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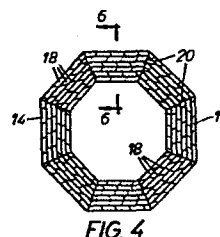
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54 Elongate structural members comprised of composite wood material.

57 An elongate structural member is constructed of a plurality of elongate panels (14) fixedly joined together to form a hollow assembly, each elongate panel (14) being comprised of a plurality of wood flakes intermixed with a binder and compressed, substantially all of the flakes being aligned generally parallel to the longitudinal axis of the elongate panel (14).



ELONGATE STRUCTURAL MEMBERS COMPRISED
OF COMPOSITE WOOD MATERIAL

The present invention relates to composite wood material and more particularly to the construction of elongate structural members such as utility poles, pilings, cross-ties and cross-arms from composite wood material. Such structural members can possess strength properties as good as or better than similar structures comprised of high-grade solid wood and can be manufactured at a cost making them competitive with such solid wood structures.

While comminuted wood materials have been found to be useful in other applications such as in the construction of panels or other planar structural wood products, the prior art does not suggest a suitable or commercially viable means for producing elongated structural members from such wood material.

According to the present invention there is provided an elongate structural member characterised in that it comprises a plurality of elongate panels fixedly joined together to form an elongate central cavity, said elongate panels each being comprised of a plurality of wood particles intermixed with a suitable binder and compressed to form a densified product.

In particular adjacent lateral edges of adjacent panels are adhesively bonded together.

In particular, the grain direction of the wood flakes extends parallel to their longitudinal axis, and substantially all of the elongate wood flakes are aligned substantially parallel to the longitudinal axis of the elongate structural member and define generally parallel planes.

One of the advantages of the invention is that it provides a source of wood poles or other elongate structural members independent of a supply of high strength solid wood.

Another of the advantages of the invention is that it can provide a suitable product at less cost. For example, it is estimated that a 40-foot (12.2 metres) utility pole produced in accordance of the invention may cost 30% less than a similar solid wood pole, and that the cost differentiation increases with the length of the pole required such that an eighty foot (24.4 metres) composite wood utility pole may cost 55% less than a similar solid wood pole.

A further advantage of the invention is that it permits use of wood species which are otherwise of little commercial value. Although solid wood of different species exhibits vastly different strength properties, it has been found that the composite wood material products of the invention and made from lower strength wood species are not necessarily weaker than those produced from stronger wood species. Accordingly, wood species which

would normally have little structural importance can be used advantageously.

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

Figure 1 is an elevation view of an elongate structural member according to the present invention;

Figure 2 is a perspective view of an elongate structural member comprising another embodiment of the present invention;

Figure 3 is an enlarged view of an end of the elongate structural member shown in Figure 2;

Figure 4 is a cross section view taken along line 4-4 in Figure 1;

Figure 5 is a longitudinal cross section through an elongate structural member as shown in Figure 1 and comprised of laminated sections;

Figure 6 is an enlarged perspective view of a cross-section of the laminated composite wood material comprising the elongate structural member of Figure 1;

Figure 7 is a view similar to Figure 5 but shows an elongate structural member having an alternative

configuration;

Figure 8 is a view similar to Figure 6 but illustrating composite wood material comprising the elongate structural member of Figure 7;

Figures 9-11 are cross sectional views of elongate structural members as in Figure 4 but illustrating alternative constructions;

Figure 12 is a view similar to Figure 7 but showing another alternative embodiment of an elongate structural member according to the invention, and

Figure 13 is a view similar to Figure 5 but showing another alternative embodiment of an elongate structural member according to the invention.

The example illustrated in Figure 1 is an elongate structural member 10 comprised of composite wood material and defining an elongate hollow tapered pole of the type used as a utility pole, piling, or in another similar application.

