

Jan. 23, 1962

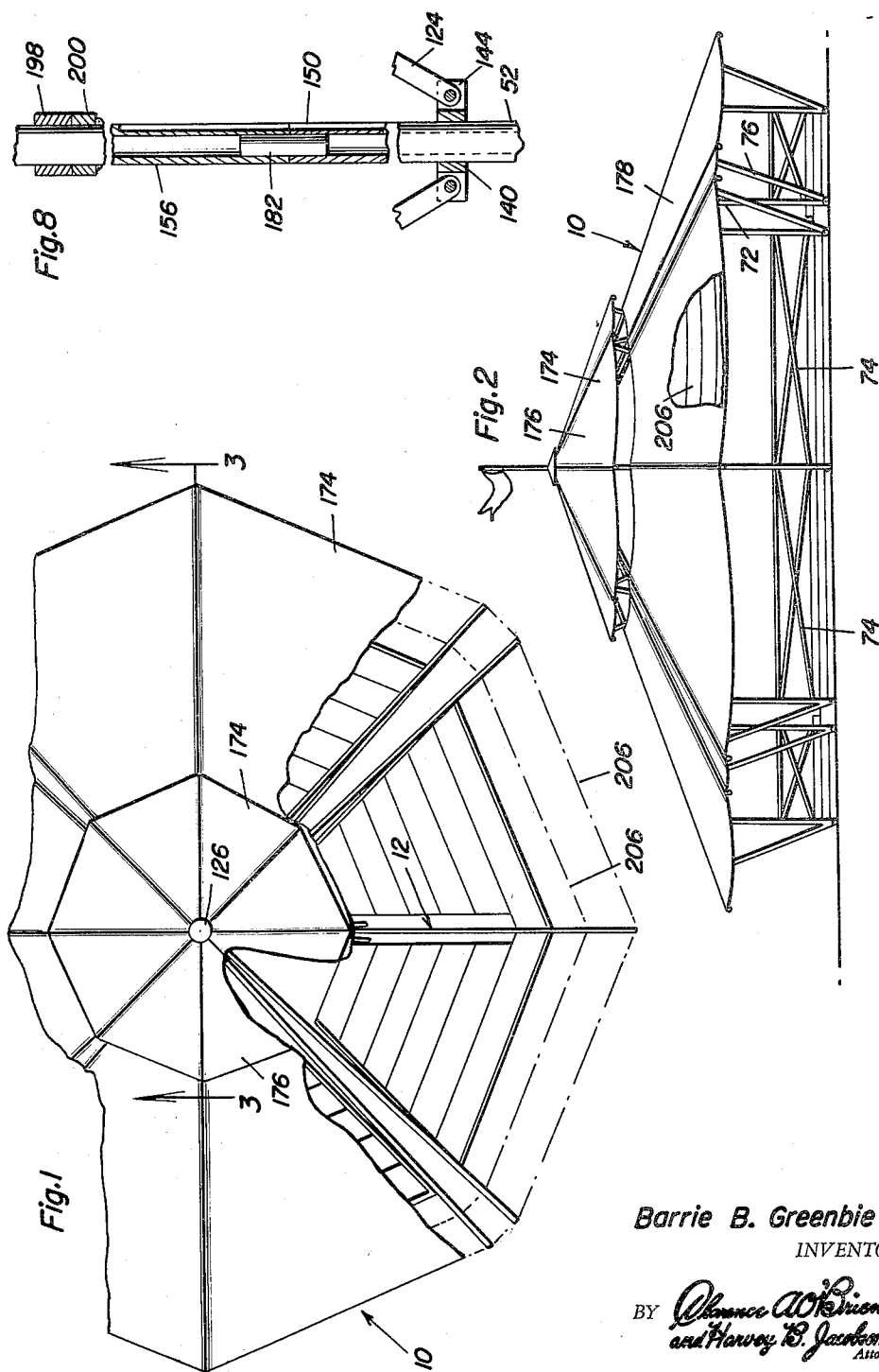
B. B. GREENBIE

3,017,893

COLLAPSIBLE BUILDING STRUCTURE

Filed Sept. 2, 1958

5 Sheets-Sheet 1



