

[54] COLLAPSIBLE FRAMEWORK AND COVER

[76] Inventor: Ted Zeigler, 2007 R St. N.W.,
Washington, D.C. 20009

[22] Filed: Feb. 20, 1973

[21] Appl. No.: 333,689

[52] U.S. Cl. 135/4 R, 52/81, 52/645

[51] Int. Cl. A45f 1/00

[58] Field of Search 135/1-5, 8;
52/80, 81, 82, 86, 109, 222, 641, 645, 646

[56] References Cited

UNITED STATES PATENTS

3,710,806 1/1973 Kelly et al. 135/4 R

Primary Examiner—J. Karl Bell

Attorney, Agent, or Firm—Walter S. Pawl

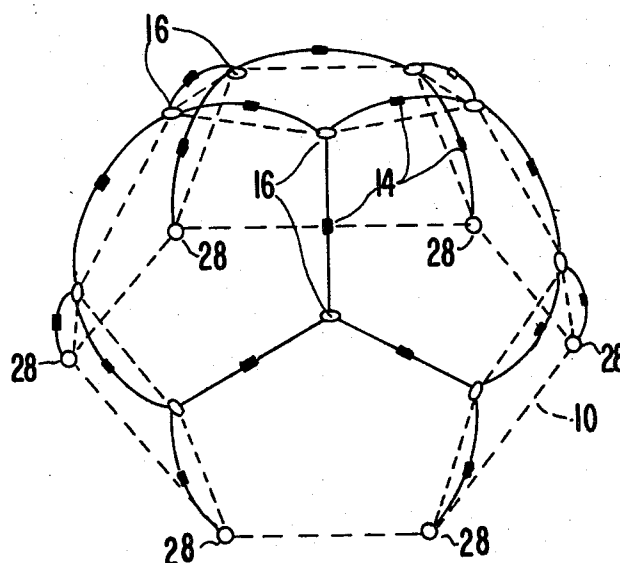
[57] ABSTRACT

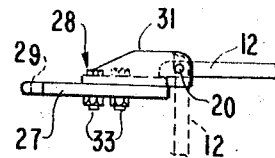
