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TENSIONED CANOPY
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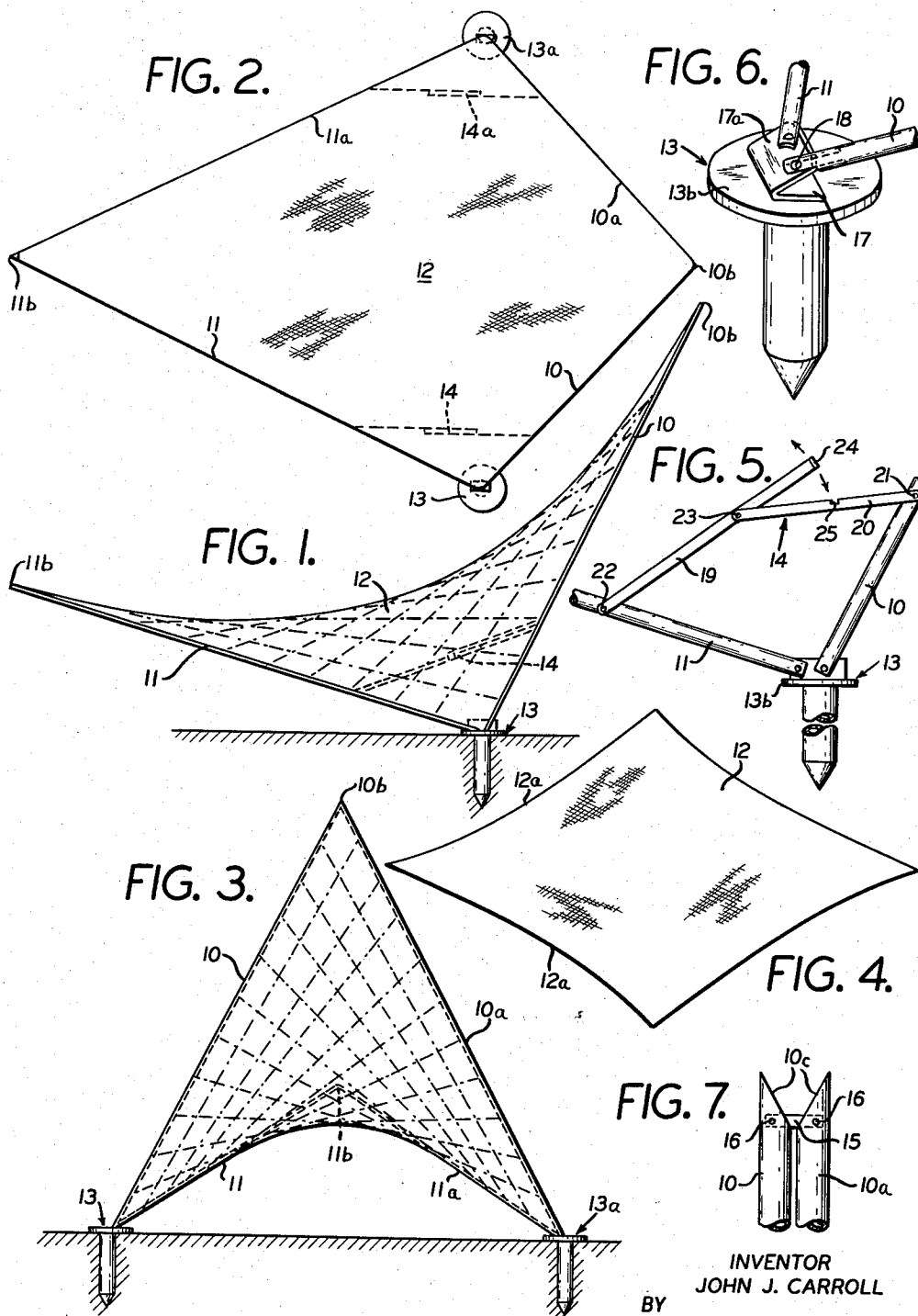


FIG. 7.

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TENSIONED CANOPY

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The present invention relates to a tensioned space structure in the form of a tensioned, flexible canopy capable of use as a shelter from the sun, rain and wind, and more particularly as a beach canopy, a garden tea house, a patio shelter, a roof structure for a house, a military tent, a car part, etc.

