



(11) Publication number : **0 674 059 A1**

(12)

EUROPEAN PATENT APPLICATION

(21) Application number : **95301871.0**

(51) Int. Cl.⁶ : **E04C 3/28, E04C 3/36,
E04B 5/02**

(22) Date of filing : **21.03.95**

(30) Priority : **25.03.94 GB 9405982**

(43) Date of publication of application :
27.09.95 Bulletin 95/39

(84) Designated Contracting States :
BE DE DK ES FR GB IT SE

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(54) **Reinforced structural member.**

(57) An elongate structural member comprising a structural outer shell (1,3,5,6) and at least one arcuate reinforcing member (4) within, for use in structural, semi-structural or cladding applications to carry floor loading, walkway loading, wheeled loading, pressure loading in buildings, bridges and other loading carrying applications.

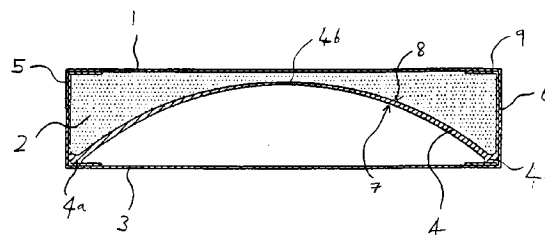


Figure 1

The present invention relates to a reinforced structural member for use in applications where load carrying capability is required, for example structural, semi-structural and cladding applications to carry floor loading, walkway loading, wheeled loading, pressure loading in buildings, bridges etc.

Traditionally solid members have been used in the above applications. Recently sectioned members have been proposed but these are mainly box-section members such as those described in WO 91/06421.

According to the present invention there is provided an elongate structural member comprising of an outer shell substantially rectangular lateral cross section and at least one substantially laminar arcuate reinforcing member within the outer shell,

said at least one reinforcing member being arcuate in a plane perpendicular to the axis of said structural member, extending between positions near opposite edges of one part of the outer shell and, in its mid section, approaching near the opposite face.

The present invention provides a member which has improved strength characteristics by efficiently transmitting loads to the bottom corners or intermediate points across the section, while providing stiffness in the longitudinal direction, preventing local buckling of the wide upper flange and resistance to in-plane loading.

It is envisaged that the space between the arcuate member and the load bearing surface opposing the arcuate surface may be filled with a foam material and/or may have rib members extending between them.

Both the outer shell and the arcuate member may be constructed by either moulding or pultruding them from fibre reinforced composite materials. This provides the member with the strength required whilst retaining a lightweight construction.

When load is applied to the load bearing surface, it is passed through the arch to the base of the structural member where it is transmitted to the supports at suitable points along the length of the member. In order to prevent the ends of the arch from splaying outwards they are restrained in one of two ways. Either, a planar sheet of a similar material to the rest of the outer shell is used to restrain the ends of the arch and also forms the base of the structural member or tension members such as wires or strips are provided spaced along the length of the structural member connecting the opposite sides of the arch to hold them in position.

It is also envisaged that to provide improved performance especially when high in-plane forces are encountered, reverse arching may be used. In such instances the structural member would contain two intersecting arcuate members, one hogging and one sagging. This also allows the member to be used either way up, avoiding the need to check which way up the arcuate member is within the outer member when

positioning the member.

If the structural members are to be used in combination, connecting portions may be provided to allow attachment of the units to each other to form floors, decks, roofs, walls, beams and columns of buildings, bridges and other forms of structure.

If the structural members are to be suspended in use then hanger portions may be provided to allow attachment to the hanging means.

The present invention will be further described hereinafter with reference to the following description of exemplary embodiments and the accompanying drawings, in which:

Figure 1 shows an example of the basic configuration with the foam filled spandrels;

Figure 2 shows the basic configuration with the reinforcing ribs provided between the arch and the load bearing surface;

Figure 3 shows the embodiment of Figure 2 with hanger and connection portions for hanging and connecting the members in use;

Figure 4 shows a further embodiment with two intersecting arches;

Figures 5 and 6 show two embodiments with two intersecting arches having the different connection portions.

Figure 7 shows a detailed view of the connection of two members using the first type of connection member.

Figure 8 shows a detailed view of the connection of three members using a T-shaped configuration of the first type of connection member.

Figures 9A-D shows for possible modes of connection using four different configurations of a the first type of connection member.

Figure 10 shows a detailed view of the connection of members using a second type of connection member.

Figure 11 shows a detailed view of the connection of three members using the second type of connection member and using an inter-connect piece.

Figures 12A-D shows four possible modes of connection using the second type of connection means.

Figure 13 shows a member according to the present invention formed in two-parts and bonded via a bonding member.

Figure 14 shows a multi-cellular embodiment of the present invention.

In the figures, like parts are indicated by like reference numerals.

Figure 1 shows the basic configuration of a first embodiment of the present invention. The structural member comprises an outer member consisting of the load bearing surface 1, two side faces 5 and 6, a fourth face 3, and an arcuate member 4. Load applied to the structural member is passed through the load

bearing surface 1 to the upper surface of the arcuate member 4. The load is supported by the strength of the arch and is passed to the ends 4a. As load is applied to the arch there is a tendency for the ends 4a to splay out unless they are restrained. This is achieved by the fourth face 3 which in use provides a tensioning force for holding the ends of the arch together and hence holding the arch in shape.

The space 2 defined between the convex surface 8 and the inside of the load bearing surface is filled with a foam material to help to distribute the load evenly to the arcuate member.

The arcuate member 4 may be formed as a single unit with the outer member (1,3,5,6) or formed separately and inserted into the outer member subsequently. Reinforcements 9 may also be used in the corners of the outer member to increase the overall stiffness and strength of the structural member. The reinforcement may be formed as part of the outer shell, part of the arcuate member or formed as a separate entity to be inserted into the outer member. The outer shell and arcuate member may have a laminated structure or be formed in a single piece.

