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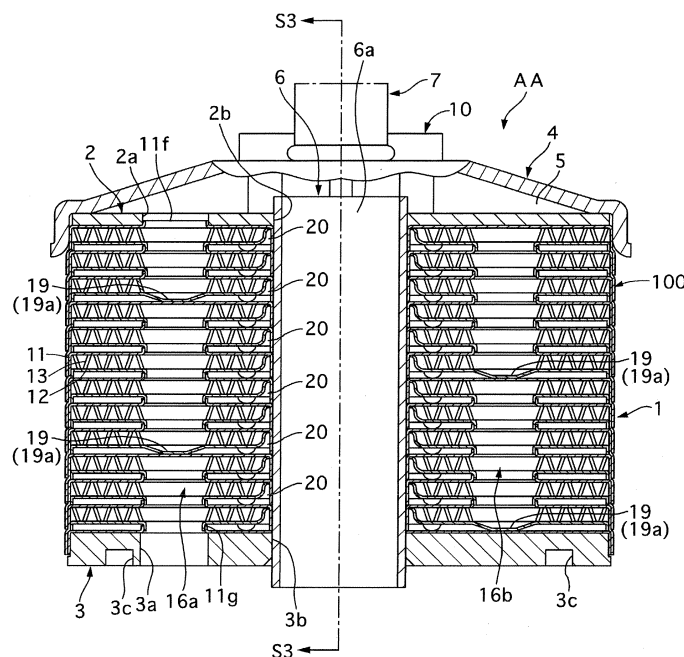
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AL BA HR MK YU(30) Priority: **29.11.2005 JP 2005343871**(71) Applicant: **Calsonic Kansei Corporation**
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158, rue de l'Université
75340 Paris Cedex 07 (FR)(54) **Core structure of housingless-type oil cooler**

(57) A housingless-type oil cooler (AA; BB) includes cooling elements (100) having first and second plates (11, 12) coupled with together, an oil return tube (6) vertically arranged through a core portion (1), and a heat-transfer suppressing means (20; 22; 24). The cooling elements (100) are piled up in a vertical direction of the core portion (1) to alternately form cooling water chambers (17) and oil chambers (15) so that the adjacent cooling water chambers (17) are fluidically connected through

a cooling water passage (18a, 18b) and the adjacent oil chambers (15) are fluidically connected through an oil passage (16a, 16b). The oil return tube (6) discharges oil introduced from one side of the core portion (1) toward its other side through the oil chambers (15) and the oil passages (16a, 16b). The heat-transfer suppressing means (20; 22; 24) is arranged between the oil chambers (15) and the oil return tube (6) to prevent heat transfer between the oil flowing in the oil chambers (15) and the oil flowing in the oil return tube (6).

FIG. 2

Description

[0001] The present invention relates to a core structure of a housingless-type oil cooler which has a plurality of plates piled up to form cooling water chambers and oil chambers therebetween without an additional housing so as to cool oil flowing through the oil chambers.

[0002] Conventional oil coolers are used for and attached to, for example, automatic transmissions to cool oil thereof. Some of the conventional ones are constructed to have an oil tube forming an oil chamber and arranged in a cooling water chamber formed between a housing of the oil cooler and the oil tube. The other conventional ones are called a housingless-type oil cooler, which is constructed to have a plurality of plates to alternately form cooling water chambers and oil chambers therebetween for removing a housing, thereby decreasing its manufacturing costs and dimensions.

[0003] Specifically, such the housingless-type oil cooler has a core portion where a plurality of first plates and a plurality of second plates are piled up alternately with each other in a vertical direction of the core portion to alternately form cooling water chambers and oil chambers. The adjacent cooling water chambers are fluidically connected with each other through a cooling water passage, and the adjacent oil chambers are fluidically connected with each other through an oil passage. An oil return tube is provided to penetrate the core portion to allow oil to flow from the one side of the core portion toward the other side thereof. This type of conventional oil coolers are disclosed in Japanese patents laid-open publication No. (Tokkaihei) 7 - 286786, No. (Tokkaihei) 11 - 351778, and No. 2000-27177.

[0004] The above known conventional core structures of the housingless-type oil coolers, however, encounter a problem in that coolability of the oil cooler deteriorates because the low-temperature oil, which is cooled by the cooling water in the cooling water chamber while it flows in the oil chambers, is reheated due to heat transfer from high-temperature oil in the oil chamber through a wall of the oil return tube while it flows through the oil return tube.

[0005] It is, therefore, an object of the present invention to provide a core structure of a housingless-type oil cooler which overcomes the foregoing drawbacks and can improve coolability of oil in the oil cooler.

[0006] According to a first aspect of the present invention there is provided a core structure of a housingless-type oil cooler including a plurality of first plates, a plurality of second plates, an oil return tube, and a heat-transfer suppressing means. The first plates are arranged alternately with the second plates so that the first plates and the second plates are piled up in a vertical direction of a core portion to alternately form cooling water chambers and oil chambers. The adjacent cooling water chambers are fluidically connected with each other through a cooling water passage, and the adjacent oil chambers are fluidically connected with each other through an oil passage. The oil return tube is arranged in the vertical direc-

tion through the core portion to discharge oil introduced from one side of the core portion toward the other side of the core portion through the oil chambers and the oil passages. The heat-transfer suppressing means is arranged between the oil chambers and the oil return tube to prevent heat transfer between the oil flowing in the oil chambers and the oil flowing in the oil return tube.

[0007] Therefore, the heat-transfer suppressing means prevents the heat transfer from high-temperature oil in the oil chamber to the oil in the return oil tube through a wall of the oil return tube while it flows through the oil return tube. This can prevent a rise in heat of the oil in the oil return tube and keep it at low temperature, thereby improving coolability of the oil cooler.

[0008] Preferably, the heat-transfer suppressing means are heat-transfer suppressing chambers that are arranged between the oil chambers and the oil return tube and are fluidically connected with the cooling water chambers.

[0009] Therefore, the heat-transfer chambers prevent heat transfer between the oil flowing in the oil return tube and the oil flowing in the oil chambers, thereby improving coolability of the oil cooler. In addition, the cooling water in the heat-transfer cools the oil flowing through the oil return tube, further improving the coolability.

[0010] Preferably, the cooling water in the heat-transfer suppressing means is a heat-transfer suppressing chambers that are arranged between the oil chambers and the oil return tube and are filled with air.

[0011] Therefore, the air, having a low heat-transfer coefficient, in the heat-transfer chambers prevents heat transfer between the oil flowing in the oil return tube and the oil flowing in the oil chambers, thereby improving coolability of the oil cooler.

[0012] The objects, features and advantages of the present invention will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view showing a housingless-type oil cooler having a core structure of a first embodiment according to the present invention;

FIG. 2 is a cross-sectional side view of the housingless-type oil cooler having the core structure of the first embodiment shown in FIG. 1;

FIG. 3 is another cross-sectional side view of the housingless-type oil cooler having the core structure of the first embodiment, taken along a line S3 - S3 in FIG. 2;

FIG. 4A is an enlarged and exploded cross-sectional view showing a first plate, a second plate, and an inner fin, which constitute the core portion of the housingless-type oil cooler shown in FIGS. 1 to 3, and FIG. 4B is an enlarged cross-sectional view of the core portion shown in FIGS. 1 to 3, both figures

being shown from the same side as shown in FIG. 2;

FIG. 5A is an enlarged and exploded cross-sectional view showing the first plate, the second plate, and the inner fin, which constitute a core portion of the housingless-type oil cooler shown in FIGS. 1 to 3, and FIG. 5B is an enlarged cross-sectional view of the core portion shown in FIGS. 1 to 3, both figures being shown from the same side as shown in FIG. 3;

FIG. 6 is an enlarged cross-sectional view of a left half part of the core structure shown in FIG. 2;

FIG. 7 is a cross-sectional view illustrating oil in the oil cooler shown in FIG. 3;

FIG. 8 is a cross-sectional view illustrating the oil in the oil cooler shown in FIG. 2;

FIG. 9A is a cross-sectional view of a first plate, a second plate, and an inner fin, which constitute a core structure of a second embodiment according to the present invention, and FIG. 9B is a cross-sectional view of the core portion of the second embodiment;

FIG. 10 is a cross-sectional view showing an oil cooler, shown from the same side as shown in FIG. 9B, having the core structure of the second embodiment;

FIG. 11 is a cross-sectional view showing the oil cooler having the core structure of the second embodiment, taken along a line S11 - S11 in FIG. 10;

FIG. 12 is an enlarged cross-sectional view of a left half part of the core structure shown in FIG. 10;

FIG. 13 is a cross-sectional view showing a left half part of a core structure of a third embodiment according to the present invention; and

FIG. 14 is a cross-sectional view of a first plate which is used in a core portion and obtained by modifying the first plates used in the core structures of the first to third embodiments.

[0013] Throughout the following detailed description, similar reference characters and numbers refer to similar elements in all figures of the drawings, and their descriptions are omitted for eliminating duplication.

[0014] Referring to FIG. 1 and FIG. 2, there is shown a core structure of a housingless-type oil cooler AA of a first preferred embodiment according to the present invention.

[0015] The housingless-type oil cooler AA includes a core portion 1, an upper cover 4 covering a top portion of the core portion 1 sandwiched between an upper casing 2, a lower casing 3, and a oil return tube 6 fixed to

the core portion and penetrating through a center axis thereof.

[0016] As shown in FIG. 2 and FIG. 3, the core portion 1 is formed in a circular cylinder shape. The upper casing 2 is placed on a top surface of the core portion 1, and the lower casing 3 is placed on a bottom surface of the core portion 1.

[0017] The upper cover 4 is formed like a dish, and covers a top portion of the upper casing 2 to form an oil tank chamber 5 defined between the upper cover 4 and the upper casing 2. The upper cover 4 is formed at its center position with a fixing hole 4c in a circular cross-section, as shown in FIG. 3, and an adapter member 10, which will be later described, is fixed to a wall portion forming the fixing hole 4c.

