June 21, 1955 G. B. WOODS 2,711,181

SPHERICAL STRUCTURE

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Fig. 1.

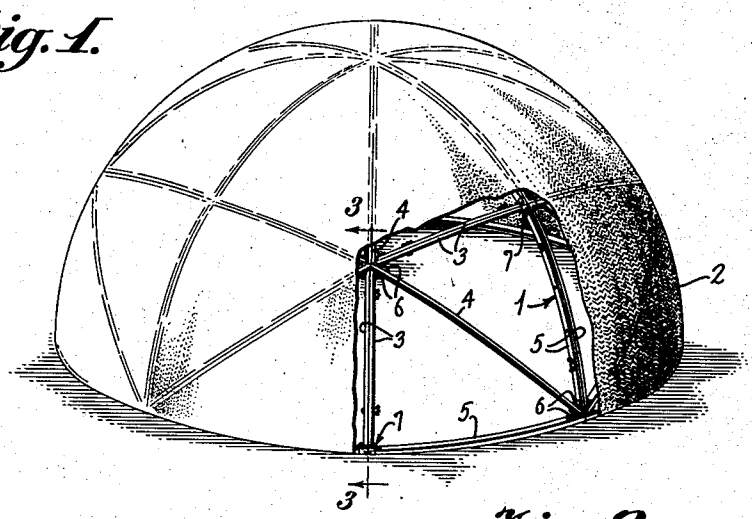


Fig. 3.

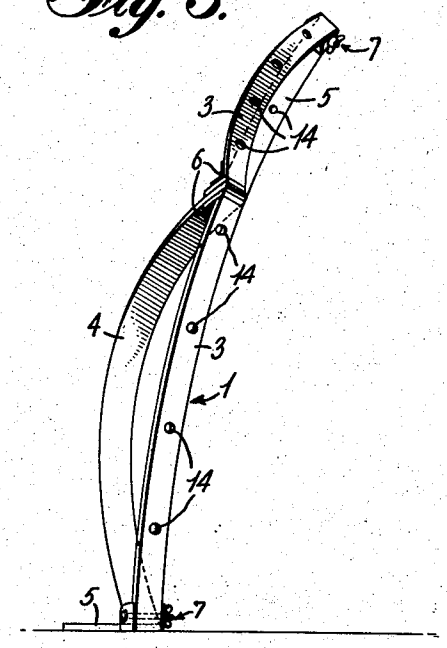
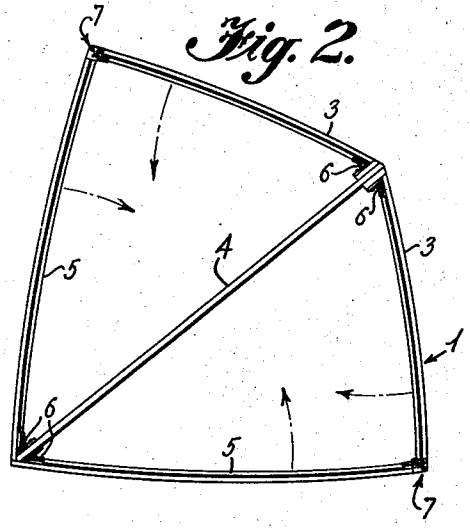


Fig. 2.



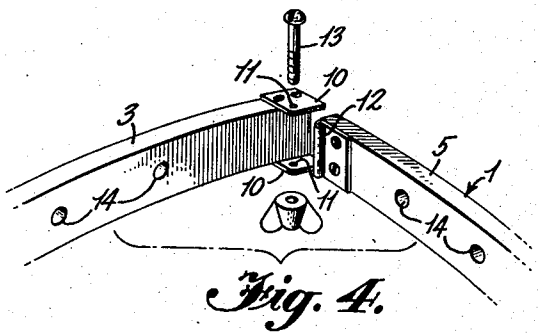


Fig. 4.

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Fig. 5.

