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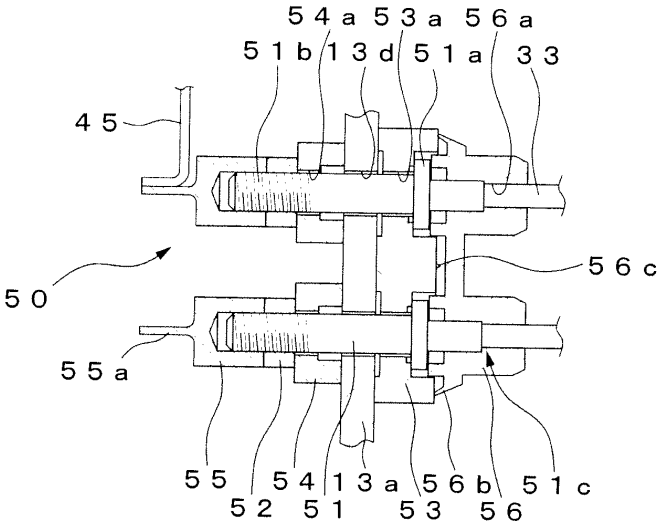
# (54) ELECTRIC COMPRESSOR

(57) The present invention provides an electric compressor which enables prescribed insulation performance to be ensured even if poly alkyl glycol type lubricating oils are used. The electric compressor is provided with an insulating cover which is provided so as to cover a connection section between a terminal body and a lead wire on the motor side, and on a surface on the side of a first insulating member of the insulating cover, there is provided a cutoff section which cuts off a leakage path by abutting against the first insulating member, whereby the leakage path between the first insulating member and the insulating cover is cut off.

FIG. 2

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## Description

Technical Field

**[0001]** The present invention relates to an electric compressor provided with a motor for driving a compression section, a motor driving circuit for driving the motor, and a sealed terminal for electrically connecting the motor and the motor driving circuit.

Background Art

**[0002]** As an electric compressor of this kind, there has hitherto been known an electric compressor which is provided with a compression section for compressing a cooling medium, a motor for driving the compression section, a motor driving circuit for driving the motor, and a sealed terminal which is provided in a partition wall for partitioning a space on the motor side and a space on the motor driving circuit side and is intended for electrically connecting a lead wire on the motor side and a lead wire on the motor driving circuit side (refer to Patent Literature 1, for example).

Prior Art Document

Patent Document

**[0003]**

Patent Document 1: Japanese Patent Publication 11-324920

Summary of The Invention

Problems to be Solved by The Invention

**[0004]** In an open-type compressor in which the driving torque is transmitted from outside, poly alkyl glycol (PAG) type lubricating oils are used to lubricate sliding parts in the housing. However, because poly alkyl glycol type lubricating oils have low electrical insulation performance and it is impossible to use these lubricating oils in the electric compressor, expensive polyol ester (POE) type lubricating oils are used in the above-described electric compressor in which a motor is incorporated. As a result of this, it is necessary to use different kinds of lubricating oils in open-type compressors and the above-described electric compressor and, therefore, work such as maintenance becomes complicated.

**[0005]** The object of the present invention is to provide an electric compressor which enables prescribed insulation performance to be ensured even if poly alkyl glycol type lubricating oils are used.

Means for Solving The Problem

**[0006]** In order to achieve the above object, the present invention provides an electric compressor which includes: a compression section for compressing a cooling medium, a motor for driving the compression section, a motor driving circuit for driving the motor, a sealed terminal which is provided in a partition wall for partitioning a space on the motor side and a space on the motor driving circuit side and is intended for electrically connecting a lead wire on the motor side and a lead wire on the motor driving circuit side, and an insulating cover provided so as to cover a connection section between the sealed terminal and the lead wire on the motor side. In this electric compressor, the insulating cover has a cutoff section which is provided on a surface on the partition wall side and cuts off a leakage path by abutting against a member on the partition wall side.

**[0007]** As a result of this, because the cutoff section provided in the insulating cover abuts against the member on the partition wall side, a leakage path between the member on the partition wall side and the insulating cover is cut off.

Effects of The Invention

**[0008]** According to the present invention, it is possible to cut off a leakage path between the member on the partition wall side and the insulating cover and, therefore, it is possible to ensure prescribed insulation performance even if poly alkyl glycol type lubricating oils are used.

Brief Description of The Drawings

**[0009]**

Figure 1 is a side sectional view of an electric compressor in an embodiment of the present invention.
Figure 2 is a sectional view of a sealed terminal.
Figure 3 is an exploded perspective view of the sealed terminal.
Figure 4 is a partial sectional view of the sealed terminal.
Figure 5 is a partial sectional view of a sealed terminal showing another example of an insulating cover.
Figure 6 is a partial sectional view of a sealed terminal showing another example of a cutoff section.
Figure 7 is a partial sectional view of a sealed terminal showing another example of a cutoff section.
Figure 8 is a partial sectional view of a sealed terminal showing another example of a cutoff section.
Figure 9 is a partial sectional view of a sealed terminal showing another example of an air vent portion.
Figure 10 is a partial sectional view of a sealed terminal showing another example of an air vent portion.

