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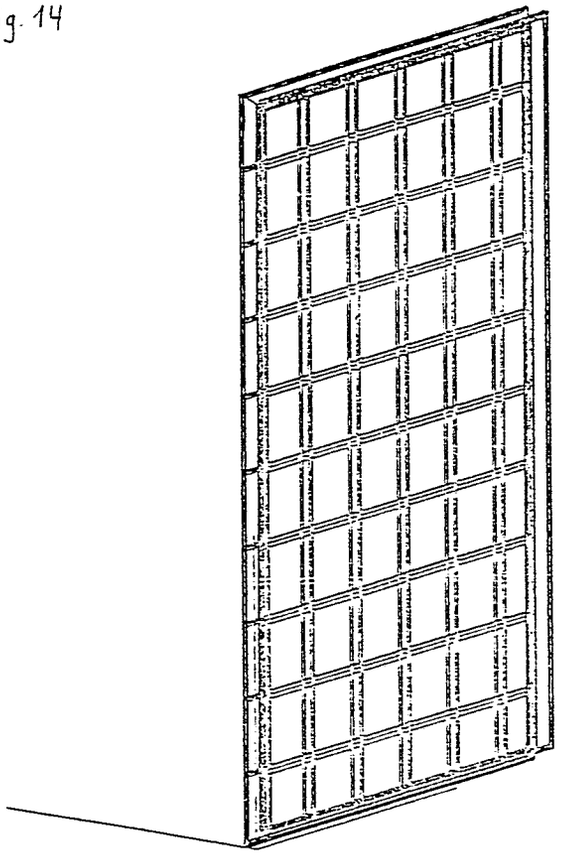
(54) Structural elements, frames thereof, panels and prefabricated building structures.

(57) A self-supporting prefabricated building structure is formed from a plurality of structural panels inter-

connected edge-to-edge. The panels have elongate peripheral structural elements which are joined to corresponding elements of adjacent panels to form box-section load-supporting structural columns or beams of the building. The structure avoids the need for making separate building frames or skeletons and allows a self-supporting building to be formed simply by interconnecting prefabricated panels.

Fig. 14



Structural elements, frames thereof, panels and prefabricated building structures

Background of the Invention

This invention relates to building structures in general and more particularly to prefabricated steel building structures.

It is an subject of the invention to provide an integrated system for producing steel frame prefabricated building structures having vertical, horizontal and roofing elements formed from prefabricated panels which are selfsupporting and offer the possibility of eliminating a primary building skeleton structure.

Conventional steel frame building structures generally require a primary skeleton structure including, inter alia, vertical supporting columns, horizontal beams, roof trusses and the like, with secondary paneling elements, for example, being attached in various ways to the primary frame structure to provide both vertical walls, horizontal floors, ceilings, roofing elements and the like. By contrast, the present invention offers the possibility of constructing a prefabricated steel building construction without the need for separate primary and secondary structures.

Summary of the Invention

The present invention is based on the novel concept of providing elongate metal profiled elements, of specified cross-sectional profile, which may be used as edge elements for prefabricated metal frames and panels and which maybe interconnected to corresponding elements of adjacent such frames or panels both vertically and horizontally to form an integrated metal building structure with the interconnected profiled elements forming vertical support columns, horizontal beams of the structure, and the like.

Thus, in one aspect of the invention, self-supporting prefabricated modular metal building panels are provided having peripheral elements which are shaped in profile for interconnecting adjacent panels together with the profiled elements forming a load-supporting building frame or skeleton.

In another aspect of the invention, the elongate metal profiles, which can be used as peripheral elements for structural panels, may alternatively be connected together individually to form box-shaped and like support columns and beams. Preferably, however, the system uses prefabricated panels with the profiled peripheral edge elements to construct vertical, horizontal and inclined structural walls.

The invention is based on a universal node, that is, on a system of connecting two, three or four of the profiled elements in such a manner that a load-supporting column is provided vertically or horizontally at the juncture of the elements. The particular profiles of the elements allow for this form of construction. In practice, the geometry of the elements may be reduced to two elementary shapes which may be combined to form rectangular or triangular frames panels

The essence of the inventive system may be said to comprise a universal form of box-section joint formed by connecting together three or more of the profiled elements, any one or more of which may itself form a peripheral element of a prefabricated panel. For example, one particularly useful form of profiled element in accordance with the invention has a profile substantially in the form of an elongated C with a linear web and symmetrical end portions. The end portions may have a first part extending from the web at an angle of about 135° and a second terminal part angled at about 90° with respect to the first part. In use, a boxsection column may be formed by combining four of the C sections together with the end portions facing outwardly and preferably with distance pieces or spacers therebetween. The structure provides a substantially rectangular box-section column or beam. The joints between the respective profiled elements which may include bolts and the like extending through the distance pieces have multiple functions, namely, the distance pieces provide for interruptions in a thermal bridge between elements and provide a space for the positioning of seals and the like. Further, the joints enable a link between vertical panels and beams to be provided and represent points for receiving additional strengthening should this become necessary for certain applications.

The above-described joint of four back-to-back C-shaped profiled elements represents a basic node structure of the inventicn which may be formed, for example, from vertical or horizontal panels with one or more of the individual profiled elements forming the periphery thereof.

For example, prefabricated vertical building panels may be formed from two frames having respective peripheral elements comprising the C-shaped profiled elements described above. In forming a prefabricated panel, the frames are connected together so that the respective profiled elements assume the required positions for connecting together with an adjacent panel in a manner whereby the four profiled elements together combine to provide the box-section node described

above. For panels forming outer building walls, the respective inner and outer frames comprise secondary bracing structure in different directions. Thus, the secondary structure of an external frame may be horizontally disposed while the secondary structure of an internal frame may be vertical. Braces are thus created within the panels providing stiffness for resisting vertical and horizontal forces. Portions of the secondary structure may be interconnected by distance pieces and the like at their points of intersection.

Outer panels may be filled with mineral wool and the like for insulation and like purposes between the secondary structure of the two frames. Final lining material may comprise exterior type plywood for the exterior of such panels and plasterboard or the like for the interior thereof. The panels may also be apertured for window openings and the like where required.

Horizontal beams in accordance with the invention may likewise comprise box-like or other composite sections made from combinations of the profiled elements which again may form peripheral edges of horizontal panels forming floor panels or ceiling panels. Beams are permanent structures by means of which one-way spans are overcome and they are disposed at modular distances corresponding to the panels. Thus, for example, the top cord of a beam may carry floor panels while the bottom cord carries a suspended ceiling.

Self-supporting floor panels, which may combine to form the beams at the edges thereof, may comprise the abovedescribed C sections as the peripheral elements in similar manner to the previously described vertical panels and may include secondary panel structure with plywood flooring or the like. The secondary structure may in this case comprise corrugated steel sheet or may comprise U-section bracing elements as in the vertical panels. Horizontal universal node joints may be formed in like manner to the previously described vertical nodes.

Roof panels may be formed in similar manner to the previously described floor panels and various roof pitches may be obtained by placing appropriate inserts within the universal node structure.

The inventive system is primarily intended for the production of various building structures, particularly structures having first, second floor and loft storeys. It is also possible for the structure to be utilized for larger buildings.

The system allows for the production of load-supporting panels at a manufacturing site so that there is subsequently a minimal need for labor, machinery and construction time during on-site assembly. The system is easily and fully dismantleable so that buildings may be constructed and moved from one site to another.

Brief Description of Drawings.

Figure 1 is an end view of an elongate steel profiled structural element in accordance with the invention.

Figure 2 is a view similar to Figure 1 of a secondary elongate structural element for use in the invention.

Figure 3 is an end view of a node structure or joint formed from four elongate elements of the type shown in Figure 1.

Figure 4 is an end view of a joint structure formed from the primary and secondary structural elongate elements.

