



(11)

EP 4 773 159 A1

(12)

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

(43) Date of publication:
08.07.2026 Bulletin 2026/28

(51) International Patent Classification (IPC):
H01F 27/08 ^(2006.01) **H01F 17/06** ^(2006.01)
H01F 27/02 ^(2006.01) **H01F 27/22** ^(2006.01)

(21) Application number: **24859009.3**

(52) Cooperative Patent Classification (CPC):
H01F 17/06; H01F 27/02; H01F 27/08; H01F 27/22

(22) Date of filing: **28.03.2024**

(86) International application number:
PCT/JP2024/012817

(87) International publication number:
WO 2025/046960 (06.03.2025 Gazette 2025/10)

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(72) Inventors:
• **YADA, Tetsuya**
Kasugai-shi, Aichi 480-0303 (JP)
• **OKADA, Yuya**
Kasugai-shi, Aichi 480-0303 (JP)
• **YASUNISHI, Yuki**
Kasugai-shi, Aichi 480-0303 (JP)

(74) Representative: **Cleveland Scott York**
5 Norwich Street
London EC4A 1DR (GB)

(30) Priority: **31.08.2023 JP 2023141522**

(71) Applicant: **Kitagawa Industries Co., Ltd.**
Inazawa-shi, Aichi 492-8446 (JP)

(54) **NOISE FILTER**

(57) Provided is a noise filter having higher heat dissipation performance than conventional products and capable of suppressing a temperature rise even when each part including a conductor is miniaturized. A noise filter includes a magnetic core, a conductor, a mold part, and a thermally conductive part. The mold part is formed of a first thermally conductive material. The thermally conductive part is formed of a second thermally conductive material having a thermal conductivity higher

than the first thermally conductive material, and is disposed so as to be in contact with an external member to which heat is to be dissipated, during use of the noise filter. The mold part has an opening portion penetrating the mold part and reaching an outer peripheral surface of the magnetic core. The thermally conductive part has an insertion portion to extend into the opening portion, and is configured to be in contact with the magnetic core at the insertion portion.

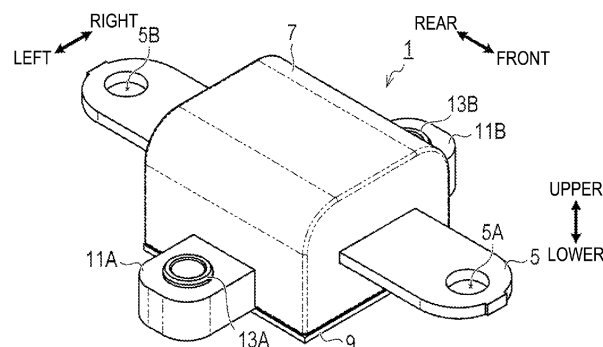


FIG. 1A

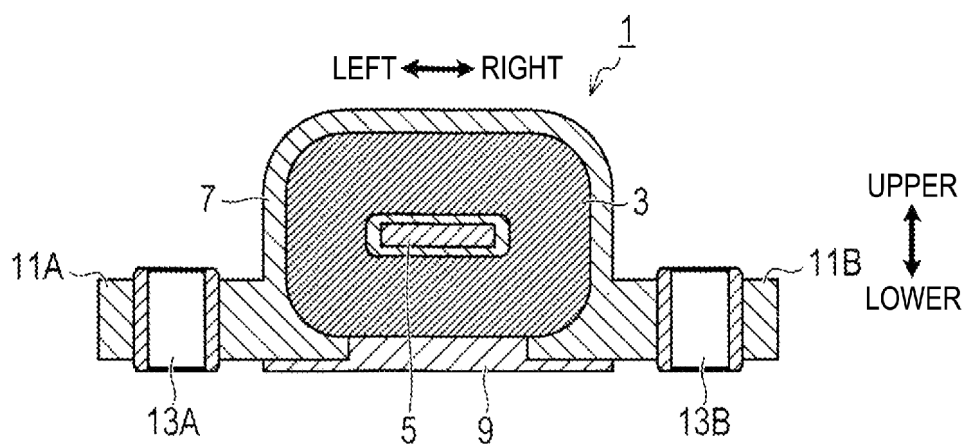


FIG. 1B

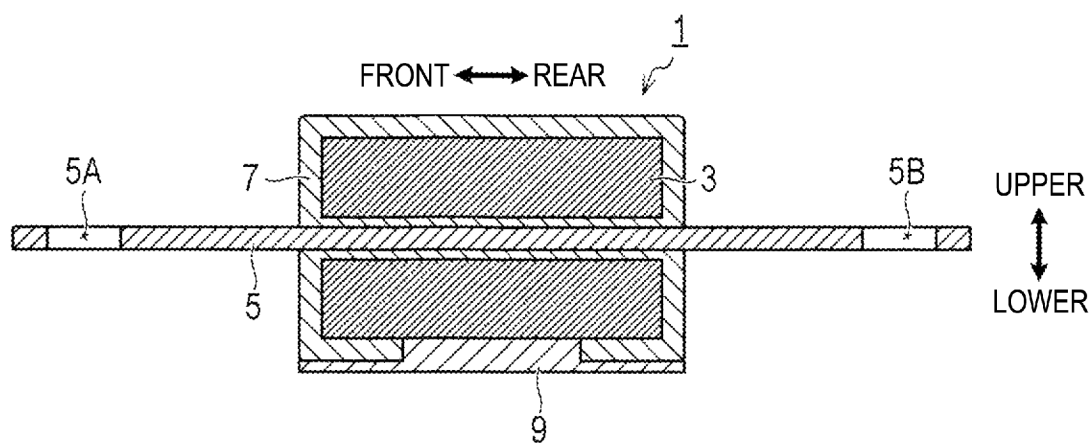


FIG. 1C

Description

Technical Field

[0001] The present disclosure relates to a noise filter. 5

Background Art

[0002] A noise filter as disclosed in Patent Document 1 below has been proposed. The noise filter described in Patent Document 1 includes a magnetic core and a conductor (a conductive bar in Patent Document 1), and has a structure in which a portion of the magnetic core and a portion of the conductor are molded by a resin material. 10 15

Citation List

Patent Literature

[0003] Patent Document 1: Japanese Unexamined Patent Application Publication No. 2020-5043A 20

Summary of Invention

Technical Problem

[0004] The noise filter as described above forms a portion of a power supply path to a motor serving as a power source in, for example, an electric vehicle, a hybrid vehicle, or the like. In such an application, a large current is caused to flow through the conductor, and the conductor generates heat accordingly. If the magnetic core becomes excessively high in temperature due to the heat generation of the conductor, the performance of the noise filter may be adversely affected. In addition, if the noise filter becomes excessively high in temperature, when an electronic component or the like is present in the vicinity of the noise filter, the performance of the electronic component or the like may be adversely affected. Therefore, it is important to appropriately suppress the heat generation of the noise filter. 25 30

[0005] As a method for suppressing the heat generation of the conductor, for example, increasing the thickness of the conductor can be considered. However, in this case, the size of the noise filter is increased, making it difficult to place the noise filter in a confined space. In addition, when the noise filter is increased in size, the weight of the device including the noise filter is also increased. In addition, although an air cooling mechanism or a water cooling mechanism can be added for thermal management, this also requires a space for placing the air cooling mechanism or the water cooling mechanism, making it difficult to place the mechanism in a confined space, and leading to an increase in weight. 35 40

[0006] In one aspect of the present disclosure, it is preferable to provide a noise filter having higher heat dissipation performance than conventional products and 45 50

capable of suppressing a temperature rise even when each part including a conductor is miniaturized.

