



(11)

**EP 3 392 504 A1**

(12)

**EUROPEAN PATENT APPLICATION**

published in accordance with Art. 153(4) EPC

(43) Date of publication:

24.10.2018 Bulletin 2018/43

(51) Int Cl.:

**F04B 39/00** (2006.01)

**F04B 39/06** (2006.01)

**F04C 29/00** (2006.01)

**F04C 29/04** (2006.01)

(21) Application number: **16875660.9**

(86) International application number:

**PCT/JP2016/087138**

(22) Date of filing: 14.12.2016

(87) International publication number:

**WO 2017/104683 (22.06.2017 Gazette 2017/25)**

(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 MD

(30) Priority: 16.12.2015 JP 2015245028

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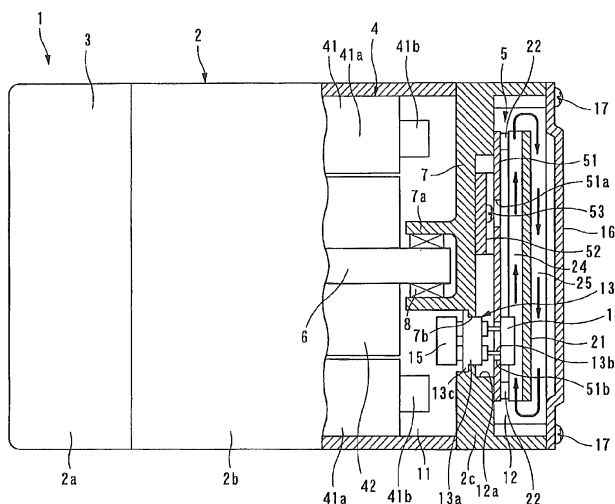
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(54) **ELECTRICALLY DRIVEN COMPRESSOR**

(57) An electrically driven compressor superior in heat dissipation of an inverter while ensuring insulation properties between the inverter and a cover is provided. A resin insulating member for covering an inverter circuit board is provided between the inverter circuit board and the cover in an inverter storage space defined by mounting a metallic cover in a metallic housing, and passages

extending in a vertical direction are formed between the inverter circuit board and the insulating member and between the insulating member and the cover, and the passage between the inverter circuit board and the insulating member and the passage between the insulating member and the cover communicate with each other on upper side and lower side of the insulating member.

Fig. 1



## Description

### Technical Field

**[0001]** The present invention relates to an electrically driven compressor including a compression mechanism and an electric motor, and an inverter configured to control driving of the electric motor stored in a housing, and more specifically, to an electrically driven compressor capable of satisfying a requirement of insulation properties and a requirement of heat-dissipation properties for the inverter.

### Background Art

**[0002]** Typically, an electrically driven compressor includes a compression mechanism configured to compress and discharge a refrigerant and an electric motor configured to drive the compression mechanism stored in a housing. In addition, the housing includes an inverter storage space for storing an inverter configured to control driving of the electric motor. The inverter storage space is sealed by a cover attached to the housing.

**[0003]** If the cover and the housing of the electrically driven compressor are both made of a metal, leakage of electromagnetic noise from the inverter to outside and entry of a flow of electromagnetic noise from the outside into the inverter may be prevented, and dissipation of heat generated by the inverter via the cover is facilitated. However, insulation properties between the cover and the inverter may be difficult to achieve.

**[0004]** The related art, therefore, proposes forming a cover including a metallic plate and an inner insulating portion made of a resin material in tight contact with an inner surface of the metallic plate (formed by molding a resin integrally with the metallic plate used as a core metal) to achieve electromagnetic shield by the metallic plate and ensure insulation properties between the metallic plate and the inverter by the inner insulating portion (see Patent Literature 1).

**[0005]** Citation List

**[0006]** Patent Literature

**[0007]** PTL 1: JP-A-2012-193660

### Summary of Invention

### Solution to Problem

**[0008]** However, the configuration described above, in which the metallic plate and the inner insulating portion surround the inverter, sacrifices cooling of the inverter because dissipation of heat generated from the inverter via the metallic plate is rather difficult due to the inner insulating portion although superior electromagnetic shield and insulation properties are achieved.

**[0009]** In view of such circumstances, it is a main object of the present invention to provide an electrically driven compressor superior in heat dissipation of an inverter

while ensuring insulation properties between the inverter and a cover.