The elongate structural member 10 is constructed of a plurality of elongate component panels 14, the panels 14 being comprised of composite wood material. In the specific construction shown in Figures 4-6, the panels 14 are illustrated as each being comprised of a plurality of planar layers 18 of composite wood material laminated

together, the layers 18 being secured together by an interface adhesive. The panels 14 so formed are mitered or otherwise cut to shape and combined to form a composite wood pole. In the illustrated construction, the respective elongate lateral edges 20 of the panels 14 are joined together by an interface adhesive to thereby join the panels 14 in an octagonal shape as illustrated in Figure 4.

The construction of the composite wood pole 10 is further shown in Figure 5, wherein the panels 14 are shown as being comprised of a plurality of planar composite wood material layers 18 of successively increasing lengths such that the thickness of each of the panels 14 tapers from the base portion of the pole 10 toward the upper end of the pole, the portions of the elongate panels 14 at the base portion of the illustrated pole 10 having a thickness of six layers 18 of composite material and the upper portions of the panels 14 being comprised of a single layer 18 of composite wood material.

Referring more specifically to the material composition of the layers 18 of the panels 14, in the preferred embodiment of the invention, they are comprised of composite wood material formed from wood flakes 22 (Figure 6) intermixed with a suitable binder material and compressed in a suitable press. In particular, the compressed product is formed by constructing a loosely felted mat of wood flakes having been mixed with a binder material and may be constructed using the operating

conditions used in the manufacture of conventional particle board. More particularly, the mat is formed by disposing the wood flakes 22 such that the planes of the flakes 22 are generally parallel to the plane of the mat and with substantially all of the flakes being aligned as illustrated in Figure 6 such that the longitudinal axes of the flakes are generally parallel to the longitudinal axis of the elongate structural component to be formed.

In a preferred form of the invention, at least 90% of the wood flakes 22 are to be aligned so as to be parallel to the longitudinal axis of the elongate panel 14 or the layer 18 being formed. The flakes 22 each have a grain direction extending generally parallel to the longitudinal axis of the flakes. Alignment of the flakes thus results in alignment of the wood grain of the flakes with the longitudinal axis of the structural member or pole 10 in a manner similar to a solid wood pole. In fact, the pole 10 may have a more uniform grain direction than that of a solid wood pole, since such wood has innate grain inconsistencies such as knots and the like.

Wood flakes 22 of the type forming the layers 18 are conveniently formed using a conventional ring flaker or a round wood flaker to commutate small logs, branches, or rough pulp wood and form suitably shaped flakes 22.

In the production of the elongated panels 14, it is preferred that the wood flakes 22 have a length of from 0.5 to 3.5 inches (1.27 to 8.89 cms), a width of 0.1 to

0.5 inches (0.25 to 1.27 cms), and a thickness of 0.01 to 0.05 inches (0.025 to 0.127 cms). Additionally it is preferred that the ratio of the average length of the flakes to the average width of the flakes be from about 4:1 to about 10:1. An example of a convenient flake geometry is the use of flakes having a length of approximately 1.6 inches (4.06 cms), a thickness of approximately 0.02 inches (0.05 cms) and a width of 0.2 to 0.5 inches (0.5 to 1.27 cms).

A convenient binder for use in the manufacture of the panels 14 can comprise phenol-formaldehyde or an isocyanate adhesive. It has been found that an 8% resin solids composition of such binder, based on oven-dry flake weight gives satisfactory strength properties to the resultant elongate structure. To maximize coverage of the flakes, the binder may be applied by spraying droplets of the binder in liquid form on to the flakes.

To preserve the elongate structural members from decay due to decay fungi and insects it is also desirable to further include a suitable fungicide in the composite wood mat. Accordingly, the wood flakes may also be treated or mixed with a suitable biocide. Such suitable biocides include pentachlorophenol, creosote, chromated copper arsenate and ammoniacal copper arsenate.