Solution to Problem

[0007]

(1) An aspect of the present disclosure is a noise filter including a magnetic core, a conductor, a mold part, and a thermally conductive part. The magnetic core is a magnetic body formed in an annular or cylindrical shape. The conductor is disposed so as to penetrate an inner peripheral side of the magnetic core. The mold part is formed of a first thermally conductive material and molds a portion of the magnetic core and a portion of the conductor. The thermally conductive part is formed of a second thermally conductive material having a thermal conductivity higher than the first thermally conductive material, is disposed so as to be in contact with a portion of the magnetic core and a portion of the mold part, and is disposed so as to be in contact with an external member to which heat is to be dissipated, thereby conducting heat of the magnetic core and the mold part to the external member, during use of the noise filter. The mold part has an opening portion configured to penetrate the mold part and to reach an outer peripheral surface of the magnetic core. The thermally conductive part has an insertion portion to extend into the opening portion, and is configured to be in contact with the magnetic core at the insertion portion. 55

[0008] According to the noise filter configured as described above, the mold part is formed of the first thermally conductive material, and the thermally conductive part is formed of the second thermally conductive material. Therefore, when the temperatures of the magnetic core and the conductor rise, the heat of the magnetic core and the conductor can be dissipated to the mold part and the thermally conductive part, and thus an excessive temperature rise of the magnetic core and the conductor can be suppressed. 35 40

[0009] In particular, the insertion portion of the thermally conductive part extends into the opening portion formed in the mold part and is in contact with the magnetic core. Therefore, the heat of the magnetic core can be directly conducted to the thermally conductive part, and the efficiency of heat conduction to the external member to which heat is to be dissipated can be improved as compared with a portion where the mold part is interposed between the magnetic core and the thermally conductive part. 45 50

[0010] Therefore, as the heat dissipation performance of the noise filter increases, heat generation of the conductor can be tolerated to a greater extent than in conventional products, and thus a conductor that is thinner and more likely to generate heat than in conventional 55

products can be adopted. This enables the noise filter to be reduced in size.

[0011] Note that the noise filter of the present disclosure may further optionally include the following configurations.

(2) In an aspect of the present disclosure, the thermally conductive part may be configured to be in contact with an inner peripheral surface of the opening portion.

(3) In an aspect of the present disclosure, the thermally conductive part may be configured to form a gap between the thermally conductive part and an inner peripheral surface of the opening portion.

(4) In an aspect of the present disclosure, the first thermally conductive material may have a thermal conductivity of 1 W/m·K or more and less than 1.4 W/m·K. The second thermally conductive material may have a thermal conductivity of 1.4 W/m·K or more and 5 W/m·K or less.

(5) In an aspect of the present disclosure, the thermally conductive part may be configured to come into close contact with the external member by deformation of the thermally conductive part when the thermally conductive part is sandwiched between the magnetic core and the external member and/or and between the mold part and the external member and receives a compressive load, during use of the noise filter.

Brief Description of Drawings

[0012]

FIG. 1A is a perspective view of a noise filter of a first embodiment. FIG. 1B is a cross-sectional view of the noise filter of the first embodiment taken along line IB-IB of FIG. 2C. FIG. 1C is a cross-sectional view of the noise filter of the first embodiment taken along line IC-IC of FIG. 2B.

FIG. 2A is a plan view of the noise filter of the first embodiment. FIG. 2B is a front view of the noise filter of the first embodiment. FIG. 2C is a right side view of the noise filter of the first embodiment. FIG. 2D is a bottom view of the noise filter of the first embodiment. FIG. 3A is a cross-sectional view of the noise filter of the first embodiment taken along line IB-IB of FIG. 2C, further illustrating a thermally conductive part in an exploded state. FIG. 3B is a cross-sectional view of the noise filter of the first embodiment taken along line IC-IC of FIG. 2B, further illustrating the thermally conductive part in an exploded state. FIG. 3C is a perspective view illustrating a use state of the noise filter of the first embodiment.

FIG. 4A is a cross-sectional view of a noise filter of a second embodiment taken along line IB-IB of FIG. 2C. FIG. 4B is a cross-sectional view of the noise filter of the second embodiment taken along line IC-

IC of FIG. 2B. FIG. 4C is an enlarged view of a portion IVC illustrated in FIG. 4A. FIG. 4D is an enlarged view of a portion IVD illustrated in FIG. 4A. FIG. 4E is an enlarged view of a portion IVE illustrated in FIG. 4B. FIG. 4F is an enlarged view of a portion IVF illustrated in FIG. 4B.

FIG. 5A is a perspective view of a noise filter of a third embodiment. FIG. 5B is a cross-sectional view of the noise filter of the third embodiment taken along line VB-VB of FIG. 6C. FIG. 5C is a cross-sectional view of the noise filter of the third embodiment taken along line VC-VC of FIG. 6B.

FIG. 6A is a plan view of the noise filter of the third embodiment. FIG. 6B is a front view of the noise filter of the third embodiment. FIG. 6C is a right side view of the noise filter of the third embodiment. FIG. 6D is a bottom view of the noise filter of the third embodiment.

20 Reference Signs List

[0013] 1, 21, 31: noise filter, 3: magnetic core, 3A: outer peripheral surface, 5: conductor, 5A, 5B: through hole, 7: mold part, 7A: opening portion, 9: thermally conductive part, 9A: first surface, 9B: second surface, 11A, 11B: fixing portion, 13A, 13B: collar, 15: insertion portion, 17: external member, 23: gap, 33A, 33B: heat dissipation fin.

30 Description of Embodiments

[0014] Next, the noise filter described above will be explained using an exemplary embodiment.

35 (1) First Embodiment

Configuration of Noise Filter

[0015] As illustrated in FIGS. 1A, 1B, 1C, 2A, 2B, 2C, and 2D, a noise filter 1 of a first embodiment includes a magnetic core 3, a conductor 5, a mold part 7, and a thermally conductive part 9. Note that the left side view of the noise filter 1 is the same as the right side view (see FIG. 2C). The rear view of the noise filter 1 is the same as the front view (see FIG. 2B).

[0016] As illustrated in FIGS. 1B and 1C, the magnetic core 3 is a magnetic body formed in an annular or cylindrical shape. As illustrated in FIGS. 1B and 1C, the conductor 5 is disposed so as to penetrate an inner peripheral side of the magnetic core 3. In the present embodiment, the conductor 5 is formed in a plate-like shape elongated in the front-rear direction in the drawing, and a plate thickness direction thereof is oriented in the upper-lower direction in the drawing. Through holes 5A and 5B penetrating in the plate thickness direction are formed near both ends of the conductor 5 in the longitudinal direction (the front-rear direction in the drawing).

[0017] The mold part 7 is formed of a first thermally

conductive material. In the present embodiment, as the first thermally conductive material, a thermally conductive resin (trade name: Xecot (registered trademark), manufactured by Unitika Ltd.) having a thermal conductivity of 1 W/m·K or more and less than 1.4 W/m·K and a volume resistivity of more than $1.0 \times 10^{13} \Omega \cdot \text{m}$ is adopted. The mold part 7 molds a portion of the magnetic core 3 and a portion of the conductor 5. A space between an inner periphery of the magnetic core 3 and an outer periphery of the conductor 5 is filled with the mold part 7.