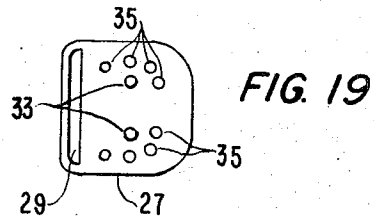
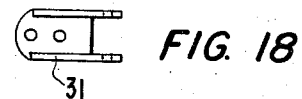
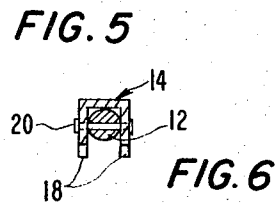
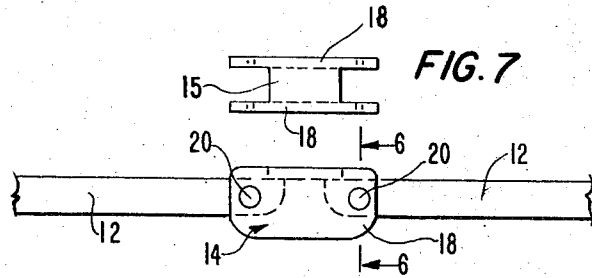
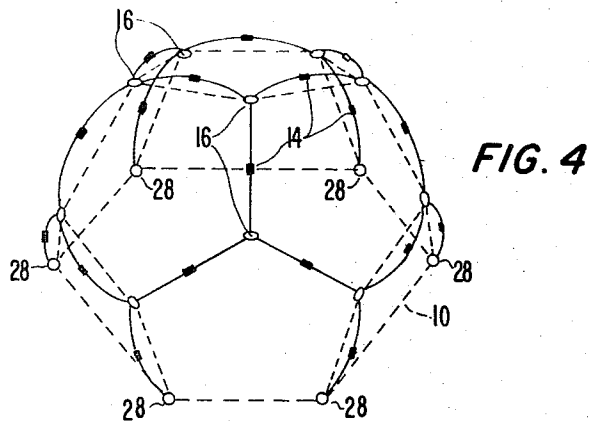
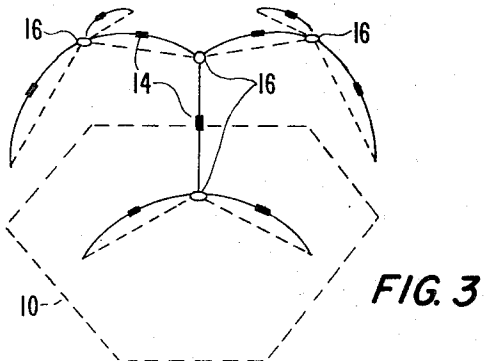
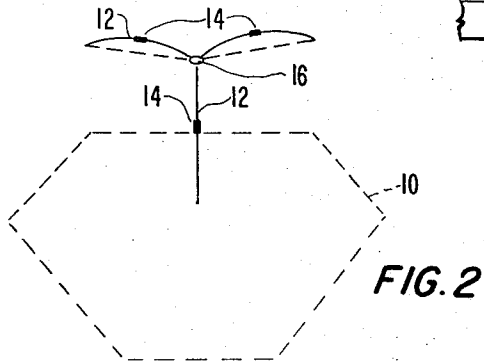
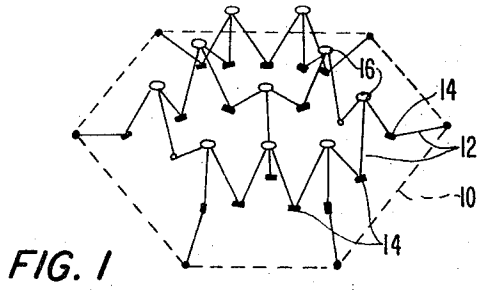
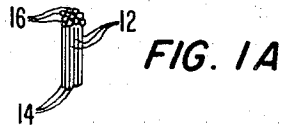
The collapsible dome framework is composed of a series of foldable resilient rods or ribs, hinged together at their ends to form, in their expanded condition, the common sides of adjacent polygons bowed outwardly

