



(11) **EP 2 063 122 A1**

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

(43) Date of publication:
27.05.2009 Bulletin 2009/22

(51) Int Cl.:
F04B 39/04 (2006.01) F04B 39/06 (2006.01)

(21) Application number: **07792202.9**

(86) International application number:
PCT/JP2007/065535

(22) Date of filing: **08.08.2007**

(87) International publication number:
WO 2008/032514 (20.03.2008 Gazette 2008/12)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

(72) Inventors:
• **KOBAYASHI, Noriyuki**
Isesaki-shi
Gunma 372-8502 (JP)
• **HIGASHIYAMA, Akiyoshi**
Isesaki-shi
Gunma 372-8502 (JP)

(30) Priority: **11.09.2006 JP 2006245694**

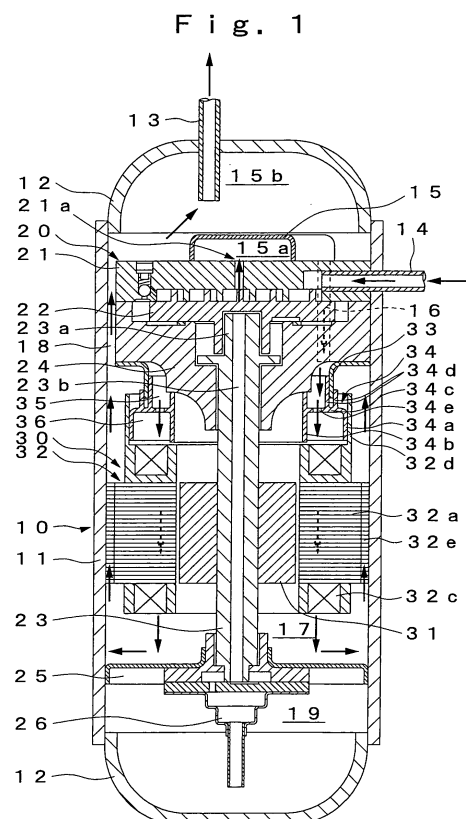
(71) Applicant: **Sanden Corporation**
Isesaki-shi, Gunma 372-8502 (JP)

(74) Representative: **Prüfer & Partner GbR**
European Patent Attorneys
Sohnckestraße 12
81479 München (DE)

(54) **COMPRESSOR**

(57) The present invention aims at providing a compressor capable of improving cooling performance on an electric motor, and further improving separation capacity of a refrigerant and lubrication oil.

Since the refrigerant flowing into a space 17 at an electric motor 30 side from a compressing part 20 is circulated toward one end in a central axis direction of a stator 32 formed in a cylindrical shape of the electric motor 30 so that a flow velocity of the refrigerant circulating in a space 36 on a downstream side may become faster than that in a space 35 on an upstream side, a coil 32c of the stator 32 can be cooled with the refrigerant which circulates so that the flow velocity thereof on the downstream side may become faster than that on the upstream side toward the one end in the central axis direction of the stator 32, thus enabling to improve cooling performance of the electric motor 30. Further, the lubrication oil included in the refrigerant can be made to adhere to the stator 32 by making the refrigerant collide with the one end in the central axis direction of the stator 32, thus enabling to efficiently separate the lubrication oil included in the refrigerant.



Description

Technical field

[0001] The present invention relates to a compressor including in a hermetic container a compressing part for compressing a refrigerant, and an electric motor for driving the compressing part.

Background art

[0002] Conventionally, as a compressor of this type, there has been known a compressor which includes a compressing part for compressing a refrigerant, an electric motor for driving the compressing part, and a housing having the compressing part and the electric motor housed inside, and which cools the electric motor with the refrigerant compressed in the compressing part and then discharges the refrigerant having cooled the electric motor (for example, refer to Patent Document 1).

[Patent Document 1]: Japanese Patent Publication No. 2005-2799

Disclosure of the invention

Problems to be solved by the invention

[0003] In the conventional compressor, an electric motor is cooled by flowing a refrigerant compressed in the compressing part into a space having the electric motor provided in. However, since the refrigerant flowing into the space having the electric motor provided in has low cooling effect on the electric motor due to slow flow velocity thereof, when increasing an output of the electric motor, it is difficult to obtain a required cooling capacity.

[0004] The present invention aims at providing a compressor capable of improving cooling performance on the electric motor and further efficiently separating lubrication oil included in the refrigerant.

