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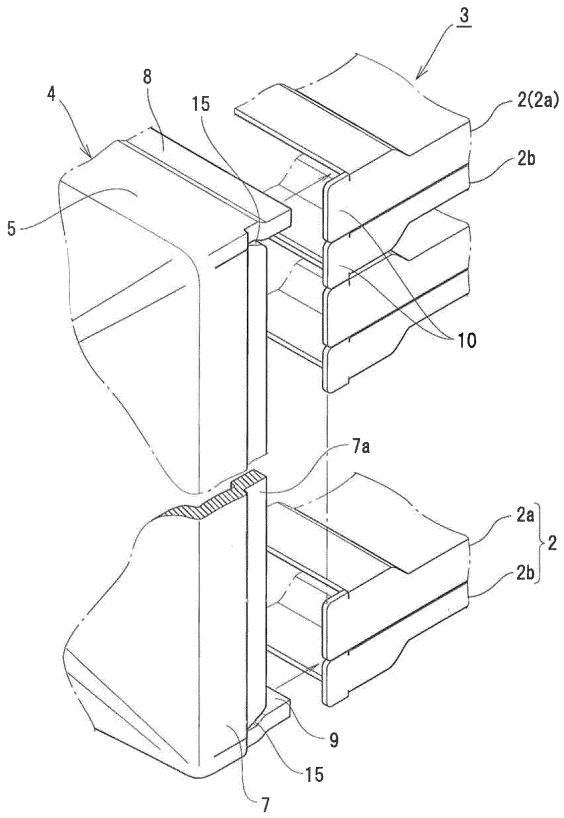
(54) TANK STRUCTURE FOR HEADER-PLATE-LESS HEAT EXCHANGER

(57) The objective is to eliminate gaps at the joint part between a tank (4) and a core (3), and thus to ensure air-tightness and liquid-tightness. Flat tubes (2) are formed by pairs of plates (2a, 2b) each of which is formed in a groove shape, the walls on both sides of each plate (2a, 2b) protrude toward the tank (4) from a groove bottom leading edge (1a) of a protruding part (1) to form protruding side walls (10). The outer edges (10a) of the protruding side walls (10) in the protruding direction are aligned so as to be flush with each other on the outer surface of the protruding part (1), and when the flat tubes (2) are stacked, the respective outer edges (10a) of adjacent flat tubes (2) contact each other. Furthermore, on the side opposite the protruding direction, inner edge surfaces (10b) of the protruding side walls (10) of the pair of plates (2a, 2b) forming each flat tube (2) contact each other. In addition, with the front ends of a pair of side plate parts (7) of the tank (4) making contact with the inside of the protruding side walls (10) of each flat tube (2), the various contacting parts are soldered to each other.

Fig.3



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Description

Technical Field

[0001] The present invention relates to a tank structure for a header-plate-less heat exchanger in which flat tubes whose both ends protrude are stacked to improve air-tightness and liquid-tightness between a core and a tank.

Background Art

[0002] As illustrated in Figs. 8 and 9, in the header-plate-less heat exchanger, flat tubes 2 whose both ends protrude in a thickness direction are stacked at a protruding part to form a core, and thus a header plate is not required. A casing 11 is fitted onto an outer circumference of the core 3 including a stack body of the flat tubes 2, and also a tank 4 is fitted onto both ends of the core 3 and, then, parts are integrally soldered and secured to each other.

[0003] As illustrated in Fig. 9, flat tubes 2 include a pair of an upper plate 2a and a lower plate 2b each bent in a groove shape (right side is not illustrated), which are fitted into each other with groove bottoms faced to each other. Further, as illustrated in Fig. 8, the casing 11 includes a casing main body 11a formed in a groove shape and an edge cap for closing a space between walls of both sides of the casing main body 11a. Furthermore, the tank 4 is integrally molded in a cylindrical shape having a square shape in cross section by press-molding.

Citation List

Patent Literature

[0004]

PTL 1: Japanese Patent Laid-Open No. 2011-2133
PTL 2: Japanese Patent Laid-Open No. 2011-232020

Summary of Invention

Technical Problem

[0005] Such a header-plate-less heat exchanger and a tank 4 need to be joined to each other without a gap by soldering. However, flat tubes 2 include a fitting body of a pair of upper plate 2a and lower plate 2b, and thus generate a gap in a fitting part B as illustrated in Fig. 9. Further, at a part of a corner C of a stack body of the respective flat tubes 2, a gap in a groove shape is generated. This is because R is generated at a corner of each plate 2a, 2b press-molded in a groove shape.

[0006] Furthermore, as illustrated in Fig. 9, a gap is generated at a portion A between the tank 4 and the flat tube 2, therefore, air-tightness and liquid-tightness may be deteriorated. That is because, since the tank 4 is integrally formed by press-molding, spring back is generated at an opening part after being molded and, thus, the flat tube 2 and the tank 4 can be hardly, closely contacted. When such a gap is generated, solder runs out, as it is called, during soldering, and thus the air-tightness and the liquid-tightness of the tank may be deteriorated.

[0007] Therefore, a purpose of the present invention is to provide a tank structure in which a gap is not generated in a soldering part between the tank 4 and the core 3 particularly.

Solution to Problem

[0008] The present invention of claim 1 is a tank structure for a header-plate-less heat exchanger in which a plurality of flat tubes (2) having a protruding part (1) whose both end parts protrude in a thickness direction is stacked, and contacts and is secured to each other to form a core (3) at the protruding part (1), and openings of a pair of tanks (4) are connected to both ends of the core (3),
wherein the tank (4) is formed in a square shape in cross section and formed of an upper end plate part (5), a lower end plate part (6) respectively located at both upper and lower ends in the stacking direction, and a pair of side plate parts (7) orthogonal to the upper end plate part (5) and the lower end plate part (6);
wherein the flat tubes (2) include a pair of plates (2a) and (2b) formed in a groove shape and fitted to each other with groove bottoms of the pair of plates (2a) and (2b) facing each other, and both side walls of the respective plates (2a) and (2b) protrude toward a tank (4) side from a groove bottom leading edge (1a) to form protruding side walls (10);
wherein outer edges (10a) of the protruding side walls (10) in a protruding direction are aligned so as to be flush with an outer surface of the protruding part (1) and, when the respective flat tubes (2) are stacked, the respective outer edges (10a) of adjacent flat tubes (2) contact each other;
wherein on a side opposite the protruding direction, inner edge (10b) of the protruding side walls (10) of the pair of plates (2a) and (2b) forming the respective flat tubes (2) contact with each other; and
wherein, with the front ends of the pair of side plate parts (7) of the tank (4) making contact with an inside of the protruding side walls (10) of the respective flat tubes (2), the respective contacting parts are soldered and secured to each other.

[0009] The present invention of claim 2 is the tank structure for a header-plate-less heat exchanger according to claim 1,
wherein a casing (11) is fitted onto an outer circumference of the core (3); and
wherein the protruding side walls (10) are soldered and secured to each other in a state of being held between the side plate parts (7) of the tank (4) and the casing (11).

