

- [54] **FLEXIBLE STRUCTURAL PANEL**
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Related U.S. Application Data

- [63] Continuation-in-part of Ser. No. 44,423, June 8, 1970, abandoned.
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 [51] Int. Cl. **E04b 7/10, E04c 1/24**
 [58] Field of Search **52/63, 81, 584, 493; 135/15 CF, 1 R; 160/387, 385, 402, 404**

References Cited

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- 1,065,237 6/1913 **Graham** 52/63
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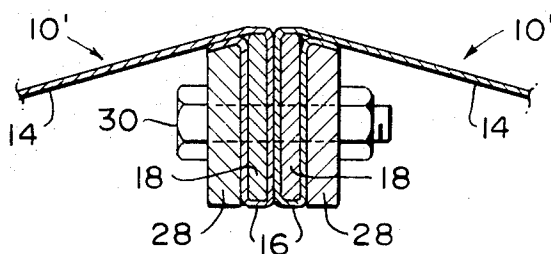
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[57]

ABSTRACT

Means for supporting and joining flexible multi-sided structural panels in radomes and the like. The panels are each provided with flexible peripherally located flaps which are reinforced by stiffening members. The panels are applied to frames made up of interconnected rigid struts, with the flaps and their respective stiffening members overlapping the struts. The frames are interconnected by means extending laterally through joints including as sandwiched elements two peripheral flaps in face-to-face contact, the stiffening members reinforcing said flaps, and a strut on each of the frames being interconnected.

3 Claims, 7 Drawing Figures



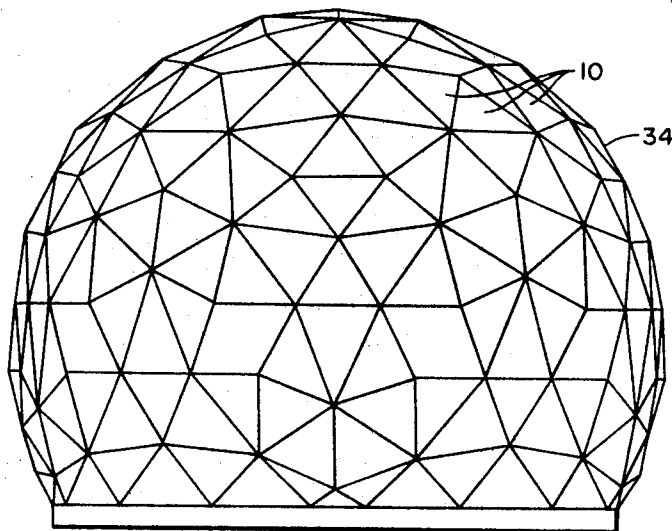
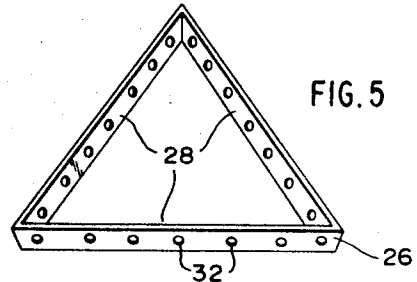
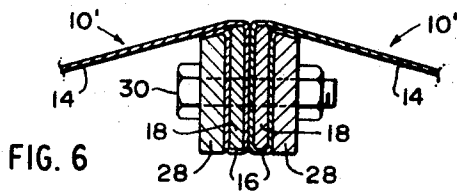
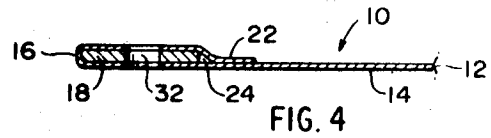
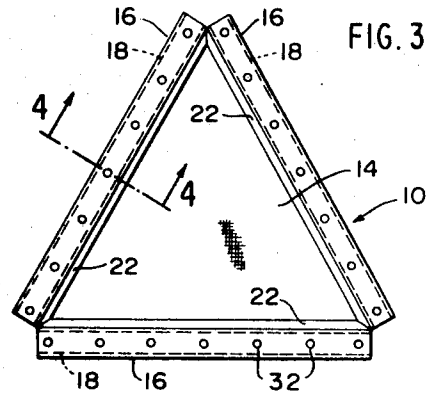
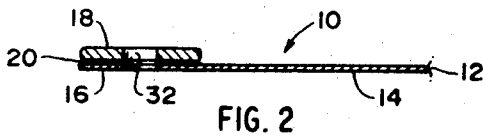
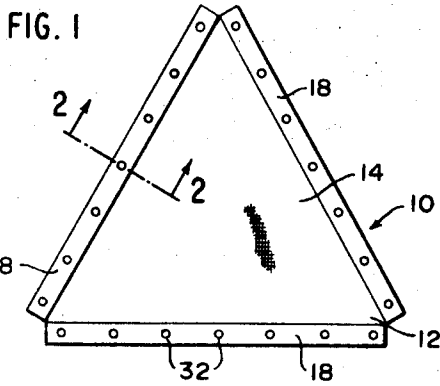


FIG. 7

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FLEXIBLE STRUCTURAL PANEL

CROSS-REFERENCES TO RELATED APPLICATIONS

This is a continuation-in-part of U.S. Pat. application Ser. No. 44,423 filed on June 8, 1970, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates generally to dome-type structures, and more particularly to an improved means for supporting and joining flexible multi-sided structural panels used in said structures.

