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(71) Applicant: **MAUNSELL STRUCTURAL
PLASTICS LIMITED**
Yeoman House, 63 Croydon Road
London SE20 7TP(GB)

(72) Inventor: **Head, Peter Richard**
10 Westfield Road
Beckenham, Kent BR3 YEU(GB)
Inventor: **Dawson, David Guy**
10 Kingswood Road
London SE20 7EN(GB)

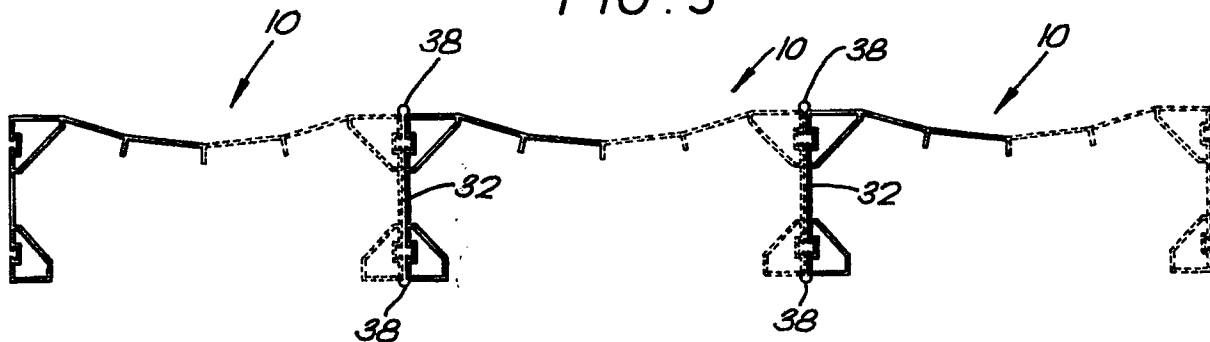
(74) Representative: **Hartley, David et al**
Withers & Rogers 4 Dyer's Buildings Holborn
London, EC1N 2JT(GB)

(54) Building system.

(57) A building system comprising a plurality of wall roof or floor members (10) each being a pultruded fibre-reinforced plastics structure and having a major face wall (12) which may be corrugated or otherwise curved and opposed side walls (14A, 14B) extending on one side of the major face wall (12) to form an open channel section. Adjacent members are at-

tached together by connector plates (32), there being an elongate connector portion of head-and-neck shaped cross-section projection (34, 36) from the plate or side wall and received within a connection channel (28, 30) extending longitudinally of side wall or plate. Such a connection also enables members to be joined end-to-end.

FIG. 3



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BUILDING SYSTEM

This invention relates to a building system, and in particular to a building system in which a plurality of pultruded fibre-reinforced plastics structural members are connected together to form a building assembly.

British Patent No. 2129465 discloses a floor and roof system comprising a plurality of load-bearing floor or roof members each in the form of a hollow, flat, plank member which is an integral pultruded structure of fibre-reinforced plastics material. The plank member has an upper major face wall, a lower major face wall spaced from the upper major face wall, and opposed side walls all formed in a single pultrusion operation, and the side walls each have an outwardly opening integral undercut connection channel which is shaped to receive slidably the connector portion of a connector member. The connection channels run parallel to the major faces of the plank member, and by arranging several plank members side by side, connector members may be slidably inserted into the connection channels to link the plank members and to form a floor or roof assembly. The assembly may be supported by suspension rods linked to the connector members. The plank members have plurality of internal stiffening webs linking the upper and lower major face walls, and a rigid plastics foam filling is provided in the interior spaces.

While the above mentioned assembly is suitable for comparatively short span floors and roofs, it becomes relatively expensive compared to more traditional structures when larger spans are required.

According to one aspect of this invention, a wall, roof, or floor assembly comprises a plurality of elongate wall members and a plurality of connector plates between the wall members. Each wall has a major face and opposed side walls extending on one side of the major face wall to form an open channel section, and is a pultruded fibre-reinforced plastics structure, preferably of constant cross-section throughout its length. Running lengthwise in each side wall there is at least one integrally formed outwardly opening undercut connecting channel. The connector plates each have elongate connector portions of head-and-neck-shaped cross-section projecting from both faces of the plate to be received within the connection channels of the wall members. In order to contribute to the stiffness of the assembly against bending about an axis transverse to the length of the wall members, the width of the connector plates is such that they extend at least over the major part of the depth of the wall member. In a preferred embodiment of the invention, they are of a width equal to or slightly

greater than the depth of the side walls.

