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A structure body and a manufacturing method of a structure body

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(56) Related Art
JP 09-221024
US 5651154
US 5810507

Abstract of Disclosure:

A hollow frame member is constituted by joining with a truss shape by ribs 13, 13A, 13B (23, 23A, 23B) between two face plates 11, 12 (21, 22). An end portion of one of the hollow frame member 10 is connected according to the rib 13A for constituting the truss. A face plate 21 of another hollow frame member 20 is joined at a vicinity of an apex of the truss of the hollow frame member 10. A face plate of the hollow frame member 10 is joined at a vicinity of an apex of the truss of the another hollow frame member 20. A load during a friction stir joining is received according to the ribs 13A, 13B (13A, 23B). Since the truss structure is formed totally, the light weight structure and the high rigidity performance can be obtained.

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COMPLETE SPECIFICATION

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INVENTION TITLE:

A structure body and a manufacturing method of a structure body

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

Background of the Invention:

[Technical Field]

The present invention relates to a structure body and a manufacturing method of a structure body. For example, the present invention is suited to a structure body and a manufacturing method of a structure body according to an aluminum alloy made extruded frame member which is used in a railway car or a building structure etc..

[Prior Art]

A friction stir joining method is a method in which by rotating a round rod (it is called as a rotary tool) which is inserted into a joining portion and moving the rotary tool along to a joining line of extruded frame members, and the friction stir joining portion is heated, softened and plastically fluidized and a solid-stately joined. The rotary tool is comprised of a small diameter portion which is inserted into the joining portion and a large diameter portion which is positioned at an outside of the small diameter portion of the rotary tool. The small diameter portion and the large diameter portion of the rotary tool have the same axis. A boundary between the small diameter portion and the large diameter portion of the rotary tool is inserted a little into the joining portion. The above stated technique is disclosed, for example

in Japanese application patent laid-open publication No. Hei 9-309164 (EP 0797043 A2).

In Japanese application patent laid open publication No. Hei 9-221024, a method for manufacturing easily a structure body of a railway vehicle. In this method, an end portion of plate of one side face of a hollow frame member is provided by projecting an end portion of plate of another side face and this projected plates are welded each other from an upper portion. Next, between another face plates are connected by using a covering plate.

A different point between the friction stir joining and an arc welding resides in that in the friction stir joining by an insertion of the rotary tool to members to be subjected to a joining a large load is acted on. This load acts mainly on an insertion direction (an axial center direction of the rotary tool) of the rotary tool. Namely, an insertion force of the tool acts on the members to be subjected to the joining.

When the hollow extruded frame members are carried out to the friction stir joining, against to a rib which connects a face plate and two parallel face plates the above stated insertion force by the rotary tool acts on, then the hollow extruded frame member is deformed. For these reasons, it is

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necessary to form a structure from which the deformation of the coupling member portion can be prevented.

The above stated deformation prevention means is disclosed in the above stated in Japanese application patent laid-open publication No. Hei 9-309164 (EP 0797043 A2). In this document, to a joining portion of the two hollow extruded frame members a vertical plate (it is called as a lengthwise rib) for joining two face plates of the hollow extruded frame member is provided. This lengthwise rib is positioned at an extension line of an axial center of the rotary tool. The lengthwise rib is one to which two face plates of the hollow extruded frame member are connected. To the lengthwise rib, since the large load acts concentrically, it is necessary to make thick a plate thickness of the hollow extruded frame member. For this reason, there is a limitation of an obtaining of a light weight structure coupling member.

Further, this lengthwise rib of the hollow extruded frame member will be studied from another aspect. When a face outside bending force acts on the hollow extruded frame member, it has well known that a portion dominating to a whole rigidity performance is the rib. To improve the rigidity performance against to the face outside bending force, it is desirable to arrange the rib to be consistent with toward a forty five angle direction against to the face plate which is a main stress force direction of a sharing force. However, the lengthwise rib being vertically to two sheet face plates hardly contribute as a strengthening member.