The structural member may also be constructed with or without a foam filling in the space 2 by using reinforcing ribs 21 to distribute the load more evenly onto the arcuate member, as shown in figure 2. The ribs may extend parallel to the axis of the structural member and perpendicular to the load bearing surface as in figure 2. However it is envisaged that there may be alternative ways of arranging the ribs, for example a fan like arrangement where the ribs are parallel to the axis of the structural member and perpendicular to a tangent at the point of intersection with the arcuate member.

The structural members may also be used by resting them on supports or by hanging them from a hanging means such as wires. To this end the structural members may be provided with hanging portions 31 and 32 as shown in figure 3 to allow attachment to such a hanging means.

Figure 5 shows an alternative construction of the present invention comprising two arcuate members which intersect each other. The second arcuate member 51 is curved in the opposite sense to the other arcuate member 4. Extra ribs 21 and 52 may be included similarly to the ribs 21 shown in figure 2. As with previous embodiments the spaces between the ribs may be filled with a foam material. Alternatively some or all of the ribs may be excluded completely whilst still using the foam filler as in the configuration shown for a single arch in figure 1.

In use the structural member may be used with several similar members adjacent to it to form a floor or deck and so on. They may also be configured with adjacent members perpendicular or at inclined angles. To accommodate this, connection portions 41-44 as shown in figures 5 & 6 may be included to fa-

cilitate connection to adjacent structural members or to inter-connect members as described below.

Figure 7 shows an example of two of the members shown in Figure 5 connected together by connection members 71. The connection members have outstanding portions 74 which are shaped to engage the recess portions 41 provided on the structural member. The two members to be connected are bonded together along their abutting surfaces 72 and to the connection members along interfaces 75 and 76. It is also envisaged that the connecting members will be connected to each other via a web portion (not shown) which runs between the edges of the members 1. Then in order to join members, the two members are slid into each side of the connecting member until the outstanding portions 74 engage the recess portions 41 such that the edge faces of the members abut against the web portion. In such a construction the edges of the members are bonded to the web portion as opposed to each other, as in the previous construction. In order to increase the strength of the joint a bolt may be passed through the connection members and the structural members to clamp the parts together. The possible positions of the bolts are indicated by dashed lines 73 in Figure 7.

Figure 8 shows an example of a connection member for connecting three structural members of the type shown in Figure 5. Again each of the three structural members is inserted into the D-shaped connection member to which they are subsequently bonded along the member's edge 83 and upper and lower 82 surfaces.

Figures 9A to 9D illustrate the various forms of connection member usable with the first connection system. This includes the cross junction of Figure 9A, corner junction of Figure 9B, T-junction of Figure 9C and a series junction of Figure 9D.

As shown in Figure 10, a connection method for the embodiments shown in Figure 6 comprises undercut recesses 43, 44 into which is inserted a connection member 100 having overhanging portions 102 adapted to engage the recess portions 43, 44 to retain the connection member in the slot. By inserting the similarly overhanging portion on the opposite side of the connecting member to the undercut recess slot of another member it is possible to hold two members together. When the two members to be connected are engaged with the connecting member, their edge faces come into abutting contact. The contacting surfaces 101 and 103 are then bonded to provide a permanent connection.

It is possible to connect the structural members in a T-junction format using an interconnect member 110 having undercut slots 111 similar to those on the structural members 1 to engage with the connecting members 100. Figure 11 shows a typical construction of a T-junction using the connection members 100 and the interconnect member 110.

Again use of such an interface member allows various different configurations for joining the members (1) together. These are shown in Figures 12A to 12D corresponding to Figures 9A to 9D.

The structural members according the present invention may be constructed in a number of different ways. For example the Figure 1 construction has the outer shell and the arcuate member constructed separately, the arcuate member then being inserted into the outer shell on construction. Alternatively the members may be formed in a single stage by moulding or pultruding them from fibre reinforced composite materials. Another method of construction is shown in Figure 13 where the structural member is formed in two halves 130, 131 which are then either bonded together directly or, as shown in Figure 13 bonded via a bonding member 132. The bonding member having a web portion 135 against which the edges of the halves of the structural member 130, 131 are abutted, and flange members 133 which also abut against the inside 136 and outside 134 surfaces of the halves 130, 131 of the structural member. The two halves and the bonding members are then bonded together at these contact surfaces to form the structural member.

A further embodiment of the present invention is shown in figure 14. This figure shows a multicellular structural member comprising two arcuate members 64 within a single outer member although it is envisaged that three or more arcuate members may be used. The arcuate members may be separated by rib members 61 as shown in figure 6. Again the spaces 62 may be filled with a foam material and/or have rib members 21 to distribute the load.

