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(54) Rail vehicle, manufacturing method thereof, and hollow shape member used for the same

Herstellungsverfahren für ein Schienenfahrzeug, und dazu verwendete Hohlkörperelemente

Procédé de fabrication d'un véhicule ferroviaire, et éléments creux utilisés pour le procédé.

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(56) References cited:
EP-A- 0 345 962
EP-A- 0 354 436
EP-A- 0 369 134
EP-A- 0 405 889
EP-A- 0 622 285
EP-A- 0 672 567
EP-A- 0 739 800
DE-U1- 9 305 321
DE-U1- 9 320 494

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a railroad vehicle, a vehicle traveling on a monorail track, namely, a rail vehicle, and a manufacturing method thereof.

Description of the Related Art

[0002] A rail vehicle is generally constructed by a rail vehicle construction body including a roof construction body constructing a top surface of a vehicle body, side construction bodies constructing side surfaces, a base frame constructing a bottom surface, and end construction bodies constructing end surfaces. In recent years, with reduction in weight and enhancement in manufacturability as the main purpose, each of the roof construction body, the side construction bodies and the base frame which construct the rail vehicle construction body is formed by joining a hollow extruded shape member of an aluminum alloy formed by two face plates and a plurality of connecting ribs connecting the face plates. For the end construction body, a ribbed extruded shape member made of an aluminum alloy is used. The structure of each of the construction bodies is shown in, for example, Japanese Patent Publication No. 2604226 (Patent Document 1).

[0003] In a rail vehicle, a current collector (pantograph) and an air conditioning device (air conditioner) are installed on a top surface of a roof construction body for the purpose of securing power and comfortability. The installation spots of the roof construction body for such devices have a low roof structure (hereinafter, called "low roof construction body") as compared with the other region of the vehicle construction body (hereinafter, called "general construction body") to avoid contact of the devices and an aerial line, except for the current collector of a pantograph.

[0004] The low roof construction body is usually manufactured separately from the general construction body, and is joined to the general construction body which is provided with a large opening on the top surface by cutting a hollow extruded shape member constructing the roof construction body or the side construction bodies in such a manner as to be fitted into the opening. The low roof construction body is constructed of a plate material and a hollow extruded shape member in accordance with the required conditions such as strength and mass. Here, in order to facilitate understanding, a method of joining the low roof construction body constructed of a plate material to the general construction body will be described.

[0005] The case where the low roof construction body is mounted from above for the purpose of simplification of manufacture of a vehicle body is assumed. In this case, an end portion of the plate material constructing the low roof construction body is fillet-welded to the surface of the face plate at the vehicle outer side of the hollow extruded shape member constructing the roof construction body or the side construction body. Therefore, a level difference occurs to the welded portion, which may cause reduction in strength of the vehicle body, or cause a noise from the level difference portion.

[0006] On the other hand, the case where the low roof construction body is mounted from below is assumed in order to avoid these problems. In this case, by providing a level difference of a height equivalent to the plate thickness of the face plate of the vehicle outer side of the hollow extruded shape member constructing the roof construction body or the side construction body at an end portion of the plate material constructing the low roof construction body, butt joint of the general construction body and the low roof construction body becomes possible. However, in mounting the low roof construction body from below, it is necessary to mount the low roof construction body from inside of the general construction body, which makes production of the vehicle body difficult.

[0007] EP-A-0354436 discloses a railway car body in which a roof construction is formed of a flat top panel of honeycomb type and sloping side panels of honeycomb type on each side. The sloping side panels of the roof are joined to the flat top panel and to sides of the car body, which are also of honeycomb type, through respective hollow profiles.

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to prevent reduction in strength and noise occurrence in a connecting portion of a low roof construction body to a roof construction body or a side construction body, and to facilitate mounting of the low roof construction body to the roof construction body or the side construction body.

[0009] In order to attain the above-described object, according to the invention, there is provided a rail vehicle as set out in claim 1.

[0010] The invention also provides a method of manufacturing a rail vehicle as set out in claim 6. t

[0011] According to the rail vehicle and its manufacturing method which are the present invention, in the rail vehicle construction body of the rail vehicle, the roof construction body constructing the top surface of the vehicle body and the side construction body constructing the side surface of the vehicle body are each constructed by the hollow shape member formed by two face plates and a plurality of ribs connecting the face plates. By lowering the low roof construction body loaded with the on roof apparatus from above, the engaging portions formed at both end portions in the vehicle width direction of the low roof construction body are mounted on the mounting portions formed at the upper end portion of the side construction body, and thereby, the low roof construction body is mounted on the side construction body. The side construction body and the low roof construction body are

welded at the welded part where the engaging portions are mounted on the mounting portions. Accordingly, a special complicated operation is not required for mounting both of them, and the side construction body and the low roof construction body can be fixed by performing welding to the vehicle outer side face plate and the vehicle inner side face plate from the surface side at both the vehicle outer side and the vehicle inner side in the obtained joint state.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a perspective view of a railroad vehicle construction body being one embodiment of a rail vehicle according to the present invention;
FIG. 2 is a view showing a part of the II-II section of the rail vehicle shown in FIG. 1;
FIG. 3 is a view showing a part of the III-III section of the rail vehicle shown in FIG. 1;
FIG. 4 is an enlarged sectional view of a part of IV in FIG. 1; and
FIG. 5 is a view showing one example of connection in the longitudinal direction of a low roof construction body and a roof construction body of the rail vehicle shown in FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] One embodiment of the present invention will be described with reference to FIGS. 1 to 5. FIG. 1 is a perspective view showing one embodiment of a rail vehicle according to the invention. As shown in FIG. 1, a rail vehicle construction body 1 is constructed by a general construction body 10 and a low roof construction body 20 for loading apparatuses. The ordinary construction body 10 is constructed by a roof construction body 11 constructing a top surface, two side construction bodies 12 and 12 constructing side surfaces, a base frame 13 constructing a bottom surface, and two end construction bodies 14 and 14 constructing end surfaces. The roof construction body 11, the side construction bodies 12 and 12, the base frame 13, the end construction bodies 14 and 14 and the low roof construction body 20 are constructed by joining a plurality of extruded shape members, respectively.

[0014] The extruded shape members constructing the roof construction body 11, the side construction bodies 12 and 12, the base frame 13 and the low roof construction body 20 are hollow shape members made of an aluminum alloy, and the extruding direction coincides with the longitudinal direction of the rail vehicle construction body 1. The longitudinal direction is the fore-and-aft direction of the vehicle, and the traveling direction of the vehicle. The extruding shape members constructing the end construction bodies 14 and 14 are ribbed shape members made of an aluminum alloy, and the extruding direction is in the vertical direction of the rail vehicle construction body 1.

[0015] FIG. 2 is a view showing a part of the II-II section of the rail vehicle shown in FIG. 1. As shown in FIG. 2, an uppermost portion 129 of the side construction body 12 is welded to the roof construction body 11 at a welded part 30. The uppermost portion 129 of the side construction body 12 becomes flat so as to connect to the roof construction body 11 smoothly continuously. The roof construction body 11 and the side construction body 12 have the face plates at the vehicle outer side and the vehicle inner side butted to each other, and upper and lower (vehicle inner and outer) face plates of the roof construction body 11 and vehicle inner and outer face plates (a face plate 121 at the vehicle outer side and a face plate 122 at the vehicle inner side) of the side construction body 12 are welded so that the surfaces of the face plates of the roof construction body 11 and the side construction body 12 are flash with each other in the butted portions, and are joined as the welded part 30. The welded part 30 is formed by welding, but may be formed by the other joint means, for example, joint by, friction stir welding. In FIG. 2, the structures other than the uppermost portion 129 of the side construction body 12 are previously included for joint with the low roof construction body 20 which will be described later, and is not used for joint with the roof construction body 11.