As stated above, in regardless that the lengthwise rib hardly contribute to the improvement of the rigidity performance when the structure body is used as the strengthening member, since this rib is necessary to make thick a plate thickness of the hollow extruded frame member so as to support the insertion force during a friction stir joining time, it makes difficult the light weight structure of the coupling member of the hollow extruded frame member.

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that that prior art forms part of the common general knowledge in Australia.

Summary of the Invention:

The present invention provides a manufacturing method of a structure body including the steps of:

preparing a hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, and said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss; and

positioning a second hollow frame member toward an extension direction of said another of said face plates; and

joining an end portion of said second hollow frame member to said end portion of said another of said face plates by friction stir welding.

The present invention also provides a manufacturing method of a structure body including the steps of:

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preparing a first hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss, and which has a seat at an end portion of said another of said face plates and at a vicinity of said truss; and

preparing a second hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss, and which has a seat at an end portion of said another of said face plates and at a vicinity of said truss; and

overlapping said end portion of said one of said face plates of said first hollow frame member to said seat of said second hollow frame member;

overlapping said end portion of said one of said face plates of said second hollow frame member to said seat of said first hollow frame member; and

joining respectively said overlapped portions, by friction stir welding.

The present invention also provides a structure body comprising:

a hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face

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plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, and a side of said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss; and

a second hollow frame member positioned substantially in an extension line direction of said another of said face plates, wherein

an end portion of said second hollow frame member is joined to said end portion of said another of said face plates according to friction stir welding.

The present invention also provides a structure body manufactured according to a method including the steps of:

preparing a first hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss, and which has a seat at an end portion of said another of said face plates and at a vicinity of said truss;

preparing a second hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss, and which has a seat at an end portion of said another of

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said face plates and at a vicinity of said truss;

overlapping said end portion of said one of said face plates of said second hollow frame member to said seat of said first hollow frame member;

overlapping said end portion of said one of said face plates of said first hollow frame member to said seat of said second hollow frame member; and

joining respectively said overlapped portion by friction stir welding.

The present invention also provides a structure comprising hollow frame members, wherein for each of said frame members:

two sheet face plates are connected with a truss shape according to plural ribs;

one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates;

said end portion of said one of said face plates and said end portion of said another of said face plates are connected to at least one of said plural ribs which constitute said truss; and

wherein said frame members are joined at the end portions of respective face plates by friction stir welding.

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Brief Description of Drawings:

Fig. 1 is a longitudinal cross-sectional view showing an essential portion of a joining portion of structure body and a manufacturing method of a structure body according to one embodiment of the present invention;

Fig. 2 is a longitudinal cross-sectional view showing a pair of hollow frame members of a structure body and a manufacturing method of a structure body according to one embodiment of the present invention;

Fig. 3 is an isometric view showing a car body of a railway car;

Fig. 4 is a longitudinal cross-sectional view showing an essential portion of a joining portion of a structure body and a manufacturing method of a structure body according to another embodiment of the present invention;

Fig. 5 is a longitudinal cross-sectional view showing an essential portion of a joining portion of a structure body and a manufacturing method of a structure body according to another embodiment of the present invention;

Fig. 6 is a longitudinal cross-sectional view showing an essential portion of a joining portion of another embodiment of the present invention;

Fig. 7 is a longitudinal cross-sectional view showing an essential portion of a joining portion of a structure body and a manufacturing method of a structure body according to another embodiment of the present invention; and

Fig. 8 is a longitudinal cross-sectional view showing

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an essential portion of a joining portion of a structure body and a manufacturing method of a structure body according to another embodiment of the present invention.

Description of the Invention:

One embodiment of a structure body and a manufacturing method of a structure body according to the present invention will be explained from Fig. 1 to Fig. 3. A car body 200 is comprised of a side structure body 201 for constituting a side face of the car body 200, a roof structure body 202 for constituting a roof of the car body 200, a stand frame 203 for constituting a floor of the car body 200, and a side structure body 204 for constituting an longitudinal direction end portion of the car body 200. Each of the side structure body 201, the roof structure body 202, and the stand frame 203 is constituted respectively by joining plural extruded frame members. A longitudinal direction of the extruded frame member is formed toward a longitudinal direction of the car body 200. The extruded frame member is a hollow frame member made of an aluminum alloy.

