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(71) Applicant: **Mitsubishi Electric Corporation**
Chiyoda-ku
Tokyo 100-8310 (JP)

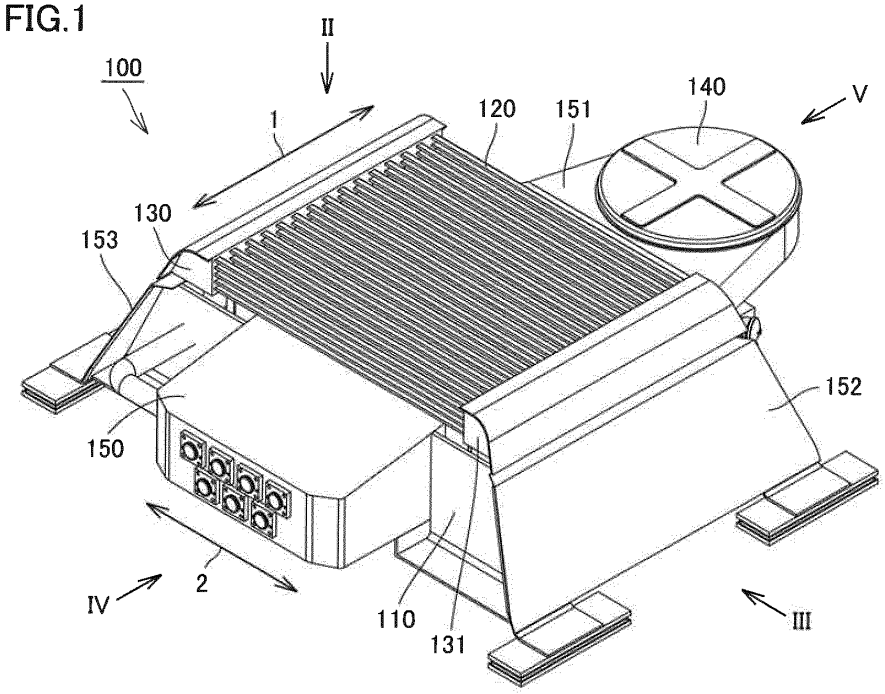
(72) Inventors:
- **KATO, Sunao**
  Tokyo 100-8310 (JP)
- **SHINJO, Koki**
  Tokyo 100-8310 (JP)
- **HAYAMIZU, Shiki**
  Tokyo 100-8310 (JP)

(74) Representative: **Witte, Weller & Partner**
Patentanwälte mbB
Postfach 10 54 62
70047 Stuttgart (DE)

(54) **TRANSFORMER FOR VEHICLES**

(57) A vehicular transformer is mounted on the roof of a vehicle. The vehicular transformer includes a tank (110) configured to house a transformer body and filled with refrigerant, a plurality of cooling pipes (120) arranged above the tank (110) and configured to cool the refrigerant by heat exchange between the refrigerant and the outside air, and a conservator (140) arranged laterally to the tank (110) in alignment with the tank (110) along a travelling direction (1) of the vehicle and configured to be in communication with the tank (110).

FIG.1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a vehicular transformer.

BACKGROUND ART

[0002] Japanese Patent No. 5805354 (Patent Literature 1) discloses a vehicular transformer as a prior art. In the vehicular transformer described in Patent Literature 1, the transformer body and the cooler are arranged side by side on the roof of a vehicle along the travelling direction of the vehicle.

[0003] Japanese Patent Laying-open No. 2006-269694 (Patent Literature 2) discloses a power device as a prior art. In the power device described in Patent Literature 2, the radiator is arranged above the main container.

CITATION LIST

PATENT LITERATURE

[0004]

PTL 1: Japanese Patent No. 5805354
PTL 2: Japanese Patent Laying-open No. 2006-269694

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0005] In a transformer in which insulating oil is circulated as refrigerant, a conservator is usually arranged above the transformer body. Thus, the transformer body and the cooler are arranged side by side along the travelling direction of the vehicle. The power device described in Patent Literature 2 is configured to condense the refrigerant evaporated from the evaporator by using the radiator, and thereby is not provided with a conservator.

[0006] As described in Patent Literature 1, in the case where the transformer body and the cooler are arranged in the vehicular transformer side by side along the travelling direction of the vehicle, there is still a room left for improving the cooling efficiency of the refrigerant by using travelling wind generated during the travelling of the vehicle.

[0007] The present invention has been made in view of the above problems, and an object thereof is to provide a vehicular transformer configured to improve the cooling efficiency of refrigerant by using the travelling wind generated during the travelling of a vehicle.

SOLUTION TO PROBLEM

[0008] A vehicular transformer according to the present invention is mounted on the roof of a vehicle. The vehicular transformer includes a tank, a plurality of cooling pipes and a conservator. The tank is configured to house a transformer body and is filled with refrigerant. The plurality of cooling pipes are arranged above the tank and configured to cool the refrigerant by heat exchange between the refrigerant and the outside air. The conservator is arranged laterally to the tank in alignment with the tank along a travelling direction of the vehicle and configured to be in communication with the tank.

ADVANTAGEOUS EFFECTS OF INVENTION

[0009] According to the present invention, it is possible to improve the cooling efficiency of refrigerant by using the travelling wind generated during the travelling of the vehicle.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

Fig. 1 is a perspective view illustrating the outer appearance of a vehicular transformer according to a first embodiment of the present invention;
Fig. 2 is a plan view of the vehicular transformer when viewed from the direction of an arrow II in Fig. 1;
Fig. 3 is a front view of the vehicular transformer when viewed from the direction of an arrow III in Fig. 1;
Fig. 4 is a left side view of the vehicular transformer when viewed from the direction of an arrow IV in Fig. 1;
Fig. 5 is a right side view of the vehicular transformer when viewed from the direction of an arrow V in Fig. 1;
Fig. 6 is a perspective view illustrating the outer appearance of a vehicular transformer according to a second embodiment of the present invention;
Fig. 7 is a front view illustrating the outer appearance of a vehicular transformer according to a first modification to the second embodiment of the present invention;
Fig. 8 is a front view illustrating the outer appearance of a vehicular transformer according to a second modification to the second embodiment of the present invention;
Fig. 9 is a plan view illustrating the outer appearance of a vehicular transformer according to a third modification to the second embodiment of the present invention;
Fig. 10 is a plan view illustrating a tank and a plurality of cooling pipes of a vehicular transformer when viewed from the above according to a fourth modification to the second embodiment of the present in-

vention;

Fig. 11 is a cross-sectional view illustrating a part of the plurality of cooling pipes illustrated in Fig. 10 when viewed from the direction of an arrow line XI-XI; and

Fig. 12 is a perspective view illustrating the outer appearance of a vehicular transformer according to a third embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0011] Hereinafter, a vehicular transformer according to each embodiment of the present invention will be described with reference to the drawings. In the following description of each embodiment, the same or corresponding parts in the drawings are denoted by the same reference numerals, and the description thereof will not be repeated.

