



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

(43) Date of publication:
28.06.2017 Bulletin 2017/26

(51) Int Cl.:
F04C 29/12 ^(2006.01) **F04C 18/356** ^(2006.01)
F04C 23/00 ^(2006.01) **F04C 29/00** ^(2006.01)
F04C 29/06 ^(2006.01)

(21) Application number: **15834041.4**

(22) Date of filing: **23.07.2015**

(86) International application number:
PCT/JP2015/003684

(87) International publication number:
WO 2016/027413 (25.02.2016 Gazette 2016/08)

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

- **MONASRY, Jafet Ferdhy**
Shizuoka-ken (JP)
- **KIMURA, Shigeki**
Shizuoka-ken (JP)
- **HATAYAMA, Masahiro**
Shizuoka-ken (JP)
- **SHIMADA, Yoshiyuki**
Shizuoka-ken (JP)

(30) Priority: **22.08.2014 JP 2014169557**

(74) Representative: **Henkel, Breuer & Partner**
Patentanwälte
Maximiliansplatz 21
80333 München (DE)

(71) Applicant: **Toshiba Carrier Corporation**
Kawasaki-shi, Kanagawa 212-8585 (JP)

(72) Inventors:
• **HIRAYAMA, Takuya**
Shizuoka-ken (JP)

(54) **ROTARY COMPRESSOR AND REFRIGERATION CYCLE DEVICE**

(57) Provided are: a rotary compressor wherein it is possible to reduce discharge resistance and pulsation, improve performance, and reduce noise; and a refrigeration cycle device. A compression mechanism part (12) has a cylinder (15) and a pair of closing members (17, 18) for closing off both ends of the cylinder (15) and forming a cylinder chamber (16) in the cylinder (15). The closing members (17, 18) are provided with discharge ports (22, 26) for discharging a hydraulic fluid compressed in the cylinder chamber (16) and discharge valves (23, 27) for opening/closing the discharge ports (22, 26). One of the discharge ports (22), which is formed in one of the closing members (17), is formed so as to have a smaller opening area than that of the other discharge port (26), which is formed in the other closing member (18). One of the discharge valves (23), for opening/closing the discharge port (22) having the smaller opening area, is opened by a smaller differential pressure than that for the other discharge valve (27).

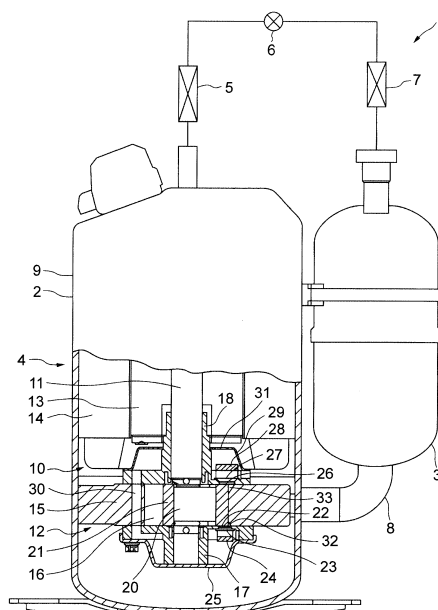


FIG. 1

Description

Technical Field

[0001] Embodiments of the present invention relate to a rotary compressor and a refrigeration cycle device.

Background Art

[0002] Conventionally, in a rotary compressor that compresses working fluid such as gas refrigerant, a cylinder chamber is formed in a cylinder by sealing both ends of the cylinder by a sealing member, and the cylinder chamber is divided into two chambers of a suction chamber and a compression chamber by a roller which rotates eccentrically and a blade which reciprocates. The working fluid sucked into the suction chamber is compressed in the compression chamber, and the compressed working fluid is discharged from a discharging port formed in the sealing member. In such a rotary compressor, in order to reduce a compression loss due to over-compression, various countermeasures are adopted. For example, in a rotary compressor disclosed in Patent Literature 1, discharging ports are formed in sealing members arranged at both ends of a cylinder respectively and a discharging valve is arranged so as to correspond to each discharging port, and in a case in which pressure in a compression chamber reaches predetermined pressure, the discharging valve is opened so that working fluid is discharged from each discharging port. With this, an amount of the working fluid passed through each discharging port is reduced, and therefore the compression loss due to the over-compression caused by a passage resistance when the working fluid is passed through the discharging port is reduced and compression performance is improved.

Citation List

Patent Literature

[0003] Patent Literature 1: JP 2013-83245 A

Summary of Invention

Technical Problem

[0004] However, in the rotary compressor disclosed in Patent Literature 1, each timing of opening of the two discharging valves is not considered. Thus, in a case in which the discharging valves of the two discharging ports through which the working fluid compressed in the compression chamber is discharged are opened at the same time, a noise is amplified by resonance of discharging pressure pulsations. Further, in a case in which delay of opening or closing of the discharging valve occurs, the pressure loss is increased.

[0005] An object of the embodiments of the present

invention is to obtain a rotary compressor and a refrigeration cycle device capable of preventing resonance of discharging pressure pulsations when working fluid compressed in one compression chamber is discharged from two discharging ports and further capable of reducing a compression loss due to over-compression caused when a discharging valve is opened in a low rotation speed and improving compression performance in the low rotation speed.

Solution to Problem

[0006] A rotary compressor according to an embodiment includes: an electric motor part; a compression mechanism part driven by a rotation shaft connected to the electric motor part, the compression mechanism compressing working fluid; and a sealed case which houses the electric motor part and the compression mechanism part, wherein: the compression mechanism part includes a cylinder, a pair of sealing members which seals both ends of the cylinder to form a cylinder chamber in the cylinder, a roller which is fitted to the rotation shaft penetrating the sealing members and is eccentrically rotated inside the cylinder chamber, a discharging port formed in the sealing member, wherein the working fluid compressed in a compression chamber formed in the cylinder chamber is discharged from the discharging port, and a discharging valve which opens and closes the discharging port, one discharging port formed in one sealing member among the pair of the sealing members is formed such that an opening area of the one discharging port is smaller than an opening area of the other discharging port formed in the other sealing member among the pair of the sealing members, and one discharging valve, which opens and closes the one discharging port having the small opening area is opened by smaller differential pressure compared to the other discharging valve among the discharging valves.

