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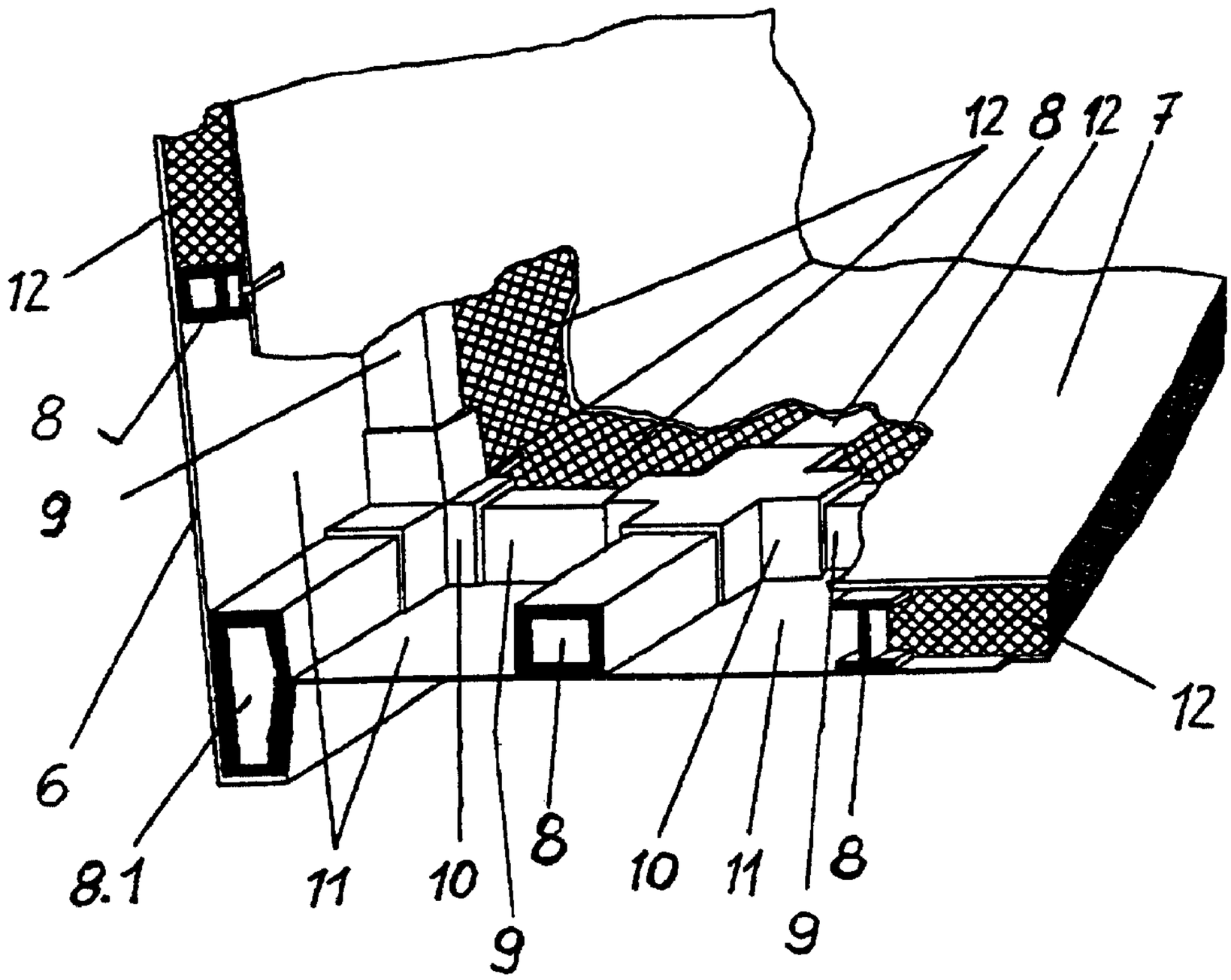

(57) Abrégé/Abstract:
A wall module for a car body, between an outer covering layer 6 and an inner covering layer 7, has a structure that is made of intersecting frame members 8, 9, whereby a thermal insulation 12 is provided in cavities 11 between the frame members 8, 9. To give the wall module a high buckling strength, in particular in the longitudinal direction of the car body, a plurality of one-piece frame members extend in the longitudinal direction of the car body and are made of a material that has a higher modulus of elasticity than the outer layers 6, 7.

