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

(11) EP 0 697 318 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.02.1996 Bulletin 1996/08

(51) Int. Cl.^{6}: **B61D 17/04**, B61D 17/10

(21) Application number: 95116676.8

(22) Date of filing: 24.11.1992

(84) Designated Contracting States:
DE FR GB IT

(30) Priority: 25.11.1991 JP 308935/91
25.11.1991 JP 308937/91

(62) Application number of the earlier application in accordance with Art. 76 EPC: 92310735.3

(71) Applicant: HITACHI, LTD.
Chiyoda-ku, Tokyo 100 (JP)

(72) Inventors:
- Hirose, Susumu
Kudamatsu-shi (JP)
- Ohara, Mamoru
Kudamatsu-shi (JP)
- Hattori, Morishige
Kudamatsu-shi (JP)
- Okazaki, Masato
Kudamatsu-shi (JP)
- Okuno, Sumio
Kudamatsu-shi (JP)
- Takeichi, Michifumi
Kudamatsu-shi (JP)

(74) Representative: Paget, Hugh Charles Edward et al
London WC2B 6HP (GB)

Remarks:
This application was filed on 23 - 10 - 1995 as a divisional application to the application mentioned under INID code 60.

(54) Body structure of railroad car

(57) A light-weight body structure of a railroad car which is superior in pressure resistance, compression strength at car ends, and bending ridigity. Of a roof construction (40), a frieze panel (22), a pier panel (23), a wainscot panel (21), an underframe (30) and an end construction (50) of a body structure of a railroad car, at least the roof construction (40), the frieze panel (22), the pier panel 23 and the wainscot panel (21) are built up by outer laminate panel members (60) each comprising face plates (61, 62), a core (63), a strength member (64), a reinforcing member (65) and connecting members (66), which are all made of a light alloy and joined together by brazing.

FIG. 1

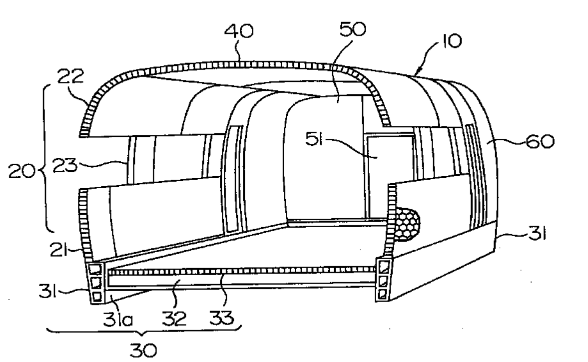
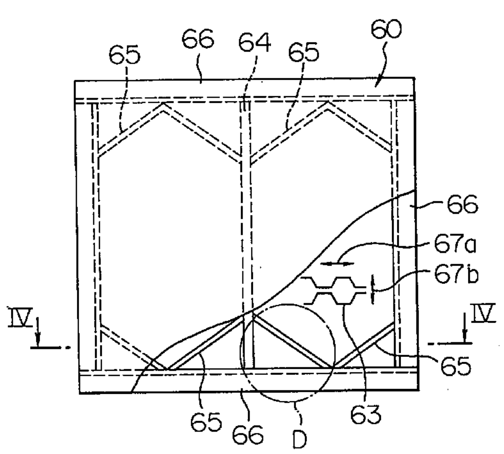


FIG. 3



Printed by Rank Xerox (UK) Business Services
2.9.9/3.4

Description

The present invention relates to construction of a body structure of a railroad car, and more particularly to a railroad car body structure which is suitable for such railroad cars as traveling at a high speed.

According to prior art disclosed in Japanese Patent Unexamined Publication No. 1-339253, a body structure of a railroad car is known which is built up by using brazed honeycomb panels made of a light alloy as outer panel members for, e.g., a side construction, a roof construction and a floor construction, and arranging skeleton members nearer to the inside of the car than those panels.

Recently, the need for railroad cars traveling at a higher speed has become ever increasingly keen. With railroad cars traveling at a higher speed, there arise problems such as destruction of rails, larger noise during the traveling, and increase in the power cost. Solving these problems requires a reduction in weight of the railroad cars corresponding to the increased traveling speed.

In iron-made body structures and light alloy-made body structures, such a reduction in weight has conventionally been made by thinning the outer panel members and the skeleton members. However, this method has limitations in an extent of weight reduction from the viewpoints of strength and rigidity of the component members. While the construction of using honeycomb panels made of a light alloy as the outer panel members and welding the honeycomb panels to the skeleton members is also prepared as mentioned above, stresses are locally concentrated in locations where the curvature is changed in a cross-section of the car and at joint portions between panels, which requires additional reinforcing members and gives rise to impediment on the weight reduction.

It is known that when a railroad car travels through tunnels at a high speed, the difference in pressure between the inside and outside of the car is abruptly changed. In particular, when two cars pass each other in a tunnel, large pressure fluctuations are caused in a short period of time. To prevent such pressure fluctuations from transmitting to the inside of the car and keep passengers from feeling uncomfortable, the cars traveling at a high speed not less than 200 km/h are of the air-tight construction.

Thus, the car body structure is subjected to the loads of passengers and various equipment, the dead load of the body structure itself, as well as the load due to the above-explained difference in pressure between the inside and outside of the car. For this reason, the body structure must be increased in rigidity and strength against the pressure load. However, increasing the rigidity and strength of the body structure is contradictory to the weight reduction thereof and hence difficult to realize.

A first object of the present invention is to provide an embodiment of a light-weight body structure of a railroad car which has superior pressure resistance.

A second object of the present invention is to provide an embodiment of a light-weight body structure of a railroad car which has superior vertical bending rigidity.

A third object of the present invention is to provide an embodiment of a light-weight body structure of a railroad car which has superior compression strength at car ends.

A fourth object of the present invention is to provide a laminate material primarily intended for a body structure of a railroad car which can reduce the number of working steps in manufacture.

A fifth object of the present invention is to provide a construction which enables provision of car windows which are rectangular and give passengers the satisfactory field of view, while ensuring the rigidity of the car body.

A sixth object of the present invention is to provide a joint structure of laminate panels which can increase the strength of panel joint portions.

A seventh object of the present invention is to provide a laminate panel in the curved form which can increase out-of-plane bending rigidity without jointing any member to an outer surface of the panel.

The above first, second and third objects are achieved by a body structure of a railroad car comprising a roof portion, a frieze panel portion, a pier panel portion, a wainscot panel portion, an underframe portion and an end portion, wherein at least said roof portion, said frieze panel portion, said pier panel portion and said wainscot panel portion are built up by outer panel members combined and joined to each other, each of said outer panel members comprising face plates, a core, a strength member, a reinforcing member and connecting members all made of a light alloy, such that said face plates are arranged to cover both sides of said core, said strength member or said reinforcing member is arranged in said outer panel member and joined together by brazing at each desired location where said core and said face plates require to be increased in strength, and said connecting members are arranged along outer peripheral edges of said outer panel member including said core, said face plates, said strength member and said reinforcing member, and joined together by brazing.

The above second and third objects are achieved by a body structure of a railroad car wherein material plates of said core in said outer panel member are arranged in the longitudinal or transverse direction of the car body so as to extend in a direction in which the strength is primarily required, depending on the installed location of said outer panel member in the car body. Specifically, those objects are achieved by arranging the core material plates in the direction in which the load is applied, or in the longitudinal direction of the car body in other areas.

The above fourth object is achieved by a body structure of a railroad car wherein said face plates, said core, said strength member, said reinforcing member and said connecting members of said outer panel member are machined in conformity with the configuration of a car body, so that the outer and inner surfaces of the car body are improved in flatness.

The above fourth object is achieved by a body structure of a railroad car wherein said strength member in said outer panel member is arranged at any angle of 0°, 30°, 60° and 90° relative to said connecting member, so that the material plates of said core are efficiently arranged.

The above fourth object is achieved by a body structure of a railroad car wherein said reinforcing member in said outer panel member is arranged at any angle of 0°, 30°, 60° and 90° relative to said strength member and said connecting member along the outer peripheral edge of the outer panel member, so that the material plates of said core are efficiently arranged.

The above fourth object is achieved by a body structure of a railroad car wherein a side construction comprising said frieze panel portion, said pier panel portion and said wainscot panel portion is integrally built up to cover from one widthwise end of said roof portion to an upper surface of a side sill of said underframe portion, said roof portion is integrally built up to cover between upper surfaces of two side constructions on both sides, and a plurality of said outer panel members, which have dimensions equal to each of plural sections of said side construction and said roof portion divided in the longitudinal and widthwise directions of the car body, are arranged side by side in both the longitudinal and widthwise directions of the car body in a zigzag pattern to thereby build up said side construction and said roof portion.

The above fifth object is achieved by a body structure of a railroad car wherein notches are provided in peripheral edges of a side window for relieving local stresses, and said strength member and said reinforcing member are appropriately arranged in said outer panel member.

The above sixth object is achieved by joining structure of a laminate panel in which face plates are arranged to cover both sides of a core, connecting members are arranged along outer peripheral edges of said core, and said components are joined together by brazing, wherein two adjacent laminate panels are joined to each other through a T-shaped joint member which is inserted between one abutted faces of the connecting members of said adjacent laminate panels, and positioned in contact with the other abutted faces of said connecting members on the inner side.

The above seventh object is achieved by a laminate panel which comprises two face plates, a core arranged between said face plates, a strength member arranged between said face plates to extend thoroughly in the curving direction and having widthwise opposite end faces each formed into a curved surface, and connecting members installed between said face plates to extend along outer peripheral edges of said panel.

When railroad cars travel through tunnels at a high speed, there occur fluctuations in pressures inside and outside of a car body. Particularly, when railroad cars pass each other, such fluctuations are maximized. These pressure fluctuations act on air-tight walls making up a body structure. To endure against the pressure fluctuations, an outer panel member of the present invention is in the form of a laminate composite built up by incorporating a core, a strength member and a reinforcing member between face plates, the latter two members corresponding to a side post, a rafter or the like which has been arranged in the more inner side of the car body than a conventional outer panel member in the prior art, arranging connecting members along outer peripheral edges of the assembly, and joining those components by brazing. Because the face plates are tightly supported by the core, the outer panel member of the present invention has high out-of-plane bending strength and is sufficiently endurable even upon the above pressure fluctuations acting on it. Accordingly, the present invention can increase pressure resistance of the body structure of the railroad car while traveling through tunnels.

Since the outer panel member of the present invention is arranged such that outer and inner surfaces of each of the connecting members along the outer peripheral edges of the outer panel member allow respective surfaces of the face plates on both sides to be flush, body structure surfaces are made easily smooth when the body structure is manufactured by combining and joining the outer panel members together. Accordingly, it is possible to increase the flexibility in a painting work on the outer side of the car body and in design for mounting internal equipment on the inner side of the car body, as well as to easily carry out such works.

Since the adjacent outer panel members are joined to each other via the connecting members making up those outer panel members, a sufficient degree of strength can be ensured at the joint portion. Also, since the outer panel members can be joined together by welding, the joining work is easily performed. Further, since the strength member and the reinforcing member, which have been installed in the more inner side of the car body than a conventional outer panel member in the prior art, are built in the outer panel member, an assembly work of the body structure is simplified. As a result, the number of working steps necessary in manufacturing the body structure of the railroad car is reduced.

In addition, with the joining structure of the laminate panel of the present invention, a joint member is caused to take part in the joint portion between adjacent two panels, whereby the modulus of section of the joint member is increased with additional joining to the panels, making it possible to enhance the strength correspondingly.

Finally, with the laminate panel of the present invention, since the panel is built to have curved surfaces by installing the core and the strength member between the face plates, and forming the strength member itself into a curved shape, the strength can be enhanced with no need of installing additional reinforcements for such curved surfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing one embodiment of a sectioned body structure of a railroad car according to the present invention.

Fig. 2 is a perspective view showing an entire appearance of the body structure of the railroad car shown in Fig. 1.

Fig. 3 is a front view showing the arrangement of an outer panel member for use in the body sttructure of the railroad car shown in Fig. 1.

Fig. 4 is a sectional view taken along line IV-IV in Fig. 3.

Fig. 5 is a front view, in enlarged scale, of an area D in Fig. 3.

Fig. 6 is a fragmentary perspective view of the body structure sectioned along line VI-VI in Fig. 2.

Fig. 7 is a front view, in enlarged scale, of an area B in Fig. 2.

Fig. 8 is a top plan view showing an underframe for the body structure of the railroad car shown in Fig. 2.

Fig. 9 is a top plan view, in enlarged scale, of an area E in Fig. 8.

Fig. 10 is a sectional view taken along line X-X in Fig. 9.

Fig. 11 is a sectional view taken along line XI-XI in Fig. 9.

Fig. 12 is a front view, in enlarged scale, of one embodiment of a side window area in a side construction.

Fig. 13 is a sectional view taken along line XII-XII in Fig. 12.

Fig. 14 is a sectional view taken along line XIV-XIV in Fig. 12.

Fig. 15 is a front view, in enlarged scale, of another embodiment of the side window area in the side construction.

Fig. 16 is a sectional view taken along line XVI-XVI in Fig. 15.

Fig. 17 is a sectional view taken along line XVII-XVII in Fig. 15.

Fig. 18 is a front view showing the detailed structure of a pier panel provided with a reinforcing member at each corner.

Fig. 19 is a front view showing the detailed structure of a pier panel provided with horizontal strength members.