[0010] The present invention of claim 3 is the tank

structure for a header-plate-less heat exchanger according to claim 1 or 2,
wherein the front end of the side plate part (7) of the tank (4) is bent inward by a thickness of the protruding side wall (10) to configure a stepped part (7a) so that the stepped part (7a) is soldered and secured to an inner surface of the protruding side wall (10).

[0011] The present invention of the claim 4 is the tank structure for a header-plate-less heat exchanger according to any of claims 1 to 3,
wherein the upper end plate part (5) and the lower end plate part (6) protrude toward the core (3) side from the side plate part (7) to form an upper fitting part (8) and a lower fitting part (9), respectively, the upper fitting part (8) and the lower fitting part (9) are fitted in, in a state where an outer surface of the upper fitting part (8) contacts with an inner surface of an upper side part of an uppermost flat tube (2) in the stacking direction and, further, an outer surface of the lower fitting part (9) contacts with an inner surface of a lower side part of a lowermost flat tube (2), and at the fitting part, the flat tube (2) and the tank (4) are soldered and secured to each other.

[0012] The present invention of claim 5 is the tank structure for a header-plate-less heat exchanger according to any of claims 1 to 4,
wherein, on borders between the side plate parts (7) and the upper end plate part (5) and between the side plate parts (7) and the lower end plate part (6), front ends at a core side of the borders are separated and cutting parts (15) are formed.

Advantageous Effects of Invention

[0013] According to the invention of claim 1, both side walls of the respective plates 2a and 2b configuring the flat tubes 2 protrude toward a tank 4 from a groove bottom leading edge 1a of the protruding part 1 to form protruding side walls 10.

[0014] The front ends of a pair of side plate parts 7 of the tank 4 are soldered and secured to each other in a state of being in contact with an inside of the protruding side walls 10 of the respective flat tubes 2. Outer edges 10a of the protruding side walls 10 in a protruding direction are aligned so as to be flush with each other on the outer surface of the protruding part 1, and when the respective flat tubes 2 are stacked, the respective outer edges 10a of adjacent flat tubes 2 contact with each other.

[0015] On the side opposite the protruding direction, inner edge 10b of the protruding side walls 10 of the pair of plates 2a and 2b forming the respective flat tubes 2 contact with each other. Therefore, a gap (B portion illustrated in Fig. 9) between the respective plates 2a and 2b forming the flat tubes is closed. Furthermore, a gap (C portion illustrated in Fig. 9) existing between the respective flat tubes 2 is closed. Moreover, an inside of the gap is closed by the side plate part 7.

[0016] As a result, the liquid-tightness and the air-tightness at the soldering part among respective parts of the tank 4, the core 3, and the casing 11 can be ensured.

[0017] According to the invention of claim 2, the protruding side walls 10 of the respective flat tubes 2 are soldered and secured to each other in a state where the protruding side walls 10 of the flat tubes 2 are held between the side plate parts 7 of the tank 4 and the casing 11. Therefore, the liquid-tightness and the air-tightness between the protruding side wall 10 and the side plate part 7 of the tank 4 can be reliably realized.

[0018] According to the invention of claim 3, the front end of the side plate part 7 of the tank 4 is bent inward by a thickness of the protruding side wall 10. Therefore, a contacting part between the tank 4 and the protruding side wall 10 is increased, thereby improving the air-tightness and the liquid-tightness therebetween.

[0019] According to the invention of claim 4, an upper fitting part of the tank 4 protruding from the side plate part 7 and a lower fitting part 9 protruding in a similar manner are fitted in, in a state where the upper fitting part thereof contacts with an inner surface of an upper side part of the uppermost flat tube in a stacking direction and the lower fitting part contacts with an inner surface of a lower side part of the lowermost flat tube and, at the fitting part, the flat tubes and the tank are soldered and secured to each other. In the case described above, the upper fitting part 8 and lower fitting part 9 that protrude can be easily deformed and, thus, can closely contact the flat tubes 2 of the core 3. Therefore, the liquid-tightness and the air-tightness of the soldering part can be ensured.

[0020] In addition to the structure described above, according to claim 5, when cutting parts 15 are provided on borders between the side plate parts 7 and the upper end plate part 5 and between the side plate parts 7 and the lower end plate part 6, each part can be easily deformed to further closely contact each contacting part, thereby ensuring the air-tightness and liquid-tightness of the soldering.

Brief Description of Drawings

[0021]

Fig. 1 is an exploded perspective view illustrating a tank structure for a header-plate-less heat exchange of the present invention.
Fig. 2 (A) is an exploded view illustrating an essential part of flat tubes 2. Fig. 2 (B) is an enlarged view of a portion B illustrated in Fig. 2(A). Fig. 2(C) is a perspective view of an essential part illustrating a combination state of the flat tubes 2.
Fig. 3 illustrates assembly of a tank 4 and the flat tubes 2.
Fig. 4 is a perspective view of an essential part illustrating the assembly state.
Fig. 5 is a vertical cross-sectional view.
Fig. 6 is a cross-sectional view taken along a line VI-VI illustrated in Fig. 5.

Fig. 7 illustrates assembly of the tank 4 and the flat tubes 2 according to a second embodiment of the present invention.

Fig. 8 is a vertical cross-sectional view illustrating an essential part of the tank structure for a header-plateless heat exchanger of prior art.

Fig. 9 is a cross-sectional enlarged view taken along a line IX-IX illustrated in Fig. 7.

Description of Embodiments

[0022] Subsequently, with reference to figures, embodiments of the present invention will be described below.

[0023] As illustrated in Fig. 1, in the heat exchanger described above, a number of flat tubes 2 are stacked at a protruding part 1 on both ends thereof to form a core 3. At parts except for the protruding part, a gap is generated between the respective flat tubes 2, and cooling water is supplied into the gap. As illustrated in Fig. 2, the flat tubes 2 include the fitting body of an upper plate 2a and a lower plate 2b that are each formed in a groove shape. An upper part of the side wall of the lower plate 2b is molded to have a step bent inward by a plate thickness of the upper plate 2a to form a stepped part 2c there. At an inside of the upper plate 2a, an upper end part of the lower plate 2b is fitted. Both end parts of the plate 2a and plate 2b in a longitudinal direction include the protruding part 1 protruding in the thickness direction. The front ends of the both side walls protrude outward from the groove bottom leading edges 1a of an upper side and a lower side of the groove bottom of each plate 2a, 2b to form a pair of protruding side walls 10. The front end of a stepped part 2c of the side wall of the lower plate 2b is aligned with the lower side of the groove bottom of the upper plate 2a.

[0024] The outer edges 10a of the protruding side walls 10 in a vertical direction are aligned so as to be flush with each other on the outer surface of the protruding part 1, and when the flat tubes 2 are stacked, the respective outer edges 10a of adjacent flat tubes 2 contact each other without a gap. Further, on the side opposite the protruding direction, inner edge 10b of the protruding side walls 10 of the pair of plates 2a and 2b forming the respective flat tubes 2 contact each other without the gap.

