United States Patent [19]

Kelly et al.

[11] **3,888,056**

[45] **June 10, 1975**

[54] **ERECTABLE BUILDING STRUCTURE JUNCTION ELEMENT**

[76] Inventors: **Vincent M. Kelly**, 61 Hassayampa Country Club, Prescott, Ariz. 86301; **Henry H. Schrieber**, 631 East Wesleyan, Tempe, Ariz. 85282

[22] Filed: **Oct. 25, 1973**

[21] Appl. No.: **409,436**

[52] **U.S. Cl.** ..... **52/109**; 52/81; 52/222; 52/646; 135/4 R

[51] **Int. Cl.** **A45f 1/16**; E04h 12/18

[58] **Field of Search** ..... 52/80, 81, 109, 646, 222; 135/4 R, 4 A, 4 B, 4 C

[56] **References Cited**

UNITED STATES PATENTS

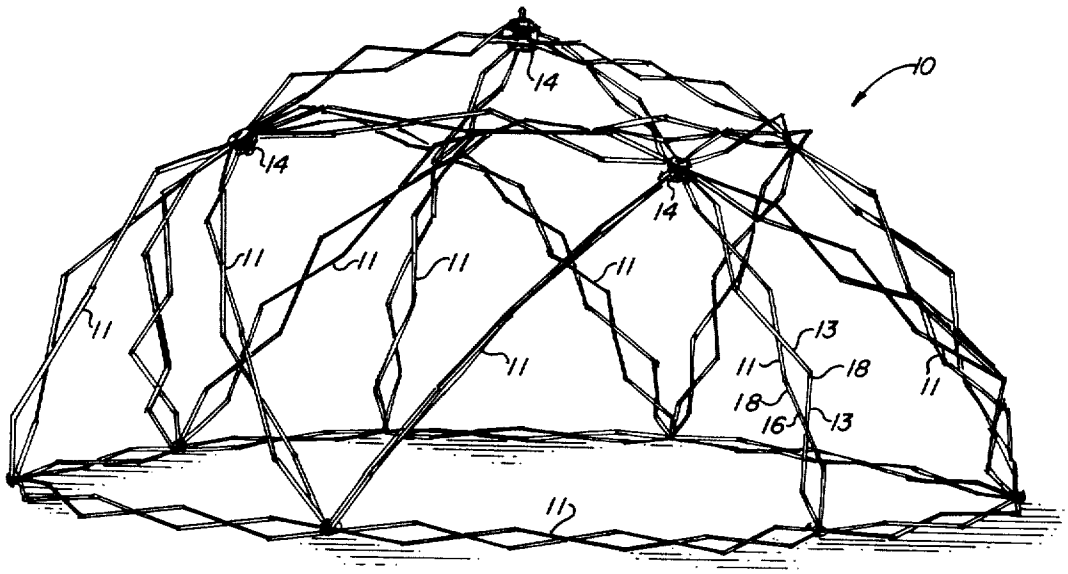
3,000,386	9/1961	Schulze	135/4 C
3,710,806	1/1973	Kelly	52/81

Primary Examiner—Henry C. Sutherland
Assistant Examiner—Robert Farber
Attorney, Agent, or Firm—Warren F. B. Lindsley

[57] **ABSTRACT**

An expandable structure employing multi-hinged, scissor-type mechanical linkages for supporting an associated flexible skin or a skeleton for supporting a rigid panel skin provides an expandable, collapsible and movable building having rigid or sliding junction linkages for interconnecting and operating the scissors-type linkages.