[0016] Each of the roof construction body 11 and the side construction body 12 is made by joining a plurality of hollow extruded shape members to one body by welding or friction stir welding.

[0017] Next, joint of the side construction body 12 and the low roof construction body 20 will be described. FIG. 3 is a view showing a part of the III-III section of the rail vehicle shown in FIG. 1. FIG. 4 is an enlarged view of a part shown by IV in FIG. 3. As shown in FIG. 3, the low roof construction body 20 is made by joining a plurality of hollow extruded shape members to be one body by welding or friction stir welding.

[0018] The low roof construction body 20 is constructed by a flat part 21, a raised part 22 raised to be joined to the side construction body 12 at both sides of the width direction of the flat part 21, and a protruded part 23 that flatly protrudes toward the joint portion with the side construction body 12 from the raised part 22. The protruded part 23 becomes the end portion in the vehicle width direction, and is joined by butting to an upper end portion 128 of the side construction body 12.

[0019] Explaining the joint portion of the side construction body 12 and the low roof construction body 20 in detail, the extruded shape member of the side construction body 12 is cut at the portion to be joined to the low roof construction body 20, and the uppermost portion 129 at the upper end side from the cut portion is removed, as can be understood by comparison with FIG. 2. The protruded part 23 of the low roof construction body 20 is joined to the spot exposed at the upper end portion 128

by cutoff to be joint portions, and the joint portions are finally bonded by welding as will be described in detail later.

[0020] As shown in FIGS. 2 to 4, in the hollow shape member 120 prepared for constructing the side construction body 12, a first protruded rib 124 and a second protruded rib 125 are formed at spots to be joined to the protruded part 23 of the low roof construction body 20 before cutoff of the uppermost portion 129. The first protruded rib 124 is formed to be protruded toward a hollow portion 126 in the hollow shape member 120 from the portion in the vicinity of the joint spot of an outer surface side face plate 121 and a connecting rib 123 for connecting the outer surface side face plate 121 and a vehicle inner side face plate 122. The protruding direction of the first protruded rib 124 is the direction which is the horizontal direction in the state where the hollow shape member 120 is vertically provided as the side construction body 12. The connecting rib 123 is formed in the hollow portion 126 of the hollow shape member 120. Protruding toward the hollow portion 126 means protruding in the horizontal direction when the uppermost portion 129 of the side construction body 12 is cut off to be exposed to the front to construct the vehicle body.

[0021] A second protruded rib 125 is formed to protrude toward an inside of a vehicle compartment from a joint spot of the vehicle inner side face plate 122 of the side construction body 12 and the connecting rib 123. The protruding direction of the second protruded rib 125 is the horizontal direction in the same meaning as in the case of the first protruded rib 124. The reason why the second protruded rib 125 protrudes to the inside of the vehicle compartment instead of the inside of the hollow portion 126 is that the corresponding portion of the hollow shape member 120 is in an arc shape. The first and the second protruded ribs 124 and 125 of the side construction body 12 do not play any role when joined to the roof construction body 11. The first and the second protruded ribs 124 and 125 function as mounting portions only when the side construction body 12 is joined to the low roof construction body 20. When the low roof construction body 20 is joined to the side construction body 12, in the upper end portion 128 of the first hollow shape member 120 constituting the side construction body 12, the vehicle outer side face plate 121 and the vehicle inner side face plate 122 are cut at both the protruded ribs 124 and 125 and removed. The remaining hollow shape member 120 is integrally joined as the side construction body 12.

[0022] Next, the low roof construction body 20 is joined to the hollow shape member 120 from which the face plates 121 and 122 at the upper end side are cut. On the occasion of the joint, a plurality of hollow shape members constructing the low roof construction body 20 are joined to be already an integrated hollow shape member 210. Engaging portions protruding in the direction to be horizontal toward the upper end portion 128 of the first hollow shape member 120 in the joined state to the low roof construction body 20 are formed at end portions in the vehicle width direction of the protruded part 23 of the low roof construction body 20. The engaging portions are engaging ribs 214 and 215 which are respectively formed corresponding to the first and the second protruded ribs 124 and 125 that are the mounting portions. The joint portions are provided as two sets of joint portions distantly placed at the vehicle inner and outer sides. Namely, the engaging rib 214 and the protruded rib 124 construct a set of joint portions at the vehicle outer side, and the engaging rib 215 and the protruded rib 125 construct a set of joint portions at the vehicle inner side.

[0023] The set of joint portions at the vehicle outer side are disposed at the outer side in the vehicle width direction from the set of the joint portions at the vehicle inner side. Namely, the first protruded rib 124 is at the outer side in the vehicle width direction from the second protruded rib 125, and the first protruded rib 124 is at the outer side in the vehicle width direction from the second engaging rib 215. The first engaging rib 214 is at the outer side in the vehicle width direction from the second engaging rib 215. By such disposition, on the occasion of lowering the low roof construction body 20, it does not interfere with the sets of joint portions at the vehicle inner side and outer side.

[0024] When the low roof construction body 20 is lowered from above, the first engaging rib 214 and the second engaging rib 215 of the low roof construction body 20 are placed to be overlaid on the top surface of the first projected rib 124 of the hollow shape member 120 constructing the side construction body 12 and on the top surface of the second protruded rib 125, respectively. The first protruded rib 124 and the second engaging rib 215 define a hollow portion 127 formed in the joint portions with the connecting ribs 123 and 213.

[0025] The first protruded rib 124 is formed to protrude in a position recessed by a predetermined depth from a surface of the vehicle outer side face plate 211 of the first hollow shape member 120. The predetermined depth is specifically the dimension corresponding to the thickness of the first engaging rib 214. Accordingly, the first protruded rib 124 is protruded from the position recessed by the amount corresponding to the thickness of the first engaging rib 214 from the surface of the vehicle outer side face plate 121 of the first hollow shape member 120. The second engaging rib 215 is formed to protrude in the position raised by a predetermined height from the vehicle inner side surface of the second hollow shape member 210. The predetermined height is specifically the dimension corresponding to the thickness of the second protruded rib 125. Accordingly, the second engaging rib 215 is formed to protrude in the position raised from the position recessed by the amount corresponding to the thickness of the second protruded rib 125, from the surface of the vehicle inner side face plate 212 of the second hollow shape member 210.

[0026] By setting the above described dimension in each set of joint portions at the vehicle inner side and outer side, the surfaces at the joint portions at the inner

side and outer side of the vehicle become smooth, and occurrence of a level difference can be avoided. When the low roof construction body 20 is overlaid on the hollow shape member 120 of the side construction body 12, the surfaces of the face plate 121, the first engaging rib 214 and the face plate 211 become continuous without forming a level difference at the vehicle outer side. At the vehicle inner side, the surfaces of the face plate 122, the second protruded rib 125 and the face plate 212 also become continuous without forming a level difference. In this explanation, the continuous surface without generating a level difference is called the coplanarity.

[0027] In each set of joint portions at the vehicle inner and outer sides, the butted portions of the overlaid first protruded rib 124 and the first engaging rib 214, and the second protruded rib 125 and second engaging rib 215, are joined by welding or friction stir welding. A butted portion 220 occurring to the set at the vehicle outer side is formed between the connecting portion of the vehicle outer side face plate 121 of the first hollow shape member 120 and the connecting fib 123, and the tip end portion of the first engaging rib 214 at the side of the second hollow shape member 210. The butted portion 220 occurring to the set at the vehicle inner side is formed between the tip end portion of the second protruded rib 125 at the side of the first hollow shape member 120 and the connecting portion of the vehicle inner side face plate 212 at the side of the second hollow shape member 210 and the connecting rib 213.