[0018] The mold part 7 has fixing portions 11A and 11B protruding in the left-right direction in the drawing. Collars 13A and 13B formed of metal are provided on the fixing portions 11A and 11B. When fixing the noise filter 1 to an attachment target portion with bolts (not illustrated), bolt shafts are passed through the collars 13A and 13B.

[0019] The thermally conductive part 9 is formed of a second thermally conductive material having a higher thermal conductivity than the first thermally conductive material. In the present embodiment, as the second thermally conductive material, a thermally conductive resin (trade name: CPLK, manufactured by Kitagawa Industries Co., Ltd.) having a thermal conductivity of 1.4 W/m·K or more and 5 W/m·K or less, a volume resistivity of more than $1.0 \times 10^{11} \Omega \cdot \text{m}$, and a hardness (ASKER C) of preferably 5 to 50 (more preferably 30 to 50) is adopted.

[0020] The thermally conductive part 9 is disposed so as to be in contact with a portion of the magnetic core 3 and a portion of the mold part 7. More specifically, as illustrated in FIGS. 3A and 3B, an opening portion 7A is formed in the mold part 7. The opening portion 7A penetrates the mold part 7 and reaches an outer peripheral surface 3A of the magnetic core 3. The thermally conductive part 9 has an insertion portion 15 protruding upward in the drawing. The thermally conductive part 9 is configured to be in contact with the magnetic core 3 on a first surface 9A located at a protruding tip of the insertion portion 15 and to be in contact with the mold part 7 on a second surface 9B located around the insertion portion 15. In addition, in the present embodiment, the insertion portion 15 is configured to be in contact also with an inner peripheral surface of the opening portion 7A.

[0021] As illustrated in FIG. 3C, during the use of the noise filter 1, the thermally conductive part 9 is disposed so as to be in contact with an external member 17 (for example, a water-cooled cooling plate) to which heat is to be dissipated, thereby conducting heat of the magnetic core 3 and the mold part 7 to the external member 17. The thermally conductive part 9 comes into close contact with the external member 17 by deformation of the thermally conductive part 9 when the thermally conductive part 9 is sandwiched between the magnetic core 3 and the external member 17 and/or between the mold part 7 and the external member 17 and receives a compressive load. This can promote heat transfer from the thermally conductive part 9 to the external member 17 as compared with a case where the thermally conductive part 9 is not

easily deformed.

[0022] Note that, in the present embodiment, the thermal conductivities of the first thermally conductive material and the second thermally conductive material were measured by a measurement method in accordance with ISO22007-2 using a commercially available hot disk method thermophysical property measurement device (TPS - 500, manufactured by Kyoto Electronics Manufacturing Co., Ltd.). In addition, the volume resistivities of the first thermally conductive material and the second thermally conductive material were measured by a measurement method in accordance with JIS K 6911 using a commercially available high-precision resistivity meter (MCP-HT450, manufactured by Mitsubishi Chemical Corporation).

Effect

[0023] According to the noise filter 1 configured as described above, the mold part 7 is formed of the first thermally conductive material, and the thermally conductive part is formed of the second thermally conductive material. Therefore, when the temperatures of the magnetic core 3 and the conductor 5 rise, the heat of the magnetic core 3 and the conductor 5 can be dissipated to the mold part 7 and the thermally conductive part 9, and thus an excessive temperature rise of the magnetic core 3 and the conductor 5 can be suppressed.

[0024] In particular, the insertion portion 15 of the thermally conductive part 9 extends into the opening portion 7A formed in the mold part 7 and is in contact with the magnetic core 3. Therefore, the heat of the magnetic core 3 can be directly conducted to the thermally conductive part 9, and thus the efficiency of heat conduction to the external member 17 to which heat is to be dissipated can be improved as compared with a portion where the mold part 7 is interposed between the magnetic core 3 and the thermally conductive part 9.

[0025] In addition, in the present embodiment, the insertion portion 15 is in contact with the inner peripheral surface of the opening portion 7A. Therefore, heat transfer from the mold part 7 to the thermally conductive part 9 occurs on the inner peripheral surface of the opening portion 7A, and thus heat dissipation from the mold part 7 can be promoted.

[0026] Therefore, as the heat dissipation performance of the noise filter 1 increases, the temperature rise of the noise filter 1 can be suppressed more than in conventional products. Alternatively, when the temperature rise of the noise filter 1 can be tolerated to the same extent as that of conventional products, heat generation of the conductor 5 can be tolerated to a greater extent than in conventional products. In this case, for example, the conductor 5 that is thinner and more likely to generate heat than in conventional products can be adopted, and thus the noise filter 1 can be reduced in size.

(2) Second embodiment

[0027] Next, the second embodiment will be described. Note that the second and subsequent embodiments are embodiments in which the configurations described as an example in the first embodiment are partially modified. Therefore, the differences from the first embodiment will be mainly described in detail. Configurations identical to those in the first embodiment will be denoted by the same reference numerals as those in the first embodiment, and detailed descriptions thereof will be omitted.

Configuration of Noise Filter

[0028] As illustrated in FIGS. 4A and 4B, a noise filter 21 of a second embodiment is different from the noise filter 1 of the first embodiment in a structure illustrated in the cross-sectional view of the noise filter 21. More specifically, as illustrated in FIGS. 4C, 4D, 4E, and 4F, the noise filter 21 of the second embodiment is different from the noise filter 1 of the first embodiment in that a gap 23 is provided between the mold part 7 and the thermally conductive part 9.

[0029] The gap 23 is formed between the inner periphery of the opening portion 7A and the outer periphery of the insertion portion 15 illustrated in FIGS. 3A and 3B in the first embodiment. In the second embodiment, the shapes and dimensions of the magnetic core 3, the conductor 5, and the mold part 7 are configured to be completely equivalent to those of the first embodiment. In the second embodiment, the shape and dimensions of the thermally conductive part 9 are configured such that the dimensions in the front-rear direction and the left-right direction in the drawing are smaller than those of the insertion portion 15 of the first embodiment illustrated in FIGS. 3A and 3B, and as a result, the gap 23 is formed.

[0030] Note that the gap 23 is located at a position where it cannot be seen from the outside of the noise filter 21 of the second embodiment. Therefore, the six views of the noise filter 21 of the second embodiment are completely the same as those of the noise filter 1 of the first embodiment.

Effect

[0031] The noise filter 21 configured as described above also has similar operations and effects to those of the noise filter 1 described in the first embodiment. Therefore, as the heat dissipation performance of the noise filter 21 increases, the temperature rise of the noise filter 21 can be suppressed more than in conventional products. Alternatively, when the temperature rise of the noise filter 21 can be tolerated to the same extent as that of conventional products, heat generation of the conductor 5 can be tolerated to a greater extent than in conventional products. In this case, for example, the conductor 5 that is thinner and more likely to generate heat than in conventional products can be adopted, and thus the

noise filter 21 can be reduced in size.

[0032] In addition, in the second embodiment, the noise filter 21 has the above-described gap 23 between the mold part 7 and the thermally conductive part 9. Therefore, the insertion portion 15 can be more easily inserted into the inner peripheral side of the opening portion 7A in the second embodiment than in the first embodiment, and thus the productivity of the noise filter 21 can be improved.