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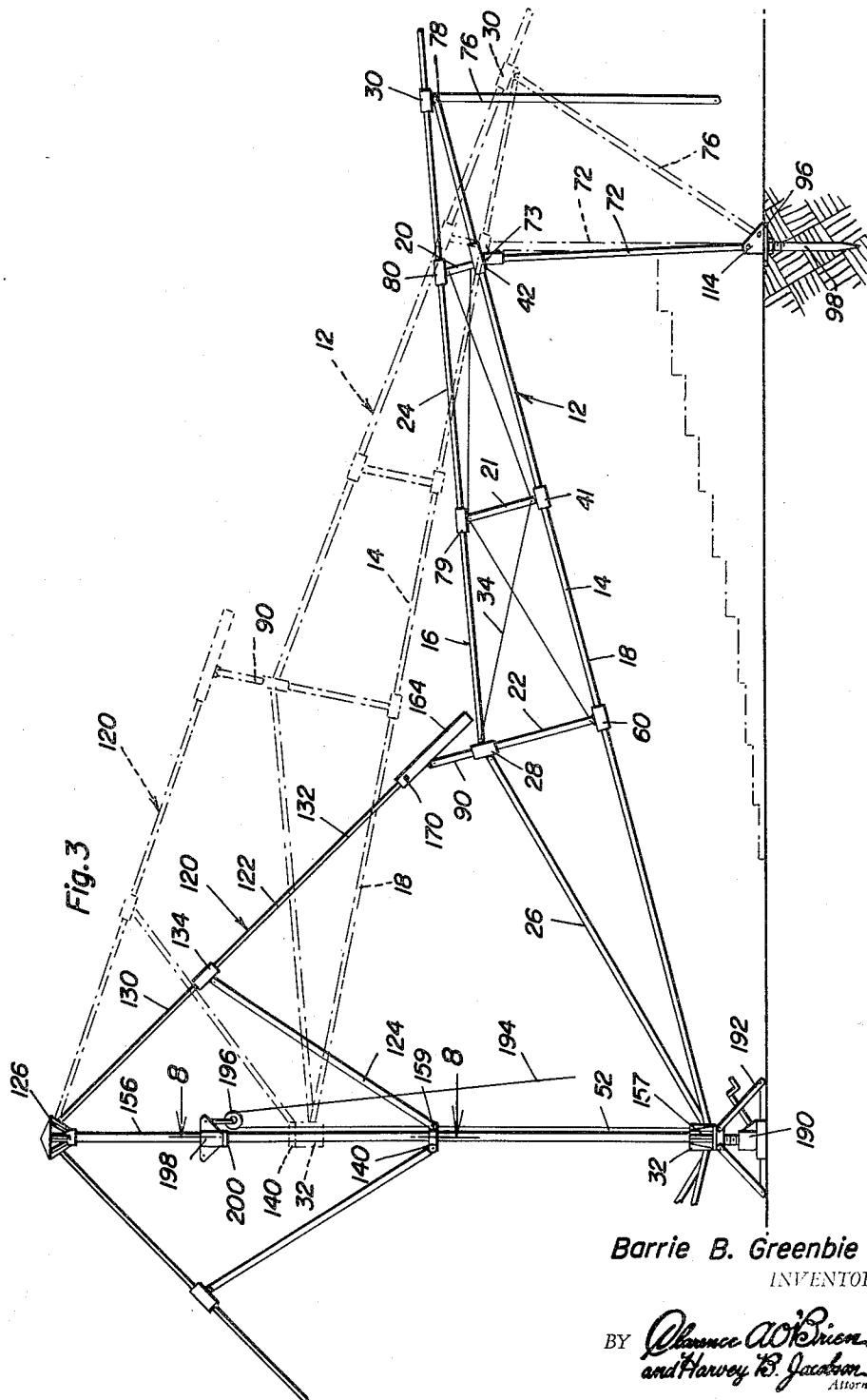
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COLLAPSIBLE BUILDING STRUCTURE

