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(72) Inventors:
• **NISHIMURA, Takayuki**
Tokyo 100-8310 (JP)
• **NODA, Toshihiro**
Tokyo 100-8310 (JP)

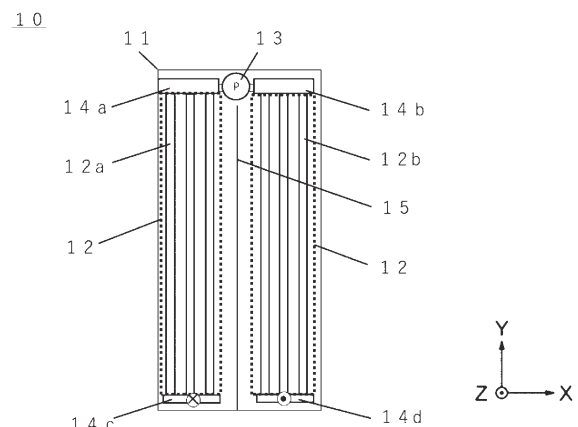
(74) Representative: **Plasseraud IP**
104 Rue de Richelieu
CS92104
75080 Paris Cedex 02 (FR)

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

(54) **TRANSFORMER FOR VEHICLE**

(57) This transformer for a vehicle comprises: a transformer body tank (11) having an inlet header (11a) through which a refrigerant flows in and an outlet header (11b) through which the refrigerant flows out; coolers (12a, 12b) on the front and rear sides in the direction of vehicle travel, said coolers being disposed in a split manner in the direction of vehicle travel so as not to protrude from the outer contour of the upper surface of the transformer body tank (11); two pipes (14a, 14b) connected to one end of the coolers (12a, 12b), respectively, on the front and rear sides in the vehicle travel direction; and a pump (13) connected to a vacant end of each of the two pipes (14a, 14b), said pump being aligned with the two pipes (14a, 14b) when viewed from above the vehicle, wherein the cooler (12b) on the front side in the direction of vehicle travel, the pump (13), the cooler (12a) on the rear side in the direction of vehicle travel, the inlet header (11a) of the transformer body tank (11), and the outlet header (11b) of the transformer body tank (11) are connected in the above order to obtain a circulation path along which the refrigerant is circulated by the pump (13).

FIG.3



Description

TECHNICAL FIELD

[0001] The present disclosure relates to a vehicle transformer, and more particularly, to a transformer installed on a roof of a vehicle.

BACKGROUND ART

[0002] Peripheral devices such as an air conditioner, a controller, and a transformer mounted on a vehicle generate a large amount of heat when they are energized. Examples of cooling methods for these peripheral devices include a forced air cooling method using an electrically powered blower, a traveling wind self-cooling method utilizing traveling wind generated by traveling of a vehicle, and the like.

[0003] When compared with the forced air cooling method, the traveling wind self-cooling method has been used more widely from the viewpoint of energy saving, low noise, maintenance saving, and the like, and has been adopted as a cooling method for peripheral devices such as a vehicle transformer installed under a floor of a vehicle.

[0004] On the other hand, in a low floor vehicle widely used in Europe, for example, since an installation space under a floor is narrow, peripheral devices such as an air conditioner and a controller are installed on a roof of the vehicle together with a vehicle transformer. In a case where the vehicle transformer is installed on the roof of the vehicle on which the peripheral devices are disposed in the vicinity thereof, traveling wind is separated by the peripheral devices. Accordingly, it is necessary to increase a spacing distance between each peripheral device and the vehicle transformer in a vehicle traveling direction for taking in the traveling wind into a cooler, when compared with a case where the vehicle transformer is installed under the floor of the vehicle, and a reduction in an installation space for the vehicle transformer is required. PTL 1 discloses a configuration of a vehicle transformer utilizing traveling wind, in which an installation space is reduced while securing a spacing distance between a peripheral device and the vehicle transformer in a vehicle traveling direction.

CITATION LIST

PATENT LITERATURE

[0005] PTL 1: Japanese Patent No. 6180684

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] In the vehicle transformer in PTL 1, a transfor-

mer main body tank to store a transformer main body is installed on a roof of a vehicle, and a cooler constituted by a plurality of cooling pipes is installed on the top of the transformer main body tank. A pump to circulate refrigerant is installed so as to protrude from a contour of an upper surface portion of the transformer main body tank in the vehicle traveling direction, and it is necessary to optimize an installation position of the pump in order to further reduce the installation space.

[0007] The present disclosure has been made in order to solve the aforementioned problem, and an object thereof is to provide a vehicle transformer utilizing traveling wind, in which an installation space for the vehicle transformer is reduced by installing a pump so as not to protrude from a contour of an upper surface portion of a transformer main body tank.

