

Description

Technical Field

[0001] The present invention relates to an aluminum-made flat tube for a heat exchanger, having a B-shape-bend cross section and being coated with a brazing filler metal on the outer face thereof.

Background Art

[0002] As seen in Fig. 9, the aluminum-made flat tube for a heat exchanger, has a flat and nearly B-shaped cross section, in which a partition part 7 stands erect at the center of the width direction and comprises its top to connect with a joint part 8 formed by folding the both edge parts of a strip-shaped material. At the joint part 8, the both edge parts of the strip-shaped material are turned-up by 180° to expose their respective brazing filler metals 3 to the inner side, the brazing filler metals 3 contacting the top of the partition part 7.

[0003] The flat tube thus formed is placed in a high temperature furnace, where the brazing filler metal 3 is fused, and then is cooled to solidify, allowing the brazing filler metal 3 to braze the top of the partition part 7 and the joint part 8 to fix with each other, as seen in Fig. 10. At that moment, fins 11 and a tube plate (not shown) also are integrally brazed to fix with each other, (for example, see the Description of USP 5765634).

[0004] The above B-shaped flat tube has an advantage of high pressure-resistance owing to the presence of the partition part 7.

[0005] The above B-shaped flat tube, however, is found to have a drawback of poor corrosion resistance in inner face of the tube. For a radiator, for example, it is a known practice that the inner face of the tube is coated with a sacrificial anode material made of an aluminum alloy to improve the corrosion resistance. However, on brazing the partition part 7 by the brazing filler metal on the outer face of the tube, both edge parts of the strip-shaped material in the width direction thereof are turned-up inward, then, it was found that the brazing filler metal 3 is held on the turned-up top face during fusing the brazing filler metal, as shown in Fig. 10, which held brazing filler metal then contacts the sacrificial anode material, and the corrosion likely proceeds at the contact section.

[0006] The reason of the phenomenon is as follows.

[0007] When the brazing filler metal 3 adheres to the sacrificial anode material 2 and when it is heated, the sacrificial anode material 2 and the brazing filler metal 2 yield a new aluminum alloy. The potential of the new aluminum alloy becomes close to the potential of the core material, thus the effect of sacrificial anode becomes extremely weak, and thereby the corrosion attack concentrates against the contact section.

[0008] In this regard, an object of the present invention is to provide a B-shaped flat tube to solve the problem

of the inner face corrosion.

Disclosure of the Invention

[0009] The first aspect of the present invention, disclosed in claim 1, is an aluminum-made flat tube for a heat exchanger, fabricated by an aluminum strip-shaped material being structured by a core material (1) coated with a sacrificial anode material (2) on the inner face thereof and coated with a brazing filler metal (3) on the outer face thereof into a nearly B-shaped cross section, which strip-shaped material is bent in the width direction thereof to have: a pair of a first flat plane (4) and a second flat plane (5), facing and extending in parallel to each other; a pair of curved parts (6) connecting the first flat plane (4) and the second flat plane (5) in the width direction; a partition part (7) being formed by turning-up the first flat plane (4) at the center in the width direction thereof of vertically inward therefrom; a joint part (8) formed by turning-up the each edge part of the strip-shaped material at the center in the width direction of the second flat plane (5) to butt the turned-up edges with each other, and by connecting the turned-up edge parts to the partition part (7); wherein the both edge parts in the width direction of the strip-shaped material are folded inward into the tube, and the edges are apart from the inner face of the second flat plane (5).

[0010] The second aspect of the present invention, disclosed in claim 2, is the aluminum-made flat tube for a heat exchanger as in claim 1, wherein the both edge parts in the width direction are formed to butt to each other in a form of umbrella-shaped cross section, and the top of the partition part (7) contacts the inner top face of the umbrella.

[0011] The third aspect of the present invention, disclosed in claim 3, is the aluminum-made flat tube for a heat exchanger as in claim 2, wherein a concave brazing filler metal basin (9) is formed near the front end of each edge part.

