March 17, 1959

J. M. EWART

2,877,508

PORTABLE BUILDING

Filed July 24, 1956

3 Sheets-Sheet 1

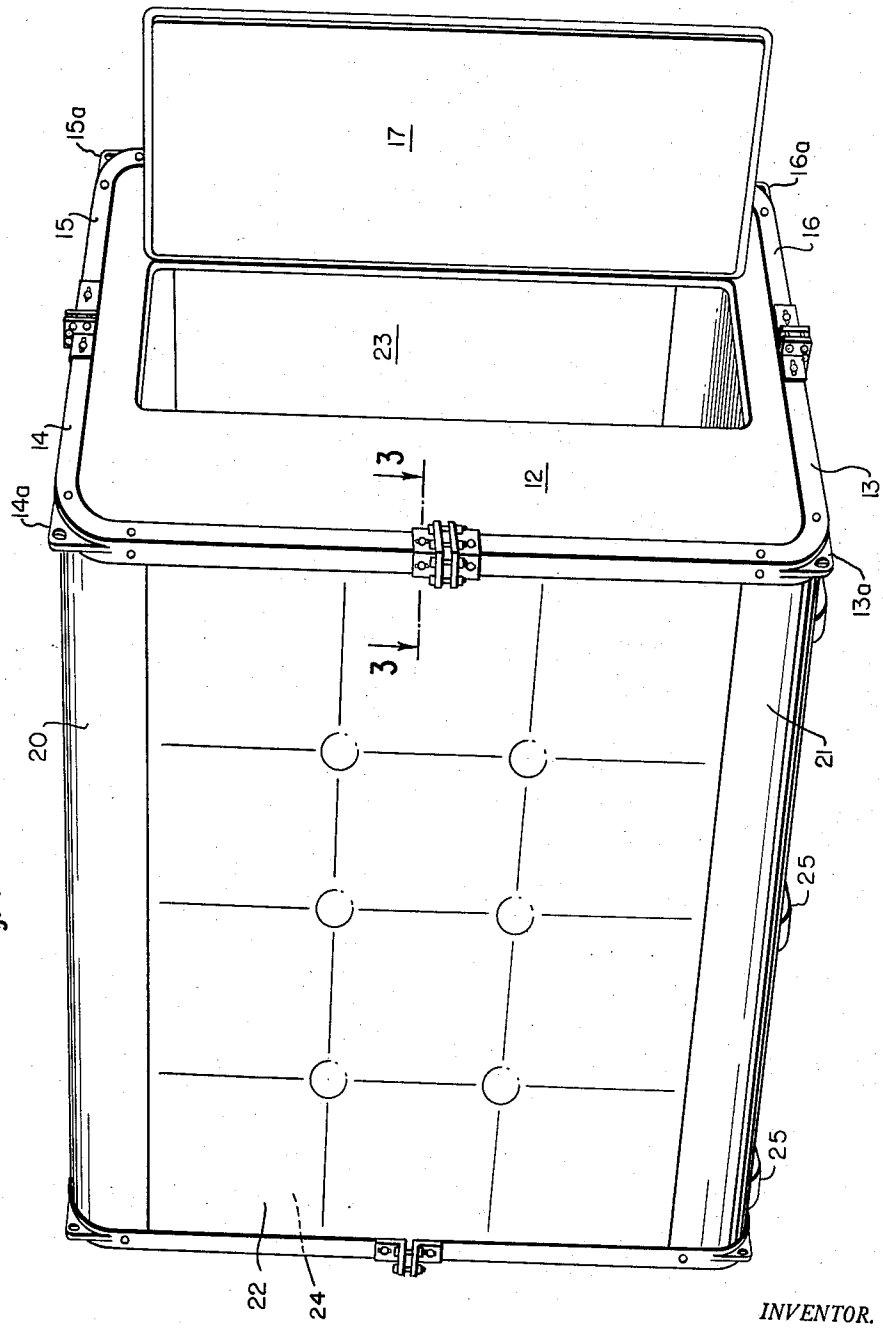


