(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 826 523 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
29.08.2007 Bulletin 2007/35

(21) Application number: **05782265.2**

(22) Date of filing: **07.09.2005**

(51) Int Cl.:
F28F 9/02 *(2006.01)*

(86) International application number:
PCT/JP2005/016442

(87) International publication number:
WO 2006/028148 (16.03.2006 Gazette 2006/11)

(84) Designated Contracting States:
DE FR GB

(30) Priority: **08.09.2004 JP 2004260961**

(71) Applicant: **Calsonic Kansei Corporation**
Tokyo 164-8602 (JP)

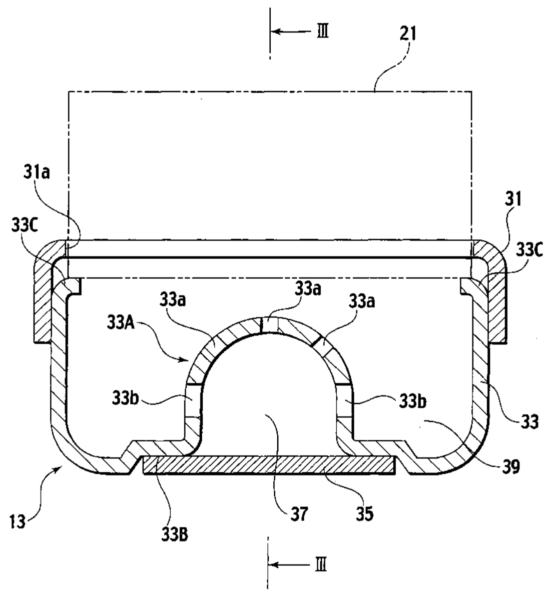
(72) Inventors:
- **MASHIKO, Seiji**
  c/oCalsonic Kansei Corporation
  Tokyo 164-8602 (JP)
- **UEBAYASHI, Kazutaka**
  c/o Calsonic Kansei Corporation
  Tokyo 164-8602 (JP)
- **IKUTA, Shiro**
  c/o Calsonic Kansei Corporation
  Tokyo 164-8602 (JP)

(74) Representative: **Grünecker, Kinkeldey,**
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) HEADER TANK FOR HEAT EXCHANGER

(57) A header tank for a heat exchanger includes tank forming sections that are joined into a tubular shape with a substantially square cross-section. The header tank has a refrigerant flow path formed inside the tank forming sections. The tank forming sections include a tank upper section (31) in which tube insertion holes (31a) for connecting tubes of a heat exchanger core are formed. The tank forming sections have a tank lower section (33) having a substantially U-shaped refrigerant split-flow groove (33A) that has, in its longitudinal direction, communication holes (33a, 33b) for the refrigerant. The tank forming sections include a plate section (35) for closing an opening of the refrigerant split-flow groove (33A) to form a refrigerant split-flow path (37) inside the tank lower section.

FIG. 2



Printed by Jouve, 75001 PARIS (FR)

Description

TECHNICAL FIELD

[0001] The present invention relates to a header tank for a heat exchanger used in vehicles and the like and specifically relates to a structure of a header tank having a function to equally distribute refrigerant to each tube.

BACKGROUND ART

[0002] A general heat exchanger used in vehicles and the like includes a heat exchanger core having flat tubes and fins alternately arranged and header tanks causing refrigerant to flow into the heat exchanger core. The header tanks among these are separated into an inlet header tank and an outlet header tank. The inlet header tank causes externally supplied refrigerant to flow into each tube of the heat exchanger core. The outlet header tank joins together flows of refrigerant which has exchanged heat with cooling air while passing through the tubes of the heat exchanger core and discharges the same to the outside. The arrangement of the header tanks includes various types depending on path of refrigerant, and a general structure is described herein.

[0003] The inlet header tank supplies the refrigerant from one end thereof. In the inlet header tank, more refrigerant is flown into tubes located further back in a supply direction of the refrigerant. The amount of refrigerant flowing into tubes located in the front side is less than that of the tubes located in the back side. Accordingly, the following header tank is proposed. Specifically, a refrigerant distribution pipe provided with a plurality of refrigerant passage holes is inserted in the header tank, and refrigerant is equally distributed from the refrigerant passage holes to the individual tubes (for example, see the Japanese Patent Laid-open Publications No. 8-86591 and No. 9-166368).

DISCLOSURE OF THE INVENTION

[0004] However, the header tank including the refrigerant distribution pipe inside requires the refrigerant distribution pipe and a holding plate holding the same, increasing component cost. Moreover, the header tank requires a process to attach these components to the inside of the header tank, increasing assembly cost. Accordingly, the aforementioned related example cannot avoid an increase in cost.

[0005] When the header tank with the refrigerant distribution pipe assembled thereto is brazed in a furnace, there is a temperature difference caused between the header tank and the refrigerant distribution pipe during heating or cooling. Differences in expansion and shrinkage due to the temperature difference distort the refrigerant distribution pipe inside the tank, thus reducing the distribution efficiency.

[0006] An object of the present invention is to reduce the manufacturing cost and improve the distribution efficiency in a header tank including a function inside to distribute refrigerant.

[0007] A first aspect of the present invention provides a header tank for a heat exchanger. The header tank includes a plurality of tank constituent portions joined into a cylindrical shape with a substantially square cross-section. The header tank includes a refrigerant passage formed within the plurality of tank constituent portions. The plurality of tank constituent portions include a tank upper portion (31) with a plurality of tube insertion holes (31a) for connection of tubes (21) of a heat exchanger core formed. The plurality of tank constituent portions include a tank lower portion (33) including a refrigerant distribution groove (33A) with a substantially U-shaped section which has a plurality of refrigerant communication holes (33a, 33b) in a longitudinal direction. The plurality of tank constituent portions include a plate portion (35) which closes an opening of the refrigerant distribution groove (33A) to form a refrigerant distribution passage (37) within the tank lower portion.

[0008] A second aspect of the present invention provides a header tank for a heat exchanger. The header tank includes a plurality of tank constituent portions joined into a cylindrical shape with a substantially square section. The plurality of tank constituent portions include a tank upper portion (51) with a plurality of tube insertion holes (51a) for connection of tubes (21) of a heat exchanger core formed. The plurality of tank constituent portions include a tank lower portion (53) including a refrigerant distribution portion (53A) with a substantially circular section integrally formed with a body of the lower portion, the refrigerant distribution portion having a plurality of refrigerant communication holes (53a, 53b) in a longitudinal direction.

[0009] A third aspect of the present invention provides a header tank (83) of a heat exchanger. The header tank (83) includes the header tank (83) formed of a single constituent material into a tubular shape with a substantially square section. An upper face of the header tank includes a plurality of tube insertion holes (61a) for connection of tubes (21) of a heat exchanger core. A lower face of the header tank integrally includes a refrigerant distribution portion (63A) with a substantially circular section with a tank body, the refrigerant distribution portion (63A) including a plurality of refrigerant communication holes (63a, 63b) in a longitudinal direction.

[0010] The refrigerant distribution portion (53A) includes a part of a plate material as a tank constituent member which is shaped into a substantially Ω-shaped section. The tank may include a plurality of joints (55A) in a portion where portions of the plate material are laid on each other in the substantially Ω-shaped section.

[0011] The refrigerant communication holes (33a, 33b) include: first communication holes (33a) through which refrigerant in gas phase passes. The communication holes include second communication holes (33b) through which refrigerant in liquid phase passes. The refrigerant distribution groove (33A) includes the first communication holes (33a) in upper part in a direction of gravity when the refrigerant flows within the header tank. The refrigerant distribution groove (33A) includes the second communication holes (33b) in lower part in the direction of gravity.

[0012] Each of the refrigerant communication holes (33a, 33b) may be positioned to have half or more of a sectional area overlapping a range of thickness (t) of the tubes (21).

[0013] The communication holes (33a, 33b) and the tubes (21) may match each other in terms of longitudinal positions in the header tank.

[0014] The joint portion (55A) may be caulked.

[0015] Each of the joint portions (55A) may include a hole and a protrusion fit in the hole.

[0016] Each of the joint portions (55C) may include a hole (55a) and a protrusion (55b) which pierces the hole (55a) and has a crushed tip.

[0017] The refrigerant distribution portion (53B) includes a refrigerant distribution pipe (37). The refrigerant distribution portion (53B) includes a support portion (55) supporting the refrigerant distribution pipe (37). The refrigerant distribution portion (53B) may include communication holes (53p) communicating with refrigerant passages on both sides of the support portion (55).

[0018] The communication holes (53p) may have an equivalent diameter of 1.0 mm or more.

[0019] The refrigerant distribution portion (53F) includes a refrigerant distribution pipe (57) having a refrigerant distribution passage defined inside. The refrigerant distribution portion (53F) includes a support portion (55) supporting the refrigerant distribution pipe (57). The refrigerant distribution portion (53F) may include communication holes (53q) allowing refrigerant passages on both sides of the support portion 55 and the refrigerant distribution passage to communicate with each other.

[0020] A fourth aspect of the present invention provides a method of manufacturing a header tank for a heat exchanger including the following steps. In a first step, a hole (55a) is opened in a first portion (101d) of a sheet (101) . In a second step, a protrusion (55b) is formed in a second portion (101e) of the sheet (101). In a third step, a third portion (101a) between the first and second portions (55a, 55b) of the sheet (101) is wound to bring the first and second portions (101d, 101e) close to each other to form a refrigerant distribution passage. In a fourth step, the hole (55a) is pierced with the protrusion (55b). In a fifth step, a tip of the protrusion (55b) piercing the hole (55a) is crushed. In a sixth step, fourth and fifth portions (101b, 101c) outside of the first and second portions (101d, 101e) in the sheet (101) are bent toward the wound third portion (101a) to form a refrigerant passage. In a seventh step, a communication hole (53f) may be opened in the third portion (101a) of the sheet (101).

[0021] According to the first aspect of the present invention, the refrigerant distribution groove is formed in the tank lower portion, and the refrigerant communication holes are provided for the refrigerant distribution groove. Moreover, the opening is closed by the plate portion to form the refrigerant distribution passage. Such a structure eliminates the need to manufacture a refrigerant distribution pipe, a holding plate, and the like as separate components, thus reducing component cost. Such a structure eliminates the need for a process to attach the refrigerant distribution pipe, holding plate, and the like to the inside of the tank, thus reducing assembly cost. Accordingly, the lower header tank 13 has the same function as a header tank including the refrigerant distribution pipe inside while further reducing manufacturing cost. The integration of the refrigerant distribution portion and the tank lower portion prevents occurrence of distortion in the refrigerant distribution groove due to the temperature difference during brazing and prevents reduction of the distribution efficiency due to the distortion within the tank as is observed in the refrigerant distribution pipe.

[0022] According to the second aspect of the present invention, the lower tank lower and the refrigerant distribution portion with a substantially circular section are integrally formed, and the refrigerant communication holes are formed in the refrigerant distribution portion. Such a structure eliminates the need to manufacture the refrigerant distribution pipe, holding plate, and plate as separate components, thus reducing component cost. Such a structure eliminates the need for a process to attach the refrigerant distribution pipe, holding plate, and the like to the inside of the tank, thus reducing assembly cost. Accordingly, this structure has the same function as that of the header tank including the refrigerant distribution pipe inside while further reducing the manufacturing cost. Integration of the tank lower portion and refrigerant distribution portion prevents occurrence of distortion in the refrigerant distribution portion due to the temperature difference during brazing and prevents reduction of the distribution efficiency due to the distortion within the tank as is observed in the refrigerant distribution pipe.

[0023] According to the third aspect of the present invention, the tank upper portion and tank lower portion are integrally formed, and the body of the header tank and the refrigerant distribution portion with a substantially circular section are integrally formed. Furthermore, the refrigerant communication holes are formed in this refrigerant distribution portion. Such a structure eliminates the need to manufacture not only the refrigerant distribution pipe, holding plate, and plate but also the tank upper portion and tank lower portion as separate components, thus reducing the number of components. The component cost can be therefore reduced. Such a structure eliminates the need for a process to attach the refrigerant distribution pipe, holding plate, and the like to the inside of the tank, thus reducing assembly cost. Accordingly, this structure has the same function as that of the header tank including the refrigerant distribution pipe inside while further reducing the manufacturing cost. Integration of the body of the header tank and refrigerant distribution portion prevents occurrence of distortion in the refrigerant distribution groove due to the temperature difference during brazing and prevents reduction of the distribution efficiency due to the distortion within the tank as is observed in the refrigerant distribution pipe.