[0018] As shown in FIG. 2, the upper casing 2 is formed like a disc, and is provided with an oil discharge port 2a at a position away from its center position, and also with a fixing hole 2b at the center position. The oil discharge port 2a is formed to have a circular cross-section, and fluidically communicates between the oil tank chamber 5 and oil passages 16a and 16b of the core portion 1.

[0019] The lower casing 3 is formed like a disc, and is provided with an oil introducing port 3a at a position away from its center position, and also with a fixing hole 3b at the center position. The oil introducing port 3a is formed to have a circular cross-section, and fluidically communicates between the oil passage 16a and a not shown automatic transmission. The lower casing 3 is formed with an O-ring groove 3c, for receiving a not shown O ring, at its bottom surface so as to ensure a gap between the lower casing 3 and the automatic transmission to be liquid-tight when they are assembled with each other.

[0020] The oil return tube 6 is formed in a circular cylinder shape, and is inserted in the fixing holes 2b and 3b of the upper and lower casings 2 and 3, respectively, to be fixed to wall portions forming the fixing holes 2b and 3b so that its upper opening is located in the oil tank chamber 5 and its lower opening is located inside the automatic transmission.

[0021] On the other hand, as shown in FIG. 3, the upper cover member 4 is further formed with two fixing holes 4a and 4b at positions which are away from its center position and opposite to each other. The upper casing 2 is further formed with two projecting portions, which are formed in a circular cylinder to project upward and have fixing holes 2c and 2d at positions which are away from both of its center position and the fixing holes 2b and 2b and opposite to each other, respectively. A cooling-water introducing pipe 7 is inserted in the fixing hole 4a of the upper cover 4 and the fixing hole 2c of the upper casing 2, and fixed to walls thereof. A cooling-water discharging pipe 8 is inserted in the fixing hole 4b of the upper cover 4 and the fixing hole 2d of the upper casing 2, and fixed to walls thereof.

[0022] The core portion 1 is constructed so that a plurality of cooling elements 100 are piled up in the vertical direction between the upper casing 2 and the lower cas-

ing 3. Each cooling element 100 has a first plate 11, a second plate 12 coupled with the first plate 11, and an inner fin 13 arranged between the first and second plates 11 and 12.

[0023] As shown in FIGS. 4A and 4B, the first plate 11 is formed like a rectangular box having an opening at its bottom side. The first plate 11 has a first cylindrical portion 11a projecting downward and shaped in a large circular cylinder at its center position, and second and third cylindrical portions 11b and 11c projecting upward and shaped in a small circular cylinder at symmetric positions with respect to the first cylindrical portion 11a.

[0024] In addition, as shown in FIGS. 5A and 5B, the first plate 11 further has fourth and fifth cylindrical portions 11d and 11e projecting upward and shaped in a small circular cylinder at positions where they are located on a line perpendicular to a line connecting the second and third cylindrical portions 11b and 11c and are in symmetric with respect to the first cylindrical portion 11a.

[0025] The second plate 12 is, as shown in FIGS. 4a and 4B, formed like a rectangular box having an opening at its bottom side. The second plate 12 has a first cylindrical portion 12a projecting upward and shaped in a large circular cylinder at its center position, and second and third cylindrical portions 12b and 12c projecting downward and shaped in a small circular cylinder at symmetric positions with respect to the first cylindrical portion 12a. The first cylindrical portion 12a has a bending portion 14, at an upper end portion thereof, narrowing its opening as a position of the first cylindrical portion 12a becomes higher.

[0026] In addition, as shown in FIGS. 5A and 5B, the second plate 12 further has fourth and fifth cylindrical portions 12d and 12e projecting upward and shaped in a small circular cylinder at positions where they are located on a line perpendicular to a line connecting the second and third cylindrical portions 12b and 12c and are symmetrical with respect to the first cylindrical portion 12a.

[0027] The first to fifth cylindrical portions 12a to 12e of the second plate 12 are arranged to correspond with the first to fifth cylindrical portions 11a to 11e of the first plate 11, respectively.

[0028] The inner fin 13 is an offset fin in the first embodiment, but another type may be used. The inner fin 13 is formed with first to fifth through-holes 13a to 13e corresponding to the first to fifth cylindrical portions 11a to 11e of the first plate 11 and to the first to fifth cylindrical portions 12a to 12e of the second plate 12.

[0029] The first plate 11 and the second plate 12 are coupled with each other, containing the inner fin 13 therein, to form an inner space therebetween for containing the inner fin 13, thereby forming the cooling element 100. The inner space forms an oil chamber 15 as shown in FIGS. 4B and 5B.

[0030] The second and third cylindrical portions 11b and 11c of the first plate 11 and the second and third cylindrical portions of the next second plate 12 are fitted

with each other, as shown in FIG. 4B, to form a pair of oil passages 16a and 16b for fluidically connecting with the adjacent oil chambers 15.

[0031] On the other hand, the second plate 12 and its adjacent first plate 11 are also coupled with each other to form a cooling water chamber 17 therebetween as shown in FIGS. 4B and 5B. Therefore, in the core portion 1 of the oil cooler AA, the oil chambers 15 and the cooling water chambers 17 are arranged alternately with each other. The fourth and fifth cylindrical portions 11d and 11e of the first plate 11 and the fourth and fifth cylindrical portions 12d and 12e are fitted with each other to form a pair of cooling water passages 18a and 18b as shown in FIG. 5B.

[0032] Incidentally, the second plate 12 is provided with a plurality of dimples 12f, four dimples 12f in the first embodiment, near the first cylindrical portion 12a on its bottom surface. The dimples 12f are not indispensable in the invention.

[0033] The second plate 12 and the next first plate 11 are kept predetermined-interval away from each other in the vertical direction by contacting the bending portion 14 with the bottom surface of the first plate 11 and connecting the dimples 12f with the upper surface of the next first plate 12.

[0034] As shown in FIGS. 2 and 6, a cylindrical portion 11f, corresponding to the second cylindrical portion 11b, of an upper-most first plate 11 is inserted into the oil discharging port 2a to fluidically communicate the oil passage 16a and the oil tank chamber 5 with each other, while the upper-most first plate 11 is not formed with a cylindrical portion corresponding to the third cylindrical portion 11c to be blocked off.

[0035] In addition, instead of the first plates 11 arranged at predetermined columns, the core portion 1 is provided between the adjacent first plates 11 with blocking-off plates 19, which has a blocking-off portion 19a at positions corresponding one of the second and third cylindrical portions 11b and 11c of the first plate 11. The blocking-off portions 19a contact on the upper surface of the next first plate 11 so that the first and second plates 11 and 12 are kept away from each other.

[0036] As shown in FIG. 3, a cylindrical portion 11h, corresponding to the fourth cylindrical portion 11d, of the upper-most first plate 11 fluidically communicates the cooling water passage 17a and the cooling-water introducing pipe 7 with each other, and a cylindrical portion 11i, corresponding to the fifth cylindrical portion 11e, of the upper-most first plate 11 fluidically communicates the cooling water passage 17b and the cooling-water discharging pipe 8 with each other.

[0037] The lower-most first plate 11 has no cylindrical portions, and is formed at its center position with a hole through which the oil return tube 6 can pass.

[0038] As shown in FIG. 6, an outer peripheral surface of the oil return tube 6 liquid-tightly contacts on inner surfaces of the first cylindrical portions 11a of the first plates 11. The bending portions 14 of the second plates 12 con-

tact with the inner surfaces of the first cylindrical portions 11a of the first plates 11 to form heat-transfer suppressing chambers 20 that are arranged around the oil return tube 6 and fluidically communicating with the cooling-water chambers 17. The heat-transfer suppressing chamber 20 corresponds to a heat-transfer suppressing means of the present invention.

[0039] Incidentally, each part of the housingless-type oil cooler AA is made of aluminum, and at least one side part of jointing parts is provided with a clad layer (a blazing sheet) thereon. Then, this temporarily assembled oil cooler AA is conveyed into a not-shown heating furnace to be heat-treated so as to be integrally formed by blazing the jointing parts. Thus assembled oil cooler AA is attached to the automatic transmission by using a bolt 9. The bolt 9 has a head to be pressed on an upper surface of the adapter member 10 at its top, and a screw portion 9a to be screwed into a screw hole of the automatic transmission at its bottom. The bolt 9 passes through a fixing hole 10a of the adapter member 10 and the oil return tube 6 in a state where there is formed a space as an oil return passage 6a for fluidically communicating the oil tank chamber 5 and a not-shown oil inlet port of the automatic transmission between the inner surface of the oil return tube 6 and the outer peripheral surface of the bolt 9.

[0040] Incidentally, the oil cooler AA may be attached to the automatic transmission by using bolts screwed into screw holes of flange portions radially projecting from the lower casing 3. In this case, the adapter member 10 is removed and the fixing hole 4c of the upper casing 4 is blocked off.

[0041] The operation of the housingless-type oil cooler AA having the core structure of the first embodiment will be described.

[0042] The cooling water is introduced into the cooling-water passage 18a through the cooling-water introducing pipe 7, and fills up each cooling-water chamber 17, then flowing out through the cooling-water passage 18b, where its flow direction is indicated by arrows in FIG. 7.

[0043] On the other hand, high-temperature oil is introduced into the oil passage 16a through oil introducing port 3a, and then is changed its flow direction by the block-off plates 19, winding its way as indicated by arrows in FIG. 8. The oil is cooled down due to heat transfer between the oil in each oil chamber 15 and the cooling water in the adjacent cooling-water chambers 17 while it flows through the core portion 1. After cooling, the oil flows into the oil tank chamber 5 through the oil discharging port 2a. Low-temperature oil in the oil tank 5 flows to the automatic transmission through the oil return passage 6a. Thus, the oil is circulated between the oil cooler AA and the automatic transmission. Incidentally, the oil introducing port 3a and the oil discharging port 2a may be replaced by each other, and the cooling-water introducing pipe 7 and the cooling-water discharging pipe 8 may be replaced by each other.

[0044] In the first embodiment, the oil flowing through the oil return tube 8 is prevented from receiving heat from

the high temperature oil flowing in the oil passages 16a and 16b, because the heat-transfer suppressing chambers 20 filled with the cooling water are located therebetween to block off the heat transfer therebetween. This improves coolability of the oil cooler AA.