[0007] Further, the refrigeration cycle device according to the embodiment is characterized to include the rotary compressor described above, a condenser connected to the rotary compressor, an expansion device connected to the condenser, and an evaporator connected between the expansion device and the rotary compressor.

Advantageous Effects of Invention

[0008] With this, the rotary compressor and the refrigeration cycle device capable of reducing discharging resistance and reducing pulsation and thereby capable of achieving improvement of performance and reduction of a noise can be provided.

Brief Description of Drawings

[0009]

Fig. 1 is a diagram illustrating a configuration of a

refrigeration cycle device provided with a rotary compressor, a part of which is illustrated by a cross-sectional view, according to a first embodiment.

Fig. 2 is a cross-sectional view of a compression mechanism part shown in Fig. 1.

Fig. 3 is a diagram illustrating a configuration of a refrigeration cycle device provided with a rotary compressor, a part of which is illustrated by a cross-sectional view, according to a second embodiment.

Description of Embodiments

(First Embodiment)

[0010] A first embodiment is described with reference to Fig. 1 and Fig. 2. Fig. 1 illustrates a whole configuration of a refrigeration cycle device 1. The refrigeration cycle device 1 is provided with a compressor body 2 and an accumulator 3. Further, there is provided a rotary compressor 4, which compresses gas refrigerant provided as working fluid, arranged in the compressor body 2, a condenser 5, which condenses the gas refrigerant of high pressure and high temperature discharged from the compressor body 2 into fluid refrigerant, connected to the compressor body 2, an expansion device 6, which reduces pressure of the liquid refrigerant, connected to the condenser 5, and an evaporator 7, which evaporates the expanded liquid refrigerant, connected between the expansion device 6 and the accumulator 3. The accumulator 3 and the compressor body 2 are connected by a suction passage 8 through which the gas refrigerant is flowed.

[0011] The compressor body 2 is provided with a sealed case 9 formed in a cylindrical shape. In the sealed case 9, an electric motor part 10 arranged at an upper side, a rotation shaft 11 connected to the electric motor part 10, and a compression mechanism part 12 driven by the electric motor part 10 via the rotation shaft 11 are housed. A lubricating oil is housed in a lower part of the sealed case 9.

[0012] The electric motor part 10 is provided with a rotor 13 to which the rotation shaft 11 is fixed, and a stator 14 fixed to the sealed case 9 so as to be arranged at a position surrounding the rotor 13. A permanent magnet (not shown) is arranged in the rotor 13, and a coil (not shown) for energization is wound on the stator 14. The rotor 13 and the rotation shaft 11 are rotated when the coil is energized.

[0013] The compression mechanism part 12 is formed to compress the gas refrigerant, and the compression mechanism part 12 is provided with a cylinder 15, a sub bearing 17 and a main bearing 18 provided as a pair of sealing members which forms a cylinder chamber 16 in the cylinder 15 by sealing both ends of the cylinder 15, and a blade 19 (see Fig. 2). The sub bearing 17 and the main bearing 18 support the rotation shaft 11 penetrated into the cylinder 15. An eccentric part 20 which is eccentric from a rotation center is arranged at a position where

the rotation shaft 11 is located in the cylinder chamber 16, and a roller 21 is fitted to the eccentric part 20. The roller 21 is arranged so as to eccentrically rotate with an outer peripheral surface linearly contacted with an inner surface of the cylinder 15 via an oil film when the rotation shaft 11 is rotated. The blade 19 is described below with reference to Fig. 2.

[0014] In the sub bearing 17 provided as one sealing member which forms the cylinder chamber 16, a discharging port 22 (one discharging port 22) through which the gas refrigerant compressed in the cylinder chamber 16 is discharged is formed, and further a discharging valve 23 (one discharging valve 23) which opens and closes the discharging port 22 and a valve holder 24 which restricts the maximum opening of the discharging valve 23 are mounted. Further, a sub bearing side muffler 25 into which the gas refrigerant discharged from the discharging port 22 is flowed is mounted to an outer peripheral part of the sub bearing 17.

[0015] In the main bearing 18 provided as the other sealing member which forms the cylinder chamber 16, a discharging port 26 (the other discharging port 26) through which the gas refrigerant compressed in the cylinder chamber 16 is discharged is formed, and further a discharging valve 27 (the other discharging valve 27) which opens and closes the discharging port 26 and a valve holder 28 which restricts the maximum opening of the discharging valve 27 are mounted. Further, a main bearing side muffler 29 into which the gas refrigerant discharged from the discharging port 26 is flowed is mounted to an outer peripheral part of the main bearing 18.

[0016] An inner space of the main bearing side muffler 29 and an inner space of the sub bearing side muffler 25 are communicated by a communication passage 30 formed in the sub bearing 17, the cylinder 15 and the main bearing 18. The gas refrigerant flowed into the sub bearing side muffler 25 is flowed into the main bearing side muffler 29 via the communication passage 30. A flow out hole 31 which flows out the gas refrigerant in the main bearing side muffler 29 into the sealed case 9 is formed in the main bearing side muffler 29.

[0017] When volume of the sub bearing side muffler 25 and volume of the main bearing side muffler 29 are compared with each other, the volume of the sub bearing side muffler 25 is smaller than the volume of the main bearing side muffler 29.

[0018] Here, a difference between the one discharging port 22 and the other discharging port 26 and a difference between one discharging valve 23 and the other discharging valve 27 are described.

[0019] An opening area of the one discharging port 22 and an opening area of the other discharging port 26 are different from each other, and the opening area of the one discharging port 22 is smaller than the opening area of the other discharging port 26. In accordance with the difference of the opening areas, a size of the one discharging valve 23 is smaller than a size of the other discharging valve 27. Further, the one discharging valve 23

is opened by smaller differential pressure (a difference between pressure inside the compression chamber and pressure outside the compression chamber, which is described below) compared to the other discharging valve 27.