[0028] Welding of the butted portion 220 at the vehicle outer side can be performed from the vehicle outer side. The butted portion 220 has a groove. The groove is filled with a welding bead222. The welding bead 222 may be protruded slightly upward from the face plate 211. Welding of a butted portion 221 at the vehicle inner side can be performed from the vehicle inner side. A groove present in the butted portion 221 is filled with a welding bead 223. The welding bead 223 may be protruded from the face plate 212 or the second protruded rib 125.

[0029] The first protruded rib 124 and the second engaging rib 215 become backings on the occasion of welding in the butted portions 220 and 221, respectively.

[0030] As for welding of the butted portions 220 and 221, when the grooves of the butted portions are large, the first protruded rib 124 and the second protruded rib 125 may be fillet-welded.

[0031] In FIG. 4, the first engaging rib 214 of the hollow shape member 210 constructing the low roof structure 20 is thicker than the face plate 211 at the other spots. The first engaging rib 214 is the vehicle outer side end portion of the projected part 23, but is not the vehicle outer side face plate 211 itself, and therefore, can be called a rib. The first engaging rib 214 is protruded from the rib 213 which connects the face plate 211 and the face plate 212.

[0032] In the hollow shape member 120 constructing the side construction body 12, the protruded ribs 124 and 125 can be said to protrude from the vicinity of the intersection points of connection of the connecting rib 123 and the face plates 121 and 122. In the hollow shape member 210, the engaging ribs 214 and 215 can be also said to protrude from the vicinity of the intersection points of the connecting portions of the face plates 211 and 212 and the connecting rib 213.

[0033] According to this, by inserting the low roof construction body 20 downward from above, the low roof construction body 20 is supported with the side construction body 12, and therefore, the mounting operation can be easily performed.

[0034] The welding beads 222 and 223 are practically in the same planes as the face plates 211 and 212 in the hollow shape member 210, and therefore, they do not become the noise generating sources.

[0035] In the above described embodiment, the protruded ribs 124 and 125 are previously provided at the first hollow shape member 120 constructing the side construction body 12, and are exposed by deleting the face plates 121 and 122, and therefore, the first hollow shape member 120 becomes large in weight. In order to prevent this, it is suitable to provide the protruded ribs 124 and 125 at only the hollow shape member 120 at the position where the low roof construction body 20 is connected without providing the protruded ribs at the first hollow shape member 120 at the position where the low roof construction body 20 is not connected at the side construction body 12. The first hollow shape member 120 with the protruded ribs 124 and 125 and the hollow shape member 120 without the protruded ribs 124 and 125 are welded at the butted portions at the end portions in the longitudinal direction. Since the butted portions are welded, the welding beads protrude, which becomes the factor of noise generation. In order to prevent this, the welding beads are cut and removed.

[0036] Next, connection in the longitudinal direction of the low roof construction body 20 and the roof construction body 11 will be described based on FIG. 5. Since a space occurs between both of them, the space is bridged by a connecting plate 40. The connecting plate 40 is constructed by a hollow shape member. End portions of the hollow shape member of the connecting plate 40 are butt-welded to end portions in the longitudinal direction of the roof construction body 11 and the low roof construction body 20. An end portion (upper end) in the longitudinal direction of the connecting plate 40 is along the shape in the width direction of the roof construction body 11. The other end portion (lower end) in the longitudinal direction of the connecting plate 40 is along the shape of an end portion in the longitudinal direction of the low roof construction body 20. The upper end of the connecting plate 40 is orthogonal to a vehicle outer side face plate 141 of a hollow shape member 140 of the roof construction body 11. A vehicle inner side face plate 142 and the rib are removed. The face of the connecting plate 40 at the low roof construction body 20 side and the vehicle outer side face plate 141 are fillet-welded to a rib 48.

[0037] Connection of the connecting plate 40 and the

hollow shape member 210 of the low roof structure 20 is the same. However, the connecting plate 40 is connected to the vehicle inner side face plate 212 of the low roof construction body 20. A rib 49 is welded between the vehicle inner side face plate 212 and the connecting plate 40. In FIG. 5, the connecting plate 40 is constructed by a hollow shape member, but its rib is not shown.

Claims

1. A rail vehicle having a vehicle body (1) in which a roof construction body (11) providing a top surface of the vehicle body, two side construction bodies (12) providing respective opposite side surfaces of the vehicle body and a low roof construction body (20), which is at a lower level than the portion of the roof construction body (11) adjacent thereto in the longitudinal direction of the vehicle and is loaded with an on-roof apparatus, are constructed by extruded hollow shape members (120) formed by two face plates (121,122) and a plurality of ribs connecting the face plates, the extrusion direction of the hollow shape members (120) corresponding to the longitudinal direction of the vehicle body (1),
wherein the low roof construction body (20), is joined at each of its end portions in its vehicle width direction to an upper end portion of the respective side construction body (12) provided by said hollow shape member (120) of the side construction body;
wherein at the joints of the side construction bodies (12) and the low roof construction body (20), the low roof construction body is mounted on the respective side construction body by engaging portions (214,215) formed at both end portions of the low roof construction body (20) in the vehicle width direction and being mounted on mounting portions (124,125) formed on the upper end portion of the respective side construction body;
wherein said joints are welded in a state in which the engaging portions are mounted on the mounting portions; and
wherein at each said joint of the respective side construction body (12) and the low roof construction body (20):

said engaging portions (214,215) are engaging ribs formed on said roof construction body to protrude in the width direction toward the upper end portion of the side construction body; and
the mounting portions (124,125) formed at the upper end portion of the side construction body are ribs protruding in the width direction that are respectively formed to protrude toward the end portion in the vehicle width direction of the low roof construction body, and have upper surfaces providing mounting surfaces on which the respective engaging ribs (214,215) are mounted;
wherein the engaging ribs (214,215) and the protruding ribs (124,125) are provided as two joint sets spaced apart and placed respectively at the vehicle outer side and the vehicle inner side; and
said joint set located at the vehicle outer side is disposed outwardly, in the vehicle width direction, with respect to the joint set located at the vehicle inner side by a distance which makes it possible to avoid interference with the joint set at the vehicle inner side when mounting the low roof construction body (20) on the side construction bodies (12) by lowering the low roof construction body (20) from above.

2. The rail vehicle according to claim 1,
wherein at said joint set at the vehicle outer side a first said protruding rib (124) protrudes in a position recessed by a predetermined depth from the vehicle outer side surface of the side construction body (12), and a first said engaging rib (214) which is formed to extend with a thickness corresponding to said predetermined depth from the face plate at the vehicle outer side, of the low roof construction body and is mounted on said first protruding rib (124); and
wherein at the joint set at the vehicle inner side a second said protruding rib (125) protrudes by extending from the face plate at the vehicle inner side of the side construction body, and a second engaging rib which is formed in a position raised by a height corresponding to a thickness of the second protruded rib (125) from a vehicle inner side surface of the low roof construction body (20), and is mounted on the second protruded rib.

3. The rail vehicle according to claim 2,
wherein in said joint set at the vehicle outer side, the face plate (121) of the side construction body (20) at the vehicle outer side and said first engaging rib (214) of the low roof construction body are welded from the vehicle outer side; and
wherein in said joint set at the vehicle inner side, said second protruded rib (212) of the side construction body and the vehicle inner side face plate of the low roof construction body are welded from the vehicle inner side.

