

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a heat exchanger having a pair of header tanks and a plurality of tubes inserted into the header tanks. More particularly, the invention relates to an attachment structure of the heat exchanger where the tubes are brazed to the header tanks.

2. Description of the Related Art

[0002] In a heat exchanger, generally, a plurality of juxtaposed tubes are communicated with a pair of header tanks opposing to each other at an interval. Further, heat radiation fins are interposed between the adjoining tubes. In operation, heat exchange fluid flows from one header tank to the other header tank through the tubes. During this flowing of the heat exchange fluid, the heat exchanger carries out heat exchanging operation between the heat exchange fluid in the tubes and another heat exchange fluid passing through the fins.

[0003] Meanwhile, when carbon dioxide gas as one supercritical fluid is used for the heat exchange fluid for refrigerating cycle and heat pump cycle, it is necessary to assure a sufficient flame-proof strength for the header tanks due to an increased interior pressure in the heat exchanger. For this purpose, Japanese Patent Application Laid-open No. 11-351783 discloses a heat exchanger equipped with header tanks in which a plurality of cylindrical portions having substantially circular sections are juxtaposed in order to avoid concentration of stress due to high pressures, providing a multi-bore structure. In this view, the header tanks are formed by extrusions, pressed goods, etc.

[0004] In the heat exchanger, each of the header tanks is provided by welding an inner member to an outer member by caulking. The outer member is provided with a plurality of insertion holes for the tubes. In assembling, the tubes are inserted into the inner member through the insertion holes of the outer member and successively, the tubes are brazed to the outer member for integration.

[0005] In the above-mentioned heat exchanger, if the inner member of the header tank has a plurality of insertion grooves formed therein at positions corresponding to the insertion holes of the outer member, then it becomes possible to engage respective ends of the tubes inserted into the insertion holes of the outer member with the insertion grooves of the inner member, thereby effecting both positioning and fixing of the tubes.

[0006] In connection, if each of the insertion grooves is formed so as to make its inside width equal to an inside width of the insertion groove, there is a possibility that when brazing the tubes to the header tanks, a mol-

ten brazing filler metal enters a clearance between the insertion groove of the inner member and the tube through a clearance between the insertion hole of the outer member and the tube. Consequently, due to the capillary phenomenon of the former clearance, the molten brazing filler metal further creeps in the back of the insertion groove and reaches the tip surface of the tube, so that an opening (communication part) at the tip of the tube may be clogged up with the molten brazing filler metal disadvantageously.

SUMMARY OF THE INVENTION

[0007] In the above-mentioned situation, it is an object of the present invention to provide a heat exchanger that can prevent the molten brazing filler metal from reaching the tip surfaces of the tubes in insertion into the insertion grooves of the inner member while assuring the brazing strength about the tubes.

[0008] To attain the above object, the first aspect of the invention provides a heat exchanger comprising, a pair of header tanks arranged at a predetermined interval, each of the header tanks including an inner member having at least one insertion groove formed therein and an outer member having at least one insertion hole formed therein and covering the inner member thereby defining a hollow part in the header tank, and a plurality of tubes arranged between the header tanks in communication with the header tanks, each of the tubes having an end to be inserted into the insertion hole of the outer member of the header tank and also inserted into the insertion groove of the inner member of the header tank, wherein the insertion groove has a broad portion of which inside width is larger than an inside width of the insertion hole, wherein the tube is brazed to the outer member's part about the insertion hole.

[0009] In the heat exchanger of the first aspect, owing to the formation of the broad portion of each insertion groove, it is possible to suppress capillary phenomenon of a molten brazing filler metal in a clearance between the inside member and the tube. Therefore, when brazing the tube to the periphery of the insertion hole of the outer member, the molten brazing filler metal does not reach the tip surface of the tube but remains in the broad portion, whereby it is possible to prevent an opening (or communication space) at the tip of the tube from being clogged with the brazing filler metal.