3 Claims, 7 Drawing Figures



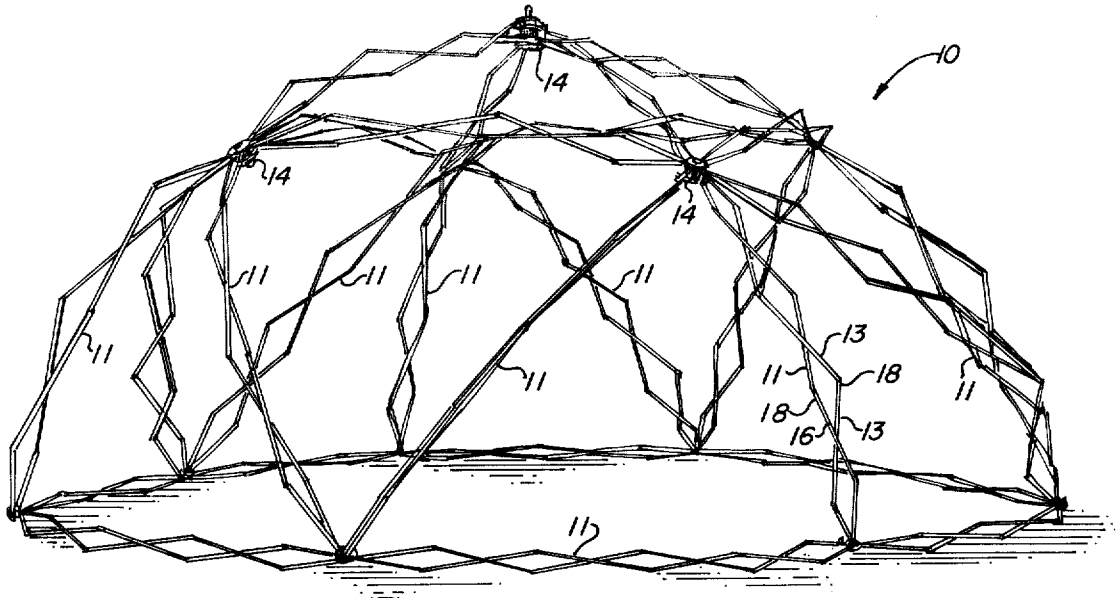

10
14
14
14
11
11
11
11
11
11
11
13
18
18
16
13
11

Fig-1

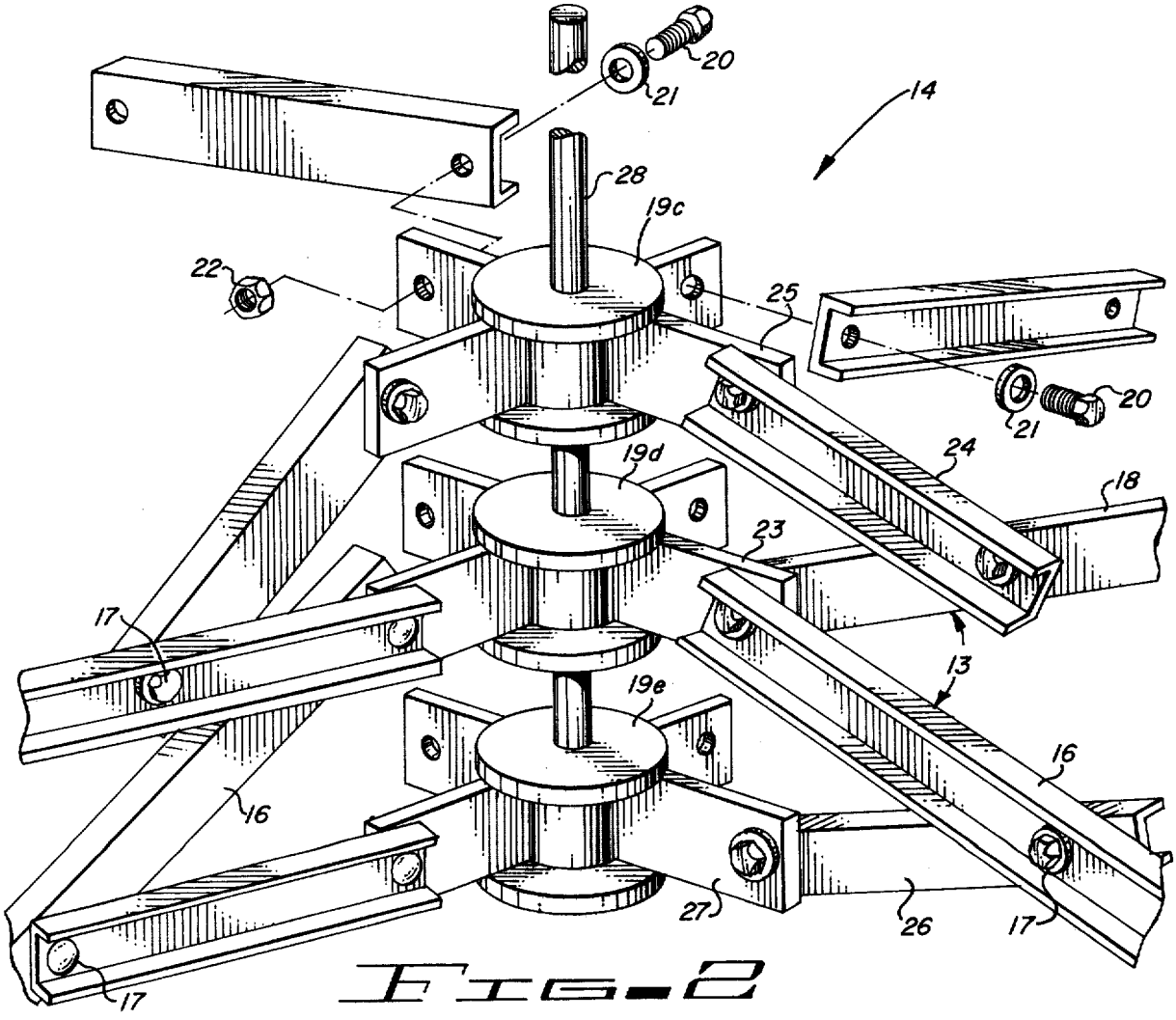

20
21
14
28
19c
22
25
20
21
19d
24
18
23
17
13
19e
16
16
27
26
17
17

Fig-2

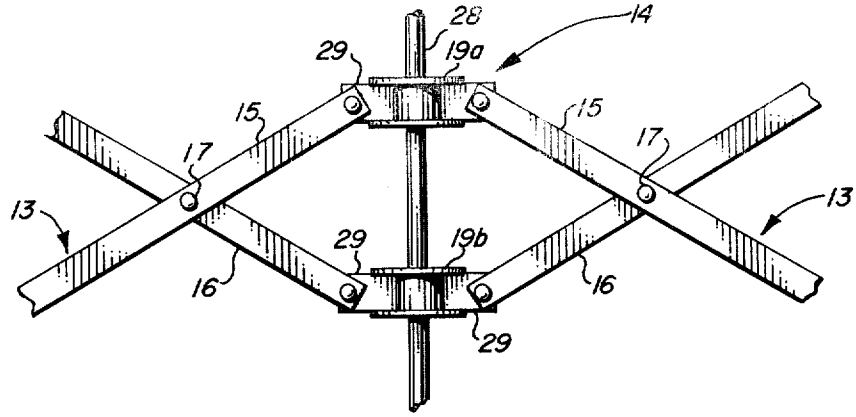


Fig-3

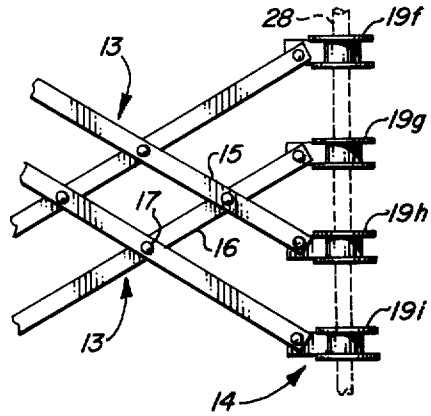


Fig-4

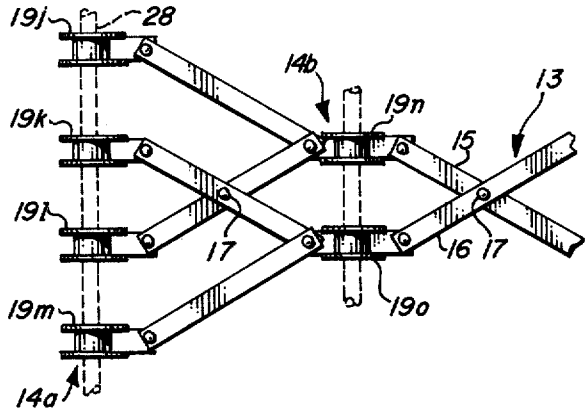


Fig-5

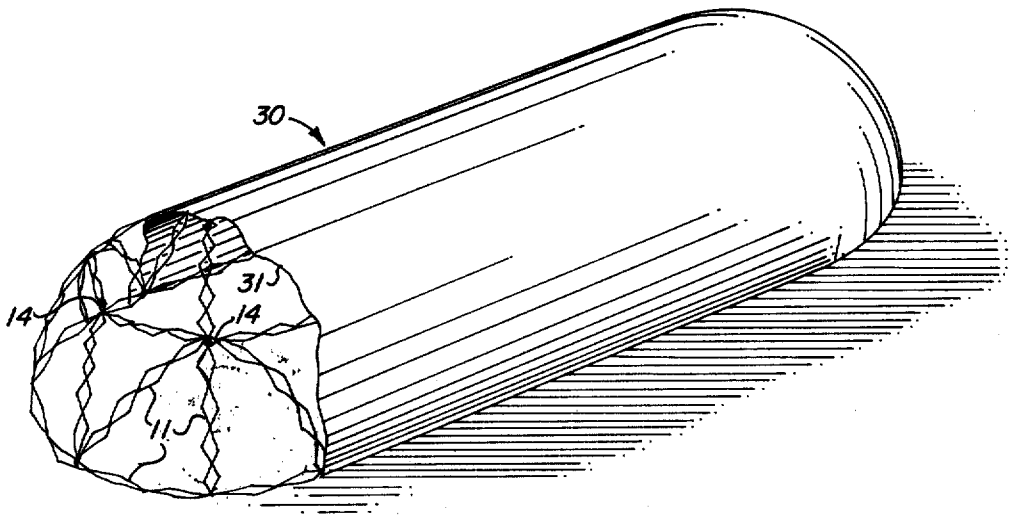


Fig-6

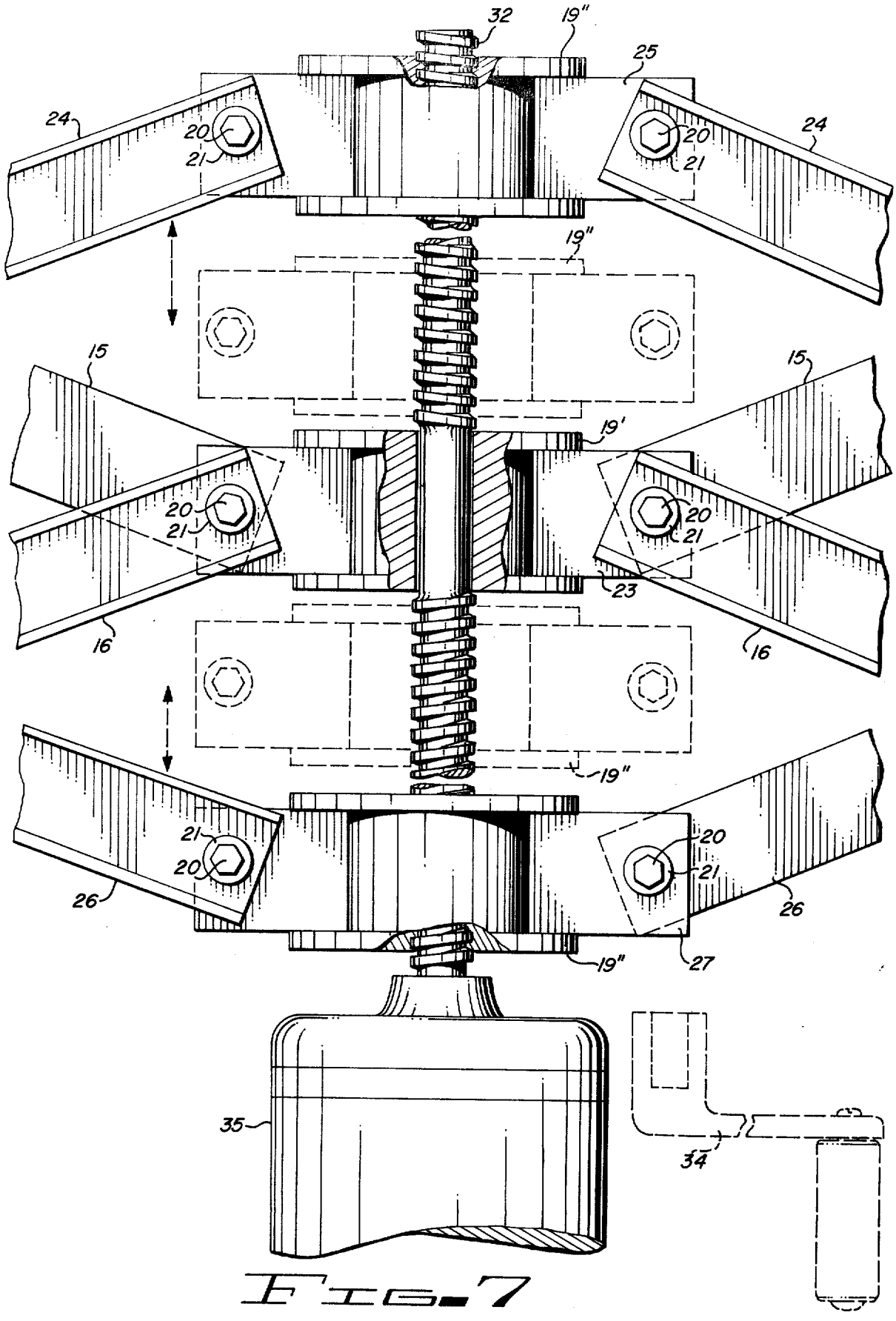

32
19"
25
24
20
21
24
19"
15
15
19'
20
21
20
21
23
16
16
19"
21
20
20
21
26
26
19"
27
35
34

FIG. 7

ERECTABLE BUILDING STRUCTURE JUNCTION ELEMENT

BACKGROUND OF THE INVENTION