Dome-type structures are frequently used to house radar equipment and are commonly referred to as "radomes." Such dome structures are conventionally constructed with a basic supporting framework on which a plurality of predetermined shaped panels are mounted to form a generally spherical enclosure.

The panels heretofore employed in such structures have generally been fabricated of rigid materials with integral depending flanges provided around their periphery for attachment to the supporting framework. One problem with rigid panels arises from the fact that the dome components frequently must be shipped considerable distances to the construction site in a disassembled state. The panels with their rigid, integral, depending peripheral flanges prevent the panels from being shipped in either a flat or "rolled up" condition and thus require more expensive shipping space than panels which can be shipped in either of the aforementioned conditions.

A further inherent drawback of rigid panels is that their laminated construction requires that they be relatively thick, when compared with flexible membrane panels, in order to have a workable fatigue stress resistance.

SUMMARY OF THE INVENTION

In accordance with the present invention, a flexible structural panel particularly useful in dome structures, such as radomes, has a plurality of stiffened, peripheral flaps adapted to be folded over a supporting framework during construction. The flaps may be reinforced by securing the stiffening means during production, in which case the panels can be shipped in a flat condition to the ultimate construction site. Alternatively, the flaps may be formed with pockets or other means adapted to receive stiffening means so that the panels can be rolled up or folded for storage and shipment to further decrease the panels' shipping space requirements.

The provision of a flexible panel of appropriate sheet material greatly increases the fatigue stress resistance with a concomitant increase in the longevity of the panels. Moreover, the panels can have a lesser thickness than rigid panels to further decrease their shipping costs while at the same time improving the electrical properties of the panels when they are used to house radar equipment.

During assembly at the construction site, the panels are applied to frames made up of a plurality of interconnected rigid struts, with the panel flaps and their respective stiffening means overlapping the struts. The panel-frame assemblies are then interconnected by means, such as for example bolts, extending laterally through joints which include as sandwiched elements two peripheral panel flaps in face-to-face contact, the stiffening members reinforcing said flaps, and a strut on

each of the frames being interconnected. The joints are thus extremely tight and the stiffening members distribute the retaining forces of the connecting bolts more uniformly over the lengths of the panel flaps.

These objects and other objects, features and advantages of the invention will become more apparent as the following detailed description proceeds with continuing reference to the appended drawings wherein the thickness dimensions of the various sheet materials are exaggerated for the purposes of clarity and wherein:

FIG. 1 is a plan view of a flexible panel according to the preferred embodiment of the invention;

FIG. 2 is a fragmentary sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a view similar to FIG. 1 showing an alternative embodiment of the invention;

FIG. 4 is a fragmentary sectional view taken along line 4—4 of FIG. 3;

FIG. 5 is a perspective view of a frame element adapted for use with the panels shown in FIGS. 1-4;

FIG. 6 is a fragmentary sectional view showing a typical joint where the panel-frame assemblies are interlocked; and,

FIG. 7 is a diagrammatic view in side elevation of a typical radome that is fabricated by interlocking a plurality of the panel-frame subassemblies.

DESCRIPTION OF THE EMBODIMENTS

Referring to FIGS. 1 and 2, one embodiment of a flexible structural panel member in accordance with the present invention is generally designated by the numeral 10. The panel 10 comprises a sheet of flexible material 12 formed to have a predetermined shaped panel area 12 (in this case triangular) and marginal or peripheral flexible flaps designated typically at 16 extending outwardly from the periphery of the panel area 14. To provide a means for mounting the panel 10 to a supporting frame, as hereinafter described, the flaps 16 are stiffened or reinforced. In the embodiment depicted in FIGS. 1 and 2, the flaps 16 are stiffened by stiffening members 18 which are secured to the peripheral flaps 16 by an adhesive 20.

An alternative panel embodiment is shown in FIGS. 3 and 4 and generally designated as 10'. The panel 10' also comprises a flexible sheet of material 12 formed to have a triangular flexible panel area 14 and flexible peripheral flaps 16. In this case, however, each peripheral flap is widened and folded back toward the panel area 14 where it is bonded to itself at 22 to define an elongated peripheral pocket 24 disposed parallel to the periphery of the panel area 14. The pockets 24 each define a means for receiving the batten-like stiffening members 18 by insertion. The bond 22 may be made in any manner desired, such as for example, by heat sealing, adhesion, or sewing. The stiffening members 18 may be fixedly secured in the pockets 24 at the production site by adhering them therein, or, alternatively, the panels 10' may be folded or rolled during transit and the stiffening members inserted at the ultimate construction site.