Fig. 20 is a front view showing the detailed structure of a pier panel provided with horizontal strength members and reinforcing members.

Fig. 21 is a front view showing the detailed structure of a pier panel provided with horizontal and vertical strength members and reinforcing members.

Fig. 22 is a front view showing the detailed structure of a pier panel provided with diagonal reinforcing members crossed each other.

Fig. 23 is a front view showing the detailed structure of a pier panel provided with diagonal reinforcing members crossed each other and a horizontal strength member.

Fig. 24 is a top plan view showing a roof construction of the body structure of the railroad car shown in Fig. 2.

Fig. 25 is a top plan view, in enlarged scale, of an area L in Fig. 24.

Fig. 26 is a front view showing an end construction of the body structure of the railroad car shown in Fig. 2.

Fig. 27 is a front view of a surface plate, partly omitted, showing another embodiment of the outer panel member according to the present invention.

Fig. 28 is a sectional view taken along line XXVIII-XXVIII in Fig. 27.

Fig. 29 is a top plan view, in enlarged scale, of an area N in Fig. 27.

Fig. 30 is a vertical sectional view showing another embodiment of the underframe for the body structure of the railroad car according to the present invention.

Fig. 31 is a vertical sectional view showing still another embodiment of the underframe for the body structure of the railroad car according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First, one embodiment of the present invention will be described with reference to Figs. 1 and 2. In these Figures, denoted by reference numeral 10 is a body structure of a railroad car which comprises a pair of side constructions 20, an underframe 30, a roof construction 40, and a pair of end constructions 50.

The side construction 20 comprises a wainscot panel 21, a frieze panel 22 and a pier panel 23, each of which is built up by combining and joining outer panel members 60, each being of the laminate structure described later, and called as mentioned above depending on the location of a car body where the panel is used. The wainscot panel 21 and the frieze panel 22 are arranged above and below a window opening of the side construction 20, respectively. The pier panel 23 is installed between the wainscot panel 21 and the frieze panel 22. The side construction 20 is integrally built up over the range from an upper surface of a side sill 31 of the underframe 30 to an end of the roof construction 40, described later, in the circumferential direction of the car body. The size of each outer panel member 60 in the longitudinal direction of the car body corresponds to the length of each of plural sections resulted by dividing the side construction 20 in the longitudinal direction of the car body, and is preferably integer time(s) as much the seat pitch arranged in a passenger car. The side construction 20 is assembled by arranging the individual outer panel members 60 side by side in the longitudinal direction of the car body, joining those outer panel members 60 to each other by welding so as to form respective blocks of the wainscot panel 21 and the frieze panel 22, and joining those blocks to each other through the pier panels 23 by welding.

Denoted by reference numeral 31 is a side sill as one component of the underframe 30 and arranged at each end of the underframe 30 in the widthwise (transverse) direction of the car body to thoroughly extend in the longitudinal direction of the car body. 32 is a cross beam installed between the side sills 31, which are arranged parallel to each other, to extend thoroughly in the widthwise direction of the car body. The cross beam 32 has both ends joined to respective inner side faces 31a of the side sills 31. Also, between the side sills 31, the cross beam 32 is arranged plural in number parallel to each other with a predetermined pitch in the longitudinal direction of the car body. 33 is a floor panel installed over the side sills 32 and formed of a member of the laminate structure described later. The floor panel 33 is arranged plural in number in the longitudinal direction of the car body such that, as shown in Figs. 10 and 11, the floor panels 33 jointed to each other through the cross beams 32 and also jointed to the inner side faces 31a of the side sills 31 in a vertical cross-section taken along the widthwise direction of the car body, thereby building up the underframe 30. Furthermore, every two adjacent floor panels 33 are abutted at their ends against the cross beam 32 therebetween in such a manner that the floor panels 33 are joined to each other and, simultaneously, to the cross beam 32.

The roof construction 40 is built up by combining and jointing the outer panel members 60, each being of the laminate structure described later. The roof construction 40 is in the form of an integral block covering an area defined by upper ends of the paired side constructions 20 which serve as opposite side walls of the body structure 10, and upper ends of the paired end constructions 50 which serve as opposite end walls of the body structure as described later. The dimensions of each outer panel member 60 in the longitudinal and widthwise directions of the car body corresponds to the length and width of each of plural sections resulted by dividing the roof construction 40 in the longitudinal and widthwise directions of the car body, respectively. It is to be noted that although the body structure 10 shown in Figs. 1 and 2 has the roof construction 40 built up by arranging and joining a plurality of outer panel members 60 in the longitudinal direction of the car body, the roof construction 40 may be built up by arranging a plurality of outer panel members 60 in each of the longitudinal and widthwise directions of the car body when the size of the outer panel member 60 is relatively small. Thus, the roof construction 40 is assembled by arranging the required number of outer panel members 60 in both the longitudinal and widthwise directions of the car body, joining those outer panel members 60 to each other by welding to form a block of the roof construction 40, and then welding the block to the side constructions 20 and the end constructions 50.

The end construction 50 may be built up by welding conventional outer plate members to skeleton members of the car body like the prior art, but will be explained here in connection with the case of using the outer panel members 60 of the laminate structure described later. Use of the outer plate members 60 is effective particularly when the pressure resistance during the traveling through tunnels is problematic. The pressure resistance of the car body is increased as the car body configuration approaches a sphere. However, because the end constructions 50 are used to connect adjacent cars to each other and hence are positioned perpendicular to the traveling direction of the cars, the displacement at a central portion of the end construction 50 is larger than that at any other portions. Accordingly, characteristics of the outer panel member 60 described later can be best utilized. The end construction 50 serves as each end wall of the body structure 10 and is built up integrally with respective ends of the side constructions 20, the underframe 30 and the roof construction 40. The outer panel members 60 are arranged on the upper, left and right sides of a through passage 51 of the end construction 50.

A description will be given of a method of assembling the body structure 10 built up as explained above. The two side constructions 20, the underframe 30, the roof construction 40 and the two end constructions 50 are separately fabricated and then joined to each other to complete the body structure 10. First, the side constructions 20 are vertically arranged on upper surfaces of the underframe 30 at both ends in the widthwise direction of the car body, i.e., on the side sills 31, respectively, and the end constructions 50 are vertically arranged on upper surfaces of the underframe 30 at both ends in the longitudinal direction of the car body, respectively. Then, the underframe 30 and the side constructions 20 are joined to each other, while the underframe 30 and the end constructions 50 are joined to each other. At the same time, the side constructions 20 and the end constructions 50 are also joined to each other. The roof construction 40 is placed on the two side constructions 20 and the two end constructions 50 thus assembled, followed by joining the roof construction 40 to the two side constructions 20 and the two end constructions 50. The body structure 10 is completely built up in this way.

Figs. 3 and 4 will be next described. The outer panel member 60 comprises face plates 61, 62, a core 63 installed between the face plates 61 and 62, one or more strength members 64, reinforcing members 65, and connecting members 66 arranged around outer peripheral edges of the outer panel member. The strength members 64 are each basically arranged to extend thoroughly between the connecting members 66 opposite to each other for interconnection of the connecting members. When the two strength members 64 are arranged to cross each other, these strength members 64 are joined to each other at the crossing point. The reinforcing members 65 are installed to connect between the adjacent strength members 64 and between the strength member 64 and the connecting member 66. When the outer panel member 60 is curved in itself, it is natural that the strength member 64 is also curved in the direction of thickness of the outer panel member 60 itself. In the case where the core 63 making up the curved outer panel member 60 is formed of a honeycomb core built up by jointing a plurality of bent material plates, an L direction 67a of the honeycomb core should be set perpendicular to the strength member 64. In other words, the honeycomb core serving as the core 63 should be arranged such that the L direction 67a thereof is perpendicular to a direction in which the outer panel member 60 is curved. If the honeycomb core is in itself formed to provide a curved surface by interconnecting a plurality of the material plates, which make up the honeycomb core, at their joint faces having a trapezoid shape, the strength member 64 may be arranged parallel to the direction in which the outer panel member 60 is curved.

The outer panel member 60 has higher bending and shearing rigidity than a plain flat panel, because the face plates 61, 62 are supported by the core 63 to be spaced from each other by a spacing not less than a predetermined value and the core 63 is disposed in a pattern of the dense pitch. The outer panel member 60 is formed of, for example, a honeycomb panel comprising the face plates 61, 62 made of a light alloy, a honeycomb core, as the core 63, made of a light alloy and having a pattern of hexagonal grids, as well as the strength members 64 and the reinforcing members 65 both brazed to the honeycomb core. The honeycomb core is of the structure having a plurality of cells which extend thoroughly between the two face plates. In place of the above honeycomb core made of a light alloy, the core 63 may be built by using thin panels made of a light alloy or resin or foamed panels which are formed in a grid pattern or other desired continuous pattern, and joining such panels to each other by bonding. The bonding of those panels requires use of a thermosetting adhesive or resin in consideration of a temperature rise during a subsequent during step. Further, extending joint flange portions of the connecting members is effective in preventing a thermal effect caused by the welding. Alternatively, different metallic materials may be combined with each other; e.g., a combination of the face plates made of a stainless steel and the core made of a light alloy.

The strength member 64 is in itself in the form of a flat plate and arranged with the widthwise direction thereof being perpendicular to the face plates. In addition, the longitudinal direction of the strength member 64 is set in match with the circumferential direction of the car body within an area of the relevant outer panel member. Accordingly, even when the outer panel member 60 is not planar but curved in conformity with the configuration of the car body, the strength member 64 can be easily and high-precisely manufactured by cutting a flat plate into a corresponding arcuate shape. In terms of strength, since the strength member 64 in the form of a flat plate is tightly supported by the core 63, the strength member 64 is prevented from tilting and a sufficient degree of bending rigidity can be ensured. Other than the form of a flat plate, the strength member may be formed of a U-shaped or □-shaped bar in cross-section. Although such a shaped bar cannot sharply be bent in its entirety, it can be bent without deforming the cross-sectional shape and, therefore, may be used instead. In the case of using such a shaped bar, a reduction in dimensional accuracy due to the bending can be avoided by machining. This allows the above shaped bar to be used as the strength member. When the difference in pressure between the inside and outside of the car body comprising the body structure 10 thus built up is fluctuated, the outer panel members 60 function as air-tight walls to maintain the pressure inside the car body constant.

Fig. 5 shows an arrangement of the core 63. The core 63 is built up by superposing a plurality of corrugated plates (material plates) one above another in the L direction 67a so as to define hexagonal cells 68, and joining the adjacent material plates to each other with a braze 69 applied to the gap therebetween. In the case of a laminate panel using the core 63, the shearing strength of the core 63 in the L direction 67a, i.e., a direction in which the material plates are each continuously extended, is about 1.6 times higher than that in the W direction 67b, i.e., a direction perpendicular to the L direction 67a. This difference is attributable to the direction of array of the corrugated plates making up the core 63.

By installing the reinforcing member 65 such that it forms 60° relative to the strength member 64 and 30° relative to the connecting member 66, the reinforcing member 65 intersects the corrugated plates of the core 63 of the outer panel member 60 at their upper cores 63a and lower corners 63b, whereby the corrugated plates of the core 63 can be cut at those corners and hence can be standardized to two types of form. Alternatively, by installing the reinforcing member 65 such that it forms 30° relative to the strength member 64 and 60° relative to the connecting member 66, the reinforcing member 65 intersects the corrugated plates of the core 63 of the outer panel member 60 at their centers between the upper corners 63a, whereby the corrugated plates of the core 63 can be cut at those centers and hence can be standardized to one type of form.

As shown in Fig. 6, the outer panel member 60 is structured such that the connecting members 66 are provided along the outer peripheral edges of the outer panel member 60 and one member 60 is joined to another through the connecting members 66. Thereore, the joint portions between the other panel members 60 can be prevented from lowering in strength as compared with the case where the face plates 61, 62 are directly joined to each other.

Further, the strength member 64 corresponds to a conventional side post, rafter or the like which is installed between the face plates 61 and 62 as a part of the laminate structure. Considering the load due to the difference in pressure between the inside and outside of the car body, particularly, the strength member 64 is required to be arranged in the circumferential direction of the car body structure 10 in a vertical cross-section.

More specifically, in the wainscot panel 21, the frieze panel 22 and the pier panel 23, the strength members 64 are each arranged to extend over the entire side construction 20 in the vertical direction. As mentioned before, the strength member 64 is arranged with the widthwise direction thereof being perpendicular to the face plates. The strength members 64 of the frieze panel 22 have the radius of curvature of their widthwise edges smaller than that of the strength members 64 of the wainscot panel 21 and the pier panel 23. Also, the strength members 64 of the frieze panel 22 have the radius of curvature of their widthwise edges which varies to become smaller as the edges approach the roof construction 40. Thus, with the outer panel member 60 of the present invention, the laminate panel can be fabricated in such a manner as allowing the widthwise curved edges of the strength member 64 installed in the outer panel member 60 to be formed into a desired shape, e.g., an arcuate curve or a curve including the different radii of curvature.