[0024] The joint portions prevent separation of portions of the plate materials laid on each other to improve the brazing properties.

[0025] The individual communication holes allow gas and liquid of the refrigerant to be efficiently discharged therethrough.

[0026] The positioning of the communication holes and tubes allows refrigerant having passed through the communication hole to efficiently flow into the tubes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

[FIG. 1] FIG. 1 is an external perspective view showing an entire structure of a heat exchanger according to a first embodiment.

[FIG. 2] FIG. 2 is a cross sectional view of a lower header tank taken along a line II-II of FIG. 1.

[FIG. 3] FIG. 3 is a longitudinal sectional view taken along a line III-III of FIG. 2.

[FIG. 4] FIG. 4 is a cross sectional view of an upper header tank taken along a line IV-IV of FIG. 1

[FIG. 5] FIG. 5 is a cross sectional view of a lower header tank for a heat exchanger according to a second embodiment.

[FIG. 6] FIG. 6 is a cross sectional view of a join portion of the lower header tank of the heat exchanger according to the second embodiment.

[FIG. 7] FIG. 7 is a cross sectional view of a lower header tank according to a third embodiment.

[FIG. 8] FIG. 8 is a perspective view of a header tank according to a fourth embodiment.

[FIG. 9] FIG. 9 is a transverse cross-sectional view of a distribution pipe having a joint portion of another aspect in the header tank of FIG. 8.

[FIG. 10] FIG. 10 is a longitudinal cross-sectional view of the header tank of FIG. 8.

[FIG. 11] FIG. 11 is a cross sectional view of a distribution pipe of a header tank according to a fifth embodiment.

[FIG. 12] FIG. 12 is a cross sectional view of the distribution pipe of FIG. 11 with a protrusion and a caulking hole being not attached thereto.

[FIG. 13] FIG. 13 is a side view of a metal sheet as a raw material.

[FIG. 14A] FIG. 14A is a schematic view showing a first step of a method of manufacturing a header tank.

[FIG. 14B] FIG. 14B is a schematic view showing a second step of the method of manufacturing a header tank.

[FIG. 14C] FIG. 14C is a schematic view showing a third step of the method of manufacturing a header tank.

[FIG. 14D] FIG. 14D is a schematic view showing a fourth step of the method of manufacturing a header tank.

[FIG. 14E] FIG. 14E is a schematic view showing a fifth step of the method of manufacturing a header tank.

[FIG. 14F] FIG. 14F is a schematic view showing a sixth step of the method of manufacturing a header tank.

[FIG. 15] FIG. 15 is a perspective view of a header tank according to a sixth embodiment.

[FIG. 16] FIG. 16 is a cross sectional view of the header tank of FIG. 15.

[FIG. 17] FIG. 17 is a perspective view showing a header tank of a different aspect from the header tank of FIG. 15.

[FIG. 18] FIG. 18 is a cross sectional view of the header tank of FIG. 17.

BEST MODE FOR CARRYING OUT THE INVENTION

[0028] Hereinafter, a description is given of embodiments showing best modes for carrying out a header tank for a heat exchanger according to the present invention.

First Embodiment

[0029] FIG. 1 is an external perspective view showing an entire structure of a heat exchanger according to an embodiment. A heat exchanger 11 roughly includes a lower header tank 13, an upper header tank 15, and a heat exchanger core 17. The heat exchanger core 17 includes a plurality of tubes 21, through which refrigerant 19 flows, and cooling fins 23. The tubes 21 and cooing fins 23 are alternately arranged. The lower end of the heat exchanger core 17 is connected to the lower header tank 13 and communicates with an end of each tube 21. The upper end of the heat exchanger core 17 is connected to the upper header tank 15 and communicates with the other end of each tube 21.

[0030] Both ends of the lower header tank 13 are closed by end plates 25. One of the both ends is connected to an inlet pipe 27, which supplies the refrigerant 19. The both ends of the upper header tank 15 are also closed by end plates 25. One of the both ends is connected to an outlet pipe 29, which discharges the refrigerant 19.

[0031] In FIG. 1, the refrigerant 19 supplied from the inlet pipe 27 is distributed to each tube 21 while flowing through a not-shown refrigerant distribution passage and a refrigerant passage of the lower header tank 13 and passes within each tube 21. During this time, a not-shown heat exchange medium such as cooling air flows among the tubes 21 and fins 23 of the heat exchanger core 17. The heat exchange medium exchanges heat with the refrigerant 19 passing within each tube of the heat exchanger core 17. Flows of the refrigerant 19 are joined together within the upper header tank 15 and then discharged through the outlet pipe 29 to the outside.

[0032] In the embodiment, the refrigerant 19 is supplied to the lower header tank 13 and passes within the heat exchanger 11. The heat exchanger 11, in which flows of the refrigerant 19 are joined together within the upper header tank 15 and discharged to the outside, is described. The path through which the refrigerant 19 flows is not limited to that of the embodiment and may be anther path. For example, the refrigerant 19 may be supplied to the upper header tank 15 and passed within the heat exchanger 17. Such flows of the refrigerant 19 may be then joined together in the lower header tank 13 and discharged to the outside.

[0033] Next, a description is given of structures of the lower and upper header tanks 13 and 15.

[0034] FIG. 2 is a cross-sectional view along a line II-II of FIG. 1 and shows a structure of the lower header tank 13. The lower header tank 13 includes a lower tank upper 31, a lower tank lower 33, and a plate 35.

[0035] The lower tank upper 31 as a tank constituent member is shaped to have a square U-shaped section by bending a plate at both ends. Flat part thereof includes tube insertion holes 31a for connection of the tubes 21. The tube insertion holes 31a are formed at regular intervals in a longitudinal direction. The lower tank lower 33 as a tank constituent member includes a refrigerant distribution groove 33A with a U-shaped section, which is shaped by pressing center part of a plate material. The peripheral wall of the refrigerant distribution groove 33A includes refrigerant communication holes 33a and 33b, which are formed along the longitudinal direction. Herein, the communication holes 33a allow passage of gas of the refrigerant. The communication holes 33a are positioned in upper part in the direction of gravity when the refrigerant is flown within the lower header tank 13. The communication holes 33b allow passage of liquid of the refrigerant. The communication holes 33b are positioned in lower part in the direction of gravity. Refrigerant such as carbon dioxide is fed to the header tank with gas and liquid phases being mixed. The communication holes 33a and 33b, which are arranged as shown in FIG. 2, efficiently discharge the gas and liquid of the refrigerant, respectively.

[0036] FIG. 3 is a cross-sectional view along a line III-III of FIG. 2, showing a positional relation among the tubes 21 and communication holes 33a and 33b. The communication holes 33a and 33b are positioned so as to fully or partially match the tube insertion holes 31a in the longitudinal direction of the header tank or in a plan view thereof. Half or more of sectional areas of the communication holes 33a and 33b only needs to overlap a thickness range t of tube width. Such arrangement allows the refrigerant having passed through the communication holes 33a and 33b to efficiently flow into tubes 21. In this embodiment, the communication holes 33a are provided at the top of the refrigerant distribution groove 33A and on both sides thereof, but the number of the communication holes may be properly determined. For example, the communication hole may not be provided at the top the communication holes but provided only on the both sides of the top.

[0037] As shown in FIG. 2, the bottom face of the lower tank lower 33 includes a step portion 33B. The plate 35 is embedded in the step portion 33B to close the opening of the refrigerant distribution groove 33A, thus forming a refrigerant distribution passage 37 within the tank.

[0038] Furthermore, the lower tank lower 33 is bent at both ends to have a square C-shaped cross section. The both ends thereof individually include flanges 33C for positioning of the tubes 21. Each tube 21 may be positioned by setting width between both ends of the lower tank lower 33 according to the tube width and abutting the ends of the tubes 21 on the both ends of the lower tank lower 33.

[0039] As shown in FIG. 2, the lower tank upper 31, lower tank lower 33, and plate 35 are combined and brazed to be joined into the lower header tank 13 having a tubular shape with a square section. The refrigerant distribution passage 37, which communicates in the longitudinal direction within the tank, and a refrigerant passage 39, through which the refrigerant distributed from the refrigerant distribution passage 37 flows, are formed.

[0040] FIG. 4 is a cross-sectional view along III-III of FIG. 1, showing the structure of the upper header tank 15. The upper header tank 15 includes an upper tank upper 41 and an upper tank lower 43.

[0041] The upper tank upper 41 as a tank constituent member is shaped to have a square C-shaped section by bending both ends of a plate material. The both ends include flanges 41A for positioning of the tubes 21. The upper tank lower 43 as a tank constituent member is shaped to have a square U-shaped section also by bending both ends of a plate material. Flat part thereof includes tube insertion holes 43a for connection of the tubes 21. The tube insertion holes 43a are formed at regular intervals in the longitudinal direction.

[0042] The upper tank upper 41 and upper tank lower 43 are combined and brazed to be joined into the upper header tank 15 having a tubular shape with a square section. In the upper header tank 15, a refrigerant passage 45, which communicates along the longitudinal direction within the tank, is thus formed.

[0043] The lower and upper header tanks 13 and 15 are arranged to face to each other as shown in FIG. 1 and individually connected to the heat exchanger core 17, thus completing the heat exchanger 11. When the refrigerant 19 is supplied from the inlet pipe 27 to the heat exchanger 11, the refrigerant 19 flows through the refrigerant distribution passage 37, which is formed in the lower header tank 13, to be introduced to the back of the tank. During this time, the refrigerant 19 is discharged through the individual communication holes 33a and 33b, which are positioned along the longitudinal direction of the refrigerant distribution groove 33A, and equally distributed to each tube 21.

[0044] In the lower header tank 13, the refrigerant distribution groove 33A is formed in the lower tank lower 33 and provided with the communication holes 33a and 33b. Moreover, the opening thereof is closed with the plate 35 to form the refrigerant distribution passage 37. Such a structure eliminates the need to manufacture a refrigerant distribution pipe, a holding plate, and the like as separate components, thus reducing component cost. Such a structure eliminates the need for a process to attach the refrigerant distribution pipe, holding plate, and the like to the inside of the tank, thus reducing assembly cost. Accordingly, the lower header tank 13 has the same function as a header tank including the refrigerant distribution pipe inside while further reducing manufacturing cost.

[0045] The integration of the refrigerant distribution groove 33A and lower tank lower 33 prevents occurrence of distortion in the refrigerant distribution groove 33A due to the temperature difference during the brazing and prevents reduction of the distribution efficiency due to the distortion within the tank as is observed in the refrigerant distribution pipe.

Second Embodiment

[0046] Next, a description is given of a structure of a lower header tank 73 according to a second embodiment. Hereinafter, portions equivalent to those of the first embodiments are indicated by same reference numerals, and redundant descriptions of the structure and operational effects are properly omitted.

[0047] FIG. 5 is a cross-sectional view showing a structure of the lower header tank 73, which corresponds to a cross-sectional view along II-II of FIG. 1. This lower header tank 73 includes a lower tank upper 51 and a lower tank lower 53.

[0048] The lower tank upper 51 as a tank constituent member is shaped to have a square U-shaped section by bending both ends of a plate material. The flat part thereof includes tube insertion holes 51a for connection of tubes 21. The tube insertion holes 51a are formed at regular intervals along the longitudinal direction. The lower tank lower 53 is shaped to have a Ω-shaped section by bending (or extruding) center part of a plate material, thus integrally forming a refrigerant distribution portion 53A having a circular section with the lower tank lower 53. A support potion 55 supports between the refrigerant distribution portion 53A and the body of the lower tank lower 53. Since this support portion 55 has a structure in which portions of the plate material are laid on each other by bending or the like, the support portion 55 may be separated to form gap during brazing. As shown in FIG. 6, therefore, the support portion 55 is caulked at predetermined positions to form joint portions 55A. The joint portions 55A temporarily join the portions of the plate material laid on each other to prevent the separation of the plate material, thus improving the brazing properties.

[0049] The refrigerant distribution portion 53A includes refrigerant communication holes 53a and 53b along the longitudinal direction. The communication holes 53a thereof allow passage of refrigerant in gas phase. The communication holes 53a are positioned in upper part in the direction of gravity when the refrigerant is flown within the lower header tank 73. The communication holes 53b allow passage of refrigerant in liquid phase and are positioned in lower part in the direction of gravity.