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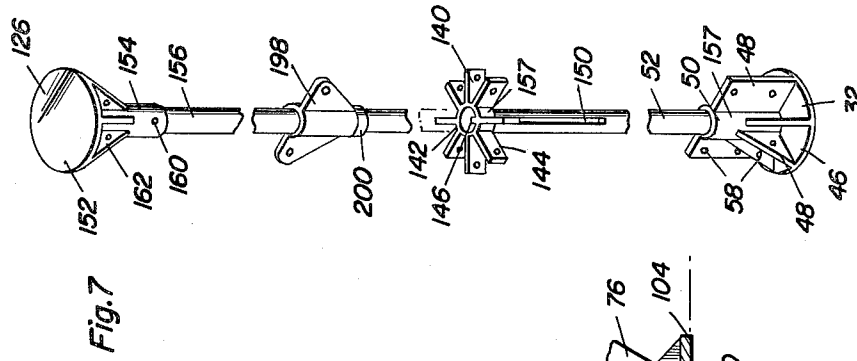
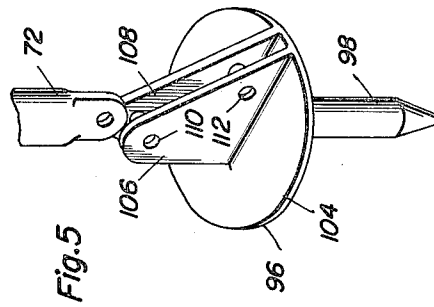
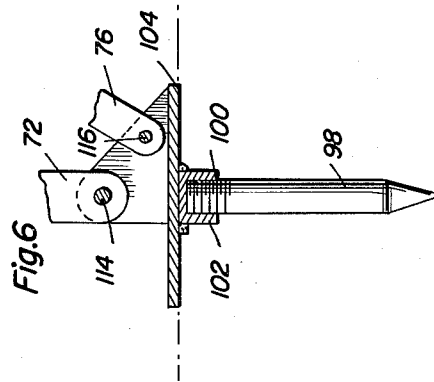
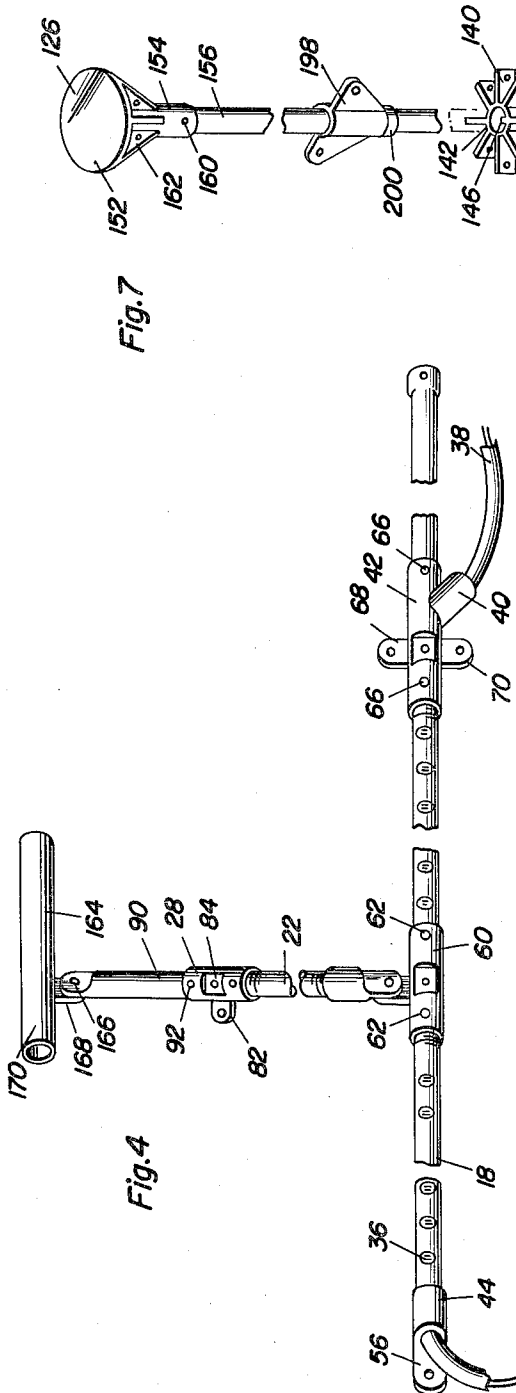
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COLLAPSIBLE BUILDING STRUCTURE

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5 Sheets-Sheet 3



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COLLAPSIBLE BUILDING STRUCTURE

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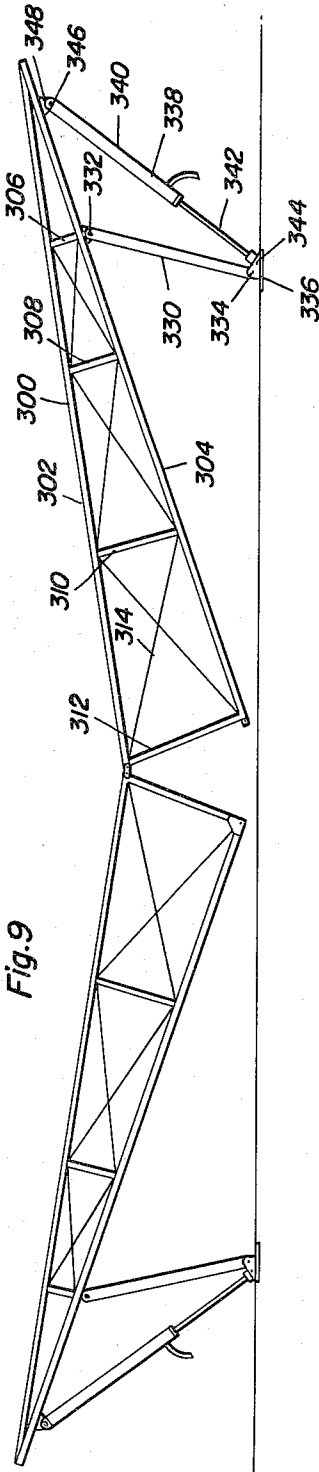