Claims

1. An elongate structural member comprising of an outer shell of substantially rectangular lateral cross section and at least one substantially laminar arcuate reinforcing member within the outer shell,
said at least one reinforcing member being arcuate in a plane perpendicular to the axis of said structural member, extending between positions near opposite edges of one face of the outer shell and, in its mid section, approaching near the opposite face.
2. A member according to claim 1 wherein said reinforcing member extends along substantially the entire length of said structural member.
3. A member according to any one of the preceding claims comprising two arcuate members contained within the outer shell such that the arcuate members curve in opposite senses.
4. A member according to claim 3 wherein the two arcuate members intersect one another.
5. A member according to any one of the preceding claims comprising at least one rib member extending between the convex surface of the or an arcuate member and the opposite surface of the outer shell.
6. A member according to any one of the preceding claims comprising foam material in at least one space formed between the surface of the or an arcuate member and the outer shell.
7. A member according to any one of the preceding claims wherein the outer shell is moulded or pultruded from a fibre reinforced composite material.
8. A member according to any one of the preceding claims wherein the or an arcuate member is moulded or pultruded from a fibre reinforced composite material.
9. A member according to any one of the preceding claims wherein the outer shell and the arcuate member are moulded or pultruded in an integral piece.
10. A member according to any one of claims 1 to 8 wherein the outer shell and the arcuate member are moulded or pultruded in two sections and bonded together.
11. A member according to claim 10 wherein the two sections are bonded together via a bonding member.
12. A member according to any one of the preceding claims wherein the outer shell comprises at least one connection portion to allow connection to at least one other member either directly or via a connection member.
13. A member according to claim 12 wherein said connection portion comprises at least one engaging recess on one of said long sides.
14. A member according to claim 12 or 13 wherein said connection portion comprises at least one undercut recessed portion on one of said short sides.
15. An elongate structural member according to any one of the preceding claims wherein the outer member comprises at least one hanger portion for hanging the elongate structural member from.

16. A composite elongate structural member comprising two members according to any one of the previous claims such that a short side of one of the members forms a short side of the other.

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17. A member according to any one of the preceding claims wherein said at least one reinforcing member is laminated.

18. A connection member for use with a member according to claim 13, said connection means being generally laminar and having projecting portions to engage said engaging recess on said engaging member.

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19. A connection member for use with a member according to claim 14, said connection means having overhanging portions for engaging said recess portions on said member.

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20. A structure comprising at least one elongate structural member according to any one of claims 1 to 16.

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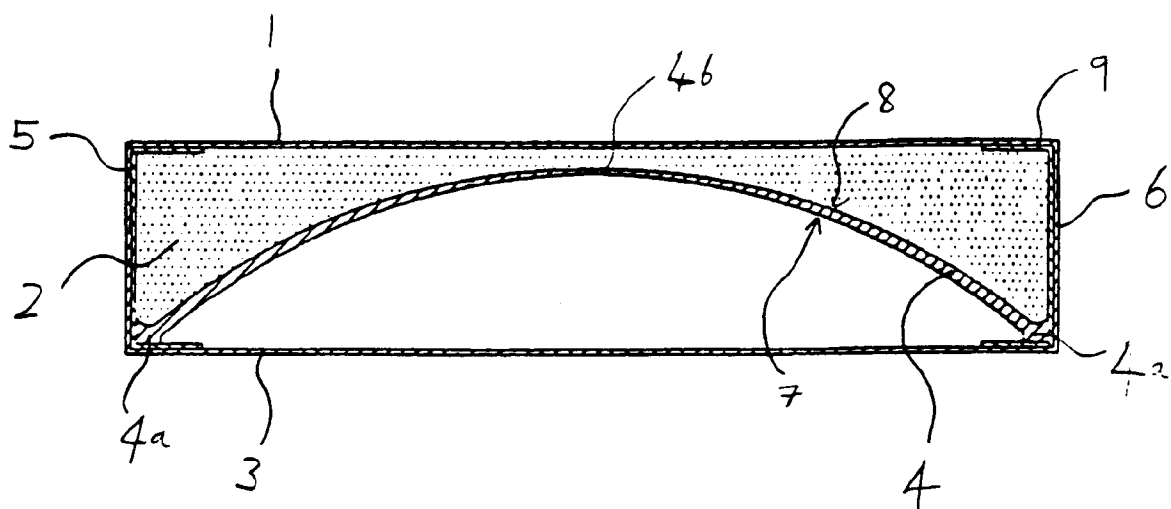