[0012] The fourth aspect of the present invention, disclosed in claim 4, is the aluminum-made flat tube for a heat exchanger as in claim 1, wherein the each edge parts in the width direction have their respective leg parts (13) formed by bending orthogonal to the second flat plane (5), while the front end portion of each bent part is turned-up toward the second flat plane (5) by a length shorter than the length of the leg part (13), and the turned-up top face contacts the top of the partition part (7).

[0013] The fifth aspect of the present invention, disclosed in claim 5, is the aluminum-made flat tube for heat exchanger as in claim 1, wherein the both edge parts in the width direction have their respective leg parts (13) bent orthogonal to the second flat plane (5), while the front end portion of each bent part is further bent to nearly parallel to the second flat plane (5), and the bent top face contacts the top of the partition part (7).

[0014] The sixth aspect of the present invention, dis-

closed in claim 6, is an aluminum-made flat tube for a heat exchanger, fabricated by an aluminum strip-shaped material being structured by a core material (1) coated with a sacrificial anode material (2) on the inner face thereof and coated with a brazing filler metal (3) on the outer face thereof into a nearly B-shaped flat cross section, which strip-shaped material is bent in the width direction thereof to have: a first flat plane (4) and a second flat plane (5), facing and extending in parallel to each other; a pair of curved parts (6) connecting the first flat plane (4) and the second flat plane (5) in the width direction; a partition part (7) being formed by turning-up the first flat plane (4) at the center in the width direction thereof vertically inward therefrom; an overlapping part (8) formed by overlapping the each edge part of the strip-shaped material at the center in the width direction of the second flat plane (5) with each other, and by connecting the overlapped part to the partition part (7); wherein one edge part in the width direction of the strip-shaped material extends over the second flat plane (5), while the other edge part is formed into a step inward the inner face by the thickness of the strip-shaped material, and the front end portion of the stepped part is turned-up to a middle position of the stepped part, then the turned-up overlapped part (10) contacts the top of the partition part (7).

[0015] The flat tube according to the present invention has a structure described above, and provides following effects.

[0016] The flat tube is an aluminum-made flat tube fabricated by an aluminum strip-shaped material being structured by a core material 1 coated with a sacrificial anode material 2 on the inner face thereof and coated with a brazing filler metal 3 on the outer face thereof. Both end parts of the strip-shaped material at the joint 8 are folded inward into the tube, while each edge of the folded parts is apart from the second flat plane 5. The configuration prevents the fused brazing filler metal from adhering to the sacrificial anode material 2 on the inner face of the second flat plane 5 during brazing, thus preventing the inner face corrosion caused by the adhesion of brazing filler metal, and thereby providing a highly reliable flat tube.

[0017] With the configuration, it is possible to structure a flat tube by letting both the edge parts in the width direction of the strip-shaped material as the basic material are formed to butt to each other in an umbrella-shaped cross section, and by letting the top of the partition part 7 contact the inner top face of the umbrella. The configuration ensures easy forming and high corrosion resistance on the inner face of the tube.

[0018] The above configuration may further have a concave brazing filler metal basin 9 formed near the front end of each edge part. With the configuration, the presence of brazing filler metal basin 9 holds the fused brazing filler metal, thereby further surely preventing the adhesion of brazing filler metal to the sacrificial anode material 2.

[0019] According to the first aspect of the present invention, both edge parts in the width direction are bent orthogonal to the second flat plane 5, and the leg part 13 is formed at the bent part, further the bent part is turned-up so as the front end portion of the bent part to become shorter than the length of the leg part 13, thereby allowing the turned-up top face to contact the top of the partition part 7. Also in this case, the turned-up part is shorter than the length of the leg part 13 so that the fused brazing filler metal is prevented from reaching the sacrificial anode material 12 on the second flat plane 5, thereby providing a highly durable flat tube.

[0020] According to the first aspect of the present invention, both end parts of the strip-shaped material are bent orthogonal to the second flat plane 5 to form the leg part 13, and the front end portion of the bent part is bent to near parallel to the second flat plane 5, thereby allowing the bent top face to contact the top of the partition part 7. In this case, the presence of leg part 13 further prevents the fused brazing filler metal from adhering to the sacrificial anode material 2 on the second flat plane 5 on fusing the brazing filler material, thereby providing a highly reliable flat tube.