Figures 5 and 6 are end views of further forms of joint structure utilizing primary and secondary elements in accordance with the invention.

Figure 7 is a plan view of a steel frame made in accordance with the invention.

Figure 8 is an end elevational view of the frame.

Figure 9 is a front elevational view of the frame.

Figure 10 is a perspective view of the frame.

Figure 11 is a plan view of a panel structure in accordance with the invention.

Figure 12 is an end elevational view of the panel structure.

Figure 13 is a front elevational view of the panel structure.

Figure 14 is a perspective view of the panel structure.

Figures 15 and 16 are sectional elevational views of different building structures using combinations of panels and joint structures as shown in the previous figures.

Description of Preferred Embodiments

Figure 1 is an end view of a basic elongate steel structural element 1 in accordance with the invention which has a profile substantially in the form of an elongated C. Thus, the profile comprises a central linear web 1a and symmetrical end flanges 1b. Each end flange has an inner portion 1c bent substantially at a 135° to web 1a and terminal outer portions 1d bent substantially at right angles to portions 1c.

The basic structural element shown in Figure 1 may be used to form peripheral elements of structural panels as will be described and may be combined edge-to-edge with other like elements to form node joints for building structures as will also be described. The respective flanges of element 1 may accordingly be provided with suitable bolt holes and the like (not shown in Figure 1). As shown, the elements may have an overall height

and width of about 2 3/8" and the element may be formed, for example, of 1/8" thick steel plate.

Figure 2 shows a secondary elongate structural steel element 2 in accordance with the invention of substantially channel or U-shaped profile with a linear web 2a and right angle flanges 2b. The element 2 may, for example, have an overall height of about I 7/8", a width of about 3/4" and may also be made of 1/8" steel plate.

Figure 3 is an-end view of a typical node structure or joint formed from four basic structural elements 1 placed substantially back-to-back to form a rectangular box-section supporting element which, in use, may constitute a vertical building column or horizontal beam with the individual structural elements 1 themselves forming peripheral edges of respective panels as will be described but not shown in Figure 3. Also, as shown in Figure 3, the respective elements 1 may be spaced apart by distancing elements 3 which may comprise insulation or other suitable building material depending on the application of the structure. As indicated in Figure 3, the respective elements may be connected together by bolt and nut connectors C.

Figure 4 shows an alternative form of joint structure using a single C-shaped structural element 1 and a pair of secondary elements 2 joined by their respective flanges. Spacing elements 3 are again provided between the structural elements which are again connected by bolt and nut-type connectors C.

Figure 5 shows another combination of elements in accordance with the invention in which a structural steel element 4 is connected between opposite pairs of the basic elements 1. In this structure, for example, the respective pairs of elements 1 may each form sections of a respective box-section node joint previously described.

Figure 6 shows alternative forms-of joint structures utilizing the sections 1 and 2 as previously described.

Figures 7 through 10 show a structural frame 5 made from the previously described structural elements 1 and 2. Thus, the frame has a periphery formed from the structural elements 1 and vertically extending bracing elements formed from the structural elements 2.

Figures 11 through 14 show a basic load-bearing structural panel in accordance with the invention which is formed by connecting together a pair of the previously described frames 5 in back-to-back relation. It will thus be evident that the respective peripheral members 1 of the panels are disposed so as to form one-half of a node joint of the type previously described in connection with Figure 3. The outer profile of the panel which is formed by the two back-to-back elements I is particularly evident in Figure 11 and it will be further evident that connecting together two like panels end-to-end will provide therebetween the basic box-section node structure shown in Figure 3. Thus, when the panels are used and connected together end-to-end to form vertical building panels, respective support columns will be integrally formed therewith by the connection of the peripheral elements which form the column and node joints. Also, in the panels shown in Figures 11 through 13, the respective bracing measured 2 may be perpendicularly oriented in the respective frames 5 and may be interconnected by spacer pieces or the like at their junction points.

It is evident that by interconnecting panels of the type shown in Figures 10 through 14, both vertically and/or horizontally, a self-supporting building structure with integrated self-supporting vertical columns and/or horizontal beams may be formed.

Figure 15 is a sectional view of a typical building structure incorporating the principles of the invention and which has, for example, a vertical column formed from a node-type joint of four basic profiled elements 1 positioned in back-to-back relation as inFigure 3. The respective elements 1 form peripheral elements of respective vertical panels forming wall structure as illustrated which includes an external lining 7, an internal lining 8 and filler material 9, such as insulation, between the respective linings.

Fig.16 shows a sectional view of a typical floor structure incorporating the principles of the invention and which has, for example. a horizontal beam formed from a node type joint of four basic profiled elements 1 positioned in back-to-back relation as in Figure 3. The respective elements form peripheral elements of respective horizontal floor panels and the top cord of an element shown in Fig.5. Bottom cord of on element shown in Fig.5 and hanging truss 10. Support a hanging ceiling structure 20.

It is evident that, in prefabricated buildings in accordance with the invention, vertical and horizontal structures and panels of the type shown in Figures 15 and 16 provide an integrated self-supporting prefabricated building construction.. While only preferred embodiments of the invention have been described herein in detail, the invention is not limited thereby and modifications may be made within the scope of the attached claims.

Claims

1. An elongate metal structural element having a profile substantially in the shape of an elongated C with a linear web and symmetrical end flanges, each end flange having an inner portion extending

from the web at an angle of about 135° and an outer portion extending from the portion at an angle of about 90°.

2. In combination, an element as defined in claim 1 and three additional like elements, the elements being positioned back-to-back with the respective inner portions interconnected whereby the respective webs form a substantially square-section box-shaped elongate support column or beam.

3. A combination as defined in claim 2 including spacer elements between the respective interconnected end portions.

4. A combination as defined in claim 2 wherein at least one of said elements forms a peripheral element of a rectangular structural frame.

5. A rectangular structural frame having elongate metal peripheral elements with a profile substantially in the shape of an elongated C with a linear web and symmetrical end flanges, each end flange having an inner portion extending from the web at a first angle and an outer portion extending from the inner portion at a second angle.

6. A frame as defined in claim 5 wherein the first angle is about 135° and the second angle is about 90°.

7. A frame as defined in claim 5 including bracing elements of a substantially channel-shaped profile extending between opposite ones of the peripheral elements.

8. A frame as defined in claim 5 secured back-to-back with another like frame to form a rectangular building panel with the webs of the peripheral elements in the respective frames diverging substantially at right angles.

9. A panel as defined in claim 8 wherein one of the frames has first bracing elements extending between opposite peripheral elements thereof and the other of the frames has second bracing elements extending between opposite peripheral elements thereof at right angles to the first bracing elements.

10. In a prefabricated building structure, a box-section load-bearing support formed from four interconnected elongate metal structural elements, each of said elements having a profile substantially in the shape of an elongated C with a linear web and symmetrical end flanges, each end flange having an inner portion extending from the web at an angle of about 135° and an outer portion extending from the inner portion at an angle of about 90°, the elements being positioned back-to-back with the respective inner portions interconnected, whereby the respective webs form a substantially square-section box-shaped elongate support.

11. A structure as defined in claim 10 wherein at least one of said structural elements forms a peripheral element of a structural panel.

12. A self-supporting building structure comprising a plurality of structural panels interconnected edge-to-edge, the panels having elongate peripheral structural elements joined to corresponding elements of adjacent panels to form box-section load-supporting structural support members of the building structure.

13. A structure as defined in claim 12 wherein the support members are vertical building columns.

14. A structure as defined in claim 12 wherein the support members are horizontal beams.

15. A structure as defined in claim 12 wherein the peripheral elements of each panel include a pair of diverging web sections with flanges connecting the respective web sections of adjacent panels to form support members of substantially rectangular box-section.