(3) Third embodiment

[0033] Next, a third embodiment will be described.

[0034] As illustrated in FIGS. 5A, 5B, 5C, 6A, 6B, 6C, and 6D, a noise filter 31 of a third embodiment is different from the noise filter 1 of the first embodiment in that the noise filter 31 includes heat dissipation fins 33A and 33B. The heat dissipation fins 33A and 33B are formed integrally with the mold part 7 by the first thermally conductive material forming the mold part 7.

Effect

[0035] The noise filter 31 configured as described above also has similar operations and effects to those of the noise filter 1 described in the first embodiment. Therefore, as the heat dissipation performance of the noise filter 31 increases, the temperature rise of the noise filter 31 can be suppressed more than in conventional products. Alternatively, when the temperature rise of the noise filter 31 can be tolerated to the same extent as that of conventional products, heat generation of the conductor 5 can be tolerated to a greater extent than in conventional products. In this case, for example, the conductor 5 that is thinner and more likely to generate heat than in conventional products can be adopted, and thus the noise filter 31 can be reduced in size.

[0036] In addition, in the third embodiment, the noise filter 31 includes the heat dissipation fins 33A and 33B, as described above. Therefore, heat dissipation from the heat dissipation fins 33A and 33B can be promoted, and thus the heat dissipation performance of the noise filter 21 can be improved as compared with a case where similar heat dissipation fins are not provided.

(4) Other Embodiments

[0037] While the noise filter has been described above with reference to the exemplary embodiments, the embodiments described above are merely examples as an aspect of the present disclosure. That is, the present disclosure is not limited to the exemplary embodiments described above, and can be carried out in various forms without departing from the technical concept of the present disclosure.

[0038] For example, in the above embodiments, the first thermally conductive material and the second thermally conductive material in which constituent compo-

nents are blended at specific composition ratios have been exemplified, but the specific components and the composition ratios of the first thermally conductive material and the second thermally conductive material are not limited to the above examples.

[0039] In addition, for example, in the third embodiment, the example in which the heat dissipation fins 33A and 33B are added to both sides in the front-rear direction of the mold part 7 has been illustrated, but similar heat dissipation fins may also be added to the upper surface side or both sides in the left-right direction of the mold part 7.

[0040] Note that a plurality of functions implemented by one component illustrated in the above embodiment may be implemented by a plurality of components. One function implemented by one component illustrated in the above embodiment may be implemented by a plurality of components. A plurality of functions implemented by a plurality of components illustrated in the above embodiment may be implemented by one component. One function implemented by a plurality of components illustrated in the above embodiment may be implemented by one component. Additionally, a portion of the configurations exemplified in the embodiments described above may be omitted. Among the above embodiments, at least part of the configuration exemplified in one embodiment may be added to or replace the configuration exemplified in another embodiment other than the one embodiment.

(5) Technical Concept Disclosed in Specification

[Item 1]

[0041] A noise filter including:

a magnetic core that is a magnetic body formed in an annular or cylindrical shape;
 a conductor disposed so as to penetrate an inner peripheral side of the magnetic core;
 a mold part formed of a first thermally conductive material and configured to mold a portion of the magnetic core and a portion of the conductor; and
 a thermally conductive part formed of a second thermally conductive material having a higher thermal conductivity than the first thermally conductive material, disposed so as to be in contact with a portion of the magnetic core and a portion of the mold part, and disposed so as to be in contact with an external member to which heat is to be dissipated, thereby conducting heat of the magnetic core and the mold part to the external member, during use of the noise filter, wherein
 the mold part has an opening portion configured to penetrate the mold part and to reach an outer peripheral surface of the magnetic core, and
 the thermally conductive part has an insertion portion to extend into the opening portion, and is configured to be in contact with the magnetic core at the inser-

tion portion.

[Item 2]

[0042] The noise filter according to Item 1, wherein the thermally conductive part is configured to be in contact with an inner peripheral surface of the opening portion.

[Item 3]

[0043] The noise filter according to Item 1, wherein the thermally conductive part is configured to form a gap between the thermally conductive part and an inner peripheral surface of the opening portion.

[Item 4]

[0044] The noise filter according to any one of Items 1 to 3, wherein

the first thermally conductive material has a thermal conductivity of 1 W/m·K or more and less than 1.4 W/m·K, and
 the second thermally conductive material has a thermal conductivity of 1.4 W/m·K or more and 5 W/m·K or less.

[Item 5]

[0045] The noise filter according to any one of Items 1 to 4, wherein the thermally conductive part is configured to come into close contact with the external member by deformation of the thermally conductive part when the thermally conductive part is sandwiched between the magnetic core and the external member and/or between the mold part and the external member and receives a compressive load, during use of the noise filter.

Claims

1. A noise filter comprising:

a magnetic core that is a magnetic body formed in an annular or cylindrical shape;
 a conductor disposed so as to penetrate an inner peripheral side of the magnetic core;
 a mold part formed of a first thermally conductive material and configured to mold a portion of the magnetic core and a portion of the conductor; and
 a thermally conductive part formed of a second thermally conductive material having a higher thermal conductivity than the first thermally conductive material, disposed so as to be in contact with a portion of the magnetic core and a portion of the mold part, and disposed so as to be in contact with an external member to which heat is

to be dissipated, thereby conducting heat of the magnetic core and the mold part to the external member, during use of the noise filter, wherein the mold part has an opening portion configured to penetrate the mold part and to reach an outer peripheral surface of the magnetic core, and the thermally conductive part has an insertion portion to extend into the opening portion, and is configured to be in contact with the magnetic core at the insertion portion.

2. The noise filter according to claim 1, wherein the thermally conductive part is configured to be in contact with an inner peripheral surface of the opening portion.
3. The noise filter according to claim 1, wherein the thermally conductive part is configured to form a gap between the thermally conductive part and an inner peripheral surface of the opening portion.
4. The noise filter according to any one of claims 1 to 3, wherein
the first thermally conductive material has a thermal conductivity of 1 W/m·K or more and less than 1.4 W/m·K, and
the second thermally conductive material has a thermal conductivity of 1.4 W/m·K or more and 5 W/m·K or less.
5. The noise filter according to any one of claims 1 to 3, wherein the thermally conductive part is configured to come into close contact with the external member by deformation of the thermally conductive part when the thermally conductive part is sandwiched between the magnetic core and the external member and/or between the mold part and the external member and receives a compressive load, during use of the noise filter.