[0021] Furthermore, it is possible that both edge parts in the width direction of the strip-shaped material overlap with each other to form a step for only one edge part by the thickness of the strip-shaped material, and that the front end portion of the stepped edge part is turned-up to a middle position of the stepped part, thereby allowing the overlapped part 10 of the turned-up part to contact the top of the partition part 7. Also in this case, the fused brazing filler metal is effectively prevented from reaching the sacrificial anode material 2 on the second flat plane 5 during fusing the brazing filler metal, thus providing a highly durable flat tube.

Brief Description of the Drawings

[0022]

Fig. 1 shows a cross sectional view of a flat tube in the first embodiment according to the present invention, giving the state before brazing.

Fig. 2 shows a cross sectional view of a main-part of the flat tube, giving the state after brazing.

Fig. 3 shows a cross sectional view of a main part of a flat tube in the second embodiment according to the present invention.

Fig. 4 shows a cross sectional view of a main part of a flat tube in the third embodiment according to the present invention.

Fig. 5 shows a cross sectional view of a main part of a flat tube in the fourth embodiment according to the present invention.

Fig. 6 shows a cross sectional view of a main part of a flat tube in the fifth embodiment according to the present invention.

Fig. 7 shows a cross sectional view of a main part

of a flat tube in the sixth embodiment according to the present invention.

Fig. 8 shows a cross sectional view of a main part of a flat tube in the seventh embodiment according to the present invention.

Fig. 9 shows a cross sectional view of a conventional flat tube, giving the state before brazing.

Fig. 10 shows a cross sectional view of a conventional flat tube, giving the state after brazing.

Best Mode for Carrying Out the Invention

[0023] The embodiments of the present invention are described below referring to the drawings.

[0024] Fig. 1 shows a cross sectional view of a flat tube in the first embodiment according to the present invention, giving the state before brazing. Fig. 2 shows a cross sectional view of a main part of the flat tube, giving the state after brazing.

[0025] The first embodiment gives a flat tube formed by bending an aluminum strip-shaped material in the width direction thereof, which strip-shaped material is structured by the aluminum core material 1 coated with a brazing filler metal 3 made of an aluminum alloy on the outer face thereof and coated with a sacrificial anode material 2 made of an aluminum alloy on the inner face thereof.

[0026] The strip-shaped material is bent in the width direction thereof to let the first flat plane 4 and the second flat plane 5 face to each other in parallel, while connecting both the first and second flat planes in the width direction thereof by a pair of curved parts 6. Furthermore, the partition part 7 is formed at the center of the first flat plane 4 in the width direction thereof by turning-up the first flat plane 4 at that position vertically inward therefrom, while both the edge parts of the strip-shaped material are folded inward into the tube at the center of the second flat plane 5 in the width direction thereof to butt to each other in a form of umbrella-shaped cross section, and the top of the partition part 7 contacts the inner top face of the umbrella. The folded part is in a state of non-contact with the inner face of the second flat plane 5. In addition, the brazing filler metal basin 9 in a concave V-shape cross section is formed near the front end of the folded part.

[0027] A plurality of the flat tubes having the above cross sectional shape is arranged at a certain space, and fins 11 are arranged between individual flat tubes, as shown in Fig. 2. At each end of the flat tube in the longitudinal direction, a hole for a header tube on the header plate (not shown) is provided to connect therewith, thus forming a core. On the both sides of the core, support members are placed to structure the heat exchanger.

[0028] Thus assembled heat exchanger is placed in a high temperature furnace, where the brazing filler metal 3 on the outer face of each flat tube is fused. By cooling to solidify the fused brazing filler metal 3, every contact part of the joint 8 of the flat tube, the top of the partition part 7 of the flat tube, the fin 11, and the like is brazed.

Since there is a gap between the folded part and the inner face of the second flat plane 5, the brazing filler metal exposed to the inner face of the tube does not adhere to the sacrificial anode material 2. In addition, the brazing filler metal basin 9 holds the brazing filler metal 3, thereby effectively preventing the migration of the brazing filler metal toward the sacrificial anode material 2.