[0020] Further, the natural frequency "f" of each of the discharging valves 23, 26 can be calculated by " $f = \sqrt{(K/m)} \div 2\pi$ ". Here, K denotes a spring constant of each of the discharging valves 23, 26, and m denotes mass of an openable part of each of the discharging valves 23, 26. Further, the natural frequency "f" of the one discharging valve 23 is set to be larger than the natural frequency "f" of the other discharging valve 27.

[0021] A part of each of the discharging ports 22, 26 is arranged so as to be shifted from the cylinder chamber 16 because of restriction in design. Further, discharging notches 32, 33 are formed on the inner peripheral part of the cylinder 15 so as to communicate the whole of the opening areas of the discharging ports 22, 26 with the cylinder chamber 16, respectively. When the discharging notches 32, 33 are compared with each other, one discharging notch 32 communicated with the one discharging port 22 formed in the sub bearing 17 is formed such that its volume is to be smaller, and the other discharging notch 33 communicated with the other discharging port 26 formed in the main bearing 18 is formed such that its volume is to be larger.

[0022] Fig. 2 is a cross-sectional view illustrating the compression mechanism part 12. A blade groove 34 is formed in the cylinder 15, and the blade 19 is housed in the blade groove 34 in a reciprocating manner. The blade 19 is biased such that a tip portion is contacted with the outer peripheral surface of the roller 21, and when the tip portion of the blade 19 is contacted with the outer peripheral surface of the roller 21, the cylinder chamber 16 is partitioned into a suction chamber 35 and a compression chamber 36. The suction chamber 35 is communicated with a suction passage 8, and the compression chamber 36 is communicated with the discharging port 22 (26).

[0023] In such a configuration of the rotary compressor 4, when the electric motor part 10 is energized, the rotation shaft 11 is rotated together with the rotor 13 around a center line, and the compression mechanism part 12 is driven by the rotation and the gas refrigerant is compressed in the cylinder chamber 16.

[0024] When the pressure of the compressed gas refrigerant reaches the set pressure, the discharging valves 23, 27 are opened, and the gas refrigerant is discharged from the discharging ports 22, 26. The gas refrigerant discharged from the discharging port 26 is flowed into the main bearing side muffler 29, and the gas refrigerant discharged from the discharging port 22 is flowed into the main bearing side muffler 29 via the communication passage 30 after flowing into the sub bearing side muffler 25. The gas refrigerant flowed into the main bearing side muffler 29 is flowed out from the flow out hole 31 into the sealed case 9.

[0025] The gas refrigerant flowed out into the sealed case 9 is flowed through the condenser 5, the expansion device 6, and the evaporator 7 in this order, and then, is returned to the rotary compressor 4, and thereby a refrigeration cycle in the refrigeration cycle device 1 is performed.

[0026] Here, the compression mechanism part 12 is provided with the two discharging ports 22, 26 of the one discharging port 22 formed in the sub bearing 17 and the other discharging port 26 formed in the main bearing 18 as discharging ports from which the gas refrigerant compressed in the cylinder chamber 16 (specifically, in the compression chamber 36) is discharged. Further, the differential pressure to open the one discharging valve 23 which opens and closes the one discharging port 22 and the differential pressure to open the other discharging valve 27 which opens and closes the other discharging port 26 are different from each other. Thus, since both discharging amounts of the gas refrigerant discharged from the discharging ports 22, 26 are reduced and the timings to open the discharging valves 23, 27 which open and close the discharging ports 22, 26, respectively are different from each other, the pulsation caused when the gas refrigerant is discharged from each of the discharging ports 22, 26 can be suppressed and the resonance of the pulsations can be prevented, and therefore the noise generated by the rotary compressor 4 can be suppressed.

[0027] Since the one discharging valve 23 which opens and closes the one discharging port 22 having a small opening area is opened by smaller differential pressure compared to the other discharging valve 27 which opens and closes the other discharging port 26 having a large opening area, the one discharging valve 23 is earlier opened at a low pressure when the discharging amount of the gas refrigerant is less in the low rotation speed, and therefore the pressure loss due to the over-compression caused when the discharging valves 23, 27 are opened can be reduced and the compression performance at the low rotation speed can be improved.

[0028] The natural frequency "f" of the one discharging valve 23 which opens and closes the one discharging port 22 having the small opening area is set to be larger than the natural frequency "f" of the discharging valve 27 which opens and closes the other discharging port 26 having the large opening area. Thus, response performance (performance to close the valve quickly when pressure is reduced) of the one discharging valve 23 can be enhanced, and the compression performance can be improved by preventing a backward flow of the gas refrigerant toward the cylinder chamber 16.

[0029] Here, in order to open the discharging valve by small differential pressure, it is necessary that the spring constant "K" of the discharging valve is set to be small, and by setting the spring constant "K" to be small, the response performance of the discharging valve is deteriorated. However, as apparent from the formula of " $f = \sqrt{(K/m)} \div 2\pi$ " described above, by setting the mass "m"

of the openable part of the discharging valve to be small, "f" can be large even if "K" is set to be small.

[0030] Accordingly, the size of the one discharging valve 23 which opens and closes the one discharging port 22 having the small opening area is small, and therefore "m" can be small.

[0031] Thus, in the one discharging valve 23, by setting "K" to be small in order to open the discharging valve 23 by the small differential pressure, the compression performance can be improved by enhancing the response performance of the discharging valve 23 while enhancing the compression performance in the low rotation speed by reducing the pressure loss due to the over-compression caused when the discharging valve 23 is opened in the low rotation speed.

