

April 1, 1969

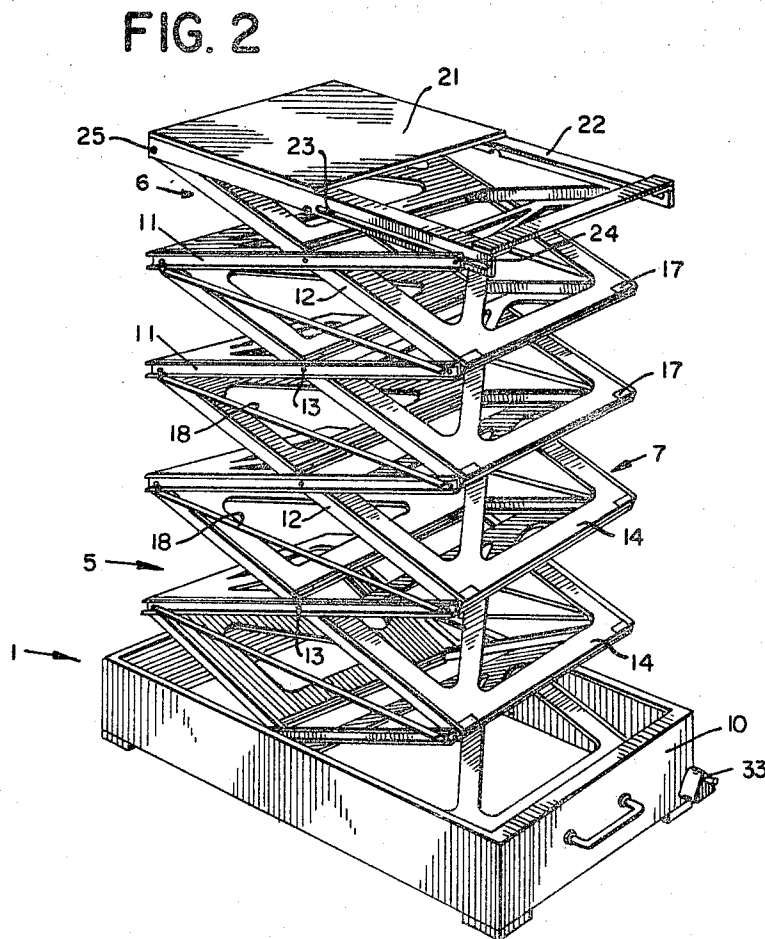
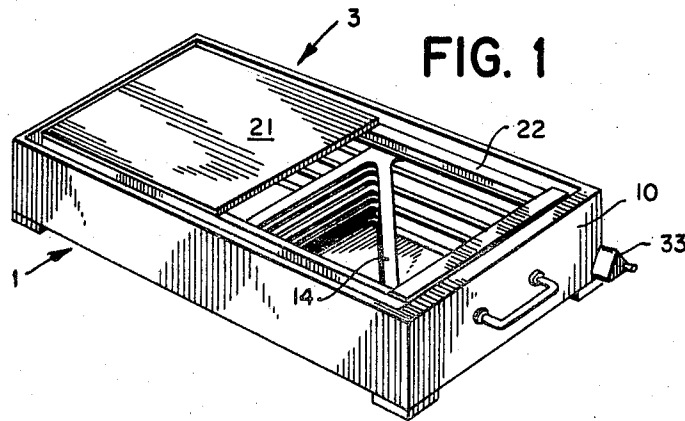
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3,435,570