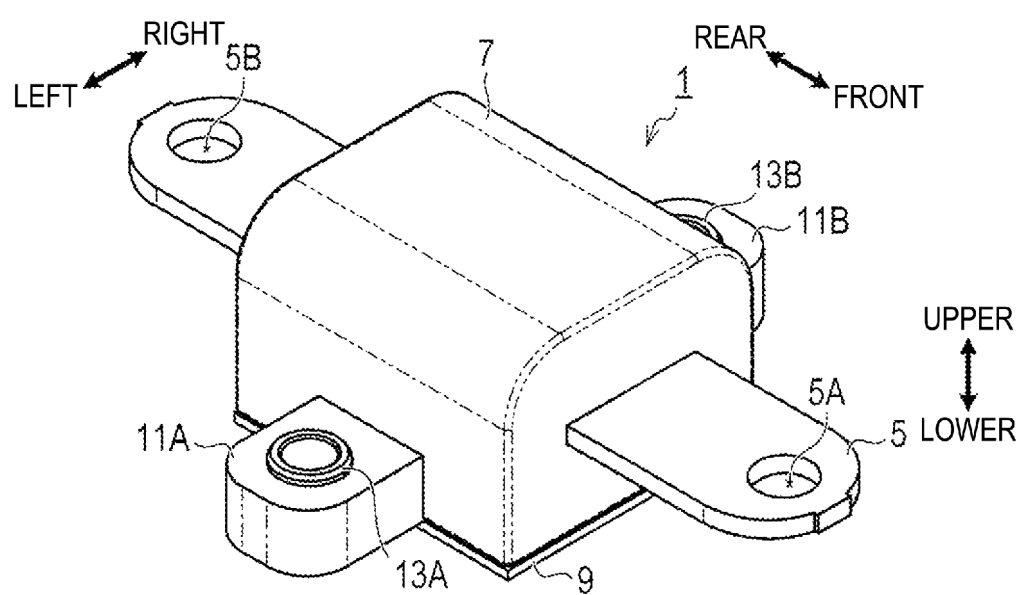


FIG. 1A

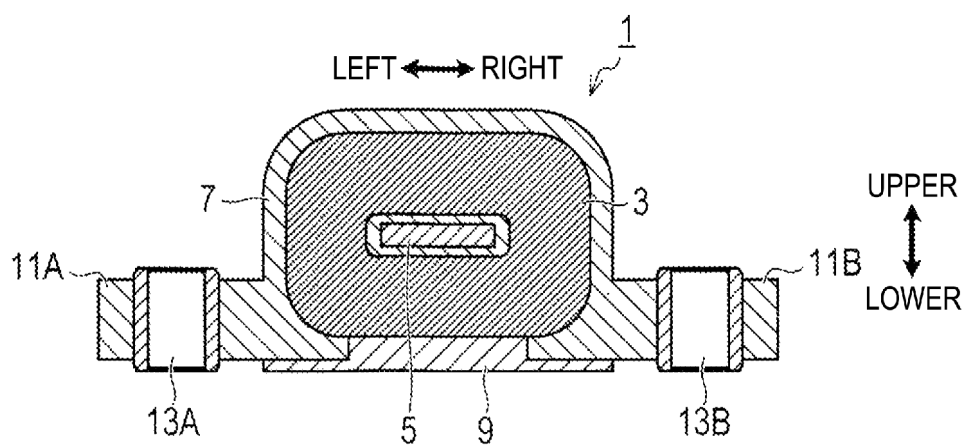


FIG. 1B

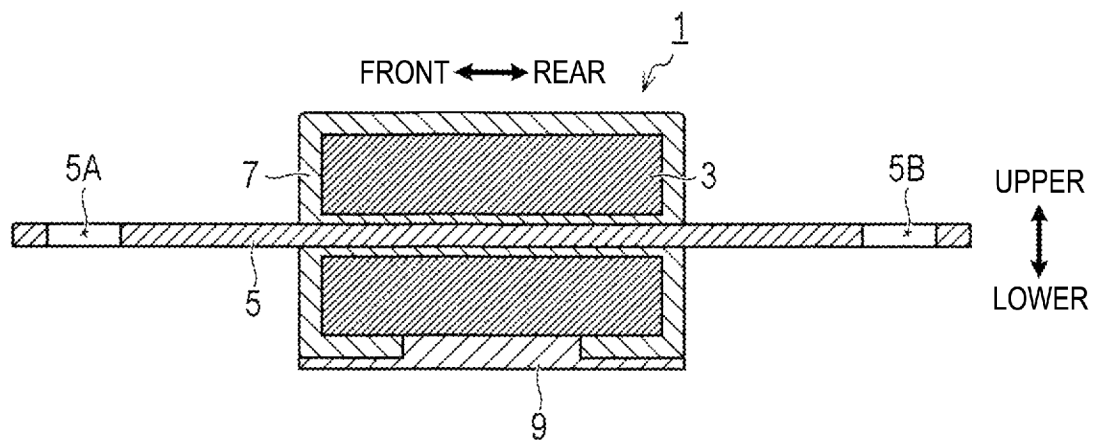


FIG. 1C

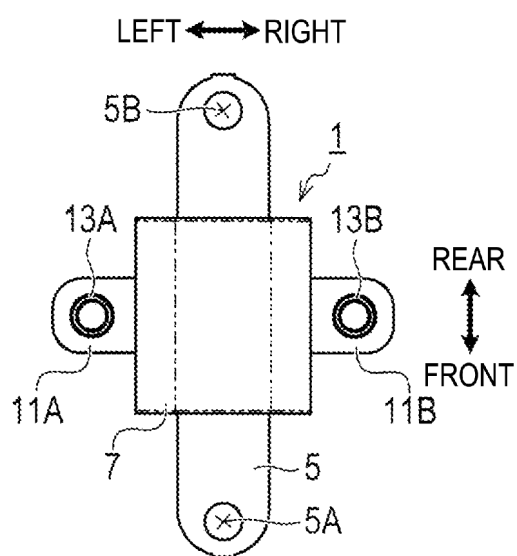


FIG. 2A

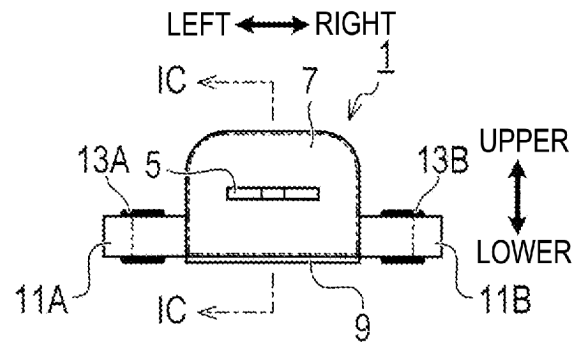


FIG. 2B

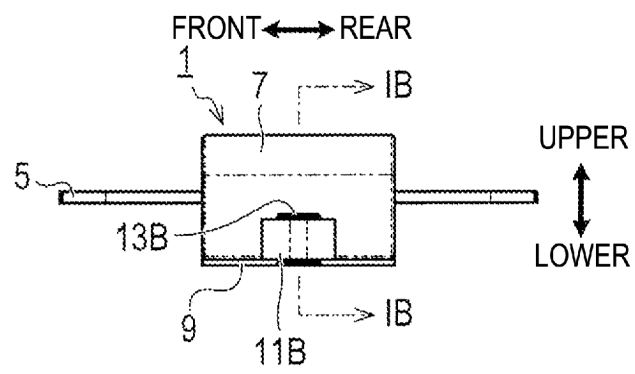


FIG. 2C

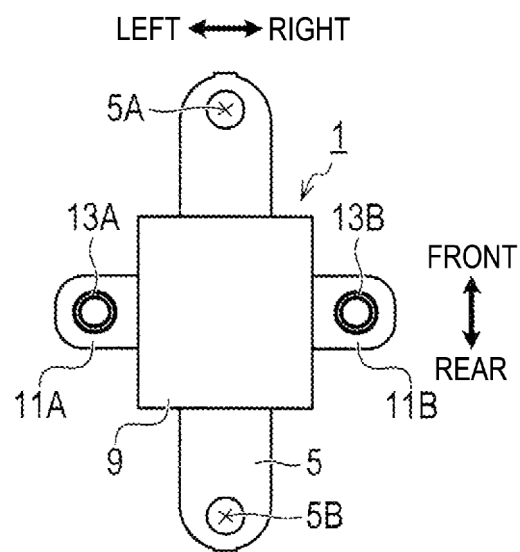


FIG. 2D

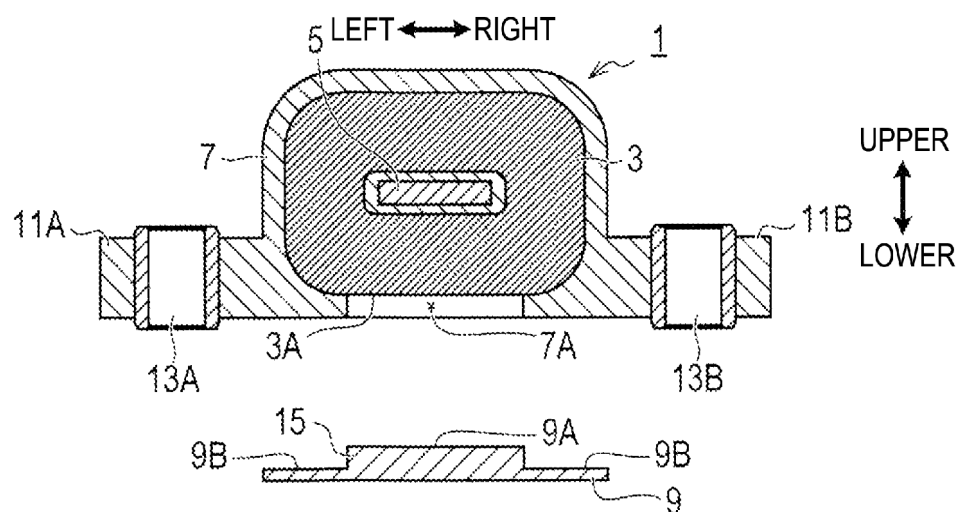


FIG. 3A

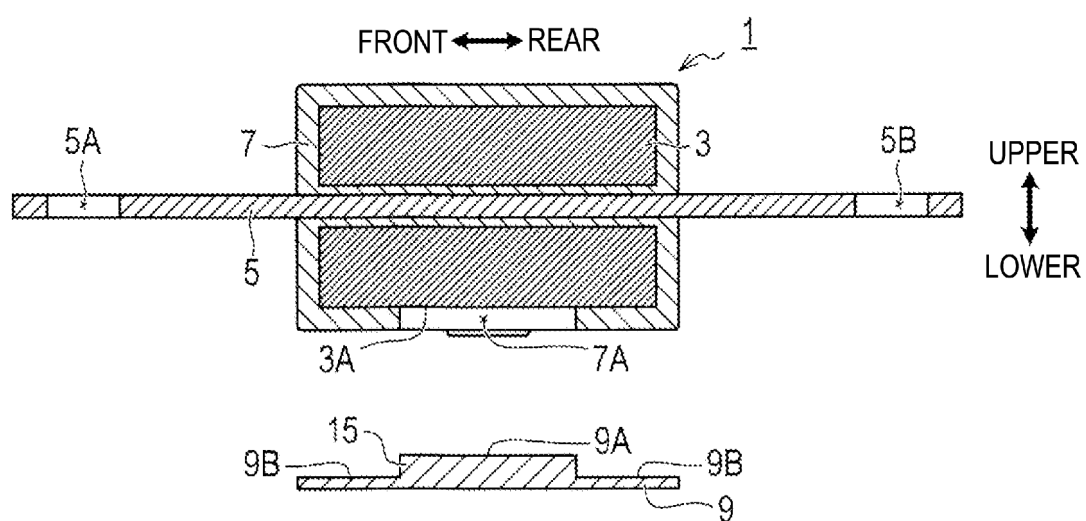


FIG. 3B

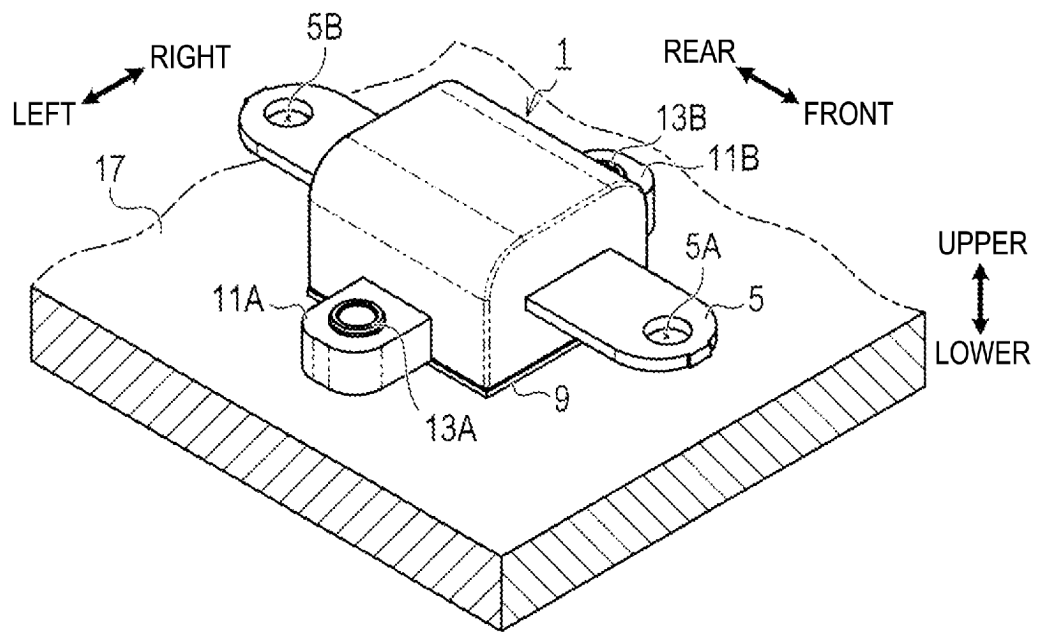


FIG. 3C

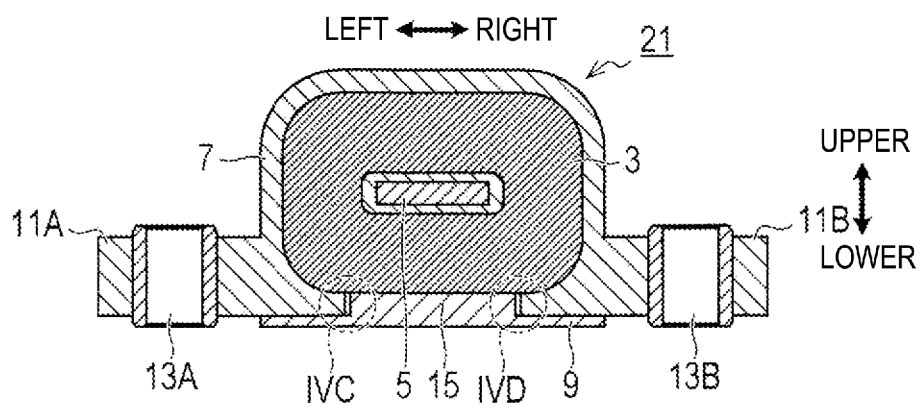


FIG. 4A

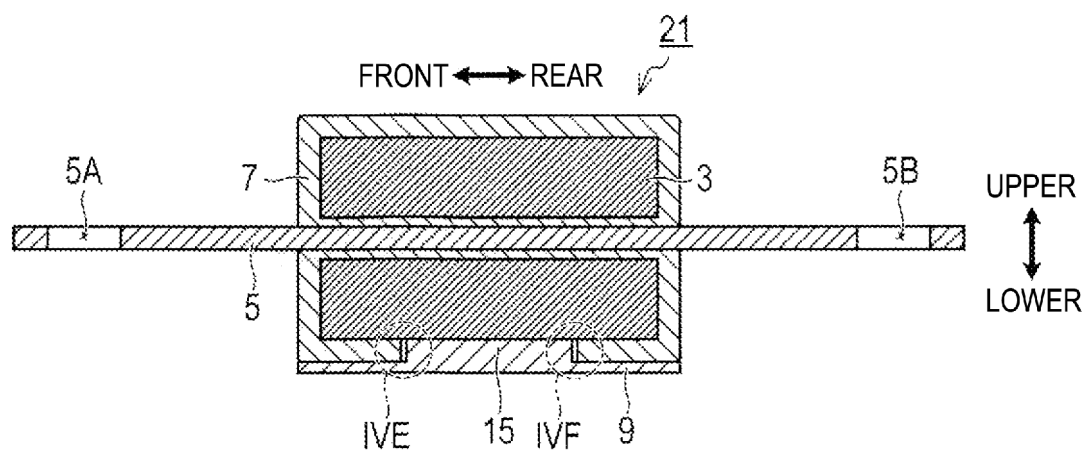


FIG. 4B

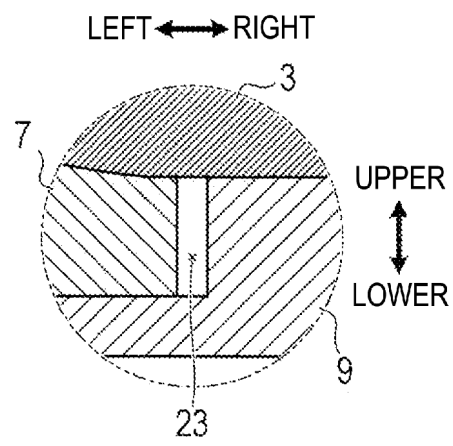


FIG. 4C

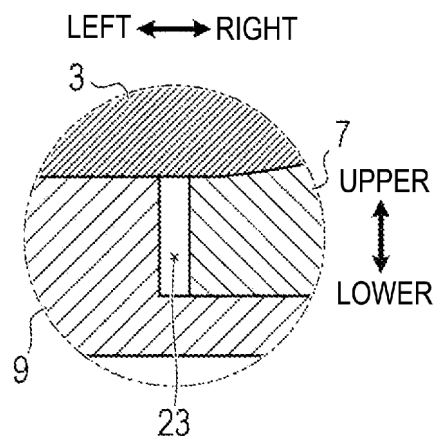


FIG. 4D

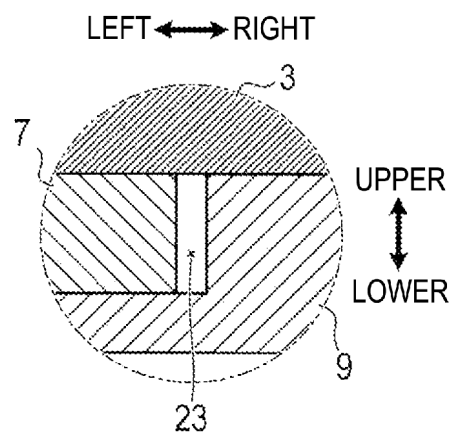