16. A structure as defined in claim 15 wherein the peripheral elements of each panel comprise a pair of interconnected structural elements, each of said structural elements having a profile substantially in the shape of an elongated C with a linear web and symmetrical end flanges, each end.flange having an inner portion extending from the web at an angle of about 135° and an outer portion extending from the inner portion at an angle of about 90°.

17. A structure as defined in claim 16 wherein the respective pairs of structural elements comprise peripheral elements of separate interconnected rectangular structural frames.

Fig. 1

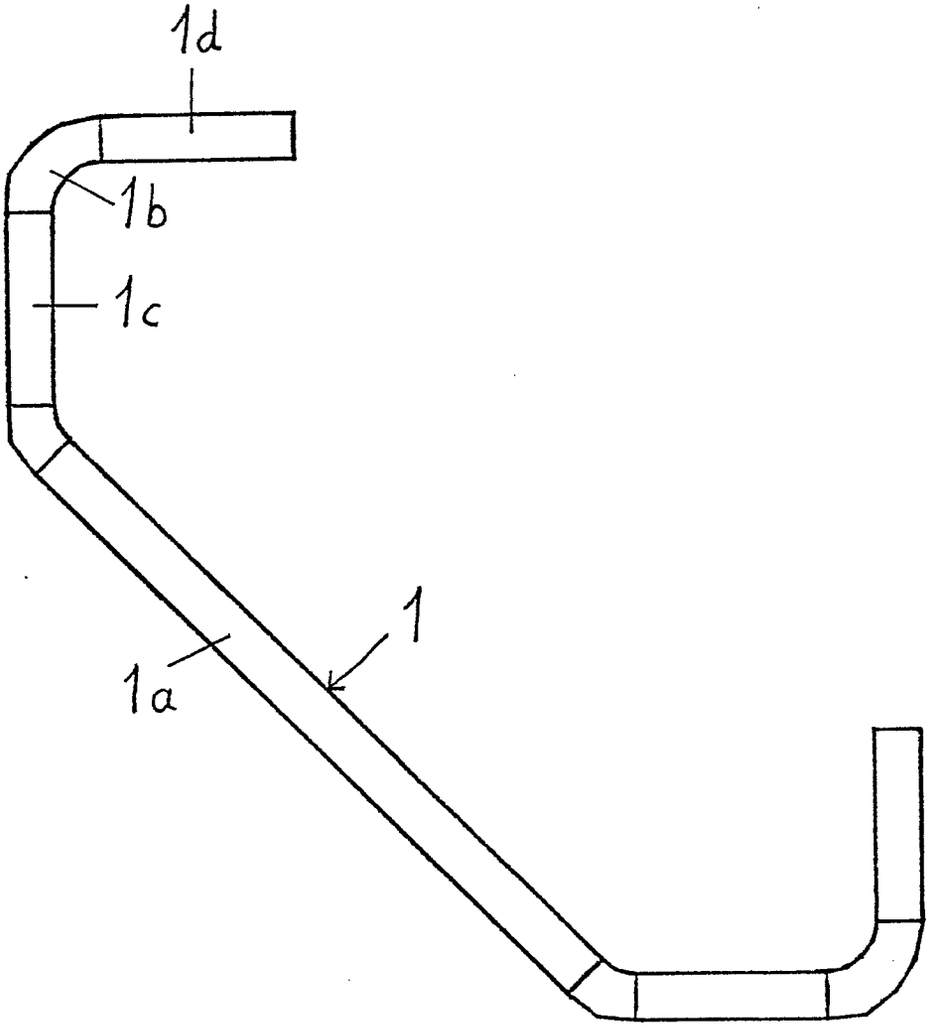


Fig. 2

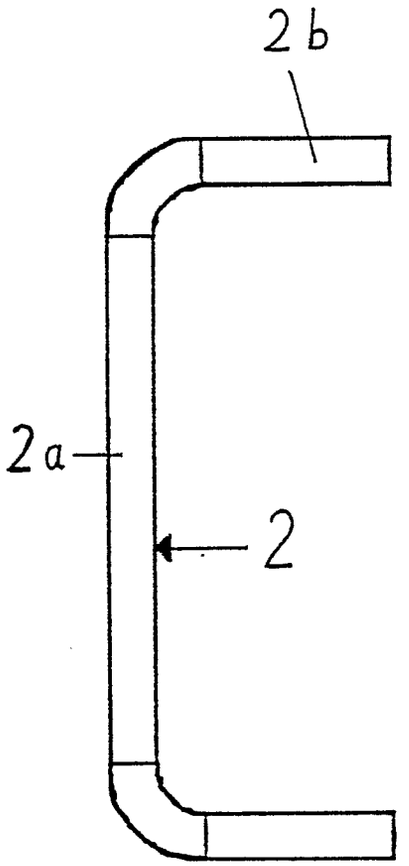


Fig. 3

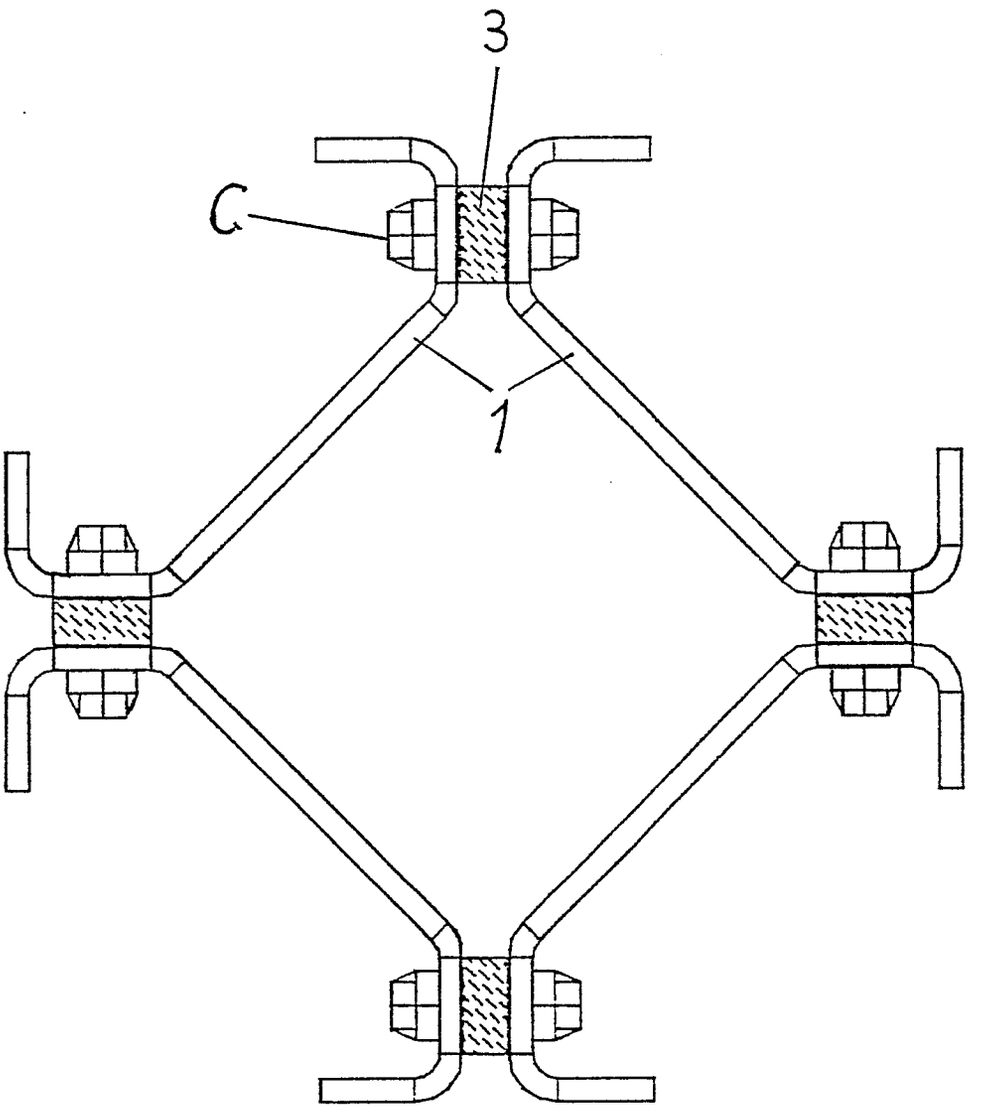


Fig. 4