In the roof construction 40, the strength member 64 is arranged to extend thoroughly the roof construction 40 in the widthwise direction thereof. Stated otherwise, the strength member 64 is arranged in the roof construction 40 such that it corresponds to a conventional rafter. Looking at the entire body structure 10, as shown in Fig. 7, the strength members 64 of the outer panel members 60 are arranged so as to align with each other in the same cross-section. Note that the face plates on the surfaces of the outer panel members 60 are omitted in Fig. 7 for easier understanding of the arrangement of the outer panel members 60 and the relationship between the respective internal structures. Thus, the outer panel members 60 are arranged in such a manner that the strength members 64 of the roof construction 40, the wainscot panel 21, the frieze panel 22 and the pier panel 23 are continuously joined to each other in the circumferential direction of the car body. This allows the load to be distributively borne by the strength members 64. In other words, the strength members 64 serve as a ring-shaped strength member arranged between the side sills at both side of the car body in the widthwise direction and, therefore, can develop a sufficient degree of strength against pressure fluctuations acting on the body structure 10.

Further, by installing the reinforcing members 65 in such a manner as to connect between the strength member 64 and the connecting member 66 or between the adjacent strength members 64, the load acting on a weld line 27 corresponding to the joint portion between the adjacent outer panel member 60 can be dispersed to relieve concentration of stresses. More specifically, with the strength members 64 built in the outer panel member 60, the connecting members 66 and the strength members 64 function to transmit various forces in the outer panel member 60. This means a high possibility that stresses may concentrate on the joint portions between the strength members 64 and the connecting members 66. The reinforcing members 65 provided as mentioned above can transmit the forces in a dispersed way and hence prevent concentration of stresses. This result in turn leads to a reduction in weight due to the reduced thickness of the connecting members 66 or an improvement in the strength of the entire body structure 10.

A description will now be given of the manner of fabricating the curved outer panel member 60. One face plate 61 is placed on a lower die having its support surface formed into a required curved surface, and the core (material plates) 63, the strength members 64 and the reinforcing members 65, which have been bent beforehand, are placed on the face plate 61. Then, these components are mutually positioned in place. At this time, since the strength members 64 and the reinforcing members 65 have their edges curved in conformity with the required curved surface, they can precisely positioned onto the lower die. After that, the other face plate 62 and an upper die are placed thereon in this order. In the case of joining the components to each other by brazing, for example, the assembly in such a condition is pressed to be joined together by the upper and lower dies in a vacuum furnace while raising a temperature. Note that brazers for use in the brazing are clad on inner surface of the face plates 61, 62 and respective surfaces of the core 63. If the face plates 61, 62 are bent into the required curved surface in advance, working efficiency is improved.

Additionally, by fabricating the body structure 10 of the railroad car using the outer panel members 60 of the present invention, an inner surface 10a of the car body structure 10 can be made smooth. Therefore, the degree of freedom in arrangement or mount positions of fixtures for internal equipment, which has been restricted by side posts, rafters or the like in the prior art, can be enlarged. This enables internal equipment fixtures or internal equipment themselves and internal finish structures to be standardized.

The case of building up each construction by using the outer panel members 60 will be described below in detail. In Fig. 6, the side construction 20 is subjected to the dead load of the base structure 10 itself, the vertical load caused by various units installed on the underside of the underframe 30, passengers and so forth and transmitted from the underframe 30, as well as the load due to fluctuations in pressures inside and outside the car body. Because of being primarily built up by the outer panel members 60, the side construction 20 has a sufficient degree of out-of-plane bending rigidity and sharing ridigity against the above loads. More specifically, since the face plates are joined to each other by the core 63 in such a manner as not to deviate from each other, the outer panel member 60 has high out-of-plane bending ridigity so that the base structure 10 can exhibit a sufficient degree of ridigity. Also, since the strength members 64 are built in the outer panel member 60, the outer panel member 60 has a higher degree of out-of-plane strength than an ordinary laminate panel in combination of only face plates and a core, which degree is comparable to or greater than that of such an ordinary laminate panel including skeleton members attached to the panel surface. To put it in more detail, the strength members 64 of the outer panel member 60 are each supported by the core on both sides and, therefore, so hard to buckle even with a relatively thin thickness as to exhibit the strength comparable to that of a thick shaped bar attached to the laminate panel surface. Accordingly, higher ridigity could be obtained than the case where a shaped bar having the same cross-sectional area as the strength member 64 is joined to the laminate panel. As mentioned above, the strength member 64 is also effective in increasing the ridigity even when the outer panel member 60 is formed to have a curved surface. Thus, the side construction 20 is less likely to deform and sufficiently endurable against the aforesaid loads.

Since the strength members 64 and the reinforcing members 65 are arranged in the surroundings of a window where the strength is required to be increased, there can be obtained the car body structure 10 in which stresses are less concentrated locally., Further, if the body structure 10 is designed with a view of standardization such that those one of the outer panel members making up the body structure 210 which make up the wainscot panel 21, the frieze panel 22, the pier panel 23 and the roof construction 40, each have the strength members 64 and the reinforcing members 65 in the same arrangement with respect to the longitudinal direction of the car body, it is possible to reduce the production cost of the outer panel members 60. It should be understood that the wainscot panel 21 and the frieze panel 22 may comprise a single type of outer panel members if dimensions are set in common to both the panels.

Fig. 7 shows an arrangement of the roof construction 40, the wainscot panel 21, the frieze panel 22, the pier panel 23, and the side sill 31 of the underframe. The outer panel members 60 respectively making up the roof construction 40, the wainscot panel 21, the frieze panel 22, and the pier panel 23 are arranged in a zigzag pattern along the longitudinal direction of the car body so that the weld lines 27 are not concentrated in the widthwise or vertical direction of the car body. This is because mechanical properties of the welded portion are inferior to those of a mother material of the connecting member 66. Preventing concentration of the weld lines 27 between the outer panel members 60 can improve reliability in the strength of the body structure 10. It is also possible to help the weight reduction by the connecting members 66 joined together via the weld lines 27 at positions of the strength members 64 so that the connecting members 66 double as the strength members 64. Moreover, the connecting members 66 vertically arranged at both sides of the pier panel 23 in the widthwise direction thereof have their opposite end projected toward the frieze panel 22 or the wainscot panel 21 out of the connecting members 66 horizontally arranged in orthogonal relation to the former vertical connecting members 66. These projected ends of the connecting members 66 of the pier panel 23 can provide the longer weld lines at joint portions with the wainscot panel 21 and the frieze panel 22, with the result of the increased strength.

In the arrangement of Fig. 7, the weld lines 27 between the adjacent outer panel members 60 respectively making up the wainscot panel 21 and the frieze panel 22 are located at the centers of side windows 24. However, by arranging the weld lines 27, i.e., the joint portions between the adjacent outer panel members 60 respectively making up the wainscot panel 21 and the frieze panel 22, to be aligned with the strength members at both sides of the pier panel 23 in the widthwise direction thereof, but deviated from each other, the number of the strength members 64 used is reduced and the weight reduction is promoted correspondingly. More specifically, the weld line 27 joining the adjacent outer panel members 60 of the wainscot panel 21 is arranged to align with one strength member of the pier panel 23 in the widthwise direction thereof, e.g., the right-hand strength member when viewed from front, while the weld line 27 joining the adjacent outer panel members 60 of the frieze panel 22 is arranged to align with the other strength member of the pier panel 23 in the widthwise direction thereof, e.g., the left-hand strength member when viewed from front. By so doing, the weld lines 27 joining between the adjacent outer panel member 60 respectively making up the wainscot panel 21 and the frieze panel 22 are deviated from each other by a distance corresponding to the width of the pier panel 23. With such an arrangement, there can be achieved a similar effect to that obtainable with the arrangement shown in Fig. 7. In addition to this effect, the connecting members 66 at the joint portions between the adjacent outer panel members 60 respectively making up the wainscot panel 21 and the frieze panel 22 can double as the strength members 64, shown in Fig. 7, which are arranged at both sides of the pier panel 23. As a result, the number of the strength members 64 used in the outer panel member 60 can be reduced in comparison with the arrangement shown in Fig. 7. This in turn leads to a further reduction in weight of the outer panel member.

Because of high bending and shearing ridigity, the outer panel members 60 are less likely to cause distortions on the surfaces of the car body due to the vertical load and residual stresses produced upon the welding and hence effective in improving an anesthetic appearance, when used to build up the side construction 20 as stated before. Also, by incorporating the strength member and the reinforcing members, which are formed in match with the car body configuration, in the outer panel member 60, the car body structure can be obtained which is more free from distortions on the surfaces of the car body than the car body structure obtained by bending outer panel members in the form of a flat plate. As a result, the work for removing distortions on the surfaces of the car body can be dispensed with. It is further possible to simplify the work for smoothing the surface of the side construction 20, which has conventionally been performed by using a plaster's putty after completion of the body structure.

The floor panel 33 of the underframe 30 shown in Fig. 8 is built up by selectively using the outer panel members 60 as they are or the outer panel members 60 with the strength members 64 and the reinforcing members 66 omitted, depending on operating conditions and load conditions of the car. In the underframe 30, the load imposing on the floor panel 33 due to the difference in pressure between the inside and outside of the car body is borne by the side sills 32 and the cross beams 32. However, with the car traveling at a higher speed, the airtight load caused during the traveling through tunnels is increased and the floor panel 33 is required to have a higher degree of out-of-plane bending rigidity. Use of the outer panel members 60 of the present invention is effective in such a case as requiring a reduction in weight, too, besides the above requirement. In the underframe 30, as shown in Fig. 9, the load imposed by compression at car ends is borne by intermediate beams 35 and a pad beam 36. A part of the floor panel 33 which overlies the intermediate beams 35 and the cross beams 32 between an end beam 34 and the pad beam 36 is built up by the outer panel members 60. Particularly, between the pad beams 36 at both sides of the underframe, the load is borne by the side sills 31. To smoothly transmit the load from the pad beams 36 to the side sills 32, therefore, respective parts of the floor panel 33 forwardly and rearwardly of the pad beams 36 are built up by the outer panel members 60 which have the strength members 64 arranged at a right angle, 30° or 60° relative to the connecting members 66. The remaining part of the floor panel 33 is built up by the outer panel members 60 with the strength members 64 and the reinforcing members 66 omitted. By arranging the core 63 in the outer panel member 60 such that the core material plates extend in the longitudinal direction of the car body, there can be obtained the car body structure with higher compression strength at car ends. Further, as shown in Figs. 10 and 11, the floor panel 33 is built up by arranging a plurality of the outer panel members 60 side by side in the longitudinal direction of the car body, and joining the adjacent U-shaped connecting members 66 of the outer panel members 60 to each other on an upper surface of the cross beam 32. More specifically, lower flanges of the adjacent connecting members 66 of the outer panel members 60 are abutted against opposite side faces of a vertical portion of the cross beam 32 and joined thereto by continuous or intermittent welding. Upper flanges of the adjacent connecting members 66 of the outer panel members 60 are arranged on an end face of the vertical portion of the cross beam 32 while leaving a root gap therebetween, so that both the upper flanges and a distal end of the cross beam are welded together. In order that the vertical portion of the inverted T-shaped cross beam 32 is inserted through one or lower joint portion between the adjacent outer panel members 60 and then the distal end of the inverted T-shaped cross beam 32 is positioned just in contact with the other or upper joint portion on the inner side, positioning bosses may be provided on the opposite side faces of the vertical portion of the inverted T-shaped cross beam 32. On the other hand, the outer panel members 60 are jointed to the side sill 31 by welding their connecting members 66 to the inner side face 31a of the side sill 31 in a vertical cross-section taken along the widthwise direction of the car body.

With such an arrangement, since the cross beam 32 is joined at the distal end of its vertical portion to the adjacent outer panel members 60 in a continuous manner, the modulus of section comparable to that obtainable with a conventional I- or U-shaped cross beam can be achieved with no need of forming an upper flat portion in the cross beam 32. This reduces the weight of the cross beam 32 itself and hence leads to a weight reduction of the entire body structure. Moreover, the above-mentioned joining structure between the adjacent outer panel members via the cross beam 32 can also be employed in other portions of the body structure 10. Specifically, it is conceivable to utilize the projecting portion of the cross beam 32 from the outer panel members 60 for attachment of units and equipment. The above joining structure is also applicable to the case where the outer panel members of the present invention are employed in general structures such as wall materials of buildings, for example.

Furthermore, as shown in Fig. 12, the side window 24 is formed in a rectangular shape for the purpose of ensuring the field of view through the side window 24, and notches 25 for relieving local stresses are provided in peripheral edges the side window near joint portions between the pier panel 23 and the frieze panel 22 as well as the wainscot panel 21 of the side construction 20. In addition, the reinforcing members 65 and the strength members 64 are provided in those outer panel members 60 of the pier panel 23, the frieze panel 22 and the wainscot panel 21 which are adjacent to the joint lines between those panels. With such an arrangement, stresses are concentrated on a portion 26 of the notch 25 mostly remote from the side window 24. Thus, such concentrated stresses are borne by the mother material of the connecting member 66. In need of enhancing the strength, it is possible to reinforce the connecting member 66 by an additional member or increase the thickness of the connecting member 66 itself at the portion 26.

A description will be next given of the structure of the side window 24 with reference to Figs. 13 and 14. The structure of the side window 24 is applicable to a serial window comprising a side windowpane 24' extended through the pier panel 23 or an ordinary sole window by changing the thickness of the pier panel 23 and the configuration of the connecting members 66 of the pier panel 22, the frieze panel 22 and the wainscot panel 21. First, looking at the structure of a serial window in which the side windowpane 24' is extended through the pier panel 23, the side windowpane 24' is held onto support flanges formed integrally with the connecting member 66 by using a fastening plate member 66a and a fastening member 66b. The fastening member 66b may be of, for example, a bolt or a rivet. In this connection, removal of an unnecessary portion 66c of the connecting member 66 in the side window 24 contributes to a further reduction in weight. Fig. 12 shows a state that the side windowpane is not fitted, while Figs. 13 and 14 show a state that the side windowpane is fitted.

