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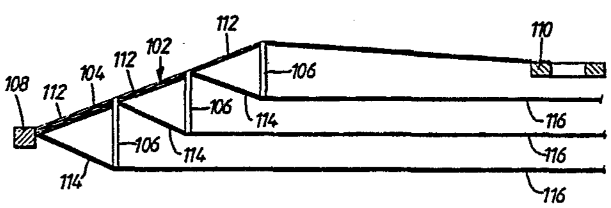
(54) **Roof structure.**

(57) A cable truss dome is constructed from a plurality of cables (104) under tension and compression members (106) arranged in triangles having non-common sides. The cable truss dome is adapted for spanning large areas where the cables form a low shallow arch which supports a flexible membrane as a covering. The triangles are kept in tension by lower tension members attached to the lower ends of the compression members (106), which may consist either of concentric rings (116, Fig. 2) or radial chords (152, Fig. 16).



ROOF STRUCTURE

The present invention relates to a roof structure constructed of tension members and compression members and suitable for spanning delineated areas of various size for providing a protective roof thereover for stadiums, arenas, and the like.

In recent years, dome and roof structures have been constructed of light weight membranes in order to achieve lower cost and to improve their performance. These structures have been constructed of either synclastic surfaces held-up and stiffened by air pressure or anticlastic surfaces formed by ridged arches, masts, and/or cables against which the membrane has been pre-stressed. The synclastic surface may have a low aspect ratio, that is, the ratio of surface area to delineated plan area. The resulting low aspect ratio has an important advantage for permanent membrane roofs, such as low profile air structures, since the membrane cost is as much as 70% of the roof cost, the balance being cables, clamps, and compression ring. However, the disadvantage of the air structure has been its dependence on mechanical systems for keeping the roof up and the resulting requirement for providing air tight buildings, snow melting systems, emergency generators, revolving doors, and the like. On the other hand, the anticlastic surface has a very high aspect ratio resulting in higher roof costs per unit of delineated plan area. For example, those anticlastic surfaces employing masts and cables have high aspect ratios in order to provide sufficiently low membrane stress, while those utilizing arches have high aspect ratios due to design considerations such as arch buckling.

In addition to the foregoing problems encountered with regard to the use of light weight membranes consisting of either synclastic or anticlastic surfaces, there has been a problem with roof insulation. Previous attempts to incorporate insulation in air supported roofs have required the installation of snow melting systems separate and apart from the interior heating system so as to prevent condensation of moisture on the upper covering membrane thereby impairing the insulation value of the insulation. In addition, it has been necessary to pressurize the insulation space to pressures higher than the interior pressure of the enclosed delineated area in order to prevent the collapse of the insulation. Further difficulties are often encountered in erecting structures constructed of continuous flexible elements such as cables with discontinuous stiff elements such as compression struts as they generally do not have the required stiffness except in their complete assembled condition.

There is therefore a need for a tension structural system, such as a cable truss dome, which is suitable for spanning large areas where the tension elements support a light weight membrane, which provides a low aspect ratio eliminating the need for supporting air pressure, and which can be erected easily.

The invention provides a roof structure for spanning a delineated area, said structure comprising support members spanning said delineated area for supporting a roof thereon, characterised in that said support members comprise tension members and compression members said tension members forming top chords spanning a portion of said delineated area and diagonal chords extending therefrom, said compression members attached between said top chords and said diagonal chords, and lower tension members connected to the bottom of said compression members.

According to a further aspect, the invention provides a method of erecting a roof structure comprising tension members and compression members for spanning a delineated area, said method comprising the steps of spanning said delineated area with said tension members, attaching one end of said compression members to said tension members at predetermined locations, attaching the other end of said compression members to said tension members to form diagonal chords therefrom, and tensioning said tension members spanning said delineated area to form said roof structure.

The roof structure preferably comprises a flexible membrane as the roof, held down on the support members by means of tensioning means such as valley cables extending between adjacent support members. This has the advantage of resisting wind-induced uplift forces which sometimes exceed the deadweight of the roof structure.

In order that the invention may be better understood, two preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, wherein:-

Fig. 1 is a top plan view showing a roof structure according to a first embodiment of the invention, constructed of a cable truss dome including a plurality of radially-arranged arched support members and a plurality of concentric tension rings, and including valley cables radially disposed between adjacent arched support members;

Fig. 2 is a partial side elevation of one of the arched support members of Figure 1, constructed of a plurality of tension members in the form of cables to provide upper tension chords and diagonal tension chords, and compression members in the form of vertical struts arranged between the upper chords and diagonal chords;

Fig 3 is a partial top plan view of a tension ring at the centre of the structure of Figure 1, having a plurality of arched support members attached thereto and extending radially outward therefrom along with the adjacent valley cables;

Fig. 4 is a partial side elevation of the tension ring of Fig. 3;

Fig. 5 is a partial side elevation of the top of a compression member in the form of a strut and attached to adjacent upper tension chords by means of a hanger;

Fig. 6 is a partial front elevation of the compression member and hanger used during construction as shown in Fig. 5;

Fig. 7 is a top plan view in cross-section of the compression member as shown in Fig. 5 and further showing a platform supported by a plurality of tension rings at the bottom of the compression member;

Fig. 8 is a partial side elevation of the bottom of the compression member and platform as shown in Fig. 7;

Figs 9 to 15 are illustrations showing the erection sequence for the roof structure of Figures 1 to 8;

Fig. 16 is a partial side elevation of a cable truss in accordance with a second embodiment of the present invention, constructed of tension members and compression members, wherein the tension members form both upper and lower tension chords, and diagonal chords extending therebetween; and

Fig. 17 is a partial side elevation of the compression members shown in Fig. 16 connected between the upper and lower tension chords by a bracket.

Referring now to the drawings wherein like reference numerals represent like elements, Fig. 1 is a plan view of a roof structure 100 in the form of a cable truss dome. The cable truss dome 100 forms an undulating supporting surface and is constructed of a plurality of arched support members 102 arranged radially to a delineated area thereby to form a dome covering a space such as a stadium or arena. As shown in Fig. 2, the support members 102 are constructed of a plurality of stranded cables 104 constituting a single, compound tension member and a plurality of rigid struts 106 forming compression members. The cables 104 are attached to a continuous compression ring 108 which is arranged to circumscribe the delineated area to be covered. The compression ring 108 acts as a foundation to the roof structure, and consists of several chords joined end-to-end. Alternatively, the cables 104 may be secured to a plurality of individual anchorage blocks (not shown) buried in the ground at locations spaced around the perimeter of the delineated area. As shown in Fig. 1, the compression ring 108 can be constructed as a portion of the perimeter wall defining the stadium or arena to be covered. The cables 104 extend radially from the compression ring 108 overlying a portion of the delineated area. Some cables 104 have their other inner ends secured to a central tension ring 110; others have their inner ends secured to the top or bottom of struts 106, as shown in greater detail in Figs. 3 and 4.