While the elongate pole 10 is shown as having an octagonal cross-sectional configuration, it should be understood that the pole could alternatively have a

circular cross-sectional configuration as illustrated in Figure 9 or a hexagonal cross-sectional configuration as shown in Figure 10. A circular configuration could be produced by constructing the pole from a plurality of elongate panels 30, each of the panels 30 being formed to have an arcuate cross-sectional configuration. The panels 30 could then be arranged such that their edges could be adhesively joined to adjacent edges of adjacent similar panels 30, the panels thus forming an elongate central cavity.

While the respective panels 14 of the elongate pole 10 are conveniently fixedly joined together by any high strength adhesive such as resorcinol, an isocyanate adhesive, or other adhesives suitable for bonding wood products, it is contemplated that the panels 14 could also be joined together by splines 32 as illustrated in Figure 11 or by a combination of splines 32 and an adhesive.

Figure 7 illustrates another alternative embodiment of an elongate structural member 34 constructed in accordance with the present invention. The elongate structural member or pole 34 shown therein is constructed in the same manner as the elongate structural member 10 shown in Figures 1 and 4-5 except that the elongate panels 36 of the pole 34 are monolithic one-piece composite wood panels rather than laminated panels 14. As illustrated in Figure 8, the elongate panels 36 forming the elongate pole 34 are similar to panels 14 in that they are comprised of composite wood material formed of elongate wood flakes 22

defining parallel planes and having longitudinal axes generally parallel to the longitudinal axes of the panels 36. The elongate pole 34 further includes a plurality of longitudinally spaced apart rigid planar octagonal diaphragms 38 housed in the elongate central cavity 39 of the pole 34 and intended to increase the strength of the pole. While the octagonal diaphragms 38 could be comprised of a plurality of materials, in a preferred form of the invention, the octagonal diaphragms 38 are comprised of composite wood material such as that comprising the panels 36.

Illustrated in Figure 2 is another alternative embodiment of an elongate structural member embodying the invention. The elongate structural member 40 shown therein comprises a hollow elongate cross arm of the type commonly employed with utility poles and used to support telephone lines or power lines. More particularly, the cross beam 40 is comprised of four planar elongate panels 42 each comprised of composite wood material produced in the manner described above. The elongate panels 42 are arranged in the manner shown in cross section in Figure 3 and are fixedly joined together by a suitable interface adhesive 44 of the type previously described. It should be understood that the panels 42 could also be secured together by other suitable joining means.

As in the case of the elongate hollow pole shown in Figures 1 and 4-6, the elongate panels 42 of the structural member 40 are comprised of elongate wood flakes

aligned such that substantially all of the flakes are positioned with their longitudinal axis generally parallel to the longitudinal axis of the elongate panels and with the flakes oriented so as to define planes substantially parallel to the plane of the elongate panel defined by the flakes.

Figure 12 illustrates a further alternative embodiment of an elongate structural member according to the invention, the elongate structural member 50 shown therein being comprised of a plurality of longitudinal sections 52, 54 and 56 mutually arranged in telescoping relationship. Each of the telescoping sections 52, 54 and 56 is comprised of a plurality of elongate panels 58, the panels 58 being fixedly joined together in such a manner as to form an elongate central cavity. The panels 58 are also comprised of elongate wood flakes aligned such that substantially all of the flakes of the panels are positioned with their longitudinal axis generally parallel to the longitudinal axis of the elongate panels and the longitudinal axis of the elongate structural member 50.

