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(54) ROTARY COMPRESSOR AND REFRIGERATION CYCLE DEVICE

(57) A rotary compressor and a refrigerating cycle device which are small in size yet large in discharge volume are provided. In a rotary compressor 2 by which the maximum discharge pressure of a working fluid becomes 3 or more MPa, any of the following relational expressions (1) to (3) are satisfied where an inner diameter of cylinder chambers 20a, 20b is D1, a total height of the cylinder chambers 20a, 20b is H, a distance from an upper end portion of a stator 14 to an inner wall surface of an upper portion of a hermetic case is L1, a sectional area of an inner side of the hermetic case is Ac, a total sectional area of a discharge flow channel 15 is Ad and a thickness of a stator core 14a of the stator 14 is T.

$$(1)\ 0.85 \times D1 < H < L1$$

$$(2)\ 0.06 < Ad/Ac < 0.13$$

$$(3)\ 1.2 < T/H < 1.5$$

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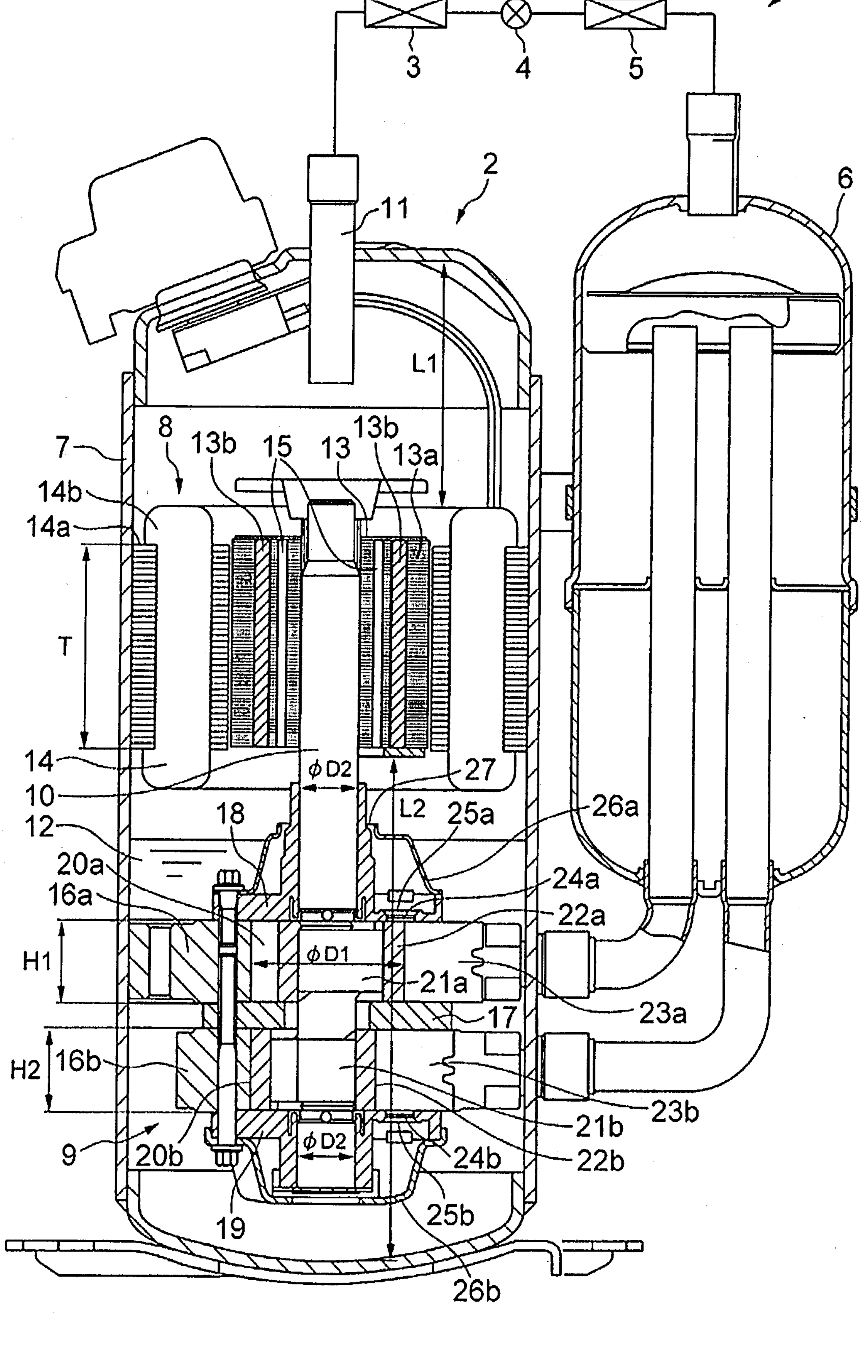
FIG. 1


1
3
4
5
2
11
6
L1
7
8
13b
15
13
13b
13a
14b
14a
T
14
10
φD2
27
L2
12
18
25a
26a
20a
24a
16a
22a
H1
φD1
21a
23a
17
H2
16b
23b
21b
9
20b
φD2
24b
22b
19
25b
26b

Description

TECHNICAL FIELD

[0001] Embodiments of the invention relate to a rotary compressor and a refrigerating cycle device which uses the rotary compressor.

BACKGROUND ART

[0002] In a rotary compressor, which houses an electric motor and a compression mechanism portion that is driven via a rotary shaft connected to the electric motor in a hermetic case and which compresses a working fluid such as a refrigerant, various measures are taken in order to increase a discharge volume of the working fluid to be compressed and discharged, for example, a measure described in the following Patent Document 1 is taken.