The structure of an ordinary sole window will now be described with reference to Figs. 15, 16 and 17. Fig. 15 shows a state that the side windowpane is not fitted, while Fig. 17 shows a state that the side windowpane is fitted. The connecting members 66 defining the rectangular circumference of the side window 24 are each integrally formed with a flange for holding the side windowpane 24', and the side windowpane 24' is fastened to the flange by a fastening member 66b via a fastening plate member 66a. In this case, the connecting members 66 installed on both lateral sides of the pier panel 23 are also integrally formed with flanges for holding the side windowpane 24', so that the side windowpane 24' is set and fastened by the fastening plate members and the fastening members of those connecting members as well. Removal of a flange 66c of the connecting member 66 on the inner side of the car body increases the degree of freedom in configuration of internal equipment mounted to an opening of the side window 24. It is said that the car body structure 10 adopting the structure of an ordinary sole window is superior in strength to that adopting the foregoing structure of a serial window, because the frieze panel 22 and the wainscot panel 21 have the same thickness as the pier panel 23 in the former.

The structure of the pier panel 23 of the side construction 20 will be described below in detail with reference to Figs. 18, 19, 20 and 21. The connecting members 66 installed at opposite edges of the outer panel member 60, in the longitudinal direction of the car body, used for the pier panel 23, i.e., at opposite right and left edges of the outer panel member 60, as shown, in the widthwise direction of the pier panel 23, have a relatively high degree of strength and, therefore, the structure of the pier panel 23 is basically strong against torsion. When outer contours of the pier panel 23 are rectilinear, the strength members 64 and the reinforcing members 65 can be dispensed with by arranging of the core 63 of the outer panel member 60 such that thin plates as materials of the core 63 extend vertically, horizontally or obliquely in match with the direction of the primary load. However, when the outer contours are curved, the thin plates as materials of the core 63 are preferably arranged to extend in the longitudinal direction of the car body (or in the horizontal direction in Fig. 18) from the standpoint of manufacturer. This is because the thin plates as materials of the core 63 become rectangular in shape and hence can easily be machined with high accuracy. If the thin plates as materials of the core 63 are arranged to extend in the circumferential direction of the car body (or in the vertical direction in Fig. 18), they become sectorial in shape and hence require complex machining to ensure plane accuracy at the finish.

A pier panel 23a of Fig. 18 is built up by installing the reinforcing members 65 in a rhombic pattern inside the outer panel member 60. The reinforcing members 65 serve to increase the shearing ridigity of the pier panel 23a and also transmit the load to near the centers of the horizontal connecting members 66, particularly, thereby averaging stresses caused along the weld lines at the joint portions.

The structure of a pier panel 23b of Fig. 19 will be next described. In the pier panel 23b, a strength member 64b is installed plural in number and perpendicularly to the connecting members 66 of the outer panel member 60 arranged in the circumferential direction of the car body, i.e., in the vertical direction. This structure is simplest and hence suitable for the car body structure subjected to the small load.

The structure of a pier panel 23c of Fig. 20 is a combination of the above pier panels 23b and 23c. For the purpose of relieving concentration of stresses on the weld lines at joint portions between the strength member 64b in the structure of Fig. 19 and the vertical connecting members 66, the reinforcing members 65 are arranged between the strength member 64b and the connecting members 66 as shown. This structure is suitable for the car body structure subjected to the relatively high load.

The structure of a pier panel 23d of Fig. 21 will now be described. The pier panel area is divided into four sections by the horizontal strength member 64b and a vertical strength member 64c separate from the vertical connecting member 66. The reinforcing member 64 is arranged, as a brace, in each section obliquely relative to the connecting members 66. This structure is effective in increasing the out-of-plane bending ridigity of the pier panel itself and also making even distribution of stresses caused along the weld lines 27 at the joint portions, when the vertical connecting members 66 arranged at the right and left sides cannot have high ridigity for the reason of concentration of stresses.

The structure of still other pier panels 23e, 23f will be described with reference to Figs. 22 and 23. The pier panel 23e is built up by diagonally installing the reinforcing members 65 so as to connect the joint points between the horizontal and vertical connecting members 66. This pier panel 23e can increase shearing ridigity with the relatively simple structure. Further, the pier panel 23f is built up by installing the strength member 64b in addition to the above structure of the pier panel 23e. The structure of this pier panel 23f can provide higher shearing ridigity than the above pier panel 23e. Although these pier panels include, as brazes, the two reinforcing members crossing each other, either one of these reinforcing members may be installed. Specifically, in consideration of the layout position of the pier panel in the body structure, one reinforcing member may be arranged such that its upper end is tilted toward the car end on each side of the car body partitioned at the center in the longitudinal direction thereof.

It is to be noted that Figs. 18, 19, 20, 21, 22 and 23 are illustrated by omitting the face plates for clarity of the Figures.

A description will be given below of the roof construction 40 with reference to Figs. 24 and 25. As mentioned before, the roof construction 40 comprises the outer panel members 60, and the strength members 64 are arranged in the circumferential direction of the car body structure 10 in a widthwise cross-section, taking into account the load due to the difference in pressure between the inside and outside of the car body. Additionally, for the purpose of preventing concentration of stresses, the reinforcing members 65 are arranged in respective portions where the strength members 64 are joined to the connecting members 66. Further, the respective outer panel members 60 of the roof construction 40 and the frieze panel 22 are arranged in a zigzag pattern in the longitudinal direction of the car body. With such an arrangement, most of the weld lines 27 extending in the circumferential direction of the car body are deviated from each other in the longitudinal direction of the car body. This results in, as mentioned before, smaller portions where the weld lines 27 are concentrated, and hence an improvement in the strength reliability. The roof construction 40 also needs mounts for installing insulators of pantographs. Supports 41 for that purpose are disposed inside the outer panel members 60. The strength members 64 are arranged in match with four sides of each support 41 and joined to the connecting members 66. The load imposed from the pantograph is fluctuated and applied in both the vertical and widthwise directions of the car body. Because the strength members 64 are arranged in match with four sides of the support 41, this structure has sufficient degree of strength against the above load conditions.

A description will be given below of the end construction 50 comprising the outer panel members 60 with reference to Fig. 26. The end construction 50 has n opening formed therein to provide the through passage 51. As mentioned before, since two cars are coupled to each other at their end constructions 50 which are vertically positioned, pressure resistance of the end construction 50 during the traveling through tunnels is more problematic as the traveling speed of cars increases. Therefore, the strength members 64 of the adjacent outer panel members 60 are arranged to align with each other for ensuring the pressure resistance strength. The end construction 50 also needs supports 52 for mounting devices which serve to prevent the car body from swinging. The supports 52 for that purpose are disposed inside the outer panel members 60. The strength members 64 are arranged along four sides of each support 52 and joined to the connecting members 66. The load imposed from the swing preventive device is fluctuated and applied in the longitudinal, vertical and widthwise directions of the car body. Because the strength members 64 are arranged along four sides of the support 52, this structure has a sufficient degree of strength against the above load conditions.

It is to be noted that Figs. 25 and 26 are illustrated by omitting the face plates for clarity of the Figures.

A description will be given below of a still another embodiment shown in Figs. 27 to 29. In Fig. 29, contact portions between material plates 78a, 79a of cores 78, 79 are illustrated as being separated from each other for showing directions of the material plates.

A strength member 70 is vertically at the center of an outer panel member 60X in the horizontal direction. The strength member 70 comprises a square pipe formed of, for example, an extruded aluminum ally having a rectangular cross-section, and is joined to the face plates 61, 62 and the core 78 by brazing. Both longitudinal ends of the strength member 70 are respectively joined to the connecting members 66, 66 by brazing. The strength member 70 is thicker than the face plates 61, 62 perpendicularly thereto. The reinforcing members 75 are also arranged at cores between the connecting members 66 and the strength member 70, in addition to the corners between the adjacent connecting members 66. Thus, the two reinforcing members 75 are arranged in a V-shaped pattern about near each middle position between the connecting member 66 and the strength member 70. In other words, the reinforcing member 75 is disposed such that it corresponds to an oblique side of a right-angled triangle. The cores 78, 79 in the form of a honeycomb are arranged in a space defined between the two face plates 61, 62. The longitudinal direction, i.e., the L direction, of the material plats 78a, 79a making up the cores 78, 79 lies parallel to the longitudinal direction of the strength member 70. When the strength member 70 is curved and the outer panel member 60 has a curved surface, the material plats 78a, 79a are arranged such that the L direction thereof lies perpendicularly to the longitudinal direction of the strength member 70. The length of each material plate 79a of the core 79 arranged at the aforesaid corner is shortened at its ends or vertical portions by an amount corresponding to the thickness of the reinforcing member 78. Brazers are clad over respective surfaces of the strength member 70 and the reinforcing member 75. The strength member 70, the reinforcing member 75 and the cores 78, 79 are all made of an aluminum alloy.

With such an arrangement, since the reinforcing member 75 is arranged only at an oblique side of a triangle at each corner, the weight of the outer panel member is not significantly increased. Also, the cores 78, 79 can have the same height and, therefore, the material plates 78a, 79a can be standardized.

Because of being in the form of a plate, the reinforcing member 75 has a small contact area with the connecting members 66, 66 and the strength member 70. Therefore, longitudinal opposite ends of the reinforcing member 75 are bent to form contact pieces 75a, 75b for increasing the size of the contact area with the connecting members 66, 66 and the strength member 70. The contact pieces 75a, 75b are positioned within the cells S so that incomplete cells are avoided.

When another reinforcing member 75 exists near the contact piece 75b, the two reinforcing members 75 may be connected together at their contact pieces 75b.

The strength member 70 is formed of an extruded aluminum alloy. The strength member 70 can be welded to an exterior strength member (skeleton member) 85 via the face plates 61, 62. Also, the strength member 70 can be used as a seat for fastening means such as screws. This equally applies to the connecting members 66, 66. When the strength member 70 has a channel-shaped cross-section, it is arranged between the two face plates such that an intermediate side between two parallel sides of the channel-shaped member is held contact with one of the face plates. The strength member 70 may have an I-shaped cross-section. In the case of using the strength member 70 of I-shaped cross-section, the area of flanges at both ends largely affects the bending rigidity of the outer panel member. In other words, by increasing the area of flanges at both ends of the strength member 70 of I-shaped cross-section, it is possible to enhance the bending ridigity of the outer panel member completed.

The width W of the strength member 70 is preferably set to such an extent that, when it is joined to the exterior strength member 85 by welding, the heat produced upon the welding will not adversely affect the brazers used to join the face plates 61, 62 and the cores 78, 79.

In the embodiment shown in Figs. 27, 28 and 29, if the cell size of the core 79 covering a triangular area defined by the reinforcing member 75 at the corner is set smaller than that of the core 78 covering other area, the strength of the corner is further enhanced. Although brazing is adopted in the above outer panel member as means for joining its respective components, diffusion joining or resistance welding may also be adopted. Further, the configuration of the core cell may be other than hexagonal, and the angle at which the reinforcing member is to be inclined is set depending on the cell configuration.

A description will be given below of embodiments of the underframe shown in Figs. 30 and 31. These Figures show embodiments in which the adjacent outer panel members 60 are joined to each other via cross beams 32a, 32b by welding. The cross beam 32a making up the underframe of Fig. 30 has its upper end inserted between the adjacent outer panel members 60. A web 32w of the cross beam 32a is formed on both sides with bosses 32r at positions contacting respective surfaces of the face plates 61. The bosses 32r serve to precisely position the adjacent outer panel members 60 with respect to the cross beam 32a. The cross beam 32a is built such that its upper end adjoins respective ends of the connecting members 66 under a condition of the bosses 32r being held in contact with the face plates 61. End faces of the outer panel members 60 adjoining the upper end of the cross beam 32a define a weld portion 27 and are joined to each other by welding. The web 32w and the outer panel members 690 are joined together at weld portions 27 including the above one.

The cross beam 32b making up the underframe of Fig. 31 has a boss 32r formed at its upper end. The connecting members 66 of the adjacent outer panel members 60 are arranged such that they contact the boss 32r of the cross beam 32b. This enables the adjacent outer panel members 60 to be precisely positioned with respect to the cross beam 32b.

With the structures of the underframe shown in Figs. 30 and 31, by arranging the adjacent outer panel members 60 so as to contact the boss(es) 32r formed on the cross beam 32a, 32b, those components to be joined together by welding can precisely be positioned. Also, the strength of joint portions between those components can be enhanced by welding the cross beam 32a, 32b and the adjacent outer panel members 60 together at the boss(es) 32r. Although the weld portions 27 in Figs. 30 and 31 are illustrated smaller than the actual size for clarifying the configurations of the boss(es) 32r and the ends of the outer panel members 60, the weld portions 27 are formed while sufficiently covering the ends of the components to be joined together.

According to the present invention, of a roof portion, a frieze panel portion, a pier panel portion, a wainscot panel portion, an underframe portion and an end portion which cooperatively construct a body structure of a railroad car, at least the roof portion, the frieze panel portion, the pier panel portion and the wainscot panel portion are built up by the above-explained outer panel members made of a light alloy. As a result, the body structure can be obtained which enables the provision of rectangular windows giving passengers the satisfactory field of view therethrough, while achieving the increased pressure resistance, the reduced number of working steps, and higher ridigity of the car body.