[0032] The gas refrigerant compressed in the cylinder chamber 16 is discharged from the one discharging port 22 and flowed into the sub bearing side muffler 25, and at the same time, the gas refrigerant is discharged from the other discharging port 26 and flowed into the main bearing side muffler 29. When the opening areas of the discharging ports 22, 26 are compared with each other, since the opening area of the one discharging port 22 is small, an amount of the gas refrigerant discharged from the one discharging port 22 and flowed into the sub bearing side muffler 25 is less than an amount of the gas refrigerant discharged from the other discharging port 26 and flowed into the main bearing side muffler 29.

[0033] Here, the gas refrigerant discharged from the discharging port 22 and flowed into the sub bearing side muffler 25 has a high temperature, and since the gas refrigerant is flowed into the main bearing side muffler 29 after passing through the communication passage 30 formed adjacent to the cylinder chamber 16, the gas refrigerant heats up the gas refrigerant in the cylinder chamber 16 in the process.

[0034] When the gas refrigerant in the cylinder chamber 16 is heated by heat from outside, the compression performance of the rotary compressor 4 is deteriorated, however since the amount of the gas refrigerant discharged from the one discharging port 22 and flowed into the sub bearing side muffler 25 is less than the amount of the gas refrigerant discharged from the other discharging port 26 and flowed into the main bearing side muffler 29, the heating of the gas refrigerant in the cylinder chamber 16 by the gas refrigerant passed through the communication passage 30 can be suppressed. With this, the deterioration of the compression performance of the rotary compressor 4 due to the gas refrigerant in the cylinder chamber 16 heated by the heat from outside can be suppressed.

[0035] Further, since the amount of the gas refrigerant discharged from the one discharging port 22 and flowed into the sub bearing side muffler 25 becomes less, the volume of the sub bearing side muffler 25 can be small. Further, since the volume of the sub bearing side muffler 25 becomes small, an oil storing amount of a lubricating oil housed in the sealed case 9 can be increased without

raising an oil level, and therefore the performance of the rotary compressor 4 can be maintained for a long period of time.

[0036] Since a part of each of the discharging ports 22, 26 is formed so as to be shifted from the cylinder chamber 16, the discharging notches 32, 33 are formed on the inner peripheral surface of the cylinder 15 in order to communicate the whole of the opening area of the discharging ports 22, 26 with the cylinder chamber 16. Since these discharging notches 32, 33 are formed, the gas refrigerant compressed in the cylinder chamber 16 is smoothly discharged from each of the discharging ports 22, 26, and therefore the compression loss due to the over-compression caused by the resistance of the passage of the gas refrigerant toward the discharging ports 22, 26 can be reduced and the compression performance can be improved.

[0037] Further, regarding the volumes of these discharging notches 32, 33, the volume of the discharging notch 32 communicated with the discharging port 22 having the small opening area is smaller than the volume of the discharging notch 33 communicated with the discharging port 26 having the large opening area. With this, total volume of the discharging notches 32, 33 can be suppressed and the amount of the gas refrigerant remaining in the discharging notches 32, 33 when the discharging of the gas refrigerant from the cylinder chamber 16 is finished can be suppressed, and therefore re-expansion loss caused when the compressed gas refrigerant remains in the discharging notches 32, 33 can be suppressed.

(Second Embodiment)

[0038] A second embodiment is described with reference to Fig. 3. Further, the same numeral reference is assigned to the same component as the component described in the first embodiment, and the description thereof may not be repeated.

[0039] A basic configuration of a rotary compressor 4A according to the second embodiment is the same as that of the first embodiment. Only one cylinder 15 is arranged in the compression mechanism part 12 in the first embodiment, while two cylinders 41, 42 are arranged in a compression mechanism part 12A in the second embodiment, and this is the difference.

[0040] A partition wall 44 having a partition wall inner space 43 therein is arranged as one sealing member between the cylinders 41, 42 adjacent to each other. A sub bearing 45 is arranged as the other sealing member at an opposite side to a side where a partition wall 44 is arranged in one cylinder 41 located at a lower side among the two cylinders 41, 42.

[0041] A main bearing 46 is arranged as the other sealing member at an opposite side to a side where the partition wall 44 is arranged in the other cylinder 42 located at an upper side.

[0042] Further, both ends of the one cylinder 41 are

sealed by the partition wall 44 and the sub bearing 45, and thereby a cylinder chamber 47 is formed inside the cylinder 41, and both ends of the other cylinder 42 are sealed by the partition wall 44 and the main bearing 46, and thereby a cylinder chamber 48 is formed inside the cylinder 42.

[0043] The sub bearing 45 and the main bearing 46 support the rotation shaft 11, and the rotation shaft 11 is inserted into the cylinders 41, 42. An eccentric part 20a which is eccentric from a rotation center of the rotation shaft 11 is arranged at a position where the rotation shaft 11 is located in the cylinder chamber 47, and a roller 21a is fitted to the eccentric part 20a. Further, an eccentric part 20b which is eccentric from the rotation center of the rotation shaft 11 is arranged at a position where the rotation shaft 11 is located in the cylinder chamber 48, and a roller 21b is fitted to the eccentric part 20b.

[0044] The partition wall 44 is formed by joining two partition walls of a first divided partition wall 44a and a second divided partition wall 44b laminated in an axial direction of the rotation shaft 11. Recessed excavated parts are formed in the first and the second divided partition walls 44a, 44b, respectively. When the partition wall 44 is formed by joining the first and the second divided partition walls 44a, 44b, the excavated parts of the first and the second divided partition walls 44a, 44b are matched with each other so that the partition wall inner space 43 is formed in the partition wall 44.

[0045] A partition wall discharging port 49a provided as one discharging port from which the gas refrigerant compressed in the cylinder chamber 47 is discharged to the partition wall inner space 43 is formed in the first divided partition wall 44a. Further, a partition wall discharging valve 50a provided as one discharging valve which opens and closes the partition wall discharging port 49a and a valve holder 51a which restricts the maximum opening of the partition wall discharging valve 50a are mounted to the first divided partition wall 44a.