Fig. 1

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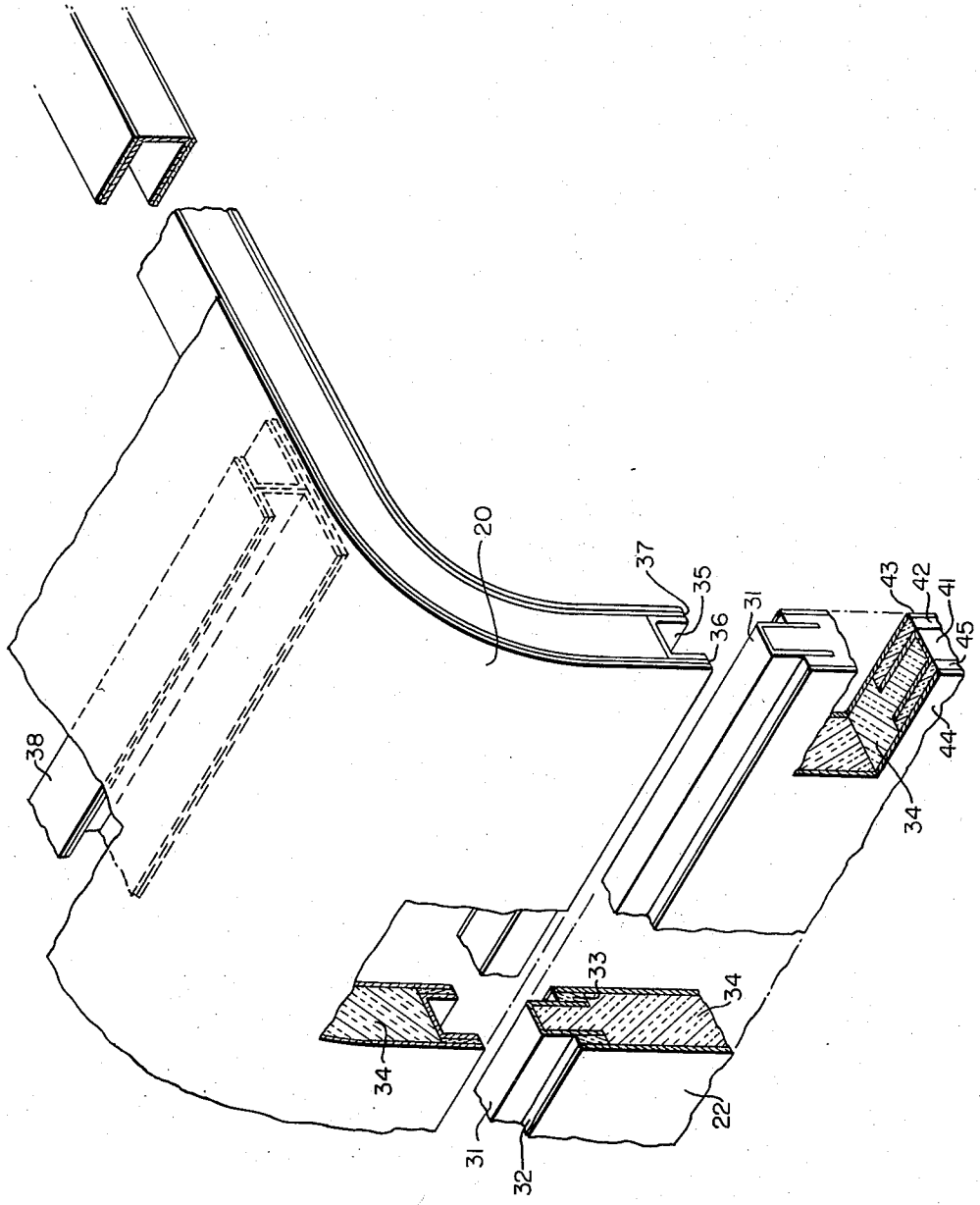