### Solution to Problem

**[0010]** In order to achieve the above-described object, there is provided an electrically driven compressor of the present invention including: a metallic housing; a compression mechanism; an electric motor configured to drive the compression mechanism; the compression mechanism and the electric motor being stored in the metallic housing; an inverter stored in an inverter storage space defined by the housing and a metallic cover attached to the housing and configured to control driving of the electric motor, the compression mechanism, the electric motor, and the inverter storage space being disposed in a horizontal direction; an insulating member covering the inverter and being provided in the inverter storage space between the inverter and the cover; and passages formed between the inverter and the insulating member and between the insulating member and the cover, the passages extending in a vertical direction; wherein the passage between the inverter and the insulating member and the passage between the insulating member and the cover communicating with each other on an upper side and a lower side of the insulating member.

**[0011]** Therefore, the inverter storage space is closed by the metallic cover, such that leakage of electromagnetic noise from the inverter to outside and entry of a flow of electromagnetic noise from the outside into the inverter may be prevented. In addition, as the insulating member covers the inverter, the insulation performances between the inverter and the cover may be secured. In addition, the passages extending in the vertical direction are formed respectively between the inverter and the insulating member and between the insulating member and the cover, and these passages (the passage between the inverter and the insulating member and the passage between the insulating member and the cover) communicate with each other at the upper side and the lower side of the insulating member. Therefore, the air in the inverter storage space convects upward by being warmed up by heat from the inverter on an inverter side of the insulating member, moves to a cover side of the insulating member through a communicating portion on the upper side of the insulating member, then convects downward in the cover side passage of the insulating member by being cooled down by contacting the cover, moves to the inverter side of the insulating member through the communicating portion on the lower side of the insulating member, then convects upward again through the inverter side passage of the insulating member by being warmed up by absorbing heat from the inverter, and the same phenomenon is repeated from then onward. In other words, air in the inverter storage space circulates in the inverter storage space by convection.

**[0012]** Therefore, the heat generated by the inverter

may be dissipated effectively even though the insulating member is disposed on the front surface of the inverter, and thus a cooling effect may be accelerated while ensuring the magnetic shield and the insulation properties.

**[0013]** The insulating member is preferably formed of a resin.

**[0014]** The resin achieves light weight and easily-to-mold insulating member.

**[0015]** Preferably, the insulating member may have a wall portion extending in proximity to the inverter in the vertical direction and a wall portion extending in proximity to the cover in the vertical direction formed alternately in the horizontal direction.

**[0016]** In such a configuration, even when the space where the insulating member is to be disposed is small, sufficient surface area of the passages between the insulating member and the inverter and between the insulating member and the cover are secured, which may avoid inconvenience such as lowering of the convection effect due to narrowed passages.

**[0017]** In the configuration described above, the cover may include a rib on the surface thereof.

**[0018]** In this configuration, the strength of the cover is enhanced and vibrations may be restricted. In addition, by increasing the surface area of the cover contacting outside air or inside air, enhancement of a cooling effect of the inverter storage space is enabled.

**[0019]** When mounting the insulating member in the housing or on the cover, preferably, a fastening member for mounting the insulating member in the housing or on the cover different from the fastening members for mounting the cover on the housing is employed.

**[0020]** Typically, air-tightness is required between the housing and the cover, while the insulating member does not need air-tightness and needs only to be fixed in the inverter storage space. However, when fixing the cover and the insulating member with the same fastening members, dimensional accuracy and surface accuracy are required for the insulating members for ensuring the air-tightness. Therefore, the different fastening members are used for the assembly of the insulating member and for the assembly of the cover to avoid the necessity of the dimensional accuracy and the surface accuracy for ensuring air-tightness of the insulating member.

#### Advantageous Effects of Invention

**[0021]** As described thus far, the electrically driven compressor of the present invention includes the insulating member configured to cover the inverter and provided in the inverter storage space between the inverter and the cover; passages formed between the inverter and the insulating member and between the insulating member and the cover so as to extend in the vertical direction, and the passages (the passage between the inverter and the insulating member and the passage between the insulating member and the cover) are configured to communicate with each other on an upper side

and a lower side of the insulating member. Therefore, the electromagnetic shield may be achieved by the metallic cover, and the insulation properties between the inverter and the cover may be secured by the insulating member covering the inverter. In addition, even when the inverter is covered with the insulating member, cooling of the inverter may be accelerated.