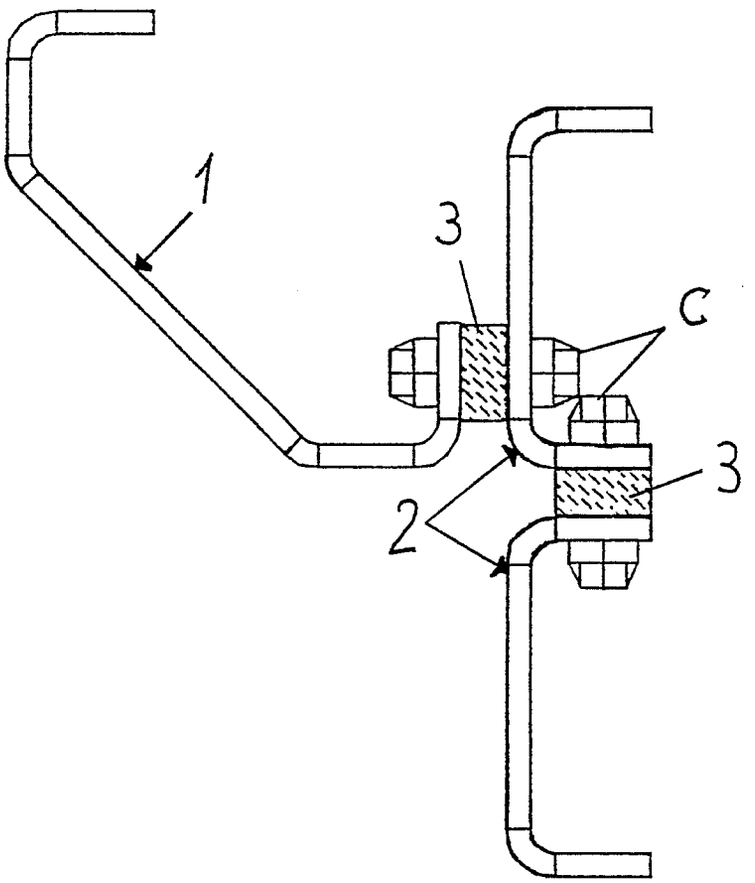


Fig. 5

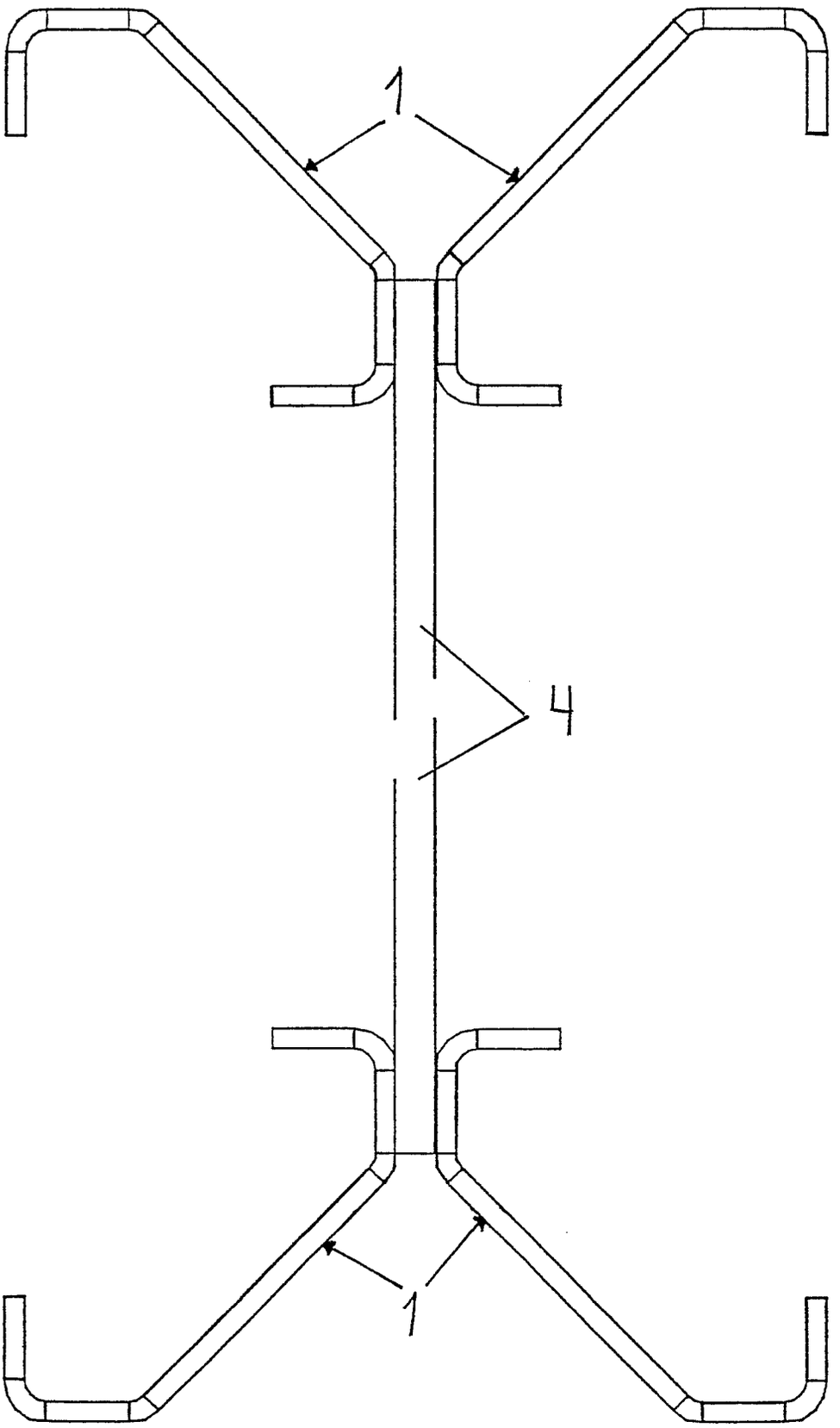


Fig. 6

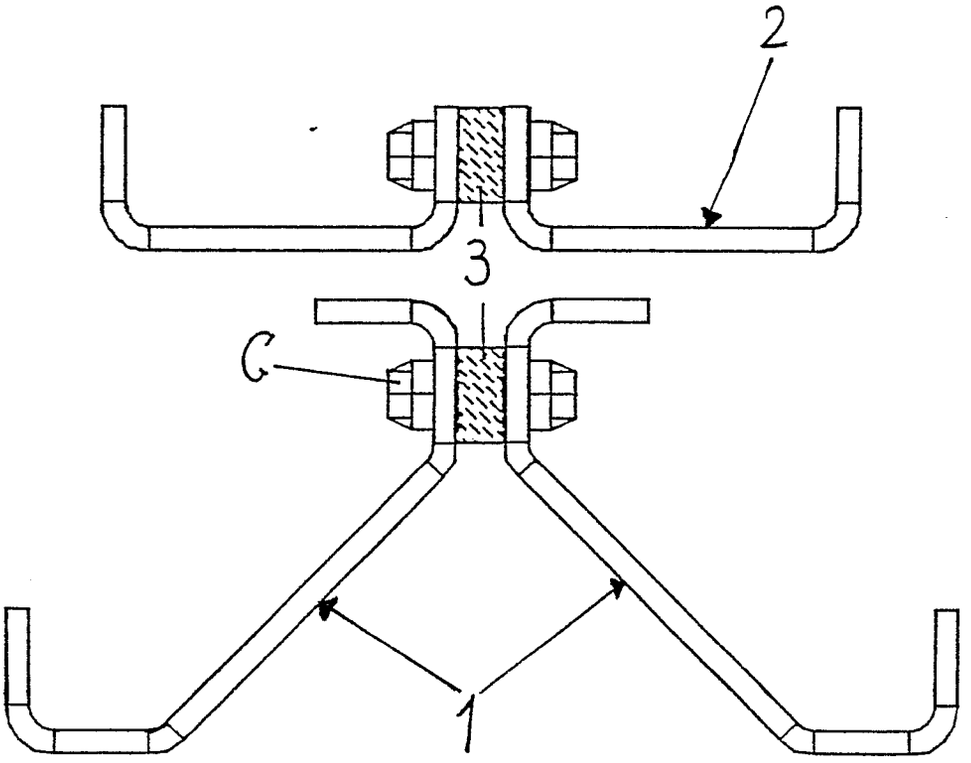


Fig. 7

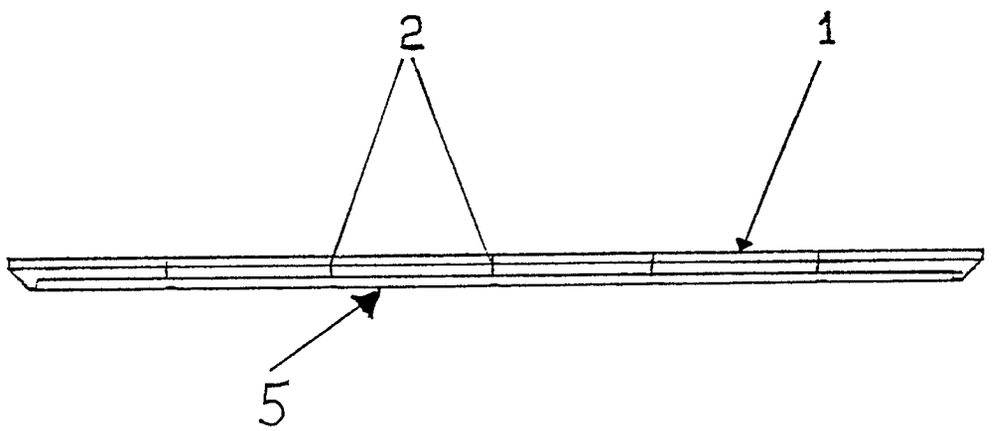


Fig. 8

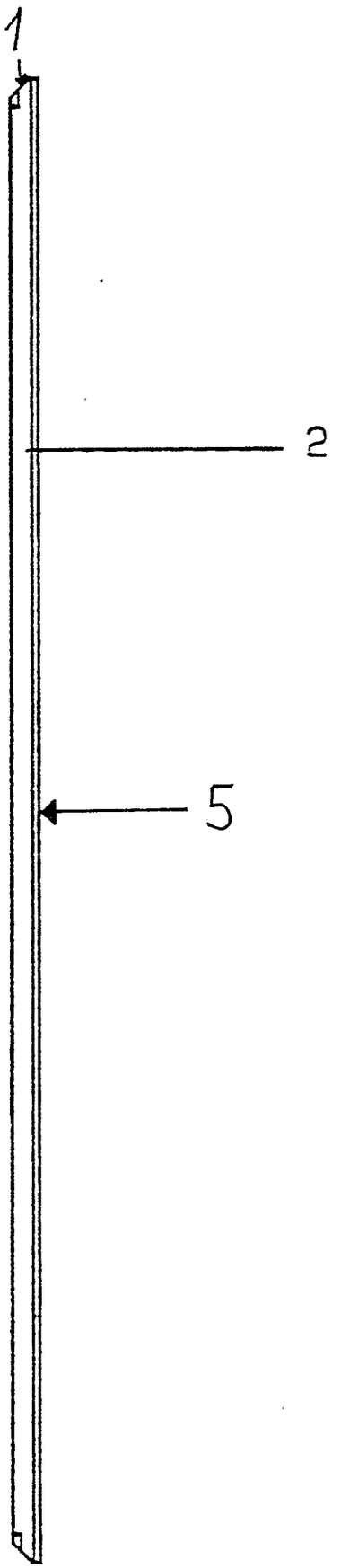


Fig. 9

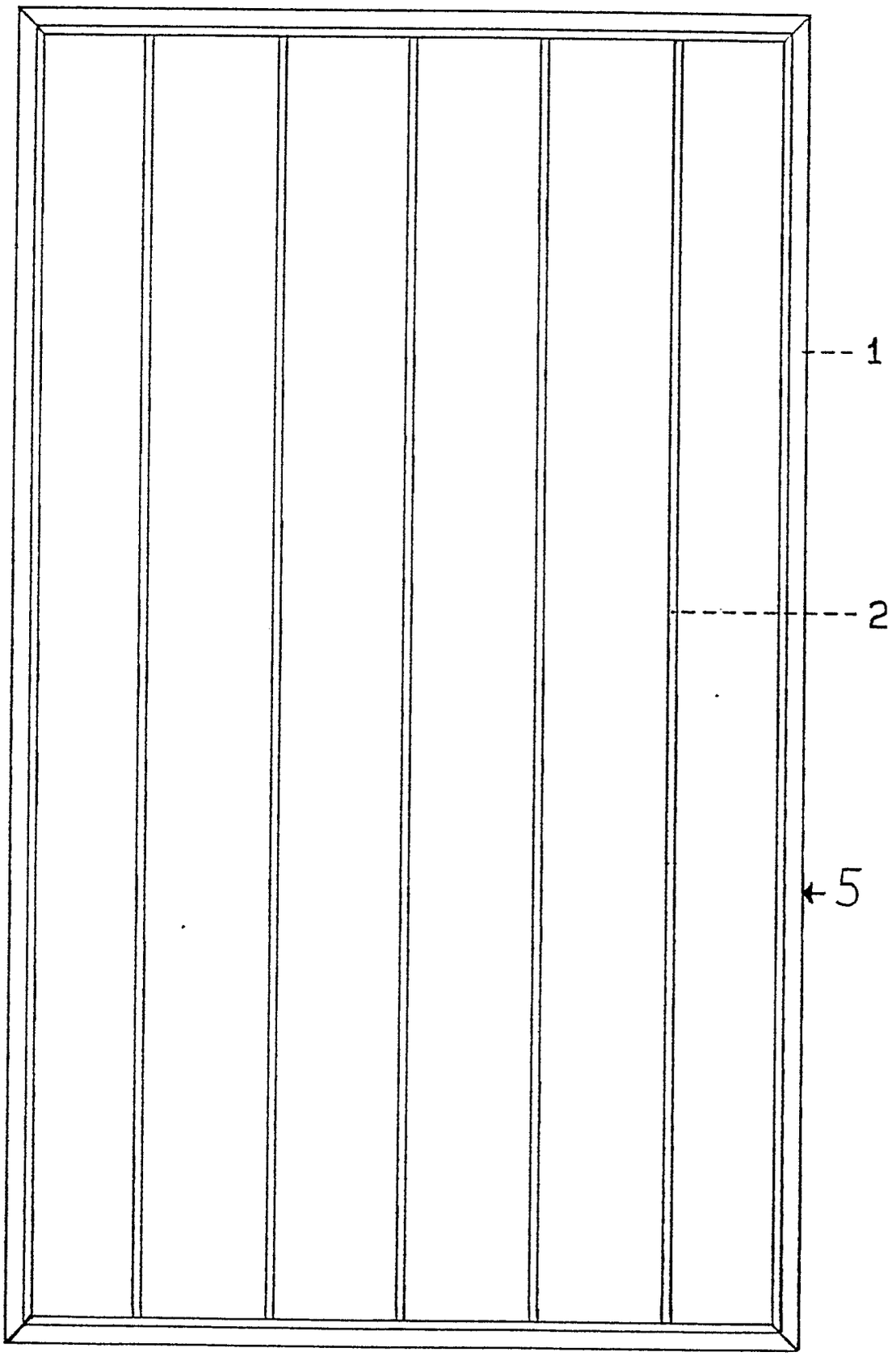