By forming the assembly of channel section wall members as described above, providing connector elements in the form of plates, it is possible for a given mass of fibre-reinforced plastics material, to create a structure with superior resistance to flexure in a direction perpendicular to the major face walls of the wall members compared to the resistance of the above mentioned prior art assembly.

The fact that the connector plates can be sandwiched between the side walls of adjacent wall members yields a large bonding area for bonding the side walls to the plates for additional strength.

In most situations, the majority of the connector plates project only by a small distance, if at all, from the edges of the side walls of the wall members. A small projection can be useful for forming an architectural feature in the form of, for example, a rounded bead running along the junction between two adjacent wall members. However, the plate construction also allows the provision of extending projections integral with a connector plate and extending outwardly well beyond the physical confines of the wall members to form fixtures or supports. In this way, it is possible when the assembly is a wall assembly to include a series of projections at a selected height for supporting a floor or a crane rail, to give just two examples. Integral extensions of the connector plates beyond the physical confines of the wall members may also be used to link the ends of the wall members to a roof, which may itself be composed of identical wall members. A further important advantage of an assembly including connector plates as described above is that it affords the possibility of joining wall members end-to-end insofar as the connector plates may overlap the ends of wall members placed end-to-end with their connector portions running from the connector channels of one wall member directly into the connection channels of other wall members. With the width of the connector plates being such that they extend over at least the major part of the depth of the wall members, such end-to-end connections can yield an assembly of large area while retaining good resistance to bending of the assembly about an axis extending transversely of the wall members.

According to a second aspect of the invention, a wall member for a wall, roof, or floor assembly comprises a major face wall and opposed side walls extending on one side of the major face wall to form an elongate open channel section, and is a pultruded fibre-reinforced plastics structure, preferably of constant cross-section. Each side wall in-

cludes integral connection means typically in the form of at least one outwardly opening undercut connection channel running lengthwise of the wall member. To give the member additional stiffness against bending about an axis extending transversely of its length and perpendicularly to the side walls, the major face wall is preferably non-planar by, for instance, having longitudinal corrugations or being curved in a transverse cross-section. Generally, the curvature is such that the major face wall has a concave outer surface, i.e. the surface on the opposite side of the major face wall from the side walls. This curved configuration also presents a greater resistance to bending about a longitudinal axis when the side walls are coupled to other elements of the assembly, as compared to a member having a planar major face wall.

To reduce the possibility of lateral flexure and buckling of the side walls, their junctions with the major face wall and their distal edges are braced with integral longitudinal flanges. In the case of the junction between each side wall and the major face wall, the flange comprises a plate inclined both to the side wall and the major face wall and joining each along a line spaced from the junction. Preferably, in the case of each side wall having two undercut connection channels, one of these channels extends into the closed space formed by the flange, the side wall, and the major face wall. At the distal edge of each side wall the flange takes the form of a first plate extending perpendicularly from the side wall edge and inwardly of the channel section of the wall member. The distal edge of this first plate is then braced by a second longitudinal plate connecting the last mentioned edge to the side wall along a line spaced from the edge of the side wall. Again, if the side wall has two connection channels, the second of these channels extends into the interior space enclosed by the side wall and the two plates bracing the distal edge of the side wall.

As stated above, the preferred major face wall is curved, presenting a concave face. Additional stiffness of the major face wall may be achieved by the use of integrally formed longitudinal ribs or webs extending inwardly of the channel section and joined to the major face wall along lines at spaced intervals between the side walls.

According to a third aspect of the invention, a connector for connecting together elongate pultruded fibre-reinforced plastics wall members in a wall, roof, or floor assembly comprises an elongate plate having on each of its major faces one or more, or preferably two or more, projecting elongate connector portions running lengthwise of the plate and each having a head and neck shaped cross-section. The plate is of substantially constant cross-section over at least part of its length and is

preferably a pultruded, fibre-reinforced component.

The invention will now be described by way of example with reference to the drawings in which:-

Figure 1 is a cross-section of a wall member in accordance with the invention;

Figure 2 is a cross-section of a connector plate for joining together wall members of the configuration of Figure 1;

Figure 3 is a cross-section of part of a wall assembly including wall members and connector plates as shown in Figure 1;

Figure 4 is a cross-section of a plank member in accordance with the invention;

Figure 5 is an exploded perspective view illustrating the junction between a wall assembly and a roof assembly;

Figure 6 is a diagrammatic side elevation showing an alternative combination of a wall assembly and a roof assembly.