[0010] In a preferred embodiment, the broad portion may be formed over the insertion groove. In this case, owing to the above formation of the broad portion, it becomes possible to suppress capillary phenomenon of the molten brazing filler metal in the clearance between the inside member and the tube.

[0011] The broad portion may be formed at the bottom of the insertion groove. Then, owing to the broad portion, it is possible to fix the end portion of the tube with both of the insertion hole and an inlet portion of the insertion groove through the brazing filler metal. As a result, the

joint strength of the tube with the inner member can be enhanced.

[0012] The insertion groove is provided, at a bottom surface thereof, with a clearance forming mechanism configured to form a clearance between a tip surface of the tube and the bottom surface of the insertion groove.

[0013] Then, by the clearance forming mechanism, it is possible to prevent an opening at the tip of the tube from being blocked up by the bottom surface of the insertion groove.

[0014] The clearance forming mechanism comprises the bottom surface of the insertion groove, which is inclined to the tip surface of the tube.

[0015] Similarly, it is possible to prevent an opening at the tip of the tube from being blocked up by the bottom surface of the insertion groove. Additionally, it is also possible to braze the tube to the header tank while making the tip surface of the tube abut on the bottom surface of the insertion groove, whereby the assembling workability can be improved.

[0016] The bottom surface inclined to the tip surface of the tube includes an arc-shaped section. Then, it is possible to prevent an opening at the tip of the tube from being blocked up by the bottom surface of the insertion groove. Additionally, it is also possible to braze the tube to the header tank while making the tip surface of the tube abut on the arc-shaped bottom surface of the insertion groove, whereby the tube can be assembled stably.

[0017] The clearance forming mechanism comprises a recess formed on the bottom surface of the insertion groove, at a position opposing the tip surface of the tube.

[0018] Owing to the formation of the recess on the bottom face of the insertion groove, it is possible to prevent an opening at the tip of the tube from being blocked up by the bottom surface of the insertion groove.

[0019] These and other objects and features of the present invention will become more fully apparent from the following description and appended claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a perspective view of a heat exchanger in accordance with the first embodiment of the present invention;

Fig. 2 is an enlarged cross-sectional view of a header tank, taken along a line 2-2 of Fig. 1;

Fig. 3 is an enlarged longitudinal sectional view of the header tank, taken along a line 3-3 of Fig. 1;

Fig. 4 is an enlarged cross-sectional view of a substantial part of the header tank in accordance with the second embodiment of the present invention;

Fig. 5 is an enlarged longitudinal sectional view of the substantial part of the header tank in accordance with the second embodiment of the present

invention;

Fig. 6 is an enlarged longitudinal sectional view of the substantial part of the header tank in the first modification of the second embodiment of the present invention;

Fig. 7 is an enlarged longitudinal sectional view of the substantial part of the header tank in accordance with the third embodiment of the present invention;

Fig. 8 is an enlarged longitudinal sectional view of the substantial part of the header tank in the first modification of the third embodiment of the present invention;

Fig. 9 is an enlarged longitudinal sectional view of the substantial part of the header tank in the second modification of the third embodiment of the present invention; and

Fig. 10 is an enlarged longitudinal sectional view of the substantial part of the header tank in the third modification of the third embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] Referring to accompanying drawings, embodiments of the present invention will be described below.

[1st. Embodiment]

[0022] According to this embodiment, as shown in Fig. 1, the heat exchanger 1 generally includes a pair of hollow header tanks 2, 2, a plurality of flat tubes 3 paralleled with each other to straddle between the header tanks 2, 2 in communication with the header tanks 2, 2 and a plurality of fins 4 each disposed between the adjoining flat tubes 3 besides the outermost tubes 4. In the heat exchanger 1, a heat exchange fluid such as cooling water, flows from one header tank 2 to the other header tank 2 through the intermediary of the tubes 3. During this flowing, the heat exchange is carried out between the above heat exchange fluid and another heat exchange fluid, for example, airflow passing through the fins 4.