#### Brief Description of the Drawings

##### **[0022]**

[Fig.1] Fig. 1 is a cross-sectional view illustrating an overall configuration of an electrically driven compressor according to the invention;

[Fig.2] Fig. 2 is an exploded perspective view illustrating an insulating member and a cover stored in an inverter storage space of a housing of the electrically driven compressor in Fig. 1.

[Fig.3] Fig. 3 is a drawing illustrating a storage state of members such as an insulating member to be stored in the inverter storage space of an inverter storage housing member. Description of Embodiments

**[0023]** Referring now to the drawings, an electrically driven compressor of the invention will be described below.

**[0024]** Fig. 1 illustrates an electrically driven compressor 1 suitable for a refrigeration cycle using a refrigerant as a working fluid. The electrically driven compressor 1 includes a compressing mechanism 3 disposed in a housing 2 made of an aluminum alloy on a left side in the drawing, and an electric motor 4 configured to drive the compression mechanism on a right side in the drawing.

**[0025]** In Fig. 1, the right side in the drawing is defined as a front of the compressor, and the left side of the drawing is defined as a rear side of the compressor.

**[0026]** The housing 2 includes a compressing mechanism storage housing member 2a configured to store the compressing mechanism 3, an electric motor storage housing member 2b configured to store the electric motor 4 for driving the compressing mechanism 3, and an inverter storage housing member 2c configured to store an inverter 5 for controlling driving of the electric motor 4, and these housing members are positioned by locating pins, not illustrated, and are fastened by fastening bolts in an axial direction.

**[0027]** A cover 16 is fixed to an end of the inverter storage housing member 2c. In other words, the cover 16 is disposed at an end of the housing 2.

**[0028]** The electric motor storage housing member 2b includes an intake port, not illustrated, in a peripheral wall thereof, and is configured to let the refrigerant be introduced through the intake port from an external refrigerant circuit, not illustrated. The compressing mechanism storage housing member 2a also includes a discharge port and is configured to let the refrigerant compressed by

the compression mechanism be discharged to the external refrigerant circuit through the discharge port. The compression mechanism here may have various forms, and, for example, a scroll type including a fixed scroll fixed to the compressing mechanism storage housing member 2a and a pivotal scroll disposed to face the fixed scroll in the axial direction.

**[0029]** The electric motor storage housing member 2b includes an electric motor storage space 11 formed therein, in which a stator 41 and a rotor 42 constituting the electric motor 4 are provided. The stator 41 includes an iron core 41a having a cylindrical shape, and a coil 41b wound on the iron core 41a, and is fixed to an inner surface of the electric motor storage housing member 2b. The electric motor storage space 11 is provided with a drive shaft 6 rotatably supported at one end thereof by the inverter storage housing member 2c described later and rotatably supported at the other end thereof at a boundary portion between the electric motor storage housing member 2b and the compressing mechanism storage housing member 2a. The drive shaft 6 is provided with the rotor 42 rotatably stored inside the stator 41 and made of magnet fixed thereto, and the rotor 42 is configured to be rotated by a rotational magnetic force generated by the stator 41 to rotate the drive shaft 6.

**[0030]** Refrigerant gas introduced into the electric motor storage space 11 from an inlet port formed on the peripheral wall of the electric motor storage housing member 2b is introduced to the compressing mechanism 3 via a gap between the stator 41 and the housing 2 (the electric motor storage housing member 2b) and holes or the like formed in a wall portion for supporting the drive shaft 6.

**[0031]** The inverter storage housing member 2c includes a partitioning wall 7 having a pivotally supporting portion 7a integrally formed there with configured to support the drive shaft 6 on a side facing the electric motor storage housing member 2b and the drive shaft 6 is rotatably supported by the pivotally supporting portion 7a via a bearing 8. A front part of an interior of the housing 2 is partitioned into the electric motor storage space 11 for storing the electric motor 4 and an inverter storage space 12 for storing the inverter 5 by the partitioning wall 7 formed on the inverter storage housing member 2c.