Claims

1. Joining structure of laminate panels in each of which face plates (61,62) are arranged to cover both sides of a core (63), connecting members (66) are arranged along outer peripheral edges of said core (63), and these components are joined together by brazing, characterized in that two adjacent laminate panels are joined to each other through a T-shaped joint member (32,32a,32b) which is inserted between opposed faces of the connecting members (66) on the inner side.

2. A railway car including a panel joining structure according to claim 1.

3. A railway car according to claim 2 wherein said panel joining structure is in the underframe of the car.

FIG. 1

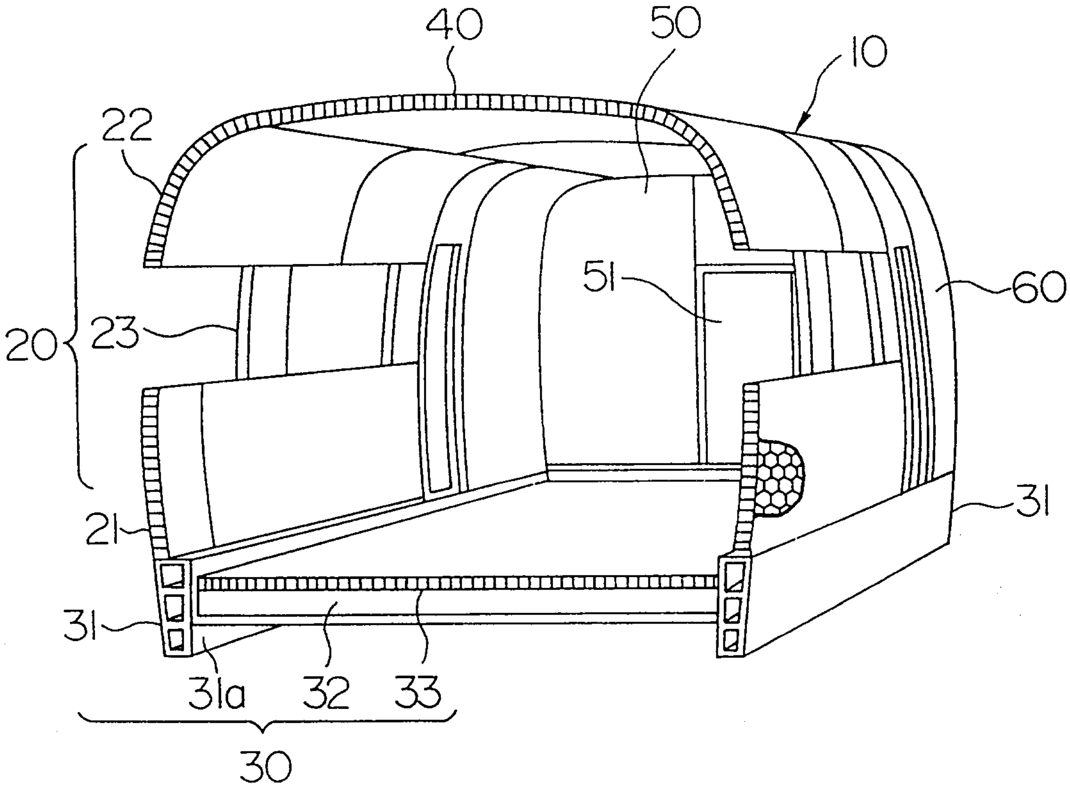
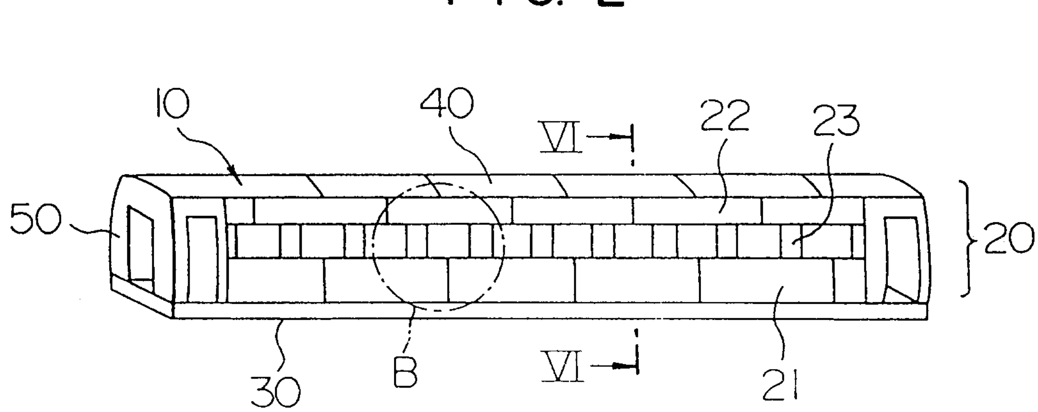
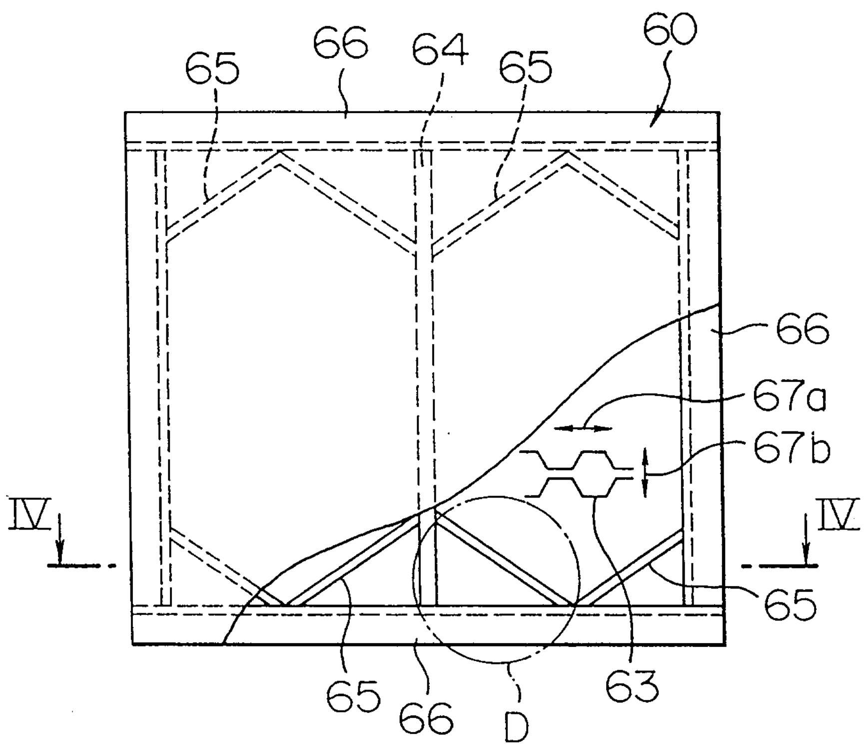

40
50
10
22
51
60
20
23
21
31
31
31a
32
33
30

FIG. 2


10
40
VI
22
23
50
20
30
B
VI
21

F I G. 3



F I G. 4

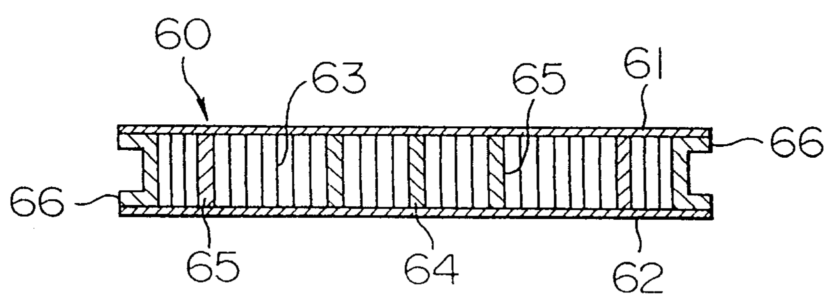
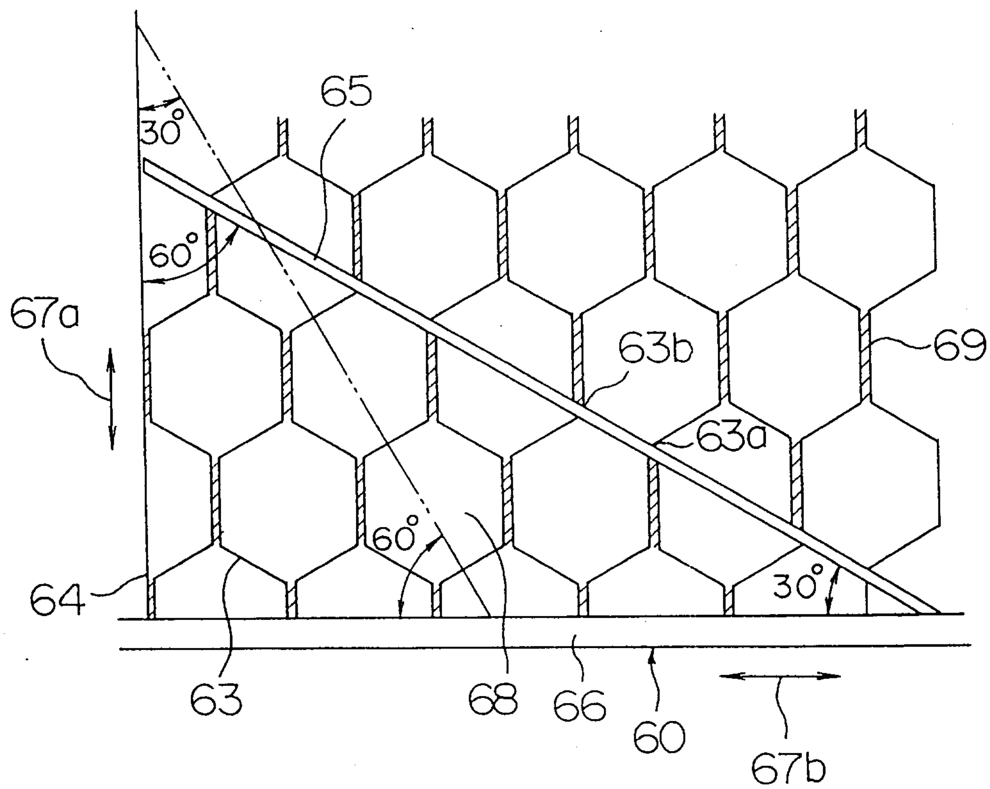