Abstract of the invention
(Figure 2)

A wall module for a car body, between an outer covering layer 6 and an inner covering layer 7, has a structure that is made of intersecting frame members 8, 9, whereby a thermal insulation 12 is provided in cavities 11 between the frame members 8, 9. To give the wall module a high buckling strength, in particular in the longitudinal direction of the car body, a plurality of one-piece frame members extend in the longitudinal direction of the car body and are made of a material that has a higher modulus of elasticity than the outer layers 6, 7.

This invention relates to a wall module for a car body, particularly for railway vehicles, having walls with outer layers of fiber-reinforced material which enclose longitudinal frame members as well as filler material. The invention also relates to a method for the manufacture of such a wall module.

This invention relates to a wall module as described in the introduction to claim 1, as well as a method for the manufacture of the wall module.

On a car body, wall modules are used (DE 38 38 686 A1) that consist of two prefabricated outer covering layers made of fiber-reinforced laminate, between which is glued a prefabricated grid structure that consists of frame members that are oriented at right angles to one another and are firmly connected to one another. The cavities between the outer layers and the individual grid fields are filled with honeycomb segments cut to fit, except for the locations in which the corresponding grid fields are going to be used for window or door openings. The honeycomb core plates are also firmly glued to the inner sides of both outer layers. The placement of the frame members is thereby selected as a function of the location of the specified door and window openings. A structure of this type requires separate manufacturing processes for the finished outer layers and for the grid frame, and then a further production step to connect them to one another.

The object of the invention is to create a wall module as described that has a high rigidity at least in the longitudinal direction of the car body and can be manufactured easily.

The invention provides a wall module for a car body, said wall module having walls which are made of outer layers made of fiber-reinforced material, between which there are frame members that run parallel to the longitudinal direction of the car body and at right angles to the longitudinal direction, as well as filler material, all of which are firmly connected to the outer layers, characterized by the fact that there are more than three frame members that run parallel to the longitudinal axis of the car body in one piece, except in the vicinity of a window or a door opening and extend over a large part of the entire length of the wall module said frame members intersecting at points and being firmly connected to one another at each intersection point by means of a node element, and that at least the frame members that run in the longitudinal direction of the car body are made of a material that has a higher modulus of elasticity than the outer layers.

The invention also provides a method for the manufacture of wall modules as claimed in any one of claims 1 to 6, characterized by the fact that a first fiber-reinforced blank is laid flat in a module mold, that the frame members are laid in an intersecting arrangement on top of the first fiber-reinforced blank, that connecting nodes are applied to the intersection points of the frame members, that filler plates, rigid expanded foam plates or plates made of honeycomb material, all of the appropriate dimensions, are inserted into cavities formed between the intersecting frame members, that a second fiber-reinforced blank is laid flat placed on top of the frame members with the inserted filler plates, rigid expanded foam plates or plates made of honeycomb material, that then the fiber-reinforced blanks and the cavities between them are saturated with a casting resin and that the casting resin is then cured.

In one configuration of a wall module of the invention, a high longitudinal rigidity is achieved by the use of an increased number of frame members that run in the longitudinal direction of the car body, which frame members preferably extend in one piece over the entire length of the wall module and are interrupted only in the vicinity of the door and window openings. The frame members that run perpendicular to the above frame members or in the peripheral direction are interrupted at each longitudinally oriented frame member, but are

positioned three-dimensionally by means of a node element that is offset laterally with respect to the longitudinally oriented frame members. The node elements thereby have at least two arms that project at an angle to one another, and the cross sections of which are adapted to the cross section of the abutting frame members that are to be held in position. The frame members can thereby be made in particular of fiber-reinforced material, which is of a type that is compatible with the material of the outer layers. At least the frame members that run in the longitudinal direction of the car body are thereby made of a material that has a higher modulus of elasticity than the outer layers. When a car body constructed in this manner has a high longitudinal stability, the outer layers therefore do not need to be designed to absorb the longitudinal forces that occur during operation or in the event of accidents. The use of very advanced and thus expensive materials can thereby be limited to the frame members that run in the longitudinal direction, whereby the upper or lower frame members can be designed in the form of upper members or longitudinal members.