SOLUTION TO PROBLEM

[0008] A vehicle transformer according to the present disclosure includes: a transformer main body tank having an inlet header through which refrigerant flows in and an outlet header through which the refrigerant flows out, to store a transformer main body; a cooler on a front side in a vehicle traveling direction and a cooler on a rear side in the vehicle traveling direction, the coolers being disposed to be divided in the vehicle traveling direction so as not to protrude from a contour of an upper surface portion of the transformer main body tank, and being long in a vehicle width direction, to cool the refrigerant by traveling wind during traveling of a vehicle; a pipe on the front side connected to one end of the cooler on the front side in the vehicle traveling direction disposed on the upper surface portion of the transformer main body tank; a pipe on the rear side connected to one end of the cooler on the rear side in the vehicle traveling direction disposed on the upper surface portion of the transformer main body tank; and a pump to connect one ends of the two pipes to each other, the pump being disposed without protruding from the contour of the upper surface portion of the transformer main body tank, and being aligned with the two pipes in a straight line in the vehicle traveling direction when the vehicle is viewed from above, wherein the refrigerant flows through the cooler on the front side in the vehicle traveling direction and the cooler on the rear side in the vehicle traveling direction, in different orientations, and the vehicle transformer has a circulation path including the cooler on the front side in the vehicle traveling direction, the pipe on the front side, the pump, the pipe on the rear side, the cooler on the rear side in the vehicle traveling direction, the inlet header of the transformer main body tank, and the outlet header of the transformer main body tank connected in this order, the refrigerant circulating through the circulation path by the pump.

ADVANTAGEOUS EFFECTS OF INVENTION

[0009] According to the present disclosure, it is possible to provide a vehicle transformer utilizing traveling wind, in which an installation space for the vehicle transformer is reduced by optimizing an installation position of a pump and thereby reducing a width of the vehicle transformer in a vehicle traveling direction.

BRIEF DESCRIPTION OF DRAWINGS

[0010]

Fig. 1 is a top view of a vehicle having a vehicle transformer installed on a roof, showing a first embodiment.

Fig. 2 is a side view of the vehicle having the vehicle transformer installed on the roof, showing the first embodiment.

Fig. 3 is a top view of the vehicle transformer installed on the roof of the vehicle, showing the first embodiment.

Fig. 4 is a side view of the vehicle transformer installed on the roof of the vehicle, showing the first embodiment.

Fig. 5 shows a circulation path for refrigerant in a transformer main body tank of the vehicle transformer installed on the roof of the vehicle, showing the first embodiment.

Fig. 6 shows a circulation path for the refrigerant in coolers of the vehicle transformer installed on the roof of the vehicle, showing the first embodiment.

Fig. 7 shows a circulation path for the refrigerant as viewed from a side surface of the vehicle transformer installed on the roof of the vehicle, showing the first embodiment.

DESCRIPTION OF EMBODIMENTS

First Embodiment.

[0011] Fig. 1 is a top view of a vehicle 1 having a vehicle transformer 10 installed on a roof 2, showing a first embodiment. Fig. 2 is a side view of vehicle 1 having vehicle transformer 10 installed on roof 2, showing the first embodiment. In the drawings, X represents a vehicle traveling direction, Y represents a vehicle width direction, and Z represents a vehicle height direction. Vehicle transformer 10 is installed on roof 2 of vehicle 1. Further, peripheral devices 3 such as a controller and an air conditioner are installed on roof 2 to be aligned with vehicle transformer 10 in vehicle traveling direction X.

[0012] Fig. 3 is a top view of vehicle transformer 10 installed on the top of the vehicle in the first embodiment. Fig. 4 is a side view of vehicle transformer 10 shown in Fig. 3. Figs. 5 to 7 show circulation paths for refrigerant in vehicle transformer 10 according to the

first embodiment, and arrows in the drawings indicate orientations in which the refrigerant flows. In the drawings, X represents the vehicle traveling direction, Y represents the vehicle width direction, and Z represents the vehicle height direction. In the drawings, a mark indicated by X within O represents that the refrigerant flows in a direction from the front toward the rear with respect to the sheet plane, and a mark indicated by small o within O represents that the refrigerant flows in a direction from the rear toward the front with respect to the sheet plane.

[0013] As shown in Fig. 3, vehicle transformer 10 includes a transformer main body tank 11, coolers 12, a pump 13, a pipe 14a, a pipe 14b, a pipe 14c, and a pipe 14d. There are two coolers 12, each constituted by a plurality of cooling pipes 12a or 12b. A partition member 15 made of an insulating material is included inside transformer main body tank 11.