Preferred Embodiments of The Invention

**[0010]** Figures 1 to 4 show an embodiment of the present invention.

**[0011]** The electric compressor of the present invention is a scroll-type electric compressor which is provided with a housing 10 formed in cylindrical shape, a compression section 20 for compressing a cooling medium, a motor 30 for driving the compression section 20, and a driving circuit section 40 as a motor driving circuit for performing the operation control of the motor 30, and for example, HFC-134a and carbon dioxide or the like are used as a cooling medium.

**[0012]** The housing 10 is composed of a first housing 11 in which the compression section 20 is housed, a second housing 12 in which the motor 30 is housed, and a third housing 13 in which the driving circuit section 40 is housed.

**[0013]** The first housing 11 is such that one end surface thereof is closed and the other end surface thereof is joined to one end surface of the second housing 12. A cooling medium discharge port, which is not shown, is provided on a peripheral surface of the first housing 11 on the side of the one end surface.

**[0014]** The second housing 12 is such that the side of one end surface thereof is joined to the first housing 11 and the side of the other end surface thereof is joined to one end surface of the third housing 13.

**[0015]** The first housing 11 and the second housing 12 are joined together by a bolt 14 via a center plate, which will be described later, for rotatably supporting the side of one end of a driving shaft, which will be described later, for driving the compression section 20.

**[0016]** The third housing 13 is such that the side of one end surface thereof is joined to the second housing 12 and the side of the other end surface thereof is closed by a closing plate 15 so as to be openable. A cooling medium suction port is provided on a peripheral surface of the third housing 13 on the side of one end surface thereof. Furthermore, the third housing 13 is such that the interior thereof is partitioned by a partition wall 13a into the side of one end surface including the cooling medium suction port and the side of the other end surface, and the third housing 13 is provided with a driving circuit housing chamber 13b for housing the driving circuit section 40 and a cooling medium suction chamber 13c in communication with the motor 30 side.

**[0017]** The compression section 20 has a fixed scroll member 21 fixed to the side of one end of the first housing 11 and a rotating scroll member 22 provided on the side of the other end of the first housing 11 so as to be rotatable with respect to the fixed scroll member 21.

**[0018]** The fixed scroll member 21 is formed from a member in the shape of a disk provided so as to divide the interior of the first housing 11, and a swirl body 21a is provided on a surface on the rotating scroll member 22 side. In the radially middle part of the fixed scroll member 21, there is provided a cooling medium discharge hole 21b for discharging a cooling medium compressed in the compression section 20. A cooling medium discharge chamber 11a is provided between one end surface in the first housing 11 and the fixed scroll member 21 so that a cooling medium discharged from the cooling medium discharge port flows into the cooling medium discharge chamber 11a.

**[0019]** The rotating scroll member 22 is such that a convoluted body 22a is provided on the surface thereof on the fixed scroll member 21 side, and to the surface on the opposite side, there is connected, via a driving bush 24, the side of one end of a driving shaft 23 for transmitting the torque of the motor 30.

**[0020]** The driving shaft 23 is provided so as to extend along the central axis of the second housing 12. The driving shaft 23 is provided in such a manner that a connection section 23a to the driving bush 24 is eccentric from the rotation center of the driving shaft 23. Also, the driving shaft 23 is such that the side of one end thereof is rotatably supported by a center plate 25 provided between the compression section 20 and the motor 30 via a ball bearing 26 and the side of the other end thereof is rotatably supported via a bearing 12a (a ball bearing 27) provided on the side of the other end surface of the second housing 12. That is, the driving shaft 23 is rotated by the motor 30 and is adapted to cause the rotating scroll member 22 to rotate on a prescribed circular orbit.

**[0021]** The center plate 25 is provided so as to divide the space on the compression section 20 side and the space on the motor 30 side in the housing 10, and there is provided a communication hole for providing communication between the space on the compression section 20 side and the space on the motor 30 side. Also, the center plate 25 is provided with a flanged portion 25a extending in the circumferential direction of an outer circumferential surface so that the flanged portion 25a becomes sandwiched between the first housing 11 and the second housing 12.

**[0022]** Between the rotating scroll member 22 and the center plate 25, there is provided a rotating position regulating mechanism 28 consisting of pins which are each fixed to the rotating scroll member 22 and the center plate 25 in order to regulate the rotating position of rotating scroll member 22, and a connecting member for connecting the pins together.

**[0023]** The motor 30 is composed of a three-phase induction motor and the like and has a rotor 31 formed from a permanent magnet fixed to the driving shaft 23, and a stator 32 which is provided so as to surround the rotor 31 and is fixed in the second housing 12.