When a high level of rigidity is required, however, the frame members that run crosswise and possibly also the node elements can thereby be made of the material that has the higher modulus of elasticity. The frame members are realized in the form of profiles, in particular in the form of hollow profiles. They are preferably also located in spaces where seats, luggage racks and similar internal fittings must be fastened.

A wall module constructed in this manner is manufactured in particular by inserting, into a workpiece mold configured so that it corresponds to the desired plane or curved configuration of a wall module, a dry blank made of fiber-reinforced material, in particular a blank made of textile fiber-reinforced pre-forms or flat fiber-reinforced blanks. The frame members to be used for the longitudinal direction are then laid on this fiber-reinforced blank and between them the individual parts of the frame members that are oriented transverse to the longitudinal members are inserted and a mutual positioning of these frame members at the butt joints or the intersections of the frame members is accomplished by means of the node elements, which merely have to be attached to the frame members. The node elements are thereby also preferably made of a fiber-reinforced material and can also be connected by means of an adhesive compound to the frame members to be fixed in position so that they provide static support even during the assembly process. The cavities that are thereby formed between the intersecting frame members are then filled with cut-to-fit rigid expanded foam plates or honeycomb material. On the exposed side of the frame members and of the rigid expanded

foam plates, all that is necessary is to place a second dry fiber-reinforced blank, and the entire system is then saturated with a casting resin and cured. Because the casting resin structure penetrates the fiber-reinforced blank, an adhesive connection with the frame members and the rigid expanded foam plates is also achieved, whereby casting resin also penetrates into the cavities in between the various elements. The saturation can thereby be carried out in particular using a vacuum bag or vacuum injection process, so that an intensive and reliable saturation and filling of cavities and a smooth configuration of the surface of the outer layer facing away from the mold is also achieved.

The invention is explained in greater detail below with reference to the exemplary embodiment that is illustrated in the accompanying schematic diagrams.

Figure 1 shows a longitudinal segment of the car body of a railway vehicle or bus, and

Figure 2 is an enlarged detail X of the system illustrated in Figure 1.

Figure 1 shows only a longitudinal segment of a wall module 1 of a car body, which can contain, in addition to window openings 2, also door openings or similar openings. The wall module 1, when completed, forms a one-piece hollow tubular body that has a floor wall 3, side walls 4 and a roof wall 5 and corresponds to the outer contour and the inner contour of a car body. Both an outer covering layer 6 and an inner covering layer are thereby formed of fiber-reinforced material saturated with casting resin.

The individual walls 3, 4, 5, have a structure between the outer layers 6, 7 that functions as a supporting skeleton and at least largely relieves the outer layers 6, 7 of the loads that occur during the operation of the vehicle. The structure thereby consists of intersecting frame members 8 and 9, whereby the one-piece frame members 8 that run in the horizontal direction and are thereby parallel to the longitudinal direction of the car body 8 extend over the entire length of the car body, except where an interruption becomes necessary as a result of window openings 2, door openings or similar openings. In the walls 3, 4, 5, the vertical frame members 9 that are perpendicular to these longitudinal members and run in the peripheral direction are

in contact at least mostly continuously with the related side flanks of the frame members 8 that run in the longitudinal direction of the car body, which frame members 8 have a rectangular cross section. The horizontal frame members 8 that run in the longitudinal direction of the car body are made of a material that has a higher modulus of elasticity than the outer layers 6, 7. These frame members 8 contribute to the high buckling strength of the car body in the longitudinal direction, a characteristic which is necessary in operation and in particular in the event of accidents. If the car body is also designed to have a high buckling strength in the peripheral direction, then the frame members 9 that run in the peripheral direction can also be made of the same material. In that case, it is particularly appropriate to also make these frame members out of fiber-reinforced material that is saturated with casting resin, so that a reliable adhesive mechanical connection can be achieved between the frame 8, 9 and the outer layers 6, 7.