ERECTABLE STRUCTURE WITH SCISSORS LINK

Filed Sept. 23, 1966

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FIG. 3

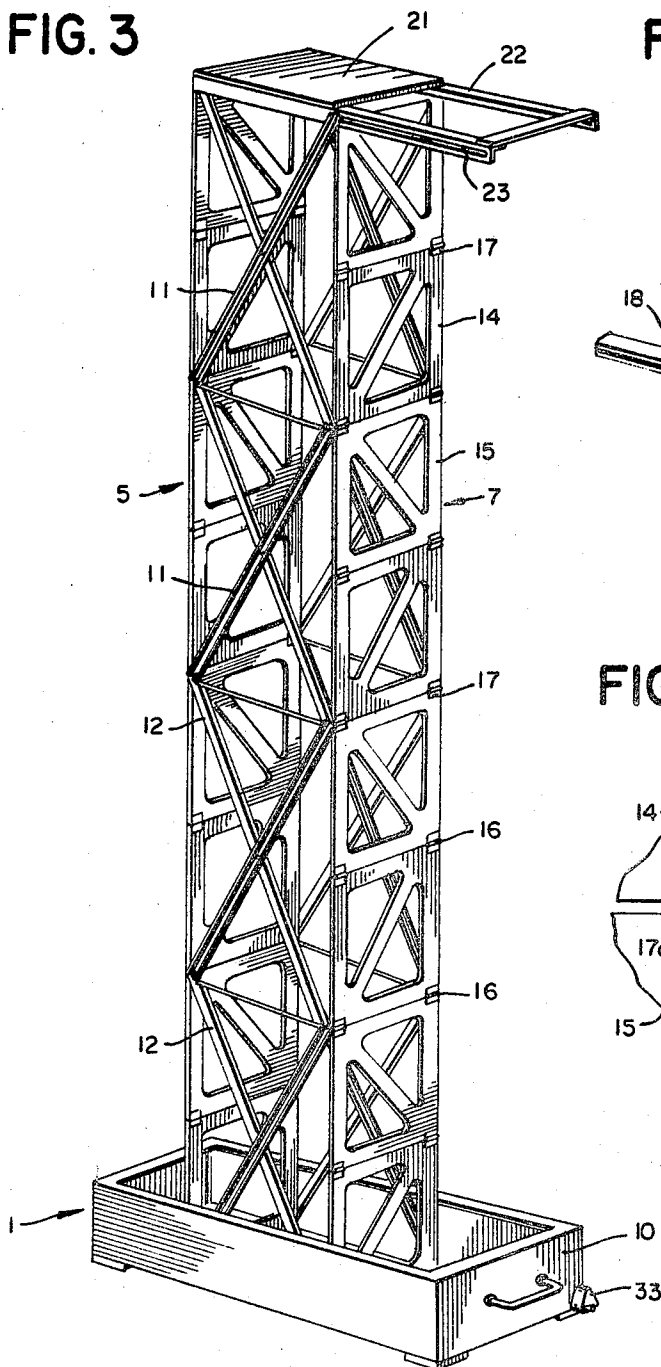


FIG. 4

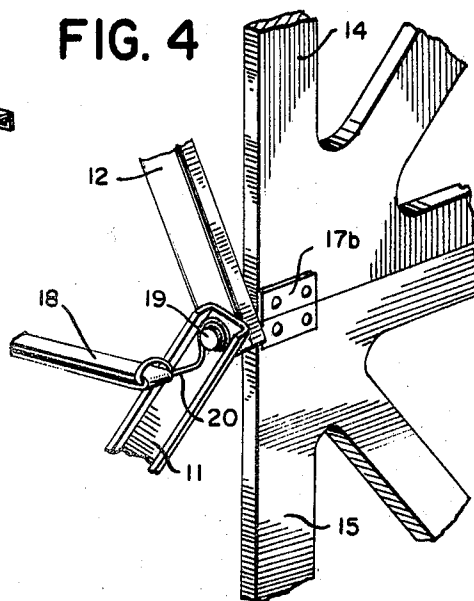
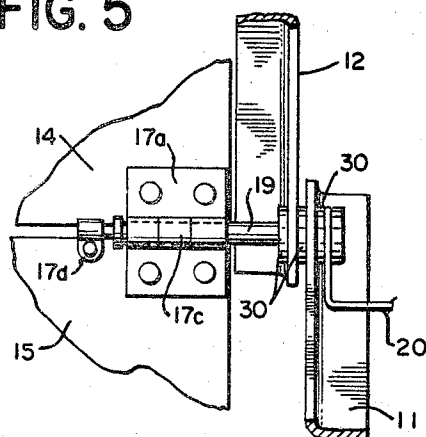


FIG. 5



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ERECTABLE STRUCTURE WITH SCISSORS LINK

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8 Claims

ABSTRACT OF THE DISCLOSURE

An erectable structure having a number of pairs of oppositely disposed scissors links connected in end-to-end relationship. A foldable, multi-section structural panel is connected between the ends of each pair of oppositely disposed links, the panel folded inwardly when the structure is packed and folding outwardly when the structure is deployed to provide a box-like structure.