4. The rail vehicle according to claim 1, 2 or 3,
wherein said mounting portions (124,125) are also formed at the side construction body at a position where the low roof construction body is not provided.

5. The rail vehicle according to any one of claims 1 to 3,
wherein an end portion in a longitudinal direction of the roof construction body (11) and the low roof construction body (20) are connected via a connecting plate (40); and
wherein the connecting plate (40) is fillet-welded to

a vehicle outer side face plate (40) of a said hollow shape member (140) of the roof construction body, and to a vehicle inner side face plate (212), of the low roof construction body.

6. A method of manufacturing a rail vehicle in which a roof construction body (11) providing a top surface of the vehicle body, two side construction bodies (12) providing respective opposite side surfaces of the vehicle body and a low roof construction body (20), which is at a lower level than the portion of the roof construction body (11) adjacent thereto in the longitudinal direction of the vehicle and is loaded with an on-roof apparatus, are constructed by extruded hollow shape members (120) formed by two face plates (121,122) and a plurality of ribs connecting the face plates, the extrusion direction of the hollow shape members (120) corresponding to the longitudinal direction of the vehicle body (1),
wherein the low roof construction body (20), is joined at each of its end portions in its vehicle width direction to an upper end portion of the respective side construction body (12) provided by said hollow shape member (120) of the side construction body;
wherein at the joints of the side construction bodies (12) and the low roof construction body (20), the low roof construction body is mounted on the respective side construction body by engaging portions (214,215) formed at both end portions of the low roof construction body (20) in the vehicle width direction and being mounted on mounting portions (124,125) formed on the upper end portion of the respective side construction body;
wherein said joints are welded in a state in which the engaging portions are mounted on the mounting portions; and
wherein at each said joint of the respective side construction body (12) and the low roof construction body (20) :

said engaging portions (214,215) are engaging ribs formed on said roof construction body to protrude in the width direction toward the upper end portion of the side construction body; and
the mounting portions (124,125) formed at the upper end portion of the side construction body are ribs protruding in the width direction that are respectively formed to protrude toward the end portion in the vehicle width direction of the low roof construction body, and have upper surfaces providing mounting surfaces on which the respective engaging ribs (214,215) are mounted;
wherein the engaging ribs (214,215) and the protruding ribs (124,125) are provided as two joint sets spaced apart and placed respectively at the vehicle outer side and the vehicle inner side; and
said joint set located at the vehicle outer side is disposed outwardly, in the vehicle width direction, with respect to the joint set located at the vehicle inner side by a distance which makes it possible to avoid interference with the joint set at the vehicle inner side when mounting the low roof construction body (20) on the side construction bodies (12) by lowering the low roof construction body (20) from above,
the method comprising the steps of:

cutting off an upper end portion of the hollow shape member of each said side construction (12) at the region where the joint is to be formed to the low roof construction body (20), thereby exposing said mounting portions (124,125) of the hollow shape member;
lowering said low roof construction body (20 loaded with the on-roof apparatus from above, and mounting said engaging portions (214,215) at both end portions in its vehicle width direction on the respective said mounting portions (124,125) appearing at the cutoff portions of the side construction bodies, joining the low roof construction body to the upper end portion of the side construction body; and
welding said joints in a state in which the engaging portions (214,215) are mounted on the mounting portions (124,125).

7. The manufacturing method of a rail vehicle according to claim 6,
wherein in the welding step at the joint where the low roof construction body (20) is joined to the upper end portion of the side construction body (12), the face plate (121) at the vehicle outer side of the side construction body (12) and the first engaging rib (214) of the low roof construction body are welded together from the vehicle outer side; and
wherein the second protruding rib (125) of the side construction body and the face plate at the vehicle inner side of the low roof construction body (20) are welded from the vehicle inner side.

Patentansprüche

1. Schienenfahrzeug mit einem Fahrzeugaufbau (1), bei dem ein eine obere Fläche des Fahrzeugaufbaus bildender Dachbaukörper (11), zwei jeweils gegenüberliegende Seitenflächen des Fahrzeugaufbaus bildende Seitenbaukörper (12) und ein Niederdach-Baukörper (20), der niedriger liegt als der in Fahrzeuglängsrichtung an ihn angrenzende Abschnitt des Dachbaukörpers (11) und ein Dachgerät trägt, aus extrudierten Hohlformteilen (120) bestehen, die durch zwei Stirnplatten (121, 122) und mehreren diese verbindende Rippen gebildet sind, wobei die Extrusionsrichtung der Hohlformteile (120) mit der Längsrichtung des Fahrzeugaufbaus (1) überein-

stimmt,
wobei der Niederdach-Baukörper (20) an jedem seiner Endteile in seiner Fahrzeugbreitenrichtung mit einem oberen Endteil des betreffenden, von dem Hohlformteil (120) des Seitenbaukörpers gebildeten Seitenbaukörpers (12) verbunden ist,
wobei an den Verbindungen der Seitenbaukörper (12) mit dem Niederdach-Baukörper (20) dieser an dem jeweiligen Seitenbaukörper durch Eingriffsteile (214, 215) montiert ist, die an beiden Endteilen des Niederdach-Baukörpers (20) in Fahrzeugbreitenrichtung ausgebildet und an am oberen Endteil des jeweiligen Seitenbaukörpers gebildeten Montageteilen (124, 125) montiert sind,
wobei die Verbindungen in einem Zustand geschweißt werden, in dem die Eingriffsteile an den Montageteilen montiert sind, und
wobei an jeder Verbindung des jeweiligen Seitenbaukörpers (12) und des Niederdach-Baukörpers (20):

die Eingriffsteile (214, 215) Eingriffsrippen sind, die an dem Dachbaukörper so ausgebildet sind, dass sie in Breitenrichtung in Richtung des oberen Endteils des Seitenbaukörpers vorstehen, und
die an dem oberen Endteil des Seitenbaukörpers gebildeten Montageteile (124, 125) in Breitenrichtung vorstehende Rippen sind,

die jeweils so ausgebildet sind, dass sie in Fahrzeugbreitenrichtung des Niederdach-Baukörpers in Richtung des Endteils vorstehen, und Montageflächen vorsehende Oberflächen aufweisen, an denen die jeweiligen Eingriffsrippen (214, 215) montiert sind,
wobei die Eingriffsrippen (214, 215) und die Vorsprungsrippen (124, 125) zwei Verbindungssätze bilden, die in Abstand voneinander an der Fahrzeugaußenseite beziehungsweise der Fahrzeuginnenseite angeordnet sind, und
der an der Fahrzeugaußenseite befindliche Verbindungssatz bezüglich des an der Fahrzeuginnenseite befindlichen Verbindungssatzes in Fahrzeugbreitenrichtung außen in einem Abstand angeordnet ist, der es ermöglicht, beim Montieren des Niederdach-Baukörpers (20) an den Seitenbaukörpern (12) durch Absenken des Niederdach-Baukörpers (20) Störungen mit dem Verbindungssatz an der Fahrzeuginnenseite zu vermeiden.