Cables 104 extending from the compression ring 108 to the central tension ring 110 form upper tension chords 112 or ridge cables of the support members 102. On the other hand, a number of these cables 104 initiating from the compression ring 108 diverge from the upper chords and constitute diagonal tension chords 114 extending downwardly at an angle from successive predetermined locations along the support members 102. As best shown in Fig. 2, a plurality of cables 104 are secured to the compression ring 108 and extend radially towards the tension ring 110. At a first outermost, predetermined location, a number (one or more) of cables 104 are peeled away from the remaining cables and are arranged extending downwardly from those remaining cables forming the upper tension chord 112, to provide a first diagonal tension chord 114. Similarly, at the next successive predetermined location, a number of cables 104 are again peeled away from the remaining cables 104 and extend at an angle downwardly from those remaining cables forming the next upper chord 112 to provide the next diagonal chord 114. The upper chords 112 and underlying diagonal chords 114 form two adjacent sides of a triangle. Struts 106 are connected between the upper chords 112 and diagonal chords 114 to complete the third side of each triangle by means of the structure shown in Figs. 5 through 8, to be described hereinafter. These triangles are arranged in a substantially vertical orientation lying within a common plane. Each support member 102 comprises a discrete series of such triangles each connected to one or two neighbouring triangles only at respective vertices, so that the triangles do not share common sides. In this manner, the strut 106 of one triangle has its upper end attached to the cables 104 at the intersection of the upper chord 112 and diagonal chord 114 of an adjacent triangle nearer the centre of the structure. Thus, the number of cables 104 forming successive upper chords 112 successively decreases towards the centre of the structure, as a corresponding number of these cables are peeled away to provide the diagonal chords 114. The number of cables 104 contained within each diagonal chord 114 is preferably the same, although it may vary.

To complete the support members 102, and maintain the diagonal chords in tension, a plurality of concentric tension rings 116 each constructed of stranded cables 118 are secured to the lower ends of corresponding struts 106 of adjacent support members 102 as best shown in Figs. 7 and 8.

Overlying the support members 102 is a flexible membrane 120 serving as a roof over the delineated area. The membrane 120 may be formed of a woven synthetic fabric, although it is contemplated that other materials such as canvas or thin metallic formed membranes may also be utilized. The membrane 120 is constructed to be weather resistant and preferably of a non-combustible composition. Coated fabrics may be employed for the membrane 120 such as Teflon (Registered Trade Mark) coated glass fibre, silicon-coated glass fibre, silicon-coated polyester, and the like. In addition, the membrane 120 can be translucent to allow light into the enclosed volume, and may be adapted to provide good acoustic properties. A plurality of valley cables 122 are positioned between adjacent support members 102 and extend between the compression ring 108 and tension ring 110. The flexible membrane 120 is maintained under tension by prestressing the valley cables 122, for example, as disclosed in U.S. Patent No. 3,807,421. That portion of the flexible membrane 120 extending in V-shaped cross-section between adjacent support members 102 can be in the form of rectangles, trapezoids, triangles, wedge shapes, and the like. In this regard, the flexible membrane 120 can be constructed of a plurality of triangular shaped panels radiating outwardly from the central tension ring 110 such that the joints between adjacent panels can be continuously heat-sealed or adhered in place during field installation so that there are no joints intersecting with those of adjacent panels.

Turning now to Figs. 5 and 6, each strut 106 is attached to the cables 104 at a predetermined location by means of a hanger 124. The upper end of the hanger 124 is provided with a pivotable U-shaped bracket 126 through which the cables 104 extend. To secure the bracket 126 to the cables 104, a number of cables may be terminated and secured to the hanger by means of a fixture 128. As previously noted, a number of cables 104 extend through the U-shaped bracket 126 and are displaced at an angle downwards to provide the diagonal chords 114. In addition, supplemental diagonal chords 114' may be employed by securing same between the hanger 124 and the lower end of an adjacent strut 106 as shown. Bracing between adjacent support members 102 is not required due to the fact that the cables 104 forming the upper chords 112 and diagonal chords 114 are under tension. However, trussing or cross-bracing between adjacent support members 102 can be provided for the purpose of load redistribution and facilitating the erection of the cable truss dome 100. In this regard, the trussing or bracing can be achieved by providing cross-bracing in the form of diagonal cables 130 secured between corresponding struts 106 of adjacent support members 102. In particular, the diagonal cables 130 are secured at one end to the hangers 124 and attached at their other ends to the lower ends of corresponding struts 106, as shown in Figs. 7 and 8. Although the diagonal cables 130 are shown seven in number, it is expected that only two or three such diagonal cables would be required. To facilitate load redistribution, these diagonal cables are clamped at their crossing point.

The cables 104 continuing through the hangers 124 within a support member 102 are secured to the central tension ring 110 in the manner shown in Figs. 3 and 4. In addition, the valley cables 122 are also secured to the central tension ring 110 between adjacent cables 104. Thus, the support members 102 have one end attached to the tension ring 110 and extend radially outward therefrom, while having their other ends attached to the compression ring 108. The lower ends of the struts 106 are provided with a support 132 arranged generally transverse to the strut and extending outwardly along the direction of the support members 102. The support 132 is adapted for securing the cables 118 of the individual concentric tension rings 116 thereto. A platform 134 is disposed overlying the cables 118 to provide a catwalk for maintenance and installation personnel. The platform 134 overlies the concentric tension rings 116 between adjacent struts 106, and a safety handrail 136 is provided on either side of the platform.

As thus far described, the cable truss dome 100 incorporates a structural system that uses trusses that have upper chords 112 made of tension members comprising a plurality of prestressed cables 104. The cables 104 are anchored to the compression ring 108 or buried anchorage blocks (not shown). The diagonal chords 114 are discontinuous from one another, are attached to the nested, concentric tension rings 116. As the cable truss dome 100 is a tension dome and dome buckling is not a problem, the rise of the dome can be made as shallow as possible consistent with water drainage and the functions required of the enclosed space. Thus the aspect ratio, i.e. the ratio of dome surface area to delineated plan area, can be made a minimum. The anticlastic membrane surface can be prestressed by the valley cables 122 that pull the flexible membrane 120 down against the upper chords 112 of each of the support members 102. With the upper chords 112, diagonal chords 114, and tension rings 116 constructed of cables prestressed to a perimeter restraining system, i.e. the compression ring 108, these elements can be combined with rigid elements such as beams or trusses in such a manner so as to impart additional stiffness to these elements without introducing compression forces.

The uniqueness of the cable truss dome 100 is demonstrated by the fact that it is not triangulated. The rigidity of a triangular structure is not required of the cables truss dome 100 as structural roof membranes, i.e., architectural fabrics, permit the membrane to act as both a deck and a weathering membrane. This membrane, if properly shaped and prestressed, can accommodate the large displacements of a structural system that is not triangulated. Thus, non-linear large displacement structural analysis is possible using digital computers. In addition, the cable truss dome 100 can be formed with either circular or non-circular plan configurations based on skewed symmetric principles, for example as in U.S. Patent No. 3,841,038. As previously noted, the prestressed flexible membrane 120 covering the cable truss dome 100 has shallow undulations permitting the aspect ratio to be a minimum thus allowing maximum economy in the flexible membrane.

This economy is further enhanced by the use of individual multi-stranded cables 104 which permit maximum efficiency in the use of material in the upper chords 112 and diagonal chords 114. This efficiency is achieved in that the number of individual cables 104 required in successive upper chords 112 decreases from the perimeter to the centre of the structure. This amount of decrease in the numbers of individual cables 104 between adjacent chords can be of the same order of magnitude as the number of cables required in the individual diagonal chords 114. Consequently, the number of end connections required of the cables 104 is minimized. Further, the use of a plurality of cables 118 in the construction of each of the tension rings 116 allows the resulting structure to function as the support for a catwalk as previously described.