**[0032]** In this example, the inverter storage space 12 is defined by fixing the cover 16 to the inverter storage housing member 2c with screws 17.

**[0033]** The electrically driven compressor 1 thus includes the compressing mechanism 3, the electric motor 4, and the inverter 5 (the inverter storage space 12) disposed in this order in a horizontal direction.

**[0034]** The inverter 5 includes an inverter circuit board 51 having an inverter circuit mounted thereon and disposed along the partitioning wall 7 of the inverter storage housing member 2c as illustrated in Fig. 2, and in this example, the partitioning wall 7 is provided with a depressed portion 12a on a side facing the inverter storage space 12 and the inverter circuit board 51 is placed and

fixed to a peripheral edge of the depressed portion 12a.

**[0035]** An inverter module 52, which is a modulated switching element for the inverter circuit is fixed to a back surface of the inverter circuit board 51, that is, the surface facing the partitioning wall 7. The inverter module 52 includes a heat-generating element integrated therein, and thus is in tight contact with a flat mounting surface formed on the partitioning wall 7 via a thermally conductive material such as silicone grease and is fixed to the partitioning wall 7 by screws 53 inserted through screw through holes 51a formed on the inverter circuit board 51 to keep the tight-contact state, such that the inverter module 52 is cooled down by the refrigerant gas introduced into the electric motor storage space 11 via the partitioning wall 7.

**[0036]** The partitioning wall 7 includes a through hole 7b for mounting a terminal (air-tight terminal) 13.

**[0037]** In this example, the terminal (air-tight terminal) 13 includes a body portion 13a made of a hard member and a plurality of (three) terminal pins 13b fixed through the body portion 13a, and the body portion 13a in which the terminal pins 13b in an air-tight manner penetrate includes a flange portion 13c which can engage the peripheral edge of the through hole 7b. The terminal 13 in this configuration is inserted into the through hole 7b from the electric motor storage space 11 and is fixed to the partitioning wall 7 by part of the body portion 13a protruding into the inverter storage space 12 to seal the through hole 7b in an air-tight manner.

**[0038]** The inverter circuit board 51 is provided with a through hole 51b, which is large enough to allow the plurality of (three) terminal pins 13b to pass through without touching, at a portion facing a portion where the terminal 13 is to be mounted.

**[0039]** An inverter side connector 14 connected to the inverter circuit via a cable, not illustrated, is fitted to portions of the terminal pins 13b projecting from a side of the inverter circuit board 51 opposite from a side facing the partitioning wall 7 through the through hole 51b of the inverter circuit board 51, and an electric motor side connector 15 connected to the stator 41 of the electric motor 4 via a cable, not illustrated, is fitted to the portions of the terminal pins 13b projecting from the rear side of the terminal 13 into the electric motor storage space 11. Therefore, the inverter circuit and the stator 41 are electrically connected via the terminal 13, and are configured to feed electricity to the electric motor 4 from the inverter 5.

**[0040]** The inverter storage space 12 is provided with a resin insulating member 21 between the inverter circuit board 51 and the cover 16 so as to cover the inverter circuit board 51.

**[0041]** The insulating member 21 is formed to a size which can cover almost the entire part of the inverter circuit board 51. In this example, the insulating member 21 is formed into a substantially rectangular shape, and is fixed at four corners thereof by fastening screws 23 into screw receiving boss portions 22 formed on the peripheral edge of the depressed portion 12a of the inverter

storage housing member 2c while the insulating member 21 is separate from the inverter circuit board 51.

**[0042]** The insulating member 21 includes wall portions 21a and 21b extending vertically in proximity to the inverter circuit board 51 and a wall portion 21c extending vertically in proximity to the cover 16 formed integrally with each other alternately in the horizontal direction. In this example, the wall portion 21c between the wall portion 21a and the wall portion 21b constitutes a wall portion in proximity to the cover 16, and the wall portions 21a, 21b on both sides constitute the wall portions in proximity to the inverter circuit board 51. This forms an ascending passage 24 extending vertically and having a large passage area with respect to the inverter circuit board 51 in an intermediate region of the insulating member 21, and descending passages 25 extending vertically and having a large passage area with respect to the cover 16 in both side regions of the insulating member 21. The terminal 13 and the inverter side connector 14 are disposed in the ascending passage 24.