2. Schienenfahrzeug nach Anspruch 1,
wobei an dem Verbindungssatz an der Fahrzeugaußenseite eine erste Vorsprungsrippe (124) an einer Stelle vorsteht, die um eine vorgegebene Tiefe gegenüber der Fahrzeugaußenseitenfläche des Seitenbaukörpers (12) zurückgesetzt ist, und eine erste Eingriffsrippe (214) so ausgebildet ist, dass sie mit einer der vorgegebenen Tiefe entsprechenden Dicke von der Stirnplatte an der Fahrzeugaußenseite des Niederdach-Baukörpers vorsteht, und an der ersten Vorsprungsrippe (124) montiert ist, und
wobei an dem Verbindungssatz an der Fahrzeuginnenseite eine zweite Vorsprungsrippe (125) von der Stirnplatte an der Fahrzeuginnenseite des Seitenbaukörpers vorsteht und eine zweite Eingriffsrippe an einer Stelle ausgebildet ist, die um eine der Dicke der zweiten Vorsprungsrippe entsprechende Höhe gegenüber einer Fahrzeuginnenseitenfläche des Niederdach-Baukörpers (20) erhaben ist, und an der zweiten Vorsprungsrippe montiert ist.

3. Schienenfahrzeug nach Anspruch 2,
wobei in dem Verbindungssatz an der Fahrzeugaußenseite die Stirnplatte (121) des Seitenbaukörpers (20) an der Fahrzeugaußenseite und die erste Eingriffsrippe (214) des Niederdach-Baukörpers von der Fahrzeugaußenseite aus verschweißt sind, und
wobei in dem Verbindungssatz an der Fahrzeuginnenseite die zweite Vorsprungsrippe (212) des Seitenbaukörpers und die fahrzeuginnenseitige Stirnplatte des Niederdach-Baukörpers von der Fahrzeuginnenseite aus verschweißt sind.

4. Schienenfahrzeug nach Anspruch 1, 2 oder 3,
wobei die Montageteile (124, 125) auch an dem Seitenbaukörper an einer Stelle gebildet sind, an der der Niederdach-Baukörper nicht vorgesehen ist.

5. Schienenfahrzeug nach einem der Ansprüche 1 bis 3,
wobei ein Endteil in Längsrichtung des Dachbaukörpers (11) und der Niederdach-Baukörper (20) über eine Verbindungsplatte (40) verbunden sind, und
wobei die Verbindungsplatte (40) mit einer fahrzeugaußenseitigen Stirnplatte (40) eines der Hohlformteile (140) des Dachbaukörpers und mit einer fahrzeuginnenseitigen Stirnplatte (212) des Niederdach-Baukörpers kehlnahtverschweißt ist.

6. Verfahren zum Herstellen eines Schienenfahrzeugs, bei dem
ein eine obere Fläche des Fahrzeugaufbaus bildender Dachbaukörper (11), zwei jeweils gegenüberliegende Seitenflächen des Fahrzeugaufbaus bildende Seitenbaukörper (12) und ein Niederdach-Baukörper (20), der niedriger liegt als der in Fahrzeuglängsrichtung an ihn angrenzende Abschnitt des Dachbaukörpers (11) und ein Dachgerät trägt, aus extrudierten Hohlformteilen (120) bestehen, die durch zwei Stirnplatten (121, 122) und mehreren diese verbindende Rippen gebildet sind, wobei die Extrusionsrichtung der Hohlformteile (120) mit der Längsrichtung des Fahrzeugaufbaus (1) übereinstimmt,
wobei der Niederdach-Baukörper (20) an jedem seiner Endteile in seiner Fahrzeugbreitenrichtung mit

einem oberen Endteil des betreffenden, von dem Hohlformteil (120) des Seitenbaukörpers gebildeten Seitenbaukörpers (12) verbunden ist,
wobei an den Verbindungen der Seitenbaukörper (12) mit dem Niederdach-Baukörper (20) dieser an dem jeweiligen Seitenbaukörper durch Eingriffsteile (214, 215) montiert ist, die an beiden Endteilen des Niederdach-Baukörpers (20) in Fahrzeugbreitenrichtung ausgebildet und an am oberen Endteil des jeweiligen Seitenbaukörpers gebildeten Montageteilen (124, 125) montiert sind,
wobei die Verbindungen in einem Zustand geschweißt werden, in dem die Eingriffsteile an den Montageteilen montiert sind, und
wobei an jeder Verbindung des jeweiligen Seitenbaukörpers (12) und des Niederdach-Baukörpers (20):

die Eingriffsteile (214, 215) Eingriffsrippen sind, die an dem Dachbaukörper so ausgebildet sind, dass sie in Breitenrichtung in Richtung des oberen Endteils des Seitenbaukörpers vorstehen, und
die an dem oberen Endteil des Seitenbaukörpers gebildeten Montageteile (124, 125) in Breitenrichtung vorstehende Rippen sind,

die jeweils so ausgebildet sind, dass sie in Fahrzeugbreitenrichtung des Niederdach-Baukörpers in Richtung des Endteils vorstehen, und Montageflächen vorsehende Oberflächen aufweisen, an denen die jeweiligen Eingriffsrippen (214, 215) montiert sind,
wobei die Eingriffsrippen (214, 215) und die Vorsprungsrippen (124, 125) zwei Verbindungssätze bilden, die in Abstand voneinander an der Fahrzeugaußenseite beziehungsweise der Fahrzeuginnenseite angeordnet sind, und
der an der Fahrzeugaußenseite befindliche Verbindungssatz bezüglich des an der Fahrzeuginnenseite befindlichen Verbindungssatzes in Fahrzeugbreitenrichtung außen in einem Abstand angeordnet ist, der es ermöglicht, beim Montieren des Niederdach-Baukörpers (20) an den Seitenbaukörpern (12) durch Absenken des Niederdach-Baukörpers (20) Störungen mit dem Verbindungssatz an der Fahrzeuginnenseite zu vermeiden,
wobei in dem Verfahren:

ein oberer Endteil des Hohlformteils jedes Seitenbaukörpers (12) in dem Bereich, in dem die Verbindung mit dem Niederdach-Baukörper (20) gebildet werden soll, abgeschnitten wird, wodurch die Montageteile (124, 125) des Hohlformteils freigelegt werden,
der das Dachgerät tragende Niederdach-Baukörper (20) abgesenkt wird, und die Eingriffsteile (214, 215) an beiden Endteilen in seiner Fahrzeugbreitenrichtung an den jeweiligen, an den abgeschnittenen Teilen der Seitenbaukörper freigelegten Montageteilen (124, 125) montiert werden,
der Niederdach-Baukörper mit dem oberen Endteil des Seitenbaukörpers verbunden wird, und
die Verbindungen in einem Zustand geschweißt werden, in dem die Eingriffsteile (214, 215) an den Montageteilen (124, 125) montiert sind.

7. Verfahren zum Herstellen eines Schienenfahrzeugs nach Anspruch 6,
wobei beim Schweißen an der Verbindung zwischen dem Niederdach-Baukörper (20) und dem oberen Endteil des Seitenbaukörpers (12) die Stirnplatte (121) an der Fahrzeugaußenseite des Seitenbaukörpers (12) und die erste Eingriffsrippe (214) des Niederdach-Baukörpers von der Fahrzeugaußenseite aus zusammengeschweißt werden, und
wobei die zweite Vorsprungsrippe (125) des Seitenbaukörpers und die Stirnplatte an der Fahrzeuginnenseite des Niederdach-Baukörpers (20) von der Fahrzeuginnenseite aus verschweißt werden.