[0014] Transformer main body tank 11 stores a transformer main body including a winding as an energization medium, an iron core, and an insulating material as an insulating medium, and the refrigerant for cooling heat generated from the winding and the iron core by energization circulates in transformer main body tank 11. Partition member 15 is provided inside transformer main body tank 11, and a flow path for the refrigerant is divided into two by partition member 15. Transformer main body tank 11 has, on an upper surface portion, an inlet header 11a through which the refrigerant flows in and an outlet header 11b through which the refrigerant flows out, inlet header 11a being provided on a negative side in vehicle traveling direction X of partition member 15, outlet header 11b being provided on a positive side in vehicle traveling direction X of partition member 15, the headers being aligned in vehicle traveling direction X.

[0015] As indicated by arrows in Fig. 5, the refrigerant flows in through inlet header 11a, then flows to a positive side in vehicle width direction Y, reaches one end of transformer main body tank 11, then flows to the positive side in vehicle traveling direction X, passes over partition member 15, then flows to a negative side in vehicle width direction Y, and then flows out through outlet header 11b.

[0016] Coolers 12 are disposed to be divided in vehicle traveling direction X on the upper surface portion of transformer main body tank 11, and cool the refrigerant by heat exchange with outside air. Cooler 12 extends long in vehicle width direction Y, and is constituted by the cooling pipes in which a plurality of cooling pipes are parallel in vehicle traveling direction X, and a plurality of cooling pipes are parallel in vehicle height direction Z. The cooling pipes of cooler 12 on the positive side in vehicle traveling direction X are referred to as front-side cooling pipes 12b, and the cooling pipes of cooler 12 on the negative side in vehicle traveling direction X are referred to as rear-side cooling pipes 12a. One ends of cooling pipes 12a on the positive side in

vehicle width direction Y are collectively connected by pipe 14a, and one ends of cooling pipes 12b on the positive side in vehicle width direction Y are collectively connected by pipe 14b. One ends of cooling pipes 12a on the negative side in vehicle width direction Y are collectively connected by pipe 14c, and one ends of cooling pipes 12b on the negative side in vehicle width direction Y are collectively connected by pipe 14d.

[0017] As indicated by arrows in Fig. 6, the refrigerant flows through cooling pipes 12a to the negative side in vehicle width direction Y, and the refrigerant flows through cooling pipes 12b to the positive side in vehicle width direction Y. It should be noted that the numbers of cooling pipes 12a and 12b are not limited.

[0018] Pump 13 connects pipe 14a and pipe 14b, and is disposed without protruding from a contour of the upper surface portion of transformer main body tank 11. As shown in Fig. 3, when vehicle transformer 10 is viewed from an upper surface, pump 13 is aligned with pipe 14a and pipe 14b in a straight line. As shown in Fig. 7, when vehicle transformer 10 is viewed from a side surface in vehicle traveling direction X, pump 13 overlaps pipe 14a or pipe 14b and a part thereof is hidden.

[0019] As indicated by an arrow in Fig. 6, the refrigerant flowing from pipe 14b into pump 13 flows out to pipe 14a.

[0020] Pipes 14a, 14b, 14c and 14d are disposed so as not to protrude from the contour of the upper surface portion of transformer main body tank 11. Pipes 14a and 14b collectively connect the one ends of cooling pipes 12a and 12b on the positive side in vehicle width direction Y, respectively, and also connect pump 13. Pipes 14c and 14d collectively connect the one ends of cooling pipes 12a and 12b on the negative side in vehicle width direction Y, respectively, and pipe 14c is connected to inlet header 11a of transformer main body tank 11 and pipe 14d is connected to outlet header 11b of transformer main body tank 11.

[0021] As shown in Figs. 5 to 7, the refrigerant flowing in from pump 13 is distributed to the plurality of cooling pipes 12a via pipe 14a, the distributed refrigerants are mixed in pipe 14c, and then the mixed refrigerant flows into transformer main body tank 11 through inlet header 11a of transformer main body tank 11. The refrigerant circulates in transformer main body tank 11, then flows out through outlet header 11b of transformer main body tank 11, is distributed to the plurality of cooling pipes 12b via pipe 14d, then the distributed refrigerants are mixed in pipe 14b, and the mixed refrigerant flows out to pump 13.

[0022] As the refrigerant, an insulating oil is utilized. In particular, a silicone oil having a high flame retardancy, an ester oil having a small load on the environment at the time of disposal, or the like is utilized for the vehicle.