**[0024]** The driving circuit section 40 is composed of an inverter circuit 41 having, on a substrate, power semiconductor elements 41a as a plurality of heat generating parts, a power circuit part 42, such as a smoothing capacitor and a noise filter, a control section 43 of a microcomputer configuration, and the like. The driving circuit section 40 is housed in the driving circuit housing chamber 13b and is fixed in the driving circuit housing chamber 13b by use of a molded resin 44.

**[0025]** This motor compressor is provided with three sealed terminals 50 provided in the partition wall 13a positioned below the cooling medium suction chamber 13c

and intended for supplying the electrical power from the inverter circuit 41 to the winding of the stator 32.

**[0026]** Each of the sealed terminals 50 is composed of a terminal body 51 inserted into a through hole 13d provided in the partition wall 13a, a fixing nut 52 for fixing the terminal body 51 to the partition wall 13a, a first insulating member 53 to be interposed on the second housing 12 side of the partition wall 13a, a second insulating member 54 to be interposed between the fixing nut 52 and the partition wall 13a, a joining nut 55 which is connectably provided to an end portion of the terminal body 51 on the driving circuit housing chamber 13b side and to which a lead wire 45 on the driving circuit housing chamber 13b side is joined by welding, and an insulating cover 56 for covering a connection section 51c between the terminal body 51 and a lead wire 33 on the motor 30 side. Here, the lead wire 45 on the driving circuit housing chamber 13b side is formed from a copper-bearing material.

**[0027]** The terminal body 51 is made of an iron-bearing metal and is such that an end portion thereof on the second housing 12 side is provided with a flange 51a and an end portion thereof on the driving circuit housing chamber 13b side is provided with a male threaded portion 51b and it is ensured that the lead wire 33 on the motor 30 side is connected to the end portion on the second housing 12 side by caulking or the like. The terminal body 51 is attached to the partition wall 13a by screwing the fixing nut 52 to the male threaded portion 51b, with the first insulating member 53 interposed on the second housing 12 side of the partition wall 13a and the second insulating member 54 interposed on the driving circuit housing chamber 13b side of the partition wall 13a.

**[0028]** The first insulating member 53 and the second insulating member 54 are each formed from a member having insulating properties, such as ceramics and synthetic resins. The first insulating member 53 is provided with three holes 53a, through each of which three terminal bodies 51 are inserted, and one first insulating member 53 is used for the three terminal bodies 51. The second insulating member 54 is provided with a hole 54a through which the terminal body 51 is inserted, and one second insulating member 54 is used for one terminal body 51.

**[0029]** The joining nut 55 is made of a copper-bearing metal and is formed in the shape of a cap nut which is such that the side of one end thereof is closed. The joining nut 55 is provided with a weld portion 55a so as to protrude from the side of one end and it is ensured that the lead wire 45 on the driving circuit housing chamber 13b side is jointed to the weld portion 55a by welding.

**[0030]** The insulating cover 56 is made of a material having elasticity and insulating properties, such as rubber, and is formed so as to cover substantially the whole surface of one end surface of the first insulating member 53. The insulating cover 56 is provided with three holes 56a through which the three lead wires 33 on the motor 30 side are each to be inserted, and it is ensure that the insulating cover 56 covers the connection sections 51c of the three terminal bodies 51 and the lead wires 33, with the lead wires 33 inserted through the holes 56a. On the surface of the insulating cover 56 on the first insulating member 53 side, there is provided a cutoff section 56b which is provided so as to extend to the first insulating member 53 side along the outer circumferential portion and cuts off a leakage path by abutting against the first insulating member 53. The cutoff section 56b is provided with an air vent hole 56c as an air vent portion for venting the air between the insulating cover 56 and the first insulating member 53 during the evacuation of the connected cooling medium circuit. The air vent hole 56c is provided by notching an end portion of the cutoff section 56b in the shape of the letter V and is formed in such a manner that the opening area becomes not more than 10 square millimeters when attached to the terminal body 51.

**[0031]** In the electric compressor configured as described above, the driving shaft 23 is rotated by passing a current to the motor 30, whereby in the compression section 20 the rotating scroll member 22 performs a rotating motion with respect to the fixed scroll member 21. As a result of this, a cooling medium which flows into the housing 10 from the cooling medium suction port cools each of power semiconductor elements of the inverter circuit 41 of the driving circuit section 40 via the partition wall 13a of the cooling medium suction chamber 13c and cools the motor 30 by flowing through the interior of the second housing 12. The cooling medium which has flown through the interior of the second housing 12 flows between the rotating scroll member 22 and the center plate 25 via the communication hole of the center plate 25, cools the rotating position regulating mechanism 50 and then flows into the compression section 20. The cooling medium compressed in the compression section 20 flows from the cooling medium discharge hole 21b into the cooling medium discharge chamber 11a and is discharged from the cooling medium discharge port.