To fix the frame members 8, 9 in position and to achieve a reliable connection between the intersecting frame members 8, 9, there are node elements 10, through which the frame members 8 that run in the longitudinal direction extend without interruption, while the frame members 9 that are oriented transversely in relation to the longitudinal members in the peripheral direction of the car body are engaged by means of each of their ends in one of the node elements. The individual arms of the node elements 10 can thereby have a closed cross section that matches as closely as possible the cross section of the frame members 8, 9 to be assembled with it. The plug-in connection thereby provides a completely rigid assembly of the frame members 8, 9. Preferably, however, the frame members 9 are connected to the node elements 10 by means of adhesive. It may thereby be appropriate to also manufacture the node elements 10 from a material that has a high modulus of elasticity.

Cavities 11 between the individual frame members 8, 9 and the cover layers 6, 7 are or become filled with a self-supporting thermal isolation material 12 in the form of rigid expanded foam plates, honeycomb core plates etc. and are also connected with the surrounding structural elements 6, 7, 8, 9 by means of adhesive.

The car body can be manufactured from a single wall module. However, it is also possible, for example, to manufacture the side walls 4 and the floor wall 3 as one piece, and to manufacture the roof wall separately from them. The roof module then only needs to be placed on the trough-like lower module, to which it can be firmly connected, by means of adhesive, for example.

A wall module is thereby preferably manufactured by inserting a first fiber-reinforced blank flat in a module mold. On this fiber-reinforced blank, the frame can then be constructed from the intersecting frame members 8, 9 including the node elements 10. Then the cavities 11 between the frame members 8, 9 are filled, as necessary, with self-supporting thermal and/or acoustical insulation material 12. Then a second fiber-reinforced blank can be placed on the exposed side of the frame, including the insulation 12, unless when the respective wall module is realized in the form of a shell or as a flat component, the first fiber-reinforced blank can be placed in corresponding fashion on the surface to be covered. By saturating the entire system with casting resin and curing or hardening the system, the desired adhesive connection is achieved between the fiber-reinforced blanks, the frame members and the thermal insulation, including the node elements. It is thereby appropriate, as early as when the frame is being assembled, to introduce the adhesive or casting resin between the node elements 10 and the frame members 8, 9, to achieve an adhesive connection of the plug-in connections over a wide area. Further improvement can be achieved by saturating the entire system with the use of a vacuum bag or vacuum injection process, so that the casting resin or a corresponding material fills up all the existing cavities and spaces and eliminates as many air spaces as possible.

With this structure, moreover, the lower or lateral longitudinal frame members 8.1 in the vicinity of the corner between the floor wall 3 and the side walls 4 can be designed in the form of continuous longitudinal beams and in the form of a continuous upper member at the transition between the side walls 4 and the roof wall 5. In this structure, the saturated fiber blanks simultaneously form the outer cover layer 6 and the inner cover layer 7, which can be manufactured in the module mold so that they have smooth surfaces, and therefore require very little or no mechanical finishing in the form of grinding, smoothing etc.

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CLAIMS:

1. Wall module for a car body, said wall module having walls which are made of outer layers made of fiber-reinforced material, between which there are frame members that run parallel to the longitudinal direction of the car body and at right angles to the longitudinal direction, as well as filler material, all of which are firmly connected to the outer layers, characterized by the fact that there are more than three frame members that run parallel to the longitudinal axis of the car body in one piece, except in the vicinity of a window or a door opening and extend over a large part of the entire length of the wall module said frame members intersecting at points and being firmly connected to one another at each intersection point by means of a node element, and that at least the frame members that run in the longitudinal direction of the car body are made of a material that has a higher modulus of elasticity than the outer layers.

2. Wall module as claimed in claim 1, characterized by the fact that the frame members are made of a fiber-reinforced material.

3. Wall module as claimed in claim 1 or claim 2, characterized by the fact that all the frame members and the node elements are made of a material that has a higher modulus of elasticity than the outer layers.

4. Wall module as claimed in any one of claims 1 to 3, characterized by the fact that appropriately sized filler plates that perform a mechanical support function, rigid expanded foam plates or honeycomb material are located in spaces that are enclosed between the frame members.

5. Wall module as claimed in any one of claims 1 to 4, characterized by the fact that the frame members have profiles that have cross sections appropriate to the expected loads.

6. Wall module as claimed in any one of claims 1 to 5, characterized by the fact that frame members extend over the entire exposed length of the wall module.