Figure 13 illustrates a further alternative embodiment of an elongate structural member according to the invention, similar to that of Figure 5 but which includes means for providing structural reinforcement for the panels 14 forming the pole and for further bonding the panels 14 together. This means comprises a foam material 24 poured or injected into the central elongate cavity 26 formed by the panels, the foam material 24 filling at

least a portion of the elongate cavity 26. In a preferred form of the invention, the foam material 24 can conveniently comprise a foam-in-place rigid polyurethane

foam which can be poured into the elongate central cavity 26 as a pourable liquid and which will then foam so as to form a rigid core filling the pole. The rigidity of the polyurethane foam core provides structural support for the elongate structure formed by the panels 14, and the polyurethane foam will also form an adhesive bond with the inner planar surfaces 28 of the panels 14 and will thus act as an additional means for bonding the panels 14 together and for preventing them from separating. An example of a suitable polyurethane foam is BAYTHERM 851 produced by Mobay Chemical Corporation of Pittsburgh, Pennsylvania. As is conventional, the polyurethane foam is made by mixing two liquid components, whereupon the liquid material foams and cures at room temperature to form a rigid foam 24. While the density of the resultant rigid polyurethane foam can be varied in a conventional manner by varying the quantities of the two components combined, it has been found that a suitable density is 2lbs/ft³ (32 kg/m³). On the other hand, the rigidity of the foam and the reinforcing strength of the foam can be increased by increasing the density of the foam used. For example, a pole having increased strength may be produced by employing foam having a density of 5lbs/ft³ (80 kg/m³), but the expense of the pole increases due to the increase in the amount of foam material used.

One of the features of the employment of polyurethane

foam material in the elongate cavity 26 is that it has a closed cell structure and thereby does not readily absorb moisture and provides an effective barrier to movement of moisture in the pole interior.

While the rigid foam material 24 has been described as comprising polyurethane, in other embodiments, the foam material could comprise other suitable foam-in-place materials. It is preferred, however, that the material have the properties of inhibiting the movement of moisture into the pole, and that it so form a bond with the panels to thereby provide structural rigidity or reinforcement to the pole. It is also preferred that the foam material be a rigid foam rather than a flexible foam so that the rigid foam provides structural support for the pole. In a preferred form of the invention it is also desirable that the foam material selected have the property of curing at room temperature. Though other foam materials can be used, manufacturing costs can be reduced if heating of the foam material to effect curing can be avoided. In other alternative forms, filler materials such as wood chips, saw dust, wood strands or the like could also be mixed into the liquid material poured into the cavity 26 to form the rigid foam.

While in the illustrated embodiment the foam material fills only the upper and lower ends of the elongated central cavity, in other arrangements the foam material could fill the entire central elongated cavity 26. In the illustrated construction, foam material 24 in the

lower end of the pole 10 will be particularly effective for inhibiting movement of moisture into the pole. The foam material 24 in the upper end of the pole 10 provides reinforcement of that end of the pole which is intended to support utility pole cross-arms or the like.

As in the case of the elongate pole 10, means can also be provided for filling at least a portion of the elongate central cavity 46 of the cross-arm, the means for filling also functioning to provide structure reinforcement or support for the elongate panels 42 forming the cross-arm and to provide means for further bonding the panels 42 together. The means for filling includes a rigid foam material 48 which can be poured or injected into the central elongate cavity 46 defined by the elongate panels. It is preferred that the foam material 48 have the property of forming an adhesive bond with the internal surfaces 50 of the panels as previously described so that the internal foam material 48 will bond the panels together. As previously described, one preferred foam material having this property and also providing structural rigidity is a rigid polyurethane foam.

The rigid foam material is placed in the cross-arm by positioning the cross-arm vertically, whereupon the polyurethane foam can be poured in its liquid state into the cross-arm. This material will then foam-in-place to fill the elongate central cavity of the cross-arm and will cure to form a rigid core for the cross-arm. The

polyurethane could also be injected into the cavity 46
using a conventional foam injection nozzle arrangement.