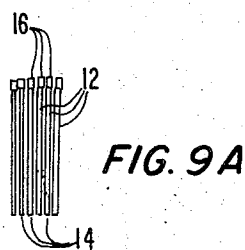
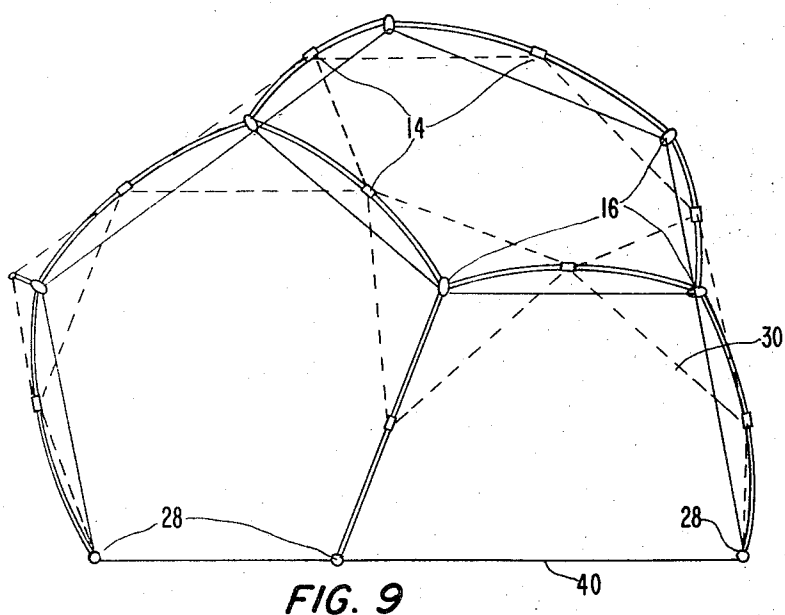
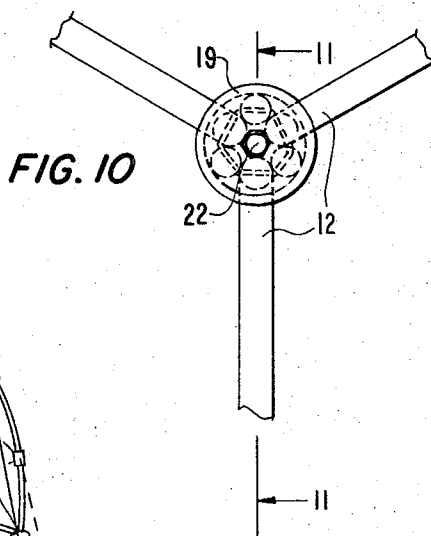
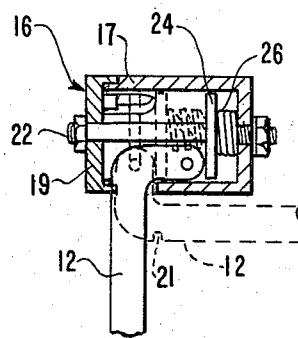
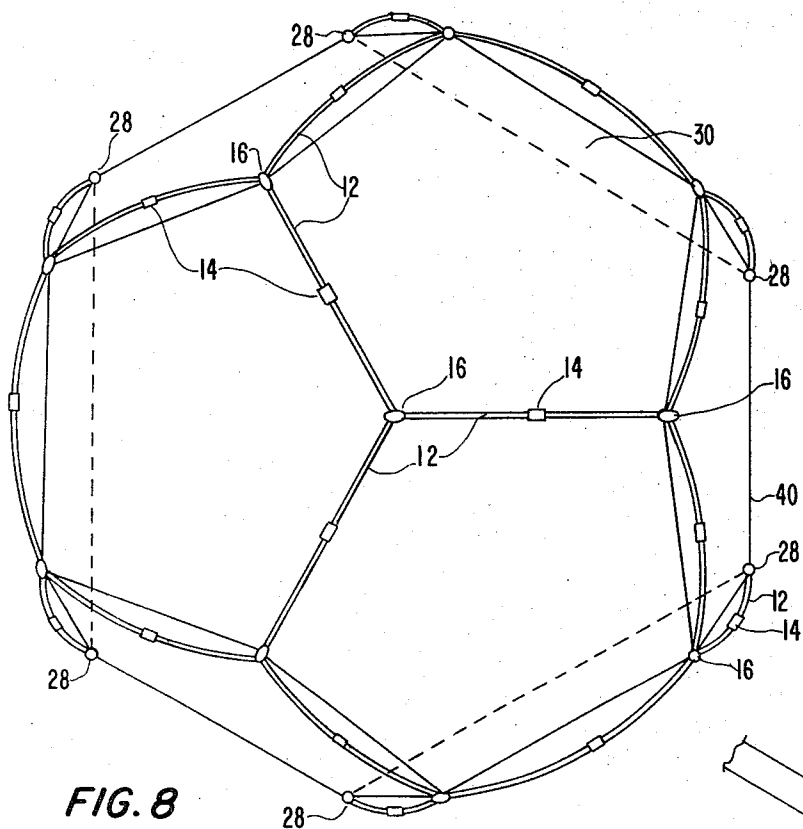
in a joined polyhedral pattern in the surface plane of the dome, the rods being foldable in one direction with respect to said dome while their opposite ends are folded in umbrella fashion in the other direction to collapse the dome frame into a compact bundle substantially half the length of the link rods.