Fig. 2

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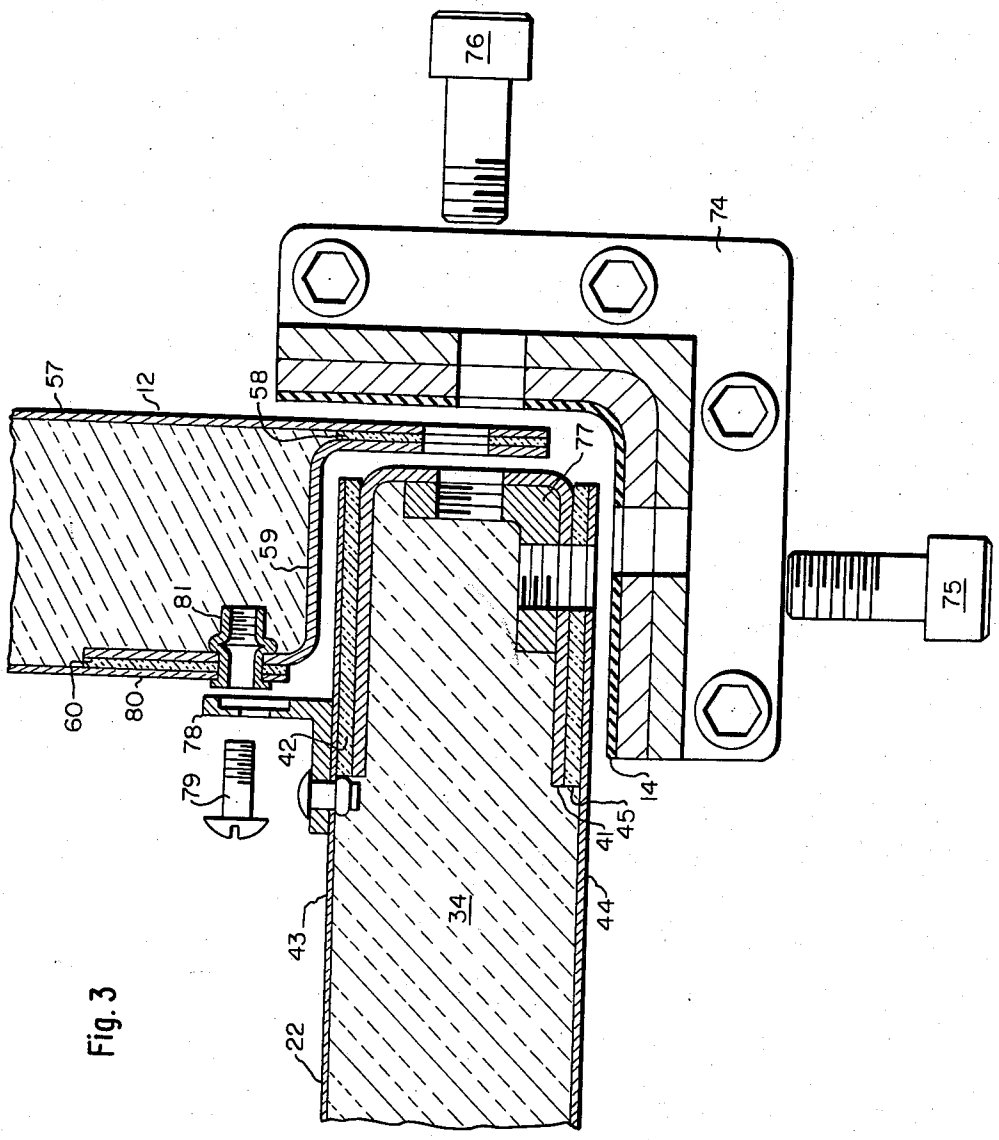


Fig. 3

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2,877,508

PORTABLE BUILDING

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Application July 24, 1956, Serial No. 599,726

9 Claims. (Cl. 20—2)

This invention relates in general to portable buildings and in particular, to a portable building which may be suspended from a helicopter and transported.