[0023] As shown in Fig. 2, the header tank 2 includes a U-shaped plate 10 as an outer member and a block 11 as an inner member. The plate 10 is provided by folding an aluminum clad material in a U-shaped manner by press working. On the other hand, the block 11 is provided by extruding an aluminum material. In assembling, the block 11 is first fitted to the interior side of the U-shaped plate 10 and successively, respective crimp portions 10a of the plate 10, which are in the form of comb teeth projecting on both sides of the plate 10, are crimped to both outer sides of the block 11, providing the header tank 2 in one body.

[0024] The block 11 is provided, on its inner side close to the tubes 3 (lower side of Fig. 2), with a boundary wall

11a. A pair of groove parts 11b, 11b having substantial semicircular sections are defined on both sides of the boundary wall 11a. The insides of the groove parts 11b, 11b are covered by the plate 10 to form a pair of airtight cylindrical portions 12, 12. Owing to the provision of the cylindrical portions 12, 12, the header tank 10 is provided with a multi-hole structure.

[0025] Of course, both ends of the header tank 10 are closed up by caps 13, as shown in Fig. 1.

[0026] The plate 10 has insertion holes 14 formed to allow the tubes 3 to be inserted thereinto, as shown in Fig. 2. Further, the block 11 has insertion grooves 15 each formed with a predetermined depth D in the boundary wall 11a to engage with respective ends 3a of the tubes 3, respectively. While the ends 3a of the tubes 3 inserted into the insertion holes 14 are engaged with the insertion grooves 15, the tubes 3 are brazed to the peripheries of the insertion holes 14, ensuring the liquid-tight performance of the header tank 2.

[0027] In such an assembling state between the tubes 3 and the header tank 2, an appropriate clearance δ 1 is defined between a tip surface 3b of each tube 3 and a bottom surface 15a of each insertion groove 15 to accomplish communication between the cylindrical portions 12, 12 on both sides of the boundary wall 11a.

[0028] According to the first embodiment of the invention, as shown in Fig. 3, each insertion groove 15 is provided with a broad portion 16 whose inside width W2 is larger than an inside width W1 of the insertion hole 14 in the plate 10 in order to suppress the capillary phenomenon of molten brazing filler metal R in respective clearances δ 2 each between the tube 3 and the inner wall of the insertion groove 15.

[0029] Additionally, it is noted that the broad portion 16 is formed throughout the insertion groove 15.

[0030] With the above-mentioned structure, owing to the provision of the insertion groove 15 with the broad portion 16 having its inside width W2 larger than the inside width W1 of the insertion hole 14, when brazing the insertion hole 14 of the plate 10 to the tube 3 inserted thereinto, the molten brazing filler metal R stays in the broad portion 16 of the insertion groove 15 to form a fillet 17, so that it is possible to prevent the brazing filler metal R from reaching the tip surface of the tube 3. In other words, it is possible to prevent an opening at the tip of the tube 3 from being clogged up with the brazing filler metal R.

[0031] Again, since the broad portion 16 is formed throughout the insertion groove 15 in this embodiment, there is produced a dimensional room between the tube 3 and the insertion groove 15 in engaging the end 3a of the tube 3 in the insertion groove 15 via the insertion hole 14. That is, since the assembling of the plate 10 with the block 11 does not require to form these elements (i.e. the grooves 15, the tubes 3, etc.) with high dimensional accuracy, it is possible to attain an improvement in productivity and a reduction in manufacturing cost.

[2nd. Embodiment]

[0032] Figs. 4 and 5 show the second embodiment of the present invention. In the second embodiment, elements identical to those of the first embodiment are indicated with the same reference numerals respectively and their overlapping descriptions are eliminated. In those figures, Fig. 4 is an enlarged cross-sectional view of a substantial part of the header tank, while Fig. 5 is an enlarged longitudinal sectional view of the substantial part of the header tank.