This invention relates to an erectable structure employing scissor links that can be extended into an erect position from a collapsed position.

Erectable structures using scissors link members for deploying the structure from a collapsed condition to one of extension and holding it there are known in the art. However, such structures heretofore known possess the disadvantage of low strength, particularly in the direction of structure's elongated axis when extended. Therefore, they have not been capable of use under high load conditions.

The present invention provides an erectable structure occupying a relatively small volume in its collapsed condition, which can be extended a substantial distance and still have the capability of resisting high bending torsional and axial loads.

In accordance with the invention pairs of scissor links are used as the structure erecting members and these links are reinforced in the erected condition of the structure by structural panels which extend in a direction generally parallel to the elongated axis of the erected structure.

It is therefore an object of the present invention to provide a novel erectable structure employing scissors links as the erecting members and a plurality of structural reinforcing panels.

A further object is to provide an erectable structure formed by a number of modules which are interconnected in a cooperating manner for deploying the structure.

Another object is to provide an erectable structure having elastic members to aid in the structure deployment.

Other objects and advantages of the present invention will become more apparent upon reference to the following specification and annexed drawings in which:

FIGURE 1 is a perspective view of the apparatus of my invention in a collapsed storage arrangement;

FIGURE 2 is a perspective view showing the structure in a partially erected condition;

FIGURE 3 is a perspective view showing the structure in a fully erected position;

FIGURE 4 is a perspective view showing the interconnection of the various elements; and

FIGURE 5 is a perspective view showing the reverse side of the portion of the structure shown in FIGURE 4.

Referring to the drawings, a container 1 of any suitable material is provided as a storage receptacle for the collapsed erectable structure 3. The erectable structure is formed by a desired number of interconnected modular units 5 (see FIG. 3). Each unit 5 includes a pair of oppositely disposed scissors links 6 which effectively define two opposing sides of the module. Each scissor link 6 is formed by a pair of rigid lifting arms, 11 and 12 which are interconnected at their centers by a pivot member 13.

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Arms 11 and 12 can be formed with any desired shape, for example, channels and tubes, which can be made of any suitable conventional structural materials.

Each module 5 also includes substantially identical and oppositely disposed structural panels 7 formed by two foldable pieces 14 and 15 connected together by intermediate hinges 16 which can open at least 180°. A pair of panels are connected to a pair of scissors links 6 to form a generally rectangular box-like module when the structure is fully deployed.

To form the erectable structure 3, a number of modules 5 are interconnected together to operate in a cooperative manner. As shown in FIG. 4, the ends of the scissors link arms 11 and 12 of two adjacent modules are pivotally connected together by any suitable means, such as bolts 19, which pass through holes in the arms. Each bolt 19 has shoulders 30 thereon to separate the arms and keep them spaced apart and from the panels to permit the latter to move freely. One leaf 17a (FIG. 5) of a hinge is fastened to a cover of each panel by suitable fasteners which extend through a back-up plate 17b on the outer surface of the panels. The knuckles 17c of the hinge protrude inwardly from the inner surface of the panels and are held together by an extension of the bolt 19 which serves as a hinge pin. The end of the hinge pin is held stationary by a fastener 17d mounted on an edge of one of the panels. A similar hinge arrangement is shown at each corner of two adjacent modules. It should be understood, of course, that any suitable hinge arrangement can be used. The hinges 16 and 17 are so arranged with respect to the panels and scissors links to allow the panels to collapse inwardly toward pivot point 13 when the structure is collapsed.