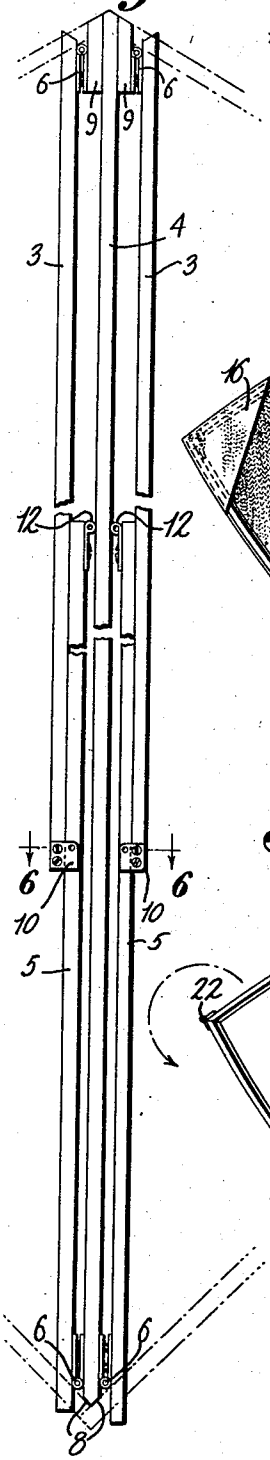


Fig. 6.

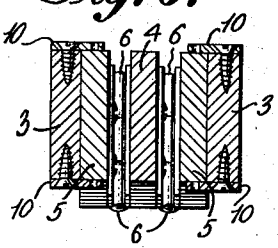


Fig. 8.

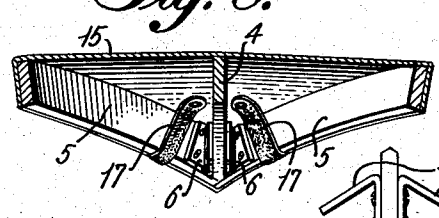


Fig. 10.

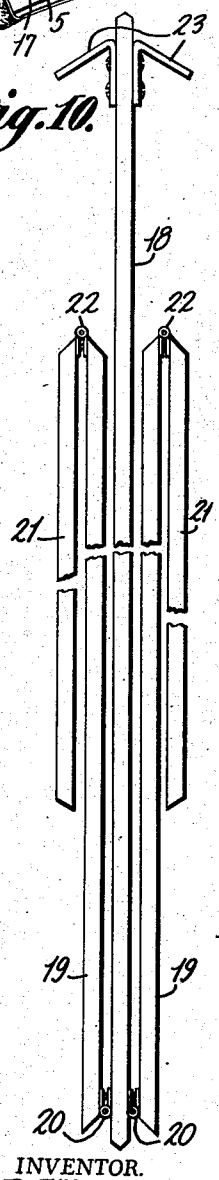


Fig. 7.

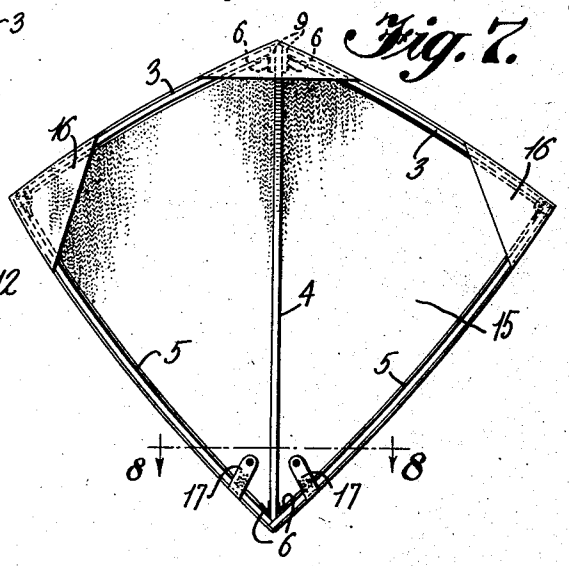
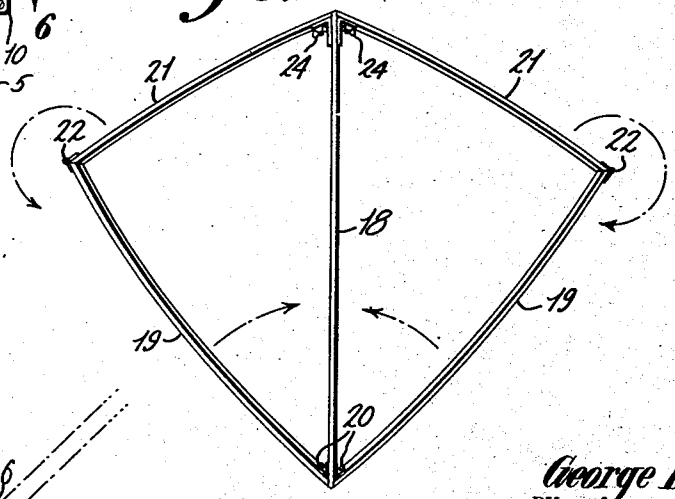


Fig. 9.