First Embodiment

[0012] Fig. 1 is a perspective view illustrating the outer appearance of a vehicular transformer according to a first embodiment of the present invention. Fig. 2 is a plan view of the vehicular transformer when viewed from the direction of an arrow II in Fig. 1. Fig. 3 is a front view of the vehicular transformer when viewed from the direction of an arrow III in Fig. 1. Fig. 4 is a left side view of the vehicular transformer when viewed from the direction of an arrow IV in Fig. 1. Fig. 5 is a right side view of the vehicular transformer when viewed from the direction of an arrow V in Fig. 1.

[0013] A vehicular transformer 100 according to the first embodiment of the present invention is mounted on the roof of a vehicle. As illustrated in Figs. 1 to 5, the vehicular transformer 100 according to the first embodiment of the present invention includes a tank 110, a plurality of cooling pipes 120, and a conservator 140.

[0014] The tank 110 is configured to house a transformer body (not shown), and is filled with insulating oil which serves as refrigerant. The transformer body includes an iron core and a winding wound around the iron core. The iron core and the winding are housed in the tank 110 and immersed in the insulating oil. The tank 110 is connected to a pump (not shown) for circulating the insulating oil.

[0015] The plurality of cooling pipes 120 are arranged above the tank 110. In the present embodiment, each of the plurality of cooling pipes 120 extends along a width direction 2 of the vehicle perpendicular to a travelling direction 1 of the vehicle. Each of the plurality of cooling pipes 120 is cylindrical in profile. Each of the plurality of cooling pipes 120 is made of a metal having high thermal conductivity such as stainless steel, copper or aluminum.

[0016] The plurality of cooling pipes 120 are arranged side by side in the height direction and are arranged side by side in the horizontal direction at each height. In the present embodiment, the plurality of cooling pipes 120 are arranged side by side in the travelling direction 1 of the vehicle at each height. The number of the cooling pipes 120 arranged in the horizontal direction at each height is greater than the number of the cooling pipes 120 arranged in the height direction. For example, if the number of the cooling pipes 120 arranged in the horizontal direction at each height is 15 and the number of the cooling pipes 120 arranged in the height direction is 4, the total number of the plurality of cooling pipes 120 is 60.

[0017] One end of each of the plurality of cooling pipes 120 is connected to a first header 130, and the other end of each of the plurality of cooling pipes 120 is connected to a second header 131. Each of the plurality of cooling pipes 120 is in communication with the first header 130 and the second header 131.

[0018] The first header 130 and the second header 131 are spaced apart from each other in the width direction 2 of the vehicle and extend along the travelling direction 1 of the vehicle. Each of the first header 130 and the second header 131 is connected to the upper surface of the tank 110 through a piping so as to be in communication with the tank 110.

[0019] As the pump is actuated, the insulating oil in the tank 110 is circulated so as to flow through the first header 130, the plurality of cooling pipes 120 and the second header 131, and back to the tank 110. As the insulating oil flows through the plurality of cooling pipes 120, it is cooled by exchanging heat with the outside air.

[0020] The conservator 140 is arranged laterally to the tank 110 in alignment with the tank 110 along the travelling direction 1 of the vehicle. When viewed from the travelling direction 1 of the vehicle, the conservator 140 and the plurality of cooling pipes 120 do not overlap.

[0021] The conservator 140 is in communication with the tank 110. The conservator 140 is provided to cope with the volume change of the insulating oil due to the temperature thereof. Specifically, when the temperature of the insulating oil in the tank 110 is raised, the insulating oil expands, and thereby, the insulating oil flows from the tank 110 into the conservator 140, and when the temperature of the insulating oil in the tank 110 is lowered, the insulating oil shrinks, and thereby, the insulating oil flows from the conservator 140 back into the tank 110.

[0022] The vehicular transformer 100 further includes an inclination portion which is configured to ascend obliquely toward the transformer body and extend toward the plurality of cooling pipes 120. Specifically, the vehicular transformer 100 includes a first inclination portion 150, a second inclination portion 151, a third inclination portion 152, and a fourth inclination portion 153.

[0023] The first inclination portion 150 is provided on the left side of the tank 110. The second inclination portion 151 is provided on the right side of the tank 110. The third inclination portion 152 is provided on the front side of the tank 110. The fourth inclination portion 153 is provided on the rear side of the tank 110.

[0024] Each of the first inclination portion 150, the second inclination portion 151, the third inclination portion

152 and the fourth inclination portion 153 may be formed as a part of the outer wall of the tank 110 or as a different member separate from the tank 110.

[0025] Each of the first inclination portion 150, the second inclination portion 151, the third inclination portion 152, and the fourth inclination portion 153 is configured to guide the wind blowing against the vehicular transformer 100 to hit the plurality of cooling pipes 120. Specifically, the first inclination portion 150 and the second inclination portion 151 guide the wind blowing in the travelling direction 1 of the vehicle to hit the plurality of cooling pipes 120. The third inclination portion 152 and the fourth inclination portion 153 guide the wind blowing in the width direction 2 of the vehicle to hit the plurality of cooling pipes 120.

[0026] In the vehicular transformer 100 according to the first embodiment of the present invention, since the plurality of cooling pipes 120 are arranged above the tank 110, it is easy for the travelling wind generated during the travelling of the vehicle to hit the plurality of cooling pipes 120, which makes it possible to efficiently cool the refrigerant flowing through the plurality of cooling pipes 120.

[0027] Since the number of the cooling pipes 120 arranged in the horizontal direction at each height is greater than the number of the cooling pipes 120 arranged in the height direction, it is possible to increase the footprint of the plurality of cooling pipes 120 so as to provide the vehicular transformer 100 in a low profile.