The use of the cable truss dome 100 is a practical consideration because of the efficiency with which the cable end forces can be resisted through the use of skewed symmetric compression rings or anchorage blocks. Given the flexibility of the cable truss dome 100, and the fact that it is not triangulated, such facts are advantages because the cable truss dome can be largely assembled on the ground or in a hanging position, with or without the flexible membrane 120, and then hoisted into position using simple cable tensioning devices that are used to put the final tension into the cables 104, as described below.

The method for erection of the cable truss dome 100 will now be described with reference to Figs. 9 through 15. The erection of the cable truss dome 100 uses the natural propensity for cables to drape in a concave upward position between anchor points under gravity. The tension ring 110 is supported on a scaffolding 138 or alternatively may be positioned on the ground and hoisted in place by jacking of the ridge cables. A bundle of cables 104, including the upper chords 112 and diagonal chords 114 for the support members 102, are positioned radially about the delineated area to be covered. The perimeter ends of the cables 104 are secured to the compression ring 108 while the other ends of those cables providing the upper chords 112 are secured to the tension ring 110. Those cables 104 providing the diagonal chords 114 are allowed to drape downwardly from the remaining cables at successive locations corresponding to the positions for the struts 106 along each support member 102. The lengths of some of the diagonal chords 114 are greater than required in the erected cable truss dome 100, in order to facilitate the erection, as described below.

The struts 106, having attached hangers 124 and supports 132, are positioned on the ground, scaffolding and/or stadium seating as shown in Fig. 6. The struts 106 are securely set so that their plan position relative to each other is maintained during the attachment of the concentric tension rings 116. The cables 118 are spun overlying the supports 132 of corresponding 106 to provide the plurality of concentric tension rings 116. The tension rings 116 are slightly tensioned as they are attached to the supports 132 of each of the struts 106. The struts 106 having attached hangers 124, supports 132 and tension rings 116, are lifted vertically upward and secured to those cables 104 forming the upper chords 112. Alternatively, the hangers 124 may be attached to the cables 104 first and the struts 106 can be attached later to the hangers during final erection of the cable truss dome 100. The attachment of the hangers 124, to the cables 104 is achieved by pivotally attaching the U-shaped bracket 126 over the cables 104 to the upper end of the hangers 124, and securing the cables thereto by means of the fixture 128. The cables 104 providing the diagonal chords 114 are inserted through the lower end of the struts 106. This procedure is repeated for all concentric rings formed by corresponding struts 106 and the tension rings 116. After the struts 106 have been set securely, cables 104 may then be arranged spanning the delineated area by successively attaching them to the top of one strut and then to the bottom of an adjacent strut, so as to form the diagonal chords 114 therebetween. This alternative method allows the cable truss dome 100 to be easily assembled and erected from a ground level position.

Engaging the free ends of the diagonal chords 114 at the outermost struts 106, these diagonal chords are then jacked by shortening their length through the struts so that the cables 104 forming the upper chords 112 and the diagonal chords 114 are placed under tension, which then lifts the outer portion of the support members 102 upwardly as shown in the sequence between Figs. 10 and 12. The jacking of the diagonal chords 114 is repeated for each of the concentric rings formed by the corresponding struts 106 and tension members 116 so as to place all cables 104 within the cable truss dome 100 in tension thereby causing the cable truss dome to invert as shown between the erection sequence of Figs. 11 through 14. The diagonal chords 114 are then secured to the struts 106, to complete the structure of the cable truss dome 100 is covered with the flexible membrane 120 and prestressed by tensioning the valley cables 122 or tensioning the diagonals 114.

As thus far described, the interior tension rings 116 are spun at grade level or on a support structure such as stadium seating and lifted with the struts 106 for attaching same to the cables 104 providing the upper chords 112. The cables 104 forming the upper chords 112 are in an inverted position and are subsequently made to assume a concave downward position by simultaneous shortening of the diagonal chords 114, one concentric ring at a time, so as to cause the support members 102 to reverse their curvature one ring at a time. Alternatively, it is contemplated that the flexible membrane 120 may be attached to the cables 104 and valley cables 122 for inflating the roof structure using mechanical blowers. The upward movement of the flexible membrane 120 by means of mechanical blowers causes the reversing of the curvature of the support members 102 and brings the struts 106 approximately into their final positions, at which the diagonal chords 114 are then attached. Using hydraulic jacks, the struts 106 are then brought into their final position in which the support members 102 assume a concave downward position, at which time the internal pressure created by the mechanical blowers is no longer required to hold the cable truss dome 100 up. By performing the erection sequence at grade level, or as close to ground as possible, such a sequence is greatly facilitated.

Turning now to Figs. 16 and 17, there is shown half of a cable truss 140 in accordance with the second embodiment of the present invention. The cable truss 140 is constructed of a plurality of tension members 142 arranged to span the delineated area, to be covered with, for example, a flexible member 120 of the type illustrated in Fig. 1. The tension members 142 are constructed of stranded cables of the type described and illustrated with respect to the previous embodiment, and are anchored in the same way to buried blocks or to a compression ring 108. The tension members 142 each overlie a portion of the delineated area and have their other ends secured to a central tension ring 144 in the manner to be described, or, in the case of a linear truss, secured to the other side. In addition to the tension members 142, the cable truss 140 also includes a plurality of rigid struts 146, which may be of varying length, and which form compression members similar in function to the struts

106 as shown in Fig. 2.

The tension members 142 are arranged in the cable truss 140 to form upper chords 148, diagonal chords 150 and lower chords 152. As shown, the number of cables within the upper chords 148 decreases from the compression ring 108 to the tension ring 144, while the number of cables within the lower chords 152 increases from the compression ring to the tension ring. By way of an example, a plurality of continuous tension members 142 are secured to the top of a first strut 146, thereby forming an upper chord 148 between the compression ring 108 and first strut 146. A tension member 142 is attached to the bottom end of an adjacent second strut 146' to form a diagonal chord 150 therebetween. The tension member 142 forming the diagonal chord 150 is then attached to the bottom end of the remaining strut 146" and has its free end attached to the lower end of the tension ring 144. The remainder of the tension members 142 attached to the top end of the first strut 146, are secured to the top end of the adjacent second strut 146' to form an upper chord 148. The number of cables in the upper chord 148 running between the adjacent first and second struts 146, 146' is less than the number of cables in the upper chord running between the compression ring 108 and first strut 146. Likewise, a tension member 142 connected to the top of the second strut 146' is attached to the lower end of the adjacent third strut 146" to form diagonal chord 150, and ultimately to the lower end of the tension ring 144 to form a lower chord 152. The remaining tension members 142 attached to the upper end of the second strut 146' are attached to the upper end of the adjacent third strut 146" in the previous manner described.

Thus the number of cables within the upper chords 148 between successive struts 146, 146', 146" decreases in number, while the number of cables within the tension members 142 forming the lower chords 152 increases between successive struts. In other words, the tension members 142 extend continuously from the compression ring 108 to the tension ring 144 in the form of an upper chord 148, a diagonal chord 150 and a lower chord 152. In turn, the struts 146, 146', 146" are secured between the upper chords 148 and lower chords 152 to maintain the tension members 142 under tension upon application of a load.

As shown in Fig. 17, the struts 146 are secured to the tension members 142 by means of saddle-type brackets 154, 154'. As shown, the upper and lower brackets 154, 154' are secured to the ends of the strut 146. The upper bracket 154 is provided with a pair of spaced ears 156 between which the tension members 142 are retained. The lower bracket 154' is in turn provided with a U-shaped retainer plate 158 to sandwich the tension members 142 therebetween, which tension members are also confined between spaced bushes 160. In this manner, the struts 146 are attached between the tension members 142, so as to maintain the tension members under tension during an applied load.