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A constitution and a joining method of a hollow extruded frame member 10 and a hollow extruded frame member 20 for constituting the side structure body 201 will be explained. Other portions and other structure bodies are similar to the above.

The hollow frame member 10 and the hollow extruded frame member 20 are comprised of two sheet face plates 11, 12 and 21, 22 and truss shape arranged plural ribs 13 and 23. The two sheet face plates 11 and 12 (the two sheet face plates 21 and 22) are substantially in parallel. A pitch of the truss according to ribs 13 and 23 is the same. The truss is constituted by the ribs 13 and 23 and a center line of a plate thickness of the face plates 11 and 12 and the face plates 21 and 22. An apex exists at a side of the face plates 11 and 12 and the face plates 21 and 22. The apex is shown by a dark round.

At a vicinity of the apex of the truss in an inner side of the railway car, rails 19 and 29 for installing machines and apparatuses are provided integrally. The rails 19 and 29 are comprised of L shape two members. The rail is a seat for installing the machines and apparatuses such as interior mounting plates and chairs, etc..

The constitution of the joining portion of the hollow extruded frame member 10 and the hollow extruded frame member 20 will be explained. To an end portion of the hollow frame member 10, there is a rib 13A which constitutes one side of the truss. An end portion of the face plate 12 is projected toward further an end portion side (a side of an adjacent hollow frame

member 20) from an end portion of the face plate 11. The rib 13A at the end portion connects the end portion of the face plate 11 with the end portion of the face plate 12. A rib 13B connects the end portion of the face plate 11 and the face plate 12. According to the ribs 13A and 13B, an isosceles triangle truss is constituted. Other truss are the isosceles triangle truss.

The end portion of the face plate 21 of the hollow frame member 20 is projected further toward an end portion side (a side of an adjacent hollow frame member 10) from the end portion of the face plate 22. There is no rib which can connect the end portion of the face plate 21 and the end portion of the face plate 22.

An inner side of the end portion of the face plate 21 is overlapped with a seat 17 which is projected from the rib 13A. The seat 17 is provided at the rib 13A which is provided at a vicinity of a cross-point of the ribs 13A and 13B. An inner side of the end portion of the face plate 22 is overlapped with a seat 27 which is projected from the end portion of the face plate 22.

When the two hollow frame members 10 and 20 are abutted, the isosceles triangle shape truss is constituted according to the ribs 23B and 13A and the face plate 21. A dimension of this truss is the same to those of other truss. Other truss are isosceles triangle shape ones.

Raised portions 15 and 25 and raised portions 16 and 26 are provided on outface side of an abutted portion. The raised portions 15 and 25 and the raised portions 16 and 26 have the

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same heights and the same widths. This abutted portion is carried out to a friction stir joining. Plate thickness of the ribs 13A, 13B and 23B are thicker that those of plate thickness of other portion ribs 13 and 23. An abutted face exists on a vertical line (a line along to a normal line of the face plate) of the apex of truss which is constituted according to the ribs 13A, 13B, and 23B and the plate faces 12 and 22. From an accuracy degree of a position of a rotary tool 250, in a practical use at a vertical line at a vicinity of the apex of the truss an axial center of the rotary tool 250 is positioned.

On the hollow frame members 10 and 20, a bed 240 is mounted where the face plates 12 and 22 are made as a lower portion. From an upper portion, the rotary tool 250 is inserted to the joining portion and the friction stir joining is carried out.

Abutted faces 15b and 26b of the raised portions 15 and 25 and the raised portions 16 and 26 are vertical against the plate faces 11 and 22. Abutted faces are vertical to the member for corresponding these. A recessed portion is constituted according to the vertical faces 15b and 26b and upper faces of the seats 17 and 27. This recessed portion is opened to a face along to the face plates 11 and 22 and an end portion side of the hollow frame members 10 and 20.

The abutted faces 15b and 26b are orthogonal to the face plates 11 and 12 and the face plates 21 and 22. Namely, the abutted faces exist along to the normal line of the face plates. The abutted faces 15b and 26b exist along to a thickness direction of the hollow frame members 10 and 20.