The concept of providing buildings and other structures which are portable is an old one. There have been many applications for such structures wherever it has been necessary to establish some sort of temporary quarters. The armed services because of the mobile nature of their operations, have considerable need for portability in the buildings which they use in the field. Similar needs exist in non-military applications as in construction work, oil exploration and similar fields.

In the past, it has been necessary primarily that the buildings be reasonably strong to withstand the unavoidable shocks and strains of moving, that they be weathertight for the protection of personnel and equipment housed within them, and that they be capable of sustaining a snow-load to which they might be exposed in some areas of operation. Some thought has been given to the weight of the structures inasmuch as it is commonly desired to transport them by truck, rail or ship but the objective of weight reduction has not been an important one. More recently, however, it has proven feasible to transport payloads of considerable weight by helicopter. Because of the helicopter's ability to reach places which are inaccessible by any other means, a building which, in addition to the qualities of structural strength and weatherproof design, could be handled by a helicopter would have numerous and unique applications.

Although such a concept appeared practical, problems heretofore of no concern became of paramount importance. For example, it would obviously be desirable to have lifting eyes located at the top of the structure to facilitate suspension by cables from a helicopter during movement. The mere provision of such eyes on conventional structures would serve no purpose whatsoever, inasmuch as the concentration of stress at the areas of attachment of the eyes during suspension by cable would result in the structure being literally pulled to pieces. Even if conventional framing techniques were used and a sufficient safety factor were built in to prevent the pulling apart of the structure, the increase in weight would render the structure unsuitable for the desired purpose. Nor is framing of the device the only problem which is encountered in providing a building capable of such use. If paneling made of corrugated steel or other well-known building materials for portable structures were used, again the weight would be so great as to preclude the use of the building with helicopter transportation.

Then, too, it is obvious that the portable structure would be of considerably greater utility if it were possible to include within the structure, equipment for use at the point of installation of the structure. By way of example, it might be desired in military use of the structure to have radio or radar equipment within the building, or perhaps, to have the building equipped as an electronic

or machine shop. Similarly, in nonmilitary use of the structure, it might be desirable to have disaster emergency equipment, construction or maintenance equipment or communication apparatus within the structure. The provision of any such equipment or apparatus entails additional weight and only if the weight of the structure itself be kept to a minimum could a helicopter conveniently handle the complete load.

The problem of providing a building which, in addition to being suitable for transportation by helicopter, could be transported and used conventionally had to be approached from a radically different viewpoint. Previous concepts of building had to be discarded in large part, simply because almost all existing structures were designed, logically enough, to obtain their basic support from below. This held true even for portable structures because the usual mode of transportation was a truck, rail flat car, or plane in which support comes from below just as it does when the structure is stationary. Despite the fact that much previous theory in portable structures might be dispensed with, it is necessary that the capability of transport by helicopter be in addition to rather than in place of other necessary qualities of portable buildings.

Finally, conventional techniques of insulation are not useful in a building designed for transport by helicopter. Either the weight is too great, the material cannot stand the unavoidably rough handling, or the insulation is simply not effective enough for the extremes of temperature encountered in those formerly inaccessible places where the structure would be uniquely valuable by reason of its portability by helicopter. Other problems of heat transfer through the walls of conventional structures arise when an objective of light weight with effective protection against heat transfer is sought.

Therefore, it is an object of the present invention to provide a lightweight, durable structure suitable for transportation by helicopter.

It is another object of the present invention to provide a building which is sufficiently weatherproof to be used in any climate without excessive heat transfer through the walls of the building.

It is still another object of the present invention to provide a building wherein the stresses set up by lifting of the building are distributed over considerable areas.

It is a further object to provide a building wherein all lifting forces are applied at the base during suspension of the building from a helicopter.

It is still a further object of the present invention to provide a building capable of transportation by any known means.