**[0043]** The insulating member 21 is attached so as to contact neither with an upper inner peripheral wall nor with a lower inner peripheral wall of the inverter storage space 12, and the ascending passage 24 (the passage between the inverter circuit board 51 and the insulating member 21) and the descending passages 25 (the passages between the insulating member 21 and the cover 16) communicate each other at the upper side and the lower side of the insulating member 21.

**[0044]** The cover 16 is hermetically fixed at a peripheral edge portion thereof to cylindrical portions 26 for fastening screws formed on an inner peripheral wall of the inverter storage housing member 2c at predetermined circumferential intervals via sealing members, not illustrated, with the screws 17.

**[0045]** The insulating member 21 may simply be disposed between the inverter circuit board 51 and the cover 16 for improving insulating performances. However, the screws (fastening members) 23 for fixing the insulating member 21 are different from the screws (fastening members) 17 for fixing the cover 16 to the housing because the inverter storage housing member 2c and the cover 16 need to have air-tightness to some extent.

**[0046]** A surface of the cover 16 has ribs 27 formed to partly protrude from the surface thereof. The shape of the ribs 27 is not specifically limited, and a contact surface area between the cover 16 and outside air or inside air may be increased by forming depression or projection on the surface of the cover 16.

**[0047]** The inverter storage space 12 in the electrically driven compressor having the configuration described above is closed by the metallic inverter storage housing member 2c and the metallic cover 16, such that leakage of electromagnetic noise from the inverter to outside and entry of a flow of electromagnetic noise from the outside into the inverter may be prevented.

**[0048]** In addition, as the resin insulating member 21 is provided so as to cover the inverter circuit board 51,

the insulation performance between the inverter and the cover 16 is enhanced and the safety may be secured.

**[0049]** In addition, in the insulating member 21, the passages extending in the vertical direction (the ascending passage 24, the descending passages 25) are formed respectively between the inverter circuit board 51 and the insulating member 21, and between the insulating member 21 and the cover 16, and these passages communicate with each other at the upper side and the lower side of the insulating member 21. Therefore, the air in the inverter storage space 12 convects upward in the inverter circuit board 51 side passage of the insulating member 21 (the ascending passage 24) by being warmed up by heat from the inverter circuit on the inverter circuit board 51 side of the insulating member 21, moves to the cover 16 side of the insulating member 21 through the communicating portion on the upper side of the insulating member 21, then convects downward in the cover 16 side passages (the descending passages 25) of the insulating member 21 by being cooled down by contacting the inner surface of the cover 16, moves to the inverter circuit board 51 side of the insulating member 21 through the communicating portion on the lower side of the insulating member 21, and then convects upward again through the inverter circuit board 51 side passage (the ascending passage 24) of the insulating member 21 by being warmed up again by absorbing heat from the inverter circuit board 51, and so forth. The same phenomenon is repeated. In other words, air in the inverter storage space circulates in the inverter storage space 12 by convection effect as indicated by arrows in Fig. 1.

**[0050]** Therefore, the heat generated by the inverter circuit may be dissipated effectively even though the resin insulating member 21 is disposed so as to cover the inverter circuit board 51, and thus a cooling effect may be accelerated.

**[0051]** In addition, the insulating member 21 includes the wall portions 21a, 21b in proximity to the inverter circuit board 51 and the wall portion 21c in proximity to the cover 16 alternately, and thus the wall portions 21a, 21b are relatively apart from the cover 16, and the wall portion 21c is relatively apart from the inverter circuit board 51. Accordingly, when a space for placing the insulating member 21 is small, the passage area of the ascending passage 24 and the descending passages 25 may be secured, and in addition, interference between the insulating member 21 and the connector or the electronic components may be avoided, so that a reduction of the convection effect may be prevented.

**[0052]** In addition, in the configuration described above, as the ribs 27 are formed on the surface of the cover 16, the surface area of the cover 16 which contacts with outside air or inside air may be increased, so that enhancement of the cooling function inside the cover 16 is enabled.

**[0053]** In addition, the fastening members (screws 17) of the cover 16 different from the fastening members (screws 23) of the insulating member 21 are employed.