FIG. 5



F I G. 6

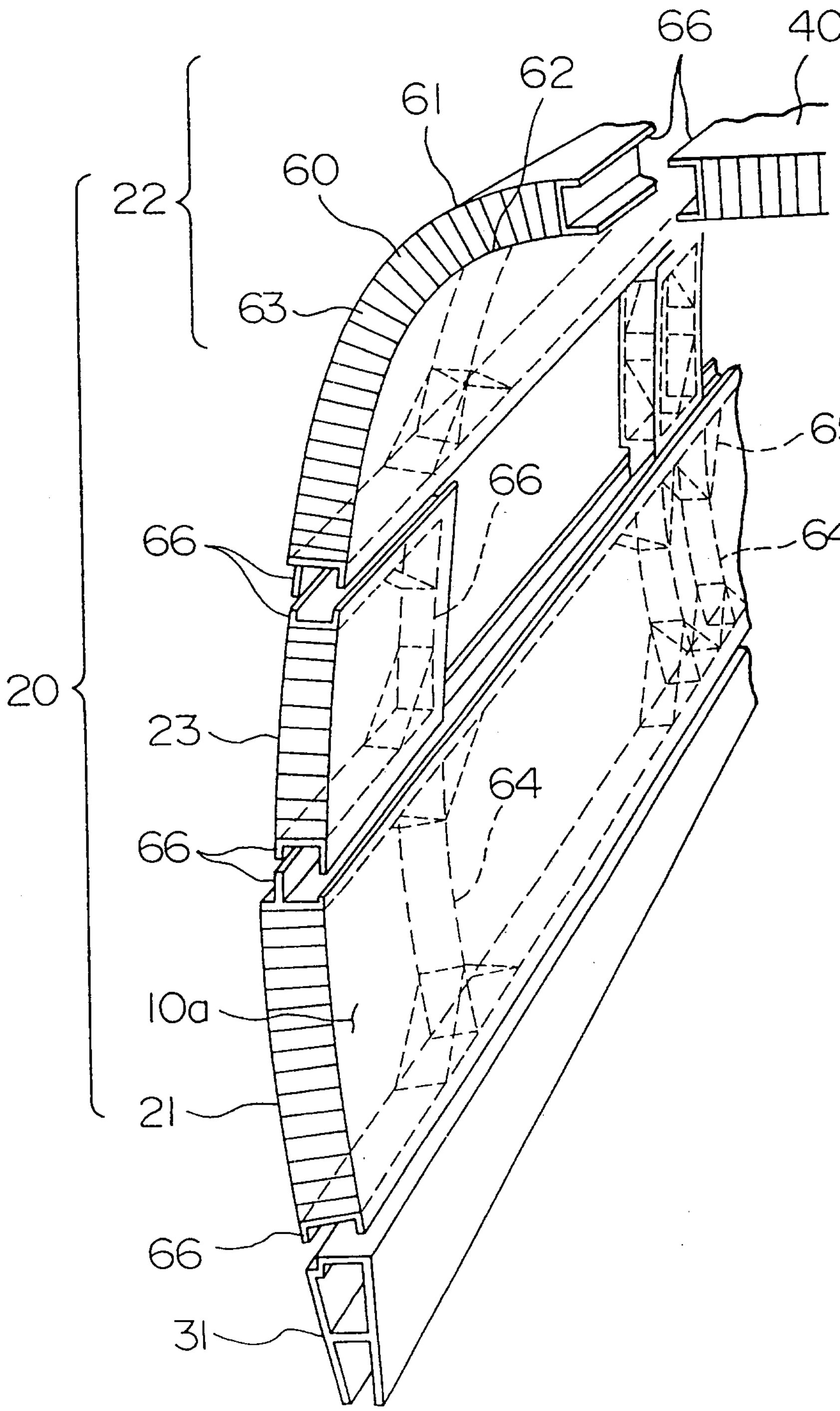
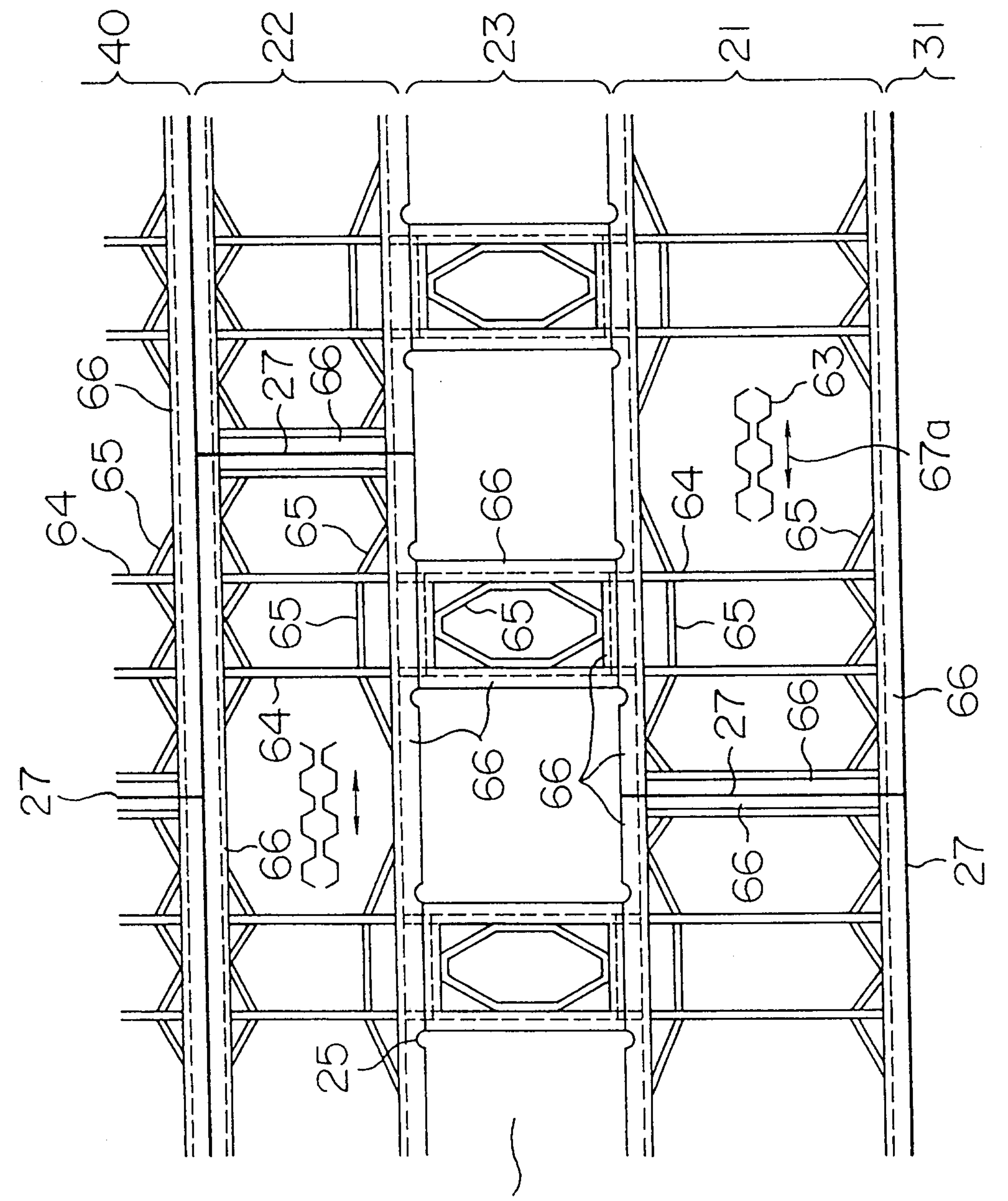
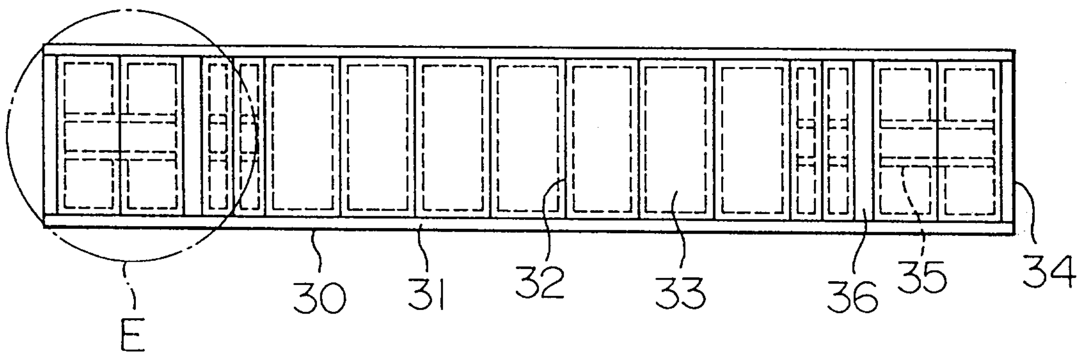