Referring to Figure 1 of the drawings, a wall member 10 in accordance with the invention has a generally curved major face wall 12 which extends between two opposed side walls 14A, 14B extending parallel to each other on one side over major face wall 12 to form an open channel section. The curvature of the major face wall 12 is such that its outwardly facing surface is concave. Ribs 16 extend from the inwardly facing surface parallel to the side walls 14A, 14B to add to the stiffness of the major face wall 12. The junctions 18A, 18B of the side walls 14A, 14B with the major face wall 12 are braced by first flanges 20A, 20B in the form of longitudinally extending inclined webs joining the inner surface of the major face wall 12 with the inner surfaces of the respective side walls 14A, 14B at locations spaced from the junctions 18A and 18B. The possibility of buckling of the side walls 14A, 14B towards or away from each other is further reduced by second flanges 22A, 22B at the distal edges of the side walls 14A, 14B, each second flange comprising a longitudinally extending plate 24A or 24B projecting inwardly and perpendicularly from the side wall 14A or 14B, and a further inclined plate 26A or 26B joining the inner edge of the first plate 24A or 24B to the inwardly facing surface of the respective side wall 14A or 14B at a point spaced from the distal edge of the side wall.

It is intended that the wall member 10 should be connected via connector plates (described below) to other identical wall members to form a wall, roof, or floor assembly. Connection of the wall member to the connector plates is effected by means of undercut connection channels 28A, 28B, 30A and 30B running lengthwise of the member 10 and integrally formed in the side walls 14A, 14B, there being two connection channels in each side wall. As will be seen, the channels are located

between the respective edges of the side walls 14A, 14B and the lines along which the flanges 20A, 20B and 26A, 26B join the side walls.

The wall member 10 is a glass fibre-reinforced plastics structure which is pultruded in a single pultrusion operation. It may therefore be cut to any required length. As a consequence of the method of manufacture, all of the features of the member 10, as described above, occur continuously throughout the member, i.e the wall member 10 is of constant cross-section throughout its length. The technique of pultrusion is a known method of manufacturing fibre-reinforced plastics sections. The technique involves pulling continuous glass reinforcing rovings and matt impregnated with plastics material through a heated dye system. The complete member is heated and cured as it is pulled from the system using jaws which grip the cured part of the member as it emerges from the dye. The process is very economical, being a continuous automated operation requiring very little manual intervention. It follows that the cost of the materials of the pultruded member form a very significant part of the overall production cost, and it is an advantage of the wall member described above that it is comparatively stiff for the amount of fibre-reinforced material used, particularly when linked to other identical members in a complete wall, roof, or floor assembly.

In this embodiment the depth of the side walls is in the region of 240mm, although of course, other sizes within a preferred range of 150 to 300 mm can be used. In the present embodiment, the width of the wall member 10 is 600 mm, giving a width to depth ratio of 2.5. Other ratios may be used, with the preferred range being from 2 to 3. The wall thickness of the major face wall and the side walls is preferably in the range 2 mm to 5 mm with the preferred thickness being 3 mm.

Referring now to Figure 2, a connector plate 32 for connecting together two wall members 10 placed side-by-side comprises another elongate pultruded glass-fibre-reinforced plastics component. The width of the plate 32 corresponds to the depth of the side walls 14A, 14B of the wall member 10, and four connector portions 34A, 34B, 36A, 36B running lengthwise of the plate 32 and having a head - and - neck shaped cross-section project from the faces of the plate at positions in registry with the undercut channels 28A, 28B, 30A, 30B of the wall member 10.

An assembly of three wall members 10 and two connector plates 32 is shown by way of example of Figure 3. In this case, the connector plates 32 extend by a small amount beyond the edges of the side walls 14A, 14B to form beads 32A and 32B of rounded cross-section at the junctions between the wall members. The function of the beads

is to hide the joins between the wall members 10 and the connector plates 32, and by arranging for the connector plates 32 to be of a different colour to the material of the wall members 10, they can be made to appear distinct from the wall members or not as required.

Since the connector plates extend the full depth of the side walls 14A, 14B of the wall members 10 they add considerably to the stiffness of the assembly against being about a transverse axis, particularly if the side walls 14A, 14B are bonded to the connector plates 32, as preferred.

It will be appreciated that building a wall, roof, or floor assembly as shown may be performed simply by applying the bonding adhesive to the faces of the side walls 14A, 14B and sliding the connector plates between the wall members with the connector portions located inside the undercut channels 28A, 28B, 30A, 30B. Wall members may be joined end-to-end by allowing the connector plates to overlap the joins.

In addition to permitting the construction of simple wall, roof, or floor assemblies, the preferred building system in accordance with the invention includes further components which, for instance, serve to join a wall assembly to a roof assembly and to serve as a mounting for other structures.