[0045] In addition, the cooling water in the heat-transfer suppressing chambers 20 cools the oil flowing through the oil return passage 6a, further improving the coolability of the oil cooler AA.

[0046] Next, a housingless-type oil cooler having a core structure of a second embodiment according to the present invention will be described with reference to the accompanying drawings.

[0047] As shown in FIG. 9A, in the housingless-type oil cooler BB having the core structure of the second embodiment, a first plate 11 has a first cylindrical portion 11a projecting downward and shaped in a large circular cylinder at its center position. The first cylindrical portion 11a has a bending portion 21, at an upper end portion thereof, narrowing its opening as a position of the first cylindrical portion 11a becomes lower.

[0048] On the other hand, a second plate 12 has a first cylindrical portion 12a projecting downward, not having a bending portion like the first embodiment.

[0049] The first plate 11 and the second plate 12 are coupled with each other, containing an inner fin 13 therebetween, to form a cooling element 100. A plurality of the cooling elements 100 are piled up in a vertical direction to form a core portion 1 of the oil cooler BB as shown in FIGS. 9B to 12.

[0050] In the assembled core portion 1, the bending portions 21 formed on the first cylindrical portions 11a of the first plates 11 and an outer surface of the oil return tube 6 are contacted with each other to form rooms as heat-transfer suppressing chambers 22 between the first cylindrical portions 11a and the outer surface of the oil return tube 6. The heat-transfer suppressing chambers 22 are arranged around the oil return tube 6 and are filled with the air for suppressing the heat transfer between the oil flowing in the oil return tube 6 and high-temperature oil flowing in oil chambers 15. The heat-transfer suppressing chamber 22 corresponds to a heat-transfer suppressing means of the present invention.

[0051] The other parts of the second embodiment are similar to those of the first embodiment, and their descriptions are omitted. The operation of the oil cooler BB of the second embodiment is also similar to that of the first embodiment, and its description is omitted.

[0052] The air in the heat-transfer suppressing chambers 22 prevents the heat transfer between the oil flowing in the oil return tube 6 and high-temperature oil flowing in oil chambers 15, because the heat transfer coefficient is low, thereby improving coolability of the oil cooler BB.

[0053] While there have been particularly shown and described with reference to preferred embodiments thereof, it will be understood that various modifications may be made therein.

[0054] The number of the cooling elements 100 may

be set arbitrarily, and positions and the numbers of the block-off plates 19 may be set arbitrarily according to need.

[0055] The heat-transfer chambers 22 filled with the air are formed by inwardly bending a peripheral portion of the end portion of the first cylindrical portion 11 a formed on the first plate 11 to contact the peripheral portion on the outer surface of the oil return tube 6 in the second embodiment. Instead of the bending portion 21 of the first cylindrical portion 11a, as shown in FIG. 13, a projecting portion 23, formed in an annular shape and inwardly projecting from an inner surface of the first cylindrical portion 11a, may be used for forming a space, as a heat-transfer suppressing chamber 24 filled with the air, between the inner surface of the first cylindrical portion 11 a and the outer surface of the oil return tube 6. This modification can provide advantages similar to those of the second embodiment. The heat-transfer suppressing chamber 24 corresponds to a heat-transfer suppressing means of the present invention.

[0056] Instead of the annular projecting portion 23, as shown in FIG. 14, a plurality of inwardly projecting portions, formed by partially cutting off the end portion of the first cylinder portion 11a of the first plate 11, may be formed on the inner surface of the first cylindrical portion 11a so as to fluidically communicate between the adjacent heat-transfer suppressing chambers 24. This modification can provide advantages similar to those of the second embodiment.

[0057] As described above, configurations of the first and second plates 11 and 12 and the oil return tube 6 may be set arbitrarily as long as they can form a heat-transfer suppressing chamber.

Claims

1. A core structure of a housingless-type oil cooler (AA; BB) **characterized in that** it comprises :

a plurality of cooling elements (100), each of the cooling elements (100) including a first plate (11) and a second plate (12) that are coupled with each other, the cooling elements (100) being piled up in a vertical direction of a core portion (1) to alternately form cooling water chambers (17) and oil chambers (15) so that the adjacent cooling water chambers (17) are fluidically connected with each other through a cooling water passage (18a, 18b) and the adjacent oil chambers (15) are fluidically connected with each other through an oil passage (16a, 16b);
an oil return tube (6) that is arranged in the vertical direction through the core portion (1) to discharge oil introduced from one side of the core portion (1) toward the other side of the core portion (1) through the oil chambers (15) and the oil passages (16a, 16b); and

a heat-transfer suppressing means (20; 22; 24) that is arranged between the oil chambers (15) and the oil return tube (6) to prevent heat transfer between the oil flowing in the oil chambers (15) and the oil flowing in the oil return tube (6).

2. The core structure according to claim 1, **characterized in that** the heat-transfer suppressing means are heat-transfer suppressing chambers (20) that are arranged between the oil chambers (15) and the oil return tube (6) and are fluidically connected with the cooling water chambers (17).
3. The core structure according to claim 1, **characterized in that** the heat-transfer suppressing means are heat-transfer suppressing chambers (22; 24) that are arranged between the oil chambers (15) and the oil return tube (6) and are filled with air.