[0033] According to the second embodiment of the invention, the broad portion 16 of the block 11 is formed at a bottom part 15b of the insertion groove 15.

[0034] An inlet portion 15c of the insertion groove 15 is formed so that an inside width W3 is generally equal to the inside width W 1 of the insertion hole 14 of the plate 10.

[0035] Thus, according to the second embodiment of the invention, since the end 3a of the tube 3 is positioned in the broad portion 16, it is possible to prevent the brazing filler metal R from reaching an opening at the tip of the tube 3, as similar to the first embodiment of the invention. Particularly, since it is possible to make the inside width W3 at the inlet portion 15c of the insertion groove 15 generally equal to the inside W1 of the insertion hole 15 of the plate 10, the brazing filler metal R molten in brazing reaches the inlet portion 15c of the insertion groove 15. Consequently, it is possible to fix the end 3a of the tube 3 with both of the insertion hole 14 and the inlet portion 15c of the insertion groove 15, whereby the joint strength of the tube 3 with the header tank 2 can be enhanced.

(1st. Modification of 2nd. Embodiment)

[0036] Fig. 6 shows the first modification of the second embodiment. In the first modification, elements identical to those of the second embodiment are indicated with the same reference numerals respectively and their overlapping descriptions are eliminated. Fig. 6 is an enlarged longitudinal sectional view of the substantial part of the header tank.

[0037] According to the modification, the block 11 is provided, at an inlet of each insertion groove 15, with chamfers 15d, 15d. Therefore, owing to the provision of the chamfers 15d, 15d, it is possible to facilitate an insertion of the tube 3 into the insertion groove 15 in spite of the arrangement of the second embodiment where the inside width W3 of the inlet portion 15c of the insertion groove 15 is generally equal to the inside width W 1 of the insertion hole 14.

[0038] In a further modification, the "straight" chamfers 15d, 15d of each insertion groove 15 may be replaced by arc surfaces (not shown).

[3rd. Embodiment]

[0039] Fig. 7 shows the third embodiment of the invention. In the third embodiment, elements identical to those of the previously-mentioned embodiments are indicated with the same reference numerals respectively and their overlapping descriptions are eliminated. Fig. 7 is an enlarged longitudinal sectional view of the substantial part of the header tank.

[0040] According to the third embodiment, as shown in Fig. 7, the insertion groove 15 is provided, on the bottom surface 15a, with a clearance forming mechanism 18 configured to assure a clearance between the tip surface 3b of the tube 3 and the bottom surface 15a.

[0041] In detail, the clearance forming mechanism 18 comprises a slanted surface 18a allowing the bottom surface 15a to be inclined to the tip surface 3b of the tube 3.

[0042] It is noted in this embodiment that the slanted surface 18a is inclined with respect to the bottom surface 15a of the insertion groove 15.

[0043] In assembling the tubes 3 to the header tanks 2, according to the third embodiment, even if the tip surface 3b of the tube 3 abuts on the bottom surface 15a of the insertion groove 15 in the process of engaging the tube 3 with the insertion groove 15 of the block 11 via the insertion hole 14 of the plate 10, it is possible to prevent an opening at the tip of the tube 3 from being blocked up by the bottom surface 15a of the insertion groove 15 due to the formation of the slanted surface 18a (the bottom surface 15a).

[0044] In other words, since the above-mentioned arrangement of this embodiment allows the tube 3 to be brazed to the header tank 2 under condition that the tip surface 3b of the tube 3 is abutting on the bottom surface 15a of the insertion groove 15, it is possible to improve the assembling workability.

(1st. Modification of 3rd. Embodiment)

[0045] Fig. 8 shows the first modification of the third embodiment. In the first modification, elements identical to those of the third embodiment are indicated with the same reference numerals respectively and their overlapping descriptions are eliminated. Fig. 8 is an enlarged longitudinal sectional view of the substantial part of the header tank.