Figure 1

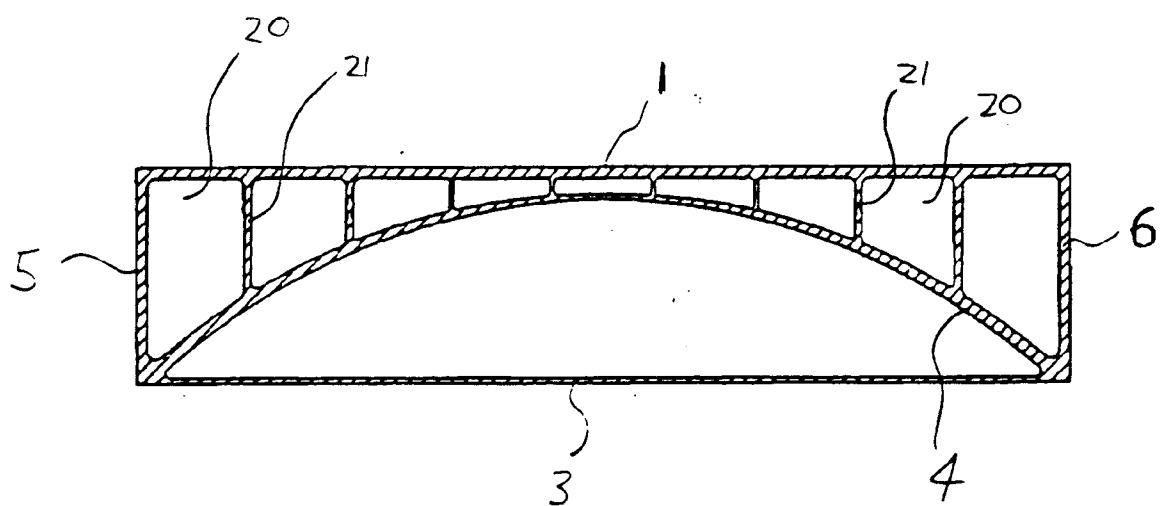


Figure 2

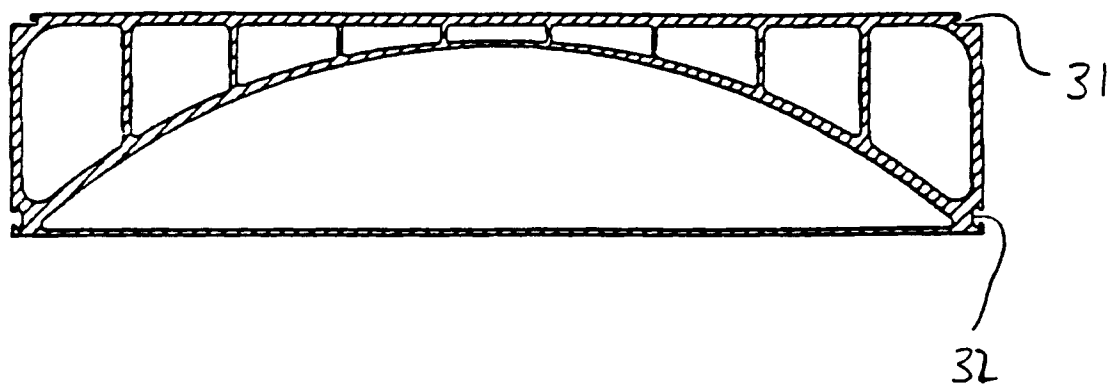


Figure 3

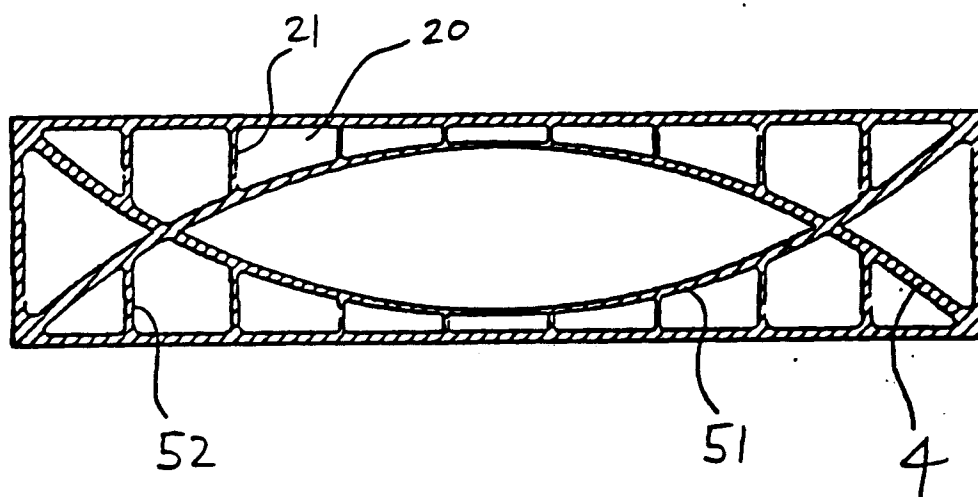


Figure 4