Fig. 9

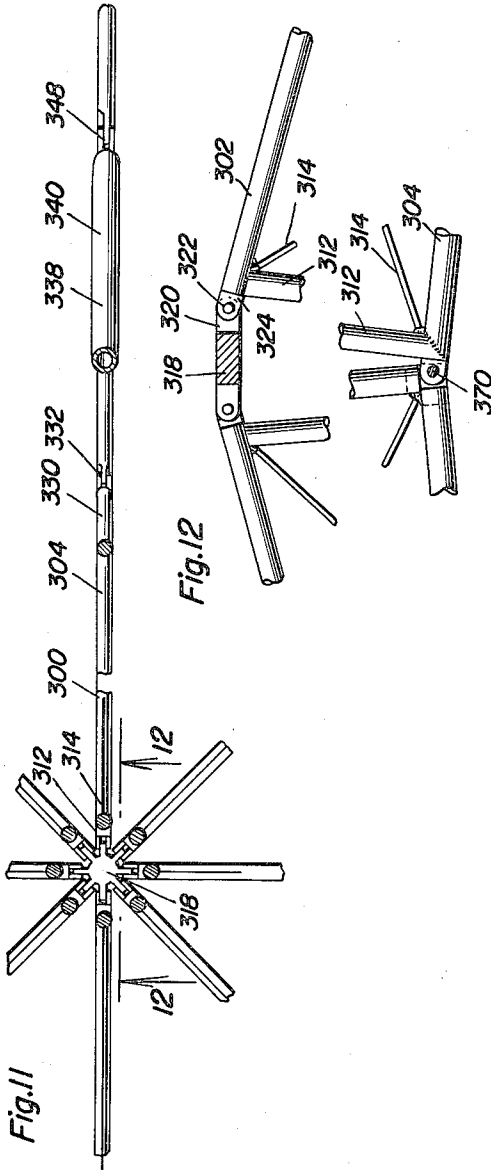


Fig. 11

Fig. 12

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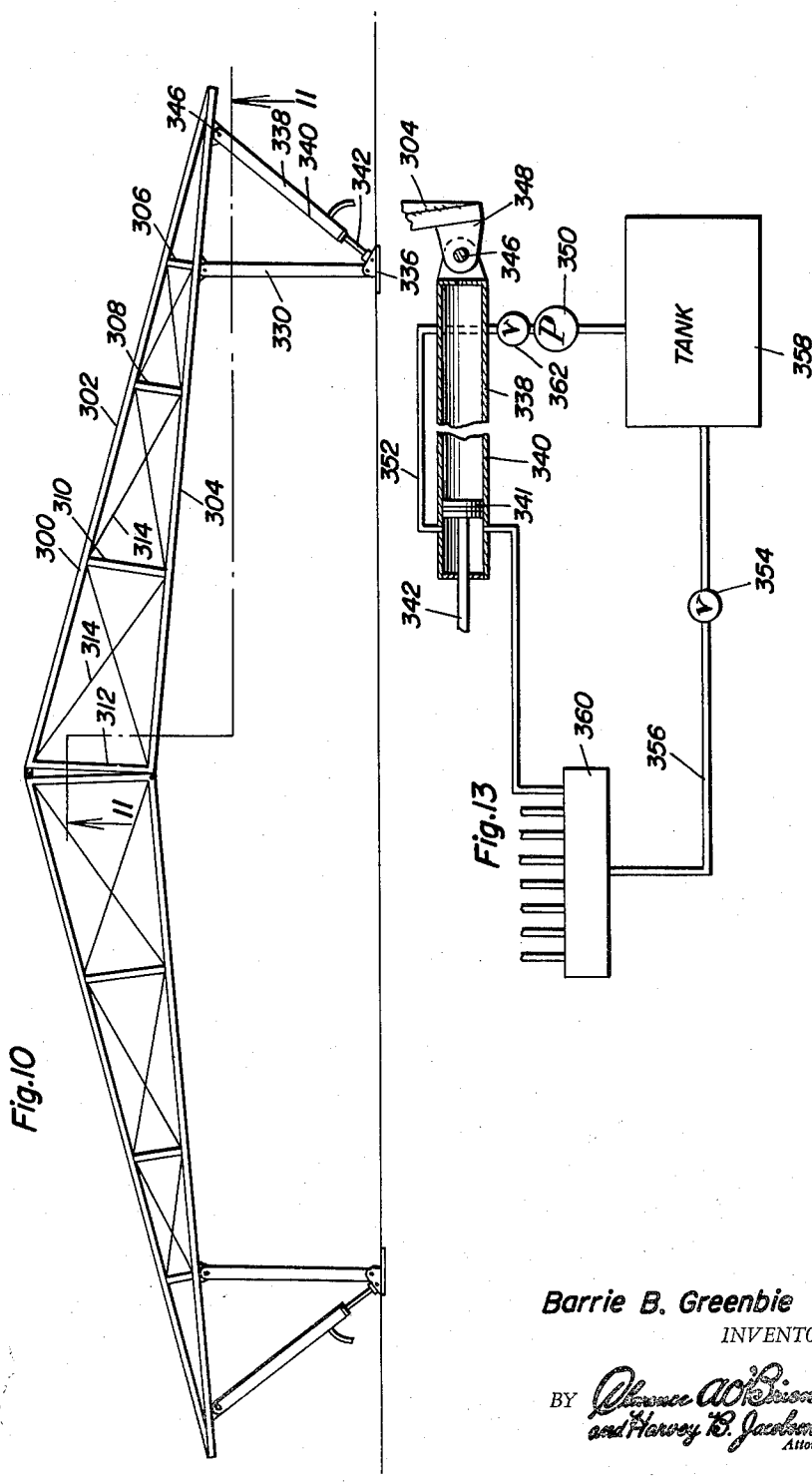
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COLLAPSIBLE BUILDING STRUCTURE

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5 Sheets-Sheet 5



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3,017,893

COLLAPSIBLE BUILDING STRUCTURE

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7 Claims. (Cl. 135—7.1)

This invention relates to structures and more particularly to collapsible structures of the type which may be erected on a site, used, then taken down for storage or for transporting to a new site for subsequent erection.

Although the invention deals principally with a portable structure, it is to be understood at the outset that it is unnecessary that the structure be moved from one place to another. The principles of the invention are applicable equally between portable and stationary structures.