[0050] The lower tank lower 53 are bent at the both ends and shaped to have a square C-shaped section. The both ends individually include flange portions 53C for positioning of the tubes 21.

[0051] This lower tank upper 51 and lower tank lower 53 are combined as shown in FIG. 5 and brazed to be joined into the lower header tank 73 having a tubular shape with a square section. This lower header tank 73 includes the refrigerant distribution passage 57, which communicates in the longitudinal direction within the tank, and a refrigerant passage 59, through which the refrigerant distributed from the refrigerant distribution passage 57 is flown, and equally distributes externally supplied refrigerant to each tube 21.

[0052] In this lower header tank 73, the lower tank lower 53 and the refrigerant distribution portion 53A with a substantially circular section are integrally formed, and the refrigerant distribution portion 53A is provided with the refrigerant communication holes 53a and 53b. This structure eliminates the need to manufacture the refrigerant distribution pipe, holding plate, and plate as separate components, thus reducing component cost. This structure eliminates the need for a process to attach the refrigerant distribution pipe, holding plate, and the like to the inside of the tank, thus reducing assembly cost. Accordingly, the lower header tank 73 has the same function as that of the header tank including the refrigerant distribution pipe inside while further reducing the manufacturing cost. In this embodiment, the communication holes 53a are provided at the top of the refrigerant distribution portion 53A and on both sides thereof, but the number of communication holes may be properly determined. For example, the communication holes may not be provided at the top the communication holes but provided only on the both sides of the top.

[0053] Integration of the lower tank lower 53 and refrigerant distribution portion 53A prevents occurrence of distortion in the refrigerant distribution portion 53A due to the temperature difference during brazing and prevents reduction of the distribution efficiency due to the distortion within the tank as is observed in the refrigerant distribution pipe.

[0054] The support portion 55 of the structure in which the portions of the plate material are laid on each other includes the joint portions 55A formed by caulking. This structure temporarily joins the portions of the plate material laid on each other in the support portion 55 and prevents separation of the plate material to improve the brazing properties.

Third Embodiment

[0055] FIG. 7 is a cross-sectional view showing a structure of a lower header tank 83 according to a third embodiment, which corresponds to a cross-sectional view along II-II of FIG. 1. The lower header tank 83 is formed into a tubular shape with a square section by bending a single plate material or a single pipe material (in the case of the plate material, joining the seam after bending). Flat part in the upper face includes tube insertion holes 61a for connection of the tubes 21. The tube insertion holes 61a are formed at regular intervals in the longitudinal direction. The center part in the lower face is shaped to have a Ω-shaped section, thus integrally forming a refrigerant distribution portion 63A with a circular section with the body of the lower header tank 83.

[0056] The refrigerant distribution portion 63A includes a plurality of refrigerant communication holes 63a and 63b in the longitudinal direction. Among these, the communication holes 63a allow passage of refrigerant in gas phase and are positioned in upper part in the direction of gravity when the refrigerant is flown within the lower header tank 83. The communication holes 63b allow passage of refrigerant in liquid phase and are positioned in lower part in the direction of gravity.

[0057] The lower header tank 83 is formed into a tubular shape with a square section by bending a single plate material or a pipe material. This lower header tank 83 includes a refrigerant distribution passage 67, which communicates in the longitudinal direction within the tank, and a refrigerant passage 69, through which the refrigerant distributed from the refrigerant distribution passage 67 flows, and equally distributes the externally supplied refrigerant to each tube 21.

[0058] A support portion 65 supports between the refrigerant distribution portion 63A and the body of the lower header tank 61. The support portion 65 is caulked at predetermined positions to form same joints as that in FIG. 6 (not shown) so that the portions laid on each other are not separated to form a gap during brazing.

[0059] In the lower header tank 83, the lower tank upper and lower tank lower are integrally formed, and the body of the lower header tank 83 and the refrigerant distribution portion 63A with a substantially circular section are integrally formed. Furthermore, the refrigerant holes 63a and 63b are provided for this refrigerant distribution portion 63A. This structure eliminates the need to manufacture not only the refrigerant distribution pipe, holding plate, and plate but also the lower tank upper and lower tank lower as separate components, thus reducing the number of components. The component cost can be therefore reduced. This structure eliminates the need for a process to attach the refrigerant distribution pipe, holding plate, and the like to the inside of the tank, thus reducing assembly cost. Accordingly, the lower header tank 83 has the same function as that of the header tank including the refrigerant distribution pipe inside while further reducing the manufacturing cost. In this embodiment, the communication holes 63a are provided at the top of the refrigerant distribution portion 53A and on both sides thereof, but the number of communication holes may be properly determined. For example, the communication holes may not be provided at the top the communication holes but provided only on the both sides of the top.

[0060] Integration of the lower tank lower 83 and refrigerant distribution portion 63A prevents occurrence of distortion in the refrigerant distribution groove 33A due to the temperature difference during brazing and prevents reduction of the distribution efficiency due to the distortion within the tank as is observed in the refrigerant distribution pipe.

[0061] The support portion 65 of the structure in which portions of the plate material are laid on each other is subjected to caulking to include the joint portions 55A as shown in FIG. 6. This structure temporarily joins the portions of the plate material laid on each other in the support portion 65 and prevents separation of the plate material, thus improving the brazing properties.

Fourth Embodiment

[0062] As shown in FIG. 8, a header tank 93A includes a first tank 51B with a U-shaped cross section. The header tank 93A includes a second tank 53B, which is joined to the first tank 51B. The first and second tanks 51B and 53B form a refrigerant passage 59 inside.

[0063] The second tank 53B is composed of a single metal sheet. The second tank 53B includes sheet edge portions 53c and 53d each having an L-shaped section. The sheet edge portions 53c and 53d are combined to form a U-shaped outer wall. Side edges 53c1 and 53d1 of the sheet edge portions 53c and 53d are joined with side edges 51c and 51d of the first tank 51B, respectively.

[0064] The second tank 53B includes a support portion 55 formed by joining the two sheets extending from the sheet end portions 53c and 53d. The support portion 55 includes joint portions 55B shown in FIG. 9. In each joint portion 55B, the two plates laid on each other are punched to be caulked. This punching forms a first hollow protrusion 55c in one of the sheets and forms a second hollow protrusion 55d, which is fit in the first hollow protrusion 55c, in the other sheet. Such temporary joint by caulking prevents separation of the sheets in the support portion 55 and prevents occurrence of gap therebetween, thus improving the brazing properties.

[0065] The second tank 53 includes a distribution pipe 53e as a refrigerant distribution portion 53A, which is continuous to each sheet of the support portion 55. The distribution pipe 53e extends in the longitudinal direction within the refrigerant passage 59 to define the refrigerant distribution passage 57 within the same.

[0066] The distribution pipe 53e includes communication holes 53f and 53g spaced apart at regular intervals in the longitudinal direction. The communication holes 53f and 53g connect the refrigerant distribution passage

57 and refrigerant passage 59. The communication holes 53f have a diameter of, for example, 0.6 mm, and the communication holes 53g have a diameter of, for example, 1.0 mm. The communication holes 53f are positioned at three to five o'clock clockwise or counterclockwise with the support portion 55 being set at 0 o'clock. The communication holes 53g are positioned at 0 to three o'clock clockwise or counterclockwise with the support portion 55 being set as 0 o'clock. As shown in FIG. 10, when width t of each tube 21 is laterally projected onto the distribution pipe 53e and the longitudinal range thereof is indicated by R1, the communication holes 53f are positioned so that half or more of the sectional area thereof overlaps the range R1. In other words, each communication holes 53f only needs to partially match the range R1 in terms of the longitudinal position.

[0067] According to this embodiment, integration of the distribution pipe 53e and header tank 93A increases the heat transfer efficiency during baking and reduces the temperature difference between the distribution pipe 53e and header tank 93A during heating or cooling. Such a reduced temperature difference reduces differences in expansion and shrinkage and eliminates distortion of the distribution pipe 53e.

[0068] The integration of the distribution pipe 53e and header tank 93A reduces the numbers of components and assembly steps, thus reducing manufacturing cost.

[0069] The header tank 93 may be shaped into a tank shape by bending a single metal sheet.

Fifth Embodiment

[0070] With reference to FIG. 11, a header tank of this embodiment includes a similar structure to the fourth embodiment and is characterized by joint portions 55C.

[0071] Each joint portion 55C includes a caulking hole 55a, which is formed in one of the sheets of the support portion 55. The joint portion 55C includes a protrusion 55b, which protrudes from the other sheet of the support portion 55. The protrusion 55C is fit into a caulking hole 55a. The tip of the protrusion 55b includes a flange or a ring-shaped stopper 55b1 extending to the outer edge of the caulking hole 55a. The stopper 55b1 prevents separation of the sheets of the support portion 55.

[0072] Next, a description is given of a method of manufacturing the header tank.

[0073] The both side edge portions of one metal sheet are bent to face to each other, thus forming the first tank with a square U-shaped section (see the first tank 51B of FIG. 8).

[0074] A description is given of a method of manufacturing the second tank 53D.

[0075] With reference to FIG. 13, a metal sheet 101 as a raw material is a clad material with a wax layer on the surface thereof.

[0076] The sheet 101 includes a center portion 101a extending from a centerline C1 toward the both side edges. The sheet 101 includes edge portions 101b and 101c extending from the both side edges toward the centerline C1. The sheet 101 includes middle portions 101d and 101e between the center portion 101a and the edge portions 101b and 101c, respectively.

[0077] With reference to FIG. 14A, a description is given of a first step. The first step uses a first table 111 and a second table 113. The first table 111 includes first processing holes 111a, 111b, 111c, and 111d, through which four punches 115a, 115b, 115c, and 115d pass, respectively. The second table 113 similarly includes second processing holes 113a, 113b, 113c, and 113d positioned to match the first processing holes 111a to 111d, respectively.

[0078] The sheet 101 is placed on the first table 111 and centered with respect to the first table 111. The second table 113 is placed on the sheet 101 to place the sheet 101 between the first and second tables 111 and 113. The punches 115a to 115d are inserted from the first processing holes 111a to 111d of the first table 111 to pierce the center portion 101a of the sheet 101 with a predetermined distance apart from the centerline C1 and enter the second processing holes 113a to 113d of the second table 113. With such piercing, four holes 101a1, 101a2, 101a3, and 101a4 are opened in the sheet 101. Among these holes, the two holes 101a1 and 101a2 correspond to the communication holes 53g. The two holes 101a3 and 101a4 correspond to the communication holes 53f.

[0079] With reference to FIG. 14B, a description is given of a second step. The second step uses a first press die 117 and a second press die 119. The first press die 117 includes protrusion portions 117a and 117b at both side edges. The first press die 117 includes a recess portion 117c between the protrusion portions 117a and 117b. The second press die 119 includes arms 119a and 119b extending from both side edges. The second press die 119 includes a protrusion portion 119c in center part. The second press die 119 includes recess portions 119d and 119e between the protrusion portion 119c and the arms 119a and 119b, respectively.

[0080] The sheet 101 is placed on the first press die 117. The second press die 119 is moved down and pressed against the sheet 101 placed on the first press die 117. The arms 119a and 119b of the second press die 119 bend the edge portions 101b and 101c of the sheet 101 at right angles to press the same against the side walls of the first press die 117. The protrusion portion 119c of the second press die 119 dents the center portion 101a of the sheet 101 and press the same against the recess portion 117c of the first press die 118. The protrusion portions 117a and 117b of the first press die 117 and the recess portions 119d and 119e of the second press die 119 hold the middle portions 101d and 101e therebetween.

[0081] With reference to FIG. 14C, a description is given of a third step. The third step uses a processing table 121, a press tool 123, and a punch tool 125. The processing table 121 has a similar structure to that of the first press die 117 and includes first and second protrusion portions 121a and 121b at both side edges. The first protrusion portion 121a includes a hole 121c, into which the punch tool 125 is inserted. The second protrusion portion 121b includes a protrusion 121d thereon.