The method for erection of the cable truss 140 will now be described briefly; it is similar to the method of erection of the cable truss dome 100 previously described with reference to Figs. 9-15. A bundle of tension members 142 is arranged overlying the delineated area between the compression ring 108 and tension ring 144. A plurality of struts 146 are attached to the tension members 142 at intermediate locations between the compression ring 108 and tension ring 144, so that the tension members are divided into upper chords 148, diagonal chords 150 and lower chords 152, as shown in Fig. 16. The tension members 142 and struts 146 may be assembled on the ground or using a scaffolding 138 in the manner previously described. The cable truss 100 is erected by tensioning the tension members 142 by engaging their free ends at their location at the compression ring 108. The tension members 142 are respectively tensioned by shortening their length between the compression ring 108 and tension ring 144, so that the tension members forming the upper chords 148, diagonal chords 150 and lower chords 152 are placed under tension, which then lifts the outer portion of the cable truss 140 upwardly. By successively tensioning those tension members 142 which form the next adjacent inward diagonal chord 150, all tension members within the cable truss 140 are placed under tension, thereby causing the cable truss to be raised into its tensioned self-supporting position, as shown in Fig. 16. Additionally, cross-bracing 130 may be provided between adjacent corresponding struts 146. The cable truss 140 can then be covered with a flexible member 120 which may be pre-stressed by the tensioning of valley cables 122 attached between the tension ring 144 and compression ring 108.

CLAIMS

1. A roof structure (100) for spanning a delineated area, said structure comprising support members (102;142) spanning said delineated area for supporting a roof thereon, characterised in that said support members comprise tension members (104) and compression members (106;146), said tension members forming upper chords (112;148) spanning a portion of said delineated area and diagonal chords (114;150) extending therefrom, said compression members attached between said upper chords and said diagonal chords, and further tension members (116;152) connected to the bottom of said compression members (106;146).

2. A roof structure (100) for spanning a delineated area, said structure comprising support members (102;142) spanning said delineated area for supporting a roof thereon, characterised in that said support members (102;142) comprise tension members (104) and compression members (106;146), said tension members forming upper chords (112;148) spanning a portion of said delineated area and diagonal chords (114;150) extending therefrom downwardly at an acute angle thereto, said compression members attached to and

extending between vertically spaced positions on said upper chords and said diagonal chords, and further tension members (116;152) connected to the junctions of said compression members with said diagonal chords to balance the forces acting at said junctions.

3. A roof structure (100) for spanning a delineated area, the structure comprising support members (102;142) spanning the delineated area for supporting a roof thereon, characterized in that each of the support members (102;142) comprises an upper tension chord (112;148) for supporting the roof thereon; a plurality of compression members (106;146) each connected at an upper end thereof to one of a number of different positions on said upper chord and, for each compression member, a diagonal tension chord (114;150) interconnecting the lower end of the compression member (106;146) and the upper end of a compression member next adjacent thereto; and is also connected to further members (116;152) each connected to the lower end of a different compression member (106;146) of the same support member to maintain the diagonal tension chords under tension; whereby, upon assembly in use, each compression member (106;146) forms, with its associated upper tension chord and

diagonal tension chord, a triangle, and each support member (102;142) comprises a plurality of such triangles which are coplanar and are each connected to an adjacent said triangle only at an adjacent vertex.

4. A roof structure according to any preceding claim, wherein said tension members comprise a plurality of cables arranged in a bundle.

5. A roof structure according to any preceding claim, further including a tension ring connected to said support members at a central position overlying said delineated area.

6. A roof structure according to claim 5, wherein said support members extend radially outward from said tension ring spanning said delineated area.

7. A roof structure according to any preceding claim, further characterised by a roof in the form of a flexible membrane overlying said support members.

8. A roof structure according to claim 7, further characterised by tensioning means extending between adjacent support members for tensioning said flexible

membrane.

9. A roof structure according to claim 7 or claim 8 characterised in that said flexible membrane comprises a plurality of adjacent wedge shaped panels radiating outwardly from a center portion of said delineated area.

10. A roof structure according to any preceding claim, further characterised by a compression member (108) forming a closed loop circumscribing said delineated area to which said support members (102;142) are attached.

11. A roof structure according to claim 4, characterised in that the number of said cables within said upper chords decreases from the perimeter of said delineated area to a central portion thereof, at each position at which a diagonal chord extracts therefrom.

12. A roof structure according to claim 11, characterised in that the number of said cables forming said lower tension members (152) increases in a direction from the perimeter of said delineated area to a central portion thereof at each position at which a diagonal chord adjoins the lower tension members.

13. A roof structure according to claim 4 or any claim dependent on claim 4, characterised in that the number of said cables within said diagonal chords remains the same from the perimeter of said delineated area to a central portion thereof.

14. A roof structure according to any one of claims 11 to 13 characterised in that at a plurality of the junctions of a diagonal chord with an upper chord, the number of cables in the upper chord to one side of said junction is not less than the sum of the number of cables in the diagonal chord and in the upper chord to the other side of said junction.

15. A roof structure according to claim 1, claim 2 or claim 3, characterised in that said further tension members comprise concentric tension rings (116) each connected to the lower end of a respective compression member (108) of each support member (102).

16. A roof structure according to any of claims 1 to 3 characterised in that at least some of said upper chords, diagonal chords, and further tension members comprise a common cable.

17. A roof structure according to claim 15 further characterised by a platform secured to said tension rings.

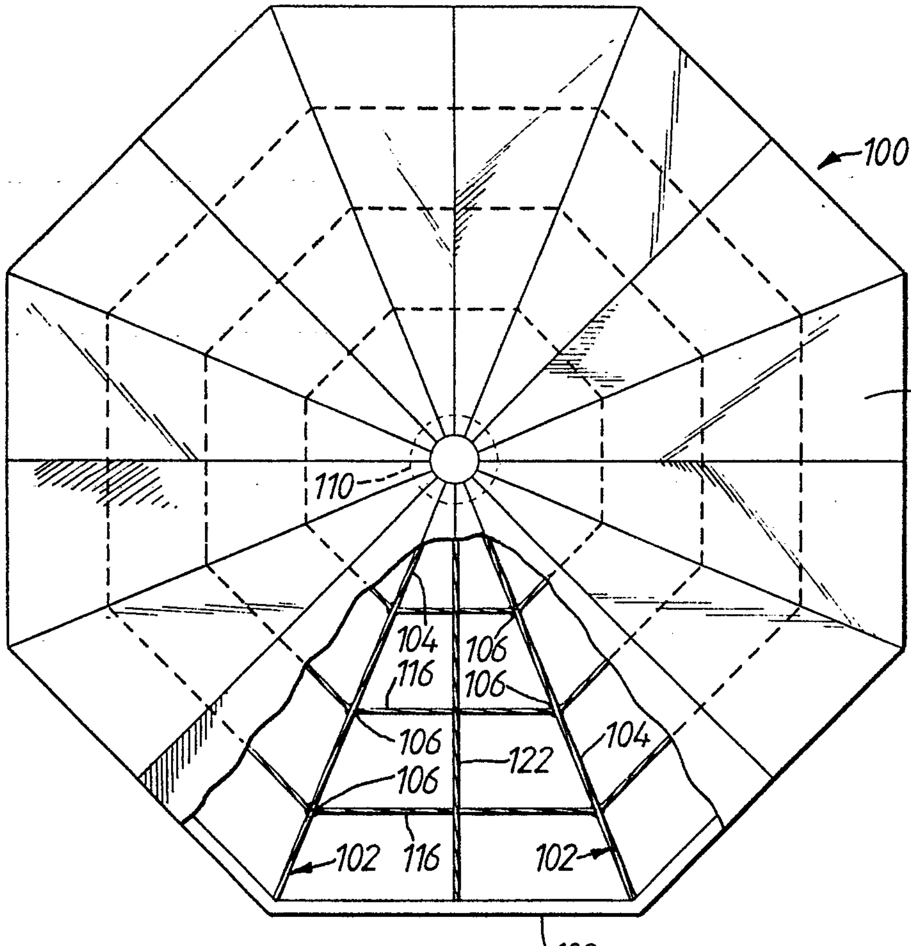
18. A roof structure according to any preceding claim characterised by bracing means (130) extending between corresponding compression members of adjacent support members.