[0046] A configuration of the second divided partition wall 44b is similar to that of the first divided partition wall 44a, and a partition wall discharging port 49b provided as one discharging port from which the gas refrigerant compressed in the cylinder chamber 48 is discharged to the partition wall inner space 43 is formed. Further, a partition wall discharging valve 50b provided as one discharging valve which opens and closes the partition wall discharging port 49b and a valve holder 51b which restricts the maximum opening of the partition wall discharging valve 50a are mounted to the second divided partition wall 44b.

[0047] A discharging port 52 (the other discharging port 52) from which the gas refrigerant compressed in the cylinder chamber 47 is discharged is formed in the sub bearing 45, and a discharging valve 53 (the other discharging valve 53) which opens and closes the discharging port 52 and a valve holder 54 which restricts the maximum opening of the discharging valve 53 are mounted to the sub bearing 45. Further, a sub bearing side muffler

55 into which the gas refrigerant discharged from the discharging port 52 is flowed is mounted to an outer peripheral part of the sub bearing 45.

[0048] A discharging port 56 (the other discharging port 56) from which the gas refrigerant compressed in the cylinder chamber 48 is discharged is formed in the main bearing 46, and a discharging valve 57 (the other discharging valve 57) which opens and closes the discharging port 56 and a valve holder 58 which restricts the maximum opening of the discharging valve 57 are mounted to the main bearing 46. Further, a main bearing side muffler 59 into which the gas refrigerant discharged from the discharging port 56 is flowed is mounted to an outer peripheral part of the main bearing 46.

[0049] An inner space of the sub bearing side muffler 55 and an inner space of the main bearing side muffler 59 are communicated by a communication passage 60 formed in the sub bearing 45, the cylinders 41, 42 and the main bearing 46. The gas refrigerant flowed into the sub bearing side muffler 55 is flowed into the main bearing side muffler 59 via the communication passage 60. A flow out hole 31 which flows out the gas refrigerant in the main bearing side muffler 59 into the sealed case 9 is formed in the main bearing side muffler 59.

[0050] Here, a difference between the partition wall discharging port 49a formed in the partition wall 44 (the first divided partition wall 44a) and the other discharging port 52 formed in the sub bearing 45 and a difference between the partition wall discharging valve 50a and the other discharging valve 53 are described.

[0051] An opening area of the partition wall discharging port 49a and an opening area of the other discharging port 52 are different from each other, and the opening area of the partition wall discharging port 49a is smaller than the opening area of the other discharging port 52. In accordance with the difference of the opening areas, a size of the partition wall discharging valve 50a is smaller than a size of the other discharging valve 53. Further, the partition wall discharging valve 50a is opened by smaller differential pressure compared to the other discharging valve 53.

[0052] Further, the natural frequency "f" of the partition wall discharging valve 50a is set to be larger than the natural frequency "f" of the other discharging valve 53.

[0053] A part of each of the partition wall discharging ports 49a and the other discharging port 52 is arranged so as to be shifted from the cylinder chamber 47 because of restriction in design. Further, the discharging notches 32, 33 are formed on the inner peripheral part of the cylinder 41 so as to communicate the whole of the opening area of each of the partition wall discharging port 49a and the discharging port 52 with the cylinder chamber 47, respectively. When the discharging notches 32, 33 are compared with each other, volume of one discharging notch 32 communicated with the partition wall discharging port 49a is set to be smaller than volume of the other discharging notch 33 communicated with the other discharging port 52.

[0054] A difference between the partition wall discharging port 49b formed in the partition wall 44 (the second divided partition wall 44b) and the other discharging port 56 formed in the main bearing 46, and a difference between the partition wall discharging valve 50b and the other discharging valve 57 are described.

[0055] These differences are similar to the difference between the partition wall discharging port 49a and the other discharging port 52, and the difference between the partition wall discharging valve 50a and the other discharging valve 53. An opening area of the partition wall discharging port 49b is smaller than an opening area of the other discharging port 56. A size of the partition wall discharging valve 50b is smaller than a size of the other discharging valve 57. The partition wall discharging valve 50b is opened by smaller differential pressure compared to the other discharging valve 57. The natural frequency "f" of the partition wall discharging valve 50b is set to be larger than the natural frequency "f" of the other discharging valve 57.

[0056] In such a configuration, when the electric motor part 10 is energized, the rotation shaft 11 is rotated together with the rotor 13 around a center line, and the compression mechanism part 12A is driven by the rotation and the gas refrigerant is compressed in the cylinder chambers 47, 48 in the rotary compressor 4A according to the second embodiment.

[0057] The gas refrigerant compressed in the cylinder chamber 47 and the gas refrigerant compressed in the cylinder chamber 48 behave similarly each other, therefore, it is described by using the gas refrigerant compressed in the cylinder chamber 47 as an example.

[0058] When the pressure of the compressed gas refrigerant reaches the set pressure, the partition wall discharging valve 50a and the discharging valve 53 are opened, and the gas refrigerant is discharged from the partition wall discharging port 49a and the discharging port 52. The gas refrigerant discharged from the partition wall discharging port 49a is flowed into the partition wall inner space 43, and the gas refrigerant discharged from the discharging port 52 is flowed into the sub bearing side muffler 55.

[0059] Here, the two discharging ports (the partition wall discharging port 49a of the partition wall 44, the discharging port 52 of the sub bearing 45) are arranged as discharging ports from which the gas refrigerant compressed in the cylinder chamber 47 is discharged. Further, the differential pressure to open the partition wall discharging valve 50a which opens and closes the partition wall discharging port 49a and the differential pressure to open the other discharging valve 53 which opens and closes the discharging port 52 of the sub bearing 45 are different from each other. Thus, since both discharging amounts of the gas refrigerant discharged from the partition wall discharging port 49a and the discharging port 52 are reduced and the timings to open the partition wall discharging valve 50a and the discharging valve 53 which open and close the partition wall discharging port

49a and the discharging port 52, respectively are different from each other, the pulsation caused when the gas refrigerant is discharged from each of the partition wall discharging port 49a and the discharging port 52 can be suppressed and the resonance of the pulsations can be prevented, and therefore the noise generated by the rotary compressor 4A can be suppressed.