[0082] The sheet 101 is placed on the upper face of the processing table 121. The punch tool 125 pierces the middle portion 101d on the protrusion portion 121a to open the hole 101f in the middle portion 101d. This hole 101f corresponds to the caulking hole 55a. A recess 123a of the press tool 123 is pressed against the middle portion 101e on the protrusion 121d of the protrusion portion 121b to form a protrusion 101g in the middle portion 101e. This protrusion 101g corresponds to the protrusion 55b. The protrusion 101g and hole 101f are formed just before a fifth step, or a caulking step, thus increasing positional accuracy.

[0083] With reference to FIG. 14D, a description is give of a fourth step. The fourth step uses a first press die 127 and a second press die 129. The first press die 127 includes a recess portion 127b with a semicircular cross section. The second press die 129 includes a cuboid die 129a and a cylindrical die 129b at an end of the cuboid die 129a.

[0084] The sheet 101 is placed on the processing table 127. The second press die 129 is moved down to press the center portion 101a of the sheet 101 against the recess portion 127b and shape a lower half 101a1 of the center portion 101a so as to have a semicircular section. The upper half of the center portion 101 and the middle portions 101d and 101e are pressed against side walls of the cuboid die 129a.

[0085] With reference to FIG. 14E, a description is given of a fifth embodiment. The fifth embodiment uses a first press die 131, second press dies 133a and 133b, and a third press die 135. The first press die 131 includes a recess portion 131b with a semicircular section in a top face 131a. The second press dies 133a and 133b include recess portions 133a1 and 133b1 with quarter circular sections, respectively. The third press die 135 includes guides 135a and 135b extending from the both side edges.

[0086] The lower half of the middle portion 101a of the sheet 101 is set in the recess portion 131b of the first press die 131. The second press dies 133a and 133b are applied to the upper half of the center portion 101a and the middle portions 101d and 101e. The upper half of the center potion 101a is brought into contact with the recess portions 133a1 and 133b1. The middle portions 101d and 101e come into contact with each other, and the protrusion 101g of the middle portion 101e is inserted into the hole 101e of the middle portion 101d. The third press die 135 is moved down toward the both edge portions 101b and 101c of the sheet 101 on the second dies 133a and 133b. The guides 135a and 135b slide on the side walls of the second press dies 133a and 133b to press the second press dies 133a and 133b to the sheet 101. The second press dies 133a and 133b pressure-bond the middle portions 101d and 101e and crushes and extends the tip of the protrusion 101g into a ring shape (caulking). The ring-shaped tip corresponds to the stopper 55b1. The recess portions 133a1 and 133b1 shape the upper half of the center portion 101a into an arc.

[0087] With reference to FIG. 14F, a description is given of a sixth step. The sixth step uses a first press die 137 and a second press die 139. The first press die 137 includes two components combined.

[0088] The components of the first press die 137 individually include convex outer walls 137a1 and 137a2. The first press die 137 includes a recess of a combination of a space 137c with a rectangular section and a space 137b with a circular section. The second press die 139 includes a recess portion 139a. The recess portion 139a includes concave inner walls 139a1 and 139a2 on both sides of the centerline C1.

[0089] The center portion 101a of the sheet 101 is set in the space 137b, and the middle portions 101d and 101e are set in the space 137c. The both edge portions 101b and 101c of the sheet 101 are set on the outer walls 137a1 and 137a2.

[0090] The second press die 139 is moved down to the first press die 137. The inner wall 139a1 and 139a2 press the both edge portions 101b and 101c of the sheet 101 against the outer walls 137a1 and 137a2. With such a press, the both edge portions 101b and 101c are bent toward the center potion 101a.

[0091] Thereafter, the middle portions 101d and 101e of the sheet 101 are brazed to complete the second tank 53D. The wax material may be applied to the middle portions 101d and 101e after the sixth step.

[0092] The both side edges of the first tank and second tank 53D are brazed to complete the header tank.

[0093] According to this embodiment, bringing the middle portions 101d and 101e of the sheet 101 into contact for caulking suppresses the separation of the sheets of the support portion 55 before baking and prevents bad brazing.

[0094] The protrusion 55b between the sheets of the support portion 55 stabilizes the fluidity of the wax to improve the brazing properties. In other words, the members having a contact point (joint) allows the wax material to easily flow on the entire contact surface.

Sixth Embodiment

[0095] With reference to FIGS. 15 and 16, a description is given of a header tank 93B according to this embodiment.

[0096] This header tank 93B is characterized by a second tank 53E. Specifically, the second tank 53E includes communication holes 53p, for example, with an equivalent diameter of 1.0 mm or more in the support portion 55. The communication holes with an equivalent diameter of 1.0 mm or more are holes having an opening area equivalent to a circular hole with a diameter of 1.0 mm or more. The communication holes 53p are formed at regular intervals in the longitudinal direction. The distribution pipe 53e further includes communication holes 53g between the communication holes 53f and 53p.

[0097] As shown in FIG. 16, the communication holes 53p communicate with refrigerant passages 59 on both sides of the support portion 55 and allow transfer of the refrigerant in liquid phase between the refrigerant passages 59.

[0098] With reference to FIGS. 17 and 18, a description is given of a header tank 93C of another aspect. This header tank 93C is characterized by a second tank 53F. Specifically, the second tank 53F includes communication holes 53q positioned so as to extend from the support portion 55 to the distribution pipe 57. These communication holes 53q also have a function to discharge liquid refrigerant from the distribution pipe 57, so that holes to discharge liquid refrigerant are eliminated.

[0099] According to the aforementioned embodiment, the communication holes 53p and 53q, respectively, keep equal liquid levels of the liquid refrigerant on each side of the support portion 55 within the header tanks 53E and 53F and thus stabilize the performance of the header tanks 53E and 53F.

[0100] This structure prevents accumulation of lubricant oil of a compressor and protects the compressor.

[0101] This structure achieves weight reduction of the header tanks 53E and 53F.

INDUSTRIAL APPLICABILITY

[0102] The header tank of the heat exchanger of the present invention is useful in terms of application to vehicle air conditioners such as compressors and evaporators.

Claims

1. A header tank for a heat exchanger, comprising:

a plurality of tank constituent portions joined into a cylindrical shape with a substantially square cross-section; and
a refrigerant passage formed within the plurality of tank constituent portions; wherein
the plurality of tank constituent portions include:

a tank upper portion (31) with a plurality of tube insertion holes (31a) for connection of tubes (21) of the heat exchanger core formed;
a tank lower portion (33) including a refrigerant distribution groove (33A) with a substantially U-shaped section which has a plurality of refrigerant communication holes (33a, 33b) in a longitudinal direction;
a plate portion (35) closing an opening of the refrigerant distribution groove (33A) to form a refrigerant distribution passage (37) within the tank lower portion.

2. A header tank for a heat exchanger, comprising:

a plurality of tank constituent portions joined into a cylindrical shape with a substantially square section; wherein
the plurality of tank constituent portions include:

a tank upper portion (51) with a plurality of tube insertion holes (51a) for connection of tubes (21) of the heat exchanger core formed;
a tank lower portion (53) including a refrigerant distribution portion (53A) with a substantially circular section integrally formed with a body of the lower portion, the refrigerant distribution portion having a plurality of refrigerant communication holes (53a, 53b) in a longitudinal direction.

3. A header tank (83) of a heat exchanger, comprising:

a header tank (83) formed of a single constituent material into a tubular shape with a substantially square section, wherein
an upper face of the header tank includes a plurality of tube insertion holes (61a) for connection of tubes (21) of the heat exchanger core; and
a lower face of the header tank integrally includes a refrigerant distribution portion (63A) with a substantially circular section with a tank body, the refrigerant distribution portion (63A) includes a plurality of refrigerant communication holes (63a, 63b) along a longitudinal direction.

4. The header tank according to any one of claims 2 and 3, wherein
the refrigerant distribution portion (53A) includes a part of a plate material as a tank constituent member which is shaped to have a substantially Ω-shaped section; and
the tank includes a plurality of joints (55A) in a portion where portions of the plate material are laid on each other in the substantially Ω-shaped section.

5. The header tank for a heat exchanger according to any one of claims 1 to 4, wherein
the refrigerant communication holes (33a, 33b) include:

first communication holes (33a) through which refrigerant in gas phase passes; and
second communication holes (33b) through which refrigerant in liquid phase passes, and
the refrigerant distribution groove (33A) includes:

the first communication holes (33a) in upper part in a direction of gravity when the refrigerant flows within the header tank; and
the second communication holes (33b) in lower part in the direction of gravity.

6. The header tank for a heat exchanger according to any one of claims 1 to 5, wherein
each of the refrigerant communication holes (33a, 33b) is positioned to have half or more of a sectional area overlapped on a range of thickness (t) of the tubes (21).

7. The header tank for a heat exchanger according to any one of claims 1 to 5, wherein
the communication holes (33a, 33b) and the tubes (21) match each other in terms of longitudinal positions in the header tank.

8. The header tank for a heat exchanger according to claim 4, wherein the joint portions (55A) are caulked.

9. The header tank for a heat exchanger according to claim 4, wherein each of the joint portions (55A) includes a hole; and a protrusion fit in the hole.

10. The header tank for a heat exchanger according to claim 4, wherein each of the joint portions (55C) includes a hole (55a) ; and a protrusion (55b) which pierces the hole (55a) and has a crushed tip.

11. The header tank for a heat exchanger according to any one of claims 2 and 3, wherein
the refrigerant distribution portion (53B) includes:

a refrigerant distribution pipe (37);
a support portion (55) supporting the refrigerant distribution pipe (37); and
communication holes (53p) which communicates with refrigerant passages on both sides of the support portion (55) .

12. The header tank for a heat exchanger according to claim 9, wherein the communication holes (53p) have an equivalent diameter of 1.0 mm or more.

13. The header tank for a heat exchanger according to any one of claims 2 and 3, wherein
the refrigerant distribution portion (53F) includes:

a refrigerant distribution pipe (57) including a refrigerant distribution passage defined inside;
a support portion (55) supporting the refrigerant distribution pipe (57); and
a communication holes (53q) allowing refrigerant passages on both sides of the support portion 55 and the refrigerant distribution passage to communicate with each other.

14. A method of manufacturing a header tank for a heat exchanger, comprising the steps of:

opening a hole (55a) in a first portion (101d) of a sheet (101);
forming a protrusion (55b) in a second portion (101e) of the sheet (101);
winding a third portion (101a) between the first and second portions (55a, 55b) of the sheet (101) to bring the first and second portions (101d, 101e) close to each other to form a refrigerant distribution passage;
piercing the hole (55a) with the protrusion (55b);
crushing a tip of the protrusion (55b) piercing the hole (55a); and
bending fourth and fifth portions (101b, 101c) outside of the first and second portions (101d, 101e) in the sheet (101) toward the wound third portion (101a) to form a refrigerant passage.

15. The method of manufacturing a header tank for a heat exchanger according to claim 13, wherein communication holes (53f) are opened in the third portion (101a) of the sheet (101).