[0029] Fig. 3 shows a flat tube of the second embodiment of the present invention. The difference from the first embodiment of Fig. 1 is that the angle between the folded part 14 and the second flat plane 5 is larger than that of the first embodiment. The large angle further effectively prevents the adhesion of brazing filler metal 3 to the inner face of the second flat plane 5 during fusing the brazing filler metal.

[0030] Fig. 4 shows a flat tube of the third embodiment of the present invention. The folded part 14 of the joint part 8 is formed by firstly turning-up by 180° to the second flat plane 5, and then the folded edge portion is tilted inward so as the front end portion of the folded edge part to become apart from the inner face of the second flat plane 5. With the configuration, the fused brazing filler metal is prevented from adhering to the inside face of the second flat plane 5 during fusing the brazing filler metal.

[0031] Fig. 5 shows a flat tube of the fourth embodiment of the present invention. The strip-shaped material is bent orthogonal to the second flat plane 5 at the joint part 8. A pair of leg parts 13 is placed to contact the bent part, while the front end portion of the bent part is further turned-up by a length shorter than the length of the leg part 13. With the configuration, even when the brazing filler metal on the outer face of the tube is fused, the fused brazing filler metal does not reach the inner face of the second flat plane 5. Even if a trace amount of brazing filler metal adheres to the leg part 13, that part is independent of the tube leak so that no effect on the corrosion resistance occurs.

[0032] Fig. 6 shows a flat tube of the fifth embodiment of the present invention. The differences from the fourth embodiment of Fig. 5 are that the front end portion of the leg part 13 is bent parallel to the second flat plane 5 and that the bent top face contacts the partition part 7. Also the embodiment does not allow the fused brazing filler metal to adhere to the sacrificial anode material 2 on the inner face of the second flat plane 5 during fusing the brazing filler metal.

[0033] Fig. 7 shows a flat tube of the sixth embodiment of the present invention. According to the embodiment, an edge part of the strip-shaped material extends over the second flat plane 5, while the other edge part is formed into a step inward into the tube by the thickness of the strip-shaped material, and the stepped edge part is further turned-up by 180°. The length of the turned-up part is shorter than the length of the stepped part. The overlapped part 10 contacts the top of the partition part 7. In this case, the brazed part at the joint of the second flat plane 5 is formed in triple layers, thereby further increasing the corrosion resistance.

[0034] Fig. 8 shows a flat tube of the seventh embodiment of the present invention. According to the embodiment, an edge part of the strip-shaped material is formed into a step by a length of double the thickness of the strip-shaped material, while the other edge part is turned-up by 180° and further is bent so as the front end of the turned-up part to become apart from the inner face of the second flat plane 5. Then, notches 12 are formed at the top of the partition part 7 at a certain interval. From the notches, the brazing filler metal 3 on the outer face of the partition part 7 flows out, thus brazing the key-shaped bend part 15 at one edge part of the second flat plane 5 with the top of the partition part 7. Both edge parts of the strip-shaped material are brazed together by the brazing filler metal coating the outer face of them.

Claims

1. An aluminum-made flat tube for a heat exchanger, fabricated by an aluminum strip-shaped material being structured by a core material (1) coated with a sacrificial anode material (2) on the inner face thereof and coated with a brazing filler metal (3) on the outer face thereof into a nearly B-shaped flat cross section, the strip-shaped material being bent in the width direction thereof to have: a pair of a first flat plane (4) and a second flat plane (5), facing and extending in parallel to each other; a pair of curved parts (6) connecting the first flat plane (4) and the second flat plane (5) in the width direction; a partition part (7) being formed by turning-up the first flat plane (4) at the center in the width direction thereof vertically inward therefrom; a joint part (8) formed by turning-up each edge part of the strip-shaped material at the center in the width direction of the second flat plane (5) to butt the turned-up edges with each other, and by connecting the turned-up edge parts to the partition part (7); wherein the both edge parts in the width direction of the strip-shaped material are folded inward into the tube, and the edges are apart from the inner face of the second flat plane (5).
2. The aluminum-made flat tube for a heat exchanger as in claim 1, wherein the both edge parts in the width direction are formed to butt to each other in a form of umbrella-shape cross section, and the top of the partition part (7) contacts the inner top face of the umbrella.
3. The aluminum-made flat tube for a heat exchanger as in claim 2, wherein a concave brazing filler metal basin (9) is formed near the front end of each edge part.
4. The aluminum-made flat tube for heat exchanger as in claim 1, wherein the both edge parts in the width direction have their respective leg parts (13) formed

by bending orthogonal to the second flat plane (5), while the front end portion of each bent part is turned-up toward the second flat plane (5) by a length shorter than the length of the leg part (13), and the turned-up top face contacts the top of the partition part (7).