[0023] At the time of energization, the refrigerant, which is a cooling medium for the winding and the iron

core, absorbs heat generated from the winding and the iron core, while circulating through cooler 12 on a front side, pipe 14b on the front side, pump 13, pipe 14a on a rear side, cooler 12 on the rear side, pipe 14c on the rear side, inlet header 11a of transformer main body tank 11, outlet header 11b of transformer main body tank 11, pipe 14d on the front side, and cooler 12 on the front side, in this order, and radiates heat at cooler 12 on the front side. It should be noted that the refrigerant may circulate through cooler 12 on the rear side, pipe 14a on the rear side, pump 13, pipe 14b on the front side, cooler 12 on the front side, pipe 14d on the front side, outlet header 11b of transformer main body tank 11, inlet header 11a of transformer main body tank 11, pipe 14c on the rear side, and cooler 12 on the rear side, in this order.

[0024] In vehicle transformer 10 configured as described above, pump 13 is installed so as not to protrude from the contour of the upper surface portion of transformer main body tank 11, and thus an installation space for vehicle transformer 10 can be reduced.

REFERENCE SIGNS LIST

[0025] 1: railroad vehicle; 2: roof; 3: device; 10: vehicle transformer; 11: transformer main body tank; 11a: inlet header; 11b: outlet header; 12: cooler; 12a, 12b: cooling pipe; 13: pump; 14a, 14b, 14c, 14d: pipe; 15: partition member.

Claims

1. A vehicle transformer comprising:

a transformer main body tank having an inlet header through which refrigerant flows in and an outlet header through which the refrigerant flows out, to store a transformer main body;
a cooler on a front side in a vehicle traveling direction and a cooler on a rear side in the vehicle traveling direction, the coolers being disposed to be divided in the vehicle traveling direction so as not to protrude from a contour of an upper surface portion of the transformer main body tank, and being long in a vehicle width direction, to cool the refrigerant by traveling wind during traveling of a vehicle;
a pipe on the front side connected to one end of the cooler on the front side in the vehicle traveling direction disposed on the upper surface portion of the transformer main body tank;
a pipe on the rear side connected to one end of the cooler on the rear side in the vehicle traveling direction disposed on the upper surface portion of the transformer main body tank;
and
a pump to connect one ends of the two pipes

to each other, the pump being disposed without protruding from the contour of the upper surface portion of the transformer main body tank, and being aligned with the two pipes in a straight line in the vehicle traveling direction when the vehicle is viewed from above, wherein
the refrigerant flows through the cooler on the front side in the vehicle traveling direction and the cooler on the rear side in the vehicle traveling direction, in different orientations, and the vehicle transformer has a circulation path including the cooler on the front side in the vehicle traveling direction, the pipe on the front side, the pump, the pipe on the rear side, the cooler on the rear side in the vehicle traveling direction, the inlet header of the transformer main body tank, and the outlet header of the transformer main body tank connected in this order, the refrigerant circulating through the circulation path by the pump.

2. The vehicle transformer according to claim 1, wherein the cooler on the front side in the vehicle traveling direction and the cooler on the rear side in the vehicle traveling direction are each constituted by a plurality of cooling pipes extending in the vehicle width direction.
3. The vehicle transformer according to claim 1, wherein an inside of the transformer main body tank is divided into two in the vehicle width direction by a partition member.
4. The vehicle transformer according to claim 3, wherein the inlet header and the outlet header of the transformer main body tank are disposed to be aligned in the vehicle traveling direction on the upper surface portion of the transformer main body tank, across the partition member.