FIG. 1

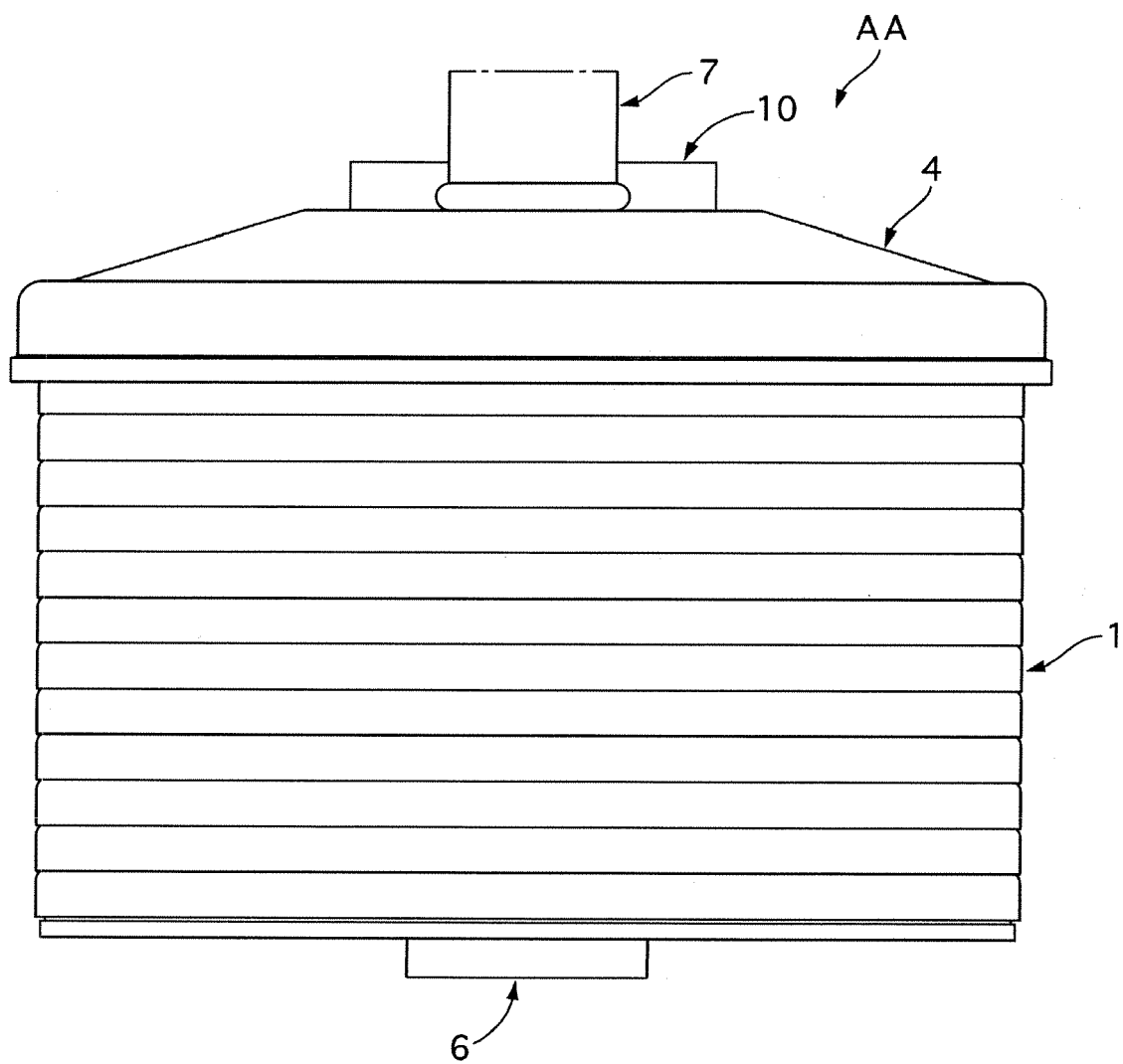


FIG. 2

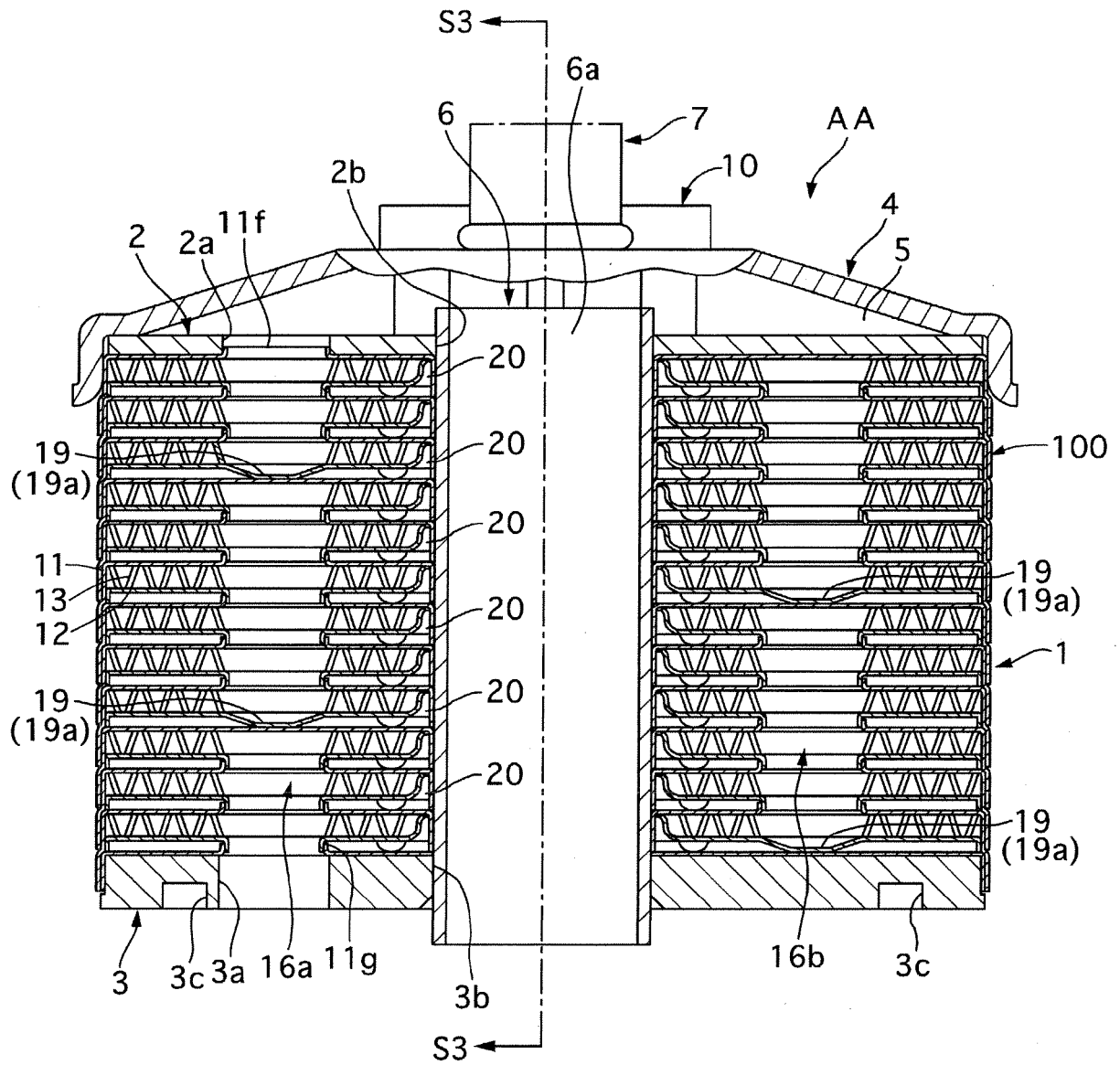


FIG. 3

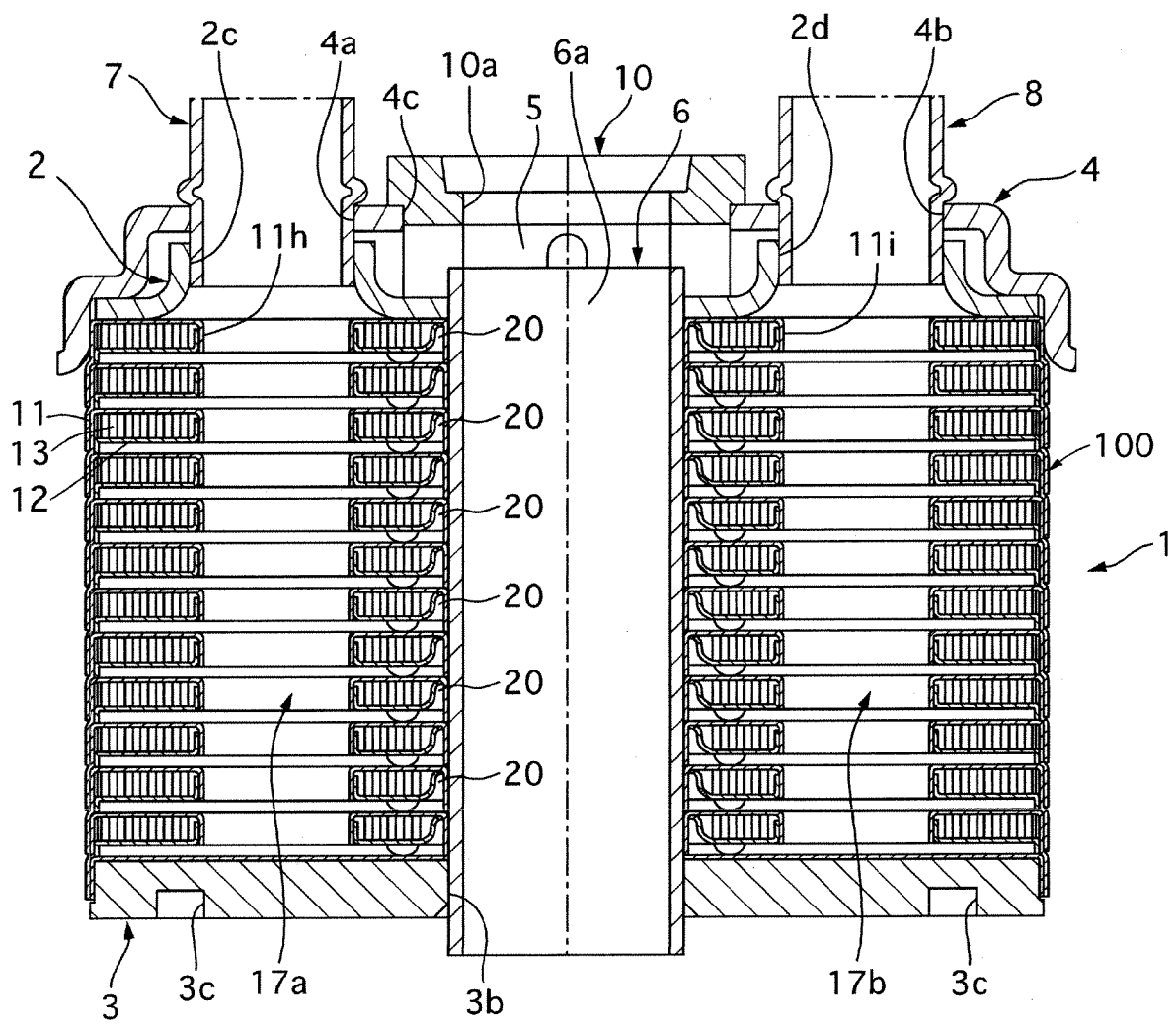


FIG. 4A

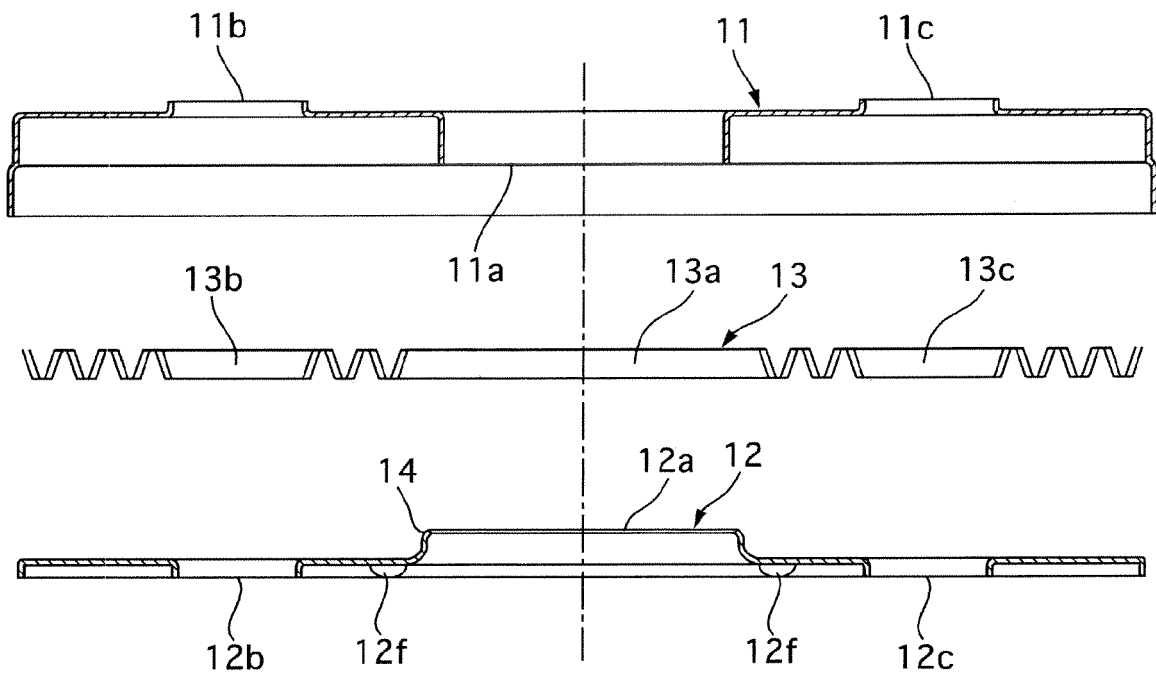