[0060] Since the partition wall discharging valve 50a which opens and closes the partition wall discharging port 49a having a small opening area is opened by smaller differential pressure compared to the other discharging valve 53 which opens and closes the other discharging port 52 having a large opening area, the partition wall discharging valve 50a is earlier opened at a low pressure when the discharging amount of the gas refrigerant is less in the low rotation speed, and therefore the pressure loss due to the over-compression caused when the discharging valves 50a, 53 are opened can be reduced and the compression performance at the low rotation speed can be improved.

[0061] The natural frequency "f" of the partition wall discharging valve 50a which opens and closes the partition wall discharging port 49a having the small opening area is set to be larger than the natural frequency "f" of the other discharging valve 53 which opens and closes the other discharging port 52 having the large opening area. Thus, response performance (performance to close the valve quickly when pressure is reduced) of the partition wall discharging valve 50a can be enhanced, and the compression performance can be improved by preventing a backward flow of the gas refrigerant toward the cylinder chamber 47.

[0062] The noise generated when the compressed gas refrigerant is discharged from the cylinder chamber 47 becomes the maximum in opening of the partition wall discharging valve 50a, which is earlier opened. However, since the partition wall 44 in which the partition wall discharging valve 50a is formed is located between the two cylinders 41, 42, the noise leaked to the outside of the rotary compressor 4A can be reduced by means of a noise insulation effect of the cylinders 41, 42.

[0063] A part of the gas refrigerant compressed in the cylinder chamber 48 is discharged from the partition wall discharging port 49b and flowed into the partition wall inner space 43, and at the same time, another part of the gas refrigerant is discharged from the discharging port 56 and flowed into the main bearing side muffler 59. Further, the gas refrigerant discharged from the discharging port 56 and flowed into the main bearing side muffler 59 is compressed in the cylinder chamber 47 and then discharged from the discharging port 52 and flowed into the sub bearing side muffler 55. And thereafter, the gas refrigerant is joined with the gas refrigerant flowed into the main bearing side muffler 59 via the communication passage 60 and is flowed out from the flow out hole 31 formed in the main bearing side muffler 59 into the sealed case 9.

[0064] Further, in each of the embodiments described above, the blade and the roller are separately arranged,

however the blade and the roller may be formed integrally.

[0065] As described above, several embodiments of the present invention are described, however these embodiments are merely described as examples, the scope of the present invention is not limited to these embodiments. These embodiments can be carried out by other various aspects, and therefore various omission, replacement, change can be carried out within the subject matter of the present invention. The embodiment and a modification(s) thereof are encompassed by the scope and the subject matter of the present invention and also encompassed by the invention described in Claims and the scope of the equivalent thereof.

Reference Signs List

[0066] 4 ... rotary compressor, 4A ... rotary compressor, 5 ... condenser, 6 ... expansion device, 7 ... evaporator, 9 ... sealed case, 10 ... electric motor part, 11 ... rotation shaft, 12 ... compression mechanism part, 12A ... compression mechanism part, 15 ... cylinder, 16 ... cylinder chamber, 17 ... sub bearing (one sealing member), 18 ... main bearing (the other sealing member), 21 ... roller, 22 ... one discharging port, 23 ... one discharging valve, 25 ... sub bearing side muffler, 26 ... the other discharging port, 27 ... the other discharging valve, 29 ... main bearing side muffler, 30 ... communication passage, 32 ... one discharging notch, 33 ... the other discharging notch, 36 ... compression chamber, 41, 42 ... cylinder, 47, 48 ... cylinder chamber, 43 ... partition wall inner space, 44 ... partition wall (one sealing member), 45 ... sub bearing (the other sealing member), 46 ... main bearing (the other sealing member), 49a, 49b ... partition wall discharging port (one discharging port), 50a, 50b ... partition wall discharging valve (one discharging valve), 52, 56 ... the other discharging port, 53, 57 ... the other discharging valve,

Claims

1. A rotary compressor comprising:

an electric motor part;
a compression mechanism part driven by a rotation shaft connected to the electric motor part, the compression mechanism compressing working fluid; and
a sealed case which houses the electric motor part and the compression mechanism part,

wherein:

the compression mechanism part includes a cylinder, a pair of sealing members which seals both ends of the cylinder to form a cylinder chamber in the cylinder, a roller which is fitted to the

rotation shaft penetrating the sealing members and is eccentrically rotated inside the cylinder chamber, a discharging port formed in the sealing member, wherein the working fluid compressed in a compression chamber formed in the cylinder chamber is discharged from the discharging port, and a discharging valve which opens and closes the discharging port, one discharging port formed in one sealing member among the pair of the sealing members is formed such that an opening area of the one discharging port is smaller than an opening area of the other discharging port formed in the other sealing member among the pair of the sealing members, and one discharging valve, which opens and closes the one discharging port having the small opening area, among the discharging valves is opened by smaller differential pressure compared to the other discharging valve among the discharging valves.

2. The rotary compressor according to claim 1, wherein the natural frequency of the one discharging valve which opens and closes the one discharging port having the small opening area is set to be larger than the natural frequency of the other discharging valve.

3. The rotary compressor according to claim 1 or 2, wherein the electric motor part and the compression mechanism part are housed in the sealed case such that the compression mechanism part is located at a lower side of the electric motor part, the one sealing member is formed by a sub bearing located at a lower side of the cylinder to support the rotation shaft, and the other sealing member is formed by a main bearing located at an upper side of the cylinder to support the rotation shaft, a sub bearing side muffler into which the working fluid compressed in the compression chamber and discharged from the one discharging port is flowed is arranged on the sub bearing, and a main bearing side muffler into which the working fluid compressed in the compression chamber and discharged from the other discharging port is flowed is arranged on the main bearing.