The plank section or member shown in Figure 4 or similar in construction and use to the wall member of Figures 1 to 3 but has a different side wall configuration. Each side 414a, 414b wall forms part of a box section integral with the major face wall 412 and braced against an inner side wall 422 by integral lateral struts 420a, 426. Also the ribs 416 extending from the inwardly facing surface of the major face wall 412 are (inverted) T-shape in cross-section, the head of the T-section being provided for sliding engagement transverse stiffeners with appropriate sockets.

Referring to Figure 5, a roof assembly 40 may be joined to a wall assembly 42, both assemblies being constructed in accordance with the invention by the use of a dual connector plate component 44 having on each of its major faces two pairs 46, 48 of connector portions of head-and-neck-shaped cross-section arranged at an obtuse angle to each other, as shown. Connector plates 32 joining the wall members 10 of the roof assembly together and the wall members 10 of the wall assembly together respectively are cut to a length such that they terminate short of the region where the wall members of the roof assembly meet the wall members of the wall assembly. The remaining lengths of the side walls of the wall members are joined together by respective arms of 44A and 44B of the plate member 44. Preferably such plate members 44 are provided at each wall member to wall member junction along the complete length of the inter-

face between the roof assembly 40 and the wall assembly 42.

The edges of the plate member 44 are curved and are spaced apart by a width considerably greater than the width of the connector plates 32 to provide angular stiffness. Buckling of the outwardly projecting portion of 44C of the plate member is restricted by ribs 50 on either side, as shown. The open ends of the wall members 10 are covered by a curved fairing 52.

One advantage of using concavely curved wall members 10 for the roof assembly 40 is that the central portion of each member 10 acts a drainage channel spaced from the junctions with the connector plates 32.

An alternative roof-to-floor junction is illustrated in figure 6. In this case, the roof assembly 40 overlaps the top of the wall assemble 42, the wall members 10 of one assembly being joined to the wall members 10 of the other by an alternative plate member 54. As before, the joining plate member 54 has on each major face two pairs 56, 58 of elongate connector portions located at an angle to each other for insertion in the undercut channels of the lower members of both the roof assembly 40 and the wall assembly 42. Again, the connector plates 32 are terminated short of the ends of the wall members 10 to allow this. Each plate member 54 projects beyond the ends of the wall members 10, and includes a cut-out 60 which may be used to mount a gutter 62. This may be covered by a gutter cover 64 held on with clips (not shown).

In a similar manner wall members 10 may be connected together at the peak of the roof by a different plate member 66 with appropriately angled connector portions 68, 70.

Interruption of the connector plates 32 in other locations affords the possibility of inserting alternative plate members such as that indicated by a reference 72 in Figure 5. This particular plate member extends inwardly beyond the wall members 10 to provide, in conjunction with other identical plate members at the same height, a platform for, in this case, a crane rail 74. Of course, intermediate floors and other structures may be supported in a similar manner.

Footings 76 for the wall members of the wall assembly 42 may be provided by sinking the ends of the wall members 10 in concrete 76 as shown, with steel reinforcing rods 78 extending transversely through holes in the wall members 10.

In the above description, reference has been made particularly to the use of wall members and connector plates for a wall assembly for a building. It is also possible within the scope of the invention to construct retaining walls, preferably with the retained material bearing against the inside of each

channel section.

Claims

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1. A wall, roof, or floor assembly comprising a plurality of elongate wall, roof or floor members and a plurality of connector plates between the members, each member having a major face wall and opposed side walls extending on one side of the major face wall to form an open channel section, and being a pultruded fibre-reinforced plastics structure, wherein the connector plates are attached to each adjacent side wall by a connection comprising an elongate connector portion of head-and-neck-shaped cross-section projecting from the plate or the wall to be received within a connection channel in the side wall or plate, the width of the connector plates being such as to extend at least over the major part of the depth of the member.

2. An assembly according to claim 1 wherein each wall member is of constant cross-section throughout its length.

3. An assembly according to claim 1 or claim 2 wherein each side wall has at least one connection channel running lengthwise thereof.

4. An assembly according to any preceding claim wherein the or each connecting channel comprises an outwardly opening undercut channel integrally formed in the wall member.

5. An assembly according to any preceding claim wherein each connector plate is equal to or slightly greater than the depth of the side walls.

6. An assembly according to any preceding claim and comprising wall, roof or floor members joined end-to-end with connector plates overlapping the ends of members placed end-to-end with their connector portions running from the connector channels of one member directly into the connector channels of other members.