FIG. 4E

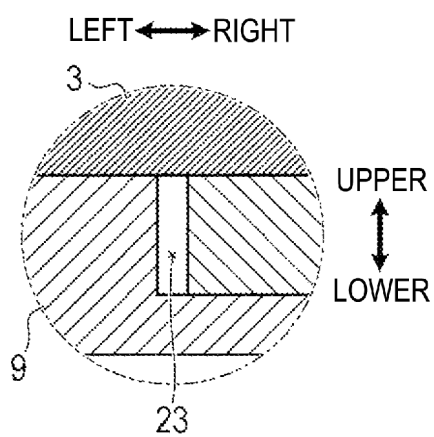


FIG. 4F

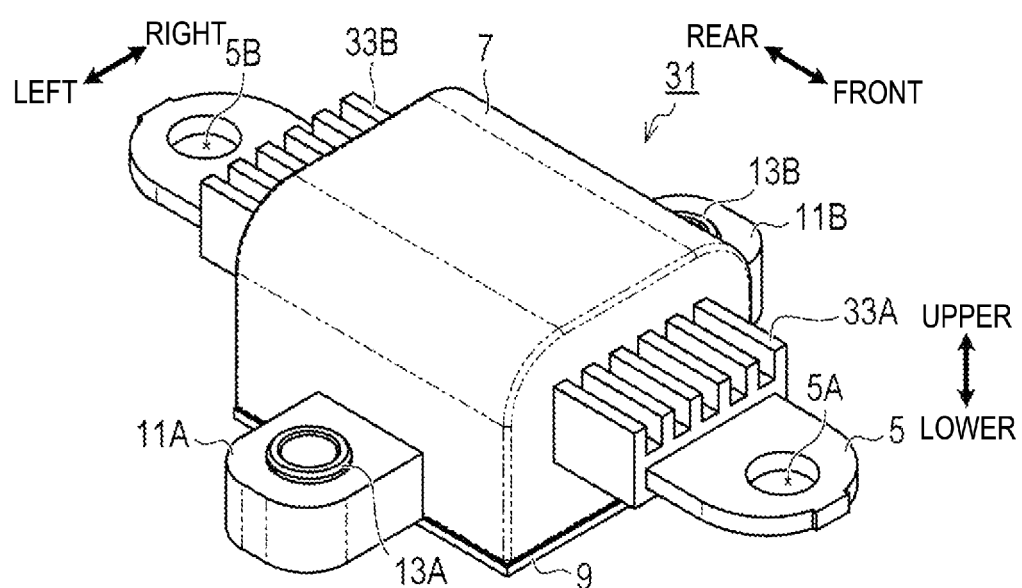


FIG. 5A

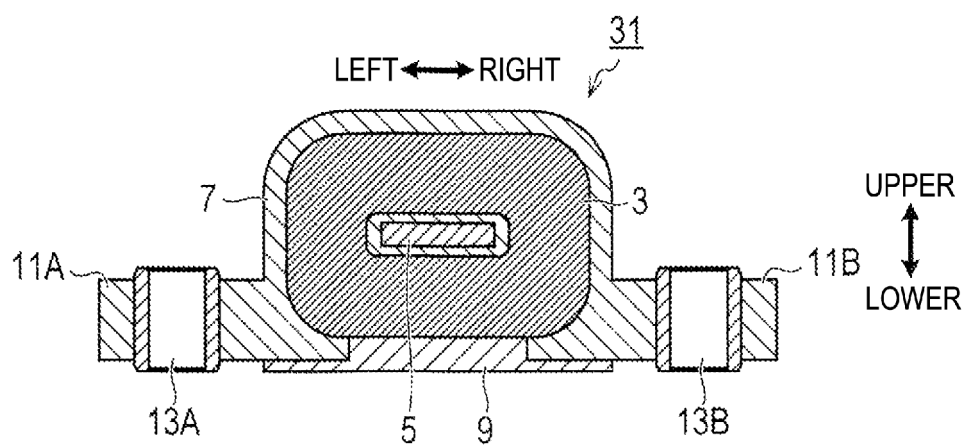


FIG. 5B

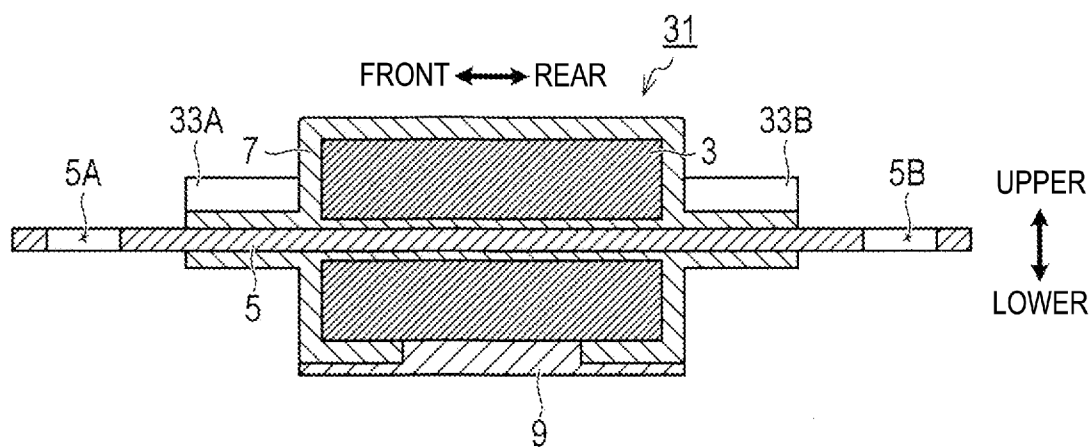


FIG. 5C

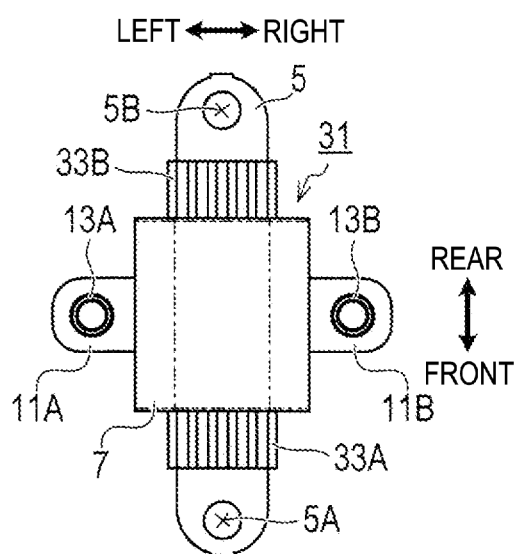


FIG. 6A

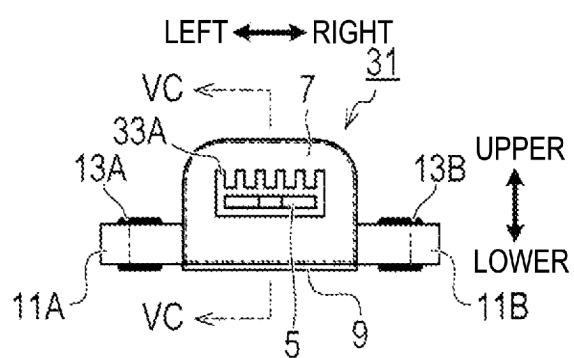


FIG. 6B

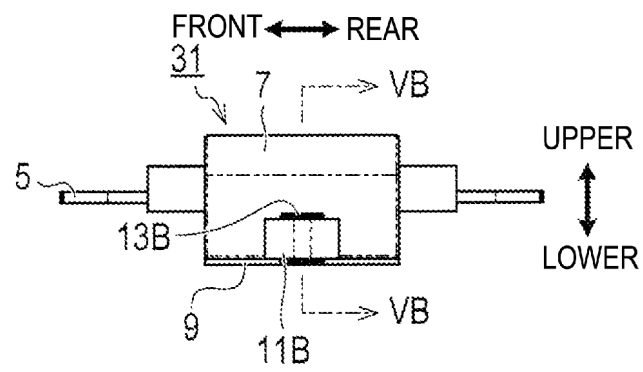


FIG. 6C

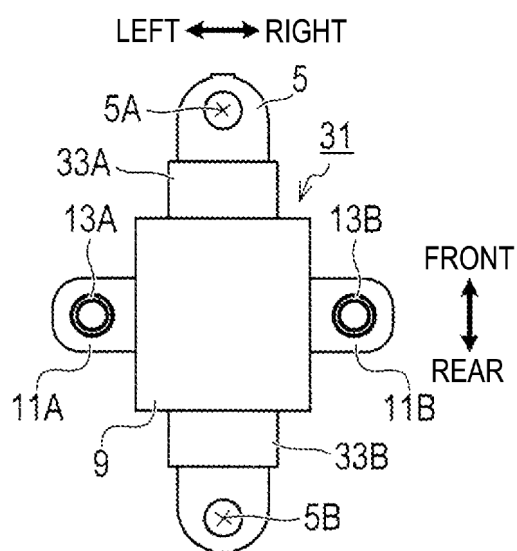


FIG. 6D

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/012817

A. CLASSIFICATION OF SUBJECT MATTER

H01F 27/08(2006.01)i; **H01F 17/06**(2006.01)i; **H01F 27/02**(2006.01)i; **H01F 27/22**(2006.01)i
 FI: H01F27/08 101; H01F17/06 D; H01F27/02 120; H01F27/22

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)