Revendications

1. Véhicule ferroviaire ayant une carrosserie de véhicule (1) dans lequel un élément de carrosserie de toit (11) fournissant une surface supérieure de la carrosserie du véhicule, deux éléments de carrosserie latéraux (12) fournissant des surfaces latérales opposées respectives de la carrosserie du véhicule et un élément de carrosserie de toit inférieur (20), lequel est à un niveau inférieur à la partie de l'élément de carrosserie de toit (11) adjacent à celui-ci dans la direction longitudinale du véhicule et est chargé avec un appareil sur le toit, sont construits à l'aide d'éléments de forme creux extrudés (120) formés par deux plaques frontales (121, 122) et une pluralité de rainures reliant les plaques frontales, la direction d'extrusion des éléments de forme creux (120) correspondant à la direction longitudinale de la carrosserie du véhicule (1),
dans lequel l'élément de carrosserie de toit inférieur (20), est relié à chacune de ses parties d'extrémité dans la direction de la largeur du véhicule à une partie d'extrémité supérieure de l'élément de carrosserie latéral respectif (12) formé par ledit élément de forme creux (120) de l'élément de carrosserie latéral, dans lequel aux jonctions des élément de carrosserie latéraux (12) et de l'élément de carrosserie de toit inférieur (20), l'élément de carrosserie de toit inférieur est monté sur l'élément de carrosserie latéral respectif par des parties d'engagement (214, 215) formées aux deux parties d'extrémité de l'élément de carrosserie de toit inférieur (20) dans la direction de la largeur du véhicule et étant monté sur des par-

ties de montage (124, 125) formées sur la partie d'extrémité supérieure de l'élément de carrosserie latéral respectif,
dans lequel lesdites jonctions sont soudées dans un état dans lequel les parties d'engagement sont montées sur les parties de montage, et
dans lequel à chacune desdites jonctions d'élément de carrosserie latéral respectif (12) et de l'élément de carrosserie de toit inférieur (20) :

lesdites parties d'engagement (214, 215) sont des rainures d'engagement formées sur ledit élément de carrosserie de toit pour faire saillie dans la direction de la largeur vers la partie d'extrémité supérieure de l'élément de carrosserie latéral, et
les parties de montage (124, 125) formées sur la partie d'extrémité supérieure de l'élément de carrosserie latéral sont des nervures faisant saillie dans la direction de la largeur qui sont respectivement formées pour faire saillie vers la partie d'extrémité dans la direction de la largeur du véhicule de l'élément de carrosserie de toit inférieur, et ont des surfaces supérieures fournissant des surfaces de montage sur lesquelles les nervures d'engagement respectives (214, 215) sont montées,
dans lequel les nervures d'engagement (214, 215) et les nervures en saillie (124, 125) sont agencées en tant que deux ensembles de jonctions espacés et placés respectivement sur le côté extérieur du véhicule et sur le côté intérieur du véhicule, et
ledit ensemble de jonctions localisé sur le côté extérieur du véhicule est disposé vers l'extérieur, dans la direction de la largeur du véhicule, par rapport à l'ensemble de jonctions localisé sur le côté intérieur du véhicule d'une distance qui rend possible d'éviter une interférence avec l'ensemble de jonctions sur le côté intérieur du véhicule lors du montage de l'élément de carrosserie de toit inférieur (20) sur les éléments de carrosserie latéraux (12) en abaissant l'élément de carrosserie de toit inférieur (20) du dessus.

2. Véhicule ferroviaire selon la revendication 1,
dans lequel dans ledit ensemble de jonctions sur le côté extérieur du véhicule, une première desdites nervures en saillie (124) fait saillie dans une position évidée d'une profondeur prédéterminée par rapport à la surface latérale extérieure de véhicule de l'élément de carrosserie latéral (12), et une première desdites nervures d'engagement (214) laquelle est formée pour s'étendre avec une épaisseur correspondant à ladite profondeur prédéterminée par rapport à la plaque frontale sur le côté extérieur de véhicule, de l'élément de carrosserie de toit inférieur et est montée sur ladite première nervure en saillie (124), et
dans lequel dans l'ensemble de jonctions sur le côté intérieur du véhicule, une seconde desdites nervures en saillie (125) fait saillie en s'étendant depuis la plaque frontale sur le côté intérieur du véhicule de l'élément de carrosserie latéral, et une seconde nervure d'engagement laquelle est formée dans une position surélevée d'une hauteur correspondant à une épaisseur de la seconde nervure en saillie (5) par rapport à une surface latérale intérieure du véhicule de l'élément de carrosserie de toit inférieur (20), et est montée sur la seconde nervure en saillie.

3. Véhicule ferroviaire selon la revendication 2,
dans lequel dans ledit ensemble de jonctions sur le côté extérieur du véhicule, la plaque frontale (121) de l'élément de carrosserie latéral (20) sur le côté extérieur du véhicule et ladite première nervure d'engagement (214) de l'élément de carrosserie de toit inférieur sont soudées depuis le côté extérieur du véhicule, et
dans lequel dans ledit ensemble de jonctions sur le côté intérieur du véhicule, ladite seconde nervure en saillie (212) de l'élément de carrosserie latéral et la plaque frontale du côté intérieur du véhicule de l'élément de carrosserie de toit inférieur sont soudées depuis le côté intérieur du véhicule.

4. Véhicule ferroviaire selon la revendication 1, 2 ou 3,
dans lequel lesdites parties de montage (124, 125) sont également formées sur l'élément de carrosserie latéral à une position où n'est pas réalisé l'élément de carrosserie de toit inférieur.

5. Véhicule ferroviaire selon l'une quelconque des revendications 1 à 3,
dans lequel une partie d'extrémité dans une direction longitudinale de l'élément de carrosserie de toit (11) et de l'élément de carrosserie de toit inférieur (20) sont reliés via une plaque de liaison (40), et
dans lequel la plaque de liaison (40) est soudée en cordon à une plaque frontale de côté extérieur du véhicule (40) dudit élément de forme creux (140) de l'élément de carrosserie de toit, et à une plaque frontale de côté intérieur du véhicule (212), de l'élément de carrosserie de toit inférieur.

6. Procédé de fabrication d'un véhicule ferroviaire dans lequel un élément de carrosserie de toit (11) fournissant une surface supérieure de la carrosserie du véhicule, deux éléments de carrosserie latéraux (12) fournissant des surfaces latérales opposées respectives de la carrosserie du véhicule et un élément de carrosserie de toit inférieur (20), lequel est à un niveau inférieur à l'élément de carrosserie de toit (11) adjacent à celui-ci dans la direction longitudinale du véhicule et est chargé avec un appareil sur le toit,