FIG. 4B

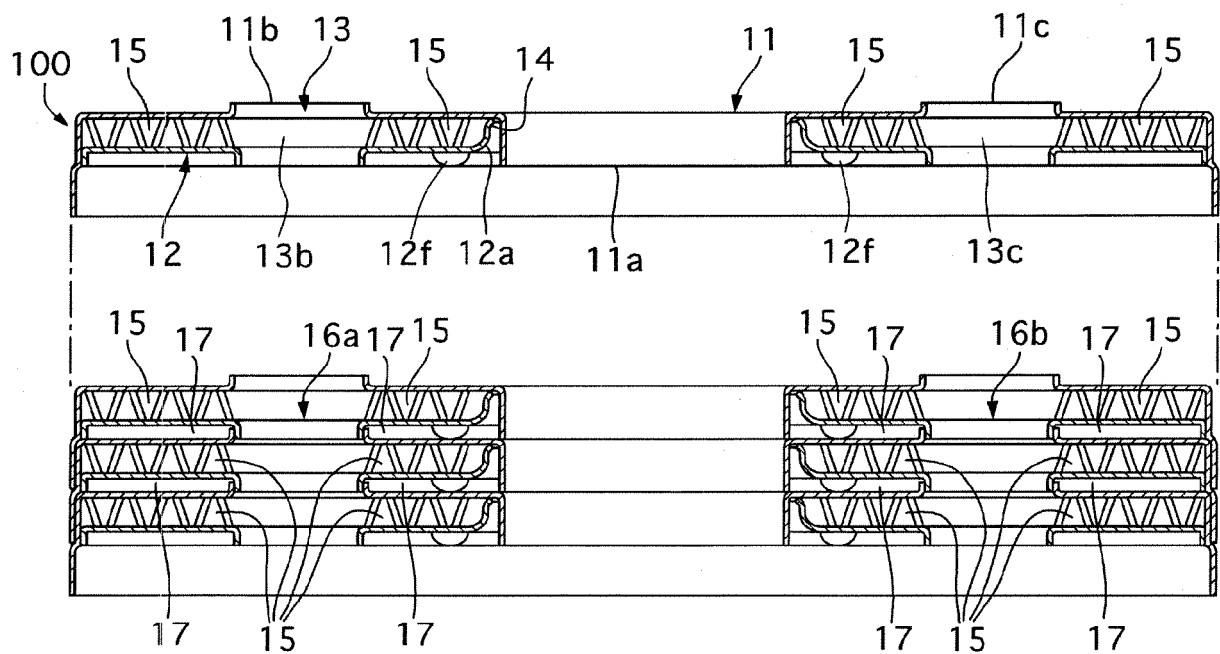


FIG. 5A

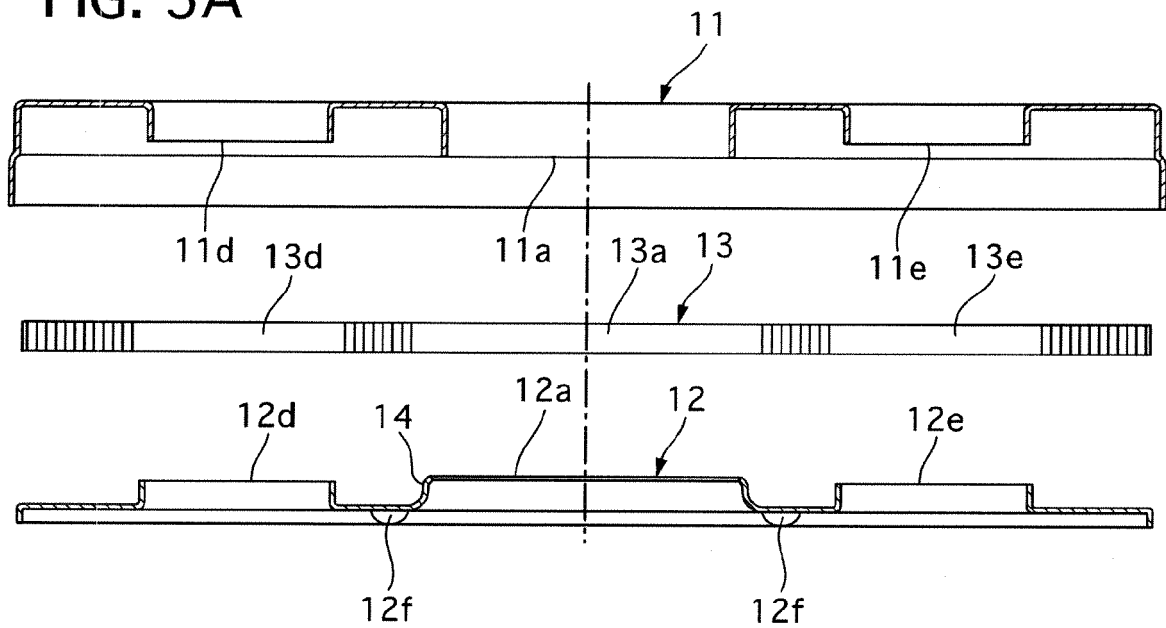


FIG. 5B

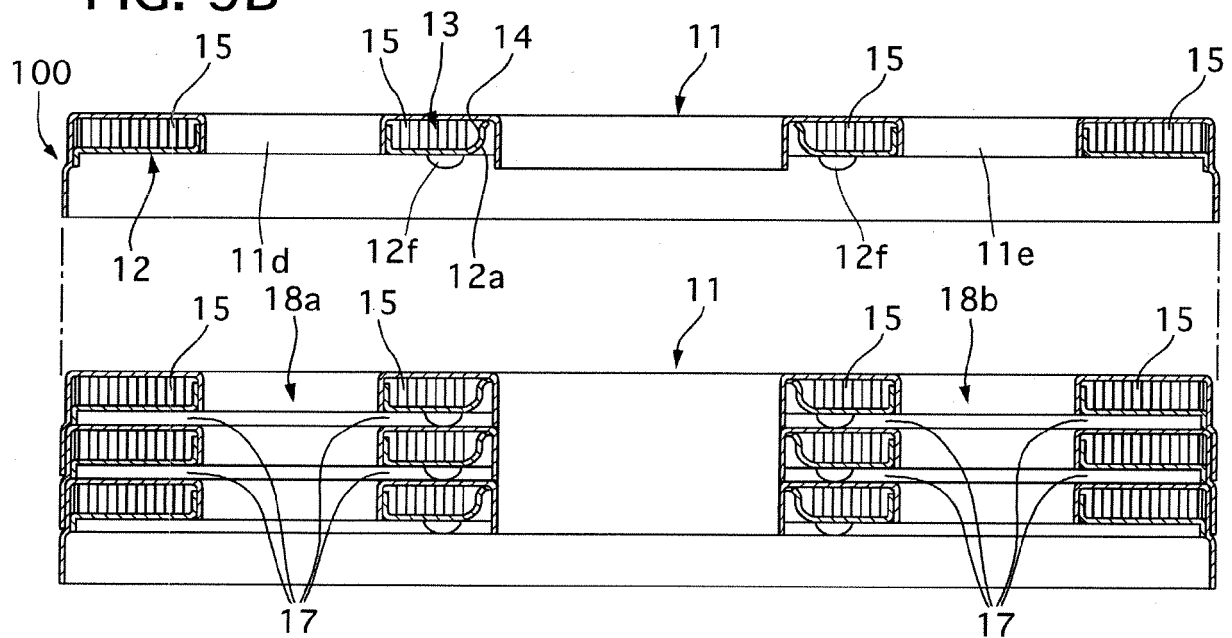


FIG. 6