**[0032]** In each of the sealed terminals 50, in performing the work to connect the lead wire 45 on the driving circuit housing chamber 13b side, the joining nut 55 is screwed to the male threaded portion 51b, with the terminal body 51 attached to the partition wall 13a, and the lead wire 45 is joined to the weld portion 55a of the joining nut 55 by welding.

**[0033]** Because the connection section 51c between the terminal body 51 and the lead wire 33 is covered with the insulating cover 56, the leakage to the housing 10 side is cut off and insulating. Also, because the cutoff section 56b of the insulating cover 56 abuts against the first insulating member 53 along the outer circumferential portion thereof, a leakage path between the first insulating member 53 and the insulating cover 56 is cut off. Furthermore, because the air vent hole 56c is provided in the cutoff section 56b, in mounting the sealed terminal 50, the air between the first insulating member 53 and the insulating cover 56 is discharged to outside from the

air vent hole 56c during the evacuation of the cooling medium circuit. The air vent hole 56c is formed in such a manner that the opening areas is not more than 10 square millimeters and, therefore, it is possible to ensure prescribed insulation performance.

**[0034]** According to the electric compressor of this embodiment, the insulating cover 56 is provided so as to cover the connection section 51c between the terminal body 51 and the lead wire 33 on the motor 30 side, and the cutoff section 56b which cuts off a leakage path by abutting against the first insulating member 53 is provided on the surface of the insulating cover 56 on the first insulating member 53 side. As a result of this, it is possible to cut off a leakage path between the first insulating member 53 and the insulating cover 56 by the cutoff section 56b and, therefore, it is possible to ensure prescribed insulation performance even if poly alkyl glycol type lubricating oils are used.

**[0035]** The cutoff section 56b is provided with the air vent hole 56c for venting the air between the insulating cover 56 and the first insulting member 53. As a result of this, it is possible to vent the air between the insulating cover 56 and the first insulting member 53 during the evacuation of the cooling medium path and, therefore, it becomes possible to positively carry out the evacuation of the cooling medium circuit.

**[0036]** The opening area of the air vent hole 56c is not more than 10 square millimeters. As a result of this, it is possible to ensure prescribed insulation performance and, therefore, this enables prescribed insulation performance to be ensured and positive evacuation to be performed.

**[0037]** The insulating cover 56 is provided integrally with the plurality of terminal bodies 51. As a result of this, it is possible to insulate the connection sections 51c between the plurality of terminal bodies 51 and the lead wire 33 by one insulating cover 56 and, therefore, it becomes possible to reduce the number of parts.

**[0038]** Although in the above-described embodiment, the insulating cover 56 is provided integrally with the plurality of terminal bodies 51, even when one insulating cover 57 is provided for one terminal body 51 as shown in Figure 5, it is possible to ensure insulation performance in the same manner as in the above-described embodiment.

**[0039]** Although in the above-described embodiment, the cutoff section 56b is provided so as to extend to the first insulating member 53 side along the outer circumferential portion of the insulating cover 56, even when a cutoff section 56d is provided so as to protrude from the outer circumferential portion side of the insulating cover 56 on the first insulating member 53 side as shown in Figure 6, it is possible to obtain the same effect as in the above-described embodiment.

**[0040]** Even if as shown in Figure 7, a cutoff section is composed of a wall 53b which extends to the insulating cover 56 side along the outer circumferential portion of one end surface of the first insulating member 53 and an extending portion 56e of the insulating cover 56 which abuts against the inner surface of the wall 53b of the first insulating member 53, it is possible to obtain the same effect as in the above-described embodiment.

**[0041]** Even if a cutoff section is composed of a ring-shaped packing 56f provided along the outer circumferential portion between the first insulating member 53 and the insulating cover 56 as shown in Figure 8, it is possible to obtain the same effect as in the above-described embodiment.

**[0042]** Although in the above-described embodiment, the air vent hole 56c as an air vent portion for venting the air between the insulating cover 56 and the first insulating member 53 is formed by notching the end portion of the cutoff section 56b in the form of the letter V, it is possible to obtain the same effect as in the above-described embodiment by providing a round air vent hole 56g having an opening area of not more than 10 square millimeters in the cutoff section 56b as shown ion Figure 9.

**[0043]** Also, as shown in Figure 10, by providing a protrusion 56h in an end portion of the cutoff section 56b and configuring an air vent portion so that a gap whose opening area is not more than 10 square millimeters is formed in the vicinity of the protrusion 56h when the cutoff section 56b is caused to abut against the first insulating member 53, it is possible to obtain the same effect as in the above-described embodiment.

Description of The Symbols

**[0044]** 13a: partition wall, 20: compression section, 30: motor, 33: lead wire, 40: driving circuit section, 45: lead wire, 50: sealed terminal, 51: terminal body, 51c: connection section, 53: first insulating member, 53b: wall, 56: insulating cover, 56b: cutoff section, 56c: air vent hole, 56d: cutoff section, 56e: extending portion, 56f: packing, 56g: air vent hole, 56h: protrusion.