The free ends of the peripheral link rods at the bottom of the dome are connected together by a peripheral tie line which holds them properly constrained at the corners of a suitably reduced polygon formed thereby at the base of the dome; and when the framework is collapsed, the outer ends of these peripheral link rods can be folded into said bundle. The tie line at the base of the framework may be constituted by the base hemline of the flexible sheet material which is formed into a dome shape to fit inside said dome framework when fully expanded, and is provided with ties for suspending it from the outwardly foldable hinges so that it may be folded compactly alongside or around the collapsed framework, ready to be expanded fully in place, when the dome framework is unfolded and all the links are sprung outwardly into the fully expanded dome.

5 Claims, 22 Drawing Figures







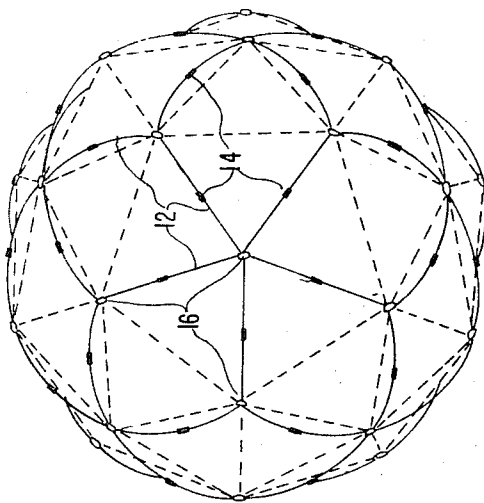


FIG. 12

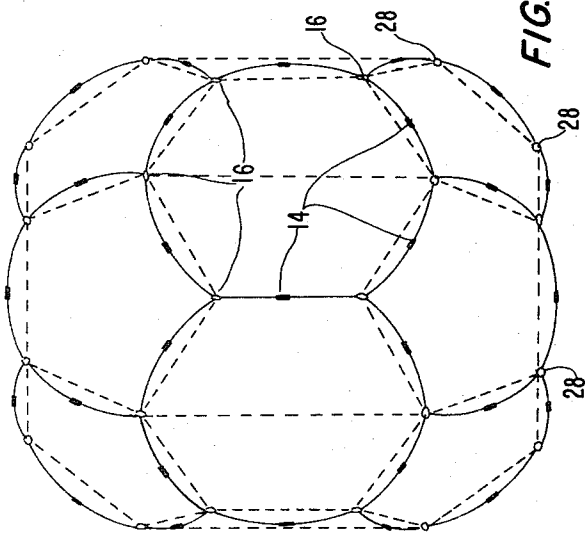


FIG. 14

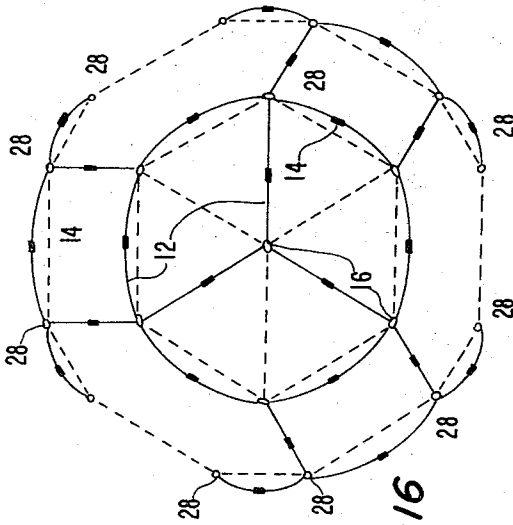


FIG. 16

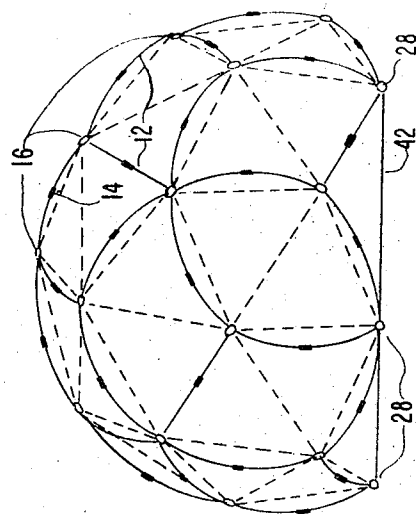


FIG. 13

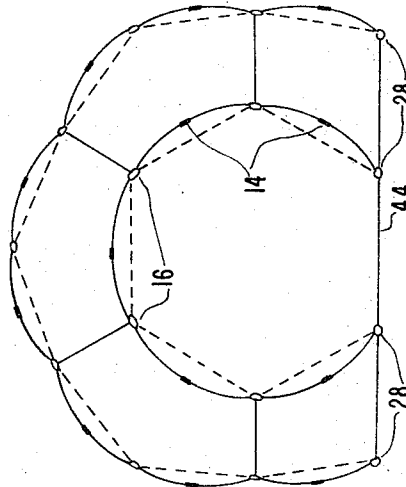


FIG. 15

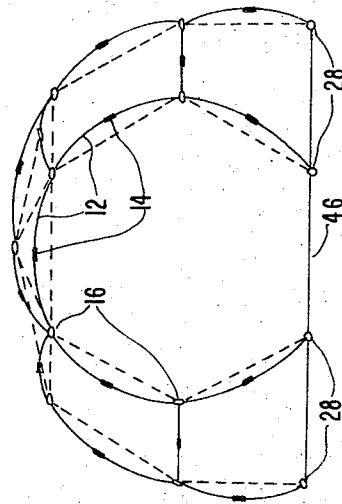


FIG. 17

COLLAPSIBLE FRAMEWORK AND COVER

The prior art, found mostly in class 135-4, shows many dome frames for tents which are collapsible but require the disassembly not merely the folding of at least some of the elements of the framework, as well as separate removal of the supported flexible sheet covering.