To aid in the deployment of the structure and to provide additional stability for the structure when erected, an elastic member such as a band 18 is provided between opposing connecting points of two modules on the same side of the structure. The elastic band 18 is connected to one end of a bracket 20 whose other end is held free to rotate on bolt 19 under a retaining lug 20. The band 18 which may be made of any conventional elastic material, such as rubber, is in a stretched condition when the structure is in its undeployed configuration, and in tension when the structure is to be erected to thereby resist outward movement of the module connecting points. Also, as best shown in FIG. 2, the bands 18 aid in deploying the structure. As can be seen, the pull exerted by bands 18 between the ends of the arms of each scissors link tends to move each link to an extended condition thereby assisting in the deployment of the structure.

As shown in FIGS. 1-3, the top module of the structure has a plate 21 which may extend entirely or part way across the module when deployed. Angle members 22 are provided on the bottom of the top module in place of elastic bands 18 to provide lateral stability. The angle members 22 are of substantially the same length as the link arms 11 and 12 are provided with a slot 23 from near the outside end of the angle to the middle of the angle. The end of arm 11 of the top module is provided with a lug 24 which slides in slot 23 while arm 12 is pivotally mounted at point 25 at the opposite end of angle 22.

The entire structure, in a collapsed condition, is stored in container 10. To erect the structure a handle 33 is rotated which in turn is connected to a screw drive mechanism (not shown). The screw drive draws the bottom ends of scissors arms 11 and 12 of the lowest module together, which in turn by scissors action and with the help of bands 18 forces the other modules into an erect position until all of the panels 14 and 15 are vertical on each side of the module. The power for the deployment may be electrical, pneumatic, manual or mechanical and may be provided by pistons as well as by screws.

The structure as described herein may be used to provide a spacecraft docking boom, a crew transfer bridge

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between spacecraft or other vehicles, a structure for assembly of a space station or space platform and a boom on which to mount solar cells, solar collectors, radiation receiving or transmitting devices such as antennas, cameras and other sensing devices. Additional uses include erectable, mobile or portable buildings such as control or observation towers, erectable, mobile or portable antenna towers, structural members for building construction and erectable, mobile and portable bridges.

The structure as disclosed herein has characteristics roughly the same as those of an equivalent truss-work box beam. The expansion ratio achievable with this device is in the order of over 30:1 compared with its undeployed condition. The collapsed structure has a height equal substantially to the sum of the thicknesses of the total number of panels 14 and 15 forming one side of the structure, a width equal substantially to the distance between the scissors links on opposite sides of a module and a length equal substantially to the length of two panels or one scissors link arm.

While a preferred embodiment of the invention has been described above, it will be understood that it is illustrative only, and the invention is to be limited solely by the appended claims.

What I claim is:

1. An erectable structure comprising a modular unit including a pair of oppositely disposed extendable scissors links, each link having a pair of arms pivotally connected intermediate their ends, a pair of foldable, multi-section structural panels, said pair of panels being oppositely disposed generally transverse to the pair of links, and pivotal means connecting each set of ends of the pair of scissors links to a respective foldable multi-section panel, each panel folding inwardly when the links are retracted and folding outwardly when the links are extended to form a generally box-like modular unit with the panels being on two opposing sides of the structure.

2. An erectable structure as in claim 7 wherein each multi-section panel is foldable at a point which lies in the same plane as the pivot point of the pair of scissors links forming the modular unit.

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3. An erectable structure as in claim 1 further comprising a plurality of said modular units, and pivotal means connecting the corners of each of the modular units to which the ends of the links are connected to the corresponding corners of the next adjacent modular unit.

4. An erectable structure as in claim 1 further comprising resilient means connected to the opposing arms of a link to draw the same together.

5. An erectable structure as in claim 3 further comprising means for pivotally connecting together the ends of the links of adjacent modular units.

6. An erectable structure as in claim 5 wherein the structural panels and scissors links of all of the modular units on a respective side of the structure lie substantially in the same respective plane when the structure is fully deployed.

7. An erectable structure according to claim 5 further comprising means for drawing the arms of a plurality of links toward each other to aid in the erection of the structure.

8. An erectable structure as in claim 7 wherein said means for drawing the arms of a link together comprises a resilient member, and means connecting said resilient member to the arms of a pair of links on adjacent modular units.

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U.S. Cl. X.R.

52—111, 645; 108—145; 182—118, 141; 248—157