## Claims

**1.** An electric compressor comprising:

a compression section (20) for compressing a cooling medium;
a motor (30) for driving the compression section (20);
a motor driving circuit (40) for driving the motor (30);
a sealed terminal (50) which is provided in a partition wall (13a) for partitioning a space on the motor (30) side and a space on the motor driving circuit (40) side and is intended for electrically connecting a lead wire (33) on the motor (30) side and a lead wire (45) on the motor driving circuit (40) side; and
an insulating cover (56) provided so as to cover a connection section (51c) between the sealed

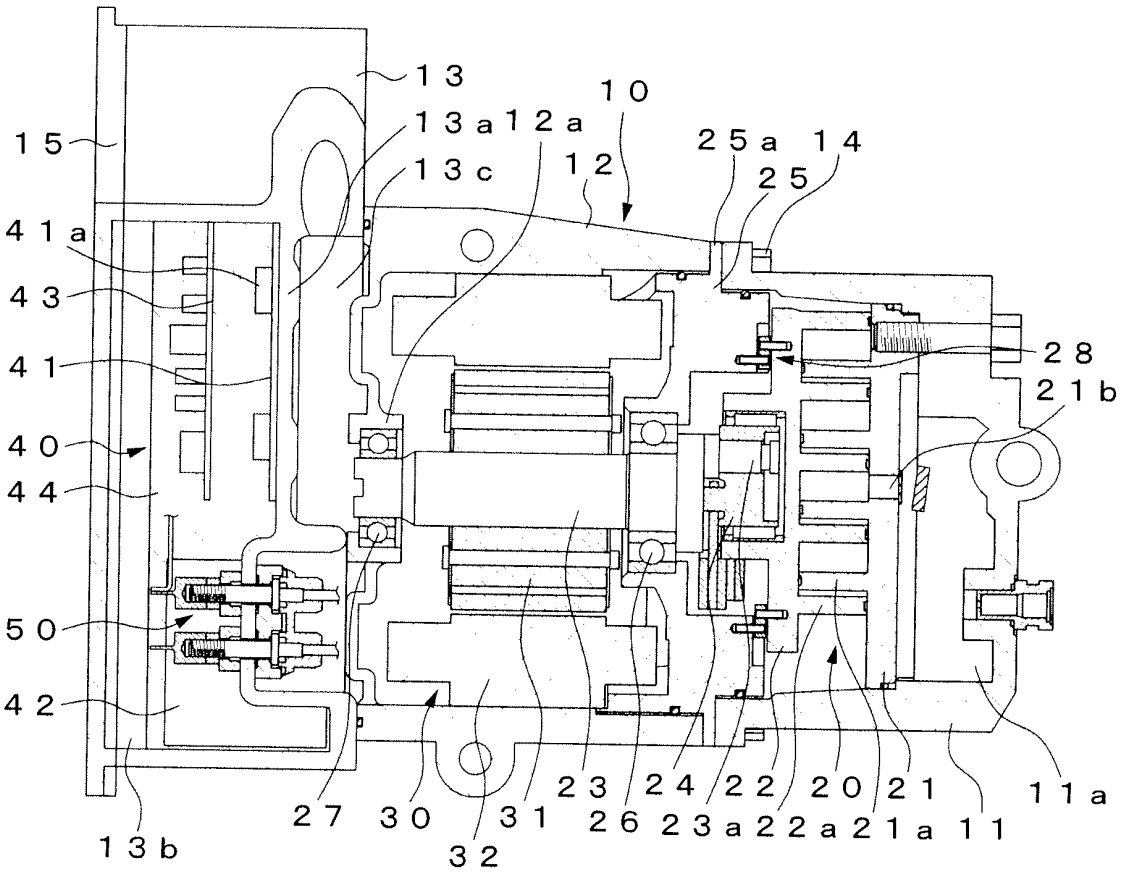
terminal (50) and the lead wire (33) on the motor (30) side,
wherein the insulating cover (56) has a cutoff section (56b) which is provided on a surface on the partition wall (13a) side and cuts off a leakage path by abutting against a member (53) on the partition wall (13a) side.

**2.** The electric compressor according to claim 1, further comprising air vent portions (56b, 56c) to vent the air in a space formed between the insulating cover (56) and the member (53) on the partition wall (13a) side.

**3.** The electric compressor according to claim 2, wherein the air vent portions (56b, 56c) are provided in the cutoff section (56b) and comprise an opening (56c) which is intended for providing communication between a space which is formed between the insulating cover (56) and the member (53) on the partition wall (13a) side and a space on the motor (30) side, and
wherein the opening (56c) has an opening area which is not more than 10 square millimeters.

**4.** The electric compressor according to any one of claims 1 to 3, wherein the insulating cover (56) is provided integrally with a plurality of sealed terminals (50).