Means for solving the problems

[0005] In order to achieve the above described object, a compressor according to the present invention includes a compressing part for compressing a refrigerant, an electric motor for driving the compressing part, a housing having the compressing part and the electric motor housed inside, and a refrigerant circulation mechanism for circulating the refrigerant to be flowed into a space at the electric motor side from the compressing part toward one end in a central axis direction of a stator formed in a cylindrical shape of the electric motor so that a flow velocity thereof on a downstream side may become faster than that on an upstream side in order to cool the electric motor with the refrigerant compressed in the compressing part.

[0006] Thereby, since the refrigerant flowing into the

space at the electric motor side from the compressing part circulates toward the one end in the central axis direction of the stator so that the flow velocity thereof on the downstream side may become faster than that on the upstream side, a coil of the stator is cooled with the refrigerant, and further the lubrication oil included in the refrigerant adheres to the stator, thus resulting in separation of the lubrication oil included in the refrigerant.

Advantages of the invention

[0007] According to the present invention, the coil of the stator can be cooled with the refrigerant which circulates so that the flow velocity on the downstream side may become faster than that on the upstream side toward the one end in the central axis direction of the stator, thus enabling to improve cooling performance on the electric motor. Further, the lubrication oil included in the refrigerant can be made to adhere to the stator by making the refrigerant collide with the one end in the central axis direction of the stator, thus enabling to efficiently separate the lubrication oil included in the refrigerant.

[0008] The above-described and the other objects, features, and advantages of the present invention will become apparent by referring to the following description and the accompanying drawings.

Brief description of the drawings

[0009]

Figure 1 is a sectional side view of a compressor showing one embodiment of the present invention; Figure 2 is a sectional plan view of the compressor; Figure 3 is a perspective view of a whole third partition member; and Figure 4 is a plan view of the third partition member.

Description of symbols

[0010] 10 ... housing, 20 ... compressing part, 30 ... electric motor, 32 ... stator, 32c ... coil, 33 ... second partition member, 34 ... third partition member, 34c ... connecting part, 34e ... communication hole

Best mode for carrying out the invention

[0011] This compressor is a hermetic compressor including a longitudinally longer shaped housing 10; a compressing part 20 provided on an upper part inside the housing 10 and compressing an absorbed refrigerant; and an electric motor 30 provided below the compressing part 20 inside the housing 10 and driving the compressing part 20. Further, this compressor uses carbon dioxide, which becomes a supercritical state by being compressed, as refrigerant.

[0012] The housing 10 includes a housing main body 11 composed of a cylindrical member disposed with a

central axis vertically oriented, and caps 12 formed in semi-spherical shapes for closing an upper end opening and a lower end opening of the housing main body 11, respectively. The cap 12 for closing the upper end opening of the housing main body 11 is connected with a refrigerant discharge pipe 13 for discharging the refrigerant compressed in the compressing part 20. Further, a peripheral surface of the housing main body 11 on which the compressing part 20 is located is connected with a refrigerant suction pipe 14 for sucking the refrigerant.

[0013] The compressing part 20 includes a fixed scroll member 21 fixed to an upper side of the housing main body 11 so as to divide the inside of the housing 10 into an upper portion and a lower portion, and a revolving scroll member 22 provided below the fixed scroll member 21 and capable of revolving with respect to the fixed scroll member 21 without rotating on its axis.

[0014] The fixed scroll member 21 is composed of a disc-like member disposed with the central axis vertically oriented, and is provided with a spiral body on a lower surface side. A central part in a radial direction of the fixed scroll member 21 is provided with a refrigerant discharge hole 21a for discharging the compressed refrigerant.

[0015] The revolving scroll member 22 is composed of a disc-like member provided opposite to the fixed scroll member 21, and is provided with the spiral body on an upper surface side. The lower surface side of the revolving scroll member 22 is connected with an upper end of a drive shaft 23.

[0016] The drive shaft 23 is disposed with the central axis, being a rotation center, vertically oriented, and a connecting part 23a with the revolving scroll member is provided eccentrically to the rotation center of the drive shaft 23. The upper end side of the drive shaft 23 is rotatably supported by an upper frame 24 provided so as to divide the upper part inside the housing 10 into an upper portion and a lower portion, while a lower side thereof is rotatably supported by a lower frame 25 provided so as to divide a lower part inside the housing 10 into an upper portion and a lower portion. The drive shaft 23 is rotated with rotating force of the electric motor 30 as a power, and by the rotation of the drive shaft 23, the revolving scroll member 22 moves on a predetermined circular track without rotating on its axis. Further, the drive shaft 23 is provided with a lubrication oil flow passage 23b along the central axis, and the lubrication oil sucked by an oil pump 26 connected to the lower end side is circulated in the lubrication oil flow passage 23b.