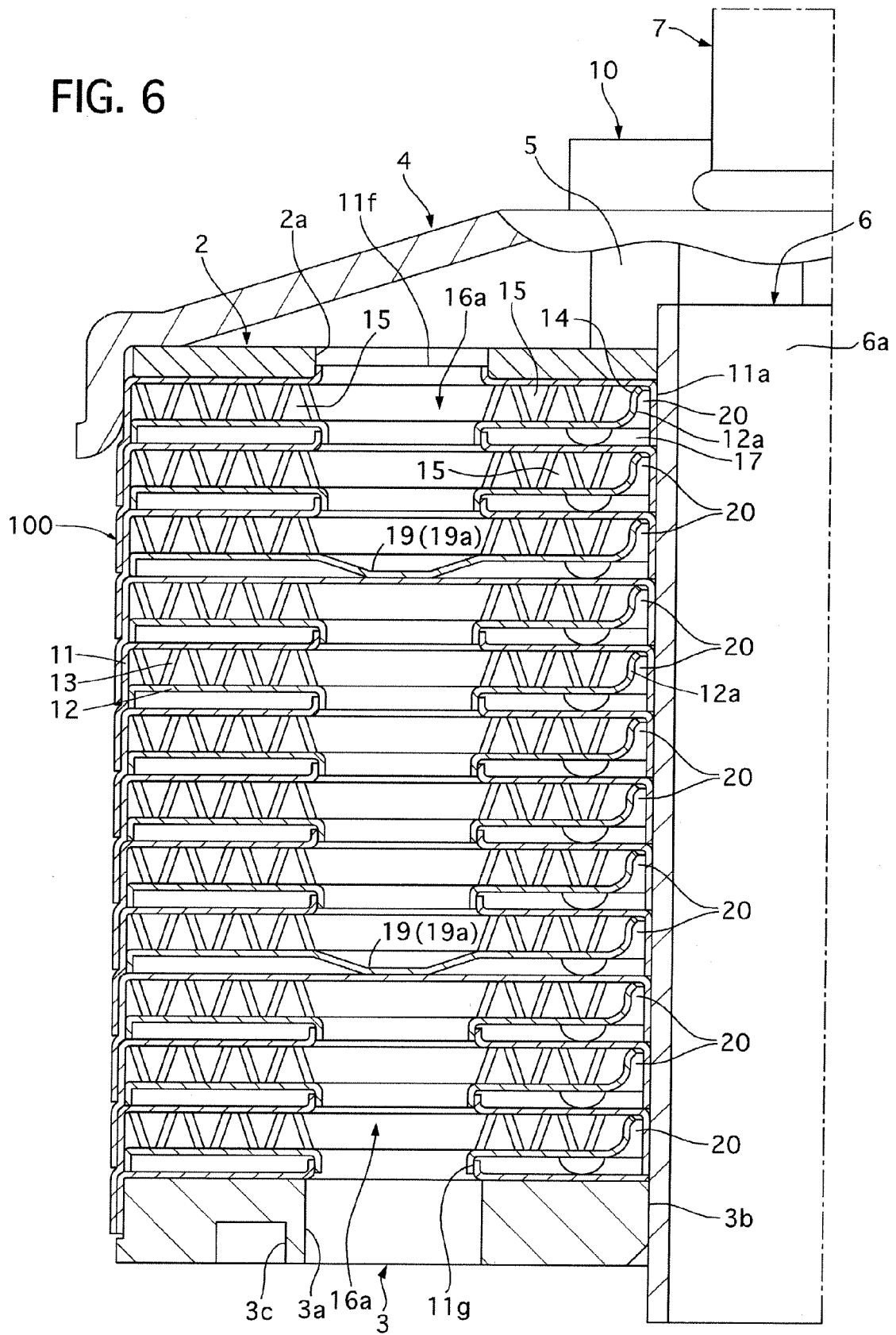


FIG. 7

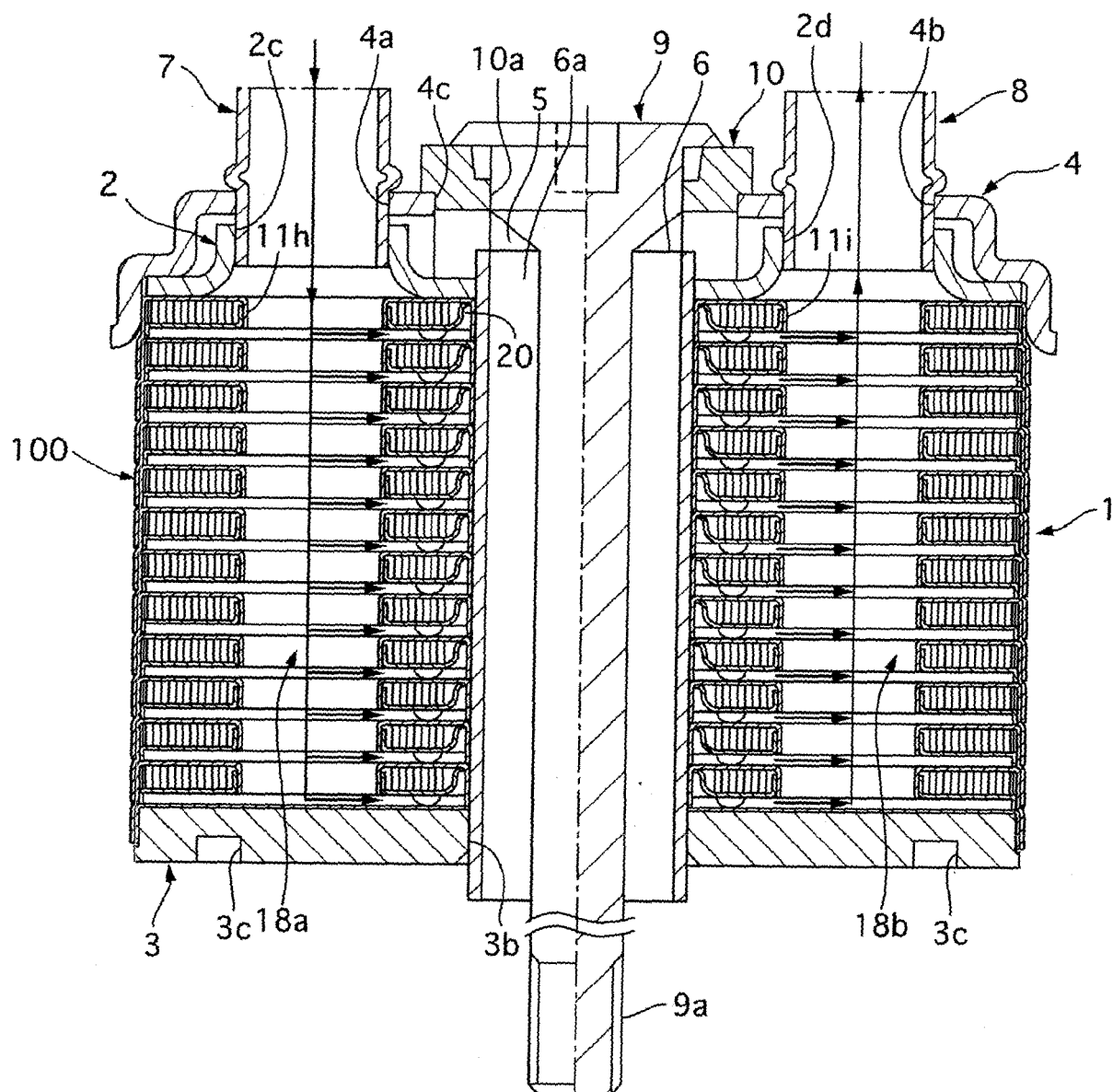


FIG. 8

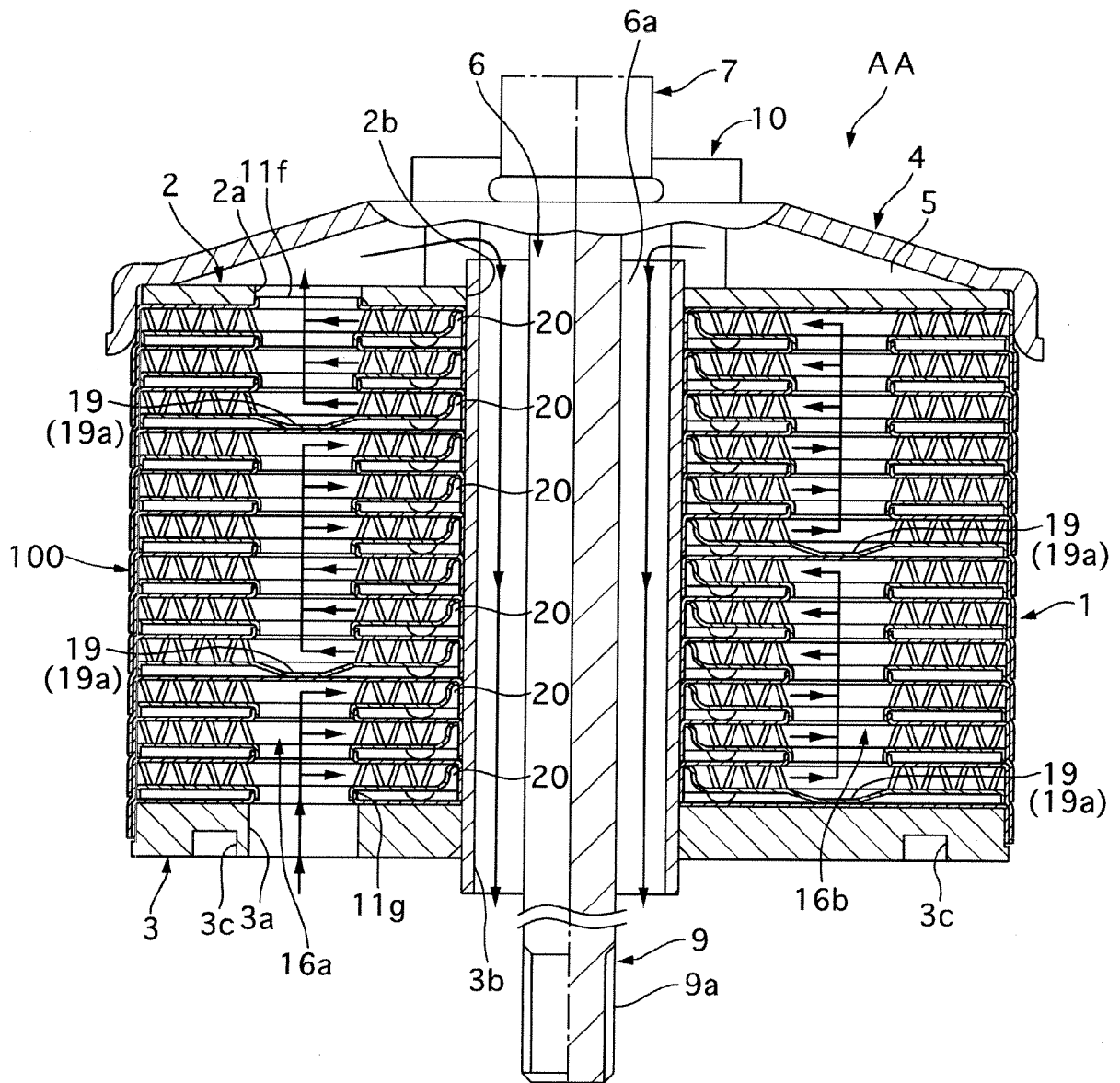


FIG. 9A

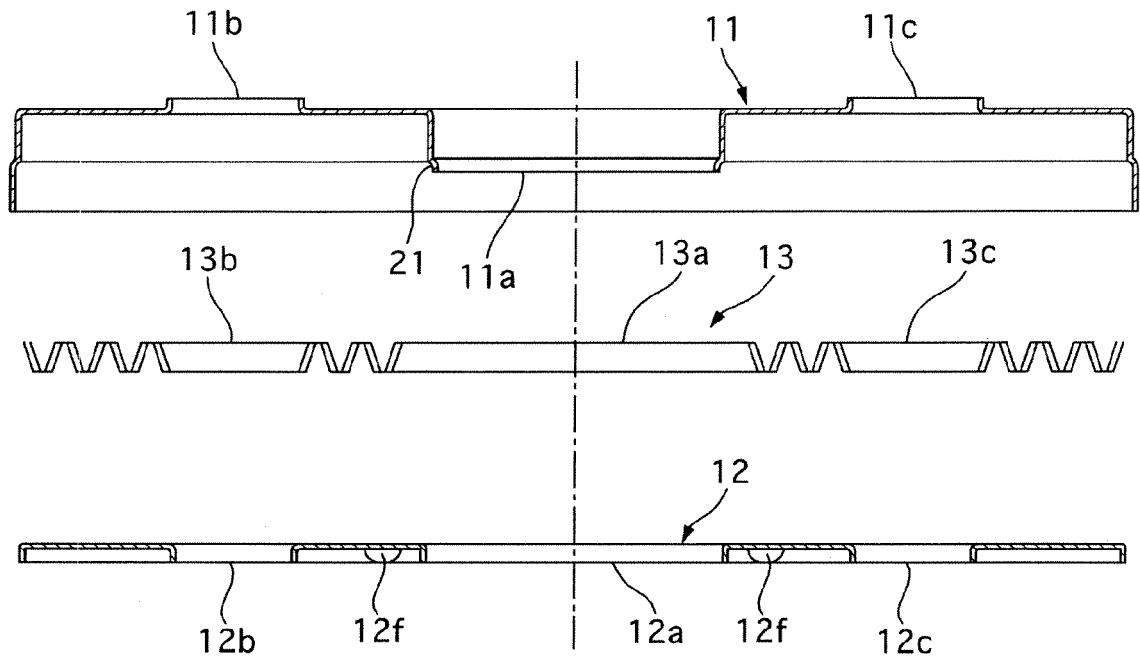


FIG. 9B