5. The aluminum-made flat tube for a heat exchanger as in claim 1, wherein the both edge parts in the width direction have their respective leg parts (13) bent orthogonal to the second flat plane (5), while the front end portion of each bent part is further bent to nearly parallel to the second flat plane (5), and the bent top face contacts the top of the partition part (7).
6. An aluminum-made flat tube for heat exchanger, fabricated by an aluminum strip-shaped material being structured by a core material (1) coated with a sacrificial anode material (2) on the inner face thereof and coated with a brazing filler metal (3) on the outer face thereof into a nearly B-shaped flat cross section, the strip-shaped material being bent in the width direction thereof to have: a first flat plane (4) and a second flat plane (5), facing and extending in parallel to each other; a pair of curved parts (6) connecting the first flat plane (4) and the second flat plane (5) in the width direction; a partition part (7) being formed by turning-up the first flat plane (4) at the center in the width direction thereof vertically inward therefrom; an overlapping part formed by overlapping each edge part of the strip-shaped material at the center in the width direction of the second flat plane (5) with each other, and by connecting the overlapped part to the partition part (7); wherein an edge part in the width direction of the strip-shaped material extends over the second flat plane (5), while the other edge part is formed into a step inward the inner face by the thickness of the strip-shaped material, and the front end part of the stepped part is turned-up to a middle position of the stepped part, then a turned-up overlapped part (10) contacts the top of the partition part (7).