[0025] The plates 2a and 2b are fitted into each other as illustrated in Figs. 2(B) and 2(C) to form the flat tubes 2. According to the embodiment described above, inner fins 13 are intermediately provided in the flat tubes 2 as illustrated in Fig. 1.

[0026] Subsequently, as illustrated in Fig. 1, the casing 11 includes a casing main body 11a formed in a groove shape and an edge cap 11b for closing a space between both side walls. The edge cap 11b is formed in a shallow groove shape to conform to an outer circumference of the casing main body 11a. Subsequently, the tank 4 is integrally molded by a press-machine. As illustrated in Fig. 1, the entire tank 4 is formed in a shallow cone shape and one end opening of the tank 4 is formed in a round shape and another end opening is formed in a square shape.

[0027] The upper end plate part 5 and the lower end plate part 6 that face each other in a vertical direction are formed in a square shape in cross section by the pair of side plate parts 7 arranged at both sides of the upper end plate part 5 and the lower end plate part 6. Further, the upper end plate part 5 and the lower end plate part 6 are provided with an upper fitting part 8 and a lower fitting part 9 formed with a step inward by a plate thickness of the flat tube 2, and the upper fitting part 8 and the lower fitting part 9 protrude toward the core 3 side from the side plate part 7. A width of the upper fitting part 8 and lower fitting part 9 conforms to an inner width of the flat tube 2. Further, from the both side plate parts 7 of the tank 4, a pair of stepped parts 7a bent inward by the plate thickness of the flat tube 2 protrude. An outer width between the stepped parts 7a conforms to the inner width of the flat tube 2 between the protruding side walls 10 provided right and left. Further, the borders between the stepped parts 7a and the upper fitting part 8 and between the stepped parts 7a and the lower fitting part 9 are separated by the cutting parts 15. Therefore, the upper fitting part 8, the lower fitting part 9, and the stepped parts 7a are each formed to be elastically deformable.

[0028] In the tank 4 configured as described above, as illustrated in Figs. 3 and 4, the upper fitting part 8 is fitted into the inside of the plate 2a of the uppermost flat tube 2 of the core 3 in the stacking direction. The lower fitting part 9 is fitted into the plate 2b of the lowermost flat tube 2 in the stacking direction in a state where the lower fitting part 9 contacts with the plate 2b. Furthermore, the stepped parts 7a of the pair of side plate parts 7 are fitted into the inside of the protruding side walls 10 of the respective flat tubes 2. As illustrated in Fig. 5, the leading edge of the stepped part 7a abuts on the groove bottom leading edge 1a of each plate 2a, 2b and a leading edge 2d of the stepped part 2c of the side wall of the lower plate 2b (Fig. 2). Then, the parts are assembled as illustrated in Figs. 4 and 5. Solder material is previously coated or applied in the gap between the contacting parts of the respective parts. As illustrated in Fig. 5, the casing main body 11a is fitted from above onto the core 3 and the tank 4 and the edge cap 11b is fitted from beneath thereon. Then, the end part of the upper plate 2a of the uppermost flat tube 2 is held between the upper fitting part 8 of the tank 4 and the casing main body 11a. Further, the end part of the lower plate 2b of the lowermost flat tube 2 is held between the lower fitting part 9 of the tank 4 and the edge cap 11b. Furthermore, as illustrated in Fig. 6, the protruding side wall 10 of the each flat tube 2 is also held between the stepped part 7a and the casing 11.

[0029] When the soldering is performed, the protruding side walls 10 are soldered in a state of close contact with each other. At this point, the upper fitting part 8, the lower fitting part 9, and the stepped part 7a are elastically de-

formed due to presence of the cutting parts 15, respectively, and the gaps between the parts adjacent to each other are soldered in a state of close contact. In order to do so, the outer circumference of the casing 11 is fastened inward with a tool (not illustrated) and soldered. Then, the air-tightness and the liquid-tightness can be ensured without generating the gap between the tank 4 and the respective flat tubes 2. The gaps generated at A, B and C in the heat exchanger of the prior art illustrated in Fig. 9 are each closed, thereby ensuring the air-tightness and the liquid-tightness. In other words, the portion A illustrated in Fig. 9 closely contacts the inner surface of the flat tube 2 due to elastic deformation of the upper fitting part 8, the lower fitting part 9, and the stepped part 7a. When the respective flat tubes 2 are stacked, at the portion B illustrated in Fig. 9, the respective outer edges 10a of the adjacent flat tubes 2 contact each other, and thus no gap is generated.

[0030] On the side opposite the protruding direction, since the inner edge 10b of the protruding side walls 10 of the pair of plates 2a and 2b forming the respective flat tubes 2 contact with each other, no gap is generated also there. Further, the side plate parts 7 of the tank 4 close the inside (portion B illustrated in Fig. 9) between the respective plates 2a and 2b forming the flat tubes. Furthermore, the side plate parts 7 also close the inside of the portion C between the respective flat tubes 2 illustrated in Fig. 9.

[0031] As illustrated in Fig. 1, the casing 11 is formed with a cooling water entrance and exit 12 at both end parts of the casing main body 11a in the longitudinal direction, and the cooling water flows in through the cooling water entrance and exit 12 to be supplied to the gap between the respective flat tubes 2. Moreover, as an example, exhaust gas at high temperature flows in from one tank 4 side, and flows through the respective flat tubes 2 to exchange heat with the cooling water.

[0032] Subsequently, Fig. 7 illustrates assembly of the tank 4 and the flat tubes 2 according to the second embodiment of the present invention. The difference between the embodiment described above and that illustrated in Fig. 3 is only a position of the cutting part 15. The cutting part 15 of the embodiment described above is formed on each plane surface of the upper end plate part 5 and the lower end plate part 6 of the tank 4. Due to the presence of the cutting parts 15, the stepped parts 7a, the upper fitting part 8, and the lower fitting part 9 can be easily molded.

Reference Signs List

[0033]

1	protruding part
1a	groove bottom leading edge
2	flat tube
2a	plate
2b	plate
2c	stepped part
2d	leading edge
3	core
4	tank
5	upper end plate part
6	lower end plate part
7	side plate part
7a	stepped part
8	upper fitting part
9	lower fitting part
10	protruding side wall
10a	outer edge
10b	inner edge
11	casing
11a	casing main body
11b	edge cap
12	cooling water entrance and exit
13	inner fin
15	cutting part

Claims

1. A tank structure for a header-plate-less heat exchanger in which a plurality of flat tubes (2) having a protruding part (1) whose both end parts protrude in a thickness direction is stacked, and contacts and is secured to each other to form a core (3) at the protruding part (1), and openings of a pair of tanks (4) are connected to both ends of the core (3),
wherein the tank (4) is formed in a square shape in cross section and formed of an upper end plate part (5), a lower end plate part (6) respectively located at both upper and lower ends in stacking direction of flat tubes, and a pair of side plate parts (7) orthogonal to the upper end plate part (5) and the lower end plate part (6);
wherein said flat tubes (2) include a pair of plates (2a) and (2b) formed in a groove shape and fitted to each other with groove bottoms of the pair of plates (2a) and (2b) facing each other, and both side walls of the respective plates (2a) and (2b) protrude toward a tank (4) side from a groove bottom leading edge (1a) to form protruding side walls (10);
wherein outer edges (10a) of the protruding side walls (10) in a protruding direction are aligned so as to be flush with an outer surface of said protruding part (1) and, when the respective flat tubes (2) are stacked, the respective outer edges (10a) of adjacent flat tubes (2) contact each other;
wherein on a side opposite the protruding direction, inner edge surfaces (10b) of the protruding side walls (10) of the pair of plates (2a) and (2b) forming the respective flat tubes (2) contact with each other; and
wherein, with the front ends of the pair of side plate parts (7) of said tank (4) making contact with an inside of said protruding side walls (10) of the respective flat tubes (2), the respective contacting parts are

soldered and secured to each other.