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SPHERICAL STRUCTURE

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Fig. 11.

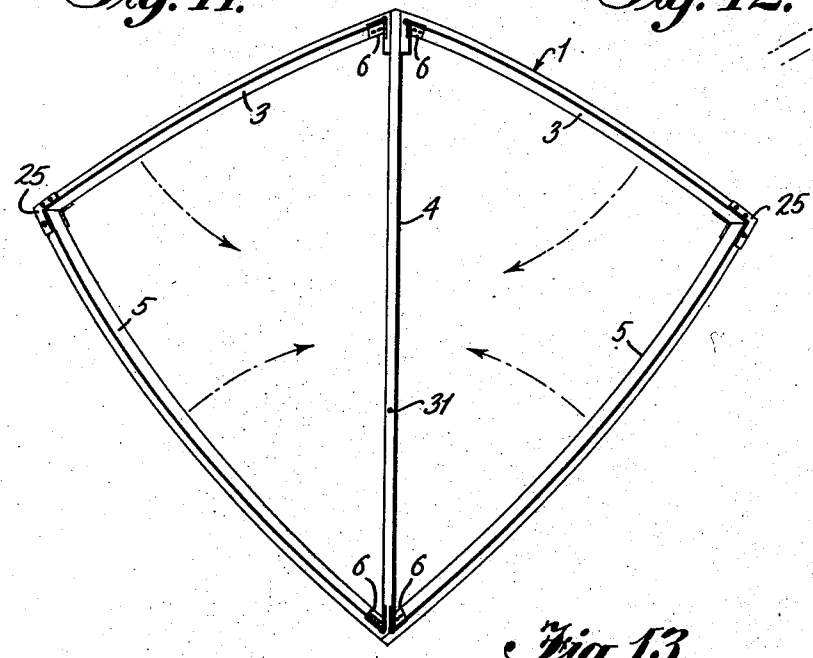


Fig. 12.

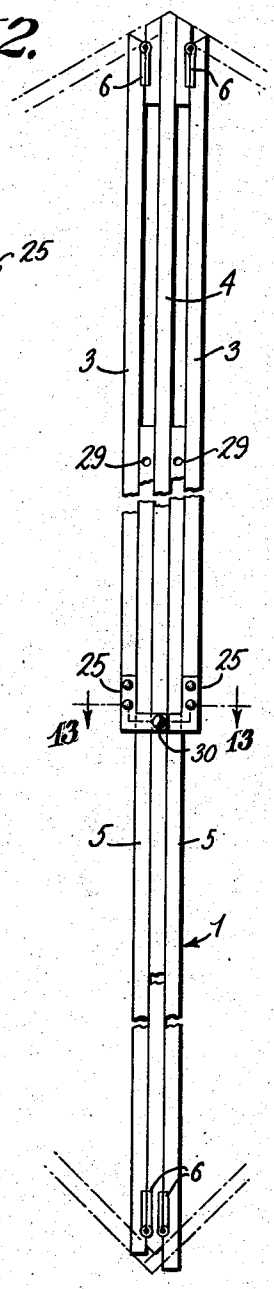


Fig. 13.

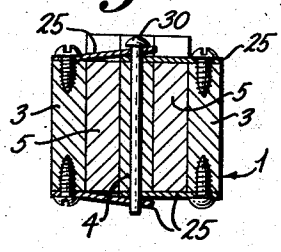
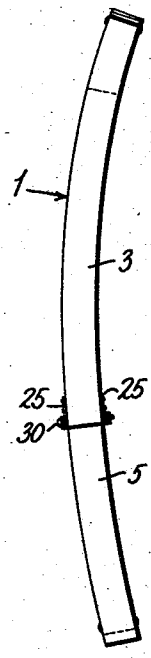


Fig. 14.



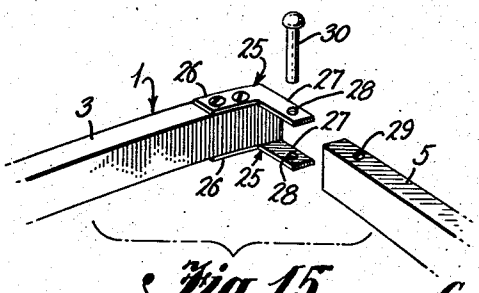


Fig. 15.