**[0054]** When the cover 16 and the insulating member 21 are fixed by the same fastening members, dimensional accuracy and surface accuracy are required for the insulating members for ensuring the air-tightness, which may increase costs. However, as the fastening members (the screw 23) of the insulating member 21 are different from the fastening members (the screw 17) of the cover 16, the dimensional accuracy and the surface accuracy for ensuring the air-tightness in the insulating member 21 are no longer necessary.

**[0055]** The example in which the insulating member 21 is fixed to the housing side (the inverter storage housing member 2c) has been described above. As an alternative, the insulating member 21 may be fixed to the cover 16 with a clearance therebetween to form passages extending in the vertical direction respectively between the inverter circuit board 51 and the insulating member 21 and between the insulating member 21 and the cover 16.

#### Reference Signs List

#### [0056]

- 1 electrically driven compressor
- 2 housing
- 3 compression mechanism
- 4 electric motor
- 12 inverter storage space
- 16 cover
- 17, 23 screw (fastening member)
- 21 insulating member
- 21a, 21b, 21c wall portion
- 24 ascending passage
- 25 descending passage
- 27 rib
- 51 inverter circuit board

#### Claims

#### 1. An electrically driven compressor (1) comprising:

- a metallic housing (2);
- a compression mechanism (3); an electric motor (4) configured to drive the compression mechanism (3), the compression mechanism (3) and the electric motor (4) being stored in the metallic housing (2);
- an inverter (5) stored in an inverter storage space (12) defined by the housing (2) and a metallic cover (16) attached to the housing (2) and configured to control driving of the electric motor (4), the compression mechanism (3), the electric motor (4), and the inverter storage space (12) being disposed in a horizontal direction;
- an insulating member (21) covering the inverter (5) and being provided in the inverter storage

space (12) between the inverter (5) and the cover (16); and passages (24, 25) formed between the inverter (5) and the insulating member (21) and between the insulating member (21) and the cover (16), the passages (24, 25) extending in a vertical direction, wherein the passage (24) between the inverter (5) and the insulating member (21) and the passage (25) between the insulating member (21) and the cover (16) communicating with each other on an upper side and a lower side of the insulating member (21).

2. The electrically driven compressor (1) according to Claim 1, wherein the insulating member (21) is formed of a resin.
3. The electrically driven compressor (1) according to Claim 1 or 2, wherein the insulating member (21) includes a wall portion (21a, 21b) extending in proximity to the inverter (5) in the vertical direction and a wall portion (21c) extending in proximity to the cover (16) in the vertical direction, the wall portions (21a, 21b, 21c) being formed alternately in the horizontal direction.
4. The electrically driven compressor (1) according to any one of Claims 1 to 3, wherein a surface of the cover (16) is provided with a rib (27).
5. The electrically driven compressor (1) according to any one of Claims 1 to 4, wherein the insulating member (21) is mounted on the housing (2) or the cover (16), and a fastening member (23) for mounting the insulating member (21) to the housing (2) or the cover (16) is different from a fastening member (17) for mounting the cover (16) to the housing (2).