2. The tank structure for a header-plate-less heat exchanger according to claim 1,
wherein a casing (11) is fitted onto an outer circumference of said core (3); and
wherein said protruding side walls (10) are soldered and secured to each other in a state of being held between the side plate parts (7) of the tank (4) and the casing (11).

3. The tank structure for a header-plate-less heat exchanger according to claim 1 or 2,
wherein the front end of the side plate part (7) of said tank (4) is bent inward by a thickness of said protruding side wall (10) to configure a stepped part (7a) so that the stepped part (7a) is soldered and secured to an inner surface of the protruding side wall (10).

4. The tank structure for a header-plate-less heat exchanger according to any of claims 1 to 3,
wherein said upper end plate part (5) and said lower end plate part (6) protrude toward the core (3) side from said side plate part (7) to form an upper fitting part (8) and a lower fitting part (9), respectively, the upper fitting part (8) and the lower fitting part (9) are fitted in, in a state where an outer surface of the upper fitting part (8) contacts with an inner surface of an upper side part of an uppermost flat tube (2) in the stacking direction and, further, an outer surface of the lower fitting part (9) contacts with an inner surface of a lower side part of a lowermost flat tube (2), and at the fitting part, the flat tube (2) and the tank (4) are soldered and secured to each other.

5. The tank structure for a header-plate-less heat exchanger according to any of claims 1 to 4,
wherein, on borders between the side plate parts (7) and the upper end plate part (5) and between the side plate parts (7) and the lower end plate part (6), front ends at a core side of the borders are separated and cutting parts (15) are formed.

Fig.1

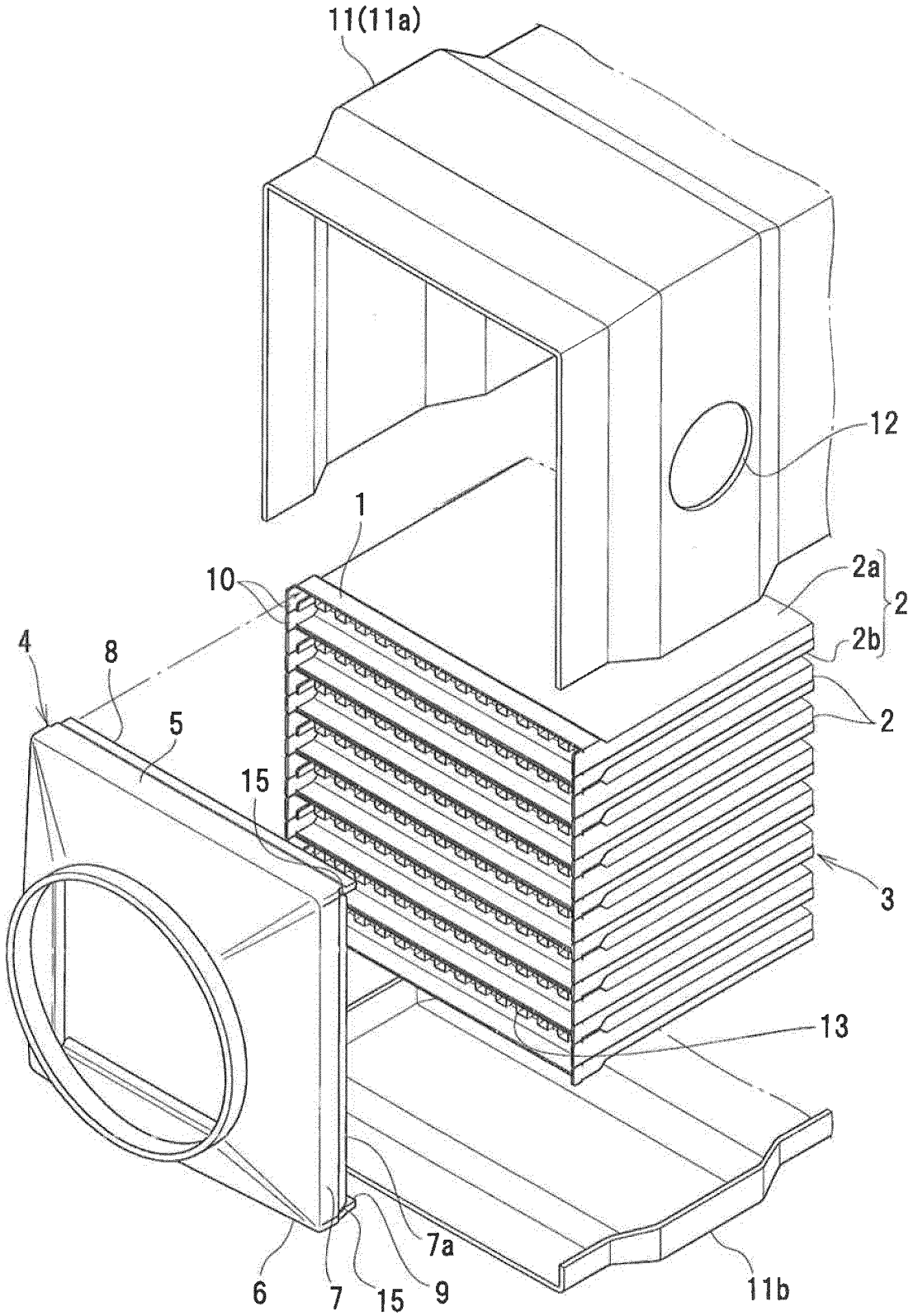


Fig.2 (A)