Fig. 10

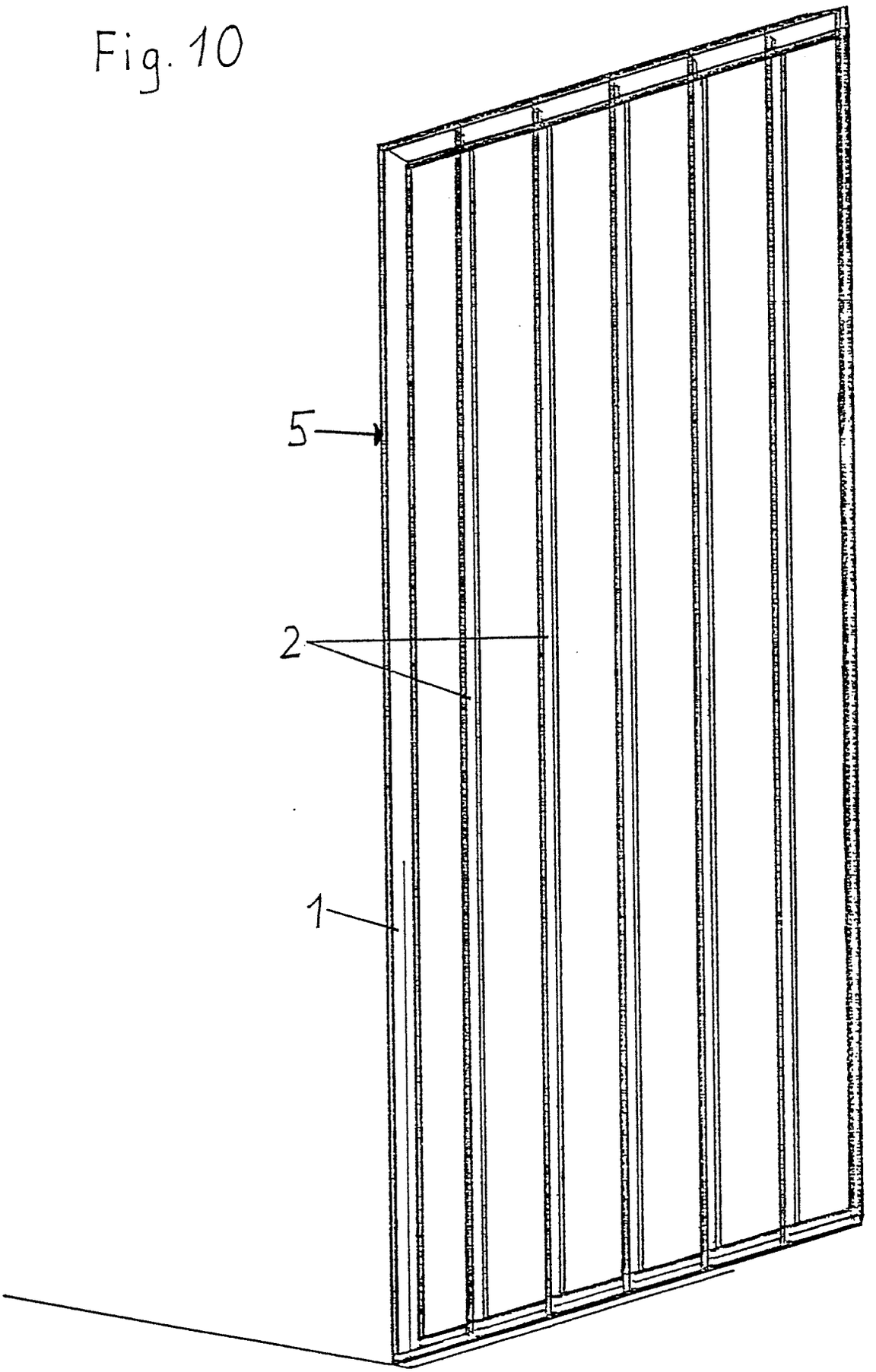


Fig. 11

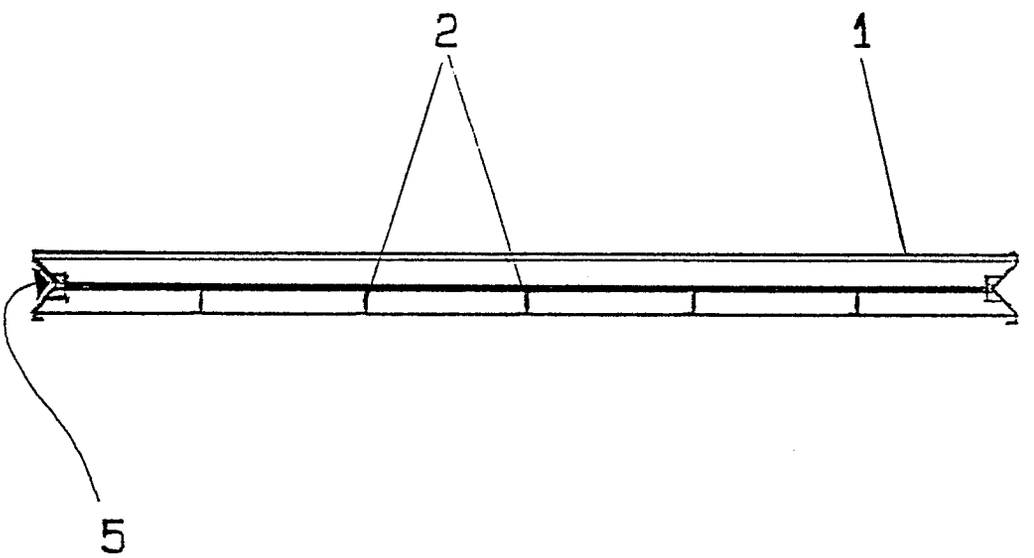


Fig. 12

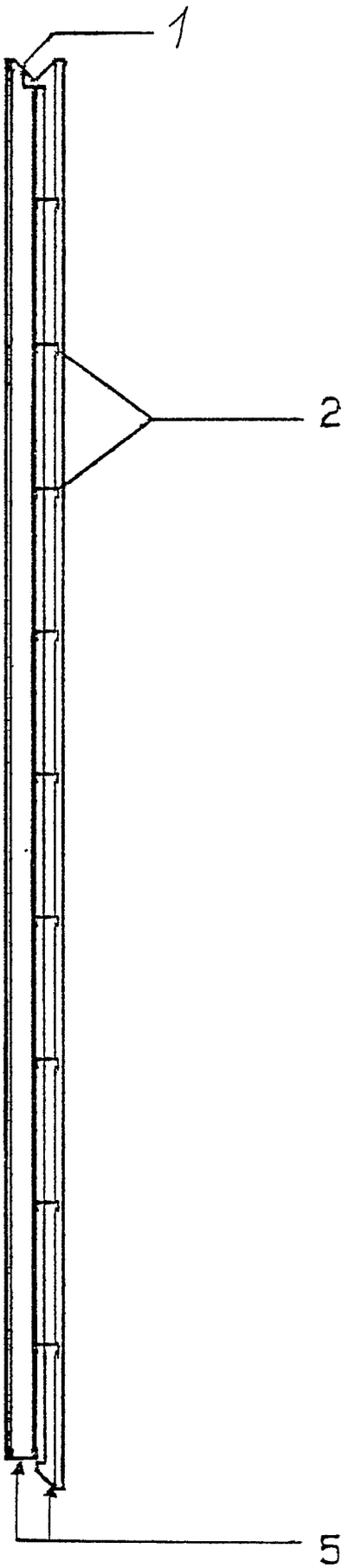


Fig. 13

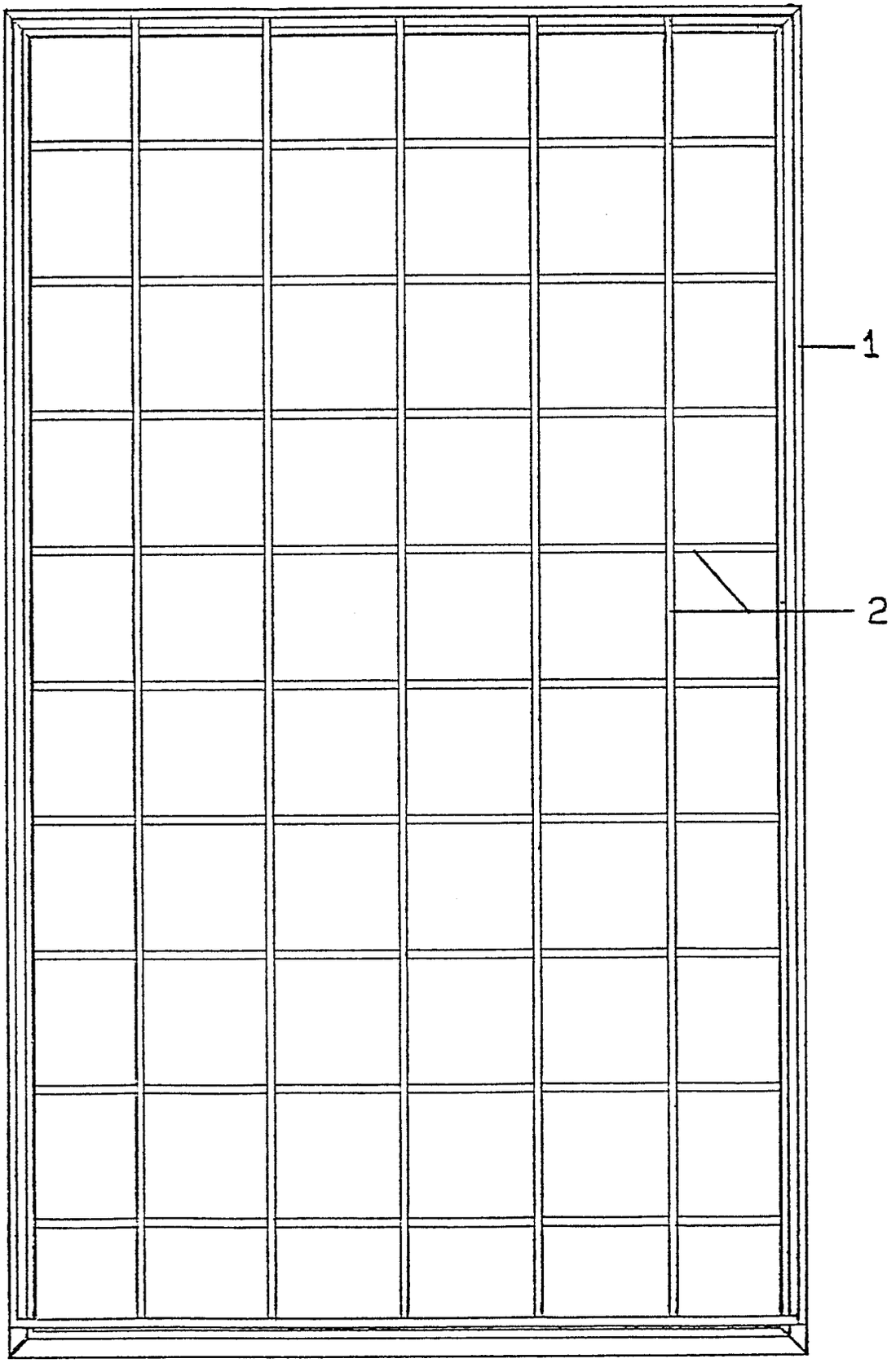
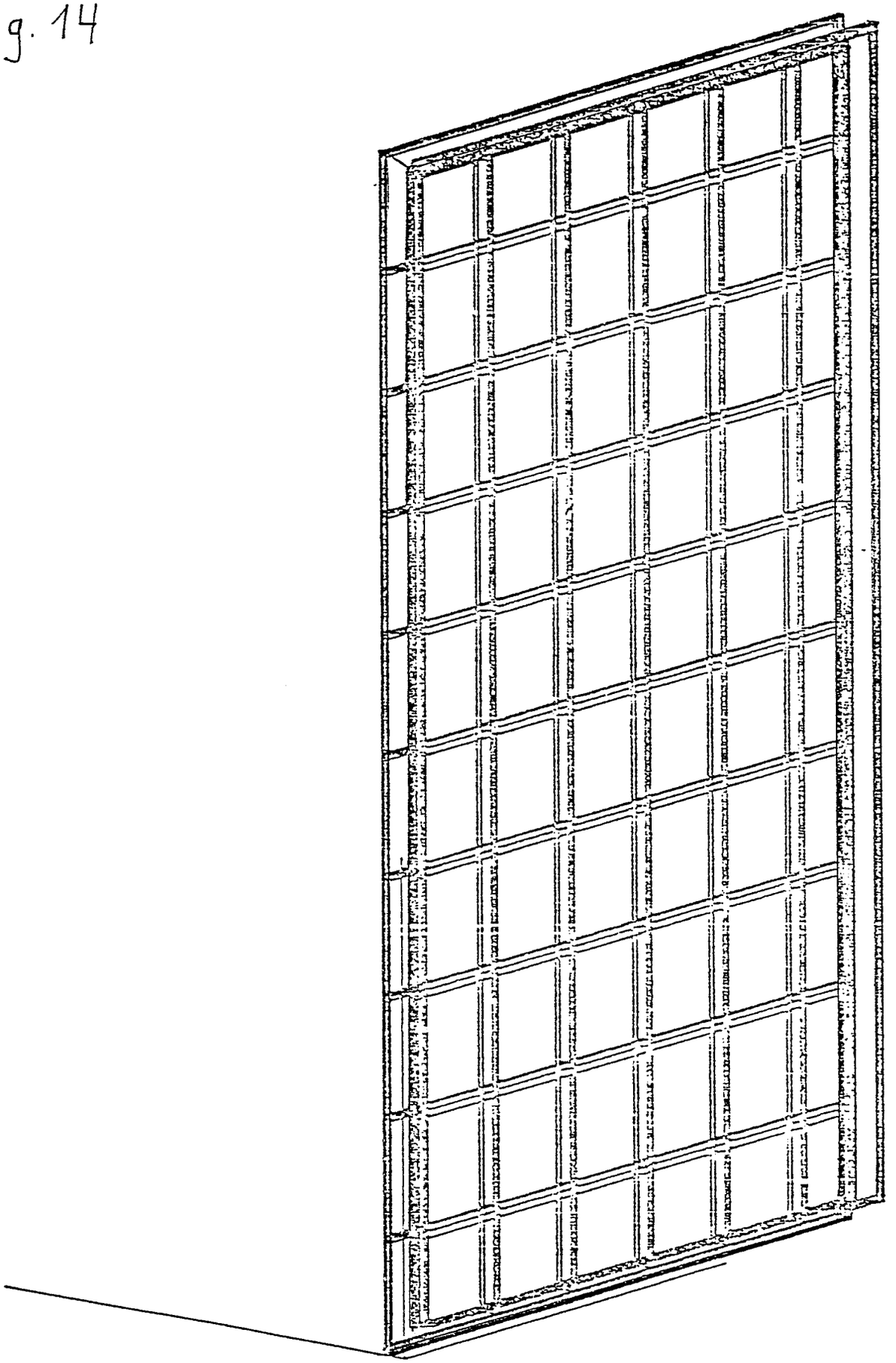