4. The rotary compressor according to claim 1 or 2, wherein the compression mechanism part includes a plurality of the cylinders, a partition wall including a partition wall inner space in the partition wall is arranged as the one sealing member between the cylinders adjacent to each other, a sub bearing is arranged as the other sealing member at an opposite side to a side where the partition wall is arranged in the one cylinder, a main bearing is arranged as the other sealing mem-

ber at an opposite side to a side where the partition wall is arranged in the other cylinder,
 a pair of partition wall discharging ports provided as the one discharging port from which the working fluid compressed in the compression chamber is discharged into the partition wall inner space is formed in the partition wall, and a partition wall discharging valve provided as the one discharging valve which opens and closes the partition wall discharging ports is arranged on the partition wall,
 an opening area of the partition wall discharging port is smaller than an opening area of the other discharging port formed in the sub bearing and the main bearing, and
 the partition wall discharging valve is opened by smaller differential pressure compared to the other discharging valve formed in the sub bearing and the main bearing.

5. The rotary compressor according to claim 1 or 2, wherein a part of the discharging port is arranged to be shifted from the cylinder chamber, a pair of discharging notches which communicates the whole of the opening area of the discharging port with the cylinder chamber is formed on an inner peripheral part of the cylinder, and volume of one discharging notch communicated with the one discharging port having the small opening area is smaller than volume of the other discharging notch.
6. The rotary compressor according to claim 4, wherein a part of the discharging port is arranged to be shifted from the cylinder chamber, a pair of discharging notches which communicates the whole of the opening area of the discharging port with the cylinder chamber is formed on an inner peripheral part of the cylinder, and volume of the one discharging notch communicated with the one discharging port having the small opening area is smaller than volume of the other discharging notch.
7. A refrigeration cycle device comprising:
 - the rotary compressor according to any one of claims 1 to 5;
 - a condenser connected to the rotary compressor;
 - an expansion device connected to the condenser; and
 - an evaporator connected between the expansion device and the rotary compressor.