[0017] The upper frame 24 is provided such that an outer periphery side at an upper surface side is extended upward across the periphery, and is connected to an outer periphery side of the lower surface of the fixed scroll member 21. The revolving scroll member 22 is in an accommodated state into a space between the upper frame 24 and the fixed scroll member 21.

[0018] A space above the fixed scroll member 21 inside the housing 10 is divided by a first partition member

15 into a space 15a at a refrigerant discharge hole 21a side of the fixed scroll member 21 and a space 15b at a refrigerant discharge pipe 13 side thereof. The space 15a at the refrigerant discharge hole 21a side communicates with a space 17 between the upper frame 24 and the lower frame 25 inside the housing 10 by a first communication passage 16 provided in the fixed scroll member 21 and the upper frame 24. Moreover, the space 17 between the upper frame 24 and the lower frame 25 inside the housing 10 communicates with the space 15b at the refrigerant discharge pipe 13 side by a second communication passage 18 provided in the fixed scroll member 21 and the upper frame 24. Moreover, a space 19 below the lower frame 25 inside the housing 10 is stored with the lubrication oil for lubricating each sliding part inside the housing 10, and the stored lubrication oil circulates in the lubrication oil flow passage 23b of the drive shaft 23 by the oil pump 26.

[0019] The electric motor 30 is provided in the space 17 between the upper frame 24 and the lower frame 25, and includes a rotor 31 composed of a permanent magnet fixed to the drive shaft 23, and a stator 32 provided so as to surround the rotor 31 and fixed to the housing main body 11.

[0020] The stator 32 has a stator core 32a provided by laminating a plurality of magnetic steel sheets formed in circular shapes in the central axis direction of the housing main body 11, a coil 32c wound around a plurality of teeth 32b provided at an inner periphery side of the stator core 32a, and a cylinder 32d extending upward from an outer periphery side of an upper surface of the stator core 32a across the periphery. Further, a peripheral surface side of the stator 32 is provided with a plurality of third communication passage 32e which is provided so as to extend in a vertical direction spaced apart from each other in the peripheral direction, and to communicate the upper and lower space 17 of the stator 32 to each other.

[0021] Moreover, the following members are provided between the upper frame 24 and the electric motors 30: a second partition member 33 which is fixed to the upper frame 24 side, and divides an inside from an outside in the radial direction across the periphery; and a third partition member 34 which is provided so that an lower end side thereof is fitted in an inner surface of the cylinder 32d as well as an upper end side thereof is connected with the second partition member 33, and which forms an annular space along the upper surface of the stator 32 of the electric motor 30.

[0022] The second partition member 33 is composed of a cylindrical member, and an upper end side thereof is fixed to the lower surface of the upper frame 24 with screws or the like with the central axis vertically oriented.

[0023] The third partition member 34 includes a first cylinder 34a extending vertically on the outer periphery side of the upper surface of the stator 32 across the periphery, a second cylinder 34b extending vertically on an inner periphery side of the upper surface of the stator 32 across the periphery, and a connecting part 34c as a flow

passage closing plate which connects the first cylinder 34a and the second cylinder 34b successively in the peripheral direction. The third partition member 34 is connected with the second partition member 33 by inserting a lower end of the second partition member 33 between a pair of cylindrical protruding pieces 34d extending upward from an outer periphery side of the connecting part 34c across the periphery, while connected with the stator 32 by inserting the first cylinder 34a in the cylinder 32d of the stator 32. The second cylinder 34b is provided so as to extend from the inner periphery side of the upper surface of the stator 32 to the lower surface of the upper frame 24 to thereby divide the upper space of the electric motor 30 into the rotor 31 side and the stator 32 side. The first communication passage 16 communicates with a space 35 located between the second cylinder 34b and the second partition member 33. In the connecting part 34c, the communicating holes 34e as a plurality of refrigerant injection holes opened in round shapes are provided spaced apart from each other in the peripheral direction, the holes communicating the space 35 between the second cylinder 34b and the second partition member 33 with a space 36 between the first cylinder 34a and the second cylinder 34b. Each communicating hole 34e increases a flow velocity of the refrigerant toward the upper part of the coil 32c of the stator 32 to thereby discharge the refrigerant by reducing a flow passage cross section area of the refrigerant which flows out of the compressing part 20 to flow into the space 17 on the electric motor 30 side.