H01F27/08; H01F17/06; H01F27/02; H01F27/22; H01F27/24; H01F37/00; H03H7/01

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2024
 Registered utility model specifications of Japan 1996-2024
 Published registered utility model applications of Japan 1994-2024

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	WO 2013/094209 A1 (PANASONIC CORPORATION) 27 June 2013 (2013-06-27) paragraphs [0009]-[0013], [0033]-[0035], fig. 1-4A, 7-8	1-5
Y	JP 2014-120559 A (KITAGAWA IND CO., LTD.) 30 June 2014 (2014-06-30) paragraphs [0015]-[0020], fig. 3-4	1-5
A	JP 2021-197383 A (TOYOTA JIDOSHA KABUSHIKI KAISHA) 27 December 2021 (2021-12-27) paragraphs [0015]-[0030], fig. 1-2	1-5
A	JP 2016-63041 A (KITAGAWA IND CO., LTD.) 25 April 2016 (2016-04-25) paragraphs [0024]-[0037], fig. 2-3	1-5

☐ 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

04 June 2024

Date of mailing of the international search report

11 June 2024

Name and mailing address of the ISA/JP

**Japan Patent Office (ISA/JP)
 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915
 Japan**

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/012817

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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO	2013/094209	A1	27 June 2013	US 2014/0253274 A1 paragraphs [0024]-[0028], [0048]-[0050], fig. 1-4A, 7-8	
				CN 103999174 A	
JP	2014-120559	A	30 June 2014	(Family: none)	
JP	2021-197383	A	27 December 2021	(Family: none)	
JP	2016-63041	A	25 April 2016	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2020005043 A [0003]