[0028] Since the vehicular transformer 100 is provided with an inclination portion configured to guide the wind blowing against the vehicular transformer 100 to hit the plurality of cooling pipes 120, it is possible to further efficiently cool the refrigerant flowing through the plurality of cooling pipes 120.

Second Embodiment

[0029] Hereinafter, a vehicular transformer according to a second embodiment of the present invention will be described with reference to the drawings. The vehicular transformer according to the second embodiment of the present invention is different from the vehicular transformer 100 according to the first embodiment of the present invention mainly on the shape of each of the plurality of cooling pipes and the connection mode between the header and the tank, the description of the same components as those in the vehicular transformer 100 according to the first embodiment of the present invention will not be repeated.

[0030] Fig. 6 is a perspective view illustrating the outer appearance of a vehicular transformer 200 according to the second embodiment of the present invention. As illustrated in Fig. 6, the vehicular transformer 200 according to the second embodiment of the present invention includes a tank 110, a plurality of cooling pipes 220, and a conservator 140.

[0031] The plurality of cooling pipes 220 are arranged above the tank 110. In the present embodiment, each of the plurality of cooling pipes 220 includes a first leg portion 221 and a second leg portion 223, each of which extends in the height direction, and a horizontal portion 222 which extends in the width direction 2 of the vehicle. One end of the horizontal portion 222 is connected to the other end of the first leg portion 221, and the other end of the horizontal portion 222 is connected to the other end of the second leg portion 223.

[0032] One end of the first leg portion 221 of each of the plurality of cooling pipes 220 is connected to the first header 230, and one end of the second leg portion 223 of each of the plurality of cooling pipes 220 is connected to the second header 231. Each of the plurality of cooling pipes 220 is in communication with each of the first header 230 and the second header 231.

[0033] The first header 230 and the second header 231 are spaced apart from each other in the width direction 2 of the vehicle, and extend along the travelling direction 1 of the vehicle. Each of the first header 230 and the second header 231 is integrally formed on the upper portion of the tank 110.

[0034] In the vehicular transformer 200 according to the second embodiment of the present invention, the plurality of cooling pipes 220, the first header 230 and the second header 231 also serve as reinforcing members of the tank 110, and thereby, the rigidity of the tank 110 itself can be reduced, which makes it possible to make the tank 110 thinner and smaller. Consequently, it is possible to make the vehicular transformer 200 smaller and lighter.

[0035] Hereinafter, modifications of the vehicular transformer according to the second embodiment of the present invention will be described with reference to the drawings.

[0036] Fig. 7 is a front view illustrating the outer appearance of a vehicular transformer 200a according to a first modification to the second embodiment of the present invention. As illustrated in Fig. 7, in the vehicular transformer 200a according to the first modification to the second embodiment of the present invention, the height of the first leg portion 221 and the height of the second leg portion 223 of the plurality of cooling pipes 220 are configured to increase gradually toward one side of the travelling direction 1 of the vehicle.

[0037] As a result, as the wind blowing toward one side of the travelling direction 1 of the vehicle passes through the plurality of cooling pipes 220, it sequentially hits the cooling pipes 220 with increasing heights. As a result, in the vehicular transformer 200a, since the wind blowing toward one side of the travelling direction 1 of the vehicle efficiently hits the plurality of cooling pipes 220, it is possible to improve the cooling efficiency of the refrigerant.

[0038] Fig. 8 is a front view illustrating the outer appearance of a vehicular transformer 200b according to a second modification to the second embodiment of the present invention. As illustrated in Fig. 8, in the vehicular transformer 200b according to the second modification

to the second embodiment of the present invention, the height of the first leg portion 221 and the height of the second leg portion 223 of the plurality of cooling pipes 220 are configured to decrease gradually to a certain height and then increase gradually to the original height toward one side of the travelling direction 1 of the vehicle.

[0039] As a result, the wind blowing toward one side in the travelling direction 1 of the vehicle first hits the first cooling pipe arranged on the other side in the travelling direction 1 of the vehicle, and thereby, a vortex is formed around the first cooling pipe hit by the wind. Due to the vortex, the wind which hits the first cooling pipe arranged on the other side is guided toward one side in the travelling direction 1 of the vehicle while being subjected to a downward force so as to hit the second cooling pipe from the other side. A vortex is also formed around the second cooling pipe from the other side, and thereby, the wind which hits the second cooling pipe from the other side is guided toward one side in the travelling direction 1 of the vehicle while being subjected to a downward force so as to hit the third cooling pipe from the other side.

[0040] As described above, in the present modification, the wind blowing toward one side in the travelling direction 1 of the vehicle forms a vortex around each cooling pipe so as to pass through the plurality of cooling pipes 220 descending sequentially as illustrated by the dotted line in Fig. 8. Thus, in the present modification, compared to the first embodiment, the wind blowing toward one side in the travelling direction 1 of the vehicle smoothly passes through the plurality of cooling pipes 220, which makes it possible to improve the cooling efficiency.

[0041] On the other hand, the wind blowing toward the other side in the travelling direction 1 of the vehicle first hits the first cooling pipe arranged at one side in the travelling direction 1 of the vehicle, and thereby, a vortex is formed around the first cooling pipe hit by the wind. Due to the vortex, the wind which hits the first cooling pipe arranged on one side is guided toward the other side in the travelling direction 1 of the vehicle while being subjected to a downward force so as to hit the second cooling pipe from one side. A vortex is also formed around the second cooling pipe from one side and the wind which hits the second cooling pipe from one side is subjected to a downward force and the wind on the other side in the travelling direction 1 of the vehicle and hits the third cooling pipe from one side.

[0042] As described above, in the present modification, the wind blowing toward the other side in the travelling direction 1 of the vehicle forms a vortex around each cooling pipe so as to pass through the plurality of cooling pipes 220 descending sequentially as illustrated by the dotted line in Fig. 8. Thus, in the present modification, compared to the first embodiment, the wind blowing toward the other side in the travelling direction 1 of the vehicle smoothly passes through the plurality of cooling pipes 220, which makes it possible to improve the cooling efficiency.

[0043] As described above, in the vehicular transformer 200b, since the wind blowing toward either side of the travelling direction 1 of the vehicle efficiently hits the plurality of cooling pipes 220, it is possible to improve the cooling efficiency of the refrigerant.