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SPHERICAL STRUCTURE

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Application May 1, 1951, Serial No. 224,015

6 Claims. (Cl. 135—4)

This invention relates to shelter construction, and more particularly to such constructions wherein the wall structure is of generally spherical curvature.

Applicant has disclosed in his co-pending application, Serial No. 124,073, now abandoned a shelter which is composed of a plurality of rigid slabs of spherical curvature, each of which is an aliquot part of a sphere of which the part is one-twenty-fourth of the surface area. The slab is kite-shaped, and the manner of determining the shape of the piece is fully described in that application.

Due to the rigid construction of the slabs, the size of the individual slab determines the storage, or shipping space which will be required for the knocked-down shelters. The concept disclosed in the mentioned application provides many advantages over previously known forms of shelter construction, but for many purposes it would be desirable in order to enhance the portability of the shelter, and to permit storage in smaller space, to reduce the knocked-down size of the unit. This could be accomplished simply by cutting the previously disclosed unit into a plurality of separable sections, as disclosed in co-pending application, Serial No. 178,961, filed August 11, 1950; but, in addition to the increased number of resulting pieces which would have to be accounted for and separately assembled, the sections still would be of somewhat bulky shape.

The object of the present invention is to provide a shelter having a rigid frame composed of a plurality of identical sections, with each section being collapsible to occupy but a fraction of its extended bulk, and the frame having a covering to form the wall of the shelter.

Another object of the invention is to provide a collapsible frame section which may be locked in both extended and collapsed positions.

A further object is to provide such a shelter frame section in which the frame members are so connected that each forms a brace for another when the frame is extended, to rigidify the section.

Other objects of the invention will become apparent from the following description when taken in conjunction with the drawings which accompany and form a part of this specification.

In the drawings:

Figure 1 is a perspective view of a shelter constructed in accordance with the present invention, a portion of the covering material being broken away to show the frame;

Figure 2 is a view of one of the frame sections in expanded position, looking at the convex side;

Figure 3 is a side view of a frame section viewed in the direction of the arrows of the line 3—3 of Figure 1;

Figure 4 is a perspective view of the locking corner of a section;

Figure 5 is a plan view of a collapsed section, parts being broken away;

Figure 6 is a transverse section through the frame in folded position, and is taken on the line 6—6 of Figure 5;

Figure 7 shows a frame section with an individual cover;

Figure 8 is a section taken on the line 8—8 of Figure 7, illustrating one means for attaching the cover to the frame;

Figure 9 shows a modified form of frame section in which the folding is accomplished in a different manner;

Figure 10 shows the frame of Figure 9 in folded position;

Figure 11 shows another modification, which is similar to that form shown in Figures 1 to 8, inclusive, but having a different type of lock;

Figure 12 is a view of this last form in folded and locked position;

Figure 13 is a transverse section through the locked members, and is taken on the line 13—13 of Figure 12;

Figure 14 is an edge view of the frame section shown in Figure 11 when in folded position; and,

Figure 15 is a perspective view of the locking corner of the frame section.

Referring to the drawings in detail, and first adverting to that form of the invention shown in Figures 1 to 6, inclusive, there is illustrated a skeleton frame 1 of hemispherical contour encased in a canvas, or other flexible material, covering 2.

The canvas covering 2 may be formed from a plurality of segmental gores, or in any other suitable manner. The way in which the cover is fabricated is unimportant, so long as it forms a hemispherical shell to fit over the frame.

The frame is formed of a plurality of identical sections. Each of the sections is substantially kite-shaped, and its shape is determined (as described in application Serial No. 124,073) by dividing a regular spherical polygon from its center to the mid-points of its sides. All of the sides are arcs of great circles of the sphere of which the frame section is an aliquot part.

Each frame section is composed of a pair of sides 3 connected to one end of a center-brace 4, and a pair of sides 5 connected to the opposite end of the center-brace 4. Each of the sides is connected to the center-brace by means of a hinge 6. When swung outwardly about their hinges, the outer ends of one side member of each pair will meet, and the two are joined by means of a fastening 7. For convenience, the sides 3 will be referred to hereafter as the upper sides, and the sides 5 as the lower sides.

The various members of the frame section may be made of wood, light metal, or the like. Each member is made from flat stock, and its top and bottom edges are arcuate, the top edge being scribed with a radius equal to the radius of the sphere of which the frame section is an aliquot part, and the bottom edge with a radius equal to the radius of the sphere less the width of the frame section. Thus, the outer edge of each member has the curvature of the spherical structure of which it is to form a part.