CLAIMS

1. An elongate structural member characterised in that it comprises a plurality of elongate panels fixedly joined together to form an elongate central cavity, said elongate panels each being comprised of a plurality of wood particles intermixed with a suitable binder and compressed to form a densified product.
2. An elongate structural member according to claim 1 characterised in that the longitudinal edges of adjacent panels are adhesively bonded together in abutting relationship.
3. An elongate structural member according to claim 1 or claim 2 characterised in that said elongate panels are planar and wherein the faces forming the longitudinal edges of the elongate planar panels are inclined to each other.
4. An elongate structural member according to any preceding claim characterised in that said wood particles comprise elongate wood flakes each having a longitudinal axis, the grain direction of said wood flakes being aligned substantially parallel with said longitudinal axis of the wood flakes, and wherein a substantial majority of said wood flakes are longitudinally aligned substantially parallel to the longitudinal axis of said elongate structural member.

5. An elongate structural member according to any preceding claim characterised in that said wood flakes have an average length of 0.5 inches to 3.5 inches (1.27 to 8.89 cms), an average width of 0.1 to 0.5 inches (0.25 to 1.27 cms), and an average thickness of 0.01 to 0.05 inches (0.025 to 0.127 cms).

6. An elongate structural member according to any preceding claim characterised in that said binder comprises an organic polyisocyanate having at least two active isocyanate groups per molecule.

7. An elongate structural member according to any preceding claim characterised in that substantially all of said elongate wood flakes are aligned substantially parallel to the longitudinal axis of the elongate structural member, said wood flakes each being generally planar and defining substantially parallel planes.

8. An elongate structural member according to any preceding claim characterised in that each of said plurality of elongate panels is comprised of a plurality of planar layers of composite wood material laminated together, each planar layer being comprised of elongate wood flakes intermixed with a binder and compressed.