Considerable difficulty has been experienced in such disassembly of the knock-down structures of these disclosures, as well as in collapsing their foldable features and their compaction into suitably small packages for transportation or storage.

The main object of the present invention is therefore to devise a fully collapsible dome frame structure of large capacity, requiring no tools or the disassembly of parts or any expertise in expanding it on either side of its base, or collapsing it into a most compact bundle whenever desired.

A further object is to make a dome-like frame structure of maximum strength to weight ratio that may be quickly sprung outwardly into fully expanded form or collapsed into a compact bundle at will.

A further object is to make a collapsible frame of a series of foldable links, at least three of which are connected to a common umbrella type hinge joint, and their peripheral spread is constricted when they are fully unfolded to enable them to be bowed into a dome shape.

A further object is to make a collapsible dome frame composed of at least one set of ribs having fold joints in their middle and radiating from a common hinge joint at the center, and tying means between the outer ends of said rods to constrain them from fully extending into a flat plane, so that they may be bowed into the curved plane of said dome after either their common hinge joint or their individual fold joints are first locked in their fully opened positions by then springing the other joints and bowing the respective ribs into the plane of the dome.

A further object is to make a collapsible dome frame composed of a plurality of sets of foldable ribs radiating from a common central hinge joint, at least one rib in each set being connected to the common hinge point of another set, the free ends of the peripherally extending ribs being peripherally constrained to enable all the ribs in their fully extended locked positions to be bowed into the plane of the dome.

A further object is to provide a dome frame having ten hinge joints for three-rib sets, nine of which joints are arranged symmetrically about the tenth one at the center, each of the ribs of the center set radiating to one of three of the other hinge joints and each of the other two ribs of these three hinge joints radiating therefrom to one of the six remaining hinge joints; and one of the other ribs of each of these six remaining hinge joints being common to each peripherally adjacent pair of said six hinge joints, and the outer ends of the remaining ribs of each of these six hinge joints being peripherally connected together by a constraining tie line to define the base of said dome frame when fully expanded.

A further object is to attach a flexible domed cover inside said dome at suitable points to support it in fully expanded condition inside said frame when the latter is fully expanded so as to let it be folded compactly next to or around the compact bundle of folded ribs when

the frame is collapsed for transportation or storage in close quarters.

Other and more specific objects will become apparent in the following detailed description of some forms of this invention as illustrated in the accompanying drawings, wherein:

FIG. 1 illustrates the arrangement of the foldable ribs and hinge joints of one form of the dome framework of this invention, in partly expanded condition,

FIG. 1A illustrates how this framework is collapsed into a compact bundle of folded ribs with their connecting folded hinge joints at one end of the bundle surrounded by the free ends of the peripheral ribs,

FIG. 2 illustrates the assembly of the three central ribs in outwardly expanded bowed positions with their hinge joint fully expanded in a plane tangent thereto,

FIG. 3 shows three additional fully expanded hinge joints at the outer ends of the three central ribs with two additional ribs in their fully extended and outwardly bowed positions,

FIG. 4 shows the remainder of the fully expanded hinge joints in the complete assembly of foldable ribs, each of these hinge joints having a common rib between each of the three pairs of peripherally spaced hinge joints, and a third rib extending outwardly from each of these six hinge joints in fully extended outwardly bowed positions forming the complete dome, and a corresponding polyhedral dome cover outlined between its points of support on the dome frame,

FIGS. 5, 6 and 7 illustrate different views of a preferred form of the hinge used in the middle of the foldable ribs,

FIGS. 8 and 9 are plan and elevational views of another form of collapsible dome frame in fully expanded position with a dome cover supported therein,

FIG. 9A shows diagrammatically this frame folded into a compact bundle of half rib length, with the hinge joints and hinges brought together at the opposite ends of the bundle,

FIGS. 10 and 11 are two views of one form of hinge joint that may be used for a set of three ribs,

FIGS. 12 and 13 are plan and elevational views of a collapsible dome framework comprising one form of a polyhedral pattern of foldable ribs hinged at their ends to radially extending hinge joints,

FIGS. 14 and 15 are similar views of another form of polyhedral pattern of the ribs,

FIGS. 16 and 17 are corresponding views of still another form of polyhedral pattern of ribs, and

FIGS. 18 and 19 are plan views of parts of a hinge joint that may be used for strapping to the hemline of the bottom of a dome cover at the corners of the base tie line, and

FIG. 20 is a side view illustrating an assembly of a hinge joint of this type that may be used at the base tie line for the free ends of the peripherally extending ribs of the dome framework.