Among the objects of the invention is to provide a structure of the general character set forth which is collapsible and portable and readily storable; which provides natural drainage for rain; which is capable of quick erection and which is simple and economical in construction and highly efficient in use.

The foregoing and other objects of the invention, not specifically enumerated, are accomplished by a tensioned structure having a hyperbolic paraboloid surface provided by tensioning a flexible web of generally diamond shape with hyperbolic sides, onto two pairs of rods, the rods of each pair being articulated for angular movement at one pair of ends and for spreading apart at their other pair of ends, said latter ends of at least one pair being pivoted to two anchoring means and the ends of the other pair of rods being preferably rigidly secured to said anchoring means, spreader and locking means being provided between the adjacent rods of the respective pairs of rods which are secured to the same anchoring means.

The invention will be better understood from the detailed description which follows, when considered in connection with the accompanying drawings which show, by way of illustration, a preferred embodiment.

In the drawings:

Figure 1 shows a diagrammatic side elevation of a tensioned structure embodying the invention;

Fig. 2 shows a top plan view of Fig. 1;

Fig. 3 shows a front elevation of Fig. 1;

Fig. 4 shows a plan of the flexible web prior to being embodied in the tensioned structure;

Fig. 5 shows a detail of the spreader and locking means and of the anchoring means of the structure;

Fig. 6 shows a perspective view of one of the anchoring means, taken at an angle of about 90° to that shown in Fig. 5.

Fig. 7 shows a detail of the articulated construction of the respective pairs of rods.

Referring to the drawings, the tensioned structure may be said to consist of two pairs of rods 10, 10a and 11, 11a, the rods 10, 10a at their adjacent ends being pivoted or articulated at 10b, the rods 11, 11a, being articulated at 11b, the pairs of rods having connected thereto the edge portions of a substantially diamond shaped web 12, the ends of the respective pairs of rods remote from their articulated ends being connected to anchoring means 13, 13a and spreader and locking means 14, 14a are provided for tensioning the structure upon erection thereof.

The rods 10, 10a are of equal length and may be formed of any desirable material which, for the sake of lightness, is preferably formed of tubular aluminum stock. The articulated ends 10b may be connected in

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any desired manner whereby the rods can be moved in a common plane about said articulated ends, and preferably the angular movement between the rods is limited to a predetermined degree. One manner of articulating the ends is shown in Fig. 7 wherein the adjacent ends of rods 10, 10a are chamfered, as shown at 10c, and are connected together by a link 15, the ends of which are respectively pivoted, as shown at 16, to the rods. The rods 10, 10a being shown as tubular, any suitable filler element (not shown) may be employed to fill the hollow end portions of said rods. The ends of the rods 10, 10a opposite to the articulated connection 10b are also pivotally connected to the anchoring means 13, 13a, in a manner to be presently explained.

The pair of rods 11, 11a, like the pair of rods 10, 10a are articulated at 11b in a manner analogous to that shown in Fig. 7, preferably the limit of the angular movement between the rods 11 and 11a being the same as between the rods 10 and 10a. The ends of the rods 11, 11a remote from the articulated connection 11b are connected to the anchoring means 13, 13a in a manner presently to be described.

The substantially diamond-shaped web 12 may be formed of any suitable tensionable material and when formed of woven fabric the warp and weft are preferably disposed substantially parallel to the sides of the diamond to better withstand the initial pre-tensioning strains upon the web when the structure is erected. To better allow for such tensioning uniformly along the edge and to fit nature of curvature of the space surface, the sides 12a of the web 12 are cut on a curve in the flat plane of hyperbolic shape. The sides of the web 12 may be secured to the rods 10, 10a and 11, 11a in any preferred manner such as by engaging around said rods and being stitched together.

The anchoring means 13, 13a as herein shown, each consists of a peg-like member having a flat top 13b to which is secured in any approved manner, such as by rivets or welding, an angle member 17, the angle of which will be determined by the angularity to which the articulated pairs of members may be moved about their respective pivots 10b and 11b. As aforementioned, the ends of the rods 10, 10a remote from the articulated connection 10b are pivotally connected to the upstanding flange 17a of the angular member 17, preferably by having the ends of the rods 10, 10a bifurcated to straddle the flange 17a to which they are then pivoted by a pin 18. The ends of the rods 11, 11a remote from the articulated end 11b may be connected to the flange 17a in an analogous manner to those of the rods 10, 10a, however, in order to give greater rigidity to the device when erected and in use, the connections between the rods 11, 11a and the flange 17 are made rigid.