By reference to Figures 2 and 5, it will be seen that the lower pair of side members have their hinges connected directly to the lower portion of the cross-brace, so that the members may lie close to the center brace when the section is folded (see Figure 5). The hinges are not positioned exactly at the ends of these members, but are spaced from the end of the cross-brace slightly, and from the ends of the side members a greater distance, with the spacing from the end of one side member being greater than the other. This is to permit a stiffening of the section when extended, by a bracing of one member by another. To further this end, the center brace has its lower end beveled from each side to provide abutting faces 8 for the side members when extended. By spacing the hinges different distances from the ends of the side members, the end of one side member may overlie, and contact, the end of the other when the side members are

swung to their open positions. Thus, when open, the side members will contact each other and the beveled faces on the center-brace, as shown in Figure 2 and in dotted lines in Figure 5.

The upper pair of side members 3 have their hinges attached to spacer blocks 9 carried by the upper end of the center-brace. The blocks are the thickness of the lower side members, and serve to space the connections to the upper side members from the center-brace a sufficient distance to permit the upper side members to lie flat against the lower side members when all of the sides are folded. The ends of the center-brace and spacer blocks form part of the outside surface of the frame section, and are cut to follow the section perimeter. The upper side members are hingedly connected to the spacer blocks in such fashion that the side members, when extended, form continuations of the beveled faces of the upper end of the center-brace and the spacer blocks. The side members have their ends beveled to solidly contact the side faces of the spacer blocks when the side members are extended. This effectively braces the upper side members in extended position.

It will be apparent that as the side members have limited outward swinging movement without contact of their hinged ends with the center-brace, having the ends of adjacent side members meet for locking just as the limit of outward movement is reached will cause the entire frame section to be quite rigid. The means for locking the free ends of the side members together may take any suitable form. In the drawings, the upper side members are provided with flat plates 10 secured to their upper and lower edges at their ends. The plates project beyond the sides of the members and are provided with aligned openings 11. The lower side members have plates carrying eyes 12 attached to their ends. When the members are in open position, the openings 11 and eye 12 will be aligned, and a pin 13 may be inserted to secure them.

When the frame sections are in extended position, they are kite-shaped, as described, and twelve of these units when fitted together will form a hemispherical frame. The units may be connected by any convenient means. The sides are illustrated as having a series of openings 14 which match with openings in the sides of other sections, so that the sections may be joined by bolts.

After the frame is assembled, the canvas cover is placed over it and may be secured in position by suitable fastening to the frame, or by pegging to the ground in a manner similar to that employed in holding a tent canvas in position. It will be obvious that an inner skin of canvas or the like may be provided to be secured to the inner side of the skeleton frame. When this is done, the space between the inner and outer coverings may be filled with an insulating material.

It may be desirable to have each frame section provided with an individual cover member, as shown in Figures 7 and 8. In this event, the cover 15 will conform to the perimetric shape of the frame section, with pocket portions 16 to receive the corners of the frame section. As the center-brace is non-collapsible, it will be necessary to provide removable means for enclosing one corner into which the center-brace extends. Straps 17 having snap fasteners may be used to hold the canvas in position at this corner. In assembling this type of unit, the upper end of the collapsed frame section will be put into the upper pocket of the cover. The lower side members 5 may then be swung outwardly, and these members will cause the upper side members 3 to move outwardly about their hinges. As the outward movement continues, the upper ends of the lower members will ride upon the inner side faces of the upper members providing a camming action to raise the upper members to position and to permit the free ends of the lower members to slip between the fastening plates 10 until the eyes 12 are positioned between the respective pairs of plates 10. Pins 13 may then be slipped into place to hold the section in extended position. By opening the frame as described, side members will be forced into position in the pockets at the sides of the cover, and the canvas can be made to fit very tightly, for the camming action of one side member upon the other will cause the canvas to be stretched. Either after or before the frame is assembled, straps 17 will be brought about the frame and fastened.

The required number of individually covered units may be assembled to form a shelter. When the shelter is to be taken down, the units will be separated, and each unit collapsed. Each of the individual canvas covers may be wrapped around the collapsed frame section with which it is used, and a very compact, portable unit will be provided.

In Figures 9 and 10, another form of frame is shown. Here, the center-brace 18 has the lower side members 19 hingedly connected to it, as at 20, and the upper side members 21 are hinged at 22 to the outer ends of the lower side members. The free ends of the upper side members are adapted to be secured to brackets 23 which are connected to the upper end of the center-brace. In collapsing this form of frame section, the securing bolts 24 are removed, and the upper side members swung outwardly around hinges 22 until the upper members lie against the sides of the lower members 19. The lower members are then swung inwardly about their hinges 20 until the side members are against the center post, as shown in Figure 12.