It is a still further object of the present invention to provide a building of extremely high strength-to-weight ratio.

In general, the present invention consists in a three-dimensional enclosure which is composed of interlocked panels having structural aluminum bands encircling the ends of the enclosure. Each panel consists of spaced, parallel "skins" bonded together by a foam core which fills the space between the skins. The peripheries of the skins are cemented or otherwise sealed to channel members, and the peripheries are so formed that all external joints are lapped to assume minimum heat transfer through the enclosure. The structural aluminum bands are provided with lifting eyes and are so joined that lifting of the structure by the eyes is possible with no stresses being concentrated at any points of the structure. Structural strengthening members to aid in supporting and mounting of equipment are provided in top and bottom panels, and skids for loading and unloading are built into the bottom panel. For a better under-

standing of the present invention, together with other and further advantages, features, and objects, reference should be made to the following detailed description of a preferred embodiment thereof which should be read in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective view of one embodiment of the portable structure,

Fig. 2 is a fragmentary perspective view of a central portion of a corner of the structure, partly cut away to show detail of the construction and interconnection of panels, and

Fig. 3 is a sectional view of the junction of side and front end panels of the structure taken along the lines 3—3 of Fig. 1.

The general organization of the portable structure is shown in Fig. 1. Six panels are assembled together to form a three-dimensional enclosure. Four structural aluminum bands enclose each end of the enclosure and are bolted together at points midway of the sides, of the top, and of the bottom of the end panels. The front panel **12** may be seen to be so enclosed by L-shaped structural aluminum bands **13**, **14**, **15** and **16**. Lifting eyes **13***a*, **14***a*, **15***a* and **16***a* are provided on the aluminum bands, although the eyes **13***a* and **16***a* may be dispensed with if desired.

The structural aluminum bands have an L-shaped cross-section and they enclose the ends of a top panel **20**, a bottom panel **21** and side panels **22** and **23** as well as the entire periphery of front panel **12**. As may be seen from the lines of demarcation in Fig. 1, top panel **20** and bottom panel **21** are generally similar in shape, each panel having a cross section which is roughly in the form of a shallow U. In the case of top panel **20**, however, the U is inverted. As will be shown and described in greater detail below, front panel **12** has a relatively thin edge which overlies the ends of the other panels with which it is enclosed by the structural aluminum bands.

A back end panel **24** abuts the opposite ends of the top, bottom and side panels, and it is also fitted into four structural aluminum bands in the same manner as the front panel **12**. Similar lifting eyes are provided on the aluminum bands encircling end panel **24**; again those on the bottom bands need not be retained.

Side panels **22** and **23** may be ribbed as shown, to provide additional rigidity. Also, in the flat portion of top and bottom panels, there are included strengthening members running from front to back which are not visible in this view. These members aid the bottom panel in supporting weight which may be placed in the shelter, and serve as frame members for the attachment of racks, shock mounts, and other equipment to the ceiling of the shelter. The strengthening members in the bottom panel also serve as mounting means for the loading and unloading skids **25**.

As noted above, the top and bottom panels are U-shaped and the side and end panels are flat. In Fig. 2, representative structure is shown although side panel **22** is shown separated from top panel **20** for clarity. Side panel **22** has a tongue **31** formed along its entire upper edge. Tongue **31** is not in direct contact with the skins of panel **22**, however. Layers of insulating material **32** and **33** are bonded to the ends of the skins and to tongue **31** by cementing or other suitable process. Filling the entire space between the skins of panel **20** is a mass of insulating foam material **34** which is placed in liquid form between the skins after they are cemented to the insulating layers and to the tongue and then permitted to expand and fill the void between skins. A preferred process of fabricating these panels is disclosed in the copending application of William Watson for a Structural Panel, Ser. No. 539,611 filed October 10, 1955, now abandoned, and assigned to the assignee of the present invention.