[0003] According to a rotary compressor described in the Patent Document 1, $H/D<0.4$ is set for a 1-cylinder type and $H/D\leq 0.3$ is set for a 2-cylinder type where an inner diameter of a cylinder chamber is D and a height of the cylinder chamber is H.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0004] [PATENT DOCUMENT 1] Patent Publication No. 4864572

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0005] However, in the rotary compressor described in the Patent Document 1, it is necessary to enlarge the inner diameter of the cylinder chamber in order to increase a discharge volume, and an inner diameter of a hermetic case also becomes large since a pressure resistance falls with the enlargement. In particular, in a case that a discharge pressure is high, it is necessary to thicken a thickness of the hermetic case, which causes enlargement of size, increase of weight and deterioration of resource-saving property of a rotary compressor. Thus, it may be considered to enlarge H/D to increase a discharge volume without enlarging an inner diameter of the hermetic case. However, in the case, since the diameter of an electric motor cannot be enlarged, a compression load torque becomes excessively large in a 4-pole electric motor which is generally used conventionally and the compressor efficiency lowers.

[0006] An object of an embodiment of the invention is to provide a rotary compressor which is small in size yet large in discharge volume and a refrigerating cycle device using the rotary compressor.

MEANS FOR SOLVING THE PROBLEM

[0007] According to a rotary compressor of an embodiment, the rotary compressor comprises a hermetic case, an electric motor which is housed at an upper portion in the hermetic case and has six or more poles, a compression mechanism portion which is housed at a lower portion in the hermetic case and is driven via a rotary shaft connected to the electric motor, and a discharge pipe which is provided at the upper portion in the hermetic case, wherein
the compression mechanism portion has two cylinders which have covered upper and lower both ends and cylinder chambers formed inside, compresses a working fluid by eccentric rotation of a roller fitted to the rotary shaft in the cylinder chambers and discharges the compressed working fluid into the hermetic case,
the electric motor has a rotor which rotates with the rotary shaft and a stator which surrounds the outer periphery of the rotor,
a discharge flow channel which leads the working fluid discharged from the insides of the cylinder chambers to a side of the discharge pipe is formed, and
a maximum discharge pressure of the working fluid becomes three or more MPa, wherein
the rotary compressor is characterized in that any of the following relational expressions (1) to (3) are satisfied where an inner diameter of the cylinder chambers is D1, a total height of the cylinder chambers of the two cylinders is H, a distance from an upper end portion of the stator to an inner wall surface of an upper portion of the hermetic case is L1, a sectional area of an inner side of the hermetic case is Ac, a total sectional area of the discharge flow channel is Ad and a thickness of a stator core of the stator is T.

$$(1)\ 0.85\times D1 < H < L1$$

$$(2)\ 0.06 < Ad/Ac < 0.13$$

$$(3)\ 1.2 < T/H < 1.5$$

EFFECT OF THE INVENTION

[0008] Thereby, a rotary compressor which is small in size yet large in discharge volume and a refrigerating cycle device using the rotary compressor can be obtained.

BRIEF DESCRIOTION OF THE DRAWINGS

[0009]

Fig. 1 is a schematic diagram of a refrigerating cycle device including a rotary compressor which is shown by a sectional view.

Fig. 2 is a graph which shows a COP ratio in a case of changing a ratio of a height and an inner diameter of cylinder chambers in a 4-pole electric motor and a 6-pole electric motor.

Fig. 3 is a graph which shows a relation between Ad/Ac and an oil discharge quantity of lubricating oil.

Fig. 4 is a graph which shows a relation between Ad/Ac and an efficiency ratio of an electric motor.

Fig. 5 is a graph which shows a relation between T/H and an efficiency ratio of an electric motor.

Fig. 6 is a graph which shows a relation between T/H and a ratio of a pressure loss of a discharge flow channel.

Fig. 7 is s a graph which shows D2/H and a COP ratio.

EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0010] An outline of a refrigerating cycle device of an embodiment will be described based on Fig. 1. As shown in Fig. 1, a refrigerating cycle device 1 has a rotary compressor 2, a condenser 3 which is a radiator connected to the rotary compressor 2, an expansion device 4 connected to the condenser 3, and an evaporator 5 which is a heat sink connected to the expansion device 4. An accumulator 6 is provided in the rotary compressor 2. In the refrigerating cycle device 1, a refrigerant which is a working fluid circulates while phase-changing to a gas refrigerant in a gas state and to a liquid refrigerant in a liquid state. Heat is radiated in a process of phase-change from a gas refrigerant to a liquid refrigerant. Heat is absorbed in a process of phase-change from a liquid refrigerant to a gas refrigerant. Using these heat radiation and heat absorption, air heating, air cooling, heating, cooling etc. are performed.

[0011] A gas refrigerant is compressed in the rotary compressor 2. In the condenser 3, the compressed gas refrigerant is condensed and becomes a liquid refrigerant. The condensed liquid refrigerant is decompressed in the expansion device 4. In the evaporator 5, the decompressed liquid refrigerant evaporates and becomes a gas refrigerant. In the accumulator 6 of the rotary compressor 2, liquid refrigerant is removed when the liquid refrigerant is contained in the gas refrigerant which is evaporated in the evaporator 5.

[0012] The rotary compressor 2 has a cylindrical hermetic case 7. Upper and lower ends of the hermetic case 7 are covered, and the hermetic case 7 is kept in an air-sealed state. An electric motor 8 is housed at an upper portion in the hermetic case 7. A compression mechanism portion 9 which is a portion to compress a gas refrigerant is housed at a lower portion in the hermetic case 7. A rotary shaft 10 is connected to the electric motor 8, and the compression mechanism portion 9 is driven via the rotary shaft 10. A gas refrigerant compressed in the compression mechanism portion 9 is discharged into an interior of the hermetic case 7, and the interior of the hermetic case 7 is filled with a high-pressure gas refrigerant. A discharge pipe 11 is provided at an upper portion of the hermetic case 7, and the high-pressure gas refrigerant in the interior of the hermetic case 7 is led to the condenser 3 through the inside of the discharge pipe 11. A lubricating oil 12 is reserved at a bottom portion in the hermetic case 7.