FIG. 1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11

FIG. 2

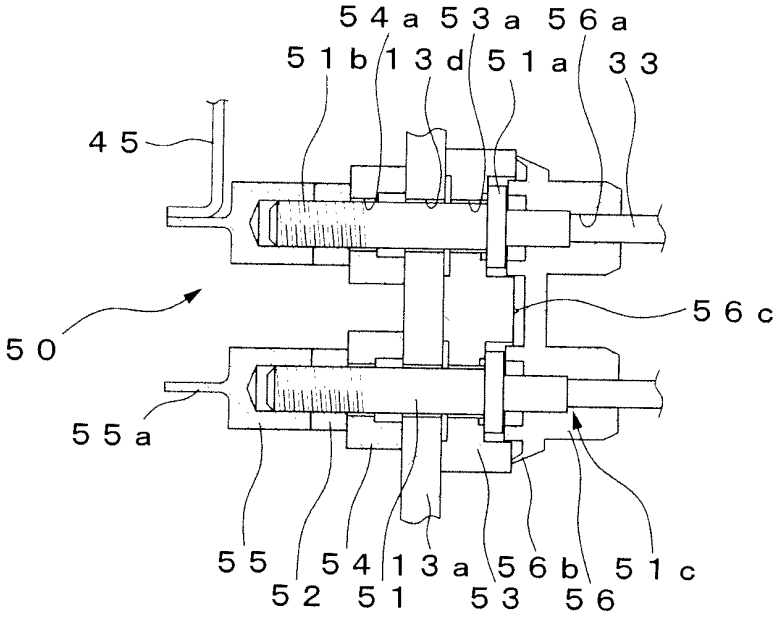
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FIG. 3