In this connection, it should be noted that all of the top, bottom, side and end panels are made in similar fashion from a pair of rigid spaced skins bonded together in the manner disclosed in the cited Watson application. The skins themselves are preferably made of strong thin sheet material such as sheet aluminum, or laminated and bonded fabric composed of glass fibers such a that sold under the trade name of Fiberglas.

The top panel **20** is joined to a grooved channel member **35** through insulating layers **36** and **37** in a manner quite similar to that in which panel **22** is joined to tongue member **31**. Tongue member **31** fits resiliently into groove member **35** when the structure is assembled providing a downwardly directed lapped joint exposed to outside weather. Here, top panel **20** is shown separated from side panel **22** in order to facilitate understanding of the manner in which the panels are fabricated and joined. As may be seen in the cut away portion of this panel, insulating foam material also fills the entire space between the skins of panel **20**. One of the strengthening members **38** previously referred to, is shown in the flat section of the top panel. In the preferred embodiment of the present invention, several similar structural members are spaced across the flat portion of top panel **20**.

With the exception of the front and back end panels **12** and **24**, all panels have ends made up on channel and insulating members. As is most easily seen in the cut-away portion of Fig. 2 in the lower right-hand corner, the typical end of a panel abutting the front and back end panels includes a channel member **41** having its open end facing inwardly. Channel member **41** may be a structural aluminum element of generally U-shaped cross-section. Cemented to the outsides of the legs of the U are a pair of similar insulating layers **42** and **45**. The skins **43** and **44** are, in turn, cemented to the insulating layers **42** and **45** respectively. Between skins **43** and **44**, as seen in the cut-away portion of the drawing, as there is between the skins at all points in the various panels there is the bonded foam material **34** which has been mentioned previously.

The resilient joining of all tongue-and-groove members in the structure is insured by the fact that the insulating layers **36** and **37** are approximately one-half the thickness of the insulating layers **32** and **33**. The same relationship holds true for all insulating layers associated with the groove members and the tongue members respectively.

The lower edge of side panel **22** contains a groove channel member identical to groove channel member **35** shown at the lower edge of the top panel **20**. Bottom panel **21** has top edges identical to the top edges of side panels **22** and **23**. Tongue members similar to tongue member **31** fit into groove members in the bottom of side panels **22** and **23**. In other words, the overlapping relationship is such that at each joint of the panels of this type which is exposed to the weather, the outermost member is a downward extension of the upper of the two panels being joined. It should also be noted that the various junctions are so constructed, that at no time when aluminum skins are used, is there a direct metallic path between an inner and an outer skin of any panel. Such direct metallic paths have been avoided by interposing insulating layers between the various metallic members.

The overlapping relationship of the front and back end panels to the ends of the top, bottom and side panels has previously been mentioned. The lapped joints so provided also contribute to the weatherproof qualities of the structure. In Fig. 3 a representative junction of the front or the back panel to any other panel is shown in some detail. To avoid confusion of the various parts, the panels have been shown slightly separated. The degree of separation is obvious from the misalignment of the holes for the various bolts. As noted in the discussion of Fig. 2, panel **22** includes skins **43** and **44** bonded together by foam material **34**. Also, skin **44** is cemented to insu-

lating layer 45 which in turn, is cemented to one side of channel 41. Similarly, skin 43 is cemented to insulating layer 42 which in turn, is cemented to the other side of channel 41.

The edges of front panel 12 are made up in a somewhat different manner. The skin 57 of panel 12 which is the outside skin, is extended outwardly beyond the rest of the panel around its entire periphery. Cemented to the extended portion of skin 57 is an insulating layer 58. A Z-frame member 59 is cemented to insulating layer 58 at one end, and to another insulating layer 60 at its opposite end. Insulating layer 60 is, in turn, cemented to the inner skin of panel 12. The space between the two skins of panel 12 is of course, filled with the bonded foam material as is the space between the skins of side panel 22.