[0046] In this modification, as shown in Fig. 8, the above slanted surface 18a at the bottom surface 15a of the insertion groove 15 is shaped to have a substantially V-shaped section on a bottom's center position P opposing the tip surface 3b of the tube 3.

[0047] Since the tip surface 3b of the tube 3 abuts on the V-shaped slanted surface 18a, the operation and effects of this modification are similar to those of the third embodiment mentioned above. Additionally, owing to the abutment of tube's corners (edges) on both sides of the tip surface 3b with the slanted surface 18a, the as-

sembling of the tube 3 can be stabilized.

[0048] Alternatively, a valley bottom of the slanted surface 18a may be further formed so as to be either flat or arc, providing a trapezoidal section.

(2nd. Modification of 3rd. Embodiment)

[0049] Fig. 9 shows the second modification of the third embodiment. In the second modification, elements identical to those of the third embodiment are indicated with the same reference numerals respectively and their overlapping descriptions are eliminated. Fig. 9 is an enlarged longitudinal sectional view of the substantial part of the header tank.

[0050] In this modification, as shown in Fig. 9, the above slanted surface 18a at the bottom surface 15a of the insertion groove 15 has an arc-shaped section.

[0051] Since the tip surface 3b of the tube 3 abuts on the arc-shaped slanted surface 18a, the operation and effects of this modification are similar to those of the third embodiment mentioned above. As similar to the first modification, owing to the abutment of tube's corners (edges) on both sides of the tip surface 3a with the arc-shaped surface 18a, the assembling of the tube 3 can be stabilized.

(3rd. Modification of 3rd. Embodiment)

[0052] Fig. 10 shows the third modification of the third embodiment. In the third modification, elements identical to those of the third embodiment are indicated with the same reference numerals respectively and their overlapping descriptions are eliminated. Fig. 10 is an enlarged longitudinal sectional view of the substantial part of the header tank.

[0053] According to this modification, the above clearance forming mechanism 18 is formed by a recess 18b on the bottom surface 15a of the insertion groove 15. The recess 18b is also arranged at a bottom's position opposing the tip surface 3b of the tube 3.

[0054] Also noted that the recess 18b is formed to penetrate the boundary wall 11a (Fig. 2) thereby communicating the cylindrical portions 12, 12 (Fig. 2) with each other. Of course, the width of the recess 18b is established smaller than a width of the so-flattened tube 3 in the short-axis direction, thereby preventing the leading end of the tube 3 from entering the recess 18b.

[0055] According to the third modification, owing to the provision of the recess 18b, it is possible to prevent the tip surface 3b of the tube 3 from being blocked up by the bottom surface 15a of the insertion groove 15 although the tube 3 abuts on the bottom surface 15a of the insertion groove 15.

[0056] Finally, it will be understood by those skilled in the art that the foregoing descriptions are nothing but three embodiments of the disclosed heat exchanger and therefore, various changes and modifications may be made within the scope of claims.

Claims

1. A heat exchanger comprising:

a pair of header tanks arranged at a predetermined interval, each of the header tanks including an inner member having at least one insertion groove formed therein and an outer member having at least one insertion hole formed therein and covering the inner member thereby defining a hollow part in the header tank; and a plurality of tubes arranged between the header tanks in communication with the header tanks, each of the tubes having an end to be inserted into the insertion hole of the outer member of the header tank and also inserted into the insertion groove of the inner member of the header tank,

wherein the insertion groove has a broad portion of which inside width is larger than an inside width of the insertion hole,

wherein the tube is brazed to the outer member's part about the insertion hole.

2. The heat exchanger of claim 1, wherein the broad portion is formed over the insertion groove.

3. The heat exchanger of claim 1, wherein the broad portion is formed at the bottom of the insertion groove.

4. The heat exchanger of claim 1, wherein the insertion groove is provided, at a bottom surface thereof, with a clearance forming mechanism configured to form a clearance between a tip surface of the tube and the bottom surface of the insertion groove.