7. An assembly according to any preceding claim wherein the major face wall is non-planar.

8. An assembly according to claim 7 wherein the major face wall has longitudinal corrugations or is curved in a transverse cross-section.

9. An assembly according to any preceding claim wherein the major face wall has a concave outer surface.

10. An assembly according to any preceding claim wherein each connector plate is of substantially constant cross-section over at least part of its length and is preferably a pultruded, fibre-reinforced component.

11. An assembly constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

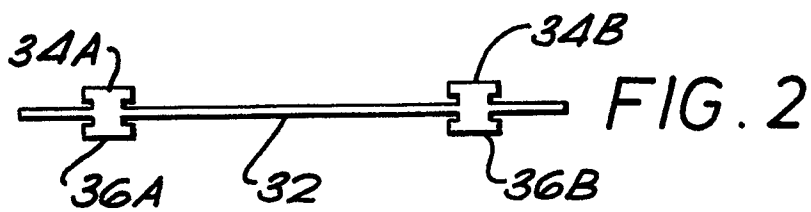
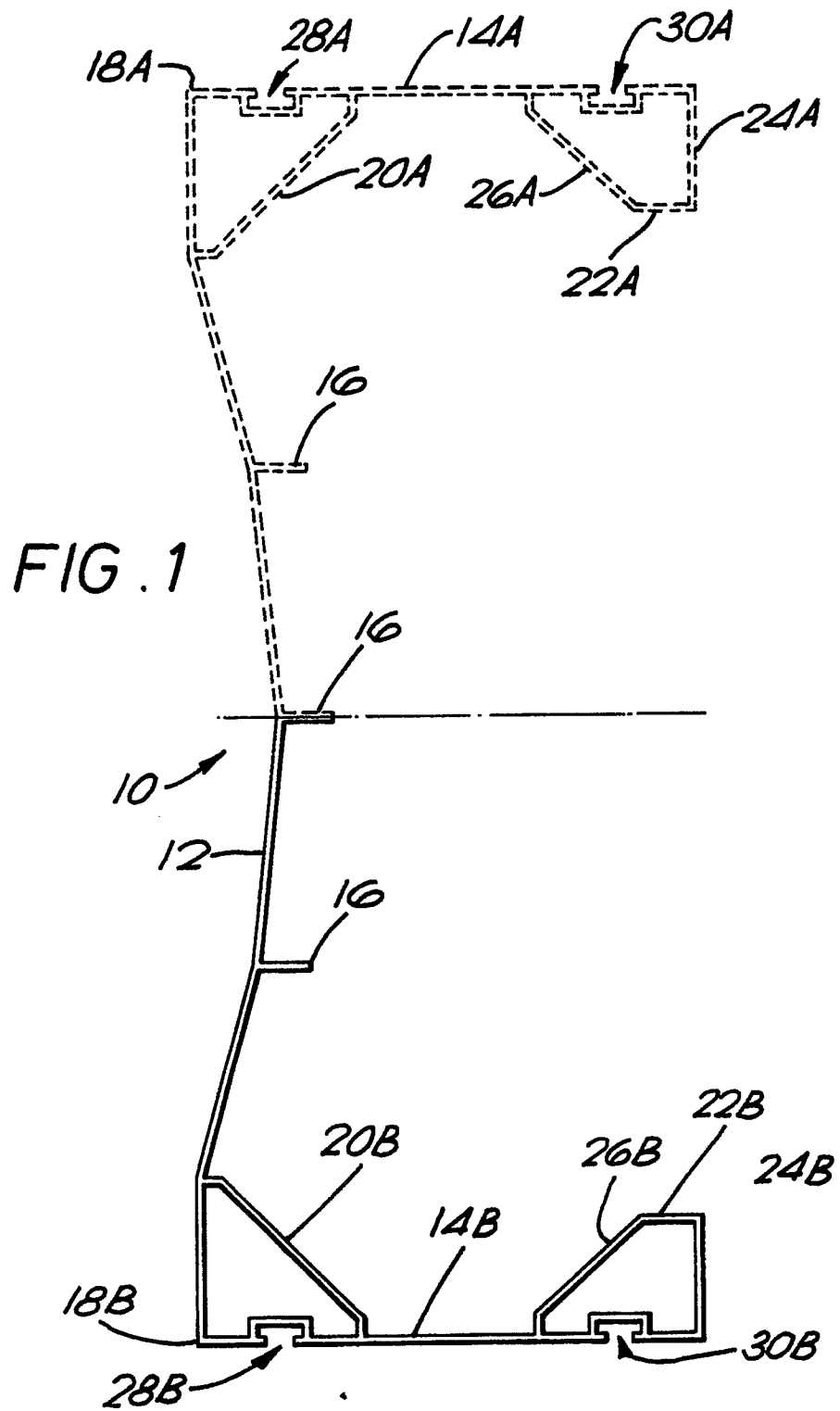