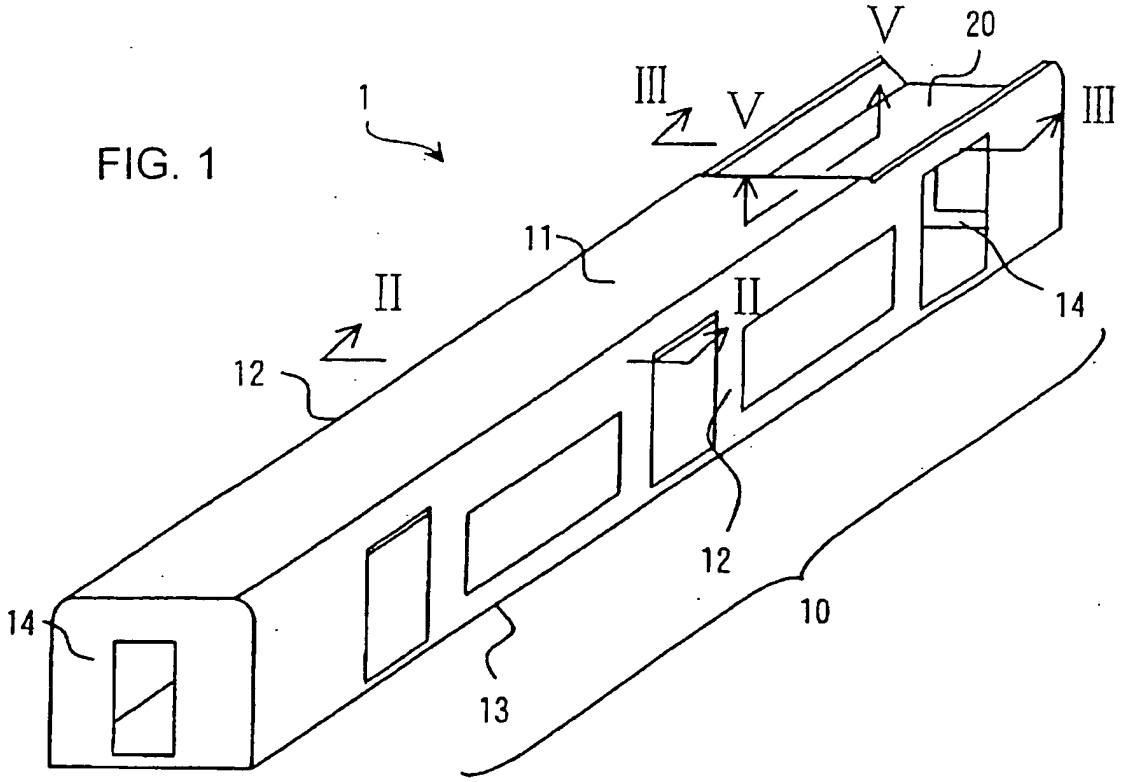
sont construits par l'intermédiaire d'éléments de forme creux extrudés (120) formés par deux plaques frontales (121, 122) et une pluralité de rainures reliant les plaques frontales, la direction d'extrusion des éléments de forme creux (120) correspondant à la direction longitudinale de la carrosserie véhicule (1),
dans lequel l'élément de carrosserie de toit inférieur (20), est relié à chacune de ses parties d'extrémité dans la direction de la largeur de l'élément de carrosserie du véhicule à une partie d'extrémité supérieure de l'élément de carrosserie latéral respectif (12) réalisé par ledit élément de forme creux (120) de l'élément de carrosserie latéral,
dans lequel aux jonctions des éléments de carrosserie latéraux (12) et de l'élément de carrosserie de toit inférieur (20), l'élément de carrosserie de toit inférieur est monté sur l'élément de carrosserie latéral respectif par des parties d'engagement (214, 215) formées aux deux parties d'extrémité de l'élément de carrosserie de toit inférieur (20) dans la direction de la largeur du véhicule et étant monté sur des parties de montage (124, 125) formées sur la partie d'extrémité supérieure de l'élément de carrosserie latéral respectif,
dans lequel lesdites jonctions sont soudées dans un état dans lequel les parties d'engagement sont montées sur les parties de montage, et
dans lequel à de chacune desdites jonctions de l'élément de carrosserie latéral respectif (12) et de l'élément de carrosserie de toit inférieur (20) :

lesdites parties d'engagement (214, 215) sont des rainures d'engagement formées sur ledit élément de carrosserie de toit pour faire saillie dans la direction de la largeur vers la partie d'extrémité supérieure de l'élément de carrosserie latéral, et
les parties de montage (124, 125) formées sur la partie d'extrémité supérieure de l'élément de carrosserie latéral sont des nervures faisant saillie dans la direction de la largeur qui sont respectivement formées pour faire saillie vers la partie d'extrémité dans la direction de la largeur du véhicule de l'élément de carrosserie de toit inférieur, et ont des surfaces supérieures fournissant des surfaces de montage sur lesquelles les nervures d'engagement respectives (214, 215) sont montées,
dans lequel les nervures d'engagement (214, 215) et les nervures en saillie (124, 125) sont agencées en tant que deux ensembles de jonctions espacés et placés respectivement sur le côté extérieur du véhicule et sur le côté intérieur du véhicule, et
ledit ensemble de jonctions localisé sur le côté extérieur du véhicule est disposé vers l'extérieur, dans la direction de la largeur du véhicule, par rapport à l'ensemble de jonctions localisé sur le côté intérieur du véhicule d'une distance qui rend possible d'éviter une interférence avec l'ensemble de jonctions sur le côté intérieur du véhicule lors du montage de l'élément de carrosserie de toit inférieur (20) sur les éléments de carrosserie latéraux (12) en abaissant l'élément de carrosserie de toit inférieur (20) du dessus,
le procédé comportant les étapes consistant à :

découper une partie d'extrémité supérieure de l'élément de forme creux de chacun desdits éléments de carrosserie latérales (12) dans la région où la jonction doit être formée dans l'élément de carrosserie de toit inférieur (20), de manière à exposer lesdites parties de montage (124, 125) de l'élément de forme creux,
abaisser ledit élément de carrosserie de toit inférieur (20) chargé avec l'appareil sur le toit du dessus, et monter lesdites parties d'engagement (214, 215) aux deux parties d'extrémité dans la direction de la largeur du véhicule sur lesdites parties de montage respectives (124, 125) apparaissant au niveau des parties de découpe des éléments de carrosserie latéraux, relier l'élément de carrosserie de toit inférieur à la partie d'extrémité supérieure de l'élément de carrosserie latéral, et
souder lesdites jonctions dans un état dans lequel les parties d'engagement (214, 215) sont montées sur les parties de montage (124, 125).

7. Procédé de fabrication d'un véhicule ferroviaire selon la revendication 6,
dans lequel à l'étape de soudage à la jonction où l'élément de carrosserie de toit inférieur (20) est relié à la partie d'extrémité supérieure de l'élément de carrosserie latéral (12), la plaque frontale (121) sur le côté extérieur du véhicule de l'élément de carrosserie latéral (12) et la première nervure d'engagement (214) de l'élément de carrosserie de toit inférieur sont soudés ensemble depuis le côté extérieur du véhicule, et
dans lequel la seconde nervure en saillie (125) de l'élément de carrosserie latéral et la plaque frontale sur le côté intérieur du véhicule de l'élément de carrosserie de toit inférieur (20) sont soudées depuis le côté intérieur du véhicule.

FIG. 1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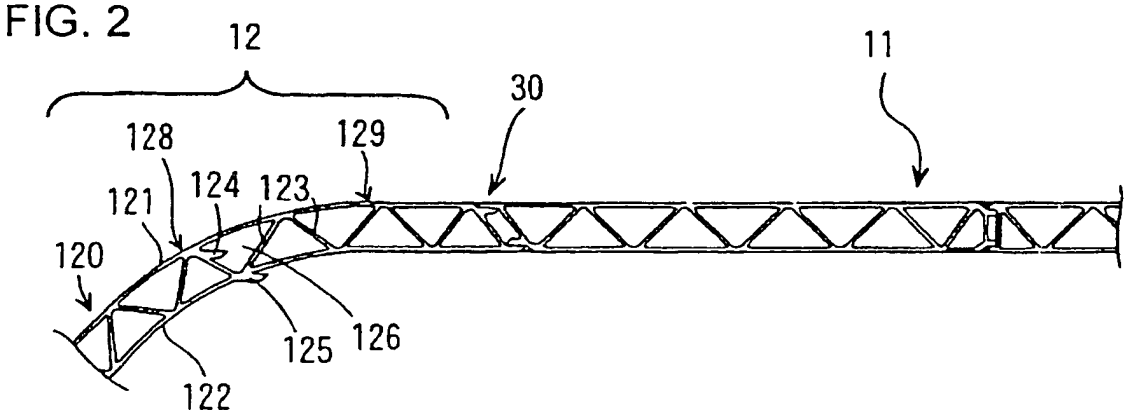
III
V
III
11
II
II
14
12
12
14
10
13