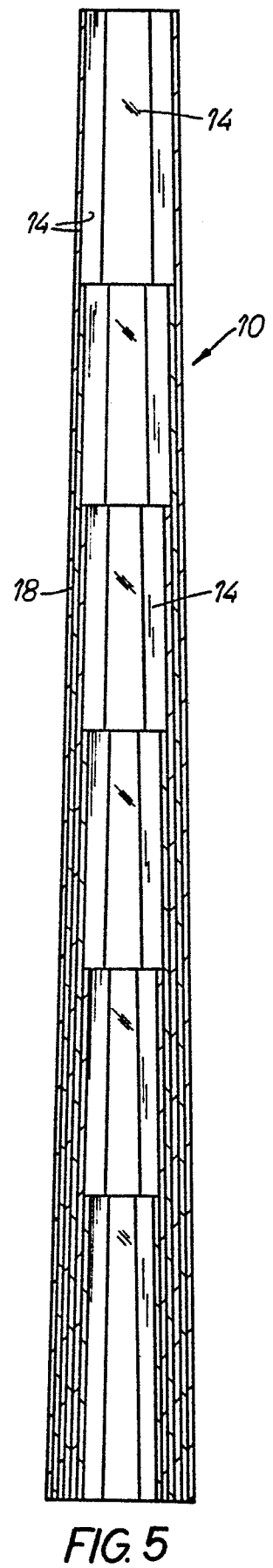
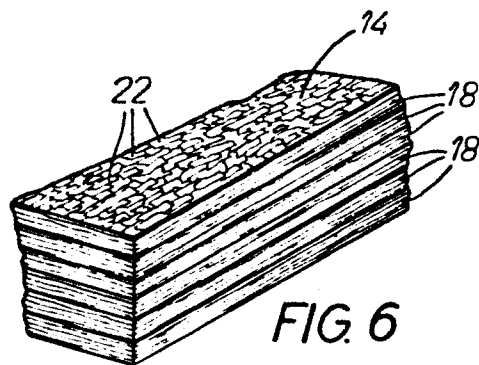
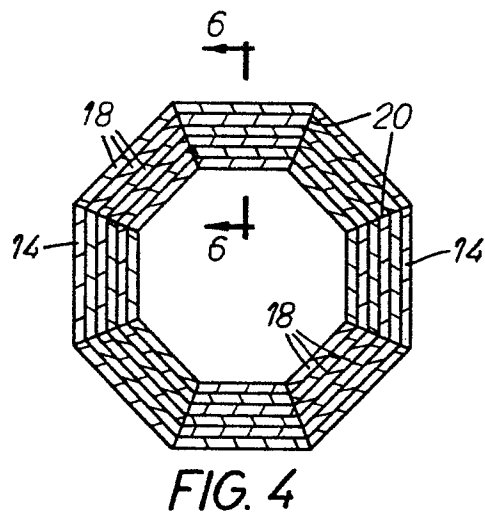
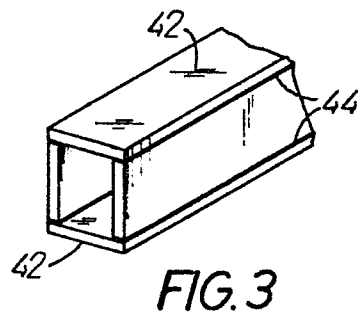
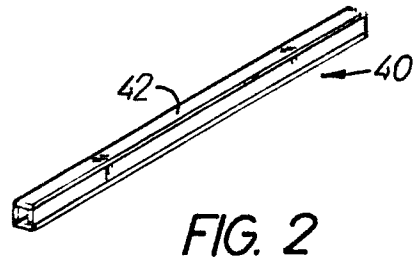
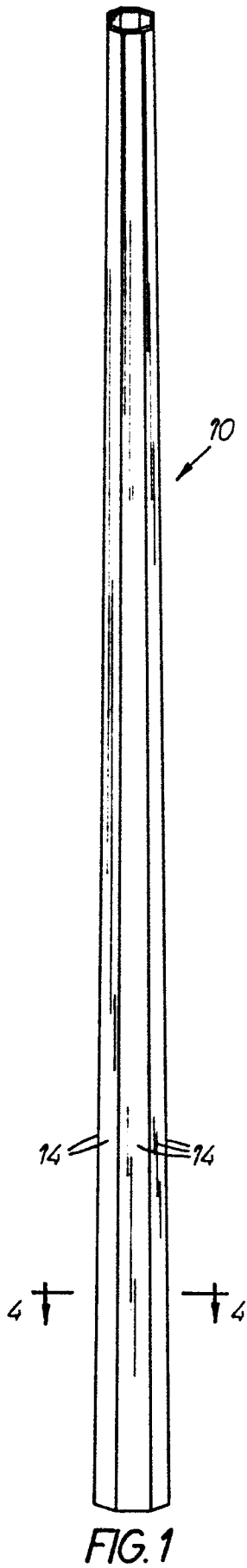
9. An elongate structural member according to any preceding claim characterised in that said elongate panels have a tapered thickness, the thickness of one end of each of said elongate panels being greater at one end of said