[0044] Fig. 9 is a plan view illustrating the outer appearance of a vehicular transformer 200c according to a third modification to the second embodiment of the present invention. As illustrated in Fig. 9, in the vehicular transformer 200c according to the third modification to the second embodiment of the present invention, the positions of the plurality of cooling pipes 220 in the width direction 2 of the vehicle are shifted to one side of the width direction 2 of the vehicle as the plurality of cooling pipes approach to one side of the travelling direction 1 of the vehicle.

[0045] As a result, as the wind blowing toward one side in the travelling direction 1 of the vehicle passes through the plurality of cooling pipes 220, it sequentially hits the cooling pipe shifted to one side of the width direction 2 of the vehicle. On the other hand, as the wind blowing toward the other side in the travelling direction 1 of the vehicle passes through the plurality of cooling pipes 220, it sequentially hits the cooling pipe shifted to the other side of the width direction 2 of the vehicle. As a result, in the vehicular transformer 200c, since the wind blowing toward either side of the travelling direction 1 of the vehicle efficiently hits the plurality of cooling pipes 220, it is possible to improve the cooling efficiency of the refrigerant.

[0046] Fig. 10 is a plan view illustrating a tank and a plurality of cooling pipes of a vehicular transformer 200d according to a fourth modification to the second embodiment of the present invention when viewed from the top. Fig. 11 is a cross-sectional view illustrating a part of the plurality of cooling pipes illustrated in Fig. 10 when viewed from the direction of an arrow line XI-XI. As illustrated in Figs. 10 and 11, in the vehicular transformer 200d according to the fourth modification to the second embodiment of the present invention, each of the plurality of cooling pipes 220 is a flat pipe, and the plurality of cooling pipes 220 cover the tank 110 when viewed from above the tank 110.

[0047] Specifically, in each of the horizontal portions 222 of the plurality of cooling pipes 220, the flat pipes are arranged such that the flat surfaces are orthogonal to the height direction. The plurality of cooling pipes 220 are arranged in a staggered manner when viewed from the extending direction of the horizontal portion 222. When viewed from above the tank 110, the plurality of cooling pipes 220 are arranged with no gap in the travelling direction 1 of the vehicle. The plurality of cooling pipes 220 cover the entire surface of the tank 110 when viewed from above the tank 110.

[0048] Thereby, the magnetic flux leaked from the transformer body may be shielded by the plurality of cooling pipes 220. As a result, it is possible to reduce the magnetic flux leaked to the outside of the tank 110, which

makes it possible to dispose electronic components which are susceptible to magnetic flux around the vehicular transformer 200d.

Third Embodiment

[0049] Hereinafter, a vehicular transformer according to a third embodiment of the present invention will be described with reference to the drawings. The vehicular transformer according to the third embodiment of the present invention is different from the vehicular transformer 200 according to the second embodiment of the present invention mainly on the extending direction of the plurality of cooling pipes and the arrangement of the headers, the description of the same components as those in the vehicular transformer 200 according to the second embodiment of the present invention will not be repeated.

[0050] Fig. 12 is a perspective view illustrating the outer appearance of a vehicular transformer 300 according to the third embodiment of the present invention. As illustrated in Fig. 12, the vehicular transformer 300 according to the third embodiment of the present invention includes a tank 110, a plurality of cooling pipes 320, and a conservator 140.

[0051] The plurality of cooling pipes 320 are arranged above the tank 110. In the present embodiment, each of the plurality of cooling pipes 320 includes a first leg portion 321 and a second leg portion 323, each of which extends in the height direction, and a horizontal portion 322 which extends in the travelling direction 1 of the vehicle. One end of the horizontal portion 322 is connected to the other end of the first leg portion 321, and the other end of the horizontal portion 322 is connected to the other end of the second leg portion 323.

[0052] One end of the first leg portion 321 of each of the plurality of cooling pipes 320 is connected to the first header 330, and one end of the second leg portion 323 of each of the plurality of cooling pipes 320 is connected to the second header 331. Each of the plurality of cooling pipes 320 is in communication with each of the first header 330 and the second header 331.

[0053] The first header 330 and the second header 331 are spaced apart from each other in the travelling direction 1 of the vehicle, and extend along the width direction 2 of the vehicle. Each of the first header 330 and the second header 331 is integrally formed on the upper portion of the tank 110.

[0054] In the vehicular transformer 300 according to the third embodiment of the present invention, the plurality of cooling pipes 320, the first header 330 and the second header 331 also serve as reinforcing members of the tank 110, and thereby, the rigidity of the tank 110 itself can be reduced, which makes it possible to make the tank 110 thinner and smaller. Consequently, it is possible to make the vehicular transformer 300 smaller and lighter.

[0055] Furthermore, since each of the plurality of cooling pipes 320 extends along the travelling direction 1 of the vehicle, the travelling wind generated during the travelling of the vehicle equivalently hits each of the plurality of cooling pipes 320, it is possible to efficiently cool the refrigerant flowing through the cooling pipe 320.

[0056] It should be understood that the embodiments disclosed herein have been presented for the purpose of illustration and description but not limited in all aspects. It is intended that the scope of the present invention is not limited to the description above but defined by the scope of the claims and encompasses all modifications equivalent in meaning and scope to the claims.

REFERENCE SIGNS LIST

[0057] 1: traveling direction of vehicle; 2: width direction of vehicle; 100, 200, 200a, 200b, 200c, 200d, 300: vehicular transformer; 110: tank; 120, 220, 320: cooling pipe; 130, 230, 330: first header; 131, 231, 331: second header; 140: conservator; 150: first inclination portion; 151: second inclination portion; 152: third inclination portion; 153: fourth inclination portion; 221, 321: first leg portion; 222, 322: horizontal portion; 223, 323: second leg portion

Claims

1. A vehicular transformer mounted on the roof of a vehicle, comprising:

   a tank configured to house a transformer body and filled with refrigerant;
   a plurality of cooling pipes arranged above the tank and configured to cool the refrigerant by heat exchange between the refrigerant and the outside air; and
   a conservator arranged laterally to the tank in alignment with the tank along a travelling direction of the vehicle and configured to be in communication with the tank.

2. The vehicular transformer according to claim 1, further comprising an inclination portion which is configured to ascend obliquely toward the transformer body and extend toward the plurality of cooling pipes.