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FIG.1

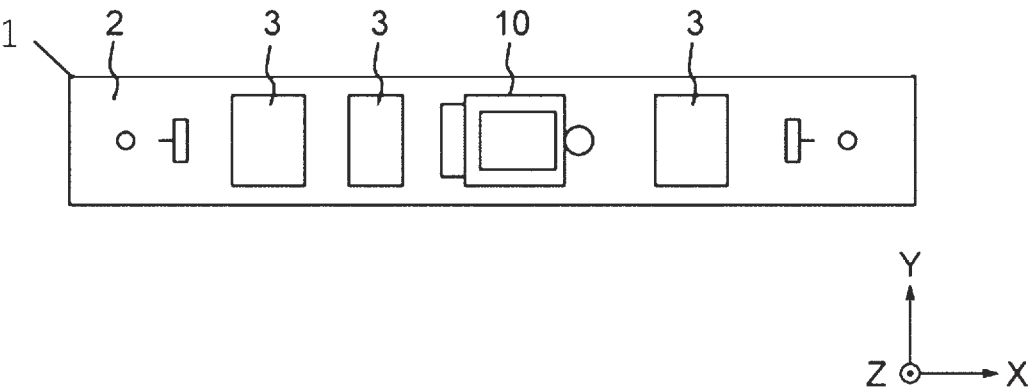


FIG.2

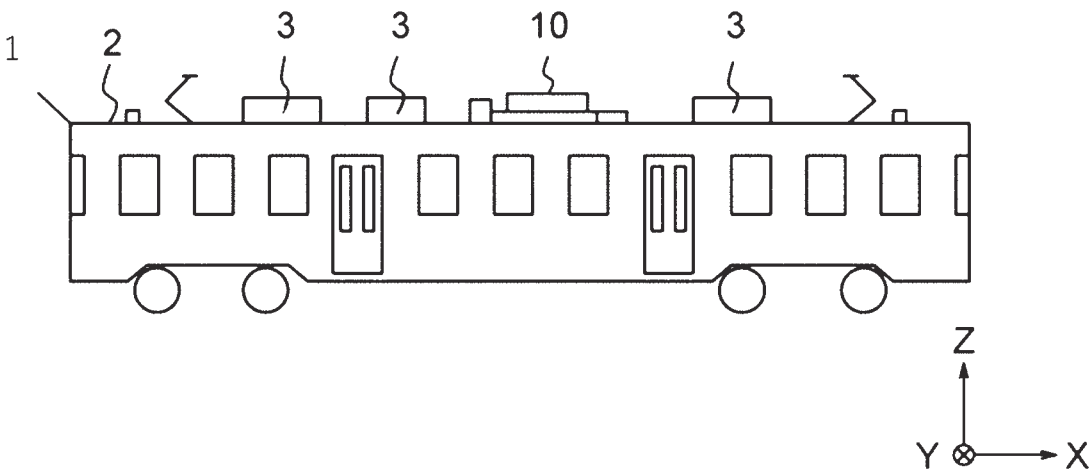


FIG.3

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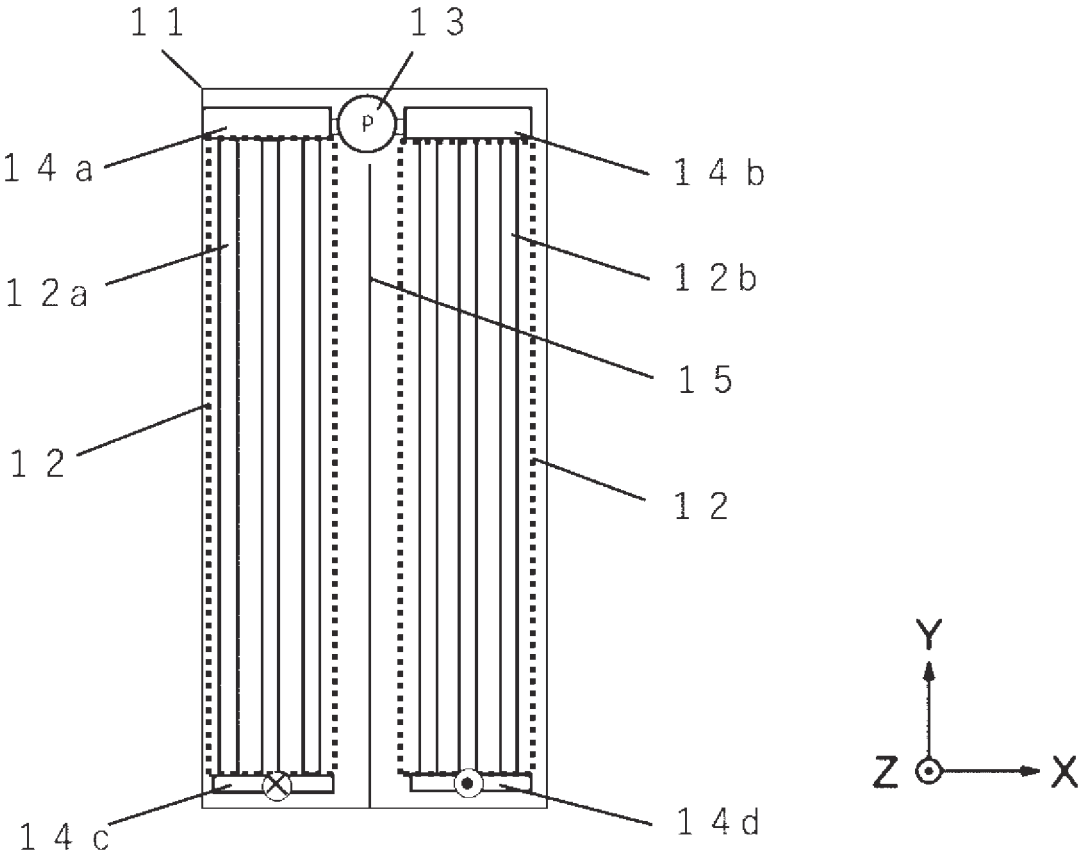