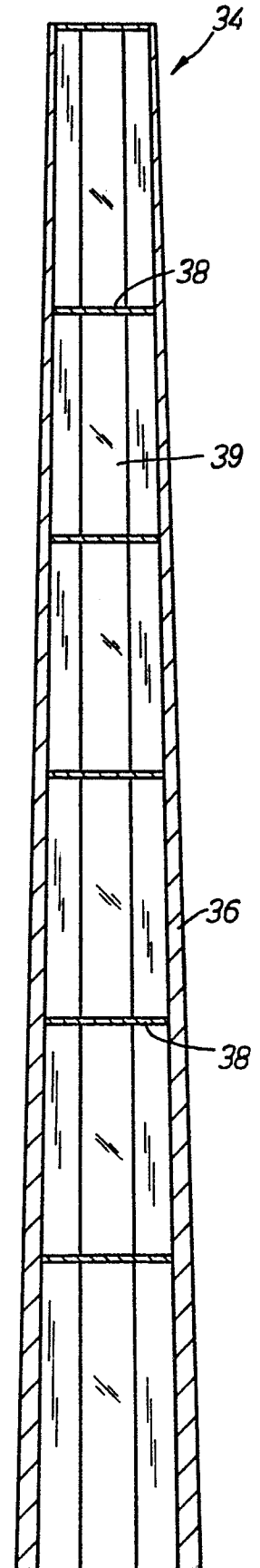
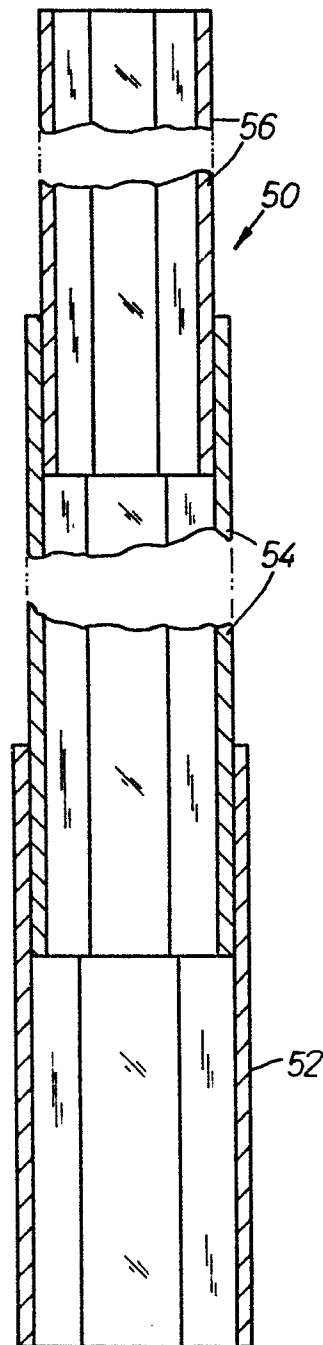
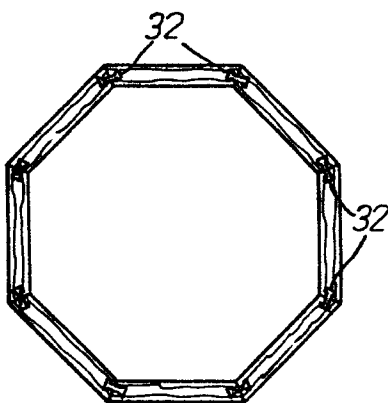
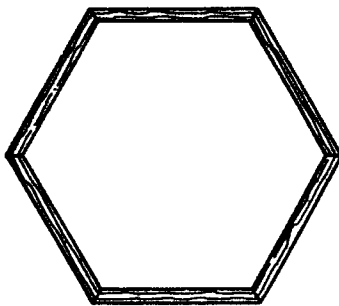
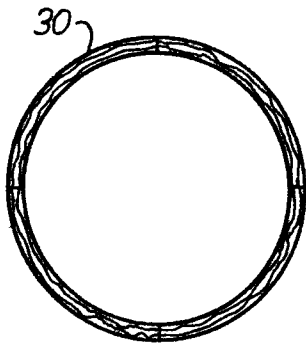
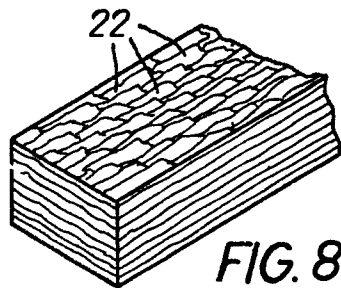
member than the thickness of said panels at the opposite end of said member.

10. An elongate structural member according to any preceding claim characterised in that it is formed longitudinally of sections which are secured together in a telescopic relationship.

11. An elongate structural member according to any preceding claim characterised by means for reinforcing said elongate structure member, said reinforcing means comprising a rigid foam material filling at least a portion of said elongate central cavity, said rigid foam material being bonded to the inwardly facing surfaces of said panels.

12. An elongate structural member according to claim 11 characterised in that said rigid foam material comprises rigid polyurethane foam.