[0013] The electric motor 8 has a rotor 13 which is fixed to the rotary shaft 10 and rotates with the rotary shaft 10, and a stator 14 which surrounds the outer periphery of the rotor 13. The number of the poles of the electric motor 8 is six or more. The rotor 13 has a rotor core 13a which is formed by laminating electromagnetic steel sheets, and a plurality of permanent magnets 13b which are inserted in an inside of the rotor core 13a. The stator 14 has a stator core 14a which is formed by laminating electromagnetic steel sheets and has a field winding 14b which is wound around the stator core 14a. In the electric motor 8, a plurality of discharge flow channels 15 are formed. The discharge flow channels 15 lead a gas refrigerant discharged into the interior of the hermetic case 7 from the compression mechanism portion 9 to a side of the discharge pipe which is an upper side in the hermetic case 7. The discharge flow channels 15 are, for example, a through-hole formed to penetrate in an up-and-down direction in the rotor 13, a gap between an inner periphery of the hermetic case 7 and an outer periphery of the stator 14, a gap between an outer periphery of the rotor 13 and an inner periphery of the stator 14 etc.

[0014] The compression mechanism portion 9 has two cylinders 16a, 16b arranged in an up-and-down direction, a partition plate 17 arranged between the cylinders 16a, 16b to cover one end faces of these cylinders 16a, 16b, a main bearing 18 arranged at a side of the electric motor that is an upward side of the cylinder 16a and is one bearing to cover an end face of the cylinder 16a on the upward side, and a sub-bearing 19 arranged at a side opposite to the electric motor that is an downward side of the other cylinder 16b and is the other bearing to cover an end face of the cylinder 16b on the downward side. A cylinder chamber 20a is formed in the interior of the cylinder 16a whose both end faces are covered by the main bearing 18 and the partition plate 17. A cylinder chamber 20b is formed in the interior of the cylinder 16b whose both end faces are covered by the partition plate 17 and the sub-bearing 19. The rotary shaft 10 is inserted through these cylinders 16a, 16b. The rotary shaft 10 is supported pivotally by the main bearing 18 and the sub-bearing 19.

[0015] Two eccentric portions 21a, 21b of a cylindrical shape are formed at the rotary shaft 10. One eccentric portion 21a is arranged in the cylinder chamber 20a, and the other eccentric portion 21b is arranged in the cylinder chamber 20b. A roller 22a is fitted to the eccentric portion 21a, and a roller 22b is fitted to the eccentric portion 21b. These rollers 22a and 22b are provided so as to rotate eccentrically while their outer peripheral faces contacts the inner peripheral faces of the cylinder chambers 20a, 20b slidably with rotation of the rotary shaft 10. A blade 23a is provided in the cylinder 16a, and a blade 23b which is reciprocating and slidable is provided in the cylinder 16b. These blades 23a, 23b partition the interiors of the cylinder chambers 20a, 20b into suction chambers which sucks a low-pressure gas refrigerant and compression chambers which compress the sucked gas refrigerant, by making tip portions of the blades 23a, 23b contact outer peripheral faces of the rollers 22a and 22b.

[0016] The main bearing 18 is provided with a discharge hole 24a and discharge valve 25a to cause the gas refrigerant compressed in the cylinder chamber 20a to discharge into hermetic case 7. The sub-bearing 19 is provided with a discharge hole 24b and a discharge valve 25b to cause the gas refrigerant compressed in the cylinder chamber 20b to discharge into the hermetic case 7.

[0017] A muffler case 26a is attached to the main bearing 18 at a position surrounding the discharge valve 25a. A gas refrigerant discharged by opening the discharge valve 25a is discharged into the muffler case 26a, and then is discharged into the interior of the hermetic case 7 from a discharge hole 27 formed in the muffler case 26a. A muffler case 26b is attached to the sub-bearing 19 at a position surrounding the discharge valve 25b. A gas refrigerant discharged by opening the discharge valve 25b is discharged into the muffler case 26b, and then flows into the interior of the muffler case 26a through a communicating passage (not illustrated) and is discharged into the interior of the hermetic case 7 from the discharge hole 27 of the muffler case 26a.

[0018] The rotary compressor 2 is set so that the maximum discharge pressure of a gas refrigerant at the time of operation becomes three or more Mega Pascal (MPa). The size of each portion in the rotary compressor 2 will be explained in detail below.

[0019] The inner diameters of the cylinder chambers 20a, 20b are the same size, and the inner diameter of these cylinder chambers 20a and 20b is expressed as D1.

[0020] The height of one cylinder chamber 20a is expressed as H1. The height of the other cylinder chamber 20b is expressed as H2. The total height H of the two cylinder chambers 20a, 20b is expressed as (H=H1+H2).

[0021] The distance from an upper end portion of the stator 14 to an inner wall surface of the upper portion of the hermetic case 7 is expressed as L1.

[0022] The sectional area in a space portion inside the hermetic case 7 is expressed as Ac.

[0023] The total sectional area of the discharge flow channel 15 is expressed as Ad.

[0024] The thickness of the stator core 14a of the stator 14 is expressed as T.

[0025] Each size explained above is set so that the following relational expressions (1) to (3) are satisfied.

$$(1)\ 0.85 \times D1 < H < L1$$

$$(2)\ 0.06 < Ad/Ac < 0.13$$

$$(3)\ 1.2 < T/H < 1.5$$

[0026] In a horizontal section at the positions of the cylinders 16a, 16b in the hermetic case 7, the average sectional area of a space S which is formed outside the cylinder chambers 20a, 20b and extends in an up-and-down direction and in a peripheral direction is expressed as Av.

[0027] The distance from a lower end portion of the rotor 13 of the electric motor 8 to an inner wall surface of the lower portion of the hermetic case 7 is expressed as L2.

[0028] Each size explained above is set so that the following relational expressions (4), (5) are satisfied.

$$(4)\ Av/Ac > 0.1$$

$$(5)\ H < L2/2$$

[0029] The inner diameter of the main bearing 18 and the sub-bearing 19 is expressed as D2.

[0030] Each size explained above is set so that the following relational expression (6) is satisfied.

$$(6)\ 0.3 < D2/H < 0.4$$

[0031] In such configuration, the compression mechanism portion 9 is driven by rotation of the rotor 13 and the rotary shaft 10 through energization to the electric motor 8. By the driving of the compression mechanism portion 9, a low-pressure gas refrigerant passes the accumulator 6 and is sucked into the cylinder chambers 20a, 20b. The sucked gas refrigerant is compressed in the cylinder chambers 20a, 20b.