[0024] In the compressor configured as described above, when the drive shaft 23 is rotated by energizing the electric motor 30, the revolving scroll member 22 revolves with respect to the fixed scroll member 21 in the compressing part 20.

[0025] Thereby, the refrigerant flowing into the housing 10 from the refrigerant suction pipe 14 flows into the compressing part 20, and is compressed between the respective spiral bodies of the fixed scroll member 21 and the revolving scroll member 22, and then discharged into the space 15a from the refrigerant discharge hole 21a. The refrigerant discharged into the space 15a circulates in the first communication passage 16 to flow into the space 35, and subsequently passes through each communication hole 34e to flow into the space 36. The refrigerant having flowed into the space 36 circulates between the coil 32c and the coil 32c of the stator 32 to flow into the lower part of the space 17 from the lower end side of the stator 32. Further, the refrigerant having flowed into the lower part of the space 17 flows into the upper part of the space 17 through the third communication passage 32e, and subsequently flows into the space 15b through the second communication passage 18 to flow out of the refrigerant discharge pipe 13 to the outside of the housing 10.

[0026] At this time, since the refrigerant discharged from the compressing part 20 to flow into the space 35 contacts with an inner wall of the space 35, the lubrication

oil included in the refrigerant adheres to the inner wall of the space 35 and thereby the refrigerant and the lubrication oil are separated from each other.

[0027] Moreover, since the refrigerant flowing into the space 36 from the space 35 contacts with the coil 32c of the stator 32 in a state of the increased flow velocity by passing through the each communication hole 34e, the lubrication oil included in the refrigerant adheres to the coil 32c, and the refrigerant and the lubrication oil are separated from each other as well as the coil 32c is effectively cooled with the refrigerant with the high flow velocity.

[0028] Thus, according to the compressor of the present embodiment, since the refrigerant flowing into the space 17 at the electric motor 30 side from the compressing part 20 is circulated toward the one end in the central axis direction of the stator 32 formed in the cylindrical shape of the electric motor 30 so that the flow velocity of the refrigerant circulating in the space 36 on the downstream side may become faster than that in the space 35 on the upstream side, a coil 32c of the stator 32 can be cooled with the refrigerant which circulates so that the flow velocity thereof on the downstream side may become faster than that on the upstream side toward the one end in the central axis direction of the stator 32, thus enabling to improve the cooling performance of the electric motor 30. Further, the lubrication oil included in the refrigerant can be made to adhere to the stator 32 by making the refrigerant collide with the one end in the central axis direction of the stator 32, thus enabling to efficiently separate the lubrication oil included in the refrigerant.

[0029] Moreover, since the refrigerant is circulated from the connecting part 34c of the third partition member 34, and the communication hole 34e provided in the connecting part 34c toward the one end in the central axis direction of the stator 32 so that the flow velocity thereof on the downstream side may become faster than that on the upstream side, the refrigerant can be circulated so that the flow velocity thereof may become faster toward the one end in the central axis direction of the stator 32 by reducing the flow passage cross section area of the refrigerant without requiring a complicated mechanism, thus enabling to reduce manufacturing cost.

[0030] Further, since the third partition member 34 is provided spaced apart from the one end in the central axis direction of the stator 32, and the plurality of the communication holes 34e are provided spaced apart from each other in the peripheral direction of the stator 32, the refrigerant can be injected uniformly to the one end surface in the central axis direction of the stator 32 across the periphery, thus enabling to improve cooling capacity of the electric motor 30, and separation capacity of the refrigerant and the lubrication oil.

[0031] Note that although the above-described embodiment shows such a compressor that the plurality of round communication holes 34e are provided in the connecting part 34c of the third partition member 34, the

compressor may be provided with a plurality of slits, each of which increases the flow velocity of the refrigerant.

[0032] The preferred mode described in the present specification is exemplary and is not restrictive. The scope of the invention is shown by the accompanying claims, and all the modifications included in the meaning of those claims are contained in the present invention.