FIG. 2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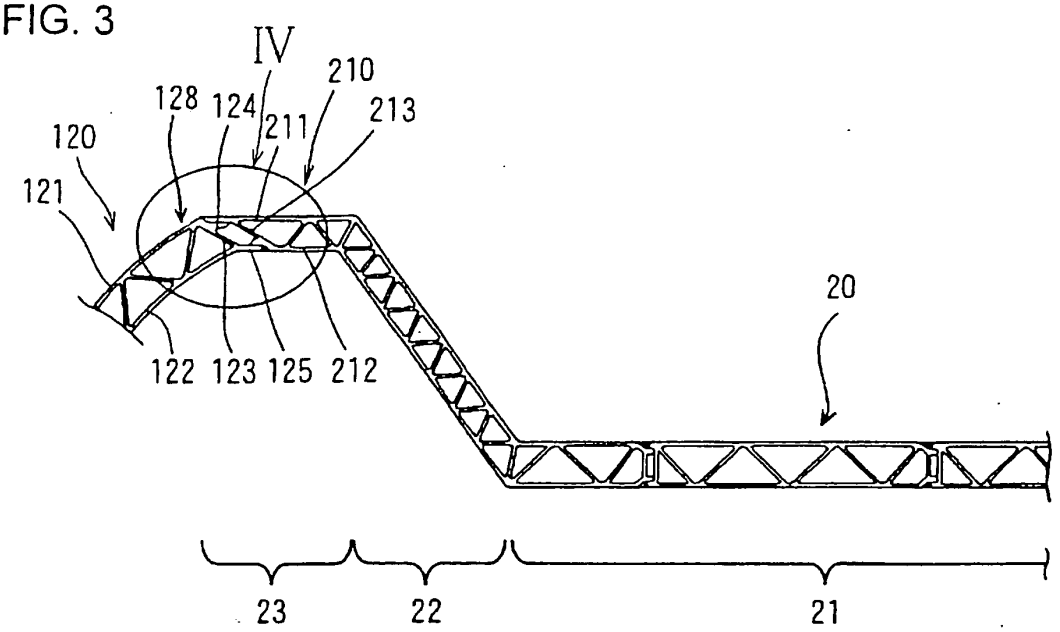
126
122

FIG. 3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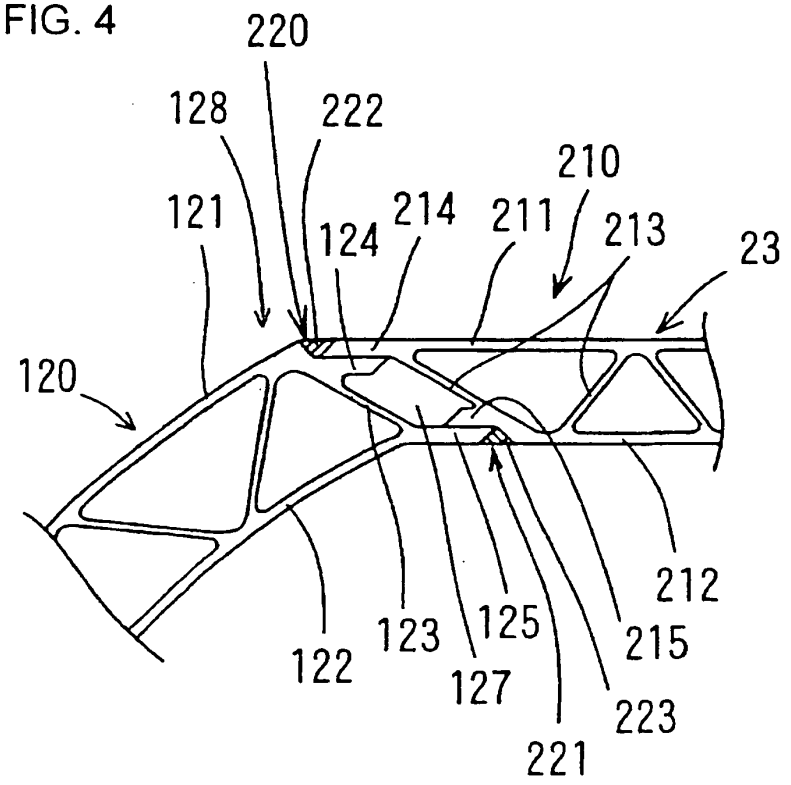
21

FIG. 4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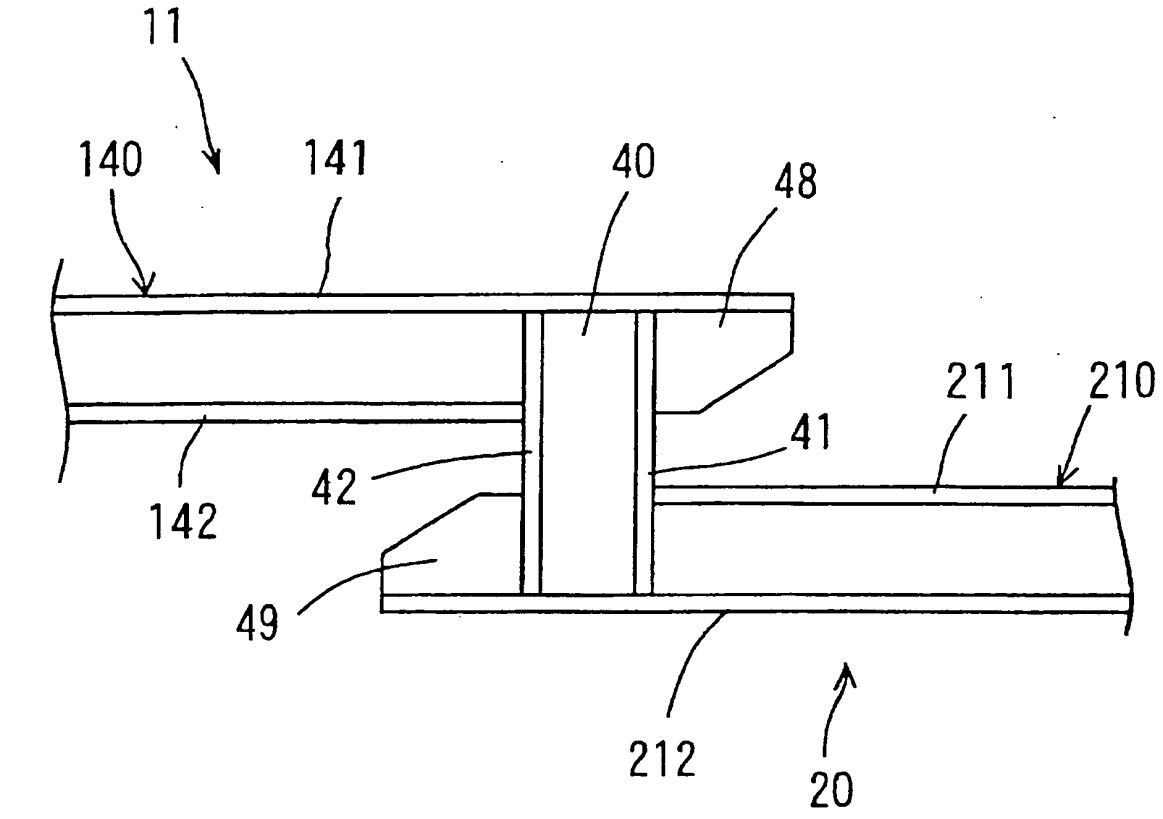
221

FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2604226 B **[0002]**
- EP 0354436 A **[0007]**