[0032] The gas refrigerant which is compressed in the cylinder chamber 20a and becomes high pressure is discharged into the muffler case 26a from the discharge valve 25a, and is discharged into the hermetic case 7 from the discharge hole 27 of the muffler case 26a. The gas refrigerant which is compressed in the cylinder chamber 20b and becomes high pressure is discharged into the muffler case 26b from the discharge valve 25b, flows into the muffler case 26a through the communicating passage which is not illustrated, then is discharged into the hermetic case 7 from the discharge hole 27 of the muffler case 26a. The gas refrigerant discharged into the hermetic case 7 from the discharge hole 27 is led to the side of the discharge pipe 11, which is the side of the upper portion in the hermetic case 7, through the discharge flow channel 15 formed in the electric motor 8, and is led to the condenser 3 through the discharge pipe 11.

[0033] Fig. 2 shows s a relation between "H/D1" and a ratio of a COP (Coefficient Of Performance) at a time of using a 4-pole electric motor and a COP at a time of using a 6-pole electric motor (a COP at a time of using a 4-pole electric motor / a COP at a time of using a 6-pole electric motor), in a case of enlarging the total height "H" of the cylinder chambers 20a, 20b to increase a discharge volume of a gas refrigerant while the inner diameter "D1" of the cylinder chambers 20a, 20b and the inner diameter of the hermetic case 7 are kept to be the same, under a rated condition using a refrigerant by which the maximum discharge pressure at a time of operation is three or more MPa (for example, R410A, R32, carbon dioxide).

[0034] From Fig. 2, it is found that, in the area of $0.85 \times D1 < H < L1$ which is an area in which the compression load torque is large, the COP ratio becomes one or more and the efficiency of a 6-pole electric motor becomes higher by copper loss suppressing effect or iron loss reducing effect due to decrease of a peak magnetic flux between iron cores at a time of a large current. Accordingly, in a case of $0.85 \times D1 < H < L1$, by using a 6-pole electric motor, promotion of small diameter of the hermetic case 7, increase of discharge volume and high efficiency can be attained at the same time, and a rotary compressor 2 which has a high pressure resistance, is small, light in weight and large in discharge volume and has a high resource-saving property can be provided.

[0035] In Fig. 2, a case in which a 6-pole electric motor is compared to a 4-pole electric motor is described as an example, but a similar effect can be obtained in an electric motor of 6 or more poles, for example, an 8-pole electric motor, a 10-pole electric motor etc.

[0036] Fig. 3 shows a measurement result of an oil discharge volume of the lubricating oil 12 from the discharge pipe 11 with respect to Ad (a total sectional area of the discharge flow channel 15)/Ac (a sectional area of the space portion of the inner side of the hermetic case 7) when $0.85 \times D1 < H$ is satisfied and the distance L1 from the upper end portion of the stator 14 to the inner wall surface of the upper portion of the hermetic case 7 is made larger than a total height H of the cylinder chambers 20a, 20b ($H < L1$).

[0037] The oil discharge quantity is denoted by a weight ratio to a circulation quantity of a gas refrigerant. The flow velocity of the gas refrigerant in the discharge flow channel 15 of the electric motor 8 becomes large as the discharge volume of the gas refrigerant is increased by changing the total height "H" of the cylinder chambers 20a, 20b without changing the inner diameter of the cylinder chambers 20a, 20b. Thus, it becomes difficult to separate lubricating oil from the gas refrigerant in the discharge flow channel 15, and it is found that the oil discharge quantity increases rapidly in a case of $Ad/Ac < 0.06$, especially.

[0038] Fig. 4 shows an efficiency ratio of the 6-pole electric motor 8 to Ad/Ac. The efficiency ratio of the electric motor 8 is denoted by a ratio to an electric motor efficiency in a case of $Ad/Ac = 0.13$. From Fig. 4, it is found that lowering of the space factor of the field winding 14b, lowering of the sectional area of the permanent magnet 13b etc. are invited in order to secure the area of the discharge flow channel 15 and that the efficiency of the electric motor 8 falls much, in a case of $Ad/Ac > 0.13$. From these, the oil discharge quantity can be reduced while suppressing deterioration of electric motor efficiency, by satisfying $H < L1$ and $0.06 < Ad/Ac < 0.13$ (the relational expression 2).

[0039] Fig. 5 shows an efficiency ratio of the 6-pole electric motor 8 to T (a thickness of the stator core 14a)/H (a total height of the cylinder chambers 20a, 20b) when $0.85 \times D1 < H < L1$ (the relational expression 1) and $0.06 < Ad/Ac < 0.13$ (the relational expression 2).are satisfied The efficiency ratio of the electric motor 8 is denoted by a ratio to an efficiency of the electric motor at $T/H = 1.2$. It is found that, in a case of $T/H < 1.2$, the thickness "T" of the stator core 14a is small with respect to a compression load torque and lowering of the efficiency of the electric motor 8 is invited.

[0040] Fig. 6 shows a relation between a ratio (T/H) of a thickness T of the stator core 14a of the stator 14 to a total height H of the cylinder chambers 20a, 20b and a ratio of a pressure loss Wd of a gas refrigerant at the discharge flow channel 15 of the electric motor 8 to a theoretical work Wth of the compressor. At $1.5 < T/H$, Wd/Wth increases rapidly. From these, the pressure loss of the discharge flow channel 15 can be reduced while suppressing deterioration of the efficiency of the electric motor, under $1.2 < T/H < 1.5$ (the relational expression 3).

[0041] Accordingly, by satisfying any of the above relational expressions 1 to 3, the rotary compressors 2, which has a high pressure resistance, is small and light in weight, has a large discharge volume, has a high resource-saving property, and moreover has a small oil discharge quantity and is high reliability can be provided.