Fig. 14



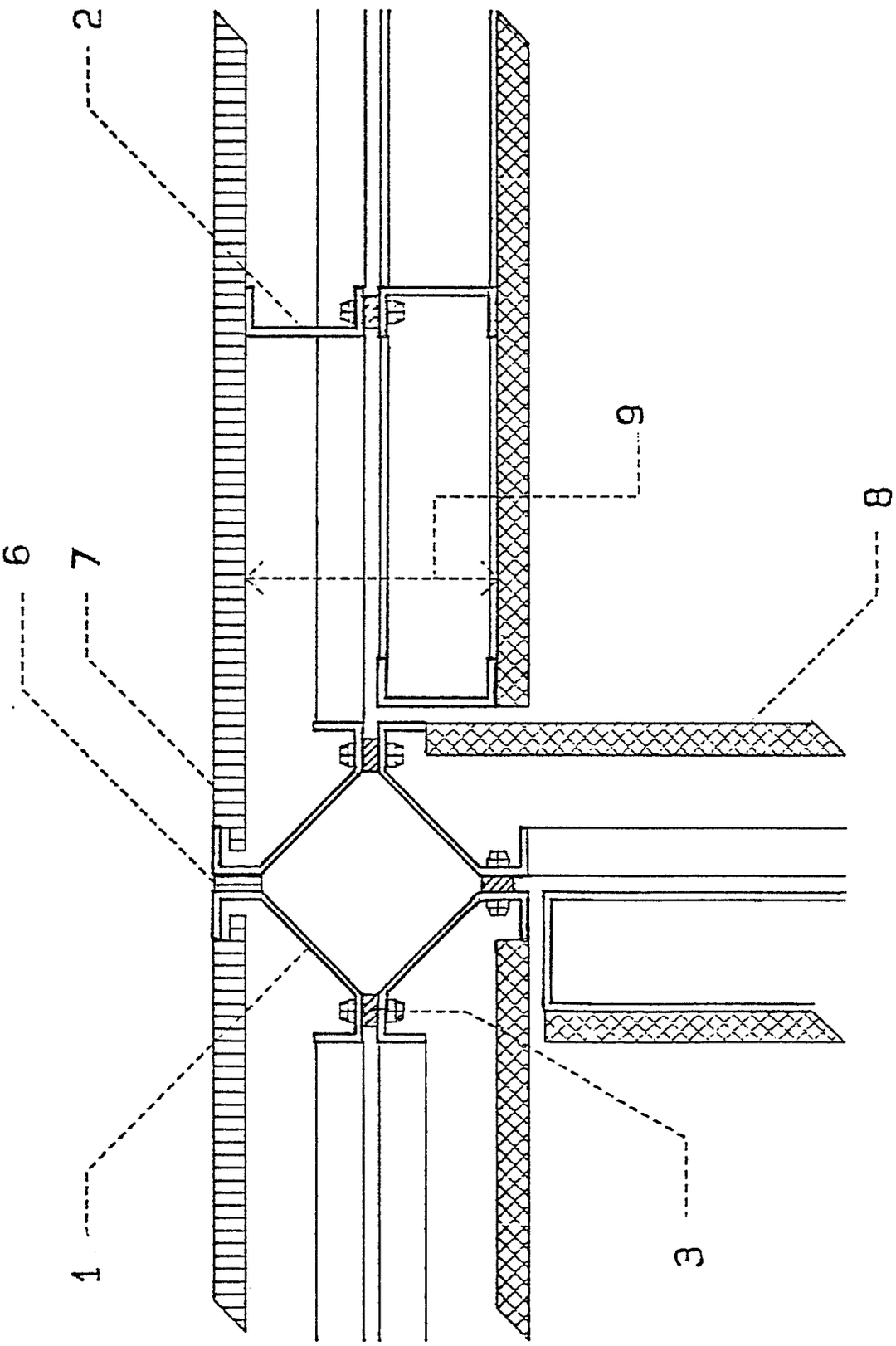


Fig. 15

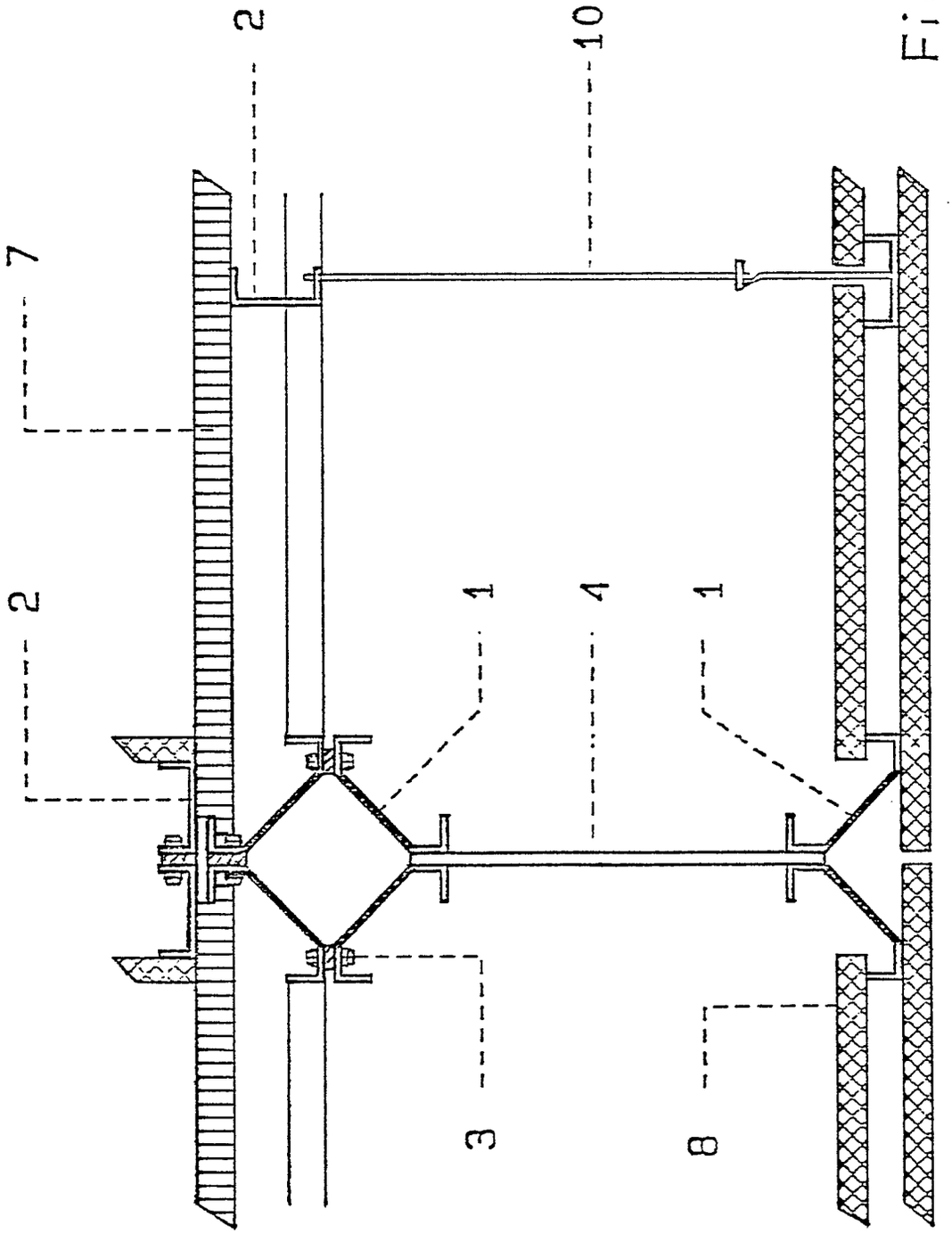


Fig. 16