The flanged connections between the structural aluminum bands are all similar. Typically, there is provided on the structural aluminum band 14 a welded flange 74 through which holes are formed to permit attachment to a similar flange on structural aluminum band 13. Connection is made between structural aluminum band 14 and channel 41 by means of a bolt 75 which passes through one leg of U-shaped channel 41 and by means of a second bolt 76 which passes through the base of U-shaped member 41. An L-shaped reinforcing member 77 having threaded openings is provided within the U-shaped channel 41 to permit proper attachment of bolts 75 and 76.

The openings through flange 74 and through structural aluminum band 14 through which bolts 75 and 76 pass, are somewhat elongated in a plane perpendicular to that of Fig. 3. The elongation of the openings is also visible in Fig. 1 of the drawings. The elongated openings in the panels are of considerable importance in that they permit some relative movement between the panels and the structural bands. When the structure is suspended from a helicopter by cables attached to the upper lifting eyes, the lifting forces are not transferred to the panels at the points of attachment of the panels to the flanges. At the other points of attachment of the panels to the structural bands, the holes in the frame are made oversize relative to the bolts and the openings in the panels. This permits the panels to have sufficient play to ensure that all lifting is done by the structural bands.

In the inside corner of side panel 22 and front end panel 12, as is typical of all junctions of side, bottom and top panels with end panels, provision is made to hold the panels together prior to assembly into the structural aluminum bands. An angle member 78 has one leg riveted to the inwardly facing surface of side panel inside skin 43. The other leg extends along the inwardly facing surface of the inside skin 80 of front panel 12. Angle member 78 has an opening formed in the leg adjacent panel 12 which is when the panels are joined aligned with an internally threaded sleeve 81 which is pressed through Z-bar 59, insulating layer 60 and skin 80. A light bolt 79 is received by sleeve 81 as a temporary device to hold the panels together. As noted above similar means are provided at similar junction points to facilitate assembly.

The weatherproofing provided by the downwardly lapped tongue-and-groove joints between top and side, and between side and bottom panels has been pointed out as has the absence of any direct metallic path between inside and outside skins at those joints. This last is of importance primarily when metallic skins are used, of course. The weatherproofing is continued at the joints of which that shown in Fig. 3 is typical. Both front and back end panels lap the ends of the side, bottom and top panels. In addition, the structural aluminum bands are so placed and shaped that the only possible opening between end and other panels is centered at the most protected point within the structural bands. Furthermore, the design objective of no metallic path between inside and outside skins is maintained at these joints also.

In exhaustive structural tests, an embodiment of the

present invention weighing only 950 pounds proved itself capable of carrying loads beyond the lifting ability of any available helicopter without damage; snow-load tests, drop and transport tests were met with equal ease. Environmental tests proved the general suitability of the structure and its weatherproof design in temperatures ranging from 80° F. to 160° F. The structure was also exposed to rain, snow, salt-spray and humidity tests successfully. The minimum heat transfer through top, sides and floor was proven in theory and empirically, a heat transfer coefficient of .247 B. t. u. per hour having been measured.

Although a preferred embodiment of the present invention has been disclosed, it should be understood that the disclosure is for purposes of illustration only. The invention should be limited only by the spirit and scope of the appended claims.

What is claimed is:

1. A portable building comprising a plurality of panels assembled to form a three-dimensional enclosure, a first structural band encircling the periphery of one end panel and the ends of all panels adjoining said one end panel, a second structural band encircling the periphery of the other end panel and the ends of all panels adjoining said other end panel, means joining said structural bands to said panels and permitting limited relative movement therebetween, and means on said structural bands for lifting said building.

2. A portable building comprising a plurality of panels assembled to form a three-dimensional enclosure each of said panels including outer and inner parallel skin members, insulating foam material bonding said skin members together, a first structural band encircling the periphery of one end panel of said enclosure and the ends of all panels adjoining said one end panel, a second structural band encircling the periphery of the other end panel of said enclosure and the ends of all panels adjoining said other end panel, means joining said structural bands to said panels and permitting limited relative movement therebetween, and means on said structural bands for suspending said building from above.