3. The vehicular transformer according to claim 1 or 2, wherein
   the plurality of cooling pipes are arranged side by side in the height direction and arranged side by side in the horizontal direction at each height, and
   the number of the cooling pipes arranged in the horizontal direction at each height is greater than the number of the cooling pipes arranged in the height direction.

4. The vehicular transformer according to any one of

claims 1 to 3, wherein each of the plurality of cooling pipes is a flat pipe.

5. The vehicular transformer according to any one of claims 1 to 4, wherein the plurality of cooling pipes cover the tank when viewed from above the tank.

6. The vehicular transformer according to any one of claims 1 to 5, wherein each of the plurality of cooling pipes is configured to extend along the travelling direction of the vehicle.

FIG.1

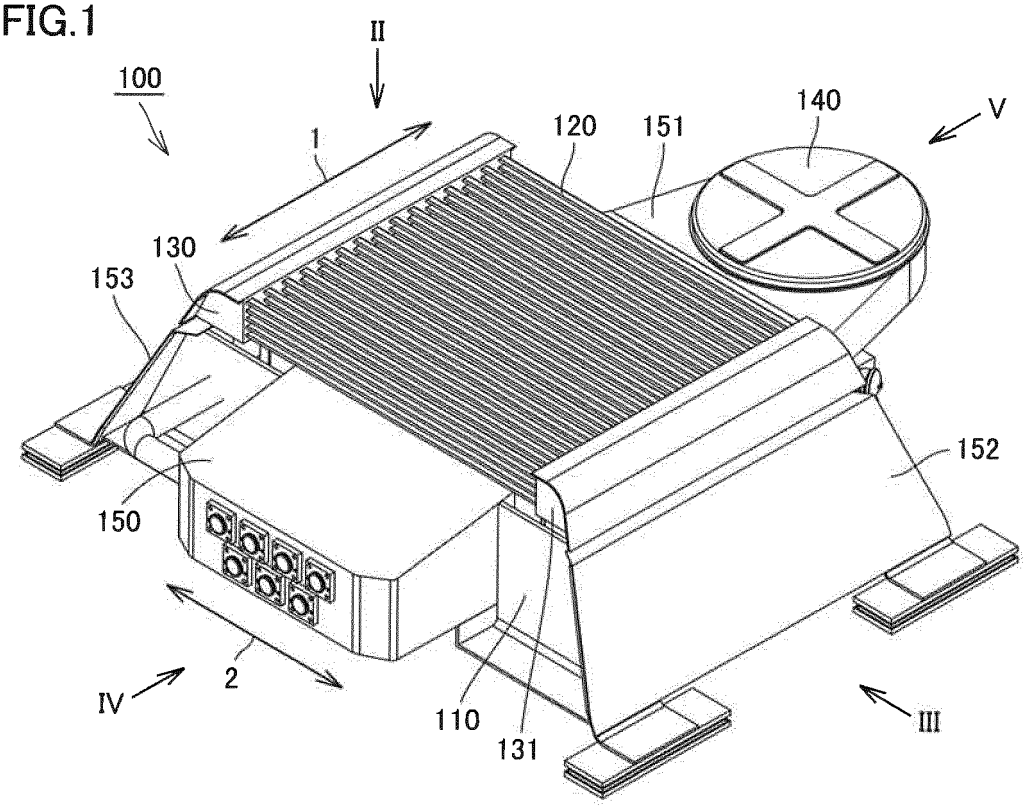

FIG.2

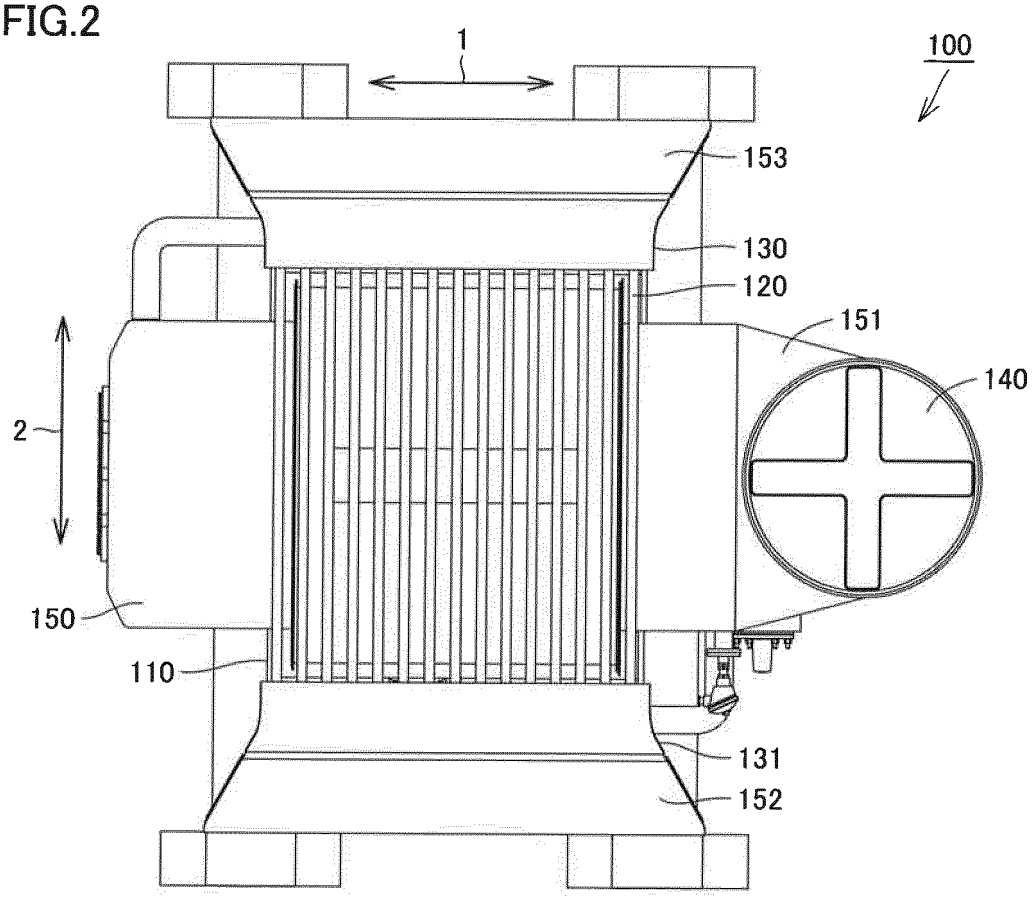
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FIG.3