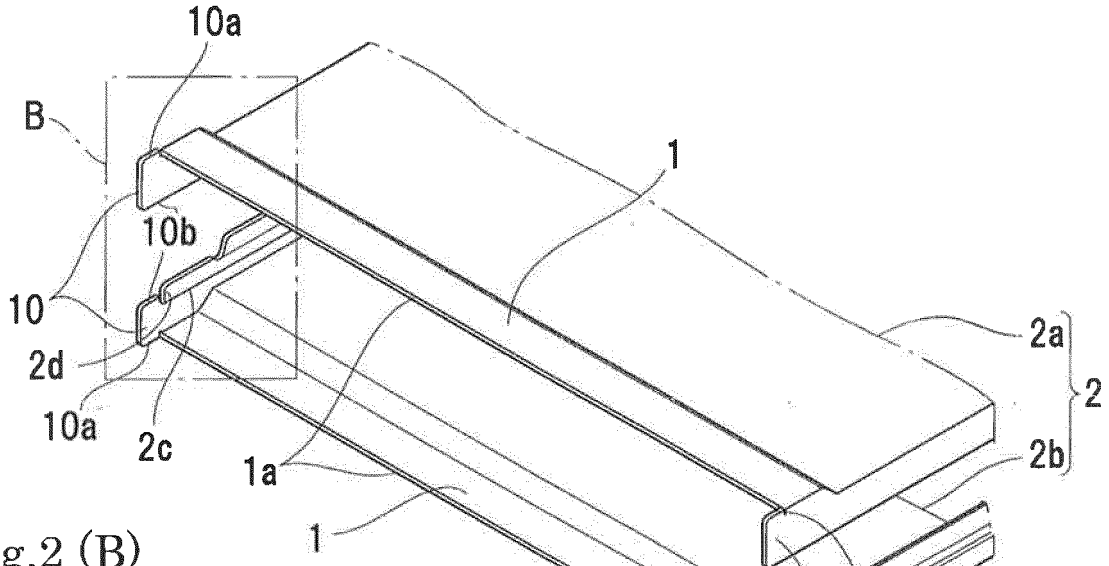


Fig.2 (B)

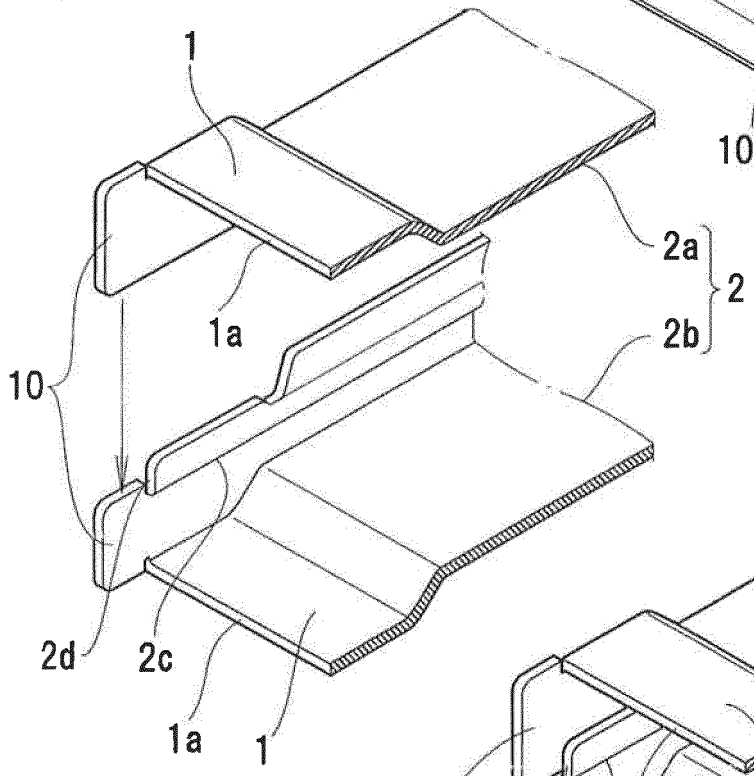


Fig.2 (C)