FIG. 1

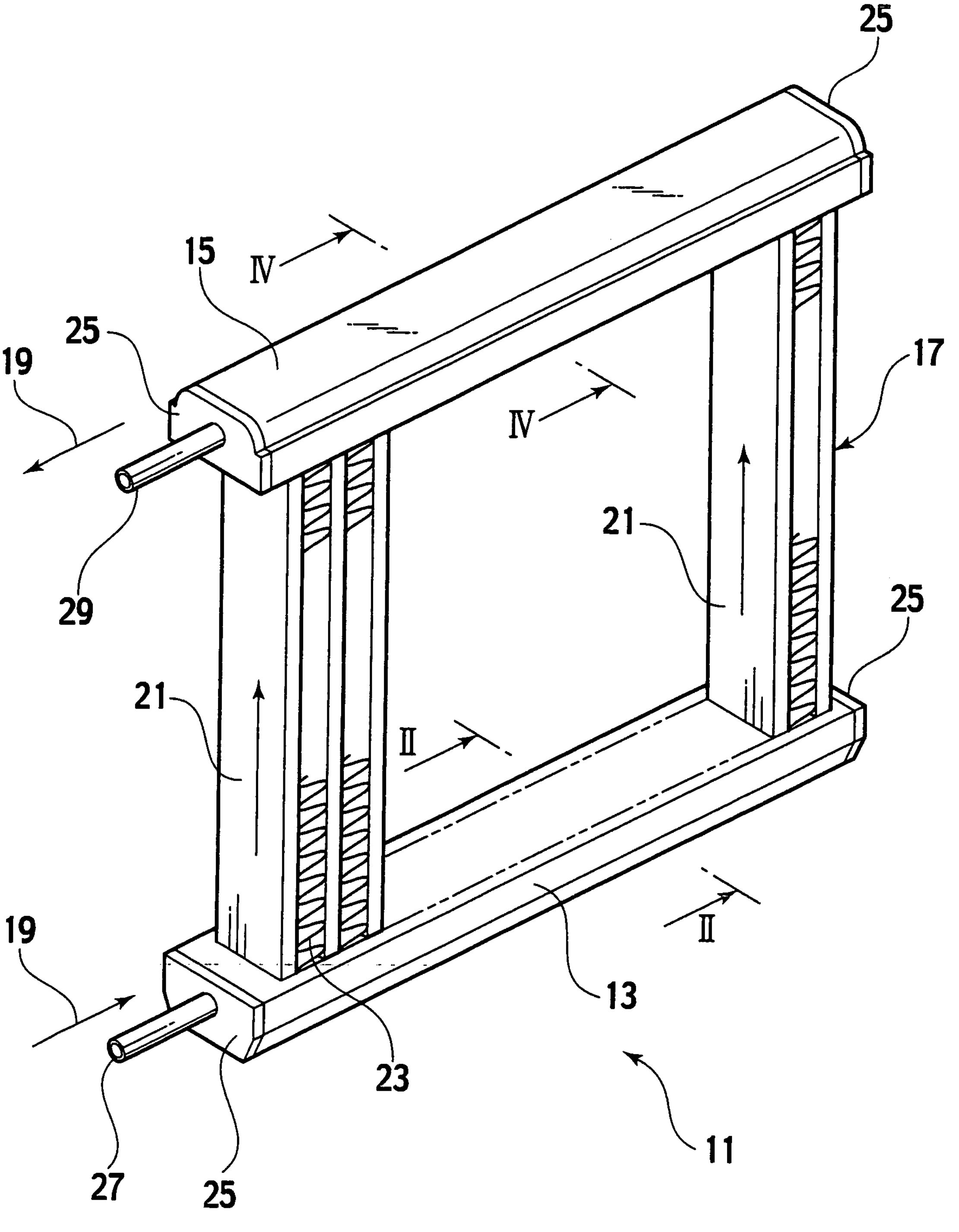


FIG. 2

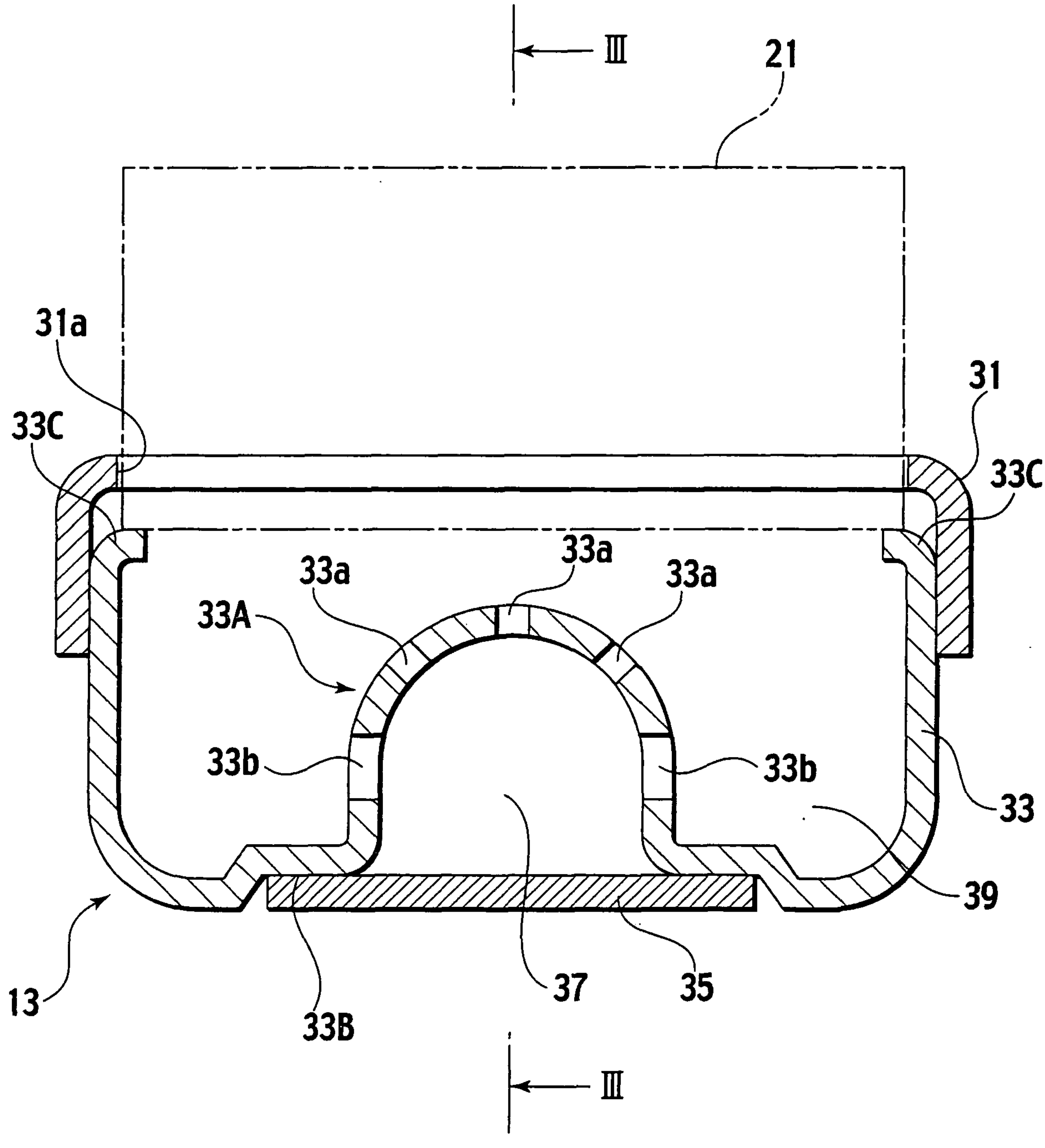

III
21
31a
33C
31
33C
33a
33a
33a
33A
33b
33b
33
39
13
33B
37
35
III

FIG. 3

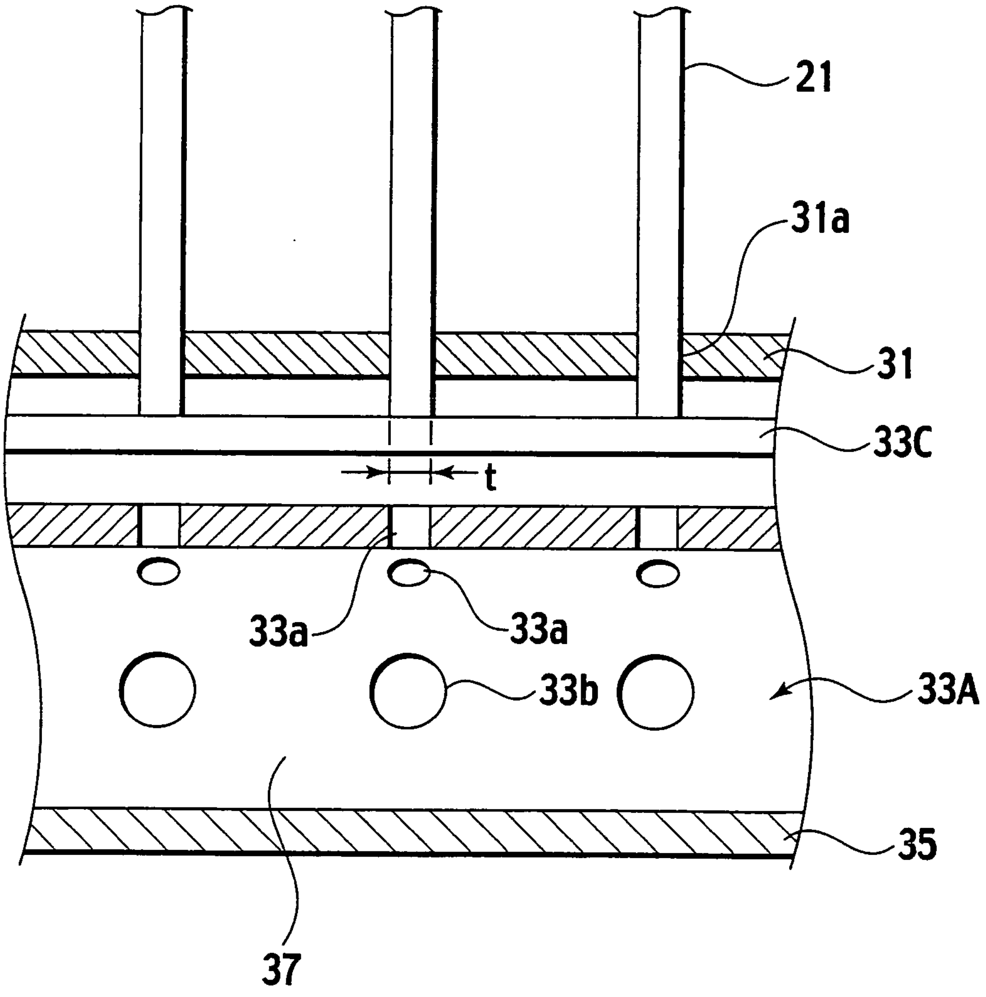


FIG. 4

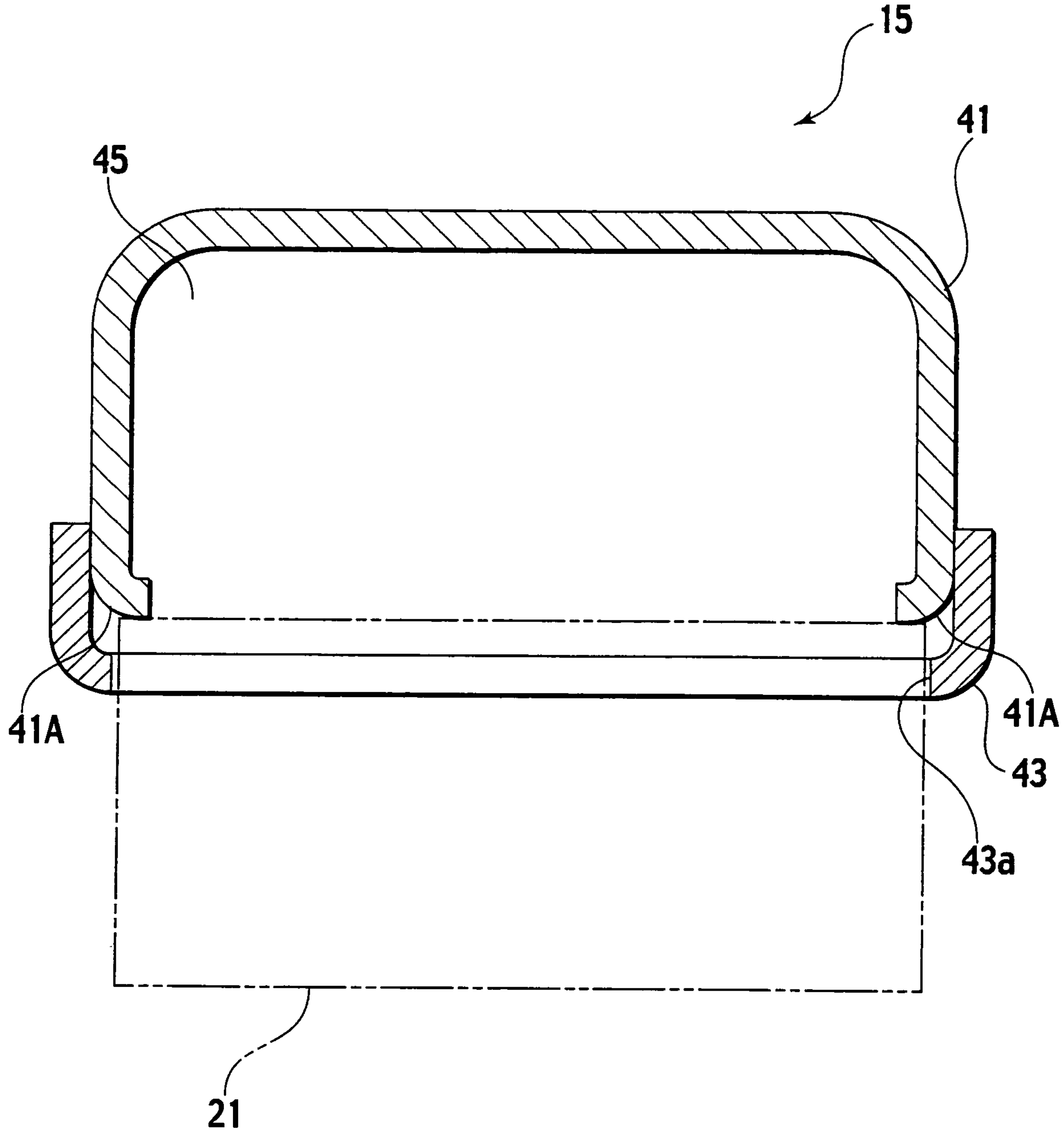


FIG. 5

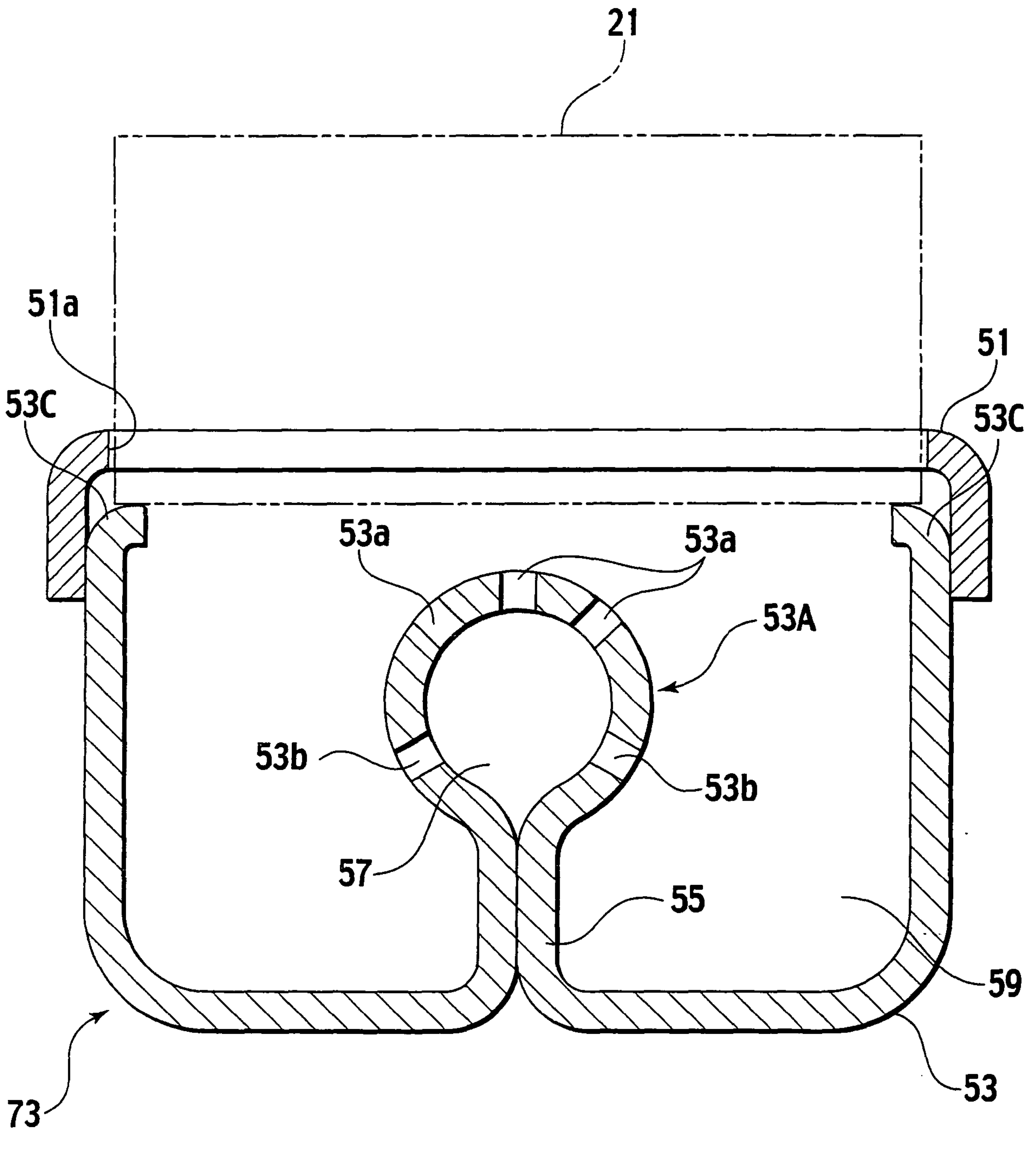


FIG. 6

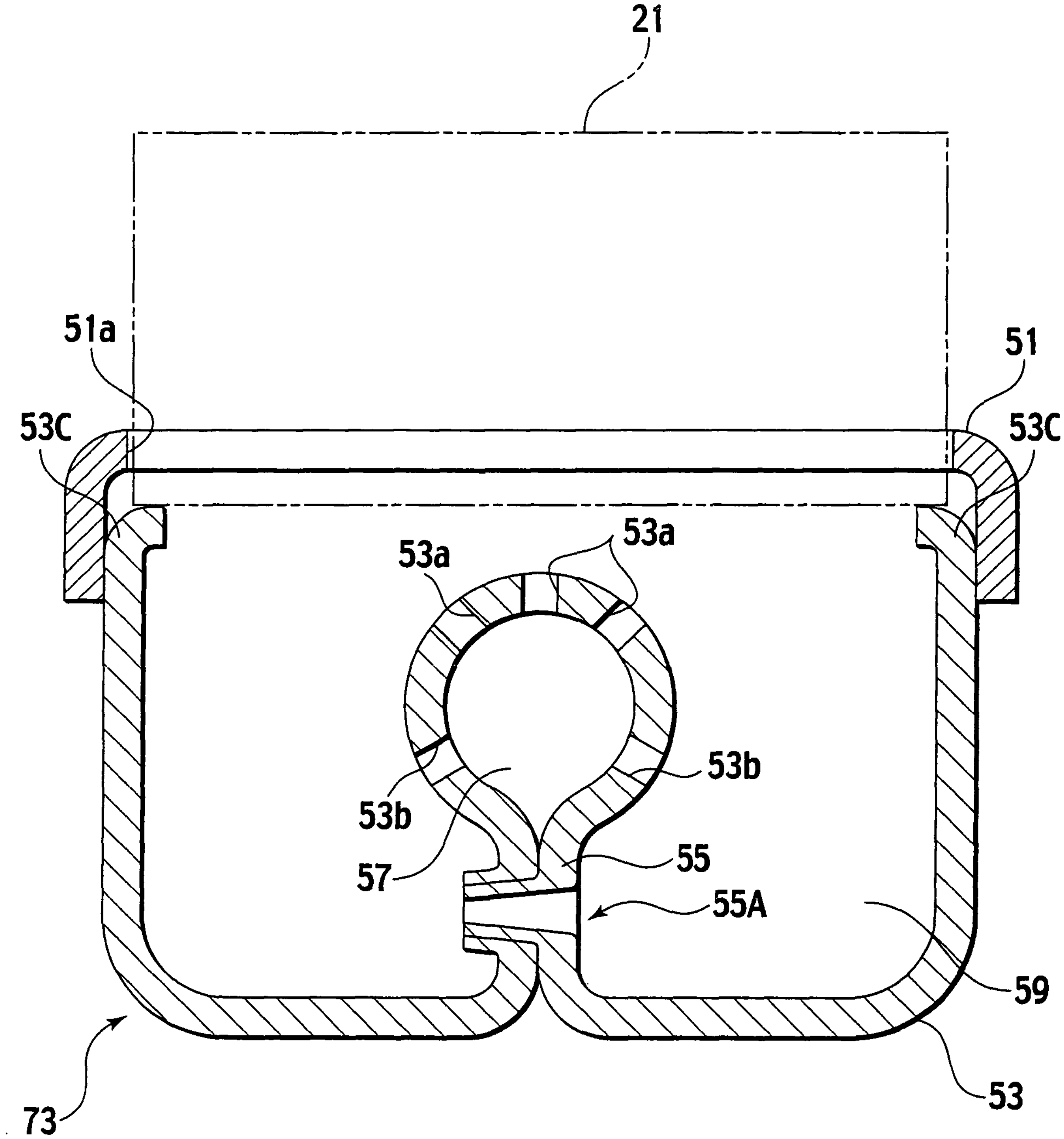


FIG. 7

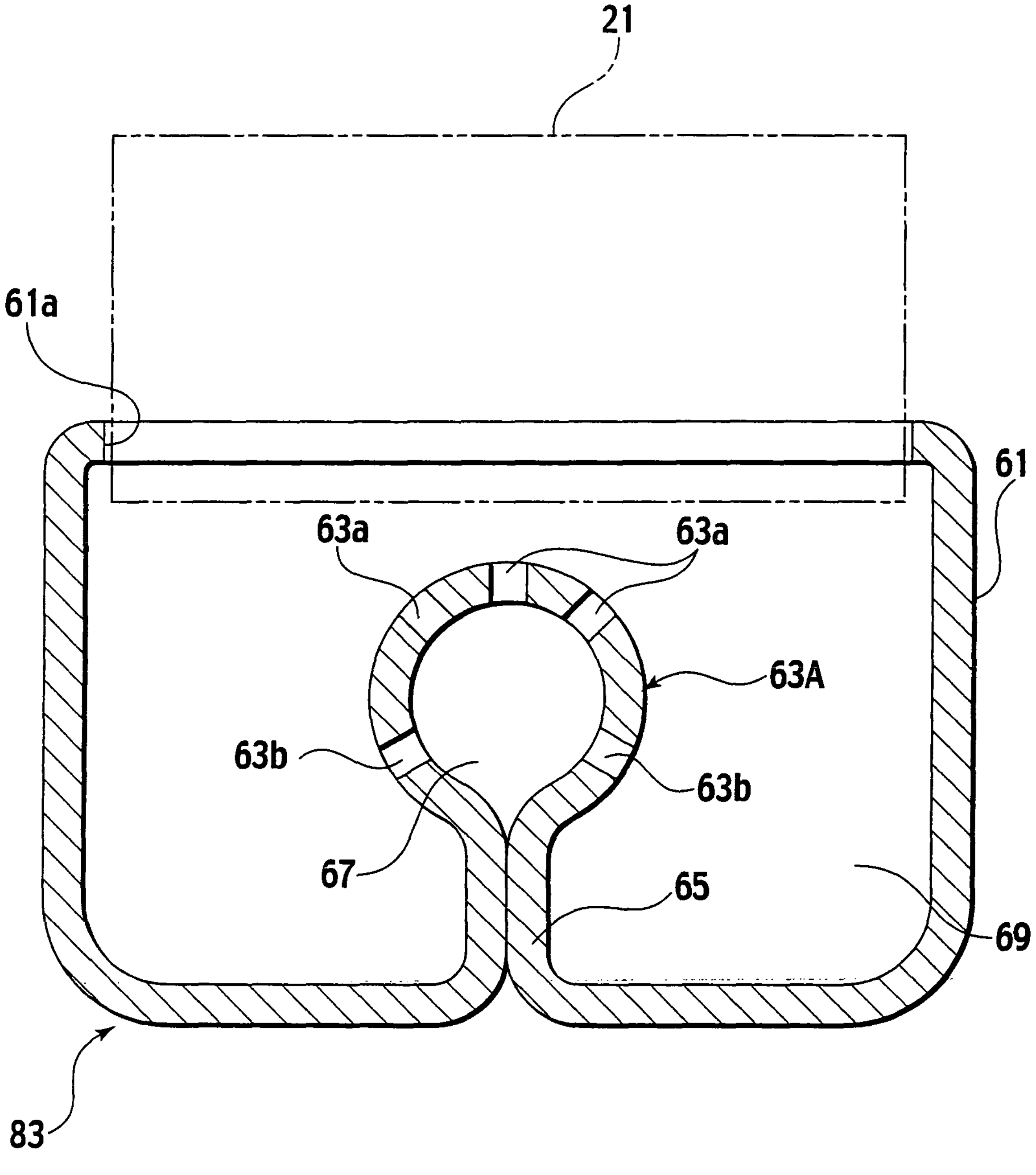


FIG. 8

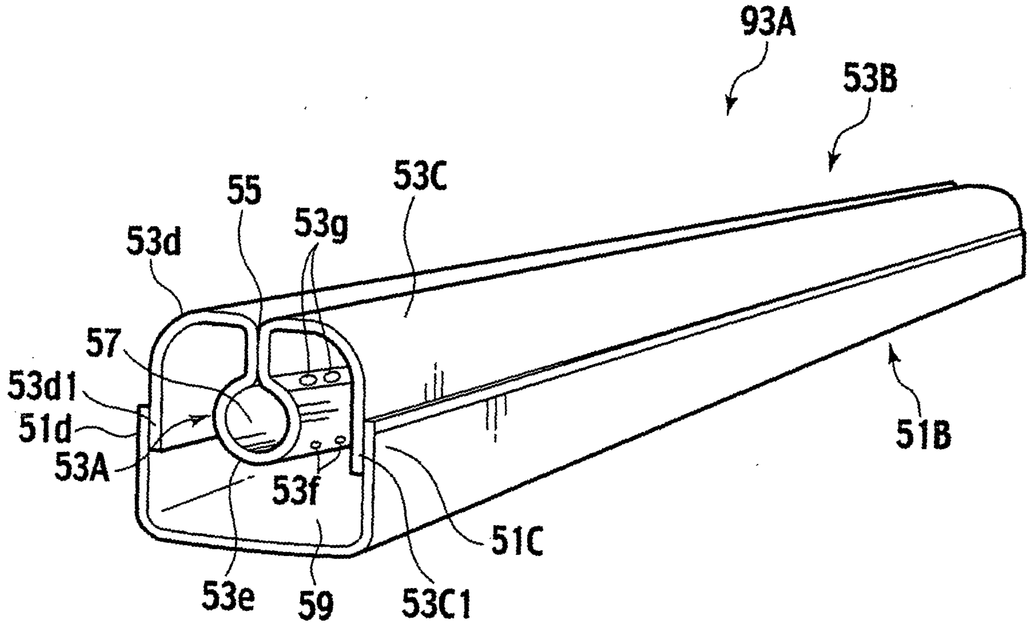


FIG. 9

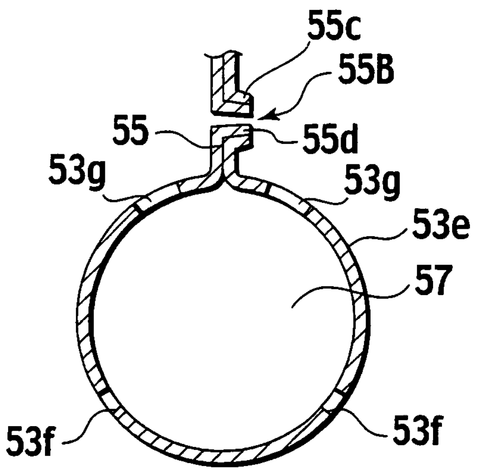


FIG. 10

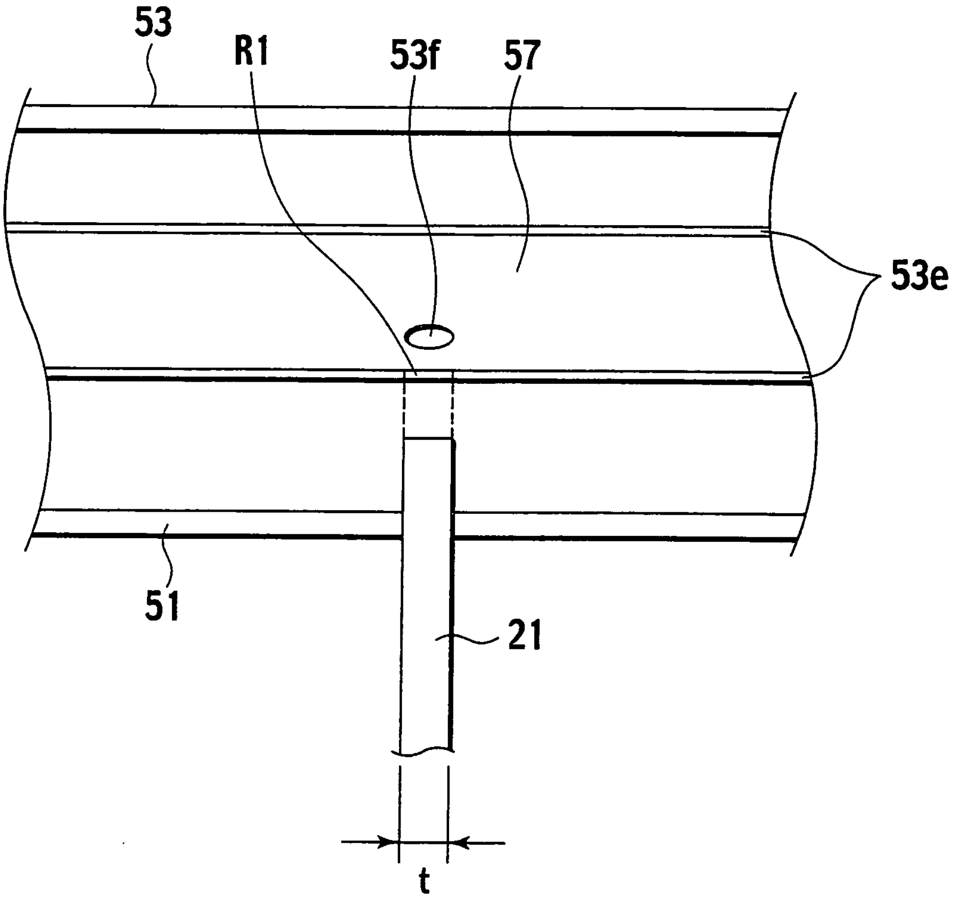


FIG. 11

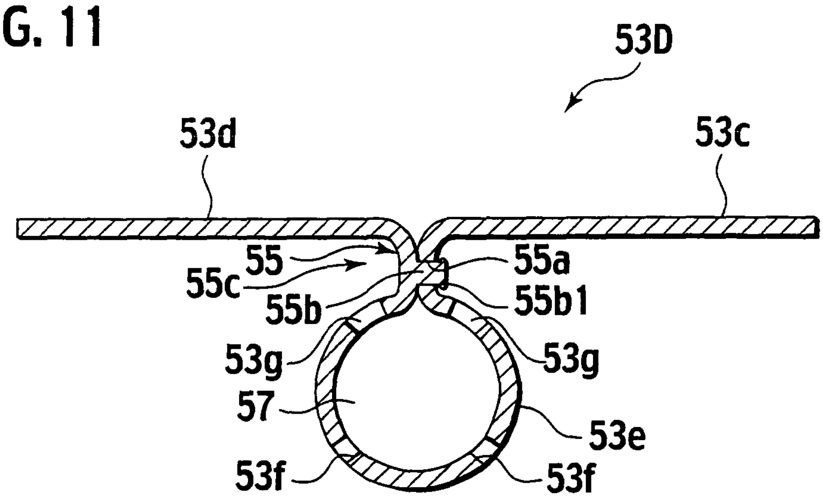

53D
53d
53c
55
55c
55a
55b
55b1
53g
53g
57
53e
53f
53f

FIG. 12

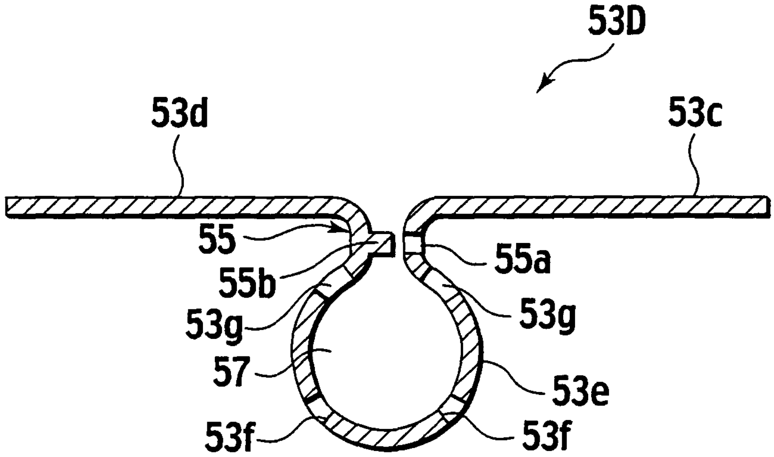