It should be noted that in all of the forms illustrated the ends of the various members are radial to the arc of the members, and that the hinges are parallel to the ends, so that when the frame is collapsed all of the arcuate surfaces are coincident, and all of the side members lie within the outline of the center-brace. In other words, the length, width and curvature of the center-brace determine the dimensions of the collapsed frame section, except for thickness. The thickness of the bundle is determined by the combined thicknesses of the center-brace and side members. Due to this arrangement, the side members when extended will be angularly disposed with respect to the center-brace, so that each side member will lie in a plane which is radial to the curvature of the sphere.

In Figures 11 through 15, a frame section is shown which is identical to that shown in Figures 1 through 6 with the exception of the fastening plates forming the connection between the free ends of the upper and lower side members. The same reference numerals have been used to indicate similar parts.

In this form of the invention, brackets 25 are secured to the upper and lower edges of the free ends of the upper side members 3. These brackets are angle brackets having the arms 26 and 27. Screws, or other suitable fastening means, attach the arms 26 to the side members 3, in such position that the arms 27 will be in alignment with, and overlie, the free ends of the lower side members when they are in fully extended position. Arms 27 of brackets 25 have substantial length, and have openings 28 which are in alignment with openings 29 in the lower side members when the frame is set up. A pin 30 is passed through these aligned openings to hold the frame extended. The position of the openings 28 in the brackets 25 is important. The openings are located a sufficient distance from the upper side members so that when the frame section is collapsed, the openings in the brackets of opposite side members will be in alignment with each other, and directly over the longitudinal center line of the center-brace. The center-brace is bored, as at 31, to receive the pin 30 so that the members of the frame section may be rigidly locked in collapsed position. This will greatly facilitate handling of the collapsed frame sections.

Figure 12 shows the hinges between the various members as countersunk into the material of the members so that the members may lie in full face contact when

the frame is collapsed. It will be obvious that this practice may be followed in all forms.

At any desirable points, special sections may be used provided with windows, or doors, or one of the sections may be left out or hinged to the next adjacent section to serve this purpose. Window openings may be provided in the canvas cover to eliminate the necessity for special sections.

While in the above several practical embodiments have been described, it will be understood that this is by way of illustration only, and changes may be made from the precise embodiments shown within the scope of the appended claims.

What is claimed is:

1. A frame section for a spherical structure comprising, a center-brace having flat parallel sides and its top edge curved to conform to a great circle of a predetermined sphere, a pair of side members of similar shape to said center-brace but shorter than said center-brace and having hinge connections connecting one member to each side near one end of said center-brace, a second pair of side members similar to the first but longer than the first and shorter than said center-brace having hinge connections connecting one member to each side near the opposite end of said center-brace whereby the frame section may be collapsed and when extended will form a frame section of substantially kite shape.

2. A frame section for a spherical structure, as claimed in claim 1, means to lock the frame section in extended position.

3. A frame section for a spherical structure as claimed in claim 1, all of said hinge connections having pivotal axes parallel to the plane of the center-brace whereby the side members and the center-brace will lie in parallel planes when the frame section is collapsed, and each of the pivotal axes of said hinge connections being parallel to a radial plane of the sphere which passes through the extended position of the side member attached to the respective hinge connection, whereby

the side member will tilt in moving from collapsed to extended position to lie wholly within said radial plane.

4. A frame section for a spherical structure as claimed in claim 3, means to lock the frame section in extended position.

5. A frame section for a spherical structure comprising, a center-brace, four side members, and hinge connections between said center-brace and said side members whereby said frame section may be collapsed, said center-brace and said side members each being curved from end to end on arcs of great circles of the sphere to which the structure is to be constructed, each of said hinge connections having its pivotal axis parallel to the plane of the center-brace whereby the side members and center-brace may lie in parallel relation when the frame section is collapsed, each hinge connection pivotal axis being also parallel to a radial plane of the sphere which passes through the extended position of the side member carried by the hinge connection, whereby each side member will tilt as it is moved to extended position and assume a position with its side face radial to the sphere, and means to join adjacent ends of adjacent side members for locking the frame section in extended position.

6. A frame section for a spherical structure as claimed in claim 5, said means to join adjacent ends of adjacent side members being adapted to cooperate with said center-brace to lock the frame section into collapsed position.

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