Claims 10

1. A compressor, comprising:

a compressing part for compressing a refrigerant; 15
 an electric motor for driving the compressing part;
 a housing having the compressing part and the electric motor housed inside; and
 a refrigerant circulation mechanism for circulating the refrigerant to be flowed into a space at the electric motor side from the compressing part toward one end in a central axis direction of a stator formed in a cylindrical shape of the electric motor, wherein a flow velocity of the refrigerant on a downstream side is faster than that on an upstream side. 20 25

2. The compressor according to claim 1, wherein: 30

the refrigerant circulation mechanism comprises a flow passage closing member for closing a refrigerant flow passage between the compressing part and the electric motor, and a refrigerant injection hole provided in the flow passage closing member. 35

3. The compressor according to claim 2, wherein:

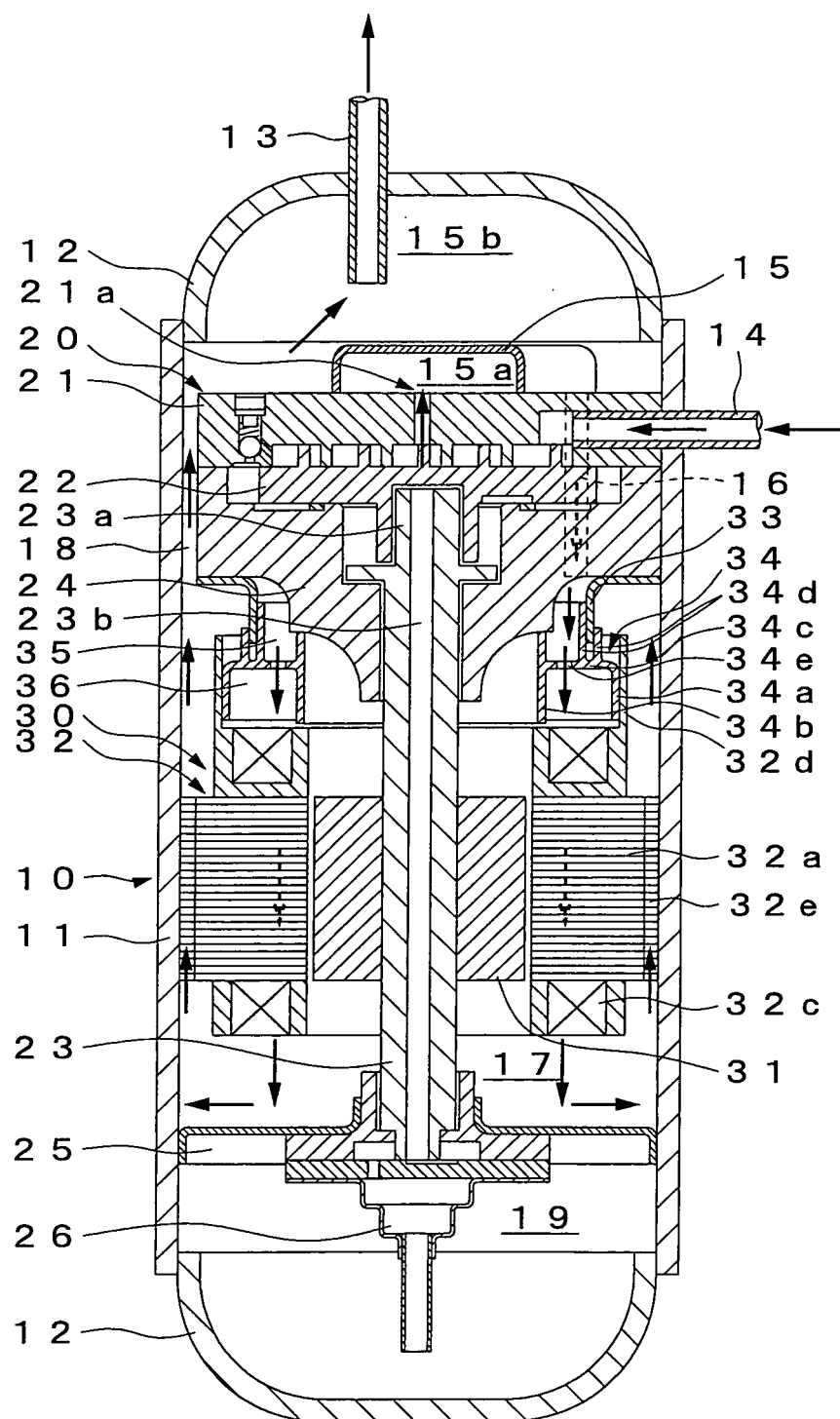
the flow passage closing member is provided spaced apart from one end in the central axis direction of the stator, and the plurality of refrigerant injection holes are provided spaced apart from each other in a peripheral direction of the stator. 40 45