5. The heat exchanger of claim 4, wherein the clearance forming mechanism comprises the bottom surface of the insertion groove, which is inclined to the tip surface of the tube.

6. The heat exchanger of claim 5, wherein the bottom surface inclined to the tip surface of the tube comprises an arc-shaped section.

7. The heat exchanger of claim 4, wherein the clearance forming mechanism comprises a recess formed on the bottom surface of the insertion groove, at a position opposing to the tip surface of the tube.

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FIG.1

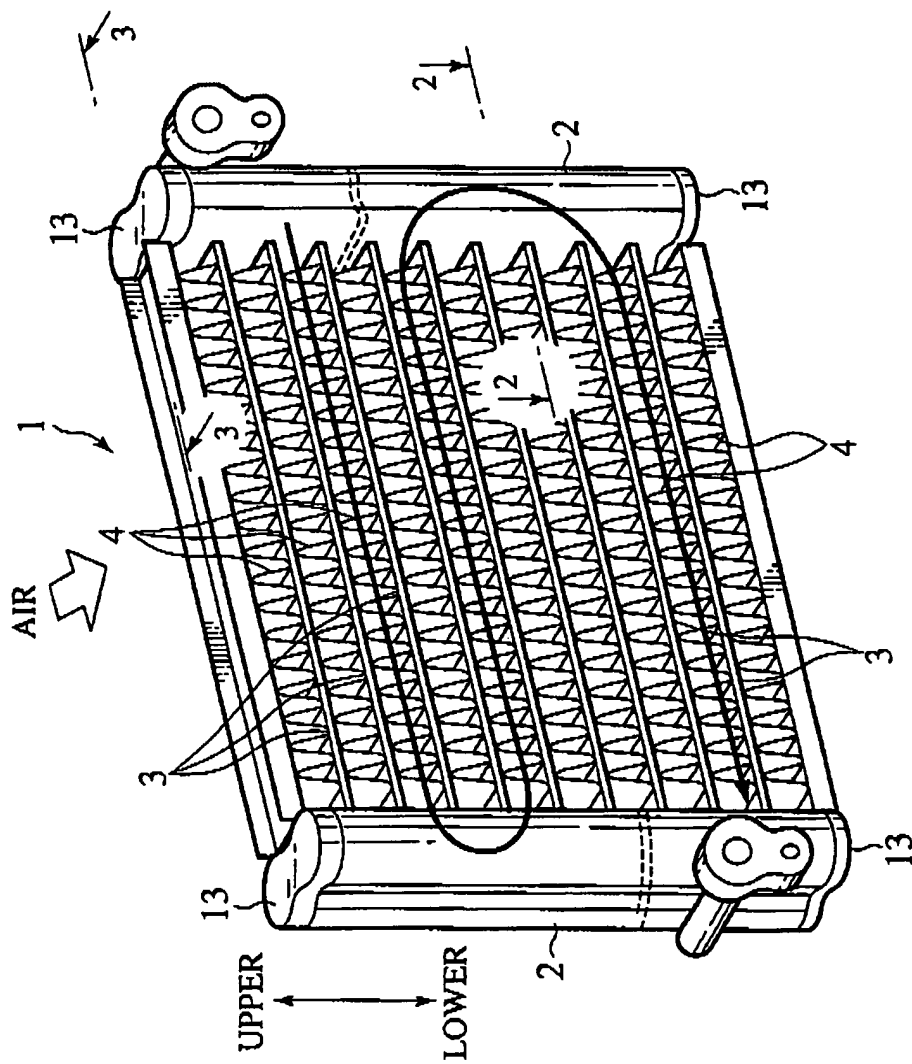


FIG.2

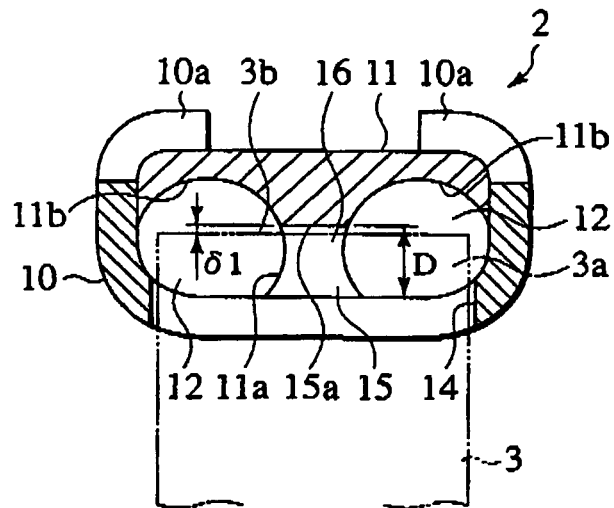


FIG.3