The positions of the abutted faces 15b and 26b are positioned toward another end portion side of the hollow frame members 10 and 20 from the normal line which passes through the apex of the truss. In a case where the abutted faces 15b, 26b exist on the normal line which passes through the apex of the truss, and in a case where the end portions of other face plates 21 and 12 are short (within an allowable error), the insertion position of the rotary tool 250 approaches toward other face plates side. In this case, there is a possibility in which the load of the rib at an approached side becomes to excess. The widths of the two raised portions 15 and 25 (16 and 26) are detected, then the axial center of the rotary tool 250 is consistent with at the center.

The manufacturing method of this structure body will be explained. The hollow frame members 10 and 20 are mounted on and fixed to the bed 240. The abutted portion of the end portions of the face plates 11 and 21 (the face plates 12 and 22) is contacted to or is approached. The raised portions 15 and 25 of the abutted portion of the upper face side face plates 11 and 21 are temporarily fixed according to an arc welding from an upper portion. The temporary welding is carried out intermittently.

The raised portions 16 and 26 are mounted on the bed 240. A vicinity of a cross-point between the rib 23B and the face plate 22 is mounted on the bed 240.

With this condition, the rotary tool 250 of a friction stir joining apparatus is inserted from the upper portion to

the abutted portion of the raised portions 15 and 25 and is moved along to a joining line and then the friction stir joining is carried out. The axial center of the rotary tool 250 is a vertical direction. However, against an advancing direction of the rotary tool 250 the axial center is inclined as already known. The width of the two raised portions 15, 25 is detected and the axial center of the rotary tool 250 is positioned at the axial center.

The rotary tool 250 comprises a large diameter portion 252 and a small diameter portion 251 at a tip end of the large diameter portion 252. The tip end of the small diameter portion 251 of the rotary tool 250 is inserted deeply from an upper face of the seat 17. A lower end of the large diameter portion 252 of the rotary tool 250 is positioned between the apex of the raised portions 15 and 25 and the outer faces of the face plates 11 and 21. A diameter of the large diameter portion 252 of the rotary tool 250 is smaller than a width which is comprised of the two raised portions 15 and 25. The small diameter portion 251 of the rotary tool 250 forms a screw member.

According to this friction stir joining a clearance formed between the abutted portion of the face plates 11 and 12 is buried and joined.

Next, this structure body is reversed and mounted on the bed 240. From the upper portion of the raised portions 16 and 26 the temporary fixing is carried out by the arc welding. Next, from the upper portion of the raised portions 16 and 26 according to the rotary tool 250 the friction stir joining is carried out.

This friction stir welding is carried out similarly to the above.

Finally, the raising portion of the outer face side of the railway car body 200 is cut off and is made to have the same face to the face plate.

According to the above, the axial center of the rotary tool 250 exists on the apex of the truss according to the two ribs 13A and 13B (the ribs 13A and 23B) or on the vertical linear line which passes the vicinity of the apex. The insertion force during the friction stir joining is supported by the two ribs 13A and 13B (13A and 23B) which are arranged toward the axial center of the rotary tool 250. For this reason, the bending of the ribs 13A, 13B, and 23B can be retrained. The plate thickness of the ribs 13A, 13B, and 23B can be thin and a light weight structure can be obtained. Of course, the bending of the face plates 11 and 12 can be restrained. The plate thickness of the ribs 13A, 13B, 23B is thicker than the plate thickness of other ribs 13 and 23.

Since the bed 240 for supporting the ribs 13A, 13B, and 23B exists, the bending of the face plate can be prevented.

Further, after the friction stir joining, when it is used as the structure body, all of the structure body are constituted substantially according to the truss structure. For this reason, the face outer bending rigidity performance can be improved and the light weight structure can be obtained.

The apex according to the two ribs 13A and 13B (two ribs 13A and 23B) may positioned at the outer face side from the face plates 11 and 21.

The joining according to the above embodiment is carried out according to the friction stir joining, however one of the joining or both of the joining may be carried out according to the arc welding. In the case of the arc welding, since there is no load during the joining, the ribs 13A, 13B, and 23B can be made thin. An upper face of a projecting seat 17 and a lower face of the seat 17 may be inclined.