The spreader and locking means 14, 14a for tensioning the structure when erected, each consists of a pair of links 19, 20, the remote ends of which are pivotally connected respectively at 21 and 22 to the rods 10 and 11, and the opposite end of the link 20 is pivotally connected at 23 to the link 19 intermediate its ends. The free end of the link 19 is formed with a bent lip 24 adapted to engage within a kerf 25 in the link 20, when the links 19 and 20 are brought into alignment.

Where the tensioned structure is to be used as a beach canopy or the like it may be readily erected by first spreading the rods 10, 10a and 11, 11a to the limits of their angular movement and with the rods so related the anchoring means 13, 13a are then inserted into the ground. The spreader and locking means 14, 14a are then moved to engage the lips 24 within the kerfs 25 to tension the web 12. When so tensioned, the web will assume the form of an hyperbolic paraboloid.

It will be readily appreciated that the device may be

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readily collapsed for storage by first disengaging the locking means, then moving the pairs of rods 10, 10a and 11, 11a into substantially parallel relation about their respective pivots 10b and 11b after which the pairs of rods may be brought together about the pivoted connections 18, in the course of which operations the web will fold between the respective rods which will all be in substantially parallel relation.

As shown in the drawings, the pair of rods 11, 11a are spaced from the ground when the canopy structure is erected but it will be apparent that the angularity between the pairs of rods 10, 10a and 11, 11a may be made as desired; also, that the lengths of the respective pairs of rods may be chosen as desired. Accordingly, if the pair of rods 11, 11a are mounted to extend in a common plane with the cap 17 of the anchoring means, the rods 11, 11a will extend substantially in contact with the ground.

In Figs. 1 and 3 of the drawings, the dot and dash lines extending over the web 12 are merely indicative of the generatrix of straight lines parallel to the edges that generate the hyperbolic paraboloidal surface when erected. It will be apparent that the fabric web 12 may be treated to render the same waterproof and fire-resistant.

From the foregoing detailed description it will be apparent that I have provided a pre-tensioned space structure possessing characteristics and adapted for accomplishing the objects of the invention set forth in the opening statement of the specification and, although I have shown but a single embodiment of the invention, it is to be understood that the details of construction and proportion of parts may be varied within the range of engineering skill without departing from the spirit of the invention as hereinafter claimed.

What I claim is:

1. A tensioned space structure comprising a web having a generally diamond shape, the edges of which are secured respectively to two pairs of rods, the rods of the respective pairs being connected to each other at adjacent ends and adapted to provide an angle so as to be spread apart at their opposite ends, anchoring means to which are connected the opposite end of one rod of each pair of rods respectively for positioning the rods of each pair at an angle to one another, said anchoring means adapted to be anchored in spaced relation to a support to hold the pairs of rods in their angular relation, and spreader means connecting the rods of each pair of rods

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which are connected to the same anchoring means for holding said rods and the web carried thereby in tension.

2. A structure as defined in claim 1 wherein the opposite ends of the rods of one pair of rods are pivotally connected to the anchoring means and the opposite ends of the rods of the other pair of rods are rigidly connected to the anchoring means.

3. A collapsible space structure that is adapted to be erected and tensioned, comprising a flexible web having a generally diamond shape, the edges of which are secured respectively to four rods, each substantially equal to a side of the diamond shaped web, said rods constituting a first pair and a second pair of rods, the rods of each pair being articulated together at one end for limited angular movement in a plane, the first pair of rods having their other ends articulated respectively to each of two anchoring means, the rods of the second pair having their other ends connected respectively to each of the two anchoring means, said anchoring means being adapted for anchoring in spaced relation to a support, and spreader and locking means pivotally connected to one rod of each of the two pairs of rods adapted when the pairs of rods are articulated to their full angular movement to an open position and the anchoring means are fixed to a support to lock the rods in such position and impart to the flexible web the form of an hyperbolic paraboloid.

4. A structure as defined in claim 3, wherein, when the locking means of the spreader are disengaged and the anchoring means are withdrawn from the support, the rods of each pair can be brought into substantially parallel relation and the rods of both pairs brought into substantially parallel relation with the web folded between the various rods.

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