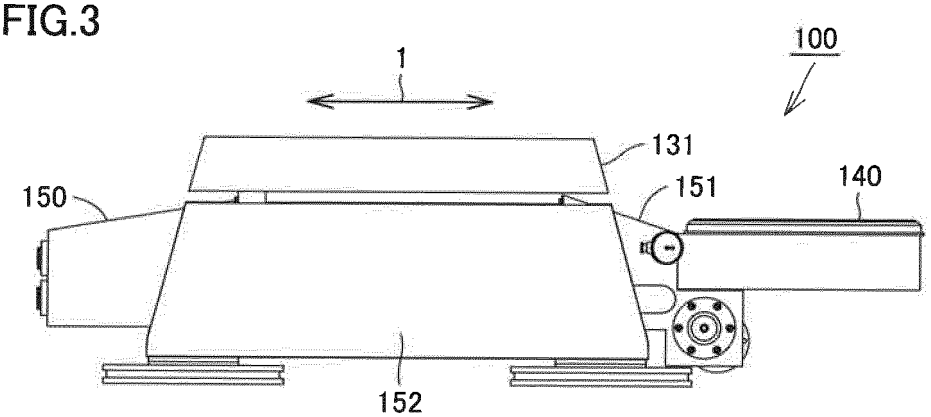
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FIG.4

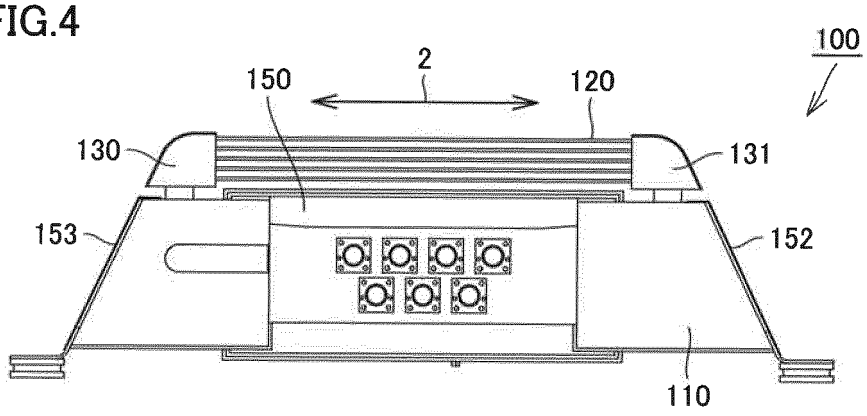
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FIG.5

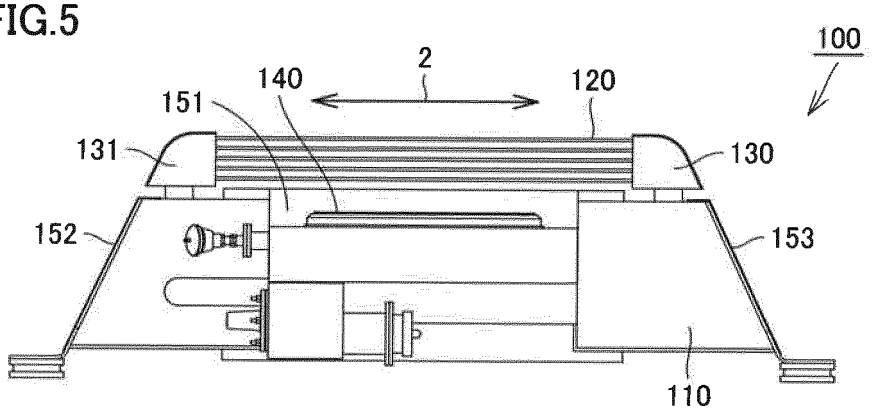
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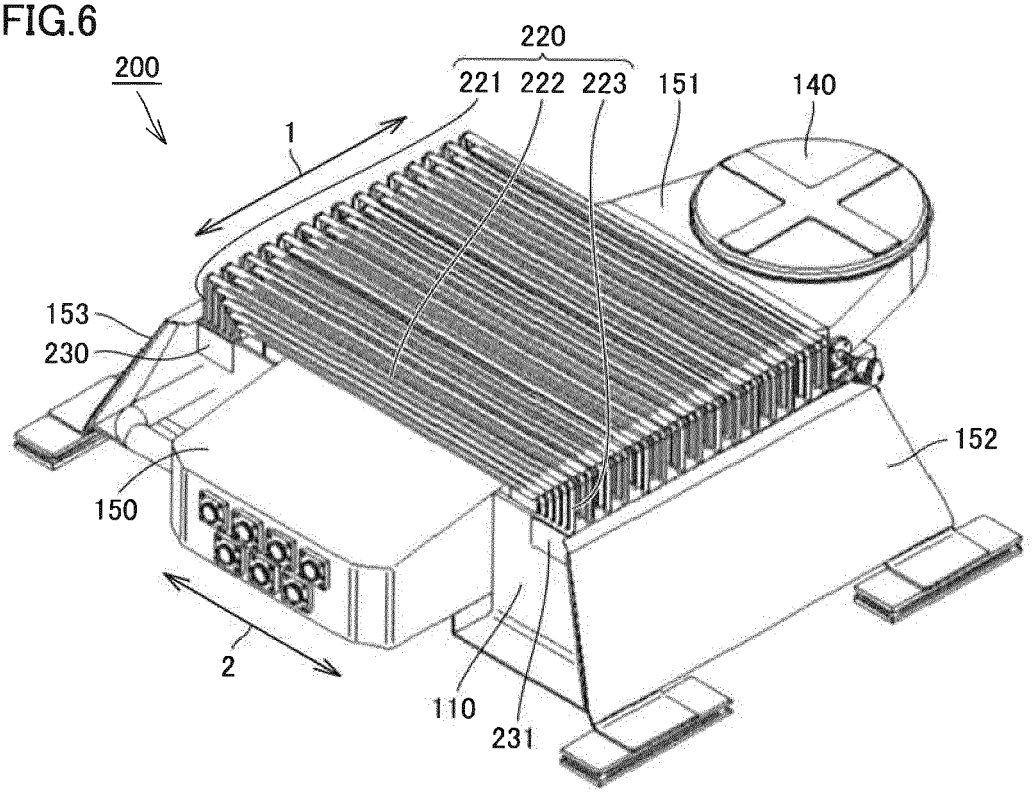
FIG.6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231