The invention provides a lightweight rigid framework for supporting a tent-like covering of plastic or other material, without interior posts or other interior supports that are located in such position as to obstruct vision from within the building.

The structure of this invention is ideally suited for a portable theater but, of course, the actual use of the structure is left within the prerogative of the owner. For instance, military installations have used numerous Quonset huts, and the principles of this invention are applicable as a substitute for a Quonset hut or as a building companion thereto. This means that this invention has application in connection with garages and many other types of occupations, trades, etc.

An object of the invention is to provide a building structure which is easily assembled with a minimum crew but yet, which provides a very sturdy, lightweight, functional and architecturally distinctive building structure with no columns or posts to obstruct vision from anywhere within the area enclosed by the building structure.

To achieve this, the invention has a plurality of cantilever trusses and exterior struts which eliminate the need for interior poles and exterior guy ropes, making the framework a self-supporting, free standing structure that is stable and which may be put to any number of uses.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a top view of a collapsible building structure constructed in accordance with the invention, parts being broken away to illustrate otherwise hidden detail.

FIGURE 2 is an elevational view of the structure in FIGURE 1.

FIGURE 3 is an enlarged fragmentary view showing one of the trusses during erection.

FIGURE 4 is an enlarged perspective view of a construction detail showing principally the wiring in the lower chord member of one of the trusses.

FIGURE 5 is a perspective view of one of the anchors used in the structure.

FIGURE 6 is a sectional view of the anchor in FIGURE 5.

FIGURE 7 is an exploded perspective view showing a portion of the temporary center post used for erection and the various parts of the structure thereon.

FIGURE 8 is an enlarged sectional view taken on the line 8—8 of FIGURE 3.

FIGURE 9 is a largely diagrammatic view showing only two of eight trusses in a modification of the invention.

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FIGURE 10 is a diagrammatic view of the embodiment in FIGURE 9 showing the two trusses erected.

FIGURE 11 is a sectional view taken approximately on the line 11—11 of FIGURE 10.

FIGURE 12 is an enlarged sectional view taken on the line 12—12 of FIGURE 11.

FIGURE 13 is a diagrammatic view showing a hydraulic or pneumatic system for erecting the structure of FIGURE 9.

In the accompanying drawings there are two embodiments of the invention which are illustrated, although the principles of the invention are applicable with numerous forms, variations and embodiments of collapsible structures. There is a collapsible building structure 10 in FIGURES 1—8, and this structure is portable. However it is to be understood that the same structure may be erected permanently or for extended periods of time without in any way affecting the invention. Taking full advantage of the advance made in this art, though, the portable phase of the invention must be considered. Structure 10 has a framework 12 made of a plurality of radial trusses. Eight such trusses have been found to be practical for erecting a building suitable for a portable theater, although this number may be increased or decreased depending on the size and nature of the building desired. A typical truss 14 (FIG. 3) is made of an upper chord member 16 and a lower chord member 18 with connecting members 20, 21 and 22 attached by fittings to the upper and lower chord members. The upper chord is made in two parts 24 and 26 which are attached to fitting 28 at their adjacent ends and which are attached at their outer ends to fitting 30 and slide 32 respectively. Guy wire bracing 34 is crossed between adjacent members 20, 21 and 22 in order to accept some of the tension stresses that are applied to the truss during and after erection.

The lower chord member 18 is shown in detail in FIGURE 4. It is hollow, as are essentially all other parts of the trusses and the remainder of the structural components in the framework 12. This is for weight economy. Moreover, using hollow members enables electrical wiring to be concealed within the framework. A group of sockets 36 are connected to the lower chord member 18 with the wiring 38 for the passing into the lower chord member by way of a sleeve 40 on fitting 42. This is the fitting to which brace 21 is fastened. Fitting 44 has wiring 38 passed through it, fitting 44 being at the inner end of the lower chord member 18 and used to facilitate attaching the lower chord member to the slide 32.

Slide 32 (FIG. 7) is made of a base plate 46 with a plurality of radial brace plates 48 fixed to it and fixed to the sleeve 50, the latter welded or otherwise secured to base plate 46 and in alignment with an opening in the center thereof. The slide is adapted to move vertically on the temporary post 52 at the center of the building structure framework to facilitate erection. The major part of the post is removed after erection so that it does not obstruct vision from anywhere within the enclosure of the building. Fitting 44 is a nipple threaded or otherwise attached to the inner extremity of the lower chord member 18, and it has an ear 56 with an opening to accommodate a hinge pin. The hinge pin is passed through one of the apertures 58 in one of the plates 48 of slide 32. Fitting 60 in the lower chord member 18 is a sleeve which is attached by pins 62 to the adjacent ends of the lower chord member parts or sections. Here again, pins 62 are suggested due to their ease of assembly and economy, although other fasteners such as screw threads could be used. Fitting 41 (FIG. 3) to which brace 21 is secured, is identical to fitting 60. However, fitting 42, to which brace 20 is attached, is slightly different because it has sleeve 40 through which the cable or other wiring 38 is