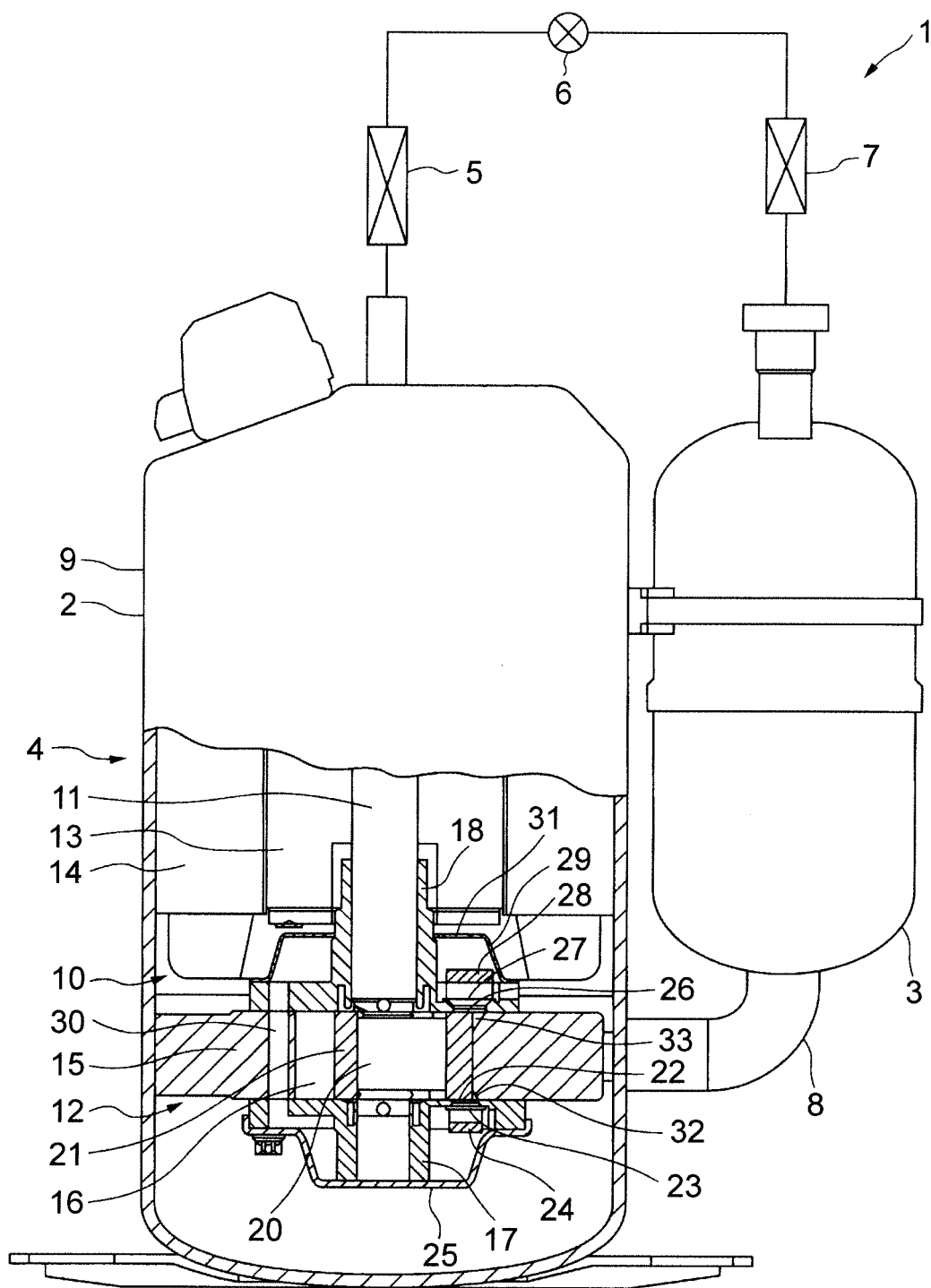


FIG. 1

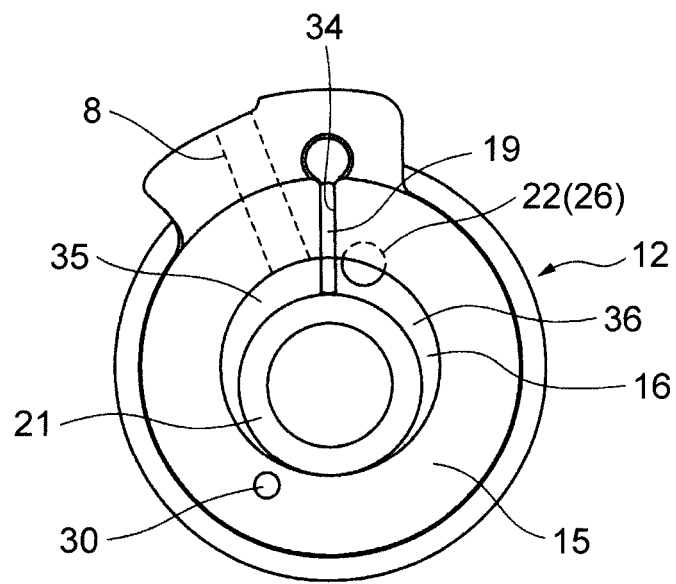


FIG. 2

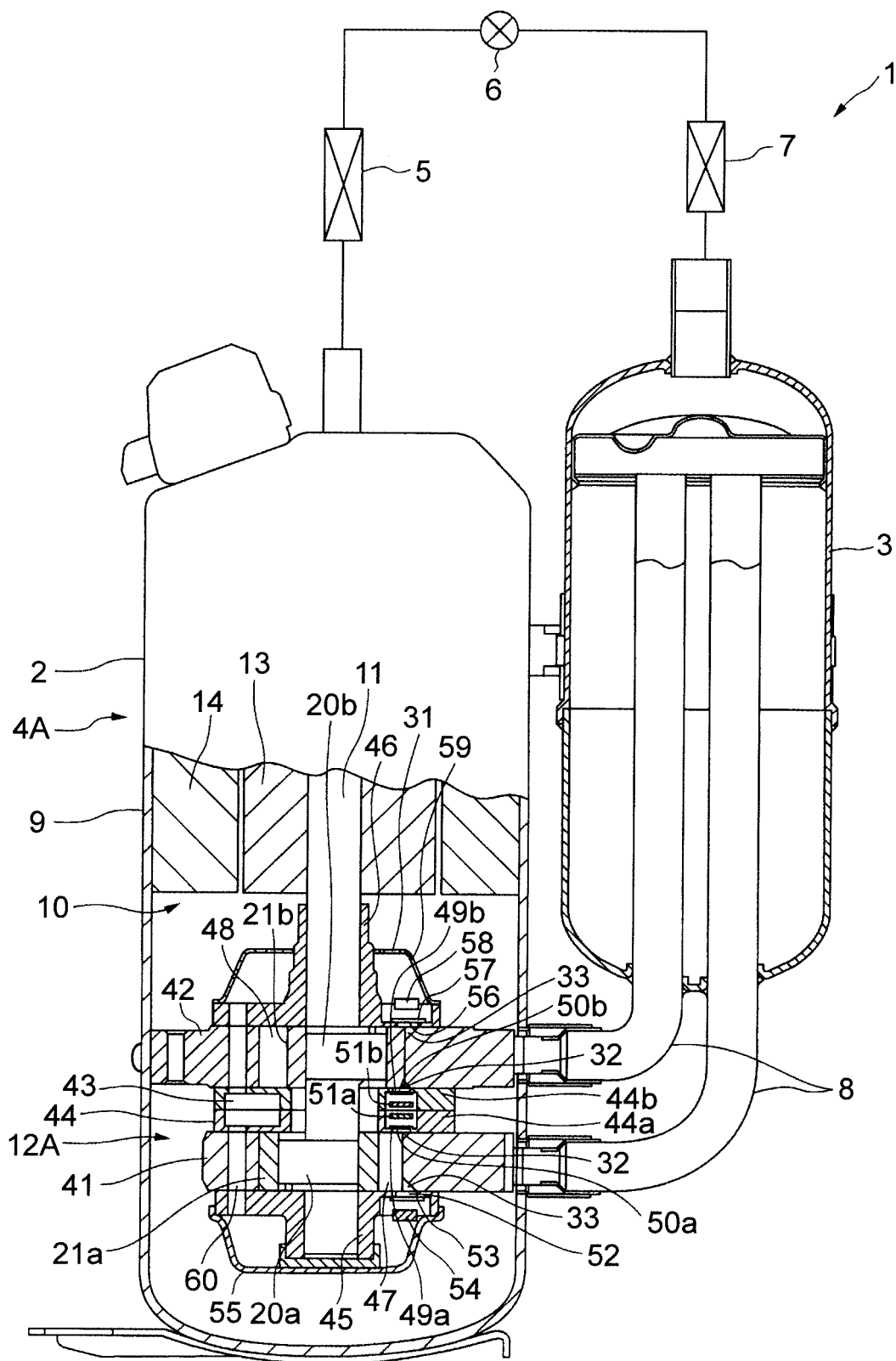


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/003684

A. CLASSIFICATION OF SUBJECT MATTER

F04C29/12(2006.01)i, F04C18/356(2006.01)i, F04C23/00(2006.01)i, F04C29/00(2006.01)i, F04C29/06(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04C29/12, F04C18/356, F04C23/00, F04C29/00, F04C29/06

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 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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.
A	JP 2008-82267 A (Daikin Industries, Ltd.), 10 April 2008 (10.04.2008), paragraph [0014] (Family: none)	1-7
A	JP 2004-278388 A (Sanden Corp.), 07 October 2004 (07.10.2004), claims (Family: none)	1-7
A	JP 2014-5825 A (Daikin Industries, Ltd.), 16 January 2014 (16.01.2014), paragraph [0029] (Family: none)	1-7

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* 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

Date of the actual completion of the international search
23 October 2015 (23.10.15)

Date of mailing of the international search report
02 November 2015 (02.11.15)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2013083245 A [0003]