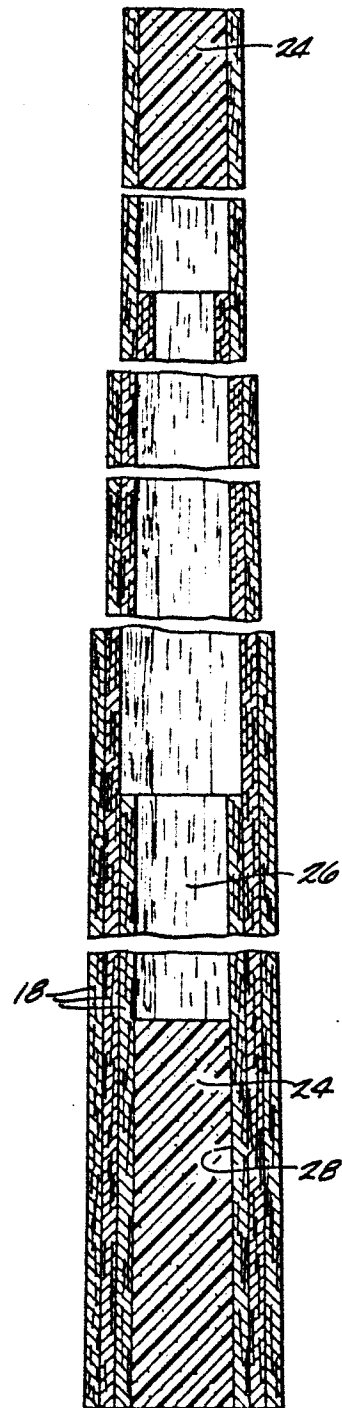


Fig 13



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. ³)
Y	--- WO-A-8 002 709 (BERGE) * page 2, lines 13-35; page 4, line 8 - page 5, line 24; figures 1-4 *	1-3, 8, 9	E 04 C 3/36 E 04 H 12/04 E 04 C 3/29
Y	--- US-A-3 956 555 (McKEAN) * Column 2, lines 6-15, 27-37, 57-61; column 4, lines 22-49; column 6, lines 15-21; figures 1, 2 *	1, 3, 4, 8, 9	
A	--- DE-A-3 010 141 (BISON ELEMENT BÄHRE) * Page 5, lines 23-30; page 6, lines 6-27; page 9, lines 25-29; figure 3 *	1, 2, 4, 6-8	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	--- FR-A-2 348 345 (ETABLISSEMENTS PAUL CHAMBRIARD) * Page 1, lines 1-23; page 2, lines 1-25, 32-34; figures 1-3 *	1-3, 8, 9	E 04 C E 04 H B 29 J
A	--- US-A-2 824 342 (HOYLE) * Column 3, line 27 - column 5, line 12; figures 1-5 *	1, 2, 11	
A	--- DE-C- 950 237 (GEWECKE) * Page 2, lines 1-54; figure 1 * --- -/-	1, 9	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 03-02-1983	Examiner SPIEGEL R.P.
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			



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. 3)
A	US-A-4 255 477 (HOLMAN) * Column 4, lines 32-49; figures 1,2,9,11 *	5	
A	DE-C- 867 907 (PÖLNITZ) * Page 2, lines 1-34; figure 1 *	10	
A	WO-A-8 100 585 (ÖBRINK) * Page 3, lines 1-29; figures 1-3 *	11,12	
A	FR-A-2 479 877 (SCIRERIE ROGER GOLAY SA) * Page 2, lines 5-26; figures 1-4 *	11,12	
E	EP-A-0 062 139 (BOARD OF CONTROL OF MICHIGAN TECHNOLOGICAL UNIVERSITY) * Whole document *	1-8,11,12	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
A	GB-A- 745 540 (EBDON)		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 03-02-1983	Examiner SPIEGEL R.P.
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			