In the above stated embodiment of the structure body and the manufacturing method of the structure body, the face plates 11 and 12 and the face plates 21 and 22 are in parallel, but it can correspond a case where one of the face plates is inclined with the another face plate.

Fig. 4 shows a further embodiment of a structure body and a manufacturing method of a structure body and a case with which the normal line of the face plate of the joining portion is inclined. One end of the hollow frame member 10 is horizontal. The hollow frame members 10 and 20 are mounted on the bed 240. This causes easily to the joining line of the end portion of the side structure body 201. The axial center of a rotary body exists along to the normal line of the face plate. This normal line passes through the vicinity of the apex of the truss. An arrow mark shows the position and the direction of the rotary tool 250.

Fig. 5 shows a further embodiment of a structure body and a manufacturing method of a structure body and will be explained. The hollow frame member 20 is a block shape member 30. It does not matter whether the member 30 is hollow or not.

Others in this embodiment according to the present invention are similarly to those of the embodiment shown in Fig. 1. In a case where the member 30 is a hollow frame member, the seat 27 is provided to a rib for connecting the raised portion 26 and the face plate 21. This rib is substantially orthogonal to (along to the normal line of the face plate) the face plate 11. The face plate 21 is substantially arranged along to an extension line of the face plate 11.

Fig. 6 shows a further embodiment of a structure body and a manufacturing method of a structure body and will be explained. In the hollow frame member 20 shown in Fig. 1 there is no rib for connecting the end portion of the face plate 21 and the end portion of the face plate 22. On the other hand, to the end portion of the face plate there are the raising portions 25 and 26. For this reason, the manufacture of the rising portion 25 is difficult. An aim of the embodiment according to the present invention shown in Fig. 6 is to improve the above stated embodiment. There is a rib 23A for connecting the end portion of the face plate 21 and the end portion of the face plate 22. The isosceles triangle is formed according to the ribs 23A and 23B and the face plate 21. With this structure, the insertion force is supported according to the two ribs 23A and 23B. The plate thickness of the ribs 13A, 13B, 23A, and 23B can be made thin. After the manufacture of the hollow frame member 20, the rib 23A can be removed, after that as shown in Fig. 1 the friction stir joining can be carried out.

Fig. 7 shows a further embodiment of a structure body

and a manufacturing method of a structure body, in Fig. 7 the rib 23A is provided to approach to the end portion of the hollow frame member. An isosceles triangle is constituted according to a center line of the rib 23A and a center line of the rib 13B. At the vertical linear line which passes through a cross-point of both center lines the axial center of the rotary tool 250 exists. According to this structure, the insertion force can be supported according to the three ribs.

Fig. 8 shows a further embodiment of a structure body and a manufacturing method of a structure body, in Fig. 8, the insertion position of the rotary tool 250 is formed between two cross-points.

A technical range according to the present invention is not limited by the wordings defined in each claim of what is claimed is or the wordings stated on the means for solving the problems and further it refers also to the range in which the man belonged in this technical field can be placed easily.

According to the present invention, since the vicinity of the apex according to the two ribs for connecting two sheet face plates is joined as the joining portion, the light weight structure and the high rigidity performance structure body can be provided.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A manufacturing method of a structure body including the steps of:

preparing a hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, and said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss; and

positioning a second hollow frame member toward an extension direction of said another of said face plates; and

joining an end portion of said second hollow frame member to said end portion of said another of said face plates by friction stir welding.

2. A manufacturing method of a structure body according to claim 1, wherein the friction stir welding is carried out at an abutted portion of said end portion of said one of said face plates and said end portion of said second member.

3. A manufacturing method of a structure body according to claim 1, wherein the joining of said end portion of said another of said face plates and said end portion of said second member is positioned at an apex of said truss.

4. A manufacturing method of a structure body according to claim 3, wherein said hollow frame member has a seat at a vicinity of said apex, and the method includes the step of:

overlapping said second member on said seat of said hollow frame member before the friction stir joining is carried out.