passed. Although the fitting 42 is selected for accepting the wiring, this being the most practical point of entry, it is to be understood that the electrical outlets 36 may be provided in any number of other hollow structural members of the framework in addition to the lower chord members of the trusses or in lieu of the lower chord members of the trusses. Fitting 42 is constructed of a sleeve having pins 66 that attach the ends of the adjacent parts or sections of the lower chord member to the fitting. Upper ear 68 protruding from the sleeve of the fitting 42 has brace 20 connected to it by means of a pin. Lower ear 70 has an aperture in it to accept a pin by which upright or post 72 is pivoted to the fitting. This post or upright is not within the enclosure of the building structure 10. On the contrary, it constitutes a part of the wall of the building should a curtain or backdrop be desired. Moreover, diagonal bracing 74 may be attached to the posts 72, there being one for each truss. The final fitting 30 on the lower part of the truss 14 is constructed of a sleeve to which adjacent parts of the upper chord member part 24 are secured, and it has a depending ear (FIG. 3) to which diagonal brace 76 is secured. Further, the depending ear has the final or outwardmost part of the lower chord member connected thereto for instance, by being attached to the same hinge pin 78 that is used for diagonal brace 76.

The upper chord member 16 has fittings 79 and 80 that are of identical construction, consisting of a sleeve with a depending apertured ear to which the braces 20 and 21 are pinned. Fitting 28 has an ear 82 protruding laterally from it and to which the part 26 of the upper chord member 16 is pinned. A flat walled notch 84 is in the sleeve of fitting 28 and it has a hole to accept a pin by which another part of section of the upper chord member is fastened. There is a member 90 that forms an axial extension of brace 22, and this is connected by pin 92 to the fitting 28 (FIGS. 3 and 4). A part of an umbrella-like framework is operatively connected with member 90 and will be described subsequently.

Returning now to the post 72 and the diagonal brace 76, attention is invited to FIGURES 5 and 6. Anchor 96 is convertible so that it may be used for piercing the soil or on a solid foundation. When the collapsible structure is to be erected on soil, sod or any other type of ground without a concrete or like foundation, anchoring pin 98 is pierced into the soil. The anchoring pin has a sharp end and a threaded end 100 which is adapted to be threaded into socket 102. The socket is secured to anchor plate 104, for instance, by being welded or brazed, and separably holds the anchoring pin 98. When the structure is to be erected on a more solid base, for instance on concrete, asphalt, etc., the anchoring pin 98 is removed and replaced by a foot. In either case, anchor plate 104 accommodates the lower ends of post 72 and brace 76. A pair of parallel plates 106 and 108 are welded or otherwise secured to plate 104 and they are spaced apart sufficiently to accept the lower extremities of the post 72 and brace 76. Pairs 110 and 112 of aligned apertures are in plates 106 and 108 so that pins 114 and 116 may pass through them and through apertures in the lower extremities of the brace 76 and the post 72. It is evident from inspection of FIGURE 3 that diagonal brace 76 remains idle during erection. But as soon as the truss has been elevated to the correct position (shown in dotted lines in FIG. 3), the diagonal brace 76 is fastened by pin 116 to the anchor 96. Moreover, during erection post 72 is capable of hinged movement about its pin 114 connecting it to anchor 96.

The previously referred to umbrella-like frame 120 has for each truss, a pair of frame members 122 and 124. The frame member 122 extends from the crown 126 to the previously referenced member 90 shown as a longitudinal coaxial extension of brace 22 of truss 14. The member 122 is made in two sections 130 and 132 connected by fitting 134. The fitting 134 is a sleeve into which the con-

fronting ends of sections 130 and 132 are placed and pinned. The frame 120 member 124 is connected to an ear on fitting 134 by a hinge pin and is connected to collar 140 that is slidable on temporary post 52. As shown in FIGURE 7 collar 140 is made of a ring 142 with a plurality of short radial arms 144, there being one arm for each brace 120 and more particularly, one arm for the frame member 124 of each frame 120. A pin is used to connect the inner end of member 124 to one of the short arms 144. Further, the ring 142 has a key 146 protruding radially inwardly, and the key slides in a keyway or slot 150 that extends longitudinally in the temporary post 52. The key 146 operating in the key slot 150 prevents the collar 140 from rotating but permits it to slide vertically on the temporary post.

Crown 126 has an upper plate 152 which may be ornamented or shaped in any other way, for instance conical as shown. The crown plate 152 is secured to a sleeve 154 that fits on the center post 156. This is a short coaxial extension of the temporary post 52 that remains high in the collapsible structure and therefore, is well out of the line of vision of any of the occupants of the building structure. Pin 160 is used to attach the sleeve 154 to the center post 156, and there are a number of radial brace plates 162 attached to plate 152 and to sleeve 154. These plates are apertured so that the inner extremity of section 130 may be attached to one of them by a pin. The outer extremity of section 132 is disposed in sleeve 164. This sleeve is connected by a pin 166 to the upper end of member 90, the pin 166 passing through aligned openings in member 90 and an ear 168 that is fixed to sleeve 164. There is a pinhole 170 in sleeve 164 by which to accept a pin for attaching the section 132 to the sleeve. As shown in FIGURES 2 and 3, the length of member 90 will determine the final spacing between the umbrella-like frame 20 and the remainder of the framework consisting chiefly of the trusses. This spacing furnishes ventilation for the interior of the building structure. Furthermore with the use of frame 120 and framework 12, the covering 174 may be applied in two sections 176 and 178 to facilitate handling. The section 176 is attached onto the frame 120 and all others like it. The covering 178 is attached to the upper chord of each truss. There is a wide selection of suitable coverings that are commercially available at the present time. However, a lightweight tough and sturdy covering is suggested, such as plastic, e.g. "Orlon" or nylon, impregnated fabric.