53D
53d
53c
55
55b
55a
53g
53g
57
53e
53f
53f

FIG. 13

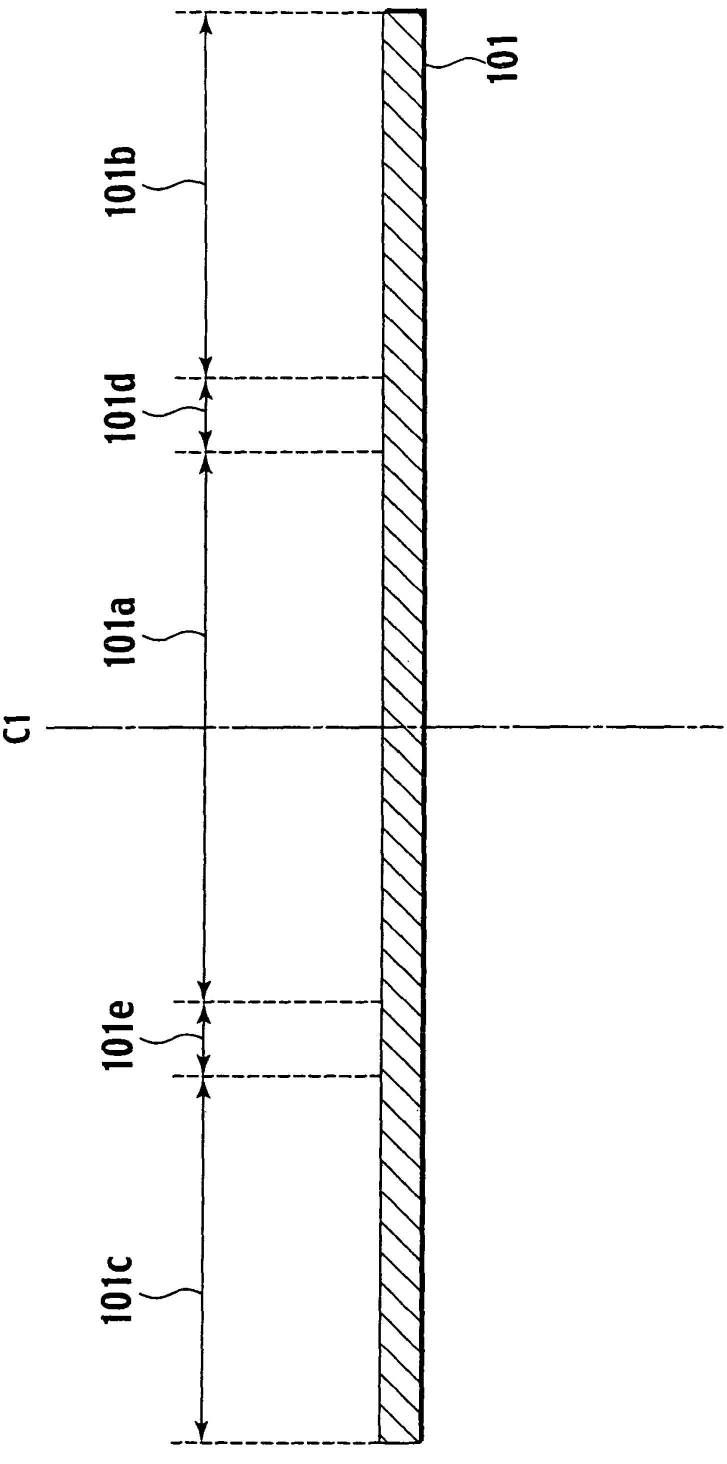


FIG. 14A

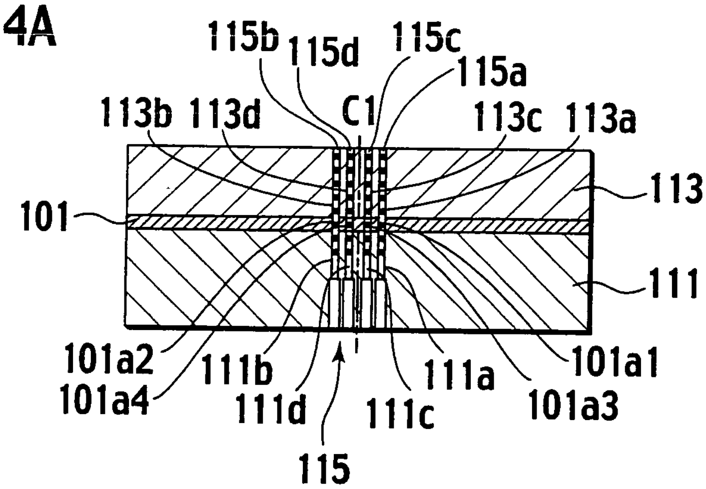


FIG. 14B

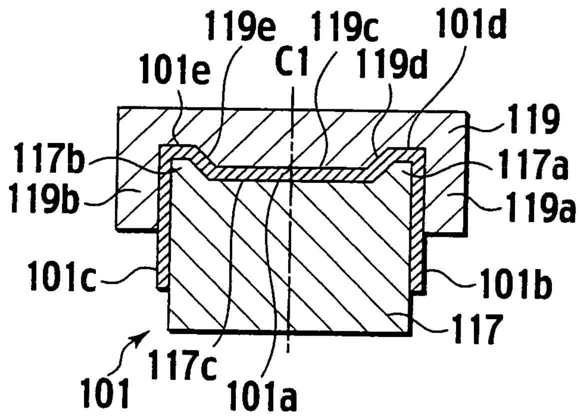


FIG. 14C

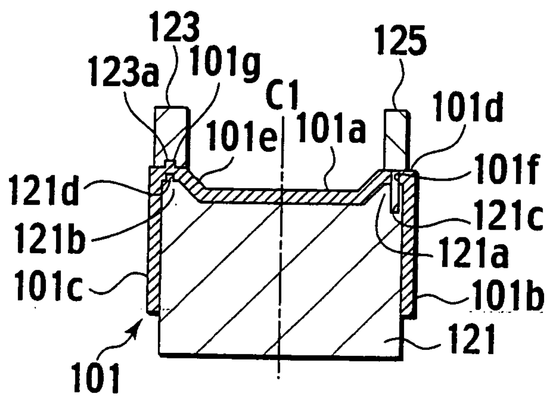


FIG. 14D

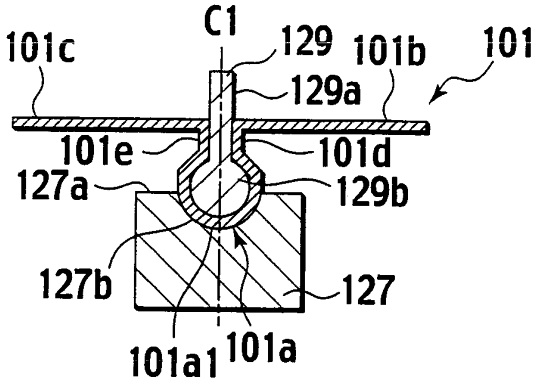


FIG. 14E

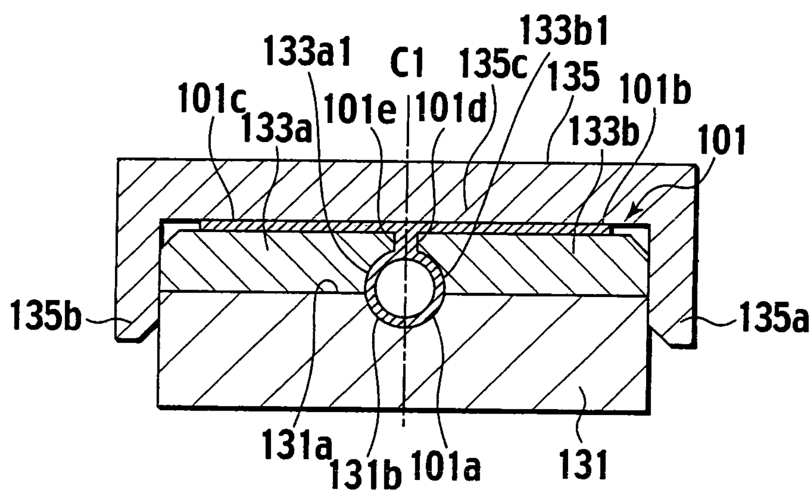


FIG. 14F

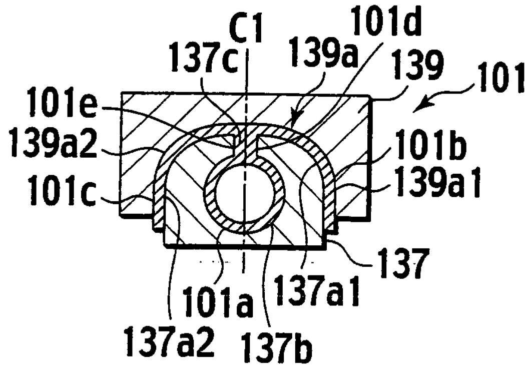


FIG. 15

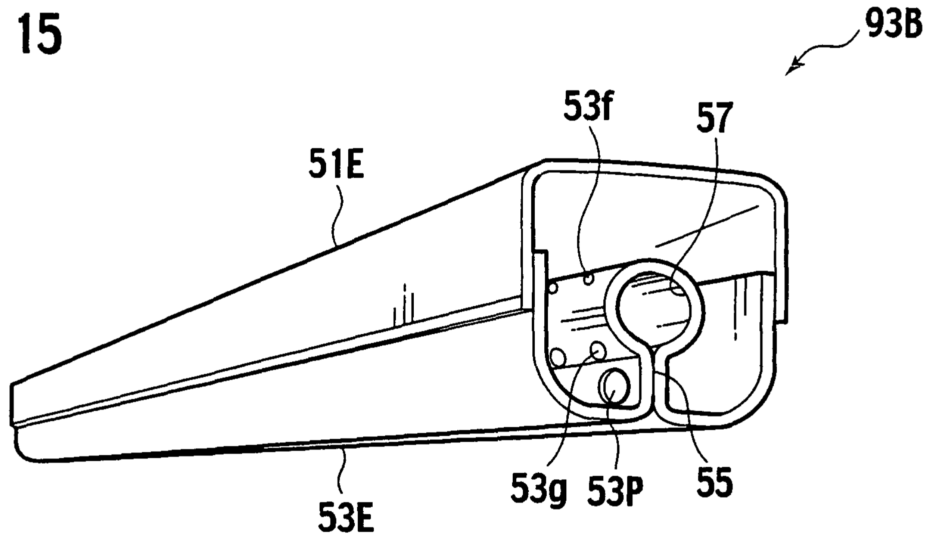
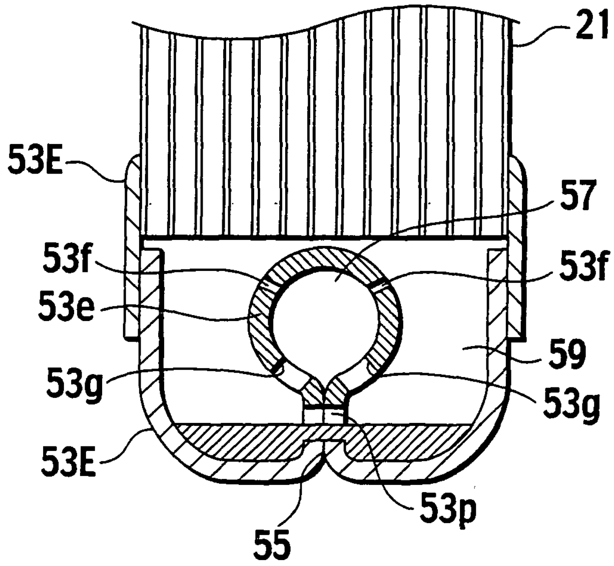

93B
53f
57
51E
53g
53P
55
53E

FIG. 16


21
53E
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53f
53f
53e
59
53g
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53E
53p
55

FIG. 17

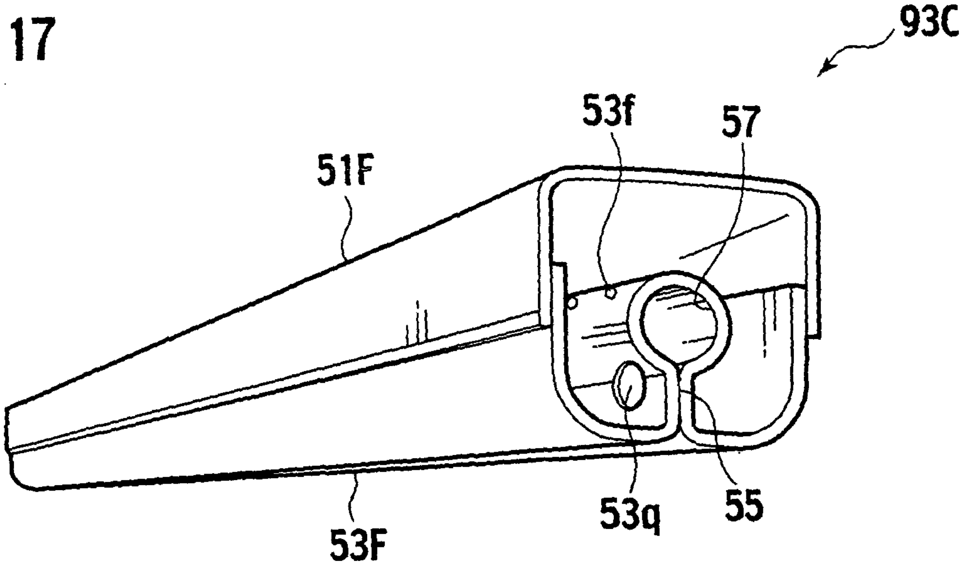