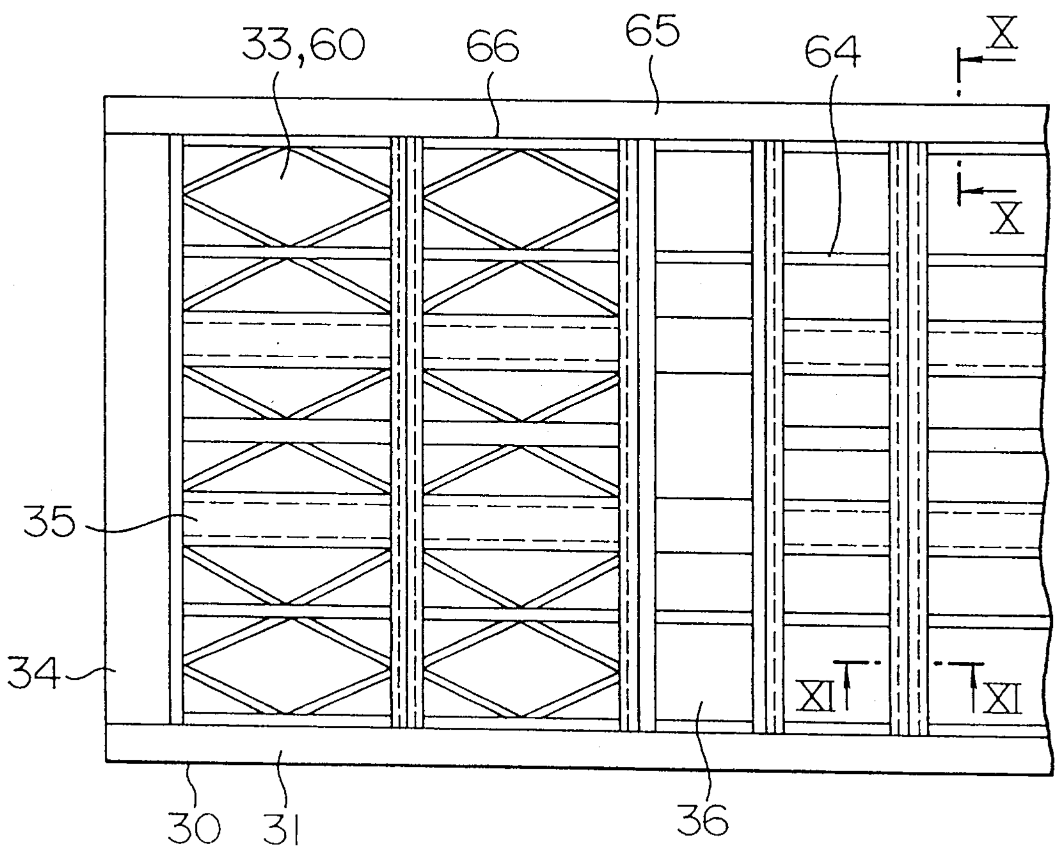
FIG. 7



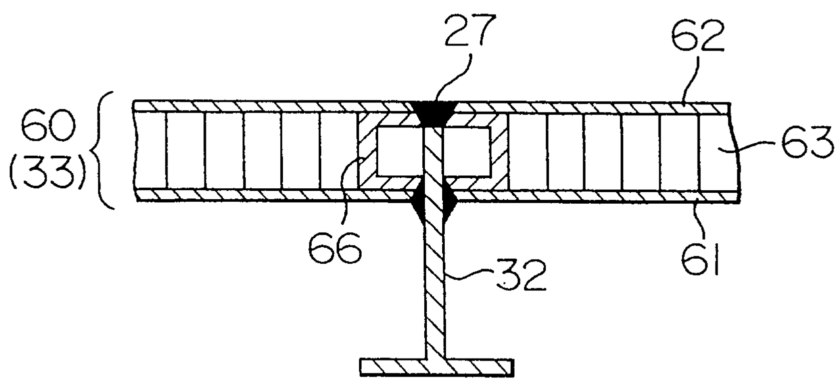
F I G. 8



F I G. 9



F I G. 10



F I G. 11

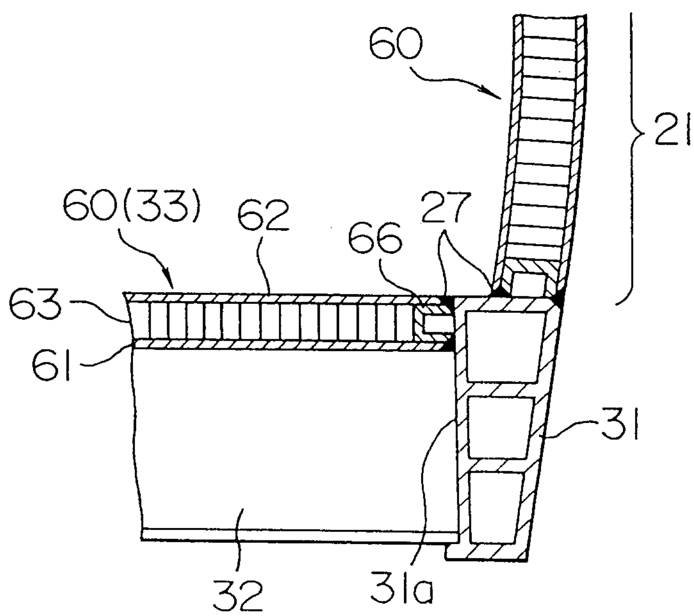


FIG. 12

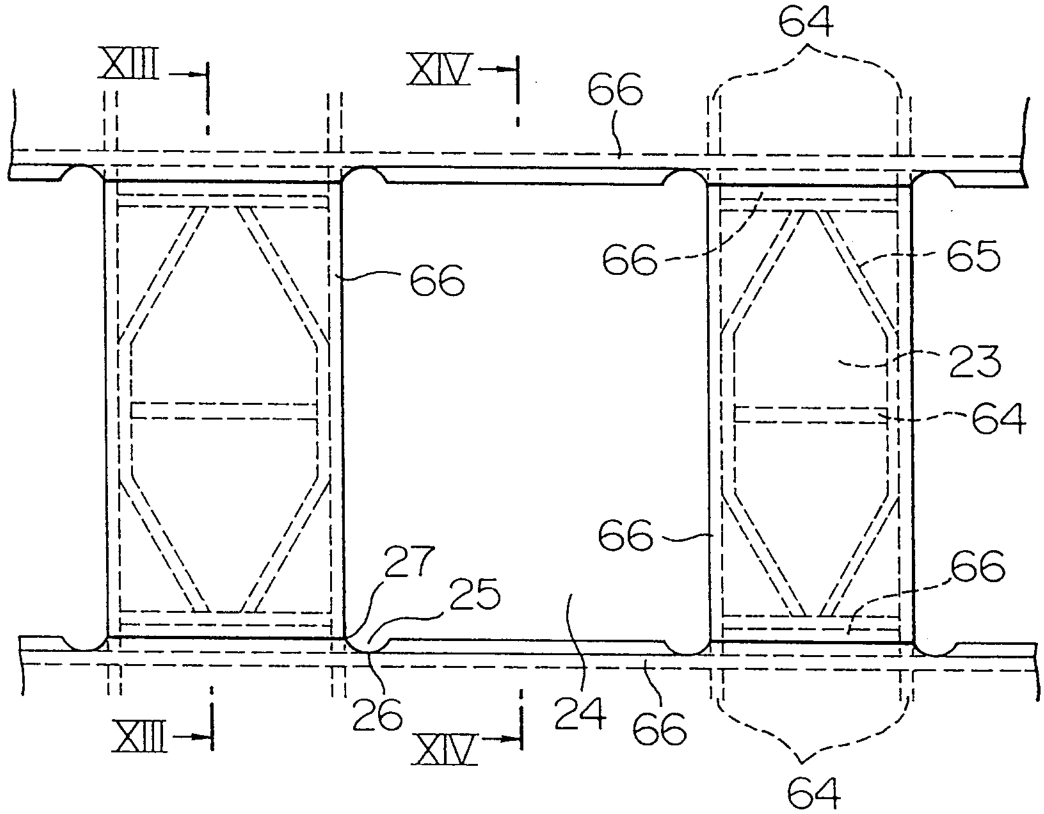
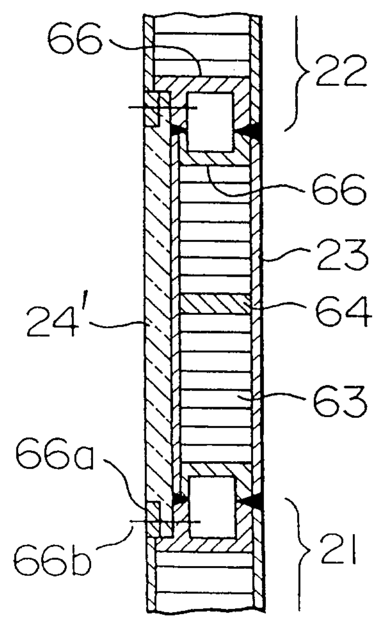
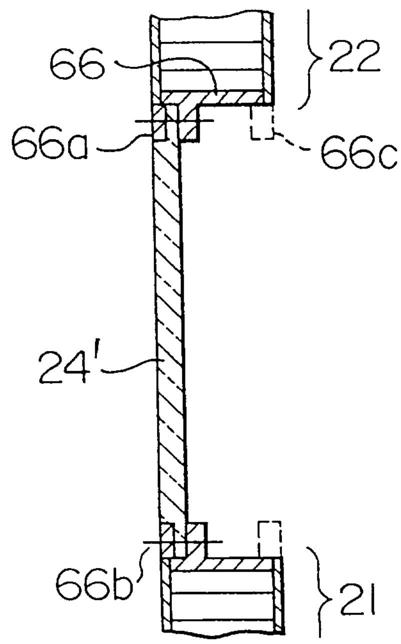

XIII
XIV
64
66
66
66
65
23
64
66
66
27
25
26
24
66
XIII
XIV
64

FIG. 13


66
22
66
23
24'
64
63
66a
66b
21

F I G. 14


66
22
66a
66c
24'
66b
21

F I G. 15

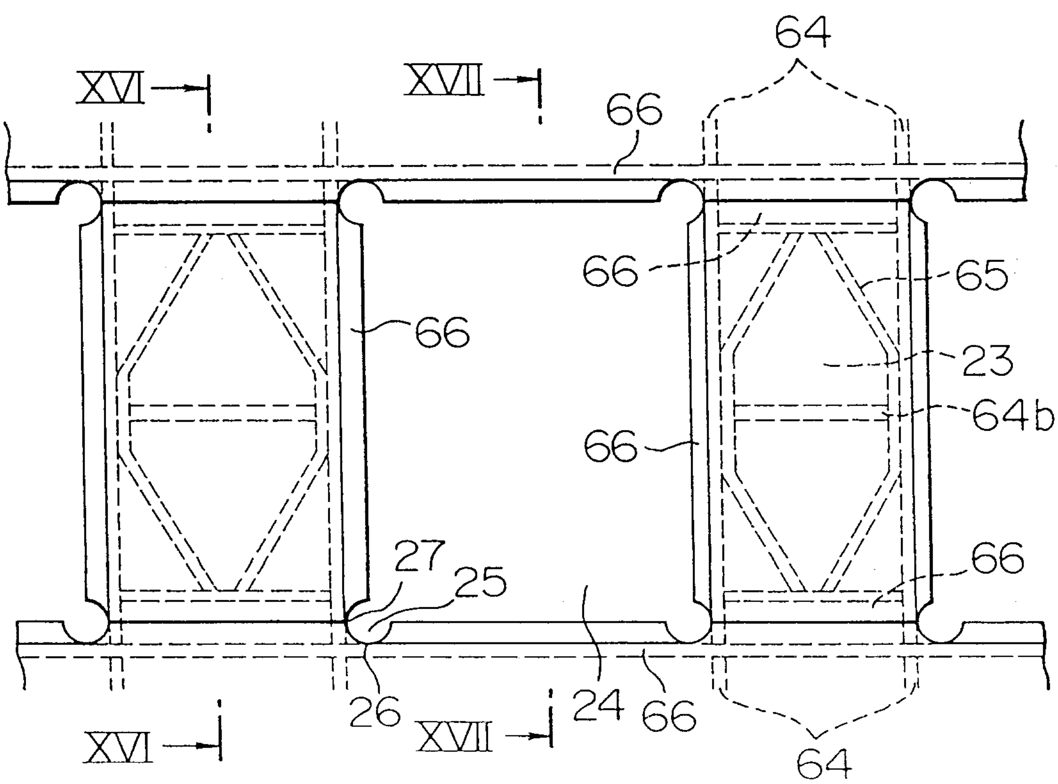

64
XVI
XVII
66
66
65
66
23
64b
66
27
25
66
26
24
66
XVI
XVII
64

FIG. 16

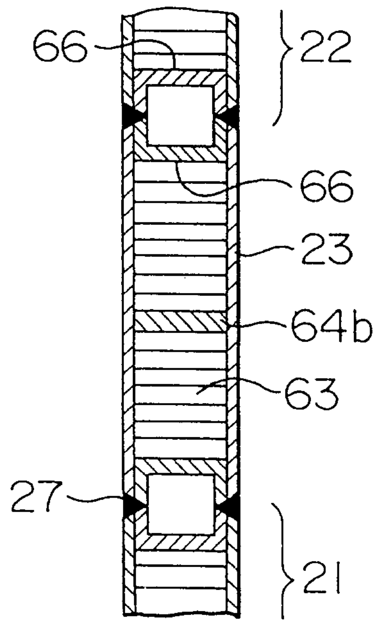


FIG. 17

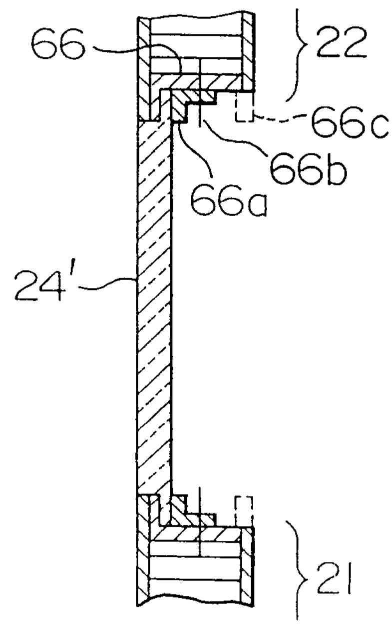


FIG. 18

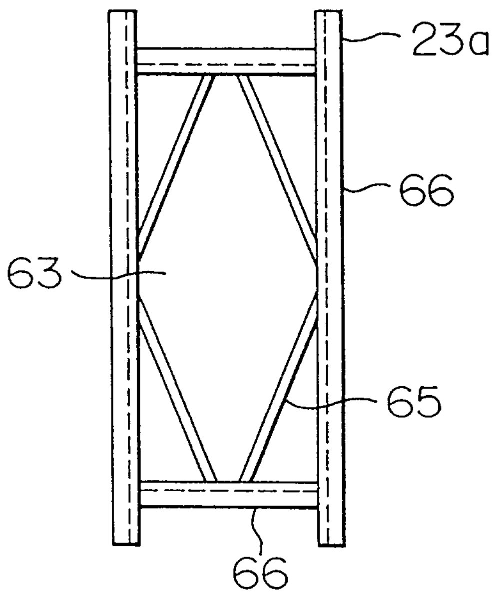
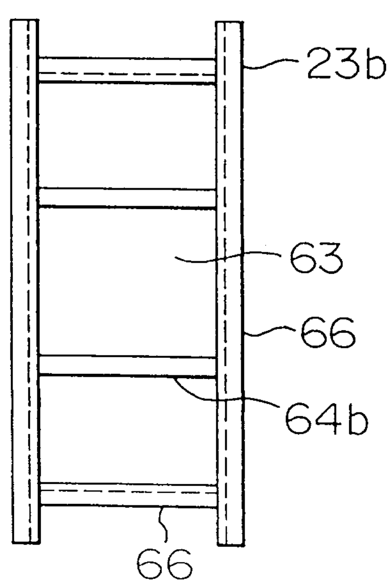
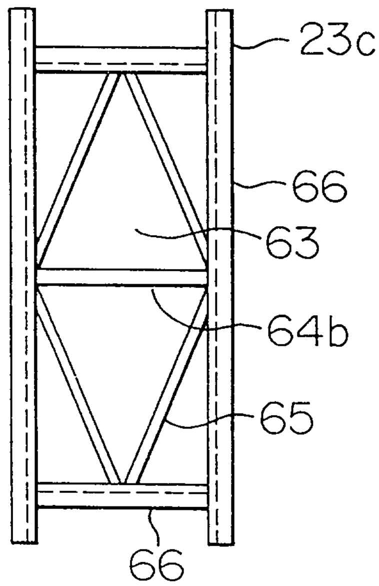


FIG. 19



F I G. 20



F I G. 21

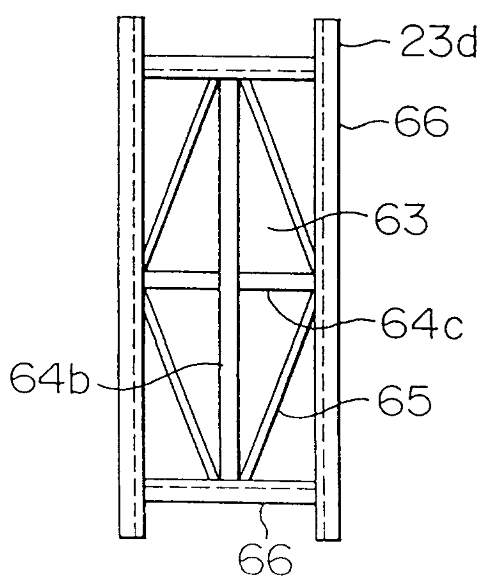


FIG. 22

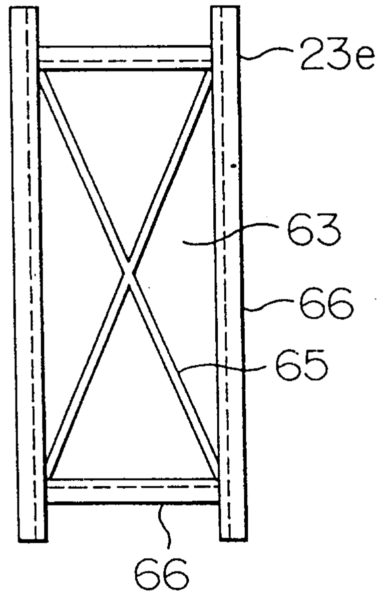
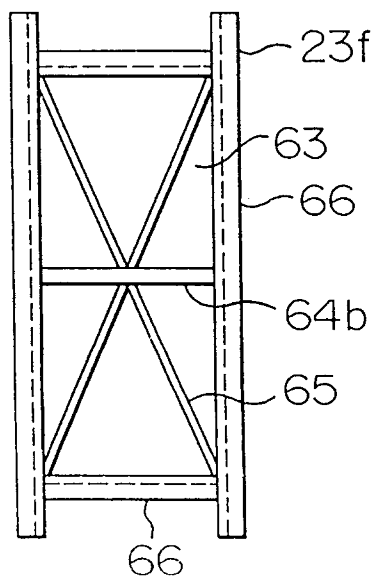
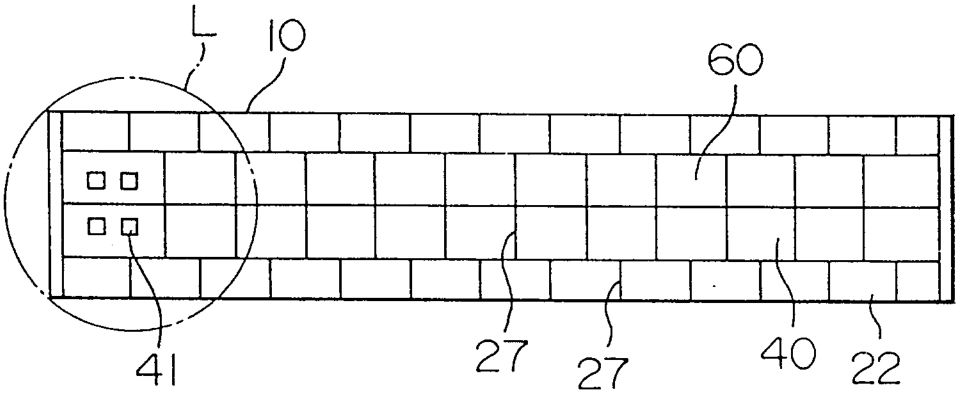