FIG. 1

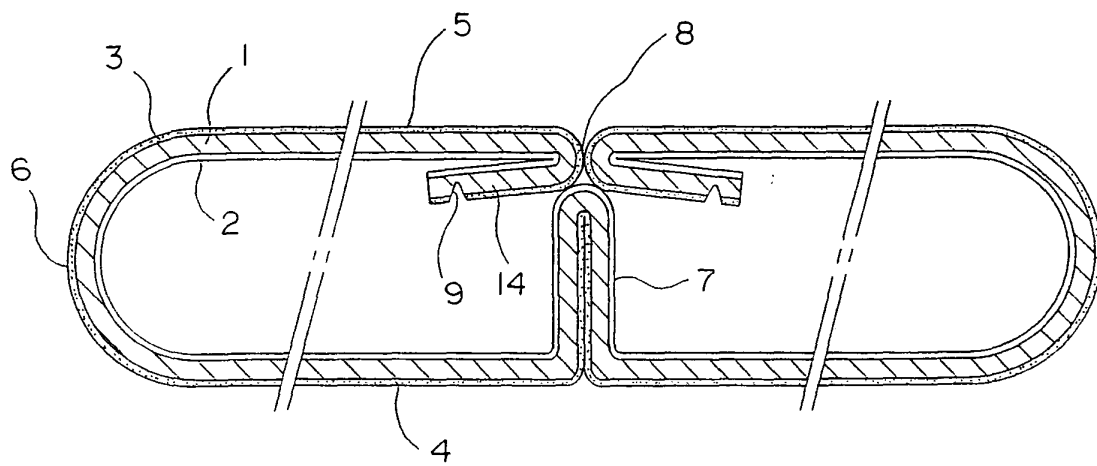


FIG. 2

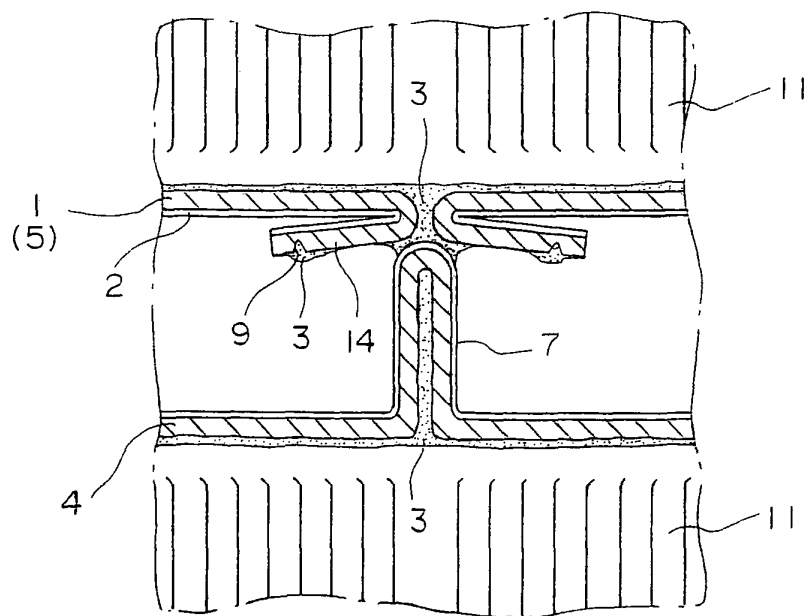


FIG. 3

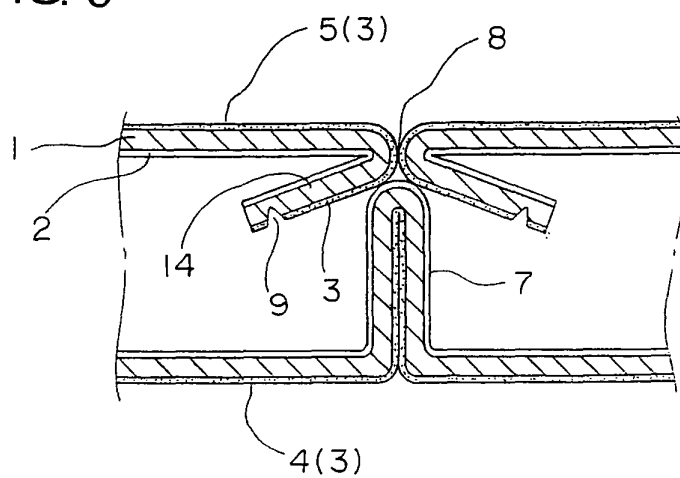


FIG. 4

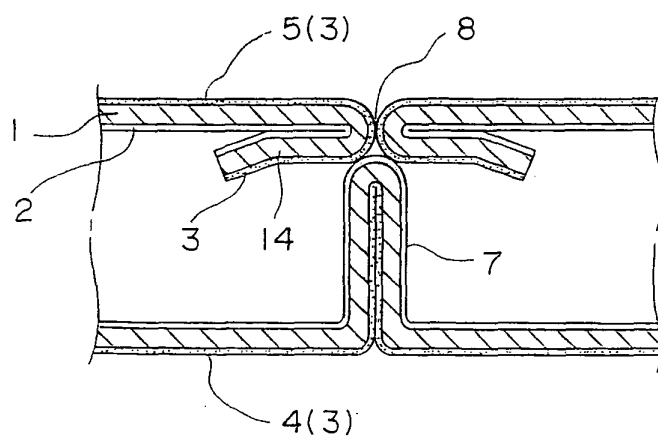


FIG. 5

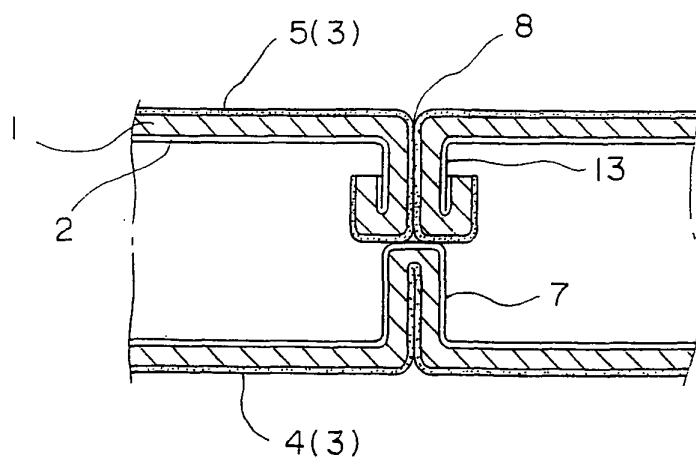


FIG. 6

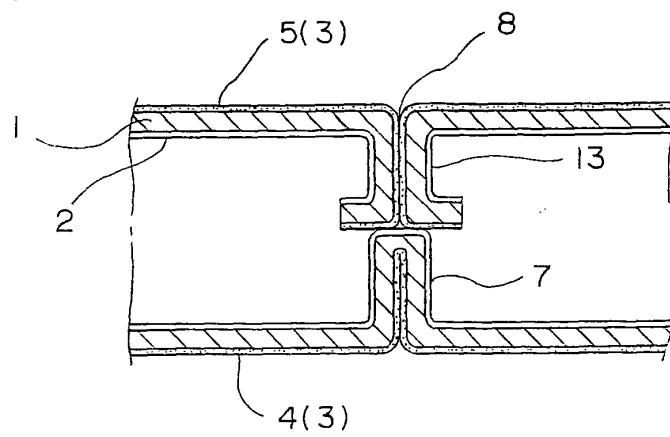


FIG. 7

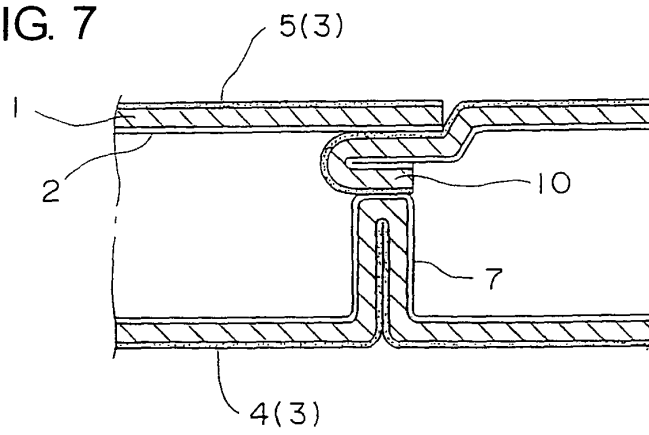


FIG. 8

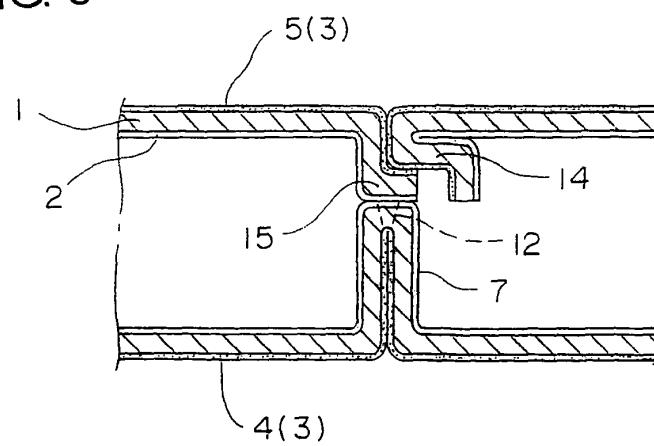


FIG. 9

PRIOR ART

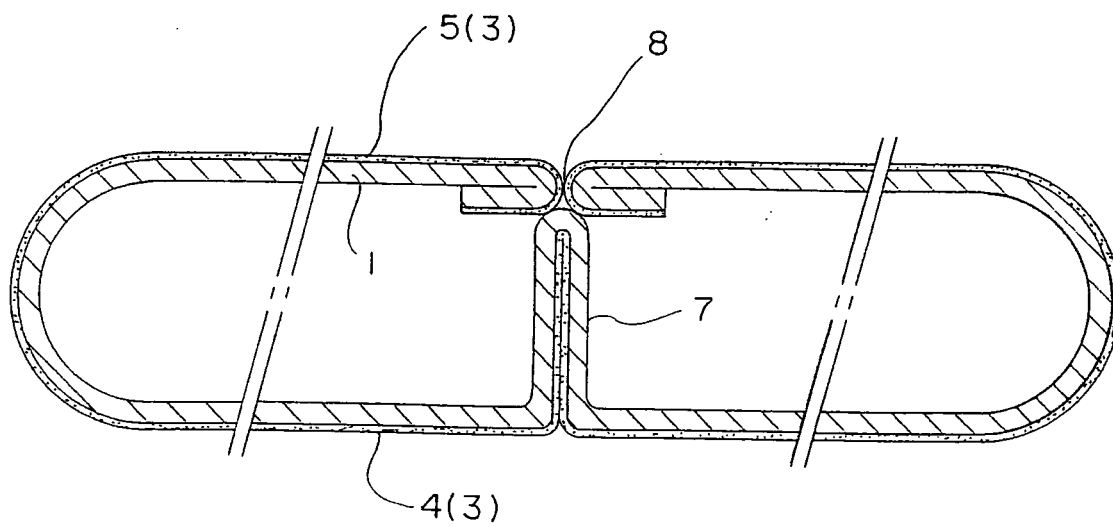
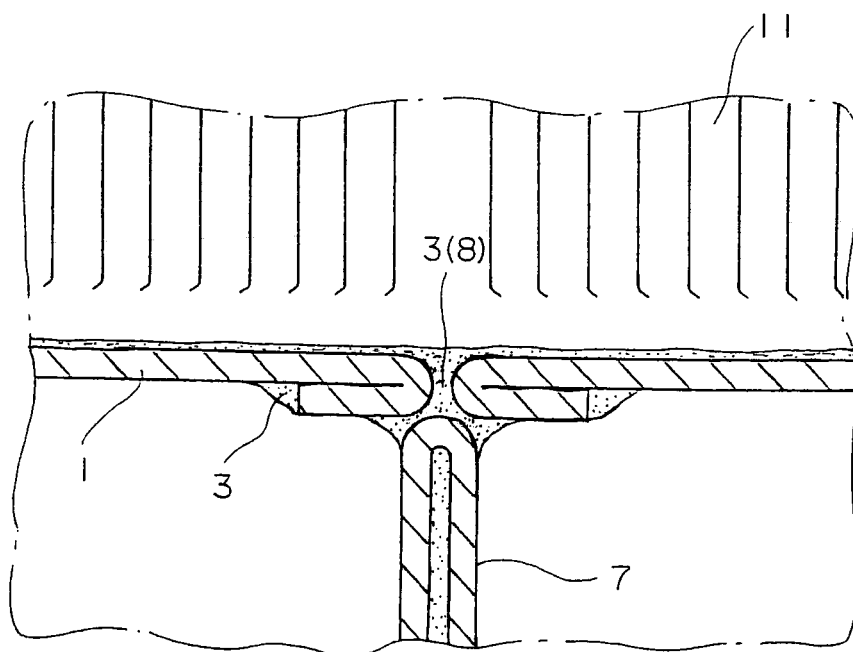


FIG. 10

PRIOR ART



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/006236

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ F28F1/02		
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) Int.Cl ⁷ F28F1/02		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2004 Kokai Jitsuyo Shinan Koho 1971-2004 Jitsuyo Shinan Toroku Koho 1996-2004		
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.
X Y	JP 2001-91178 A (Toyo Radiator Co., Ltd.), 06 April, 2001 (06.04.01), All pages (Family: none)	1-3, 5 2, 6
Y	JP 2001-108386 A (Kabushiki Kaisha Zexel Vareo Kuraimeto Control), 20 April, 2001 (20.04.01), All pages (Family: none)	2
Y	JP 2002-71286 A (Toyo Radiator Co., Ltd.), 08 March, 2002 (08.03.02), All pages (Family: none)	6
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "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 03 August, 2004 (03.08.04)		Date of mailing of the international search report 17 August, 2004 (17.08.04)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/006236

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2000-213882 A (Toyo Radiator Co., Ltd.), 02 August, 2000 (02.08.00), All pages (Family: none)	6

Form PCT/ISA/210 (continuation of second sheet) (January 2004)