FIG.7

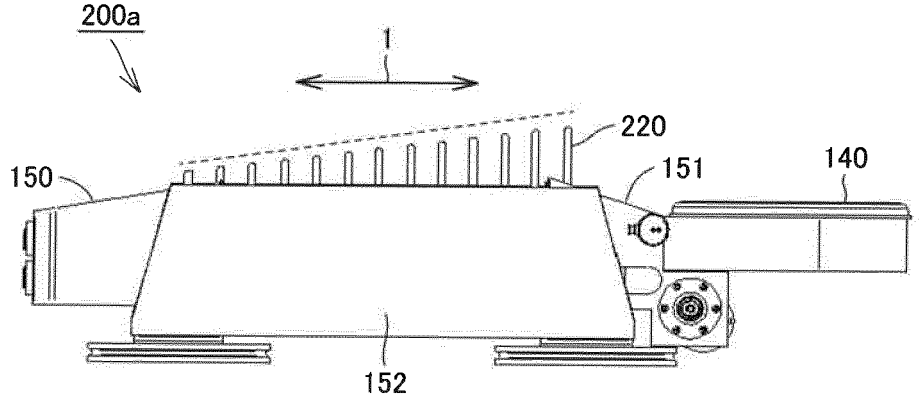
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FIG.8

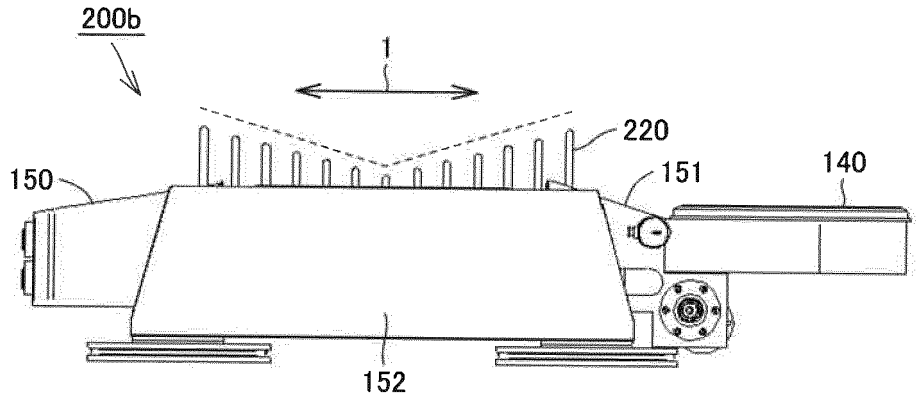


FIG.9

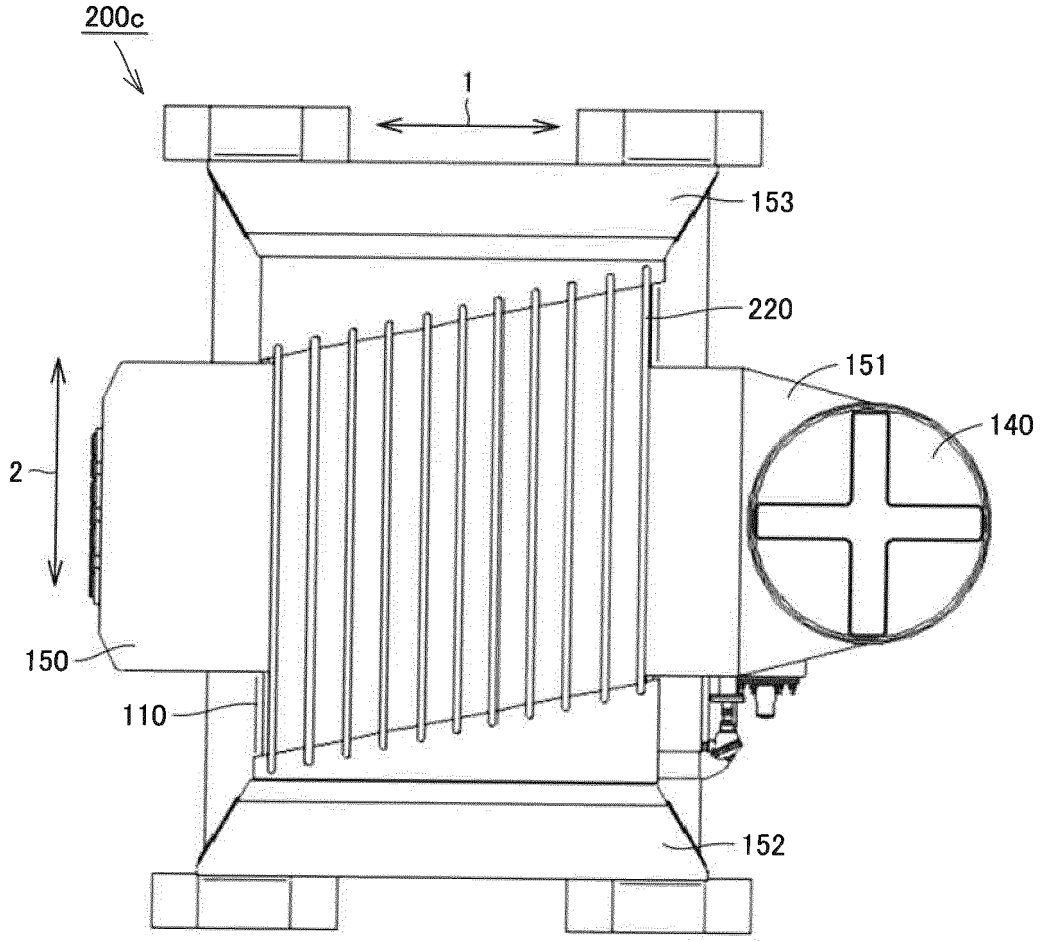


FIG.10

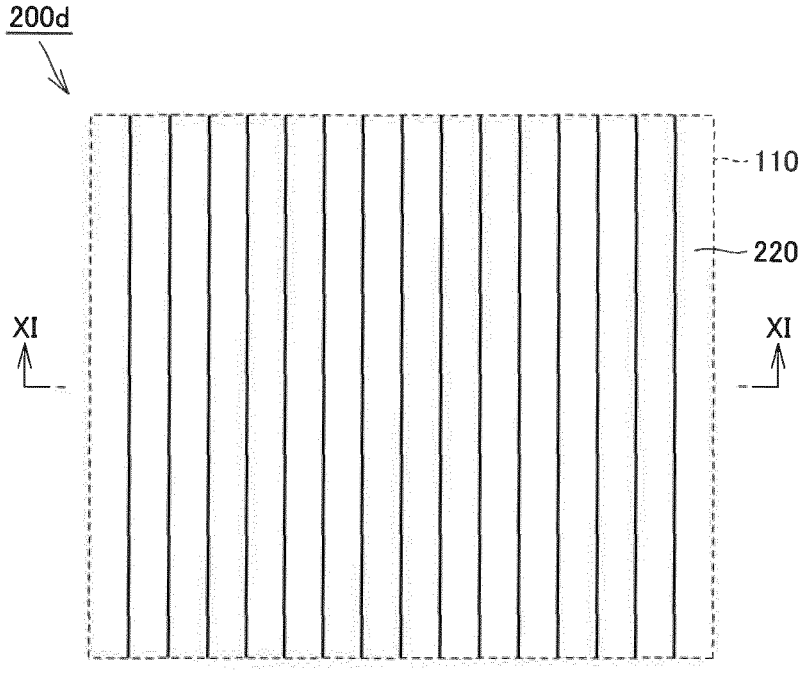


FIG.11

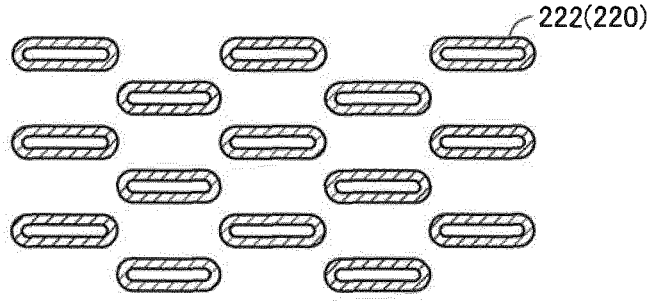
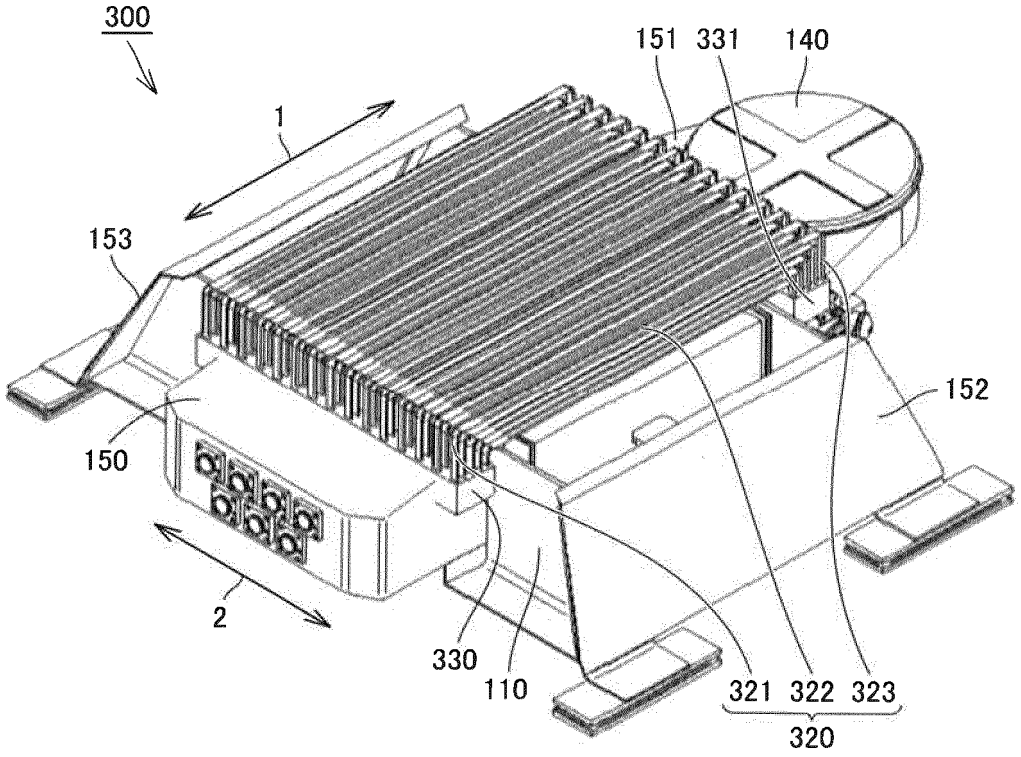


FIG.12



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/076776

A. CLASSIFICATION OF SUBJECT MATTER
H01F27/14(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)
H01F27/12-27/14, H01F30/06-30/16, H01F38/00, B61C17/00

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 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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 5805354 B1 (Mitsubishi Electric Corp.), 04 November 2015 (04.11.2015), paragraphs [0001], [0013] to [0025], [0067] to [0072]; fig. 1 to 5, 24 to 26 & WO 2016/103439 A1	1-6
A	JP 36-16534 Y1 (Hitachi, Ltd.), 22 June 1961 (22.06.1961), entire text; all drawings (Family: none)	1-6
A	JP 34-2114 Y1 (Hitachi, Ltd.), 18 February 1959 (18.02.1959), entire text; all drawings (Family: none)	1-6

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 November 2016 (16.11.16)	29 November 2016 (29.11.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/076776

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007-273777 A (Toshiba Corp.), 18 October 2007 (18.10.2007), paragraphs [0001], [0014] to [0024]; fig. 1 to 3 (Family: none)	1-6
A	JP 2013-178018 A (Sumitomo Precision Products Co., Ltd.), 09 September 2013 (09.09.2013), paragraphs [0029] to [0053]; fig. 1 to 4 (Family: none)	1-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5805354 B **[0002] [0004]**
- JP 2006269694 A **[0003] [0004]**