4. The compressor according to any one of claims 1 to 3, wherein:

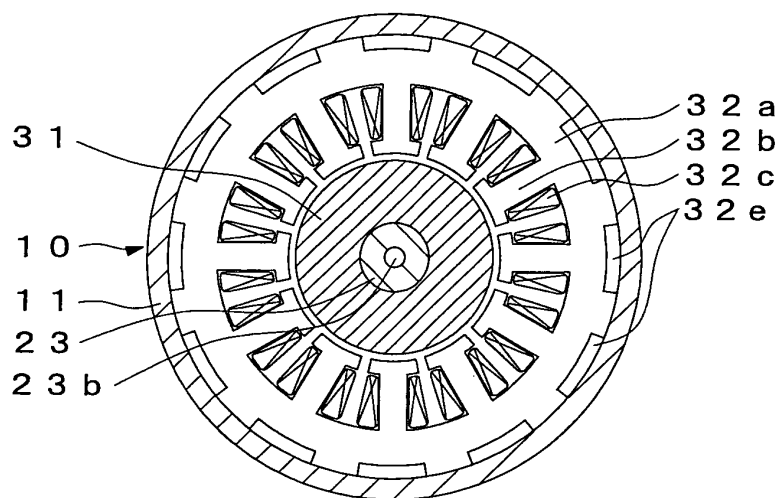
the refrigerant is carbon dioxide. 50

55

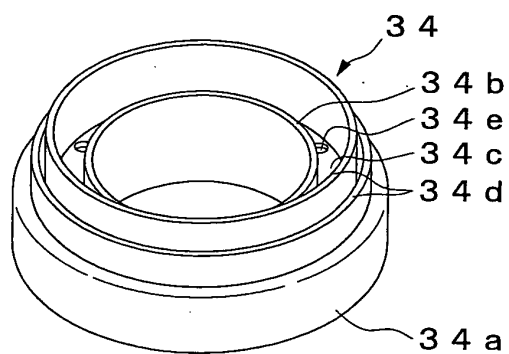
Fig. 1



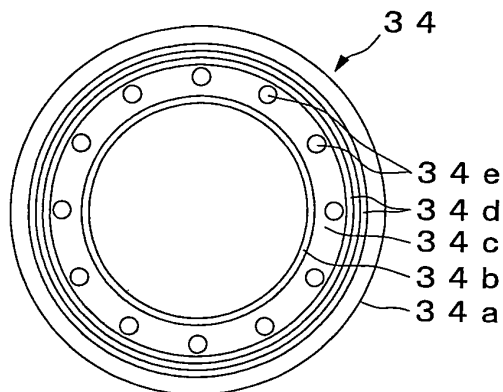
F i g . 2



F i g . 3



F i g . 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/065535

A. CLASSIFICATION OF SUBJECT MATTER

F04B39/04(2006.01) i, F04B39/06(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)

F04B39/04, F04B39/06, F04C29/04, F04C29/02

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 1996-2007

Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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.
X Y	JP 2003-286949 A (Daikin Industries, Ltd.), 10 October, 2003 (10.10.03), Par. Nos. [0026] to [0078]; Figs. 1 to 10 & BR 0303574 A & CN 1518638 A & EP 1498607 A1 & TW 587130 B B & US 2004/0197209 A1 & US 6925832 B2 & WO 2003/083302 A1	1-2 3-4
Y	JP 2001-20865 A (Matsushita Electric Industrial Co., Ltd.), 23 January, 2001 (23.01.01), Par. No. [0036]; Figs. 1 to 2 (Family: none)	3-4

☒ 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
04 September, 2007 (04.09.07)Date of mailing of the international search report
18 September, 2007 (18.09.07)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/065535

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 2006-9614 A (Matsushita Electric Industrial Co., Ltd.), 12 January, 2006 (12.01.06), Claim 5; Fig. 1 (Family: none)	4

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

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 2005002799 A [0002]