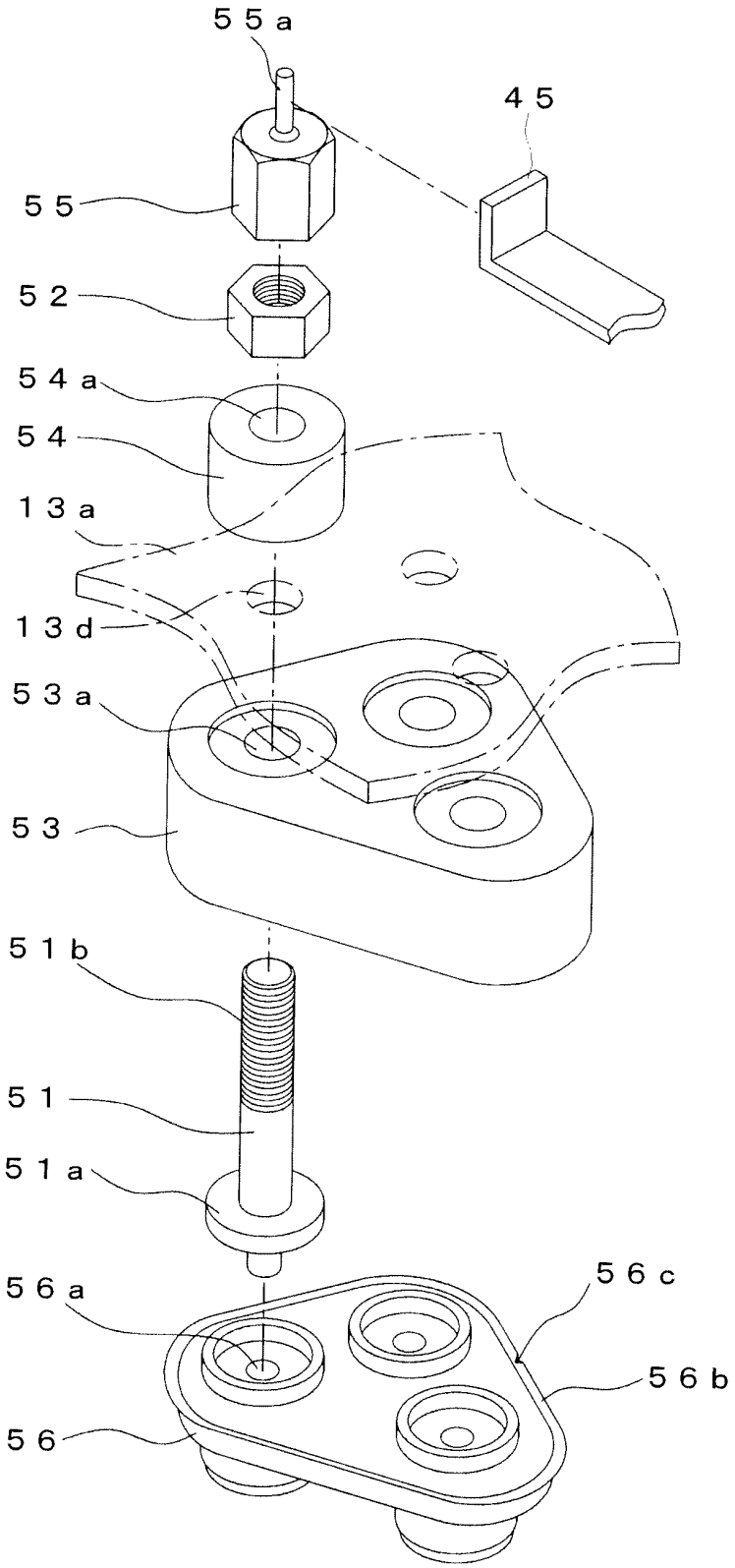

FIG. 4

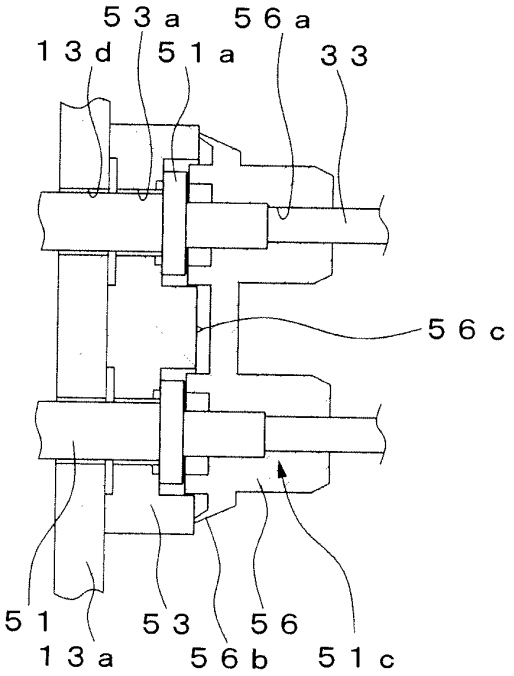
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FIG. 5

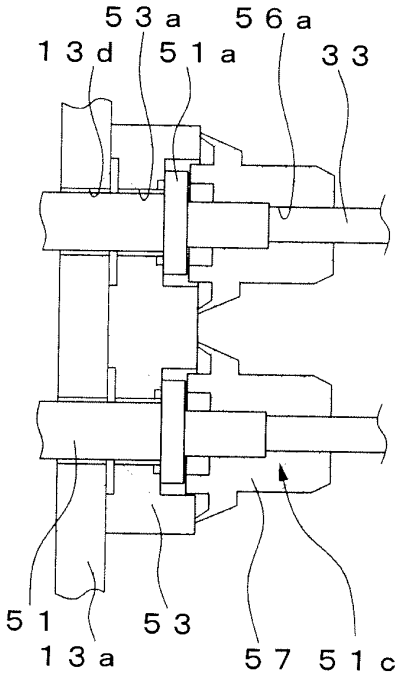
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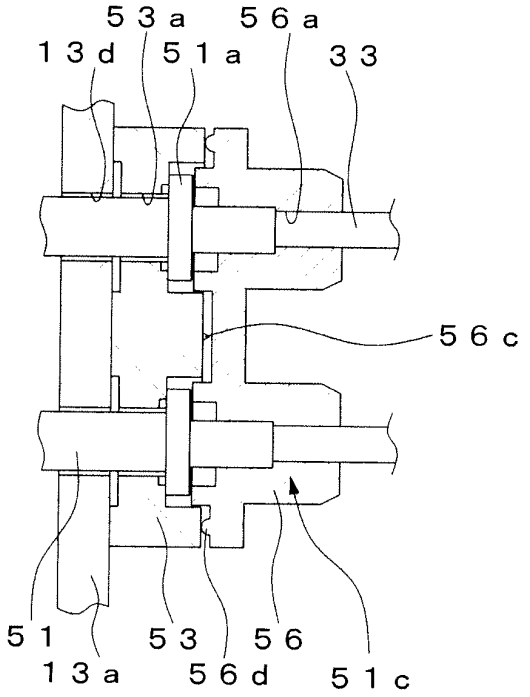
FIG. 6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51c

FIG. 7

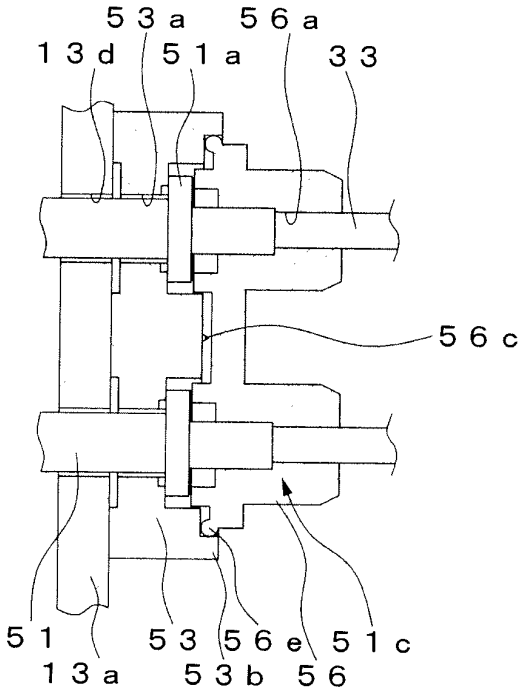
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FIG. 8