FIG. 3

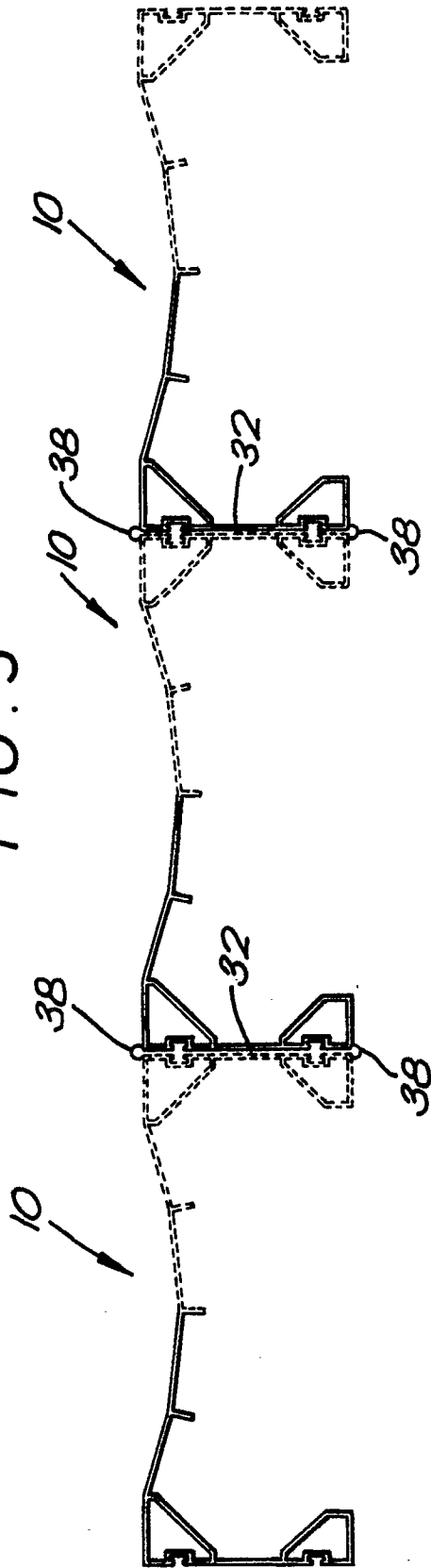
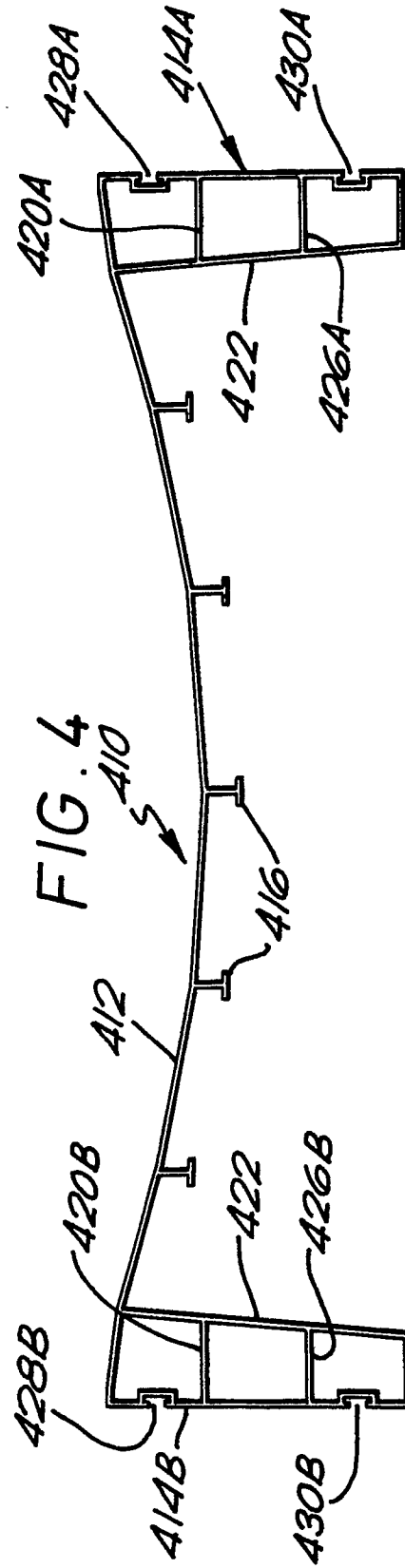


