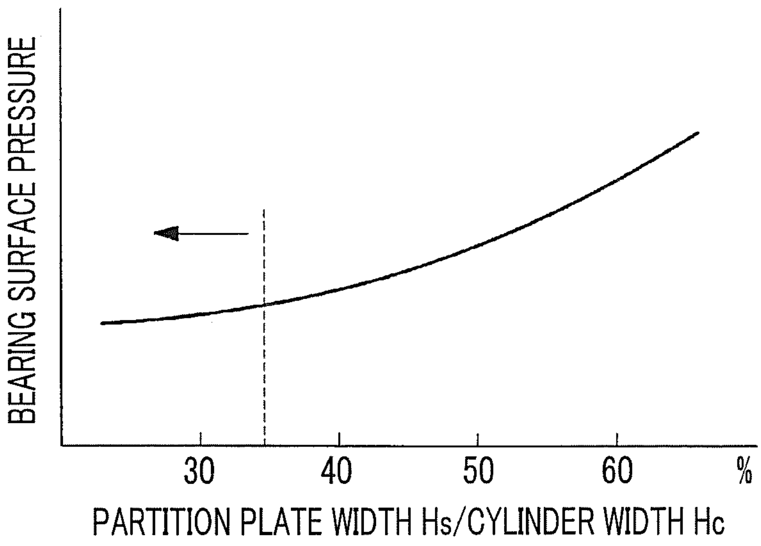
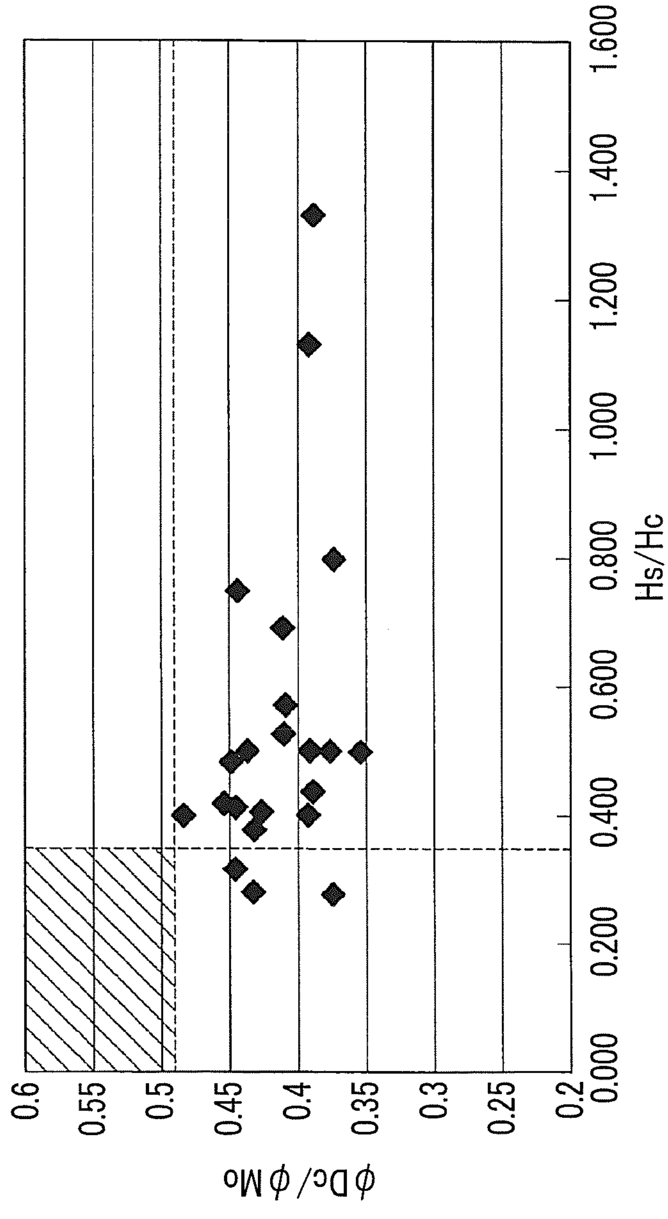

BEARING SURFACE PRESSURE
30
40
50
60
%
PARTITION PLATE WIDTH Hs/CYLINDER WIDTH Hc

FIG. 6


0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
1.600
Hs/Hc
φDc/φMo

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/056650

A. CLASSIFICATION OF SUBJECT MATTER
F04C23/00(2006.01)i, *F04C18/356*(2006.01)i, *F04C29/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04C23/00, F04C18/356, F04C29/00

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

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 3-206387 A (Hitachi, Ltd.), 09 September 1991 (09.09.1991), entire text; all drawings (Family: none)	1-5
Y	WO 2011/148453 A1 (Mitsubishi Electric Corp.), 01 December 2011 (01.12.2011), entire text; all drawings (Family: none)	1-5
Y	JP 10-9168 A (Hitachi, Ltd.), 13 January 1998 (13.01.1998), entire text; all drawings (Family: none)	1-5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 May, 2014 (07.05.14)	20 May, 2014 (20.05.14)

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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/056650

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 61-126395 A (Mitsubishi Electric Corp.), 13 June 1986 (13.06.1986), entire text; all drawings & US 4764097 A	1-5
Y	WO 2012/032765 A1 (Panasonic Corp.), 15 March 2012 (15.03.2012), entire text; all drawings & US 2013/0167580 A1	4-5
Y	JP 2008-101523 A (Daikin Industries, Ltd.), 01 May 2008 (01.05.2008), entire text; all drawings (Family: none)	5
Y	JP 2005-257240 A (Sanyo Electric Co., Ltd.), 22 September 2005 (22.09.2005), entire text; all drawings & US 2005/0210891 A1	5
A	JP 59-165885 A (Matsushita Refrigeration Co.), 19 September 1984 (19.09.1984), entire text; all drawings (Family: none)	1-5
A	JP 6-159277 A (Sanyo Electric Co., Ltd.), 07 June 1994 (07.06.1994), entire text; all drawings (Family: none)	1-5
A	JP 3-258984 A (Matsushita Refrigeration Co.), 19 November 1991 (19.11.1991), entire text; all drawings (Family: none)	1-5

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Patent documents cited in the description

- JP 4365729 B **[0004]**