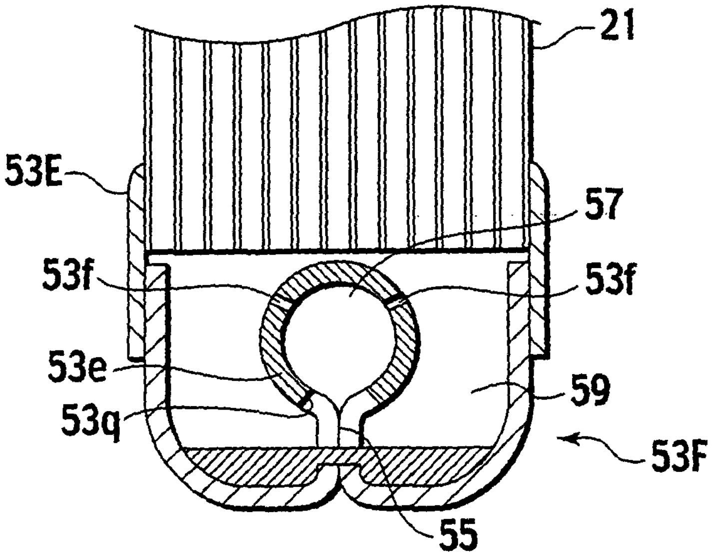


FIG. 18



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/016442

A. CLASSIFICATION OF SUBJECT MATTER
F28F9/02 (2006.01)

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)
F28F9/02 (2006.01)

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	1996-2005
Kokai Jitsuyo Shinan Koho	1971-2005	Toroku Jitsuyo Shinan Koho	1994-2005

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 2004-324937 A (Calsonic Kansei Corp.), 18 November, 2004 (18.11.04), Full text; Figs. 1 to 6 (Family: none)	1-15
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 104079/1990(Laid-open No. 063979/1992) (Mitsubishi Heavy Industries, Ltd.), 01 June, 1992 (01.06.92), Full text; all drawings (Family: none)	1-15

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

* Special categories of cited documents:
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- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "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
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "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
05 December, 2005 (05.12.05)

Date of mailing of the international search report
13 December, 2005 (13.12.05)

Name and mailing address of the ISA/
Japanese Patent Office

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Telephone No.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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