FIG.4

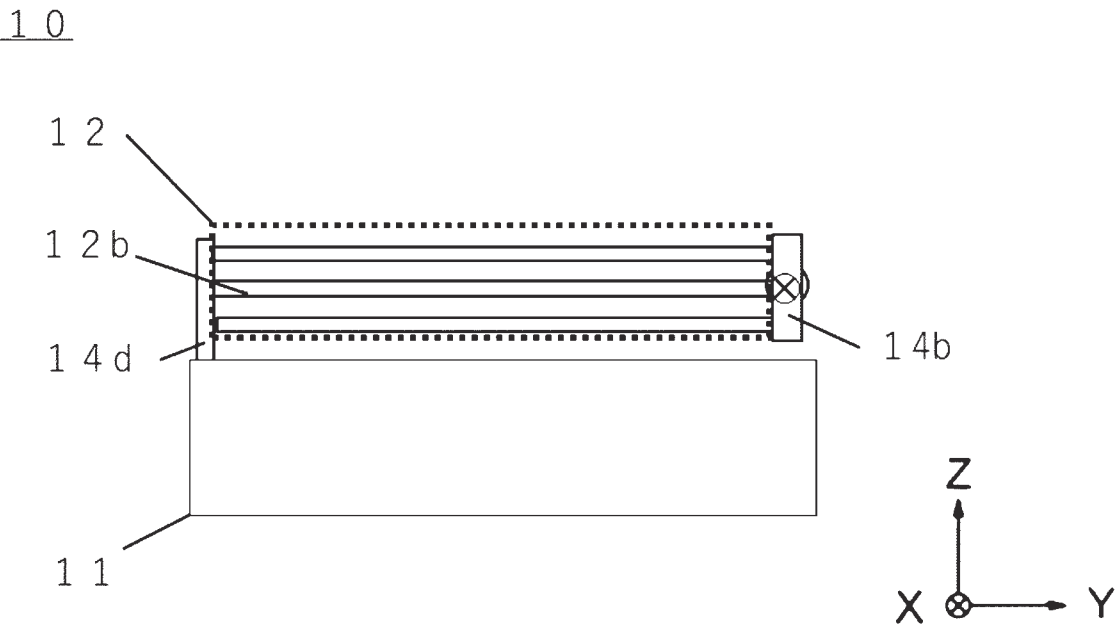


FIG.5

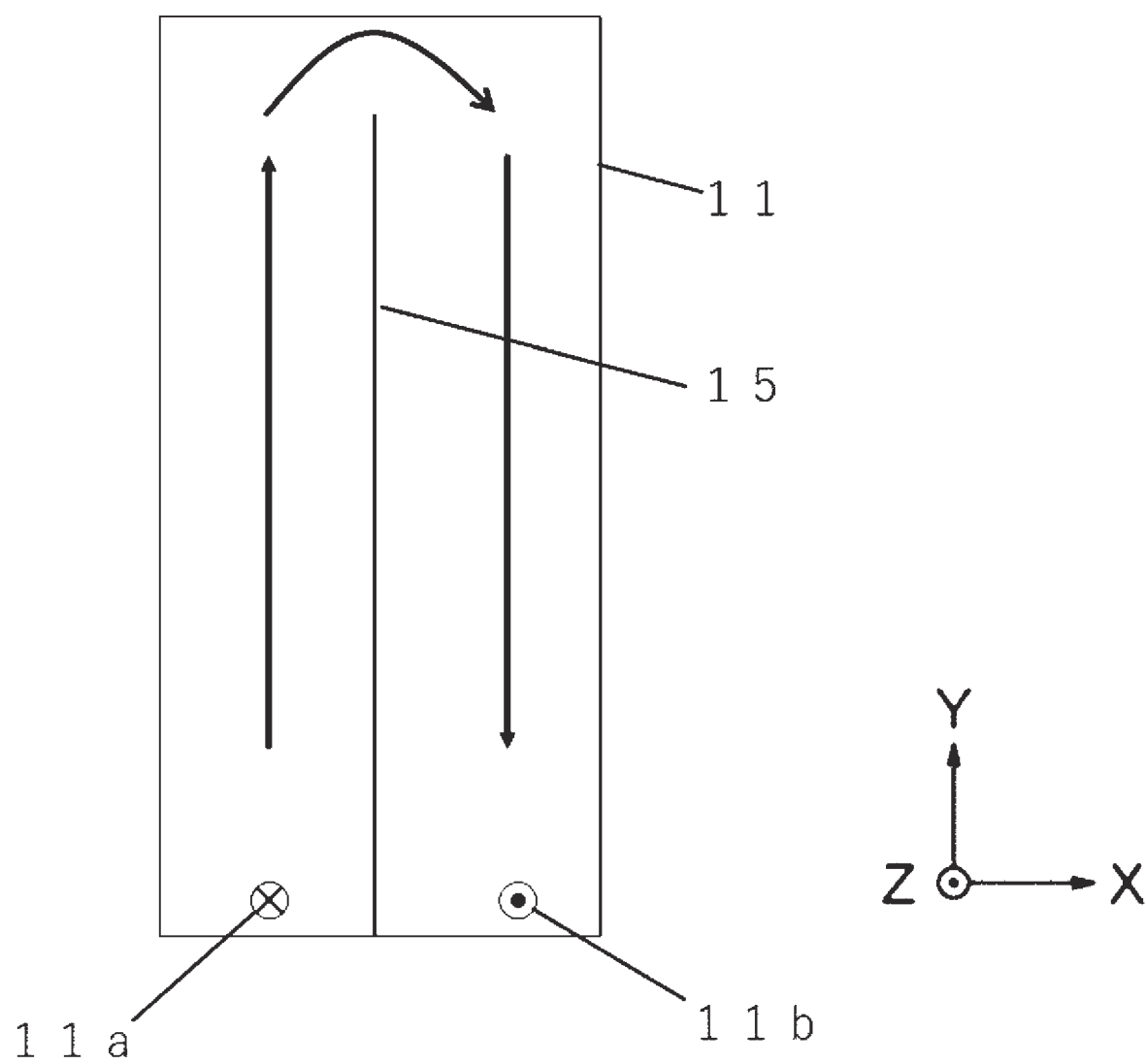


FIG.6

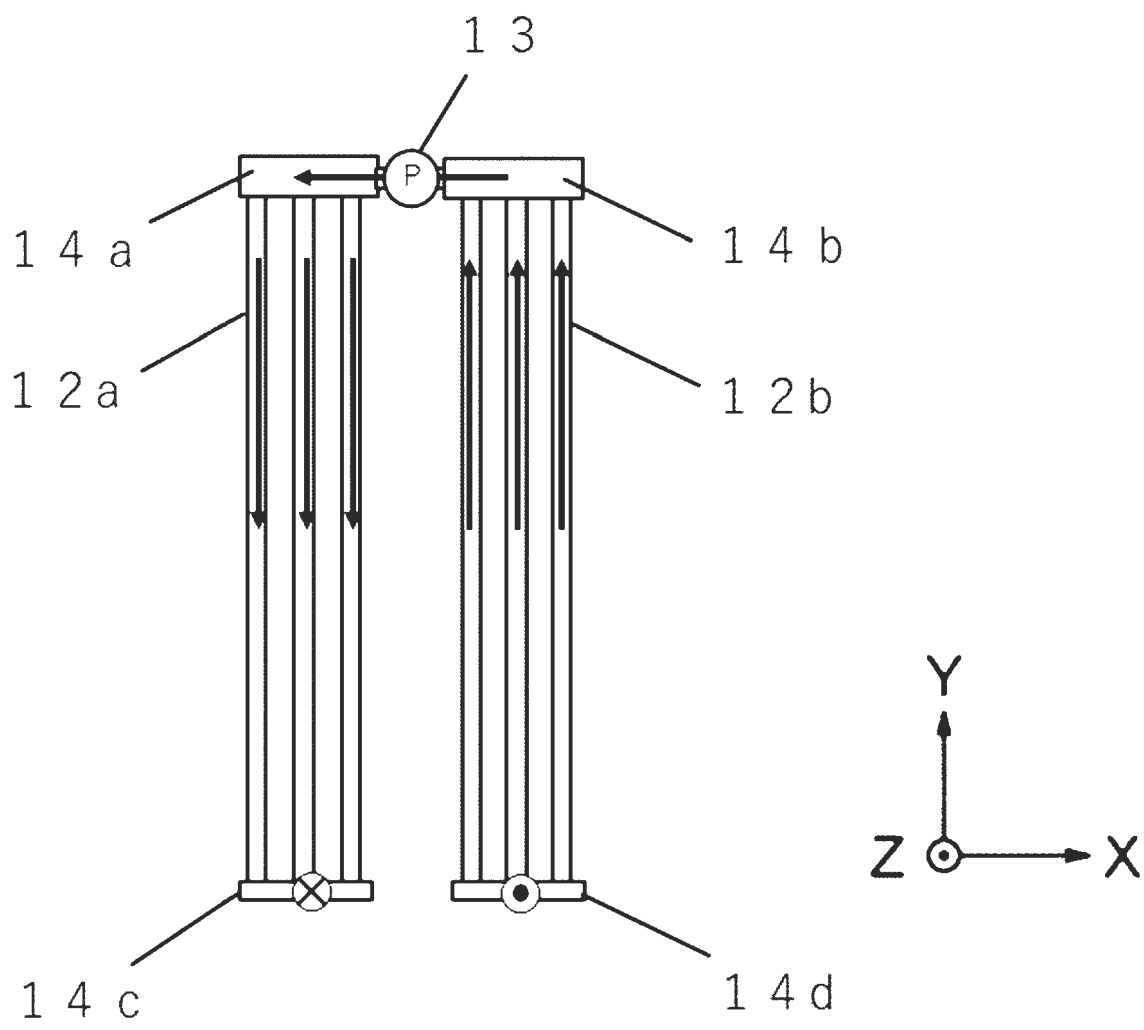
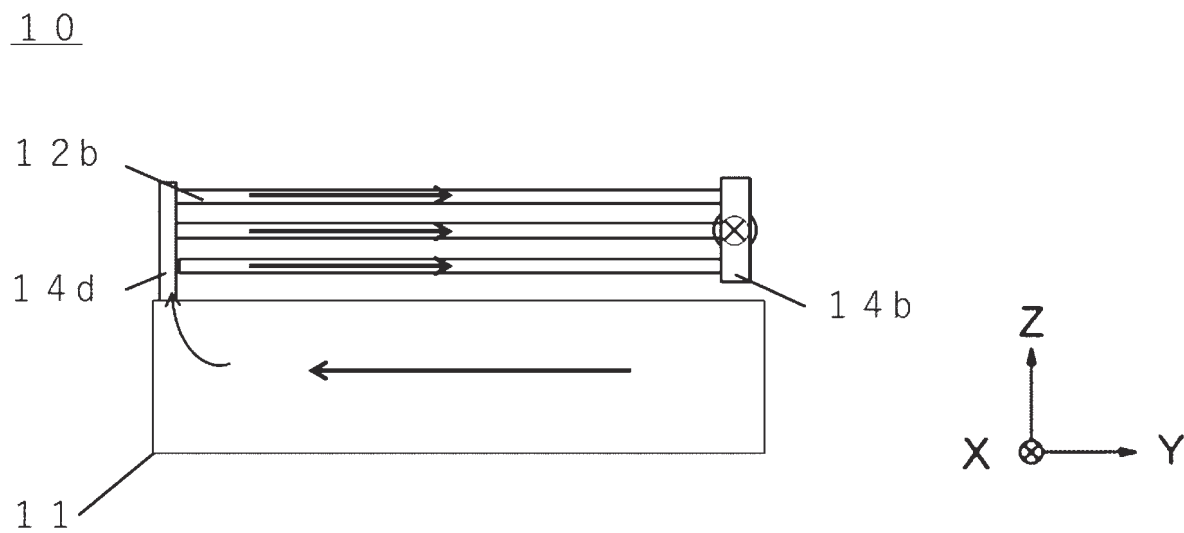


FIG.7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2023/044182

A. CLASSIFICATION OF SUBJECT MATTER

H01F 27/12(2006.01)i; **H01F 30/10**(2006.01)i
FI: H01F27/12 A; H01F30/10 S

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; H01F30/10

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.
A	WO 2018/051403 A1 (MITSUBISHI ELECTRIC CORPORATION) 22 March 2018 (2018-03-22) paragraphs [0012]-[0042], fig. 1-9	1-4
A	WO 2016/103439 A1 (MITSUBISHI ELECTRIC CORPORATION) 30 June 2016 (2016-06-30) paragraphs [0039]-[0046], fig. 12-14	1-4
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 86222/1977 (Laid-open No. 12817/1979) (MITSUBISHI ELECTRIC CORPORATION) 27 January 1979 (1979-01-27), specification, pp. 1-2, fig. 1	1-4

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

* Special categories of cited documents:

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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/JP2023/044182

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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	2018/051403	A1	22 March 2018	EP	3514812	A1	
				paragraphs [0015]-[0053], fig. 1-9			
WO	2016/103439	A1	30 June 2016	EP	3239996	A1	
				paragraphs [0040]-[0047], fig. 12-14			
JP	54-12817	U1	27 January 1979	(Family: none)			

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 6180684 B [0005]