[0042] In a case that thinning of the hermetic case 7 and increase of a discharge volume are enhanced, a sufficient quantity of the lubricating oil 12 can be reserved at the bottom of the hermetic case 7, by setting as $Av/Ac > 0.1$ (the relational expression 4) and $H < L2$ (a distance from the lower end portion of the rotor 13 to an inner wall surface of a lower portion of the hermetic case 7)/2 (the relational expression 5). Even when the lubricating oil 12 is discharged, rapid fall of the oil surface of the lubricating oil 12 can be prevented and a more reliable rotary compressor 2 can be provided.

[0043] Fig. 7 shows a COP ratio under a rated conditions to D2/H which is a ratio of an inner diameter D2 of the main bearing 18 and the sub-bearing 19 and a total height H of the cylinder chambers 20a, 20b. The COP ratio is denoted by a ratio to COP at D2/H= 0.3. In the area of D2/H<0.3, a distance between principal axes becomes large by enlarging H, the rigidity of the rotary shaft 10 becomes insufficient and bending of the rotary shaft 10 becomes excessive so that COP falls greatly. On the other hand, in the area of D2/H>0.4, the diameter of the rotary shaft 10 becomes large more than needed with respect to a compression load torque, increase of an axial sliding loss is invited, and COP falls. From these, the rotary compressor 2 which becomes much more efficient can be provided by setting as 0.3<D2/H<0.4 (the relational expression 6).

[0044] While certain embodiments of the invention have been described above, these embodiments have been presented by way of example only, and are not intended to limit the scope of the invention. Indeed, the embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the invention. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the invention.

DESCRIPTION OF REFERENCE SIGNS

[0045]

1 -- Refrigerating cycle device
2 -- Rotary compressor
3 -- Condenser (Radiator)
4 -- Expansion device
5 -- Evaporator (Heat sink)
8 -- Electric motor
9 -- Compression mechanism portion
10 -- Rotary shaft
11 -- Discharge pipe
13 -- Rotor
14 -- Stator
14a -- Stator core
15 -- Discharge flow channel
16a, 16b -- Cylinder
18, 19 -- Bearing
20a, 20b -- Cylinder chamber
22a, 22b -- Roller

Claims

1. A rotary compressor, comprising:

a hermetic case;
an electric motor which is housed at an upper portion in the hermetic case and has six or more poles;
a compression mechanism portion which is housed at a lower portion in the hermetic case and is driven via a rotary shaft connected to the electric motor; and
a discharge pipe which is provided at the upper portion in the hermetic case, wherein
the compression mechanism portion has two cylinders which have covered upper and lower both ends and cylinder chambers formed inside, compresses a working fluid by eccentric rotation of a roller fitted to the rotary shaft in the cylinder chambers and discharges the compressed working fluid into the hermetic case,
the electric motor has a rotor which rotates with the rotary shaft and a stator which surrounds the outer periphery of the rotor,
a discharge flow channel which leads the working fluid discharged from the insides of the cylinder chambers to a side of the discharge pipe is formed, and
the maximum discharge pressure of the working fluid becomes three or more MPa, wherein
the rotary compressor is **characterized in that** any of the following relational expressions (1) to (3) are satisfied where an inner diameter of the cylinder chambers is D1, a total height of the cylinder chambers of the two cylinders is H, a distance from an upper end portion of the stator to an inner wall surface of an upper portion of the hermetic case is L1, a sectional area of an inner side of the hermetic case is Ac, a total sectional area of the discharge flow channel is Ad and a thickness of a stator core of the stator is T.

$$(1)\quad 0.85\times D1 < H < L1$$

$$(2)\quad 0.06 < Ad/Ac < 0.13$$

$$(3)\quad 1.2 < T/H < 1.5$$

2. The rotary compressor according to claim 1 **characterized in that** the following relational expressions (4), (5) are further satisfied in a horizontal section at the positions of the cylinders in the hermetic case where an average sectional area of a space formed outside the cylinder chambers and extended in an up-and-down direction is Av and a distance from a lower end portion of the rotor of the electric motor to an inner wall surface of a lower portion of the hermetic case is L2.