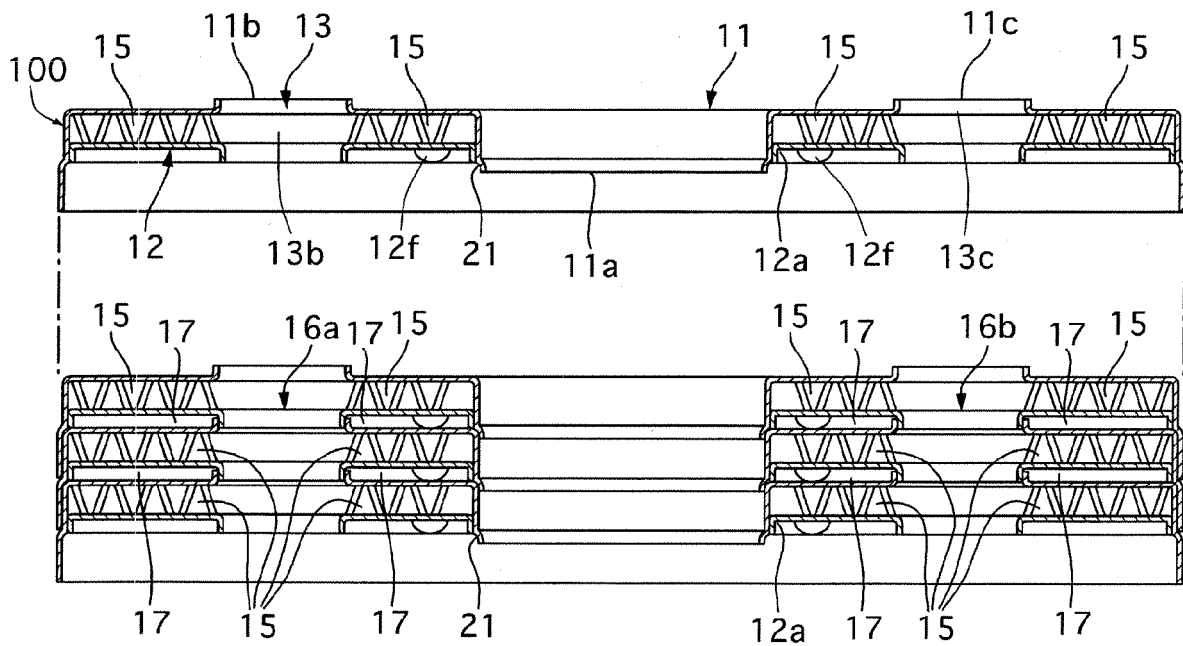


FIG. 10

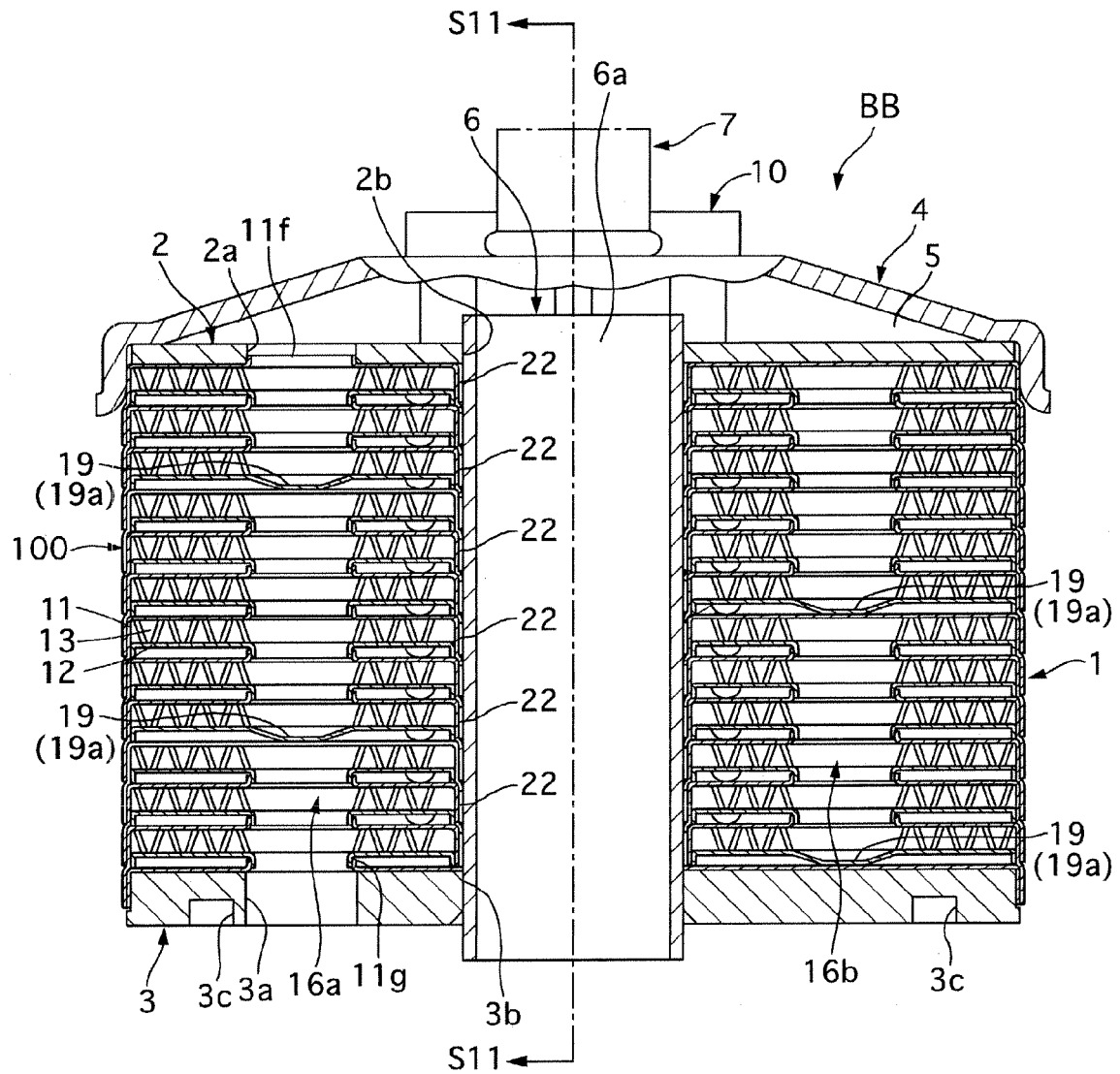


FIG. 11

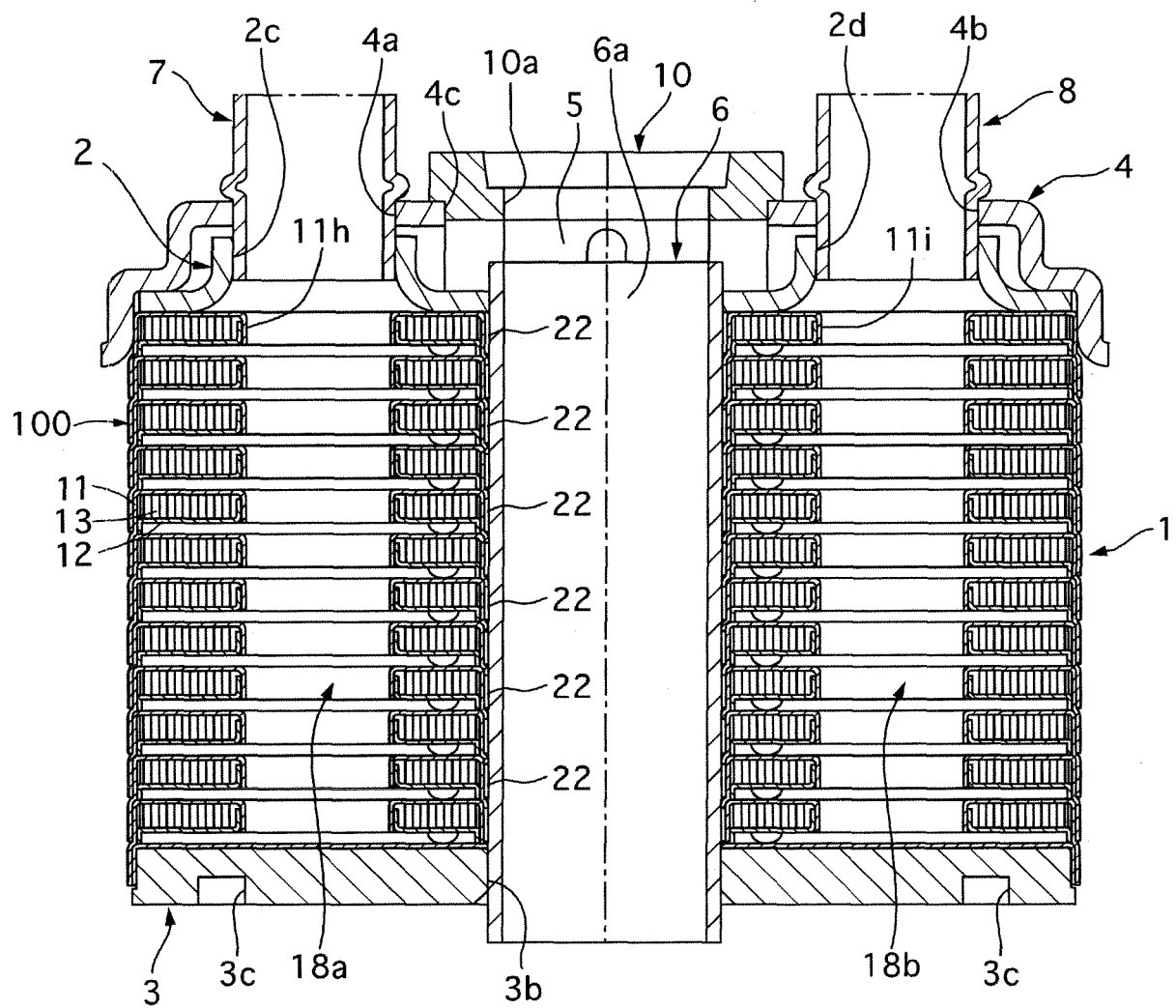


FIG. 12

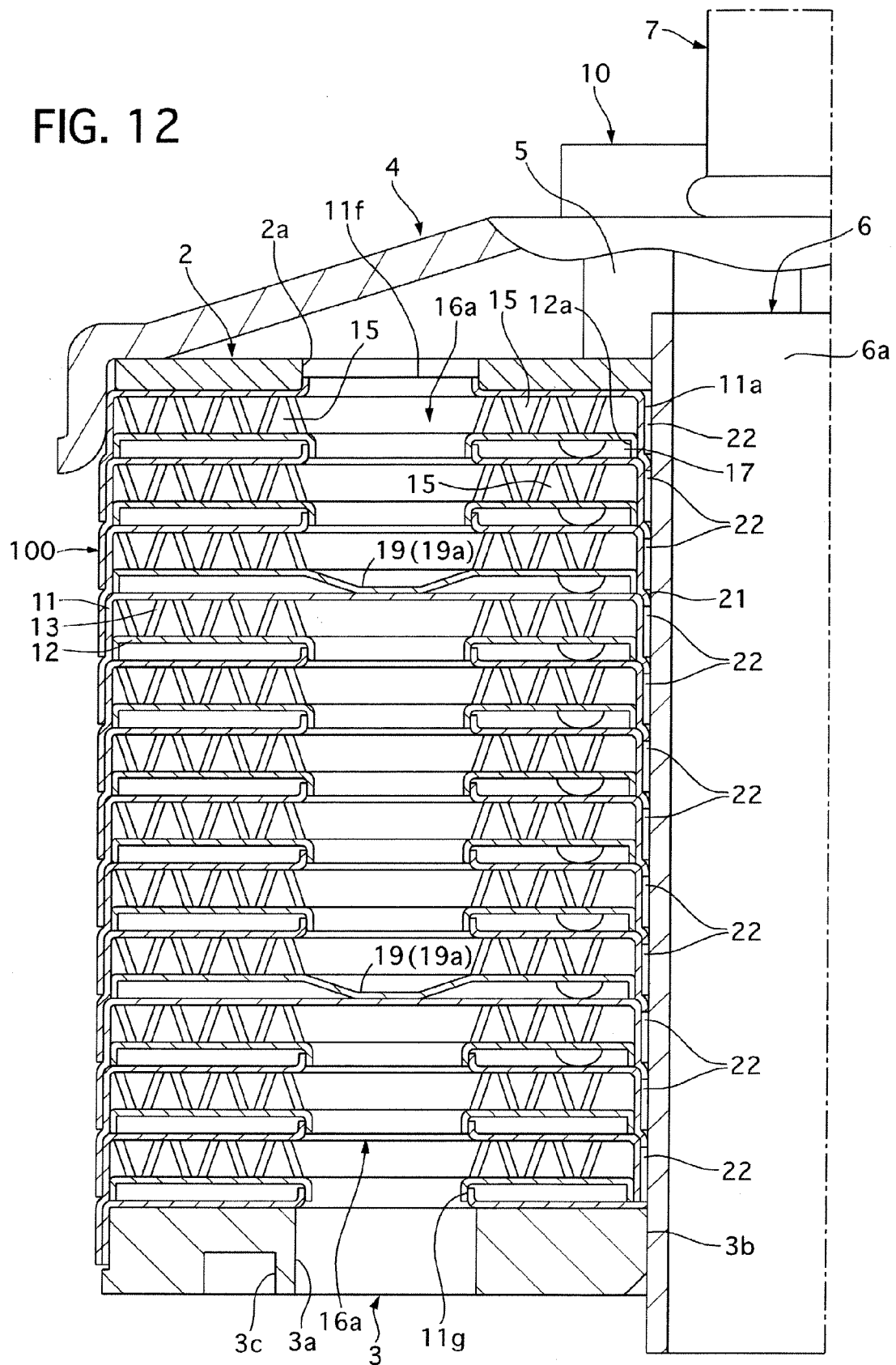