This collapsible frame system is not limited to tent supporting structures nor to the specific dome configurations illustrated, but may also be applied to canopy or roof supporting framework for portable building and shed structures, umbrellas, kites, aircraft wings, etc. wherever compact collapsibility and minimum weight-to-strength ratio are essential requirements.

The specific form of structure shown, in partly collapsed condition in FIG. 1, and fully collapsed in FIG.

1A, comprises a series of foldable struts or ribs 12, having folding hinges midway between their opposite ends and being hinged at their ends to radiating hinge joints 16 which fold in the opposite direction with respect to the common plane of said hinges when opened into their fully extended positions, the outer ends of the peripherally extending ribs being fixed by ties 18 to a spacer tie line 10 at spaced intervals corresponding to the sides of a polygon in the base plane of said dome structure, which is also the base plane of a flexible dome cover that may be supported by or in said structure when both are fully extended and the base hemline of the cover forms the spacer tie line fixed to the outer ends of the peripherally extending ribs.

The dome framework may be extended to either side of the base plane, and has means for locking the hinge joints in their fully extended positions, so that in setting up the dome structure, after unfolding the outer ends of the peripherally extending ribs and spreading the other hinges in the bundle to stretch the base tie line 10 to substantially the form of the base polygon, the radiating hinge joints 16 may be locked in their fully extended positions and the rib folding hinges 14 can then be pushed to their fully extended stops and sprung outwardly to their bowed position as determined by the polyhedral relations of the hinge joints 16 to which they are connected in the dome frame.

The corresponding dome shaped cover 30 is tied to the framework at suitable points such as the hinge joints 16 as indicated in full lines in FIGS. 8 and 9, or the rib fold hinges 14 as indicated in dotted lines in FIG. 9.

Obviously the cover 30 may be supported either inside the dome frame or over the outside thereof. However, if it is desired to keep it tied to the framework in its collapsed condition, the ties should be at the joints which fold away from the cover as the framework is collapsed, so that the ties and cover may extend free of the corresponding ends of the collapsed framework bundle and will not be caught in the rib folds but may be folded in an adjacent compact bundle or wrapped closely around the framework bundle for easy transportation or handling or storage.

It will be understood that either the hinge joints 16 or the rib fold joints 14 may be provided with locking means in their fully extended positions so as to hold them from collapsing and so that the other hinges may be sprung into their rib bowed positions while setting up the dome frame.

The locking means shown in FIGS. 10 and 11 is applied to a three hinge joint providing for the three ribs 12 to open by manually spreading them into their automatically locked fully expanded coplanar positions at 120° annular spacings. The cylindrical cage 17 houses the spring 26 which loads the washer 24 to keep the rim of the cage cap 19 in the lock groove 21 in the elbow end of the ribs 12. Washer 24 is slidable on bolt 22, so that when cage 17 is lifted against spring 28, the rim of the cage cap is lifted out of the lock grooves 21 and the ribs can start to fold in umbrella fashion, and when cage 17 is released, spring 28 will continue to urge the hinge joint to close. This simultaneously folds the rib hinges between adjacent radial hinge joints in the collapsing process, finally resulting in a compact bundle substantially half the length of the foldable ribs 12, as the outer ends of the peripherally extending ribs are

pulled inwardly and folded up around the outside of the bundle.

The tie line 10 and the dome cover, if still tied to the framework, may then be packed or wrapped in a compact bundle next to or around the collapsed frame bundle, as may be most convenient for easy handling, transportation or storage purposes.