The temporary center post is made of tubular construction and is separably attached to the permanent center post 156. One possible method of attachment is shown in FIGURE 8. In this figure there is a dowel 182 attached to either post 52 or post 156 and slidably fitted into the bore of the other. The lower end of the temporary center post 52 is disposed on a jack 190 at the center of the proposed site. The jack may be any conventional jack operated manually. A jack stand 192 is used with the jack and furnishes a guide for the piston, screw, etc. of the jack. This phase of the collapsible building structure is definitely variable since numerous jacks are commercially available and most of them will serve the purpose very well. In any case, when the jack is operated it lifts the temporary center post 52 and the center post 156 to the correct height. Slide 32 is elevated, and to facilitate lifting the slide to which all of the trusses are secured, a chain fall may be used. Since the framework is so light in comparison to its size, elaborate equipment for lifting slide 32 is unnecessary. Therefore, a rope 194 is shown entrained over a pulley 196 and secured to the slide 32. The pulley 196 is hung from a collar 198 that is slidable on the post 156 but whose downward travel is limited by fixed collar 200 that is either permanently or adjustably attached onto the post 156. As rope 194 and any others identical to it, are pulled, slide 32 is lifted thereby pivoting each

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truss 14 about hinge pins 114 and hinge pins 73 that attach post 72 to fitting 42 and each of the other posts that are identical to post 72 and fittings 42. At the same time all frames 120 are elevated (see dotted line position of FIG. 3) with the movement thereof imparted to the frame 120 by member 90 pushing upwardly on frame member 122. Collar 140 slides upwardly onto the post 156 to an over-center position so that all of the trusses now tend to move downwardly, but cannot because they remain locked in the elevated position by pins 157 and 159 entering apertures in post 156 and frame members 120 locked by pin 170 to fitting 164 as described elsewhere. Braces 76 are made secure to the anchors 96, and the building is now in the erected condition insofar as its framework is concerned. Each of the trusses attains lateral support from the other by a network of cables 206 extending between adjacent trusses and fixed thereto by cable connectors, welding or other standard techniques. Furthermore, the network of cables 206 provide for intermediate support of the covering 174.

Now, the temporary center post 52 may be removed by lowering jack 190 and slipping it from the bottom of the post 156. This leaves the entire enclosed area open and yet, the building structure is quite easily disassembled and assembled. The interior of the collapsible building structure may accommodate anything whatsoever, one or two possible uses having been discussed previously. To select but one use, note that for theatrical productions, the stage may be at the center or along any wall of the structure.

Reference is now made to FIGURES 9-13. A modification of the invention shows only a part of a finished building. This is a simplified form of the invention, omitting frame 120 for each truss, but illustrating that it is within the contemplation of the invention to use power equipment to aid in the erection of the building. Secondly, the temporary center post is not absolutely necessary and may be omitted. To be consistent with the embodiment of FIGURE 1, the embodiment in FIGURES 9-13 has eight trusses, one truss 300 of which is shown in detail. The truss 300 has an upper chord member 302 and a lower chord member 304 connected together by braces 306, 308, 310 and 312. Crossed cables 314 extend between the braces 306, 308, 310 and 312, and the cables may be attached by any available means, for instance by cable connectors or by being permanently secured. A center disc 318 having a plurality of radial arms 320, is located at the adjacent corners of each truss, each corner being at the junction of the upper chord member 302 and brace 312. The radial arms have apertures by which to accommodate hinge pins. There is a hinge pin 322 passed through an aperture in one of the arms 320 and through an ear 324 at the junction of upper chord member 302 and brace 312 (FIG. 12). The disc 318, then, constitutes means by which to hingedly connect the trusses together at a center, inasmuch as the trusses are radially arranged (FIG. 11).

Post 330 is connected by hinge pin 332 to a depending ear attached to the lower chord member 304 near its outer extremity. The lower end of the post 330 is pivoted by hinge pin 334 to an anchor 336 attached to or resting on a supporting surface. The anchor may assume any configuration, for instance it may be the same as the anchor in FIGURE 5. What responds to the diagonal brace in the embodiment of FIGURE 1, serves an additional function in the embodiment of FIGURE 9. The diagonal brace 338 of FIGURE 9 is made of a cylinder 340 and a piston with piston rod 342. The piston rod is attached by a hinge pin 344 to one or more plates of anchor 336. The cylinder 340 is attached by hinge pin 346 to an ear 348 that depends from the lower chord member 304.