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5. A manufacturing method of a structure body including the steps of:

preparing a first hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss, and which has a seat at an end portion of said another of said face plates and at a vicinity of said truss; and

preparing a second hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss, and which has a seat at an end portion of said another of said face plates and at a vicinity of said truss; and

overlapping said end portion of said one of said face plates of said first hollow frame member to said seat of said second hollow frame member;

overlapping said end portion of said one of said face plates of said second hollow frame member to said seat of said first hollow frame member; and

joining respectively said overlapped portions, by friction stir welding.

6. A manufacturing method of a structure body according to claim 5, wherein the friction stir welding is carried out at

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an abutted portion of said end portion of said one of said face plates of said first hollow frame member and said end portion of said another of said face plates of said second member.

7. A manufacturing method of a structure body according to claim 6, wherein the friction stir joining is positioned at an apex of each of said trusses.

8. A structure body comprising:

a hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, and a side of said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss; and

a second hollow frame member positioned substantially in an extension line direction of said another of said face plates, wherein

an end portion of said second hollow frame member is joined to said end portion of said another of said face plates according to friction stir welding.

9. A structure body according to claim 8, wherein the friction stir welding is carried out at an abutted portion of said end portion of said one of said face plates to said end portion of said second member.

10. A structure body according to claim 8, wherein said end portion of said another of said face plates and said end portion of said second member are positioned in the vicinity of an apex of said truss for joining thereof.

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11. A structure body manufactured according to a method including the steps of:

preparing a first hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss, and which has a seat at an end portion of said another of said face plates and at a vicinity of said truss;

preparing a second hollow frame member in which two sheet face plates are connected with a truss shape by plural ribs, one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates, said end portion of said one of said face plates and said end portion of said another of said face plates are connected by at least one of said plural ribs which constitute said truss, and which has a seat at an end portion of said another of said face plates and at a vicinity of said truss;

overlapping said end portion of said one of said face plates of said second hollow frame member to said seat of said first hollow frame member;

overlapping said end portion of said one of said face plates of said first hollow frame member to said seat of said second hollow frame member; and

joining respectively said overlapped portion by friction stir welding.

12. A structure body according to claim 11, wherein the friction stir welding is carried out at an abutted portion

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of said end portion of said one of said face plates of said first hollow frame member and said end portion of said another of said face plates of said second hollow frame member.

13. A structure body according to claim 11, wherein the friction stir joining is positioned at an apex of each of said trusses.

14. A structure comprising hollow frame members, wherein for each of said frame members:

two sheet face plates are connected with a truss shape according to plural ribs;

one of said face plates is formed shorter than another of said face plates so that an end portion of said another of said face plates is spaced from, and projects beyond, an end portion of said one of said face plates;

said end portion of said one of said face plates and said end portion of said another of said face plates are connected to at least one of said plural ribs which constitute said truss; and

wherein said frame members are joined at the end portions of respective face plates by friction stir welding.

15. A structure according to claim 14, wherein:

a raised portion is provided at a vicinity of an apex of said truss on said end portion of said another of said face plates of each hollow frame member; and

said raised portion has a first face substantially parallel to said another of said second face plates and a second face along a thickness direction of said another of said face plates.

16. A structure according to claim 15, wherein

said second face follows a line along a thickness direction of said hollow frame member and is substantially

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parallel to, but spaced marginally from, a line which passes vertically through said apex.

17. A structure body substantially as hereinbefore described with reference to the accompanying drawings.

18. A method of manufacturing a structure body substantially as hereinbefore described with reference to the accompanying drawings.