3. A portable building comprising a plurality of panels assembled to form a three-dimensional enclosure, a first structural band encircling the periphery of one end panel and the ends of all panels adjoining said one end panel, lifting eyes disposed adjacent the upper corners of said end panel and formed integrally with said first structural band, a second structural band encircling the periphery of the other end panel and the ends of all panels adjoining said other end panel, means joining said structural bands to said panels and permitting limited relative movement therebetween and lifting eyes disposed adjacent the upper corners of said other end panel and formed integrally with said second structural band.

4. A portable building comprising a top, a bottom, side and end panels assembled to form a three-dimensional enclosure, said panels being formed of outer and inner parallel skin members and insulating foam material bonded to the adjacent surfaces of said parallel skin members, said outer skin members of said end panels extending outwardly beyond the other portions of said end panels, the ends of said top, side, and bottom panels abutting and being overlapped by the outer skin members of said end panels, a structural band encircling each of said end panels and enclosing said end panels and the ends of said top, bottom and side panels adjacent thereto, means joining said structural bands to said panels and permitting limited relative movement therebetween and lifting eyes formed integrally of said structural bands and disposed adjacent the upper corners of said end panels.

5. A portable building comprising a top, a bottom, side and end panels assembled to form a three-dimensional enclosure, said panels being formed of outer and inner skin members in spaced parallel relationship, the inner juxtaposed surfaces of said skin members being bonded

together by insulating foam material, the adjacent ends of said top and side panels being joined by tongue-and-groove members, the adjacent ends of said side and bottom panels also being joined by tongue-and-groove members, each of said end panels having an outer skin extending outwardly beyond other portions of each said panel, the inner surface of said outer skin of each of said end panels abutting and overlapping the adjacent ends of said top, side and bottom panels, structural bands enclosing each of said end panels and the ends adjacent thereto of said top, side and bottom panels, means joining said structural bands to said panels and permitting limited relative movement therebetween, and lifting eyes disposed on said structural bands at least at points adjacent the upper corners of said end panels.

6. A portable building comprising a pair of relatively flat side panels, a pair of relatively flat end panels, a top panel having an inverted U-shaped cross section, a bottom panel having a U-shaped cross section, said panels being assembled to form a three-dimensional enclosure, said side panels being joined to said top and bottom panels by downwardly lapped tongue-and-groove connections, said end panels abutting and overlying the adjacent ends of said top, side and bottom panels, structural aluminum bands of L-shaped cross section encircling the peripheries of said end panels and the abutting ends of said top, side and bottom panels, means joining said structural bands to said panels and permitting limited relative movement therebetween, and lifting eyes formed on at least the corners of said structural bands adjacent the upper corners of said end panels.

7. A portable building comprising six panels assembled to form a three-dimensional enclosure, structural bands encircling two ends of said enclosure, and means on said structural bands for lifting said enclosure, each

of said panels including a pair of skin members, peripheral frame members for holding the extremities of said skin members, means joining said structural bands to said panels and permitting limited relative movement therebetween, and a quantity of insulating foam material disposed between and bonding together the adjacent inner surfaces of said skin members.

8. A portable building comprising six panels assembled to form a three-dimensional enclosure, structural bands encircling two ends of said enclosure, means joining said structural bands to said panels and permitting limited relative movement therebetween, and means on said structural bands for lifting said enclosure, each of said panels including a pair of skin members, insulating layers cemented to the inner surfaces of said skin members about their peripheries, and peripheral frame members disposed between said skin members and cemented to said insulating layers for holding said skin members, and a quantity of foam material disposed between and bonded to the adjacent inner surfaces of said skin members, said insulating layers and said foam material minimizing the flow of heat between said skin members.

9. Apparatus as in claim 8 wherein the peripheral frame members of certain of said panels are formed into cooperating tongue-and-groove members, said insulating layers cemented to tongue members being thicker than those insulating layers cemented to groove members.

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