As shown in FIGURE 13 a fluid system may be used

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for retracting the piston 341 into cylinder 340 thereby foreshortening the brace 338. The pivotal post 330 then acts as a fulcrum about which the truss swings in being elevated. FIGURE 13 has merely a diagrammatic representation of a typical fluid system. The fluid may be either liquid or gaseous inasmuch as it is within the purview of the invention to use hydraulic systems or pneumatic systems. FIGURE 13 shows a conventional compressor or pump 350 connected by line 352 to one end of the cylinder 340. When air or liquid is applied into the cylinder in this way and under pressure, the piston 331 moves inwardly of the cylinder thereby causing the erection of the truss with which the brace is operatively connected. Valve 354 is in the return line 356 that goes to tank 358. Manifold 360 is in return line 356, there being one return line from each cylinder of each truss and of course, one feed line which will be the same as line 352 for each cylinder.

When the trusses are erected by the application of fluid (gaseous or liquid) under pressure, the valve 354, in the diagrammatic system shown, remains closed. Thereafter valve 362 in line 352 between the compressor or pump 350 and cylinder 340 is closed thereby trapping the liquid or air in the cylinder. In addition or as an alternative, a mechanical lock may be used with each cylinder and piston assembly, and as a further alternative a diagonal brace may be pinned between each ear 348 and anchor 336. When erected to the piston shown in FIGURE 10 the framework remains in preparedness for the cover (not shown). Further, there are means at the adjacent parts of the lower chord members of each truss for fastening the trusses together at this point. These means may be in the form of a cable lashed around the lower ends of the braces 312, or may be pins 370 passed through apertures in ears at the inner extremities of the lower chord members of the trusses, or pins 370 in apertured ears of a disc similar to disc 318.

While the radial arrangement is the most stable of all possibilities, an oval shaped structure could be formed with two centers and lateral bracing between them. Particularly in the case of the hydraulically erected embodiment shown in FIGURES 9 and 10, this hinged truss system could be used even for a rectangular structure, with trusses arranged parallel to each other.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A collapsible and portable structure for a building, said structure comprising a plurality of radially arranged trusses, each of said trusses having an upper chord and a lower chord, means including hinge pins connecting the trusses together at the upper chord inner extremities thereof, means for attaching said trusses together at the inner extremities of the lower chords thereof after said trusses have been erected, each truss having an outer extremity region, an anchor, and a post pivoted to said anchor and pivoted to the truss in said region thereof, and a brace attached to said truss in said region and to said anchor, said brace including a cylinder with a piston and piston rod operable in said cylinder, means for supplying fluid to said cylinder and to withdraw fluid from said cylinder to extend and retract said piston rod relative to said cylinder, and means hingedly securing said cylinder and said piston rod to said anchor and said truss at a position outwardly of the hinged connection between said post and said truss.

2. A collapsible and portable structure for a building, said structure comprising a plurality of radially arranged trusses, each of said trusses having an upper chord and

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a lower chord, means including hinge pins connecting the trusses together at the upper chord inner extremities thereof, means for attaching said trusses together at the inner extremities of the lower chords thereof after said trusses have been erected, each truss having an outer extremity region, an anchor, a post pivoted to said anchor and pivoted to the truss in said region thereof, a brace attached to said truss in said region and to said anchor, said brace including a cylinder with a piston and piston rod operable in said cylinder, means for supplying fluid to said cylinder and withdraw fluid from said cylinder to extend and retract said piston rod relative to said cylinder, means hingedly securing said cylinder and said piston rod to said anchor and said truss at a position outwardly of the hinged connection between said post and said truss, a network of cables connected to said trusses to provide lateral stability for the trusses when they are erected and to provide means on which to support a covering.

3. A portable building structure comprising a plurality of trusses, means at the inner ends of said trusses hingedly connecting said trusses together, a plurality of posts, one of said posts being hingedly connected to each of said trusses inwardly spaced from the outer ends thereof, and a plurality of extensible and retractable braces, one of said braces being pivotally secured to each of said trusses outwardly of said posts for pivotally lifting the inner end of each truss upon retracting of each of said braces while each of said posts acts as a fulcrum for said truss.

4. A portable building structure according to claim 3 wherein each of said braces includes a cylinder, a piston in each cylinder, a piston rod connected to each piston and extending beyond said cylinder, and means for supplying fluid to said cylinder and withdrawing fluid from said cylinder to extend and retract said piston rod with respect to said cylinder.

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5. A portable building structure according to claim 4, including a plurality of anchors pivotally connected to the lower ends of said posts, said braces being pivotally connected to said anchors.

6. A portable building structure according to claim 4, including cables extending between said trusses to provide lateral support for said trusses, and a covering carried by said trusses.

7. In a collapsible building structure, a plurality of substantially vertical spaced wall columns, a plurality of trusses, means pivotally connecting the inner ends of said trusses to each other, means pivotally mounting said trusses respectively on said wall columns at pivotal mounts inwardly spaced from the other ends of said trusses, means for bringing said trusses to an erected position wherein said trusses are disposed in upwardly converging relation with said inner ends above said pivotal mounts on said posts, said means comprising a plurality of extensible and retractable braces pivotally connected to said trusses outwardly of the respective pivotal mounts and pivotally connected to said wall columns respectively below said pivotal mounts forming a three hinge arch so that upon retracting of said braces said wall columns will act as fulcrums for pivotally lifting the inner ends of said trusses.

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