FIG. 23



F I G. 24



F I G. 25

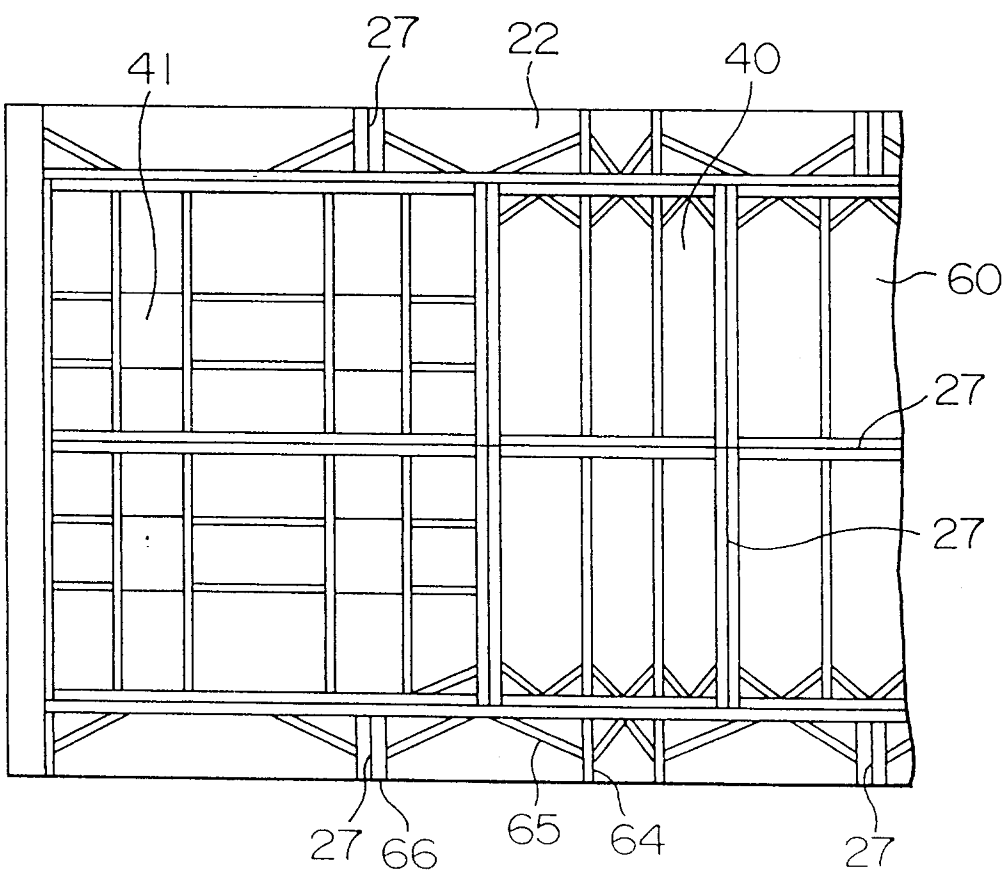


FIG. 26

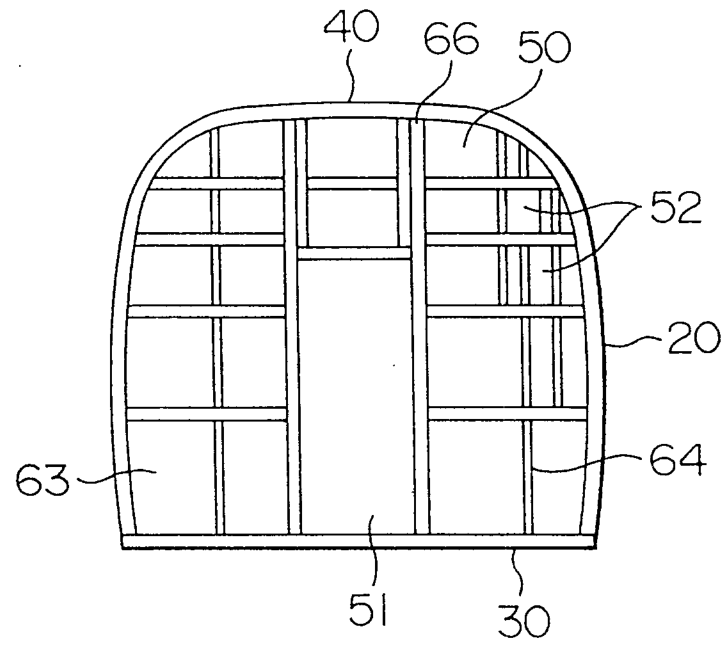
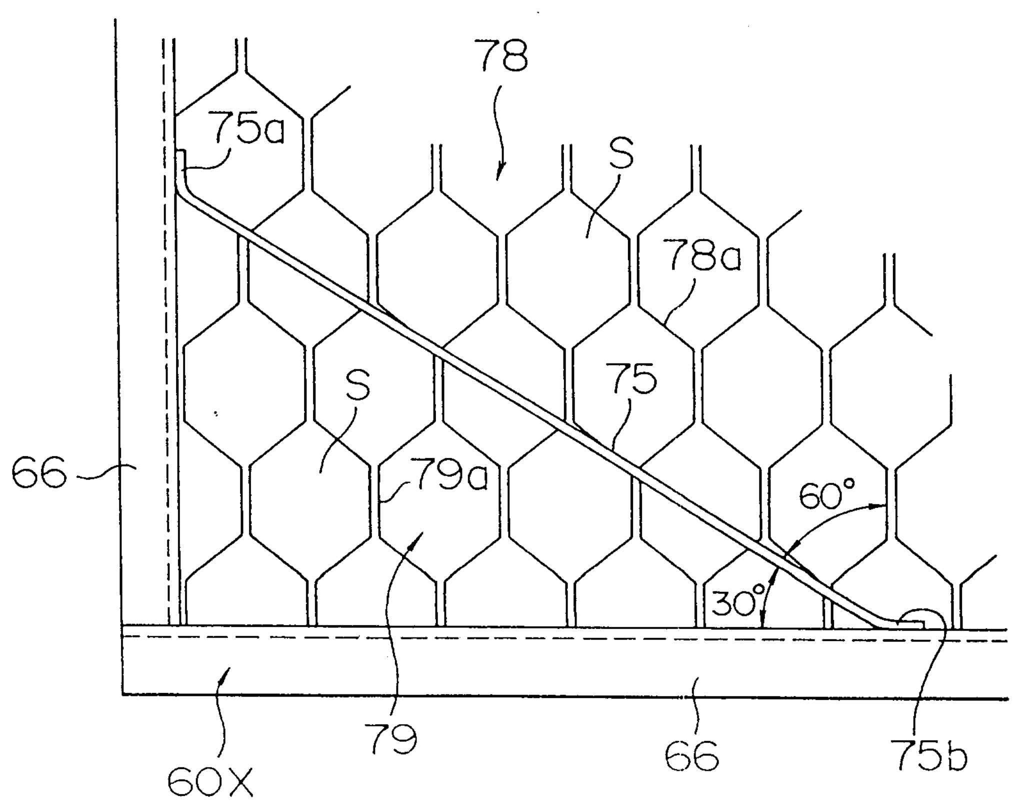
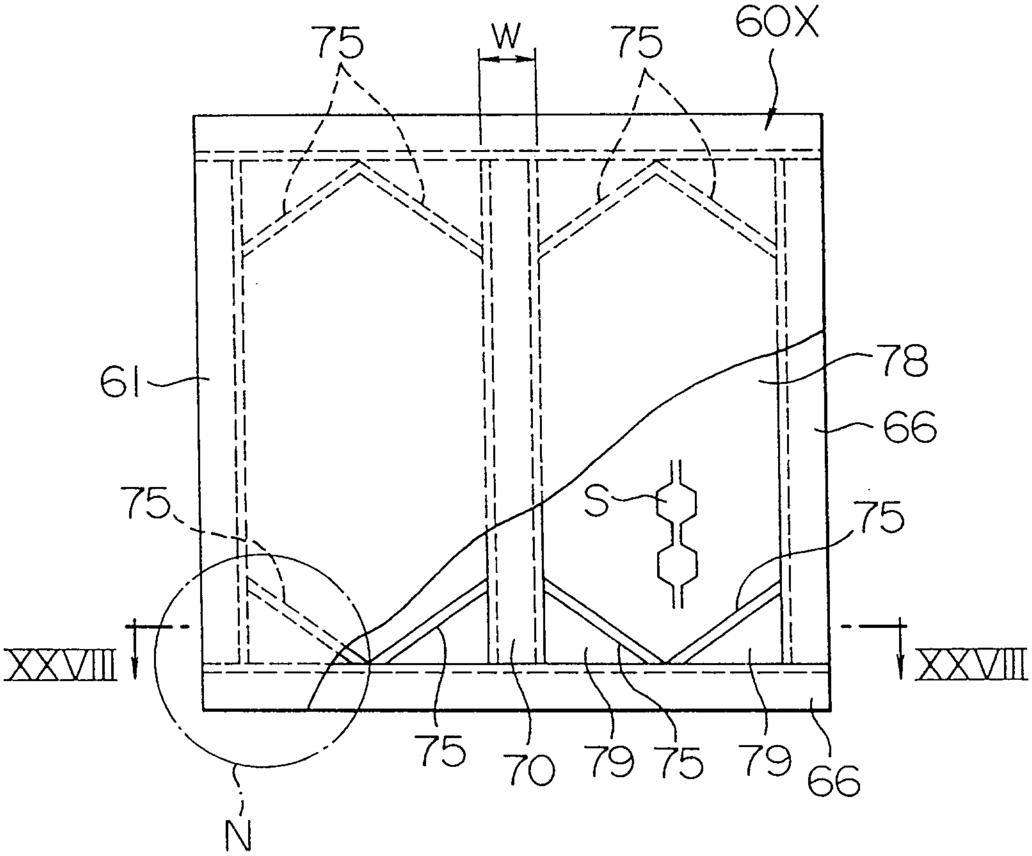

40
66
50
52
20
63
64
51
30

FIG. 29


78
75a
S
S
78a
S
75
66
79a
60°
30°
79
60X
66
75b

F I G. 27


75
W
75
60X
61
78
66
75
S
75
XXVIII
XXVIII
75
70
79
75
79
66
N

F I G. 28

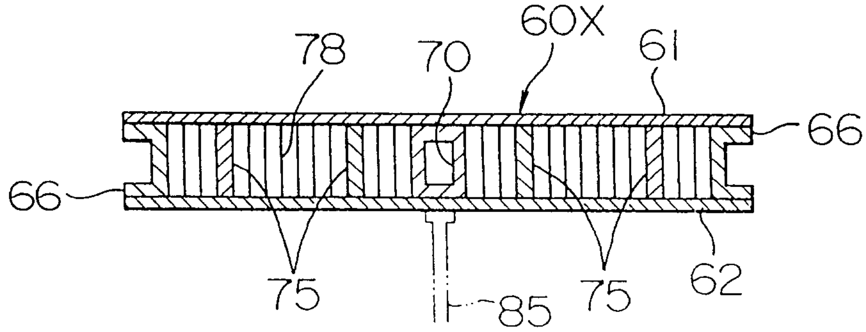

78
70
60X
61
66
66
75
85
75
62

FIG. 30

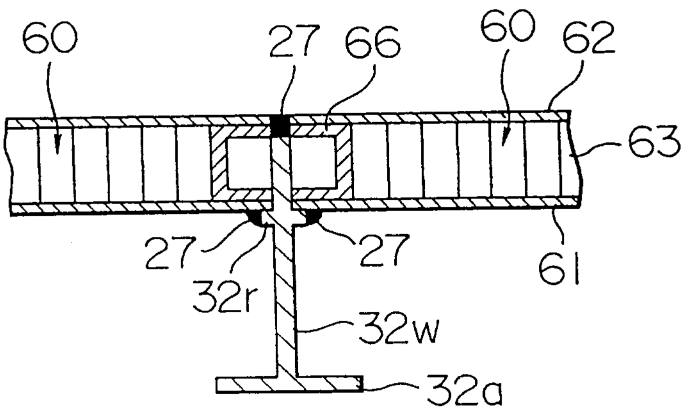
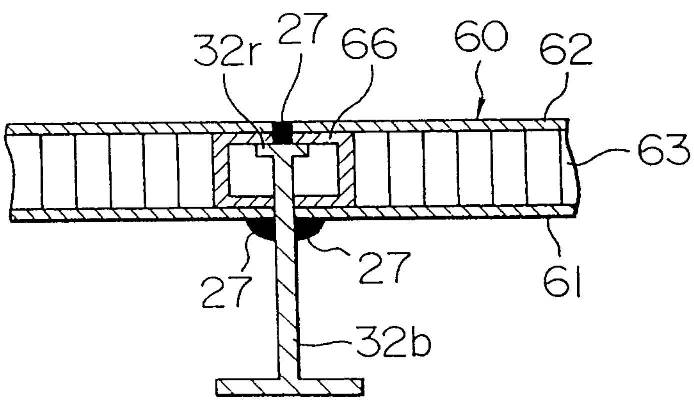


FIG. 31



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 11 6676

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
A	EP-A-0 405 889 (HITACHI LTD) 2 January 1991 * column 19, line 10 - line 28; figure 15 * ---	1	B61D17/04 B61D17/10
A	WO-A-86 00588 (ALUSUISSE) 30 January 1986 * page 5, line 6 - line 30; figure 1 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			B61D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 December 1995	Chlosta, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document