19. A roof structure according to claim 15, characterised in that said tension members comprise a plurality of concentric cables.

20. A method of erecting a roof structure according to claim 3, said method being characterised by the steps of spanning said delineated area with said tension members, attaching one end of each of said compression members to said tension members at said different points thereon, attaching the other end of each of said compression members to said tension members at another point thereon to form said diagonal chords therefrom, and tensioning said tension members spanning said delineated area to form said roof structure.

21. A method according to claim 20, characterised by tensioning said tension members by the step of shortening the length of said diagonal chords.

22. A method according to claim 20 characterised by attaching a flexible membrane to said tension members, and inflating said flexible membrane to tension said tension members.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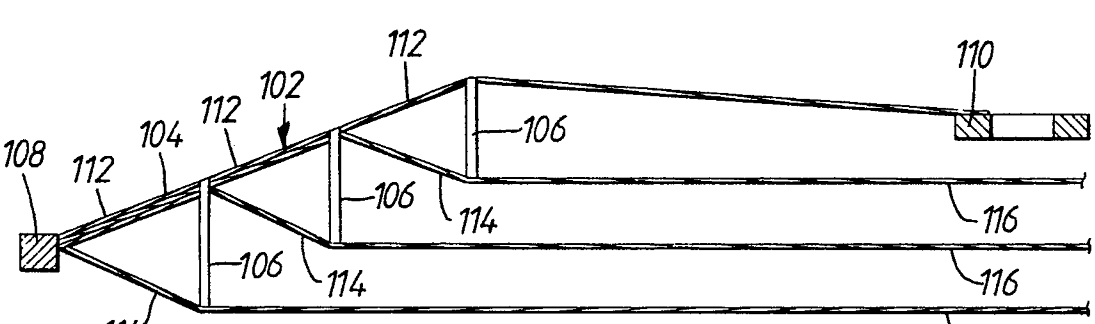
108

FIG.1.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116

FIG.2.

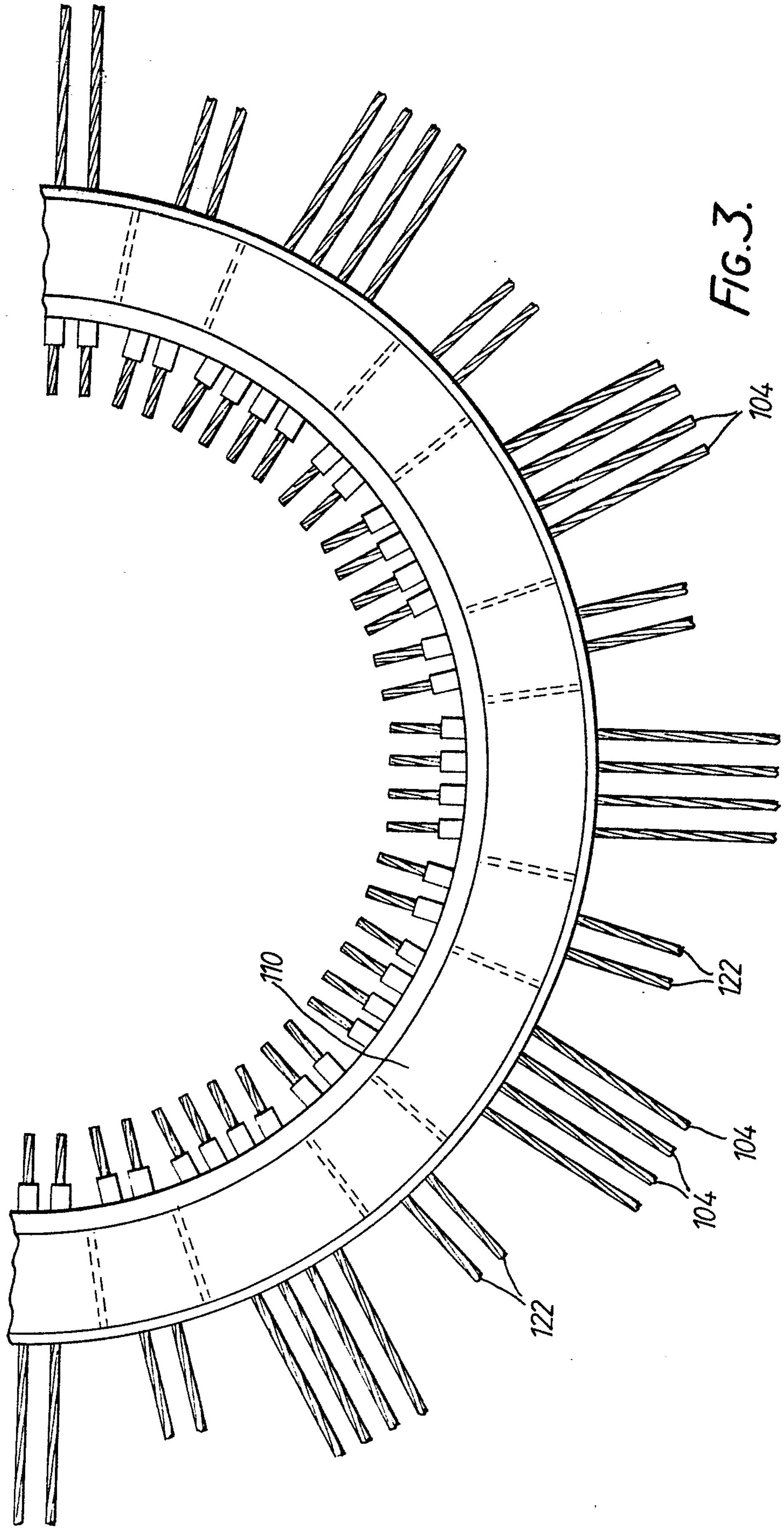

FIG.3.

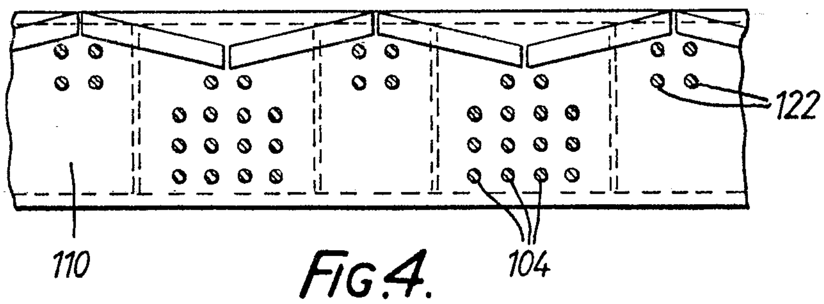

FIG.4.