$$(4)\quad Av/Ac > 0.1$$

$$(5)\quad H < L2/2$$

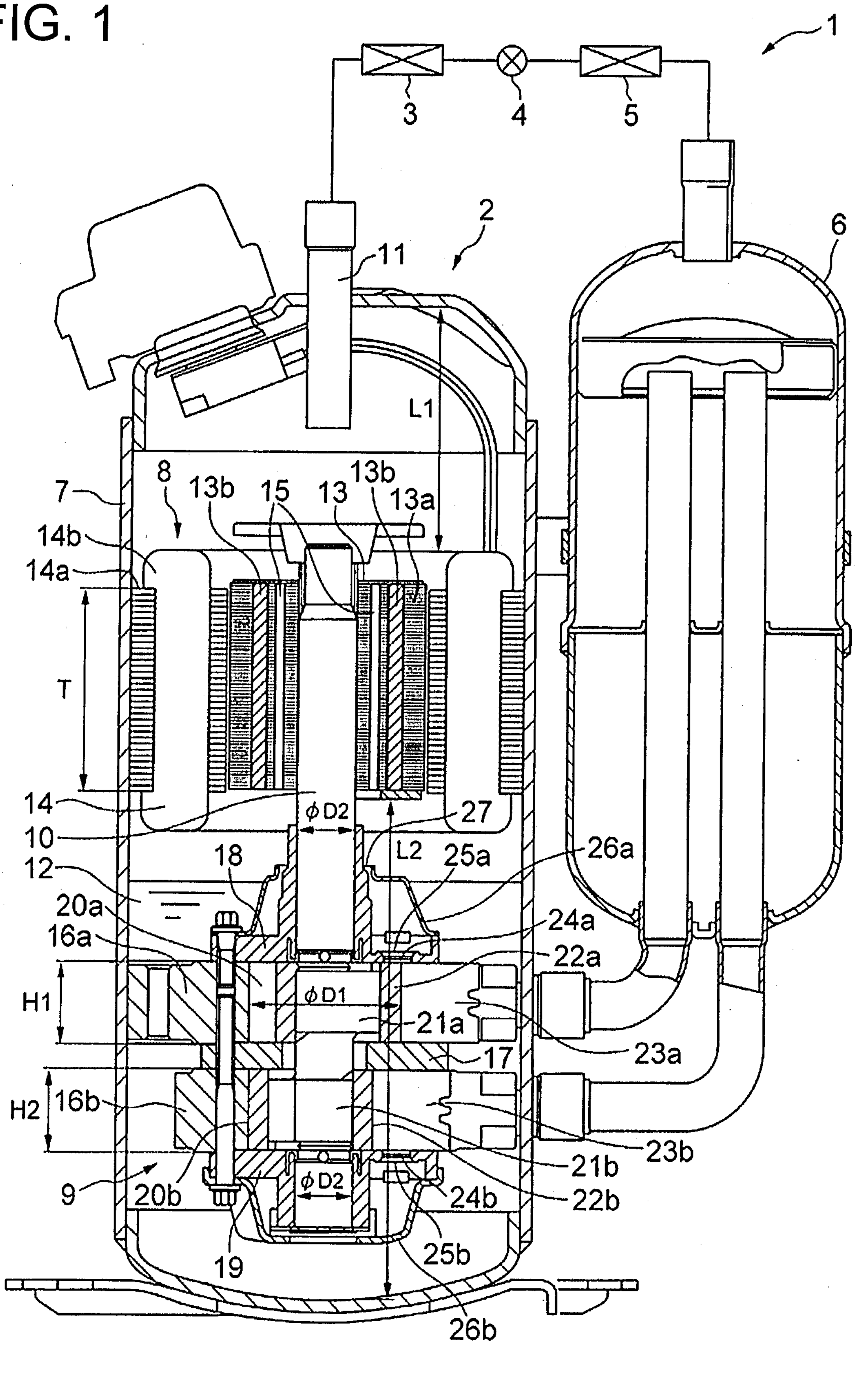
3. The rotary compressor according to claim 1 or 2 **characterized in that** the rotary shaft is supported pivotally by one bearing provided at an end face side of one of the cylinders on a side of the electric motor and by another bearing provided at an end face side of the other one of the cylinders on a side opposite to the side of the electric motor and **in that** the following relational expression (6) is further satisfied where an inner diameter of the bearings is D2.

$$(6)\quad 0.3 < D2/H < 0.4$$

4. A refrigerating cycle device, comprising:

the rotary compressor according to any one of claims 1 to 3;
a radiator connected to the rotary compressor;
an expansion device connected to the radiator; and
a heat sink connected between the expansion device and the rotary compressor.

FIG. 1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3
4
5
2
6
11
L1
7
8
13b
15
13
13b
13a
14b
14a
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14
10
ϕD2
27
L2
25a
26a
12
18
20a
16a
24a
22a
H1
ϕD1
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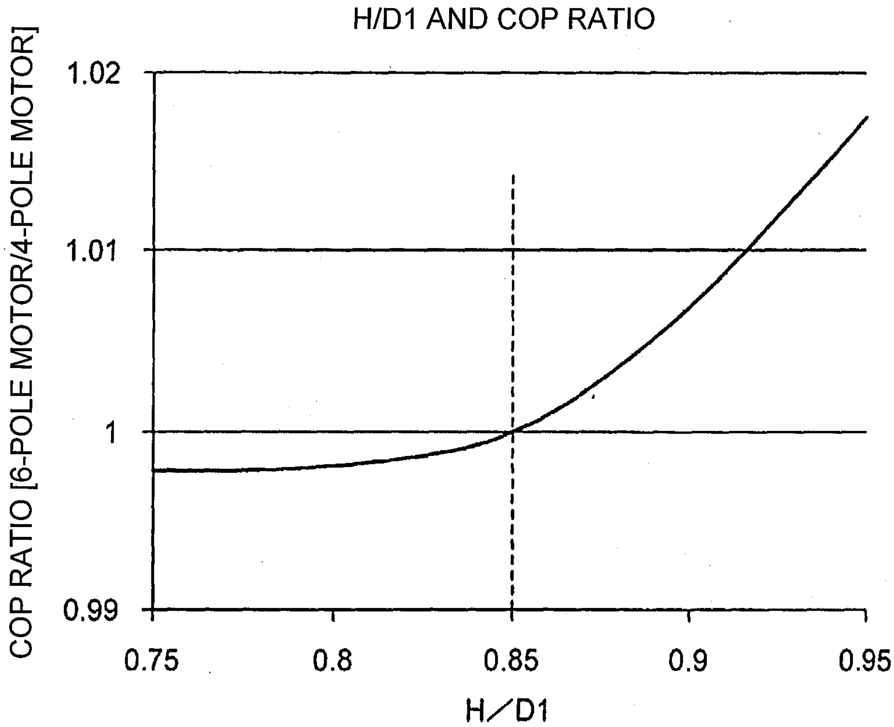
19
25b
26b

FIG. 2


H/D1 AND COP RATIO
COP RATIO [6-POLE MOTOR/4-POLE MOTOR]
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1.01
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0.99
0.75
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0.85
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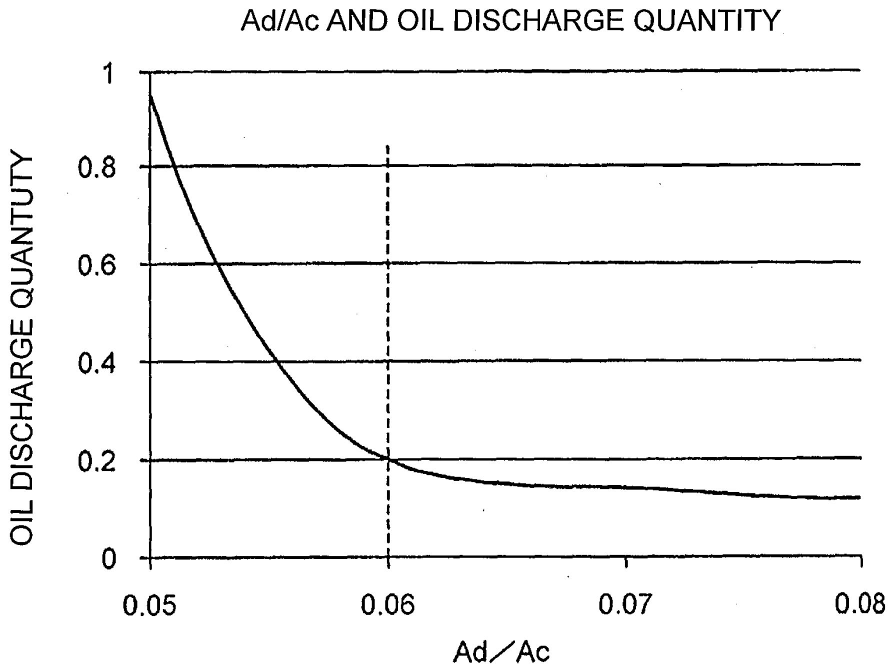
0.95
H／D1