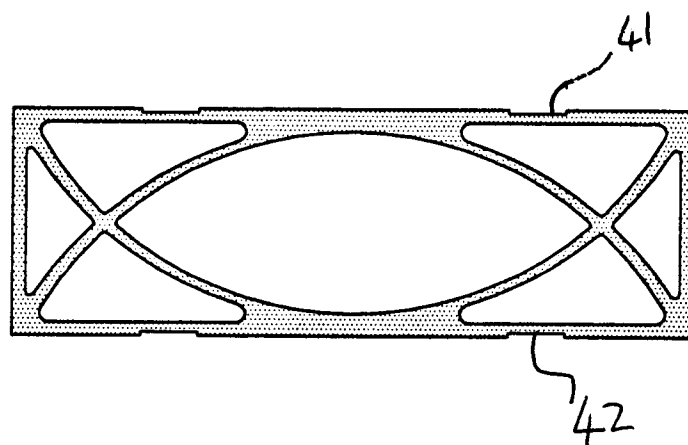


FIG. 5

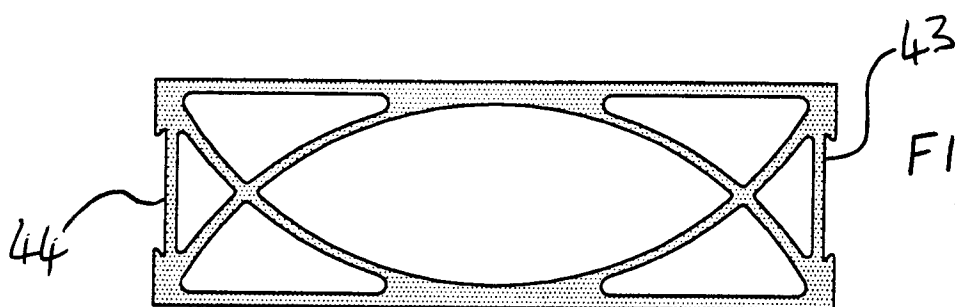
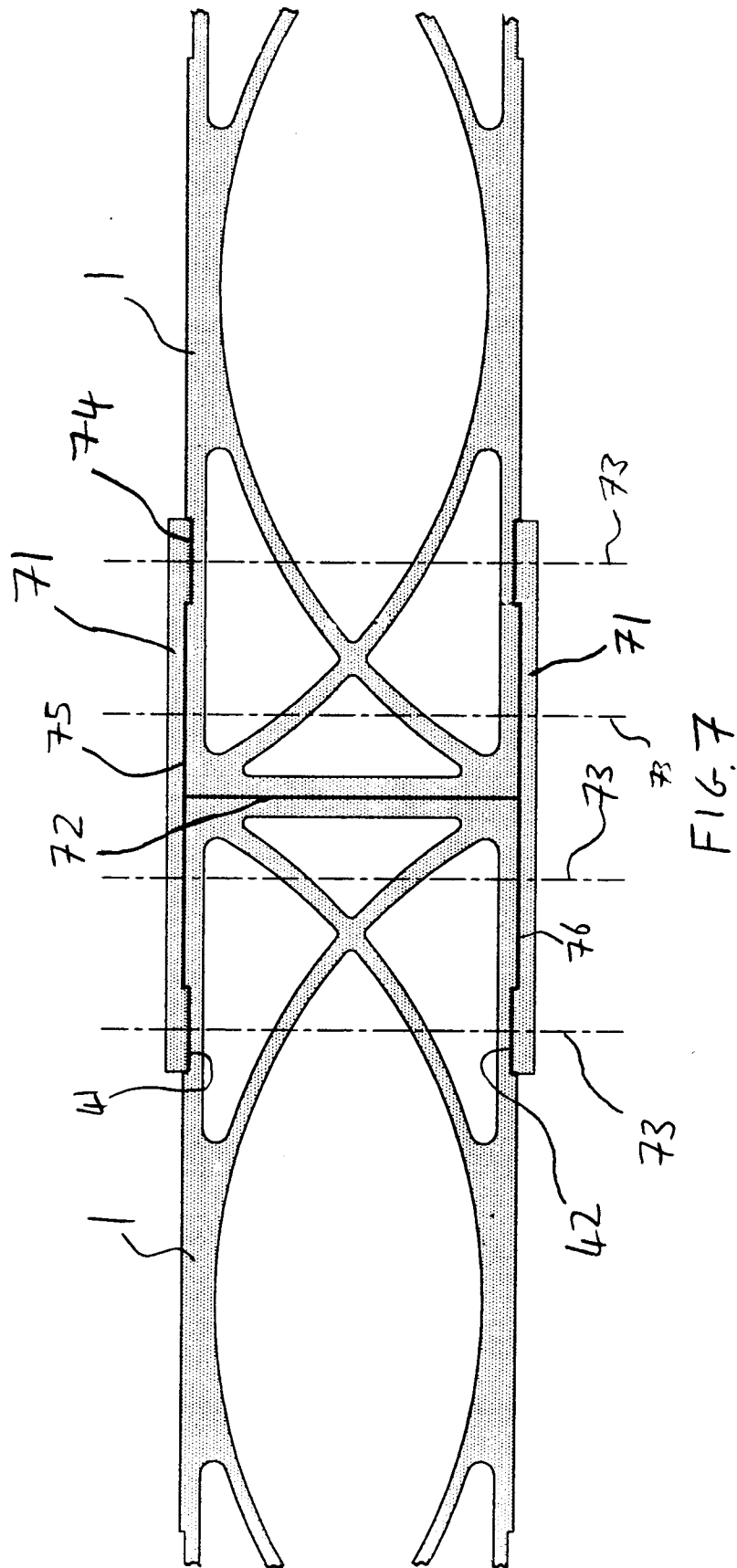
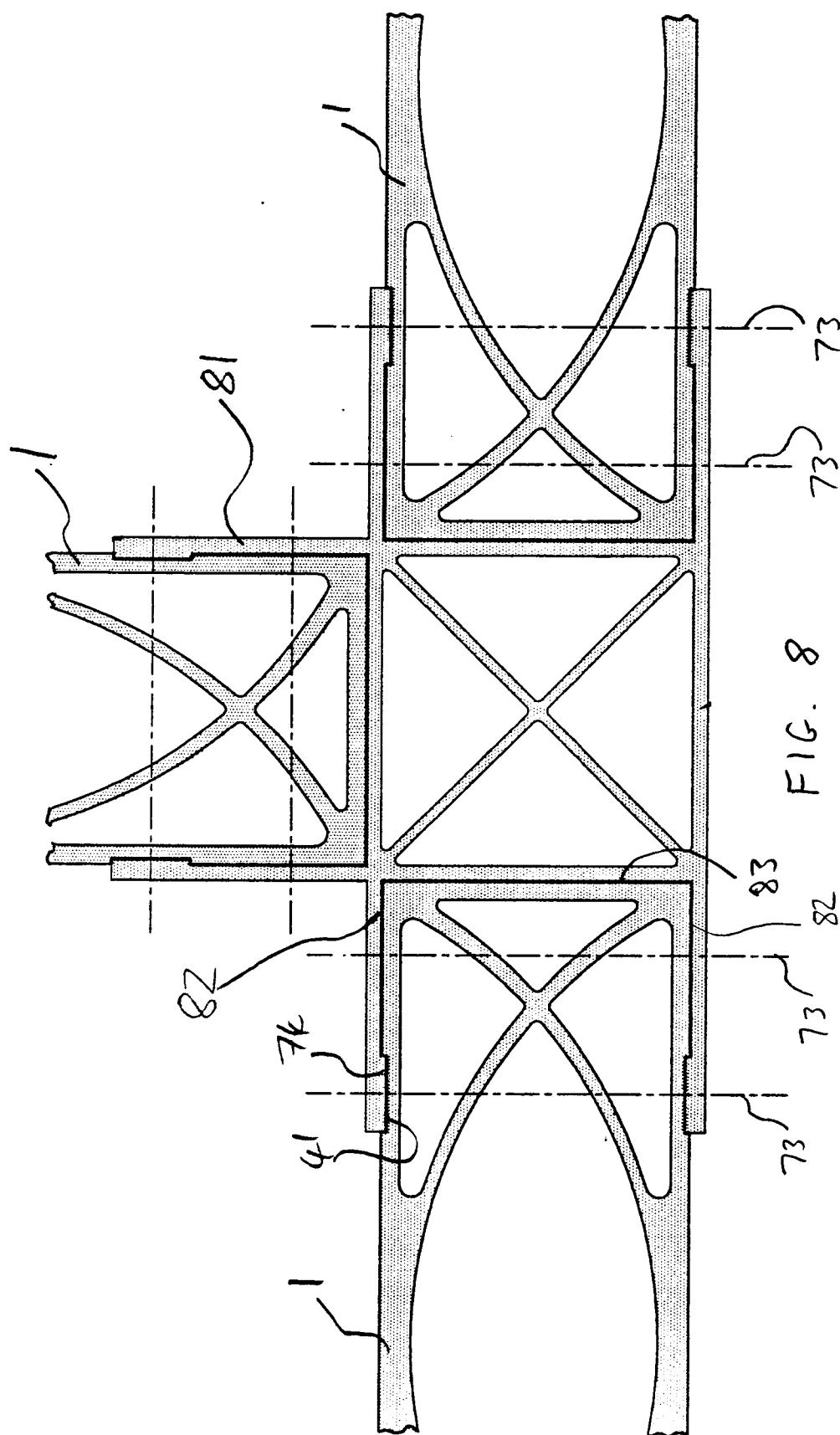