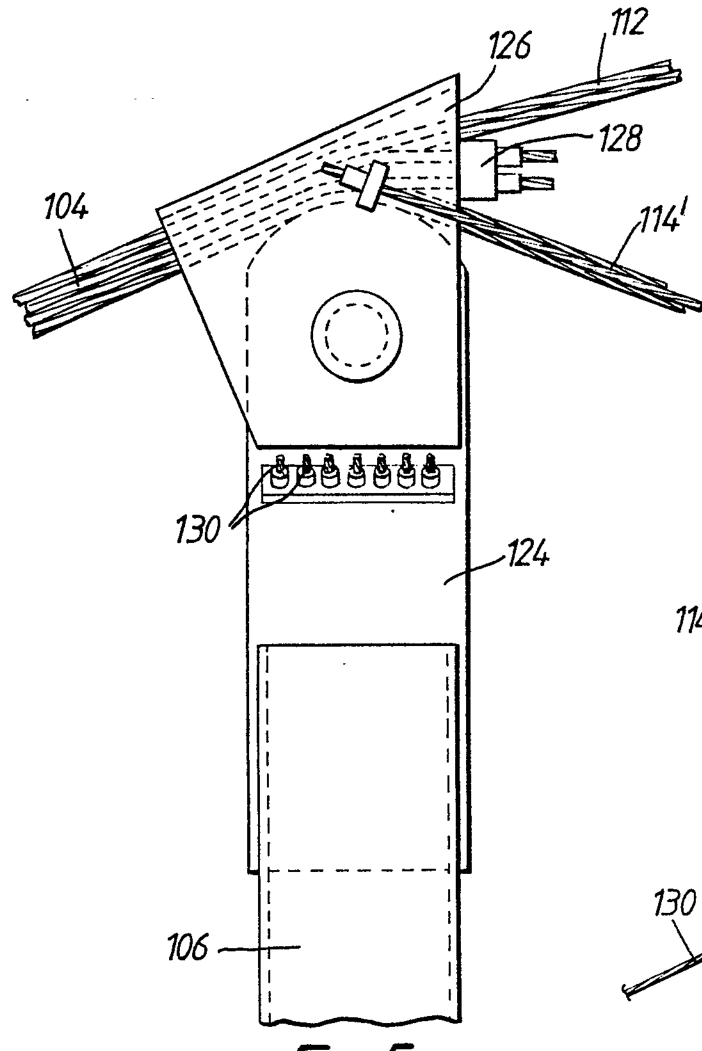

FIG.5.

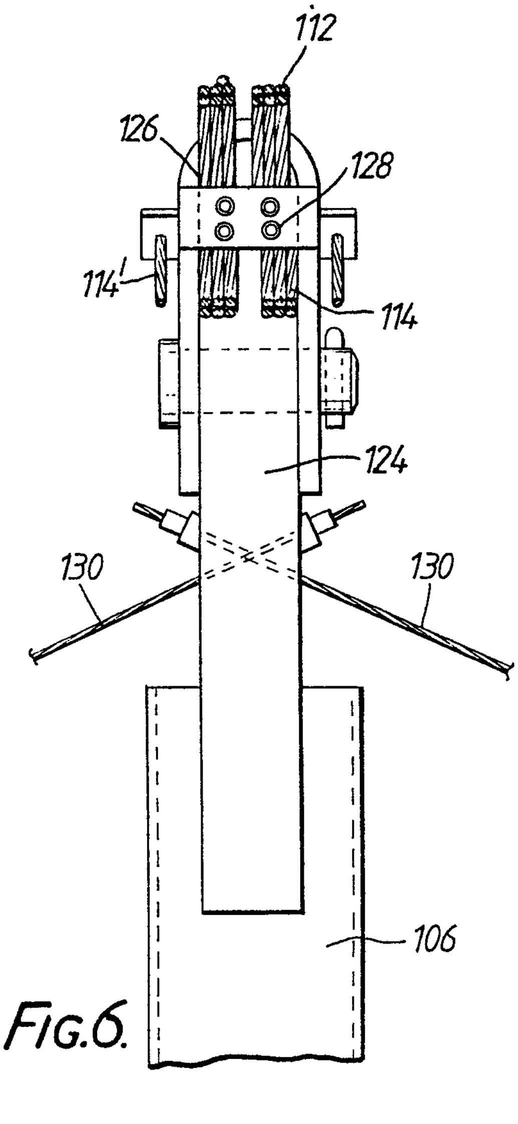

FIG.6.

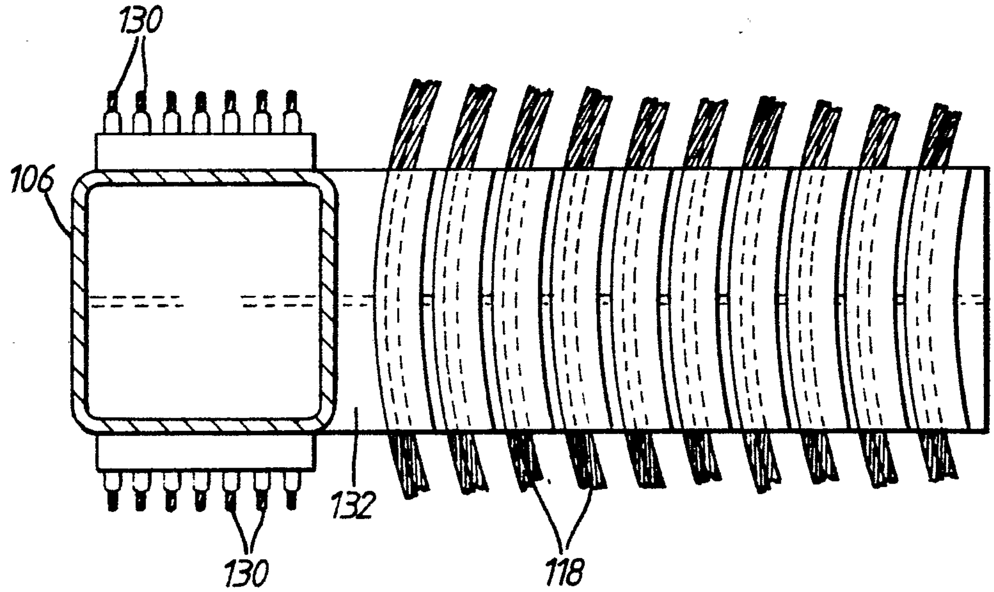

FIG.7.