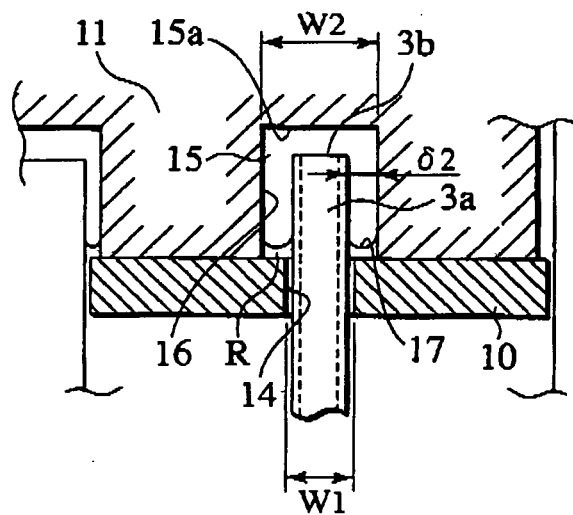


FIG.4

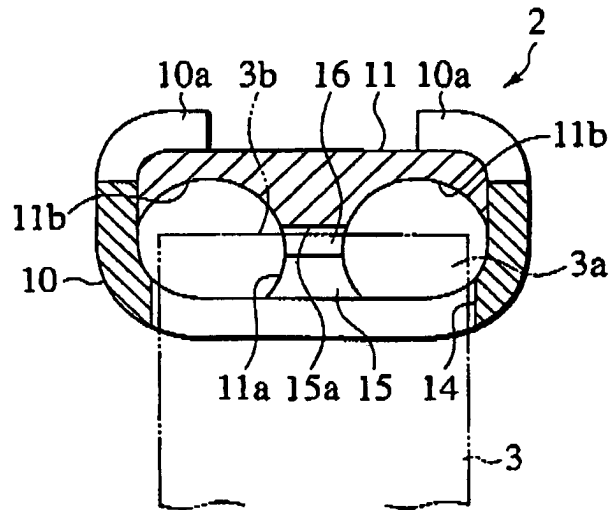


FIG.5

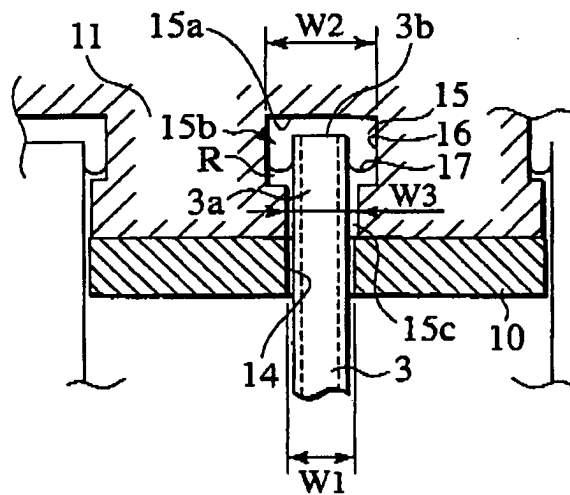


FIG.6

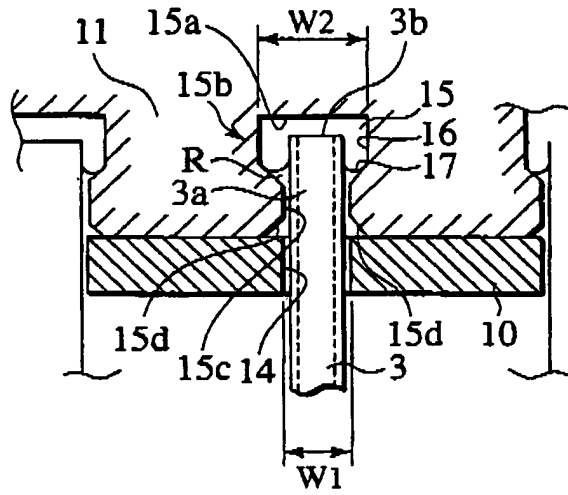


FIG.7

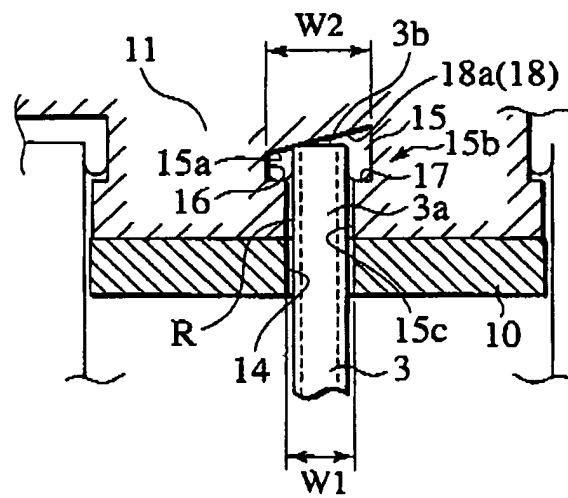


FIG.8

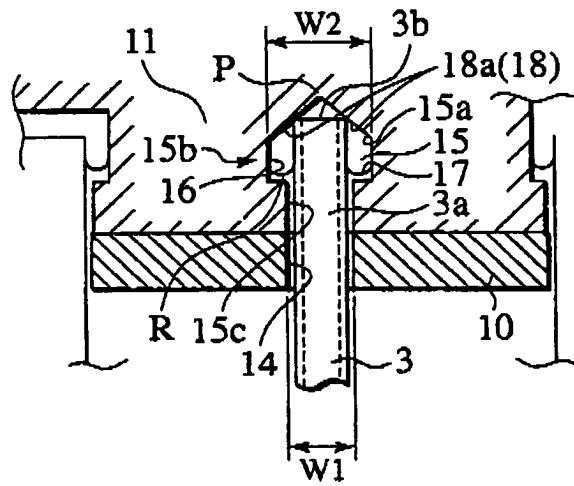


FIG.9

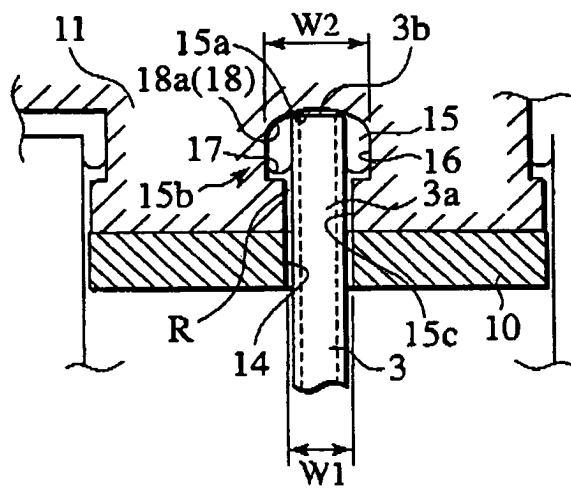


FIG.10