7. Method for the manufacture of wall modules as claimed in any one of claims 1 to 6, characterized by the fact that a first fiber-reinforced blank is laid flat in a module mold, that the frame members are laid in an intersecting arrangement on top of the first fiber-reinforced blank, that connecting nodes are applied to the intersection points of the frame members, that filler plates, rigid expanded foam plates or plates made of honeycomb material, all of the appropriate dimensions, are inserted into cavities formed between the intersecting frame members, that a second fiber-reinforced blank is laid flat placed on top of the frame members with the inserted filler plates, rigid expanded foam plates or plates made of honeycomb material, that then the fiber-reinforced blanks and the cavities between them are saturated with a casting resin and that the casting resin is then cured.

8. Method as claimed in claim 7, characterized by the fact that connecting areas between the node elements and the frame members are wetted with adhesive during their assembly.

9. Method as claimed in claim 7 or 8, characterized by the fact that the saturation is performed in a vacuum bag or using a vacuum injection process.

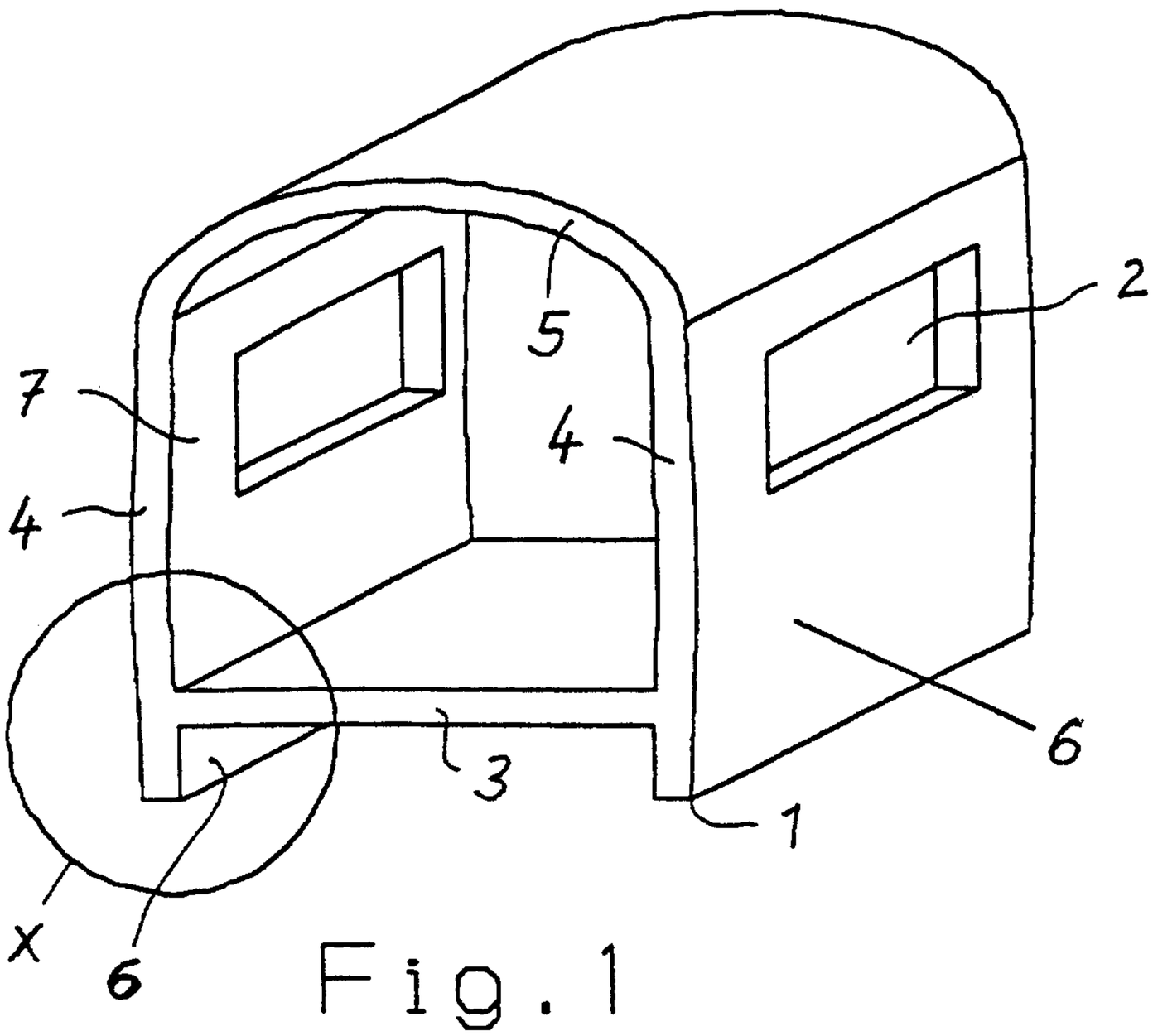


Fig. 1

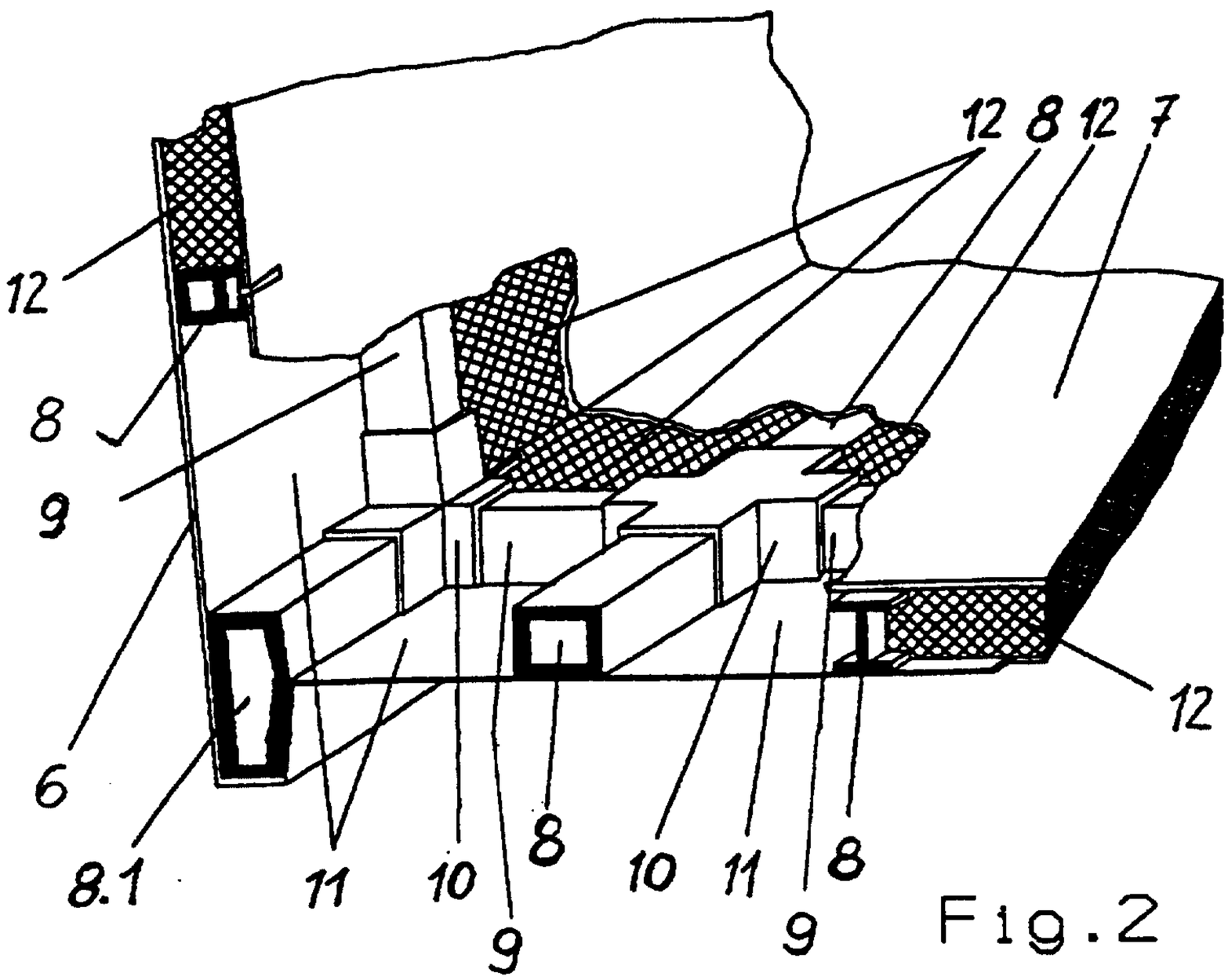
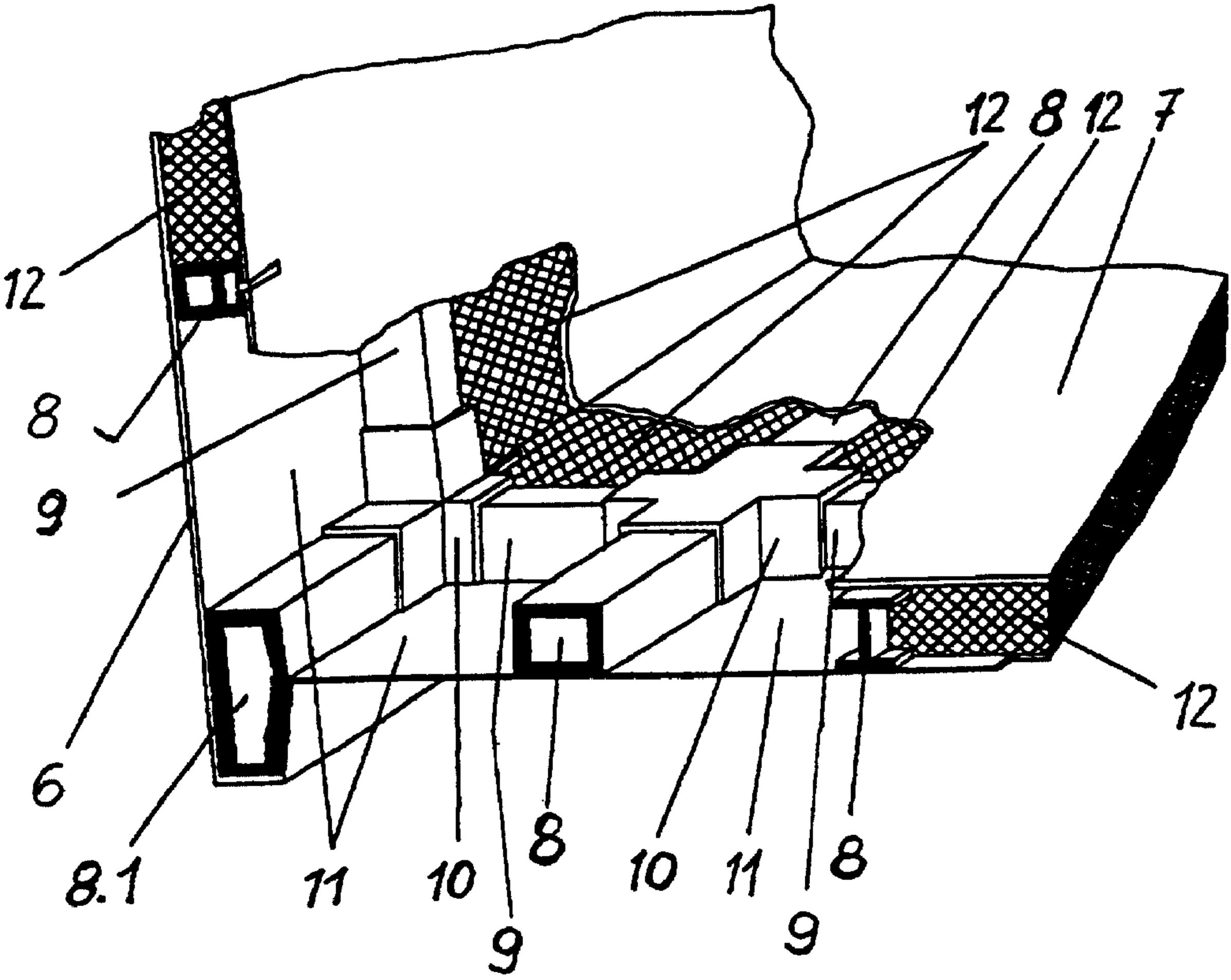


Fig. 2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