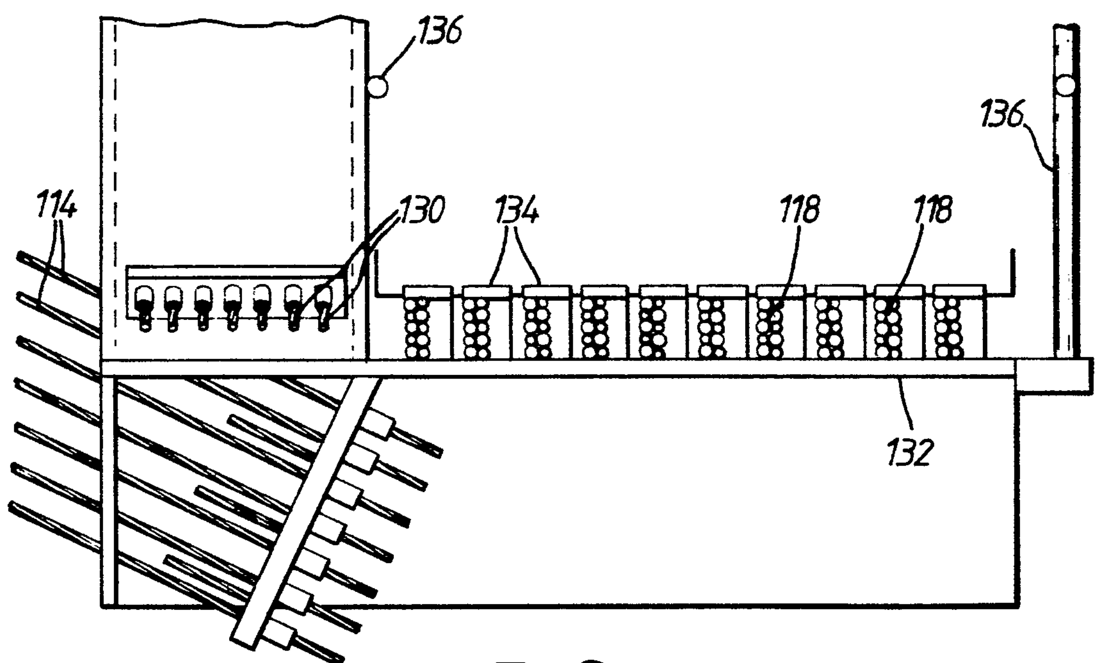

FIG.8.

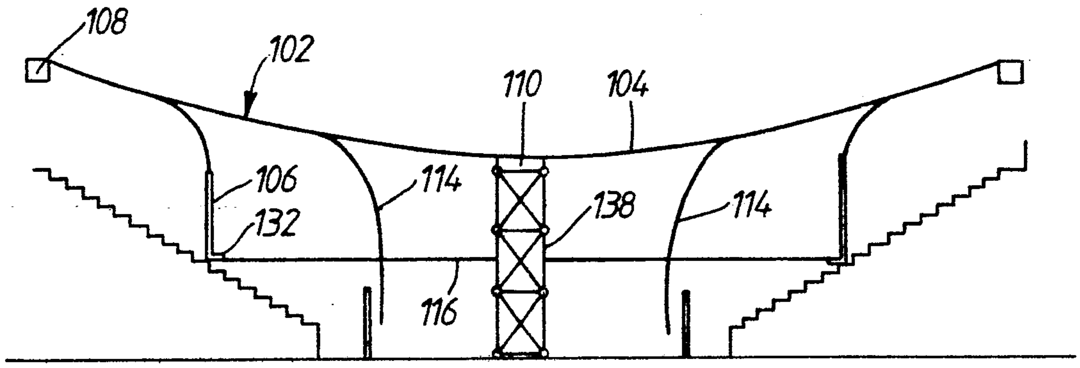

FIG.9.

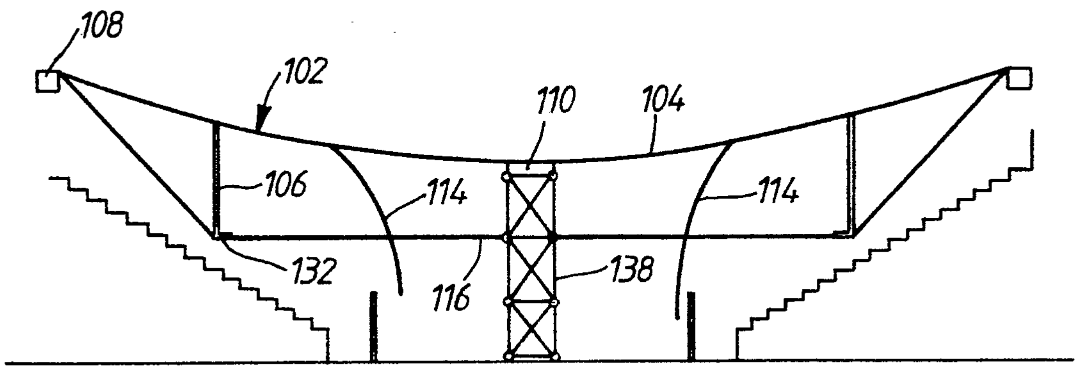

FIG.10.

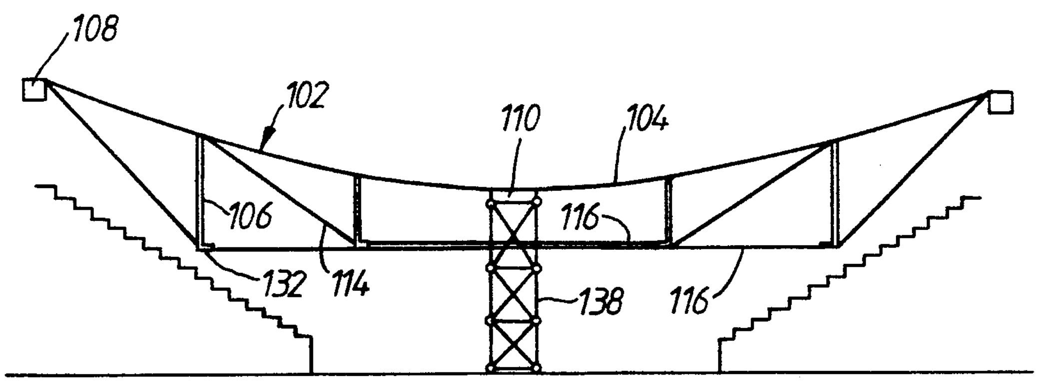

FIG.11.

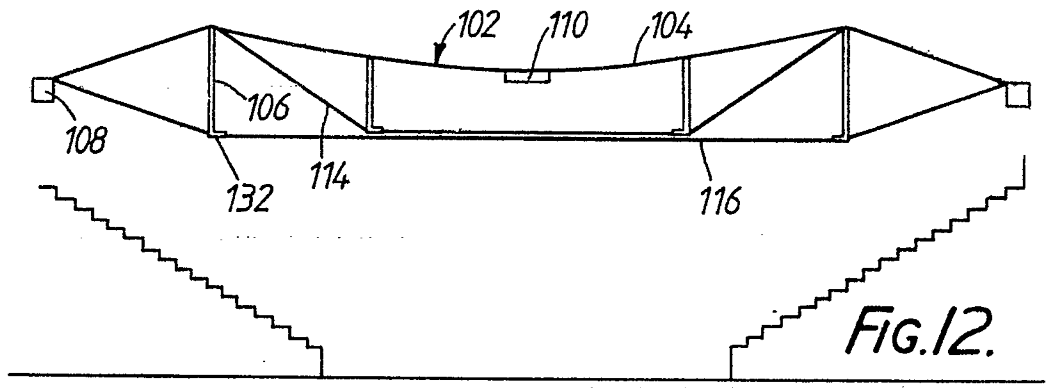

FIG.12.