However, the more practicable combination for the setting up and collapsing processes is to keep the cover or skin tied to the hinges or hinge joints that fold away from the cover side of the framework, so that the cover may fold itself into the spaces between the folded rib halves as the frame is collapsed. Much time and labor can thus be saved in both the erection and the collapsing and packing processes. Obviously, in this combination it will be necessary for the hinge pins at each fold to be spaced to provide sufficient clearance for the cover folds between adjacent substantially parallel rib halves in the collapsed bundle.

FIGS. 18, 19 and 20 illustrate parts 27 and 31 and assembly 28 of a form of hinge joints for adjustably connecting a pair of radial hinges at selected radial angles for the outer ends of peripherally extending ribs, and having a strap slot 29 for strapping the hinge joint to the edge of a base hemline 40 or other tie line at the corners of the base polygon of an expanded dome framework.

FIG. 5 is a side view of a sample form of rib folding hinges 14, comprising a pair of side plates 18 providing bearings for hinge pins 20 for the adjacent rib halves, and having a bottom plate 15 for stopping the unfolding of a rib 12 at its fully extended in-line position, so that it might be sprung into its bowed position in the dome frame when set up.

A spring latch or other locking means (not shown) may obviously be provided to lock the rib halves in their fully extended position for use in frame assemblies with no locking means on the oppositely folding radial hinge joints, which may then be sprung into the plane of the dome in the setting up process, after the folding ribs are all locked in their unfolded in-line positions, so as to bow the ribs outwardly.

The dome forms illustrated in FIGS. 1 to 11 are composed of ten hinge joints 16 having three radiating hinges at each joint, and arranged to form a pentagonal pattern of ribs, each of which serves as a common side of adjacent pentagons in the polyhedral pattern.

FIGS. 12 to 17 illustrate three of a wide variety of polyhedral patterns that may be used in this dome structure.

It will be obvious that this same arrangement of hinges and hinge joints may be used for flat canopy covers or roofs, as well as for domes and even complete volumetric enclosure surface covers.

Furthermore, instead of having mid-rib hinges in the framework between the umbrella hinges foldable in an opposite direction thereto relative to the plane of the dome or flat cover, the ribs may be made rigid and connected at their opposite ends to umbrella hinges which are foldable in relatively opposite directions with respect to the cover. Also, the ribs may be embedded in or connected to the dome cover so that the cover material itself will provide flexible hinges for the adjoining rib ends forming the radiating sides of adjacent polygons in the joined polygonal pattern of the dome or flat cover when extended into a common plane at the hinges. In any case, only one set of hinges, which are

foldable in the same direction, need to have means to hold them extended in said plane when the cover is stretched out, with releasable means for allowing the cover to collapse and the ribs to fold into a compact bundle as previously described.

Many other obvious modifications in form and details of the several parts of this structure may be made without departing from the spirit and scope of the present invention.

What is claimed is:

1. A collapsible dome frame having
at least one hinge coupling comprising a plurality of
angularly spaced hinges radiating therefrom and
opening in one direction into the plane of said
dome,
a plurality of foldable rods of resilient material connected at their opposite ends to hinges in adjacent hinge couplings to form the common sides of adjacent polygons in a polyhedral pattern in said dome,

the peripheral hinge couplings near the bottom of the dome having at least one foldable rod connected to their hinges and extending downwardly to the base of the dome, and

means for limiting the spread of the outer ends of said downwardly extending rods so that said rods when unfolded into their fully extended positions can be sprung into a bowed position into the plane of said

dome.

2. A collapsible dome frame as defined in claim 1, said spread limiting means being a tie line holding the lower ends of said downwardly extending rods in properly spaced peripheral relation in the shape of a polygon formed by the lower sides of the peripherally adjacent polygons in the polyhedral pattern at the bottom of said dome.

3. A collapsible dome frame as defined in claim 1, said spread limiting means being a hinge coupling at the lower end of each of said downwardly extending rods and foldable rods connected peripherally between them in the shape of a polygon formed by the lower sides of the peripherally adjacent polygons in the polyhedral pattern at the bottom of said dome.

4. A collapsible dome frame as defined in claim 1, and

a flexible sheet cover of corresponding dome shape and having tying means at suitable points to said dome frame for support thereon in expanded condition and collapsing therewith in a compact bundle without untying therefrom.

5. A collapsible dome frame and cover as defined in claim 4,
said cover having a base hemline forming said spread limiting means.

* * * * *

30

35

40

45

50

55

60

65