FIG. 4



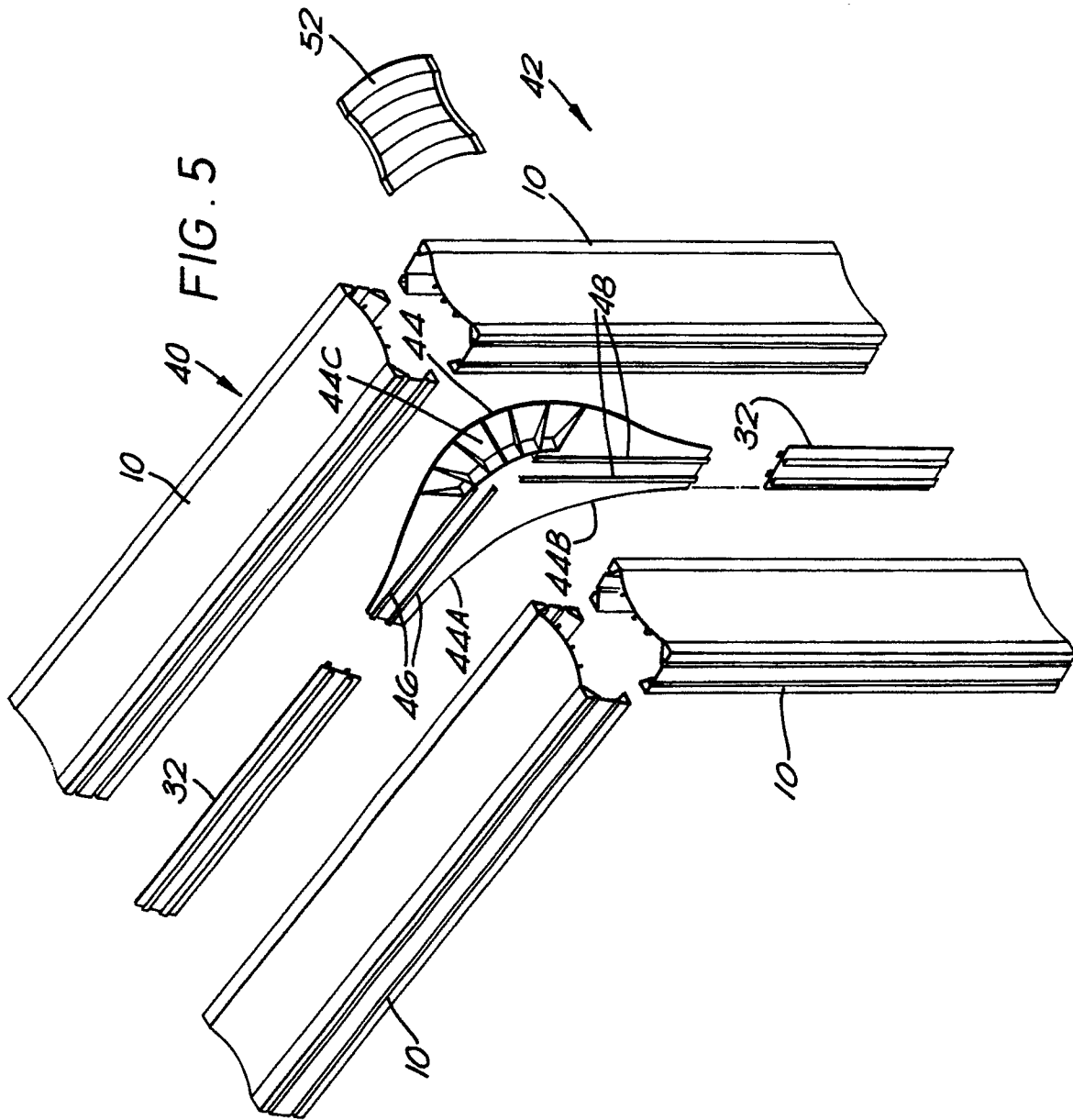
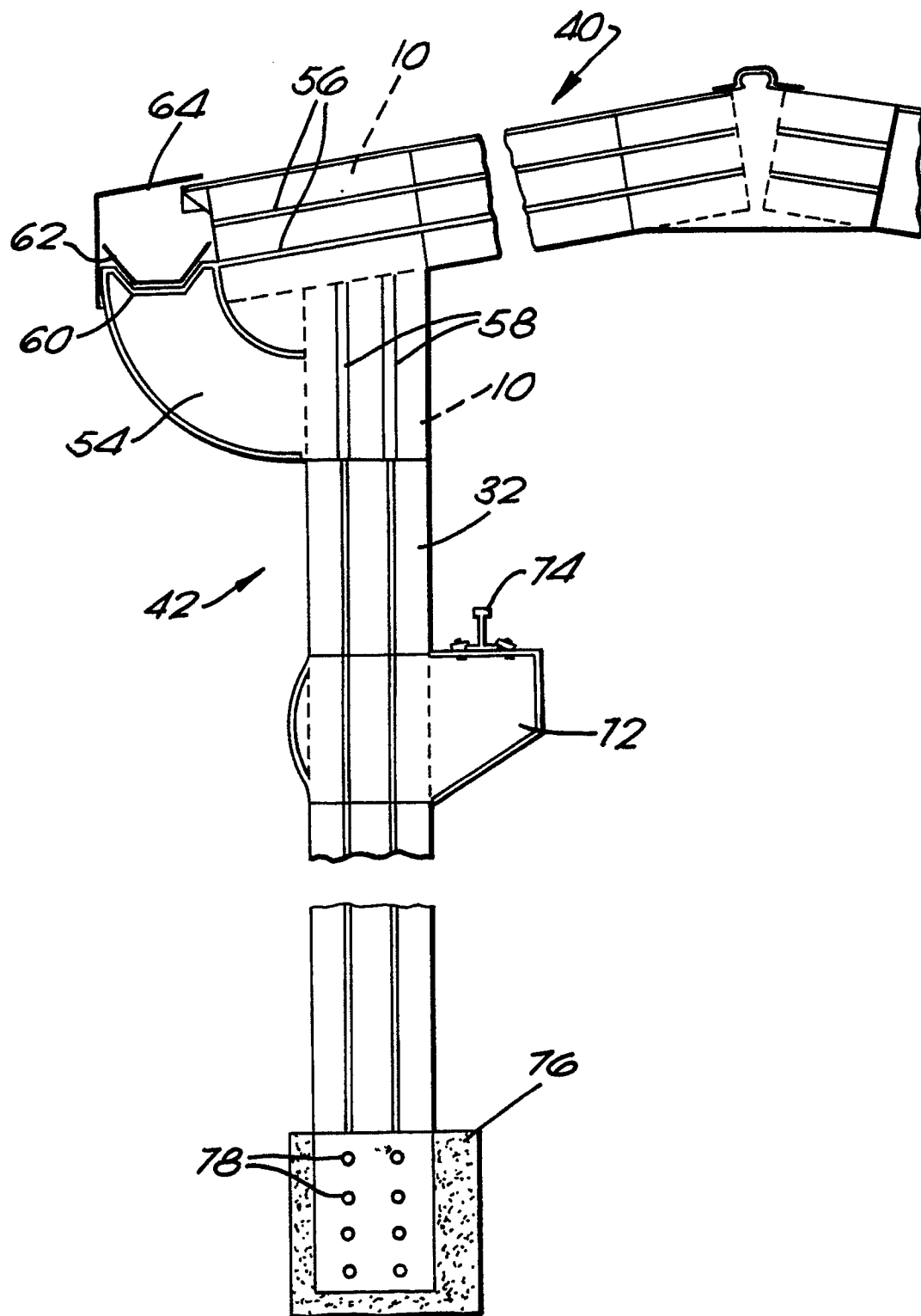


FIG. 6





European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 90 30 8703

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 124 707 (VEREINIGTE ALUMINIUM-WERKE AG) * Page 3, lines 1-22; figures 1,2 *	1-6, 11	E 04 B 1/18 E 04 B 2/72 E 04 D 3/32
Y	---	7-10	
Y	GB-A- 445 663 (T. JUNKERS) * Page 1, lines 67-86; page 2, lines 18-22; figures 1,2 *	7-9	
Y,D	---	10	
	GB-A-2 129 465 (G. MAUNSELL & PARTNERS) * Page 2, lines 90-104,114-122; figures 1,2,4 *		
A	---	1-6	
A	US-A-4 594 822 (H.J. MARSCHAK) * Column 3, lines 41-66; figures 2,3 *	1-4,7-9	
A	---		
	GB-A-2 119 425 (G. McDONALD ROBERTSON)		
A	---		
	DE-U-8 407 671 (KAISER ALUMINIUM EUROPE INC.) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			E 04 B E 04 D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 20-11-1990	Examiner KAPPOS A.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	