Other means for stiffening or reinforcing the peripheral flaps 16 can be employed to construct the improved radome panel. For example, the flaps 16 can be impregnated with an appropriate material and integrally molded with the peripheral stiffening material during production to achieve the desired result.

It should thus be apparent that the flexible panels 10 and 10' afford a significant cost savings in the overall expenses incurred in radome construction when contrasted to the rigid panels having rigid peripheral flaps fixedly fabricated at a predetermined angle to the panel area. When the flaps 16 are stiffened during production, the panels can be stacked for storage and shipment in a flat condition. On the other hand, when the flaps 16 are stiffened at the construction site by inserting the stiffening members 18 into the pockets 24, the panels 10' can be rolled or folded for storage and shipment to further decrease the required storage and shipping space.

The sheet material 12 from which the panels 10 and 10' are fabricated can be any appropriate flexible sheet material, such as, a flexible film, coated fabric or fabric-film laminate. From among the presently available materials a "Dacron" (DuPont trademark for polyethylene terephthalate) or Nylon reinforced fabric is now the preferred material. However, many other materials can also be employed, including, flexible vinyl and polyester films such as "Mylar" (DuPont trademark for polyester film) and fiber glass fabric. Such flexible materials have sufficiently low moduli of elasticity to withstand constant stressing over protracted periods of time to afford a significant increase in the useful life of the panels. The flexibility of the panels also enables the peripheral flaps 16 to be shipped at one angular disposition to the panel area 14 during shipment and then to be folded over a supporting framework during construction.

A typical frame for use in the present invention is illustrated in FIG. 5 and identified by the reference numeral 26. The frame 26 comprises three struts 28 interconnected to form a triangle of substantially the same size as the panel area 14. A plurality of panels 10 or 10' (as shown) and frames 26 are then interconnected or joined together as shown in FIG. 6. Each panel 10' is first placed on its corresponding frame assembly 26 and its stiffened flaps 16 are folded over the outside of the frame struts 28. The panel-frame assemblies are then placed together and interlocked by fastening means extending laterally through joints including as sandwiched elements two peripheral flaps 16 in face-to-face contact, the stiffening members 18 reinforcing said flaps, and the struts 28 making up each frame. By way of example, bolts 30 are shown passing through the mated struts 28 to compress the mated stiffening members 18 therebetween. Aligned apertures 32 are provided in the stiffening members 18, flaps 16 and struts 28 to receive the fastening bolts 30.

When thus assembled, the stiffening members 18 provide a means for mounting the flexible panels 14 to the supporting frames and they also tend to distribute stresses throughout the assembled structure. I have found that a thin gauge metal strip, such as 1 mm. steel, will suffice for this purpose.

An example of a dome 34 assembled from a plurality

of triangularly shaped panels 10 is shown diagrammatically in FIG. 7. The particular arrangement shown in FIG. 7 is more fully described in U.S. Pat. No. 3,392,495, issued July 16, 1968 to William Ahern and William Wainwright. The arrangement illustrated and described in the patent has the advantage of requiring only four basic triangularly shaped panel sizes to construct a radome having a minimum of parallelism among its frame elements.

However, it should be understood that the present invention is not limited solely to triangular panels 10. For example, another particularly useful panel area configuration for a dome structure is a four-sided panel area 14 defined by selecting four non-planar points on the surface of a sphere to form a hyperbolic paraboloid. Other possible geometrical shapes for the panels 10 include curved shapes such as circles, and ellipses and straight sided figures of all kinds, whether equilateral or not. When curved configurations are employed for the panel area 14, I prefer to ship the panels 10 without stiffening means and to secure the easily bent stiffening means 18 to the flaps at the construction site.

It is my intention to cover all modifications and equivalents of my invention which do not depart from the spirit and scope thereof as defined by the appended claims.

What I claim is:

1. In a structure having an exterior surface defined by a plurality of flexible panels, means for supporting and joining said panels comprising in combination:

- a. flexible flaps which are integral with the edges of said panels,
- b. elongated stiffening members overlapped by said flaps, said stiffening members being immovable laterally relative to said flaps,
- c. frames underlying each of said panels, each said frames being made up of a plurality of interconnected rigid struts, and
- d. means for joining said panels and said frames along joints adjacent to the edges of said panels, said means extending laterally through the following sandwiched elements;
 1. A flap on each of two adjacent panels, said flaps being in face-to-face relationship;
 2. the stiffening members overlapped by said flaps; and,

3. a strut on each of the frames underlying said adjacent panels.

2. The combination as claimed in claim 1 wherein said stiffening members are attached to said flaps by means of an adhesive.

3. The combination as claimed in claim 1 wherein said flaps define generally rectangular elongated pockets, and wherein said stiffening members are positioned within said pockets.

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