FIG. 3


Ad/Ac AND OIL DISCHARGE QUANTITY
OIL DISCHARGE QUANTUTY
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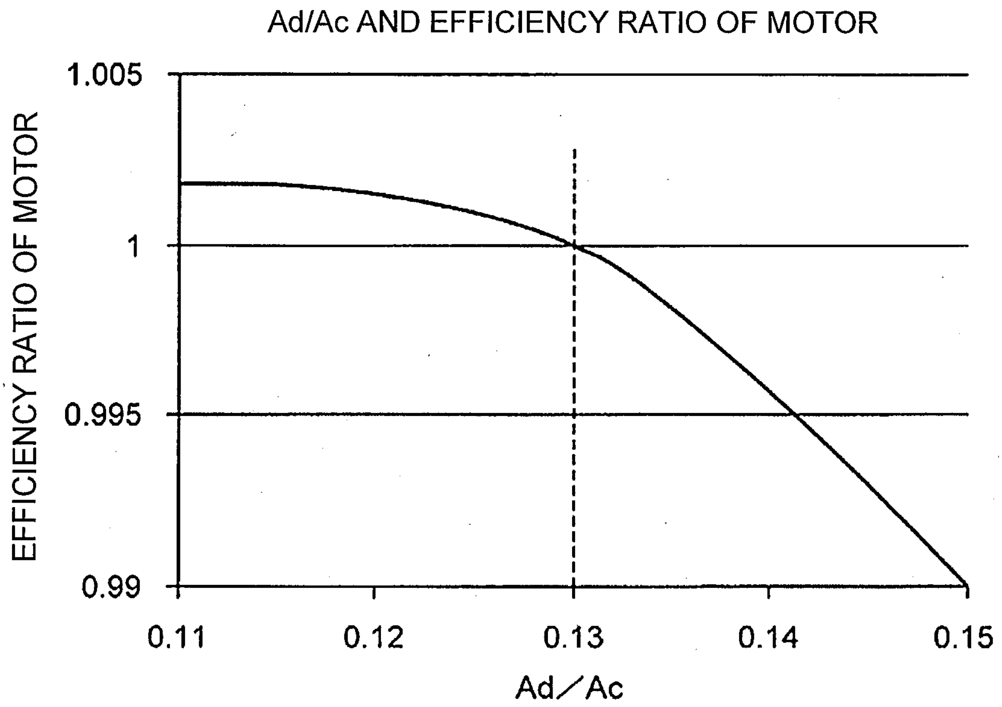
0.6
0.4
0.2
0
0.05
0.06
0.07
0.08
Ad／Ac

FIG. 4



Ad/Ac AND EFFICIENCY RATIO OF MOTOR
EFFICIENCY RATIO OF MOTOR
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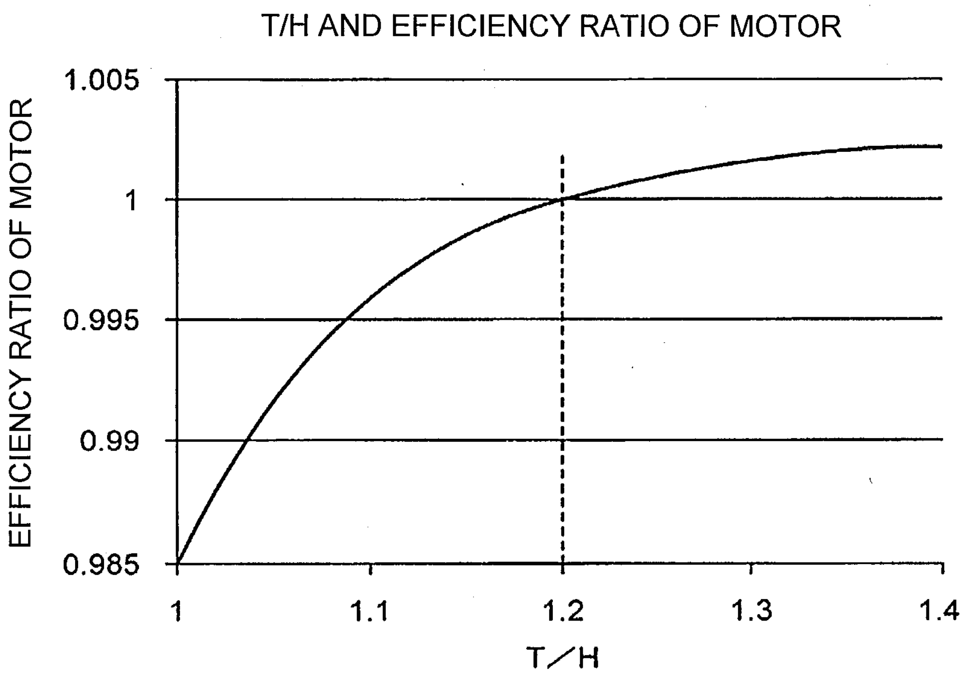
0.99
0.11
0.12
0.13
0.14
0.15
Ad／Ac