FIG. 6





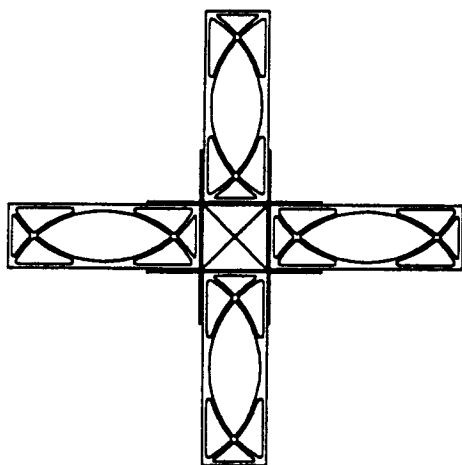


FIG. 9A

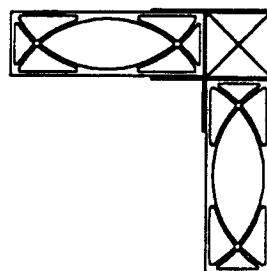


FIG. 9B

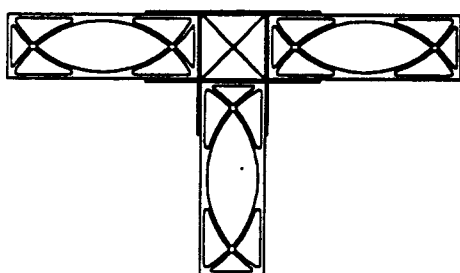


FIG. 9C



FIG. 9D

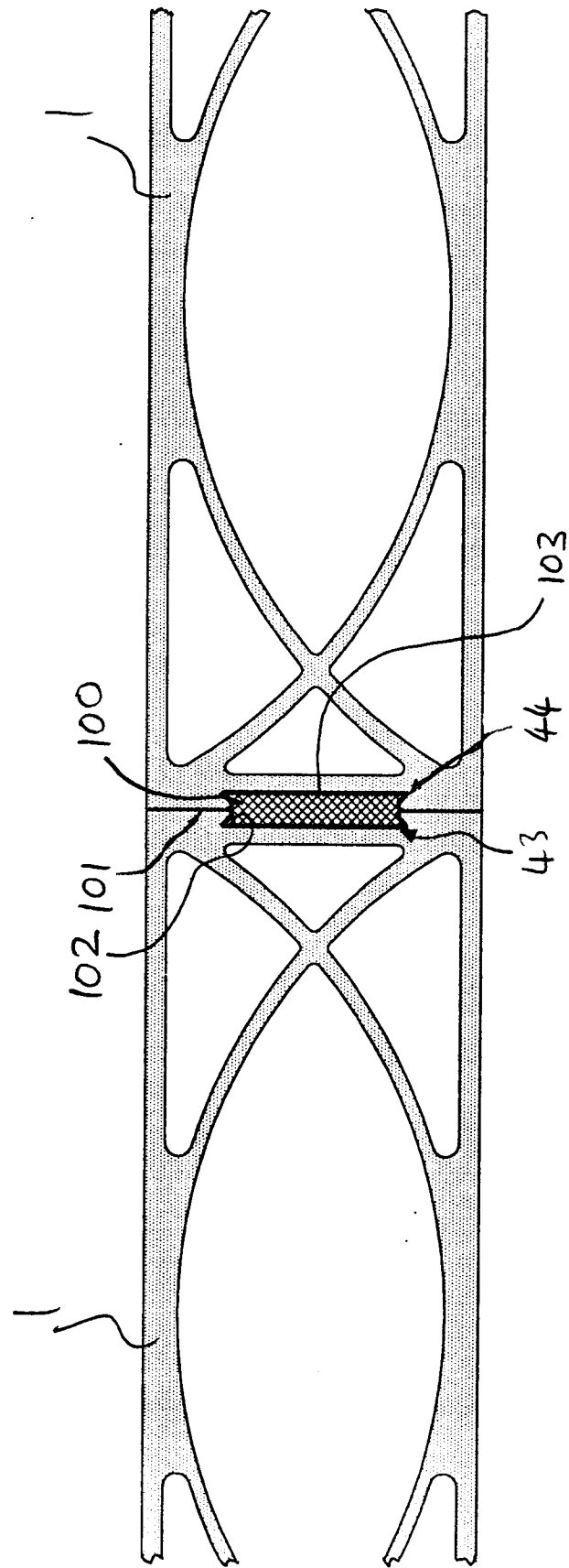


FIG. 10

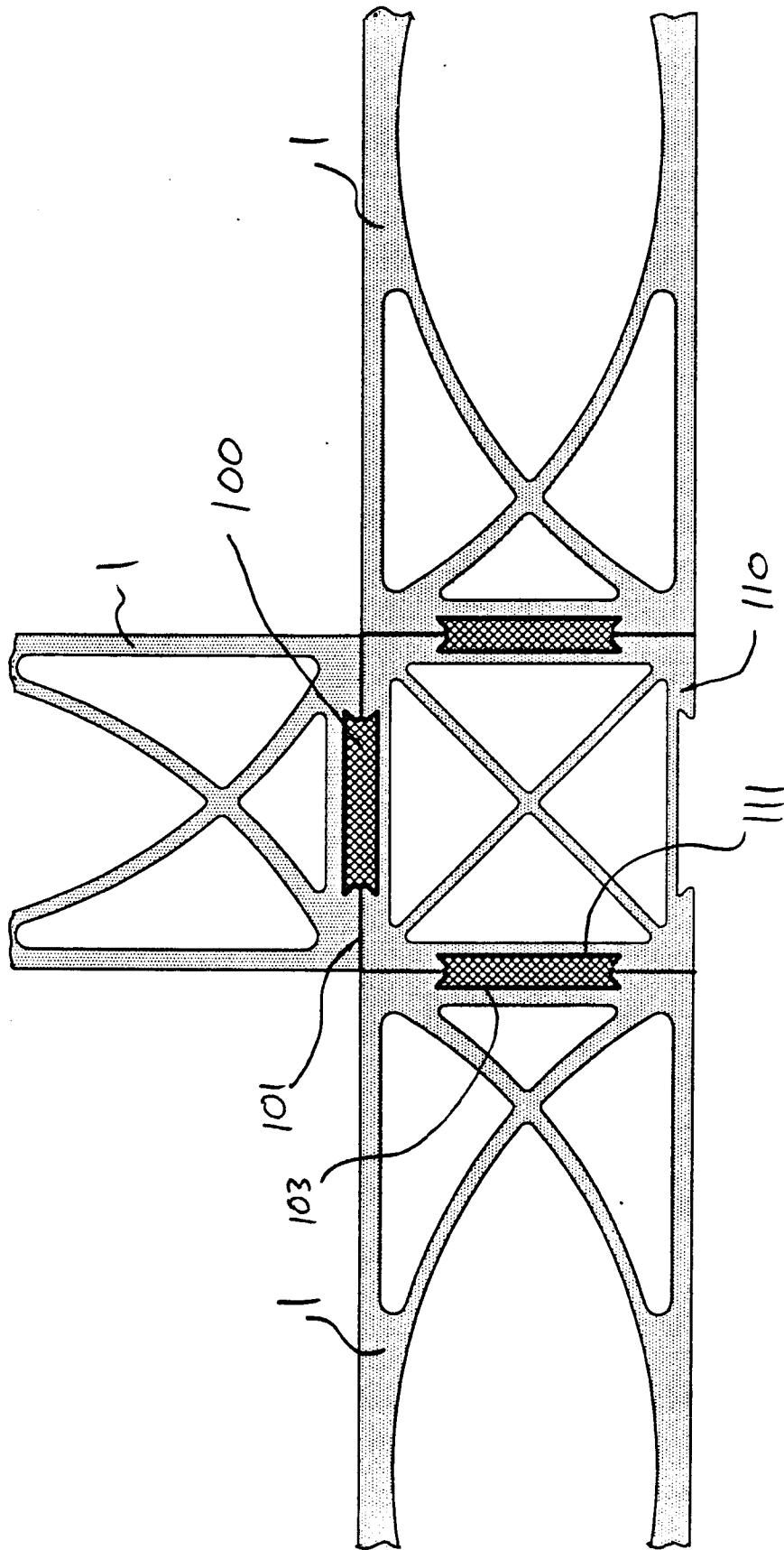


FIG. 11

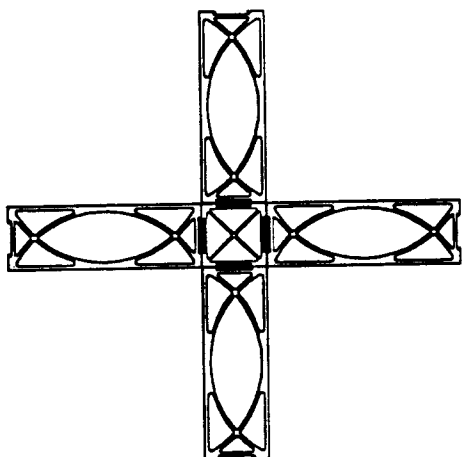


FIG. 12A

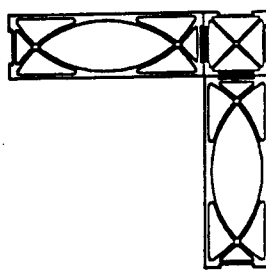


FIG. 12B

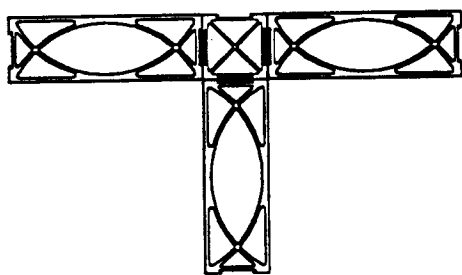


FIG. 12C



FIG. 12D

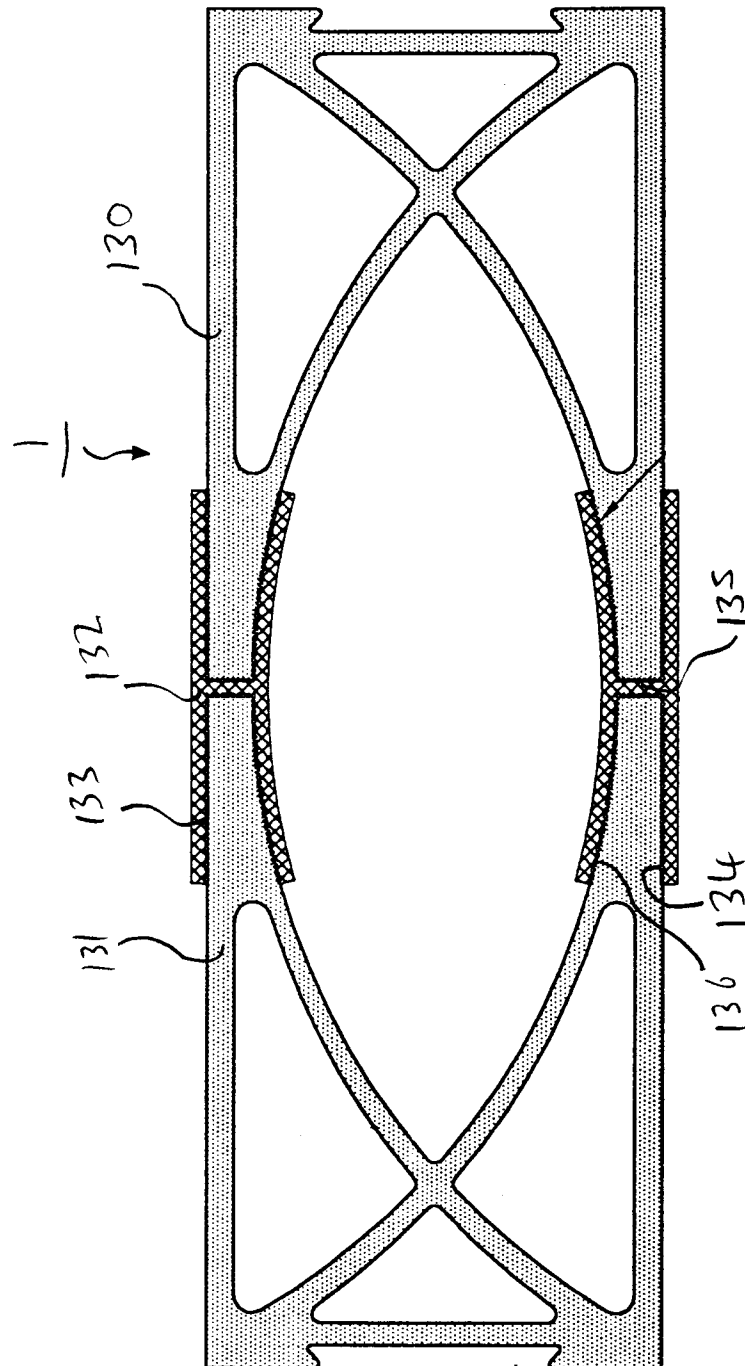


FIG. 13

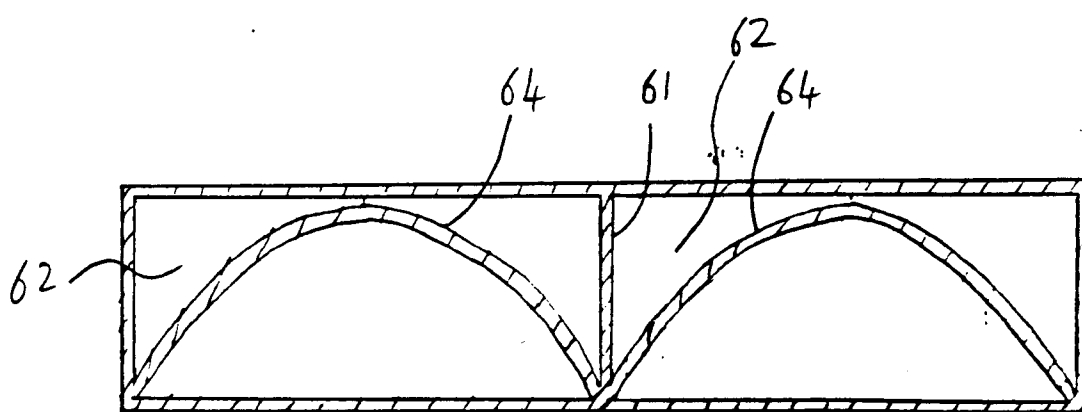


FIG. 14



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 1871

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Y		3,5,7-9, 13-15, 18,19	
A	* the whole document * ---	4	
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A	* column 3, line 10 - column 4, line 2; figures 4,5 * ---	1	
Y	DE-U-88 11 686 (MÖNCH KUNSTSTOFFTECHNIK)	5	
A	* claim 1; figures * ---	1-3	
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A	* page 18, line 4 - line 30; figures 2-5,7 *	1,10,13	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
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A	DE-A-19 65 272 (WOLFF & MÜLLER) * claims 1-3; figure 2 * ---	1-3,6	
	-/--		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 7 July 1995	Examiner Righetti, R
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			

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European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 1871

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.6)
A	DE-A-31 15 760 (O. A. BECKER) * figure 5 *	1,3,6	
A	DE-A-33 07 753 (EVERLITE A/S) * abstract; figures *	1-3	
A	GB-A-2 115 452 (CORFLEX INC.) * abstract; figures *	13,18	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 7 July 1995	Examiner Righetti, R
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p>			

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