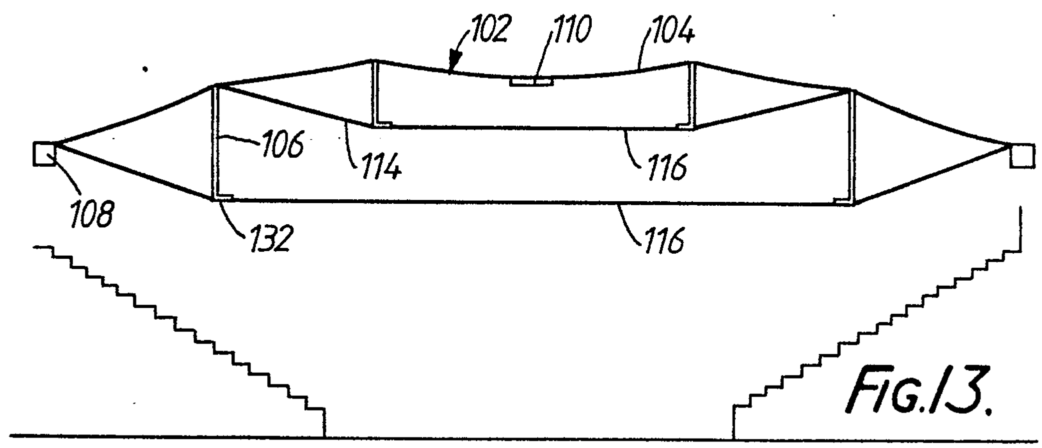

FIG.13.

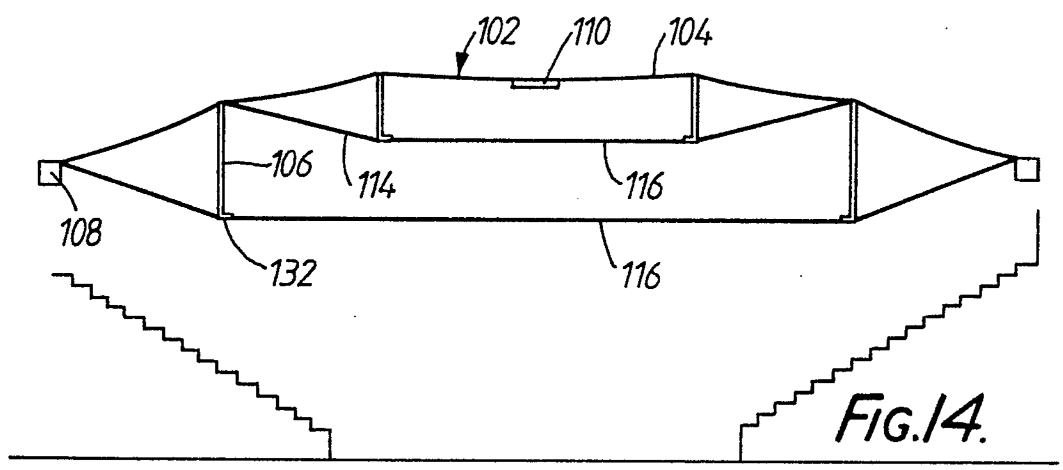

FIG.14.

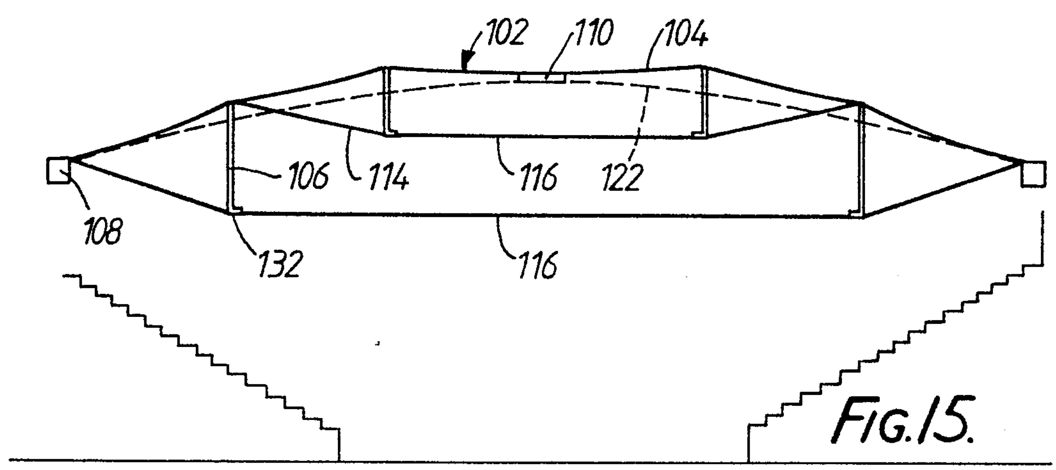

FIG.15.

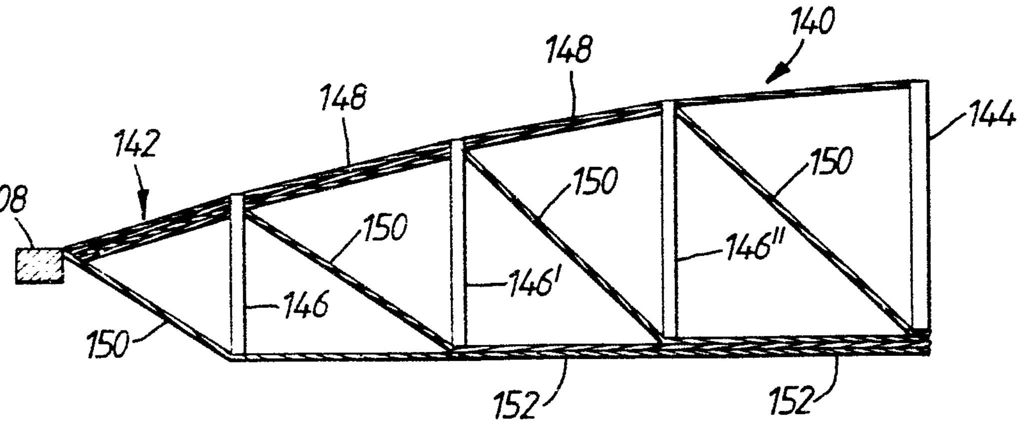
140
148
148
142
144
150
150
108
150
146''
146'
146
150
152
152

FIG.16.

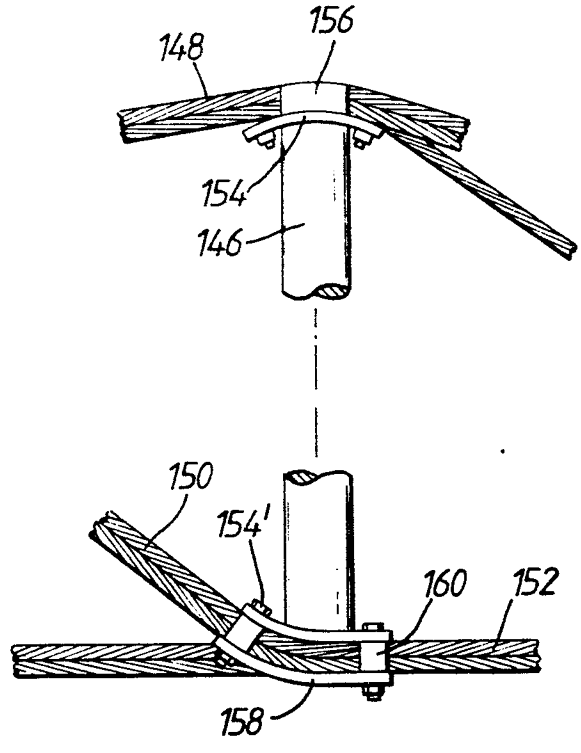
156
148
154
146
150
154'
160
152
158

FIG.17.