FIG. 5



T/H AND EFFICIENCY RATIO OF MOTOR
EFFICIENCY RATIO OF MOTOR
1.005
1
0.995
0.99
0.985
1
1.1
1.2
1.3
1.4
T／H

FIG. 6

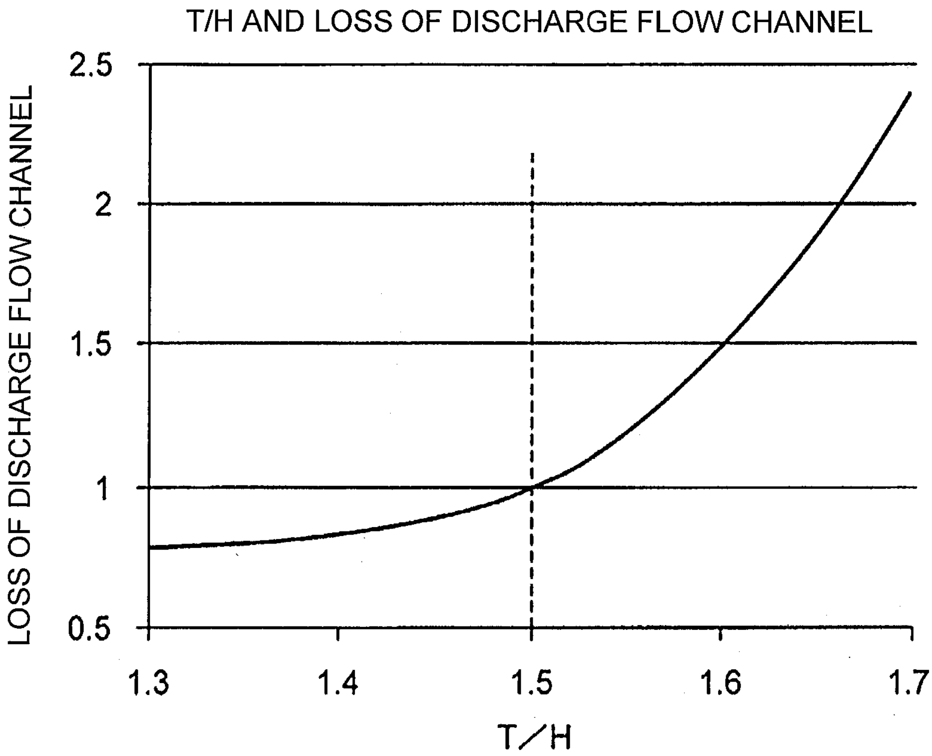
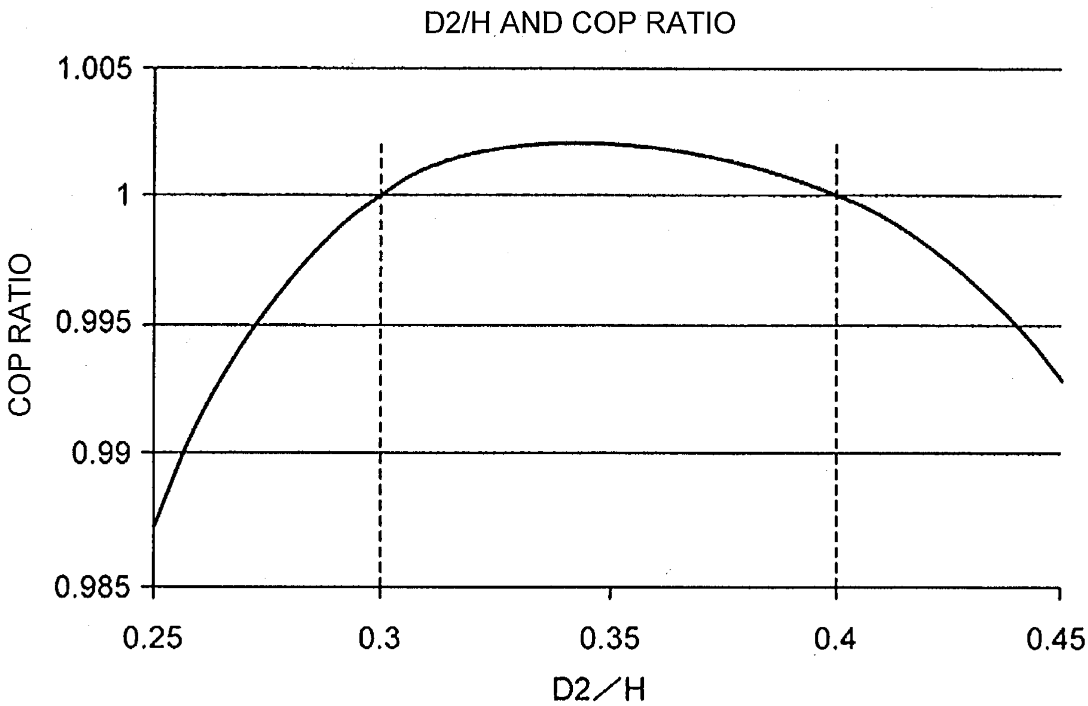

T/H AND LOSS OF DISCHARGE FLOW CHANNEL
LOSS OF DISCHARGE FLOW CHANNEL
2.5
2
1.5
1
0.5
1.3
1.4
1.5
1.6
1.7
T／H

FIG. 7


D2/H AND COP RATIO
COP RATIO
1.005
1
0.995
0.99
0.985
0.25
0.3
0.35
0.4
0.45
D2／H

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/015299

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

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2013/065706 A1 (Toshiba Carrier Corp.), 10 May 2013 (10.05.2013), & CN 103906928 A	1-4
A	JP 2008-14150 A (Toshiba Carrier Corp.), 24 January 2008 (24.01.2008), & CN 101100999 A & KR 10-2008-0003722 A	1-4
A	JP 2006-177225 A (Hitachi Home & Life Solution, Inc.), 06 July 2006 (06.07.2006), & CN 1793655 A	1-4

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

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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
09 June 2017 (09.06.17)	20 June 2017 (20.06.17)

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

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 4864572 A **[0004]**