Fig. 1

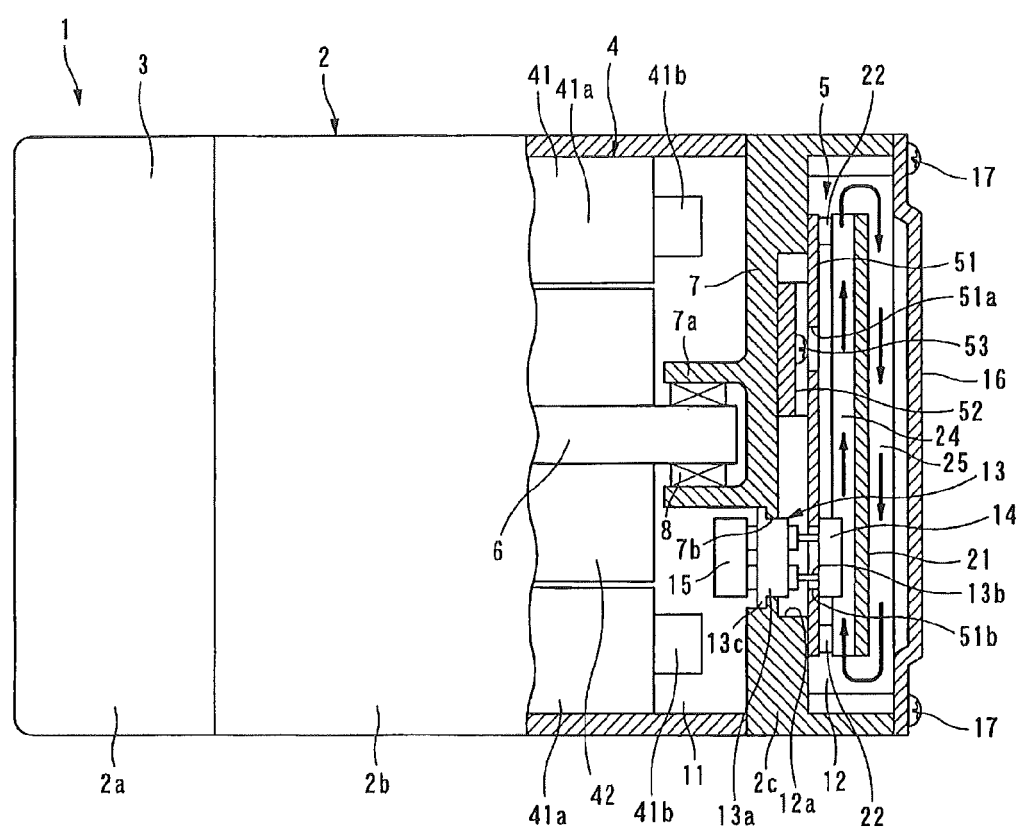


Fig. 2

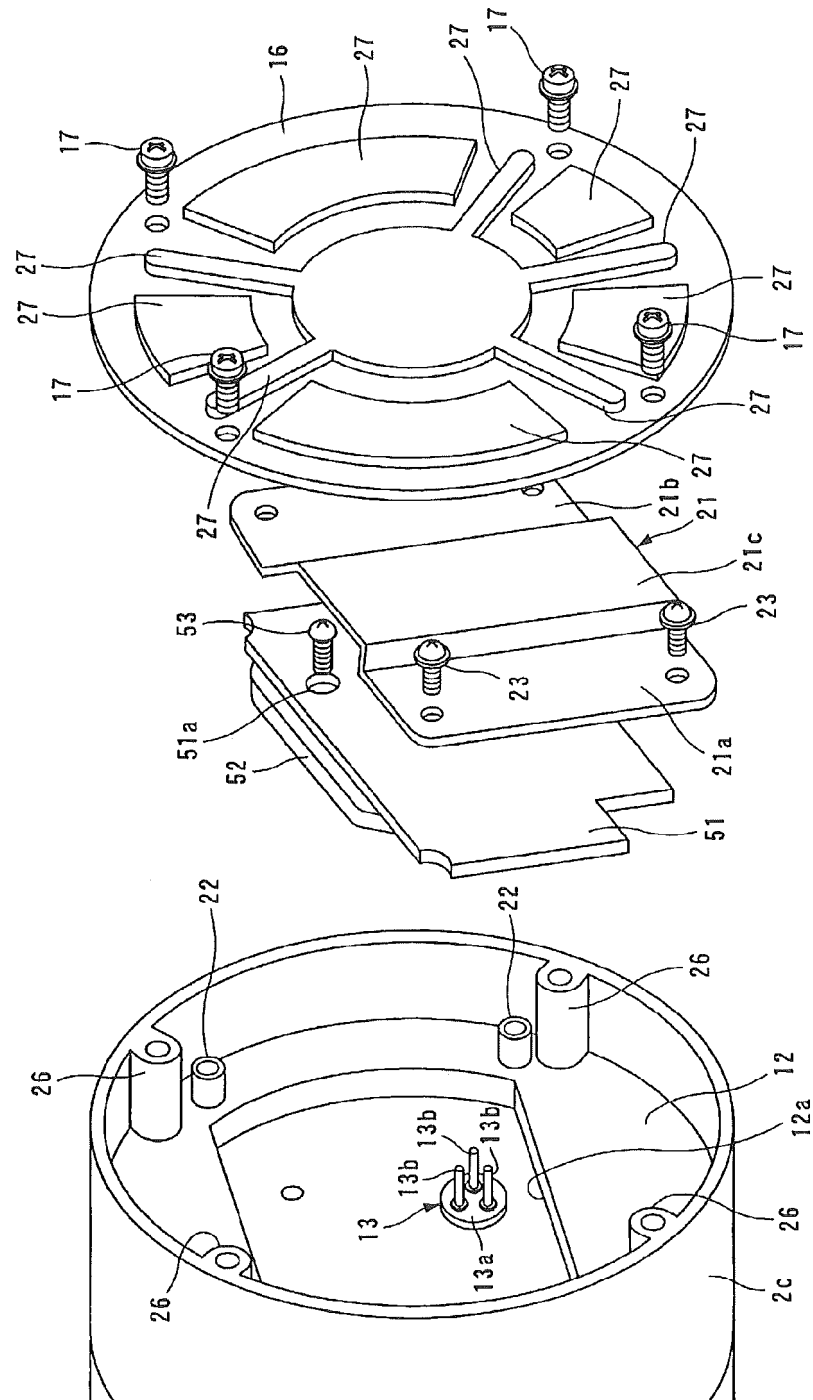
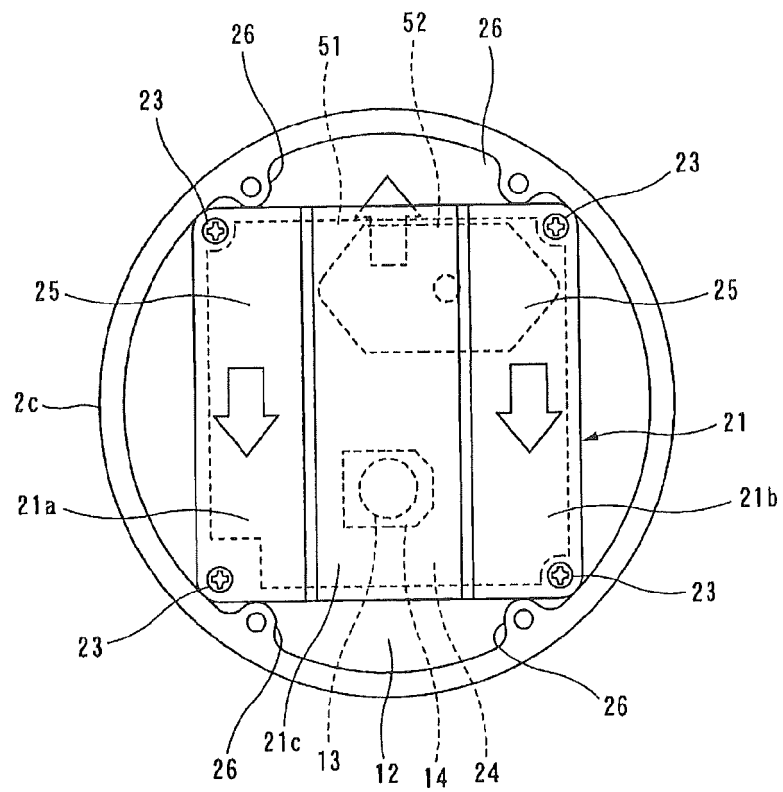


Fig. 3



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/087138

## A. CLASSIFICATION OF SUBJECT MATTER

F04B39/00(2006.01)i, F04B39/06(2006.01)i, F04C29/00(2006.01)i, F04C29/04(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, F04B39/06, F04C29/00, F04C29/04

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         | JP 2013-96297 A (Toyota Industries Corp.),<br>20 May 2013 (20.05.2013),<br>paragraphs [0014] to [0021]; fig. 1 to 3<br>& US 2013/0108485 A1<br>paragraphs [0013] to [0024]; fig. 1 to 3<br>& EP 2587060 A1 & CN 103089634 A | 1-5                   |
| A         | JP 2008-163767 A (Matsushita Electric<br>Industrial Co., Ltd.),<br>17 July 2008 (17.07.2008),<br>paragraphs [0051] to [0127]; fig. 1 to 2<br>(Family: none)                                                                 | 1-5                   |

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

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Date of the actual completion of the international search  
26 January 2017 (26.01.17)

Date of mailing of the international search report  
07 February 2017 (07.02.17)

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

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Form PCT/ISA/210 (second sheet) (January 2015)

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**Patent documents cited in the description**

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