FIG. 13

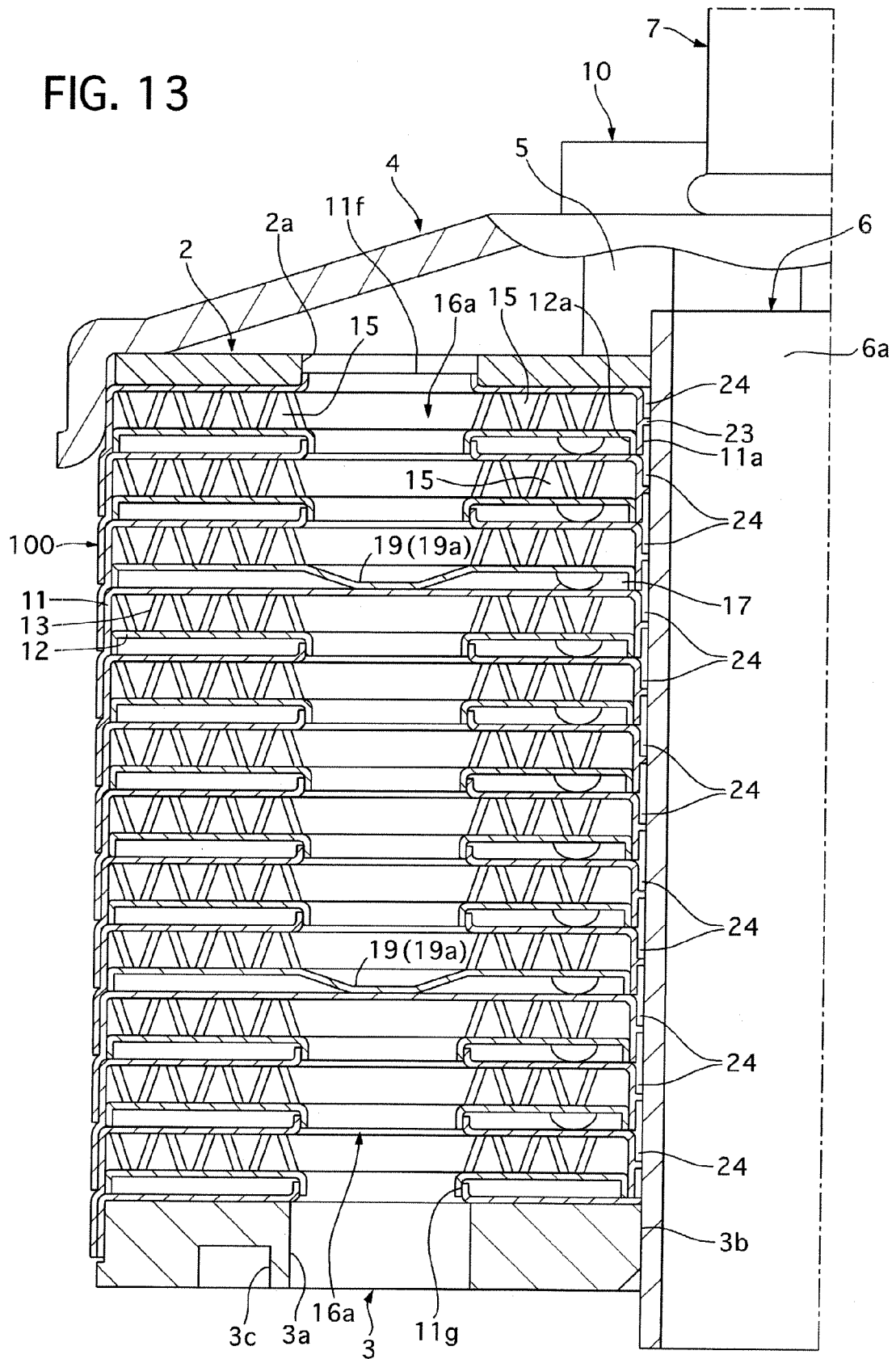
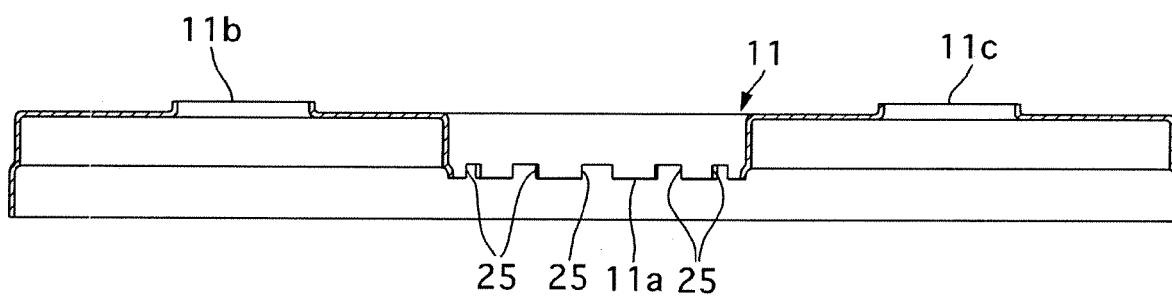


FIG. 14



REFERENCES CITED IN THE DESCRIPTION

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