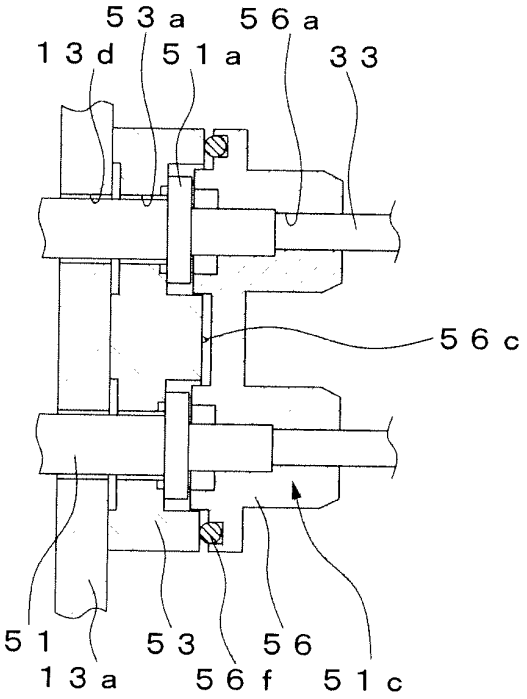
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FIG. 9

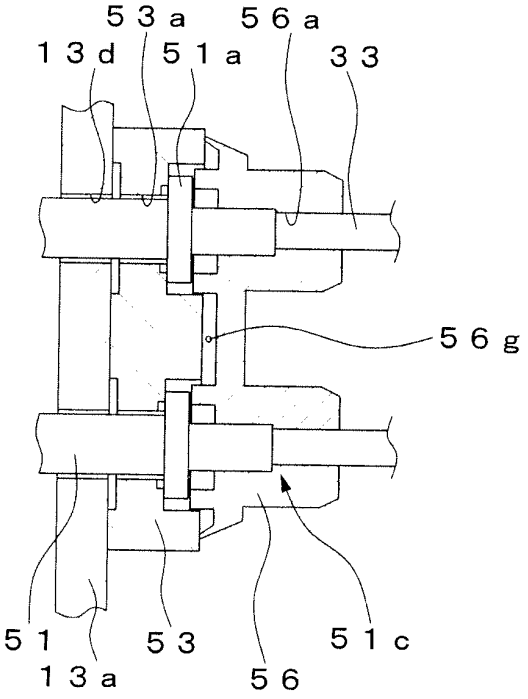
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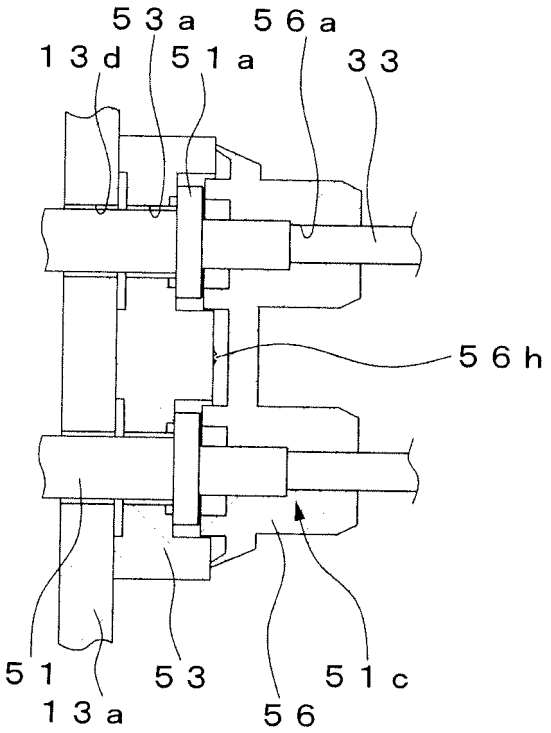
FIG. 10



**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2009/059998

A. CLASSIFICATION OF SUBJECT MATTER
*F04B39/00*(2006.01)i, *F04C29/00*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04B39/00, F04C29/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | JP 2008-19732 A (Sanden Corp.), 31 January, 2008 (31.01.08), Full text; Fig. 5 & EP 2039932 A1 & WO 2008/007534 A1 | 1-4 |
| Y | JP 4-81581 A (Matsushita Refrigeration Co.), 16 March, 1992 (16.03.92), Page 2, lower left column, line 9 to lower right column, line 17; Fig. 1 (Family: none) | 1-4 |
| Y | JP 5-263762 A (Matsushita Refrigeration Co.), 12 October, 1993 (12.10.93), Par. No. [0009]; Figs. 13 to 14 & US 5391061 A | 2-4 |

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

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| A | Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 177490/1976(Laid-open No. 94313/1978) (Mitsubishi Electric Corp.), 01 August, 1978 (01.08.78), Full text; all drawings (Family: none) | 1-4 |

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## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


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