DATED this 21st day of February, 2002

Hitachi, Ltd

by DAVIES COLLISON CAVE
Patent Attorneys for the Applicant

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FIG. 1

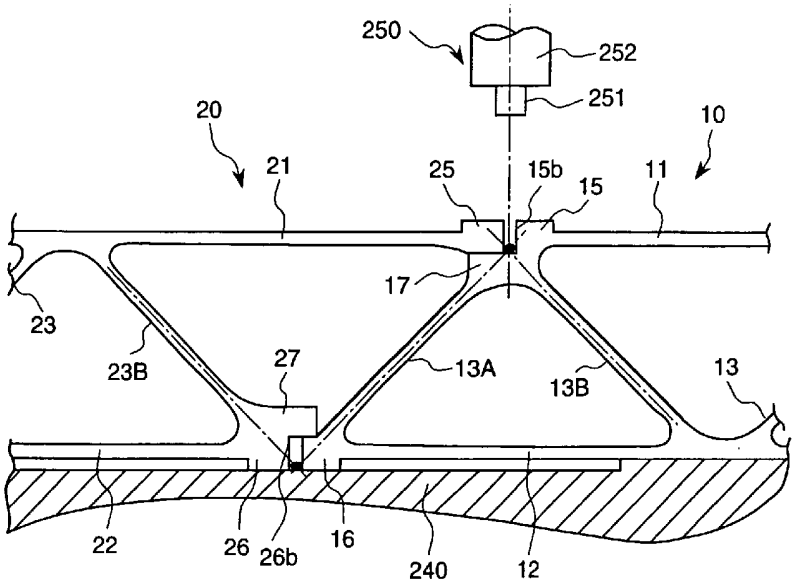

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251
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13B
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26b
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240
12