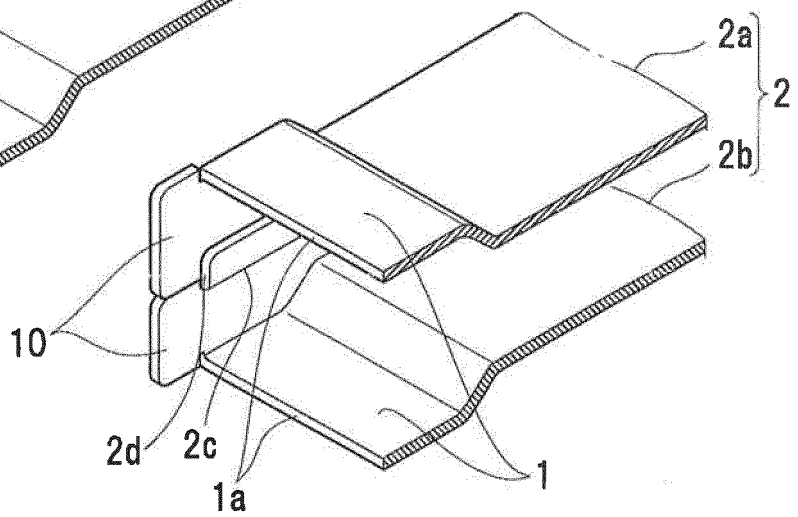


Fig.3

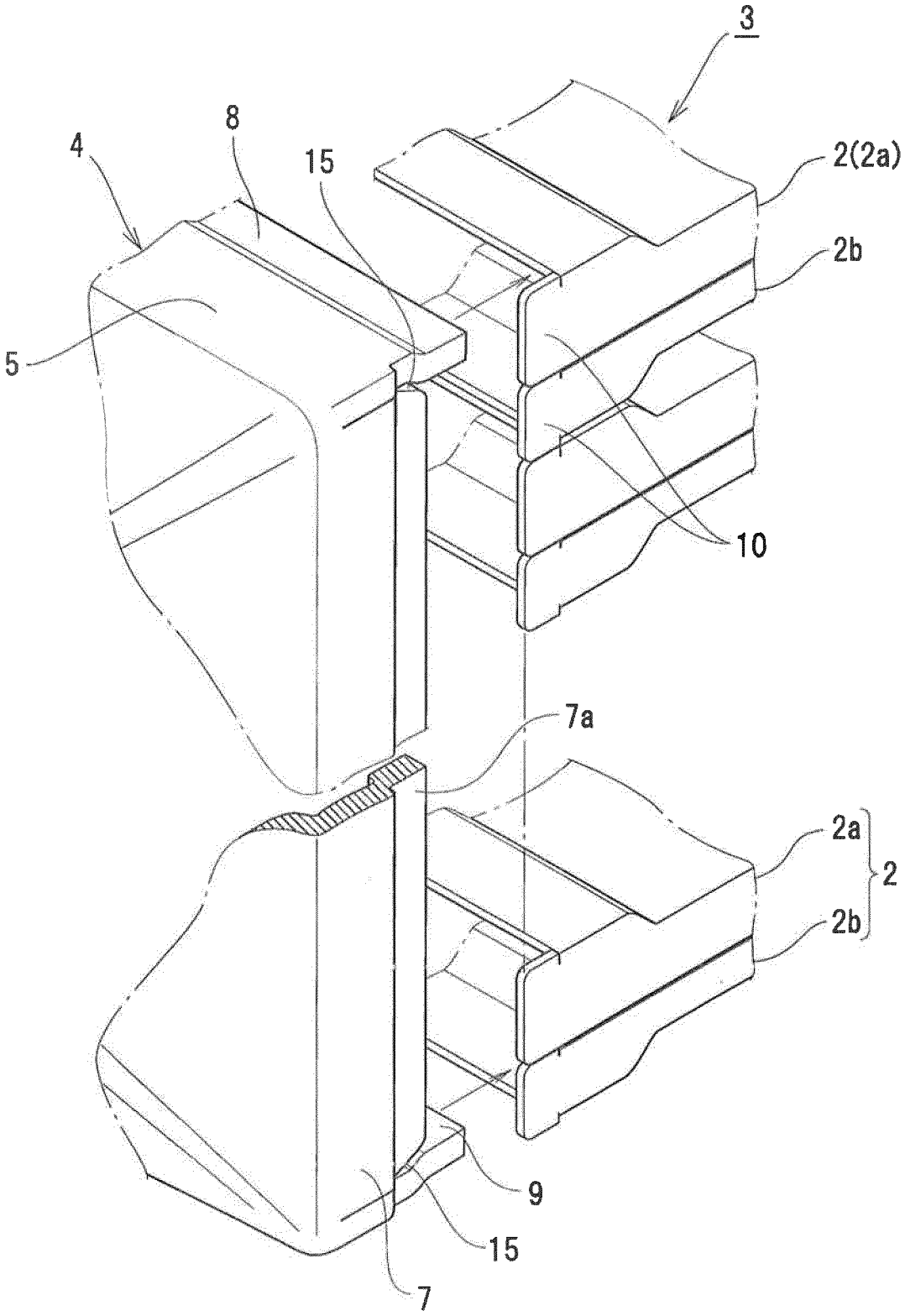


Fig.4

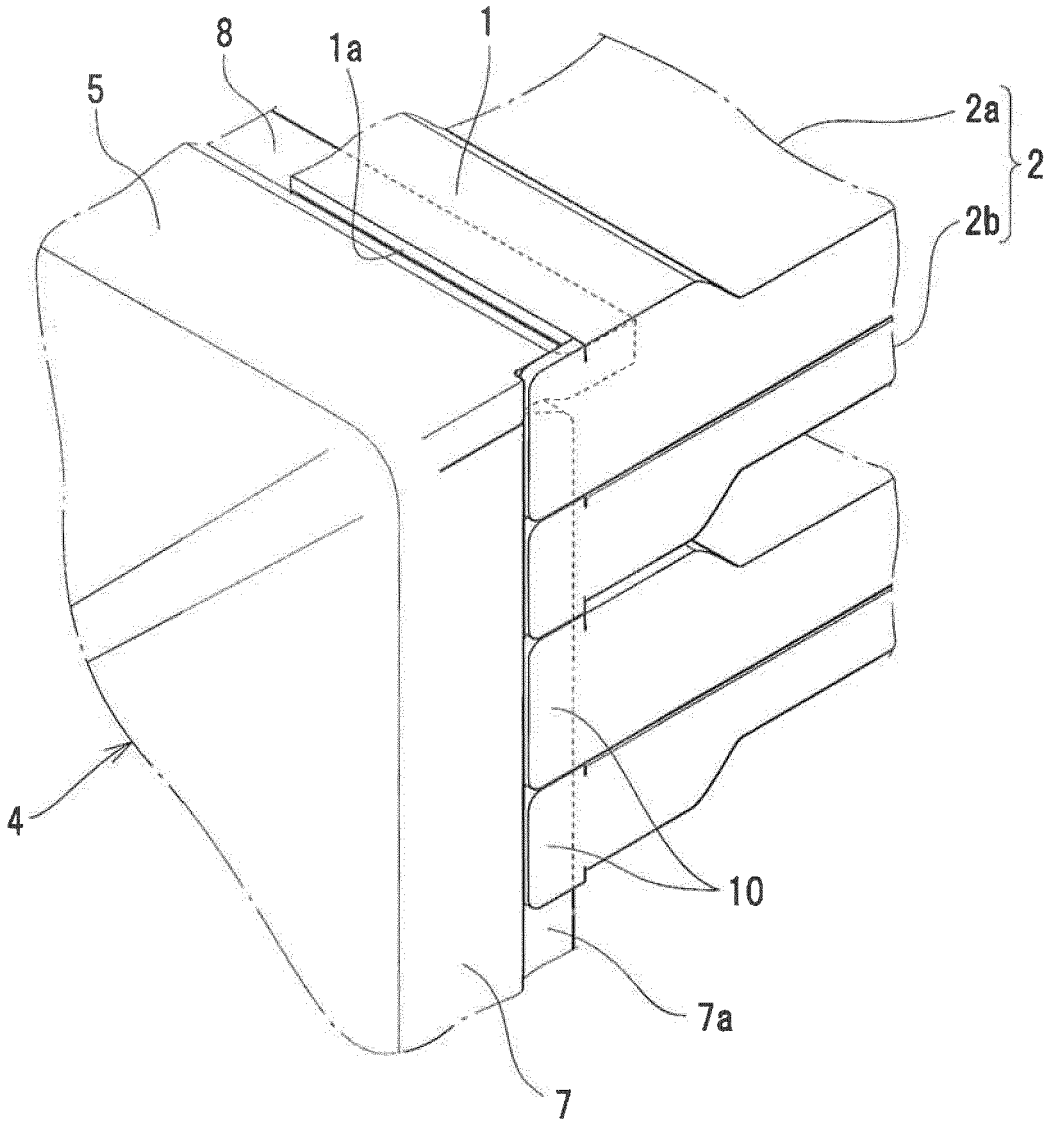


Fig.5

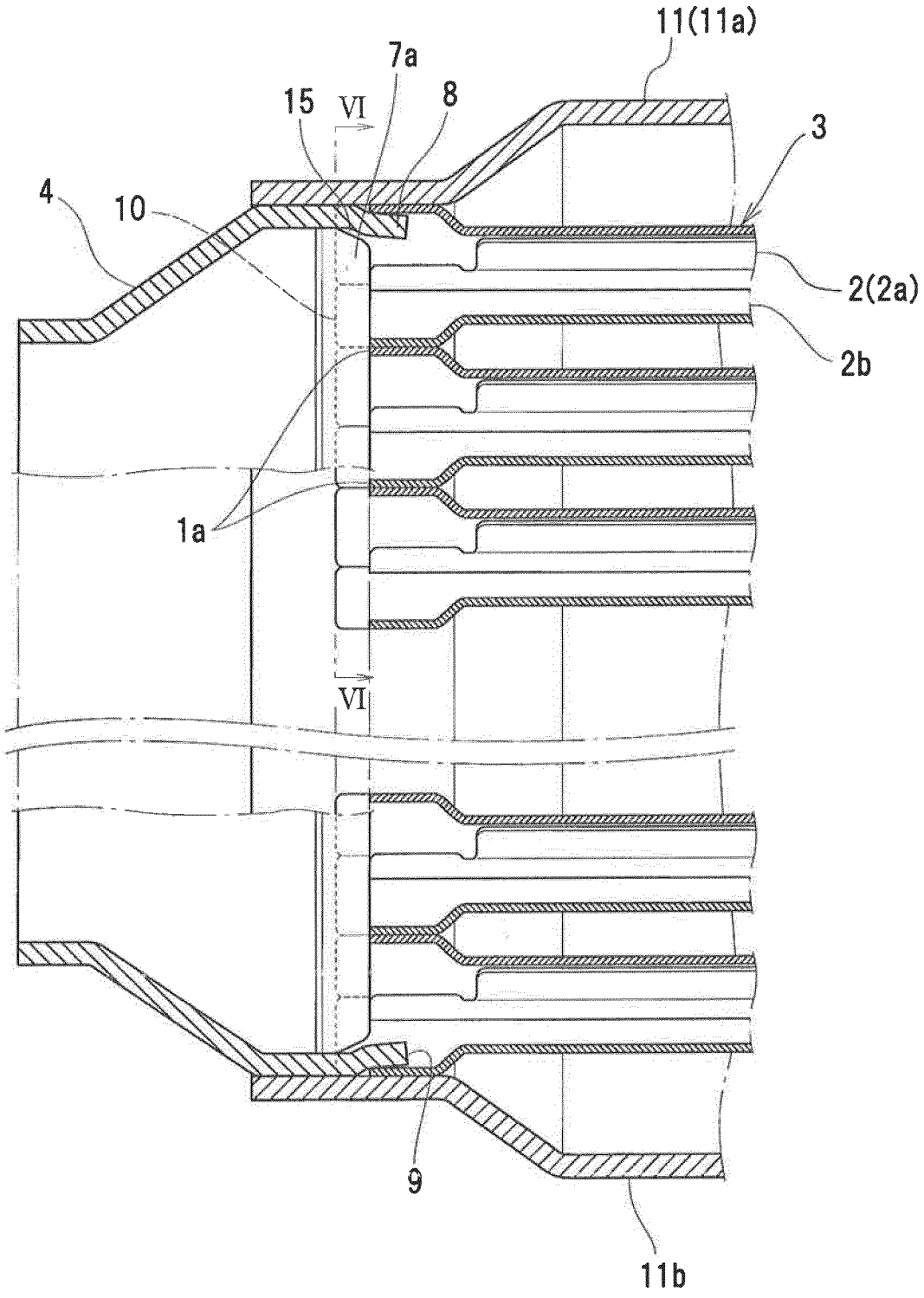


Fig.6

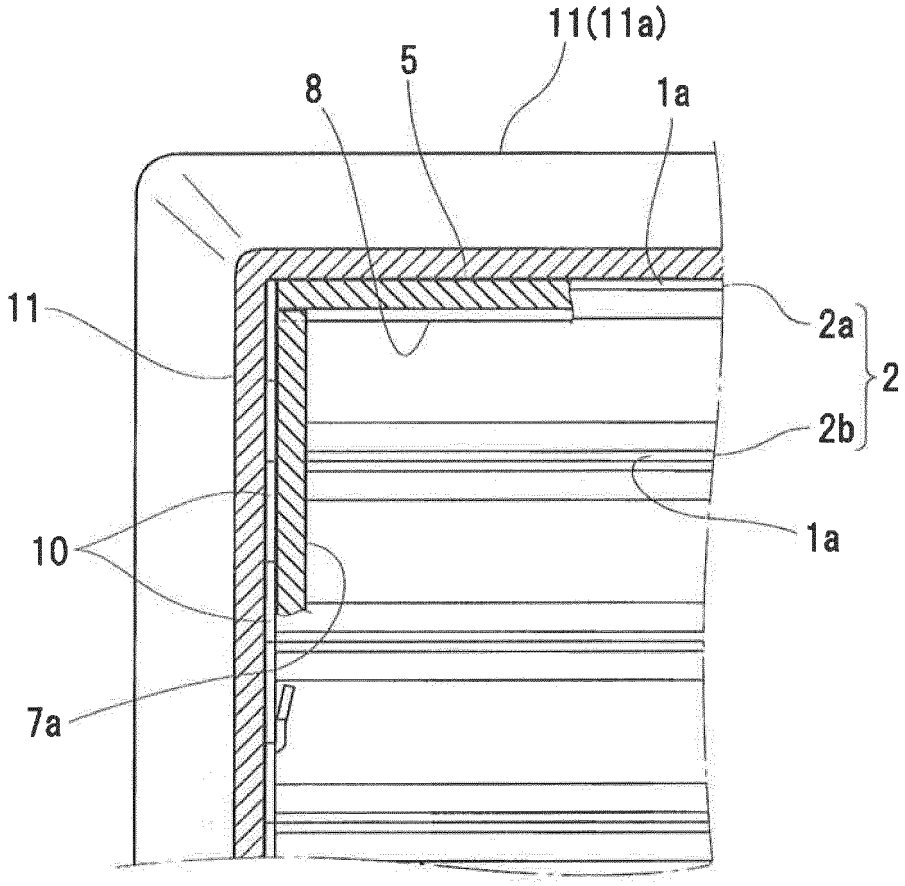


Fig.7

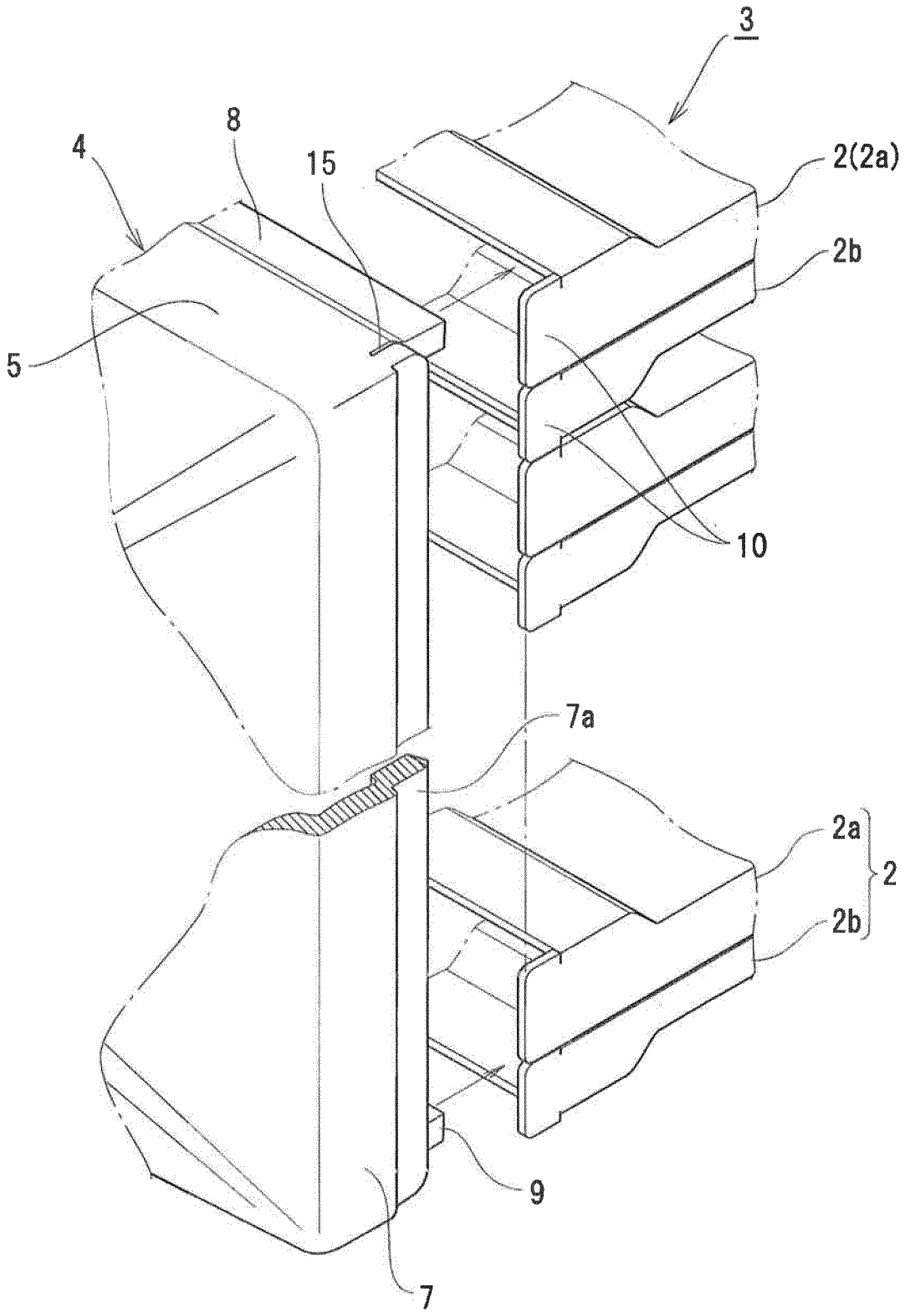


Fig.8 PRIOR ART

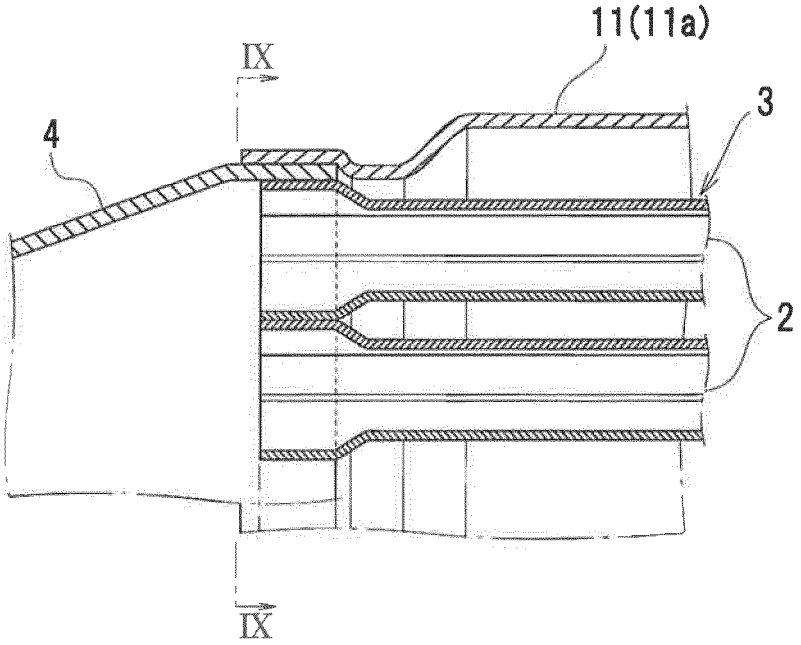
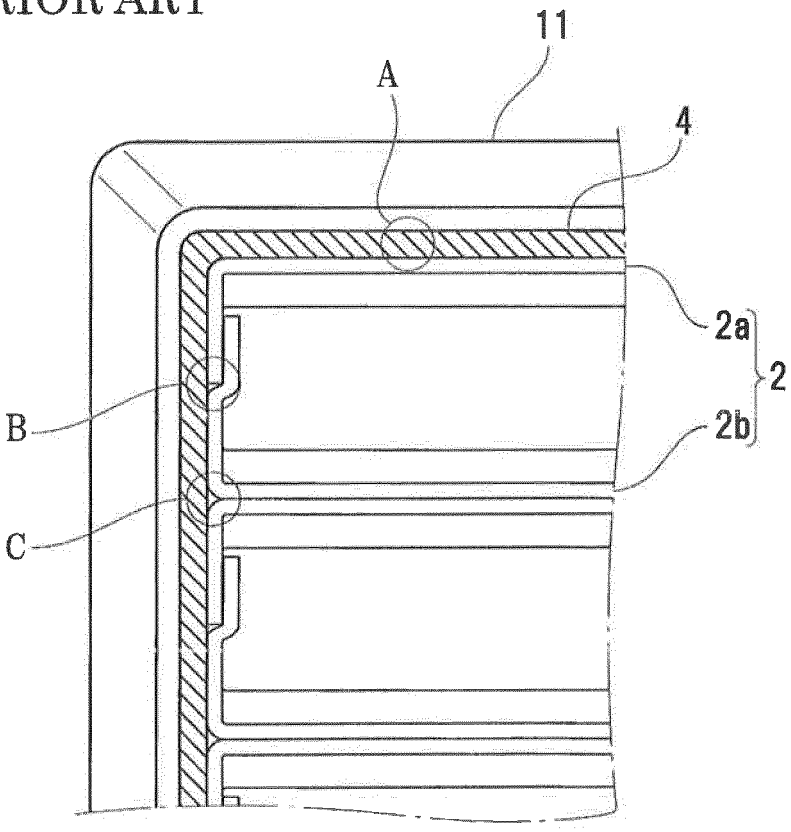


Fig.9 PRIOR ART



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/074159

A. CLASSIFICATION OF SUBJECT MATTER
F28F3/10(2006.01)i, *F28D7/16*(2006.01)i, *F28F9/02*(2006.01)i, *F28F9/18*(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)
F28F3/10, F28D7/16, F28F9/02, F28F9/18

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 1996-2014
Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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 2011-38752 A (T. RAD Co., Ltd.), 24 February 2011 (24.02.2011), paragraph [0014]; fig. 7, 8 (Family: none)	1-5
A	JP 2012-137251 A (Maruyasu Industries Co., Ltd.), 19 July 2012 (19.07.2012), entire text; all drawings & EP 2469211 A2	1-5
A	US 2006/0219394 A1 (Michael A.Martin), 05 October 2006 (05.10.2006), paragraphs [0029] to [0044]; fig. 1 to 5 (Family: none)	1-5

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

* Special categories of cited documents:
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 November, 2014 (25.11.14)	09 December, 2014 (09.12.14)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011002133 A **[0004]**
- JP 2011232020 A **[0004]**