FIG. 2

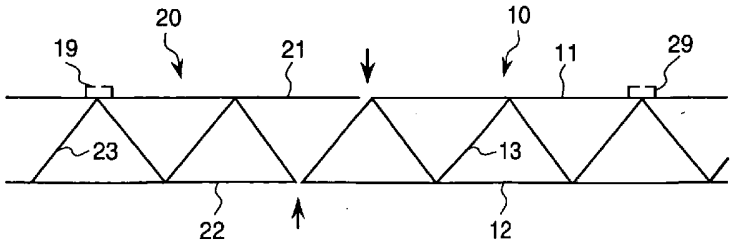

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FIG. 3

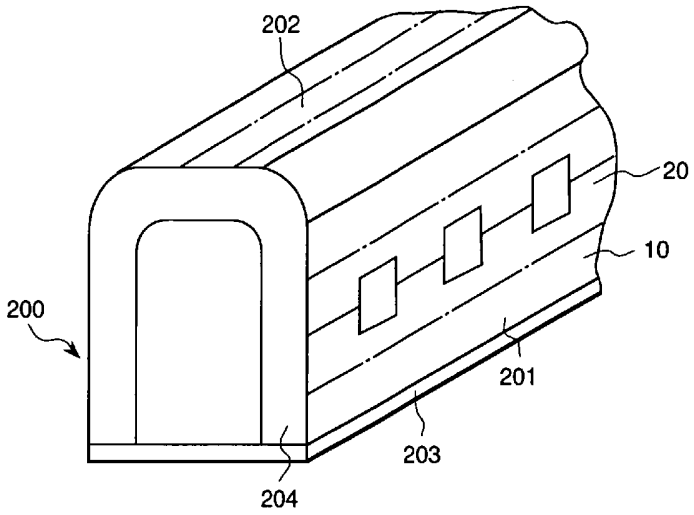


FIG. 4

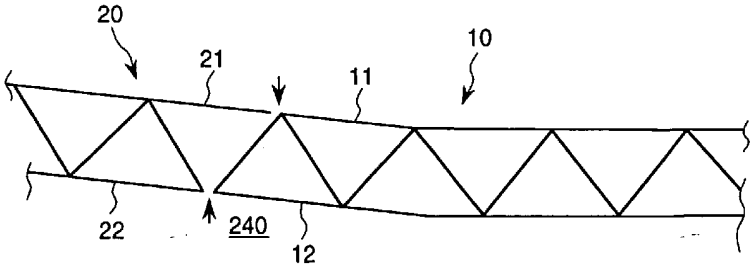


FIG. 5

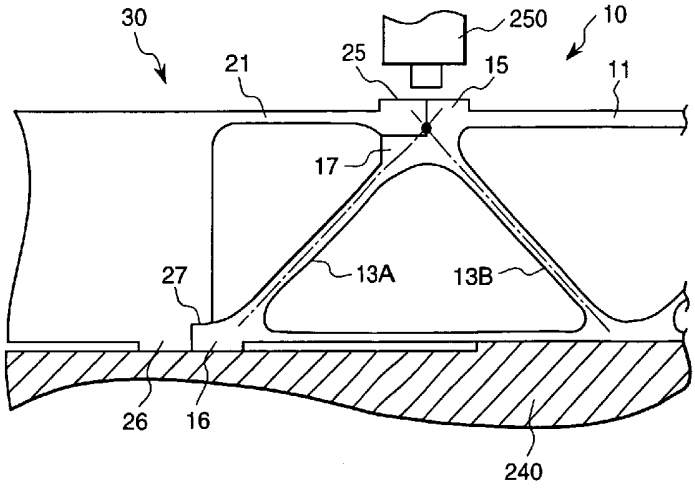

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FIG. 6

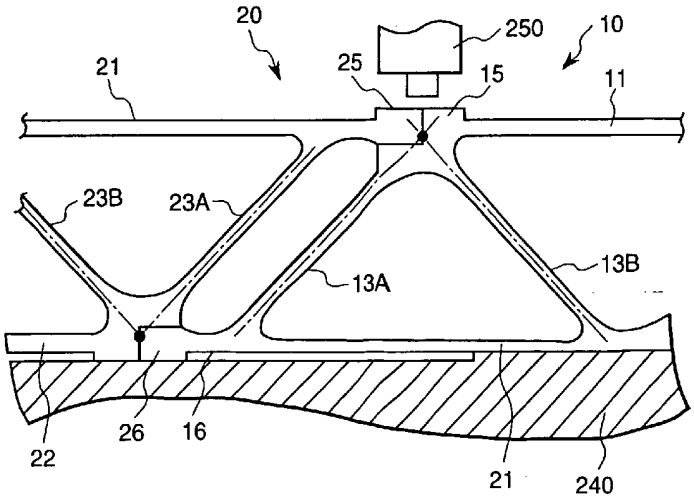

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FIG. 7

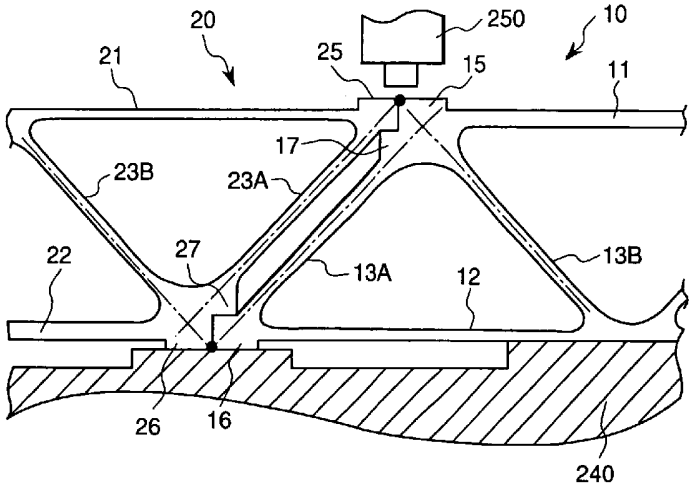
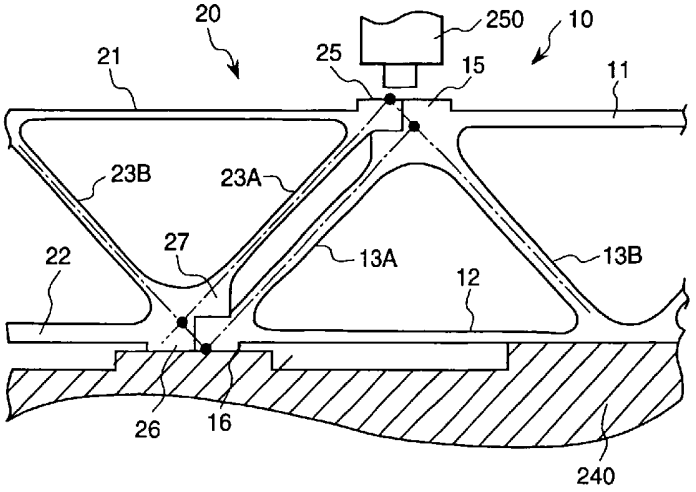

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FIG. 8


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