The present invention relates generally to collapsible structures and more particularly to elements for interconnecting and operating multi-hinged, scissors-type mechanical linkages usable in collapsible structures.

1. Field of the Invention

Struts arranged to form triangular frames employing axial loading of its component members have been widely used. Likewise multi-hinged, scissors-type mechanical linkages have been used for supporting expandable structures as evidenced by U.S. Pat. No. 3,710,806 issued Jan. 16, 1973, as well as by other articles.

In erecting the structure, the multi-hinged, scissors-type linkages must be interconnected with a junction element to provide the expansion and retraction of the scissors-type elements to erect and to collapse the supporting structure of the building. In small, relatively light structures, a simple interconnection joining the ends of the scissors-type linkage can be used to provide a pivotable and slideable interconnection to expand and contract the scissors-type linkages.

2. Description of the Prior Art

An example of a junction element usable in an erectable building structure can be obtained by referring to the aforementioned U.S. Pat. No. 3,710,806. The results were a workable junction element but a rather complex element not easily adaptable to provide a higher mechanical advantage for large structures or for structures composed of single-length expandable trusses.

A further example of prior art junction elements for operating expandable linkages is that of the common umbrella. The use of the umbrella-type junction element is not an obvious adaptation, especially in view of the use of multiple junction elements for increased mechanical advantage and the multiplicity of the interconnections needed in a geodesic type erectable building structure or a semi-circular or Quonset-type building structure. The complete adaptability of the umbrella-type junction element would be a central pole pivotably supporting rigid struts projecting from the central pole. The complex multi-interconnects or simple single interconnects of the scissors-type linkages permits the expansion of a supporting structure for a small or large building from a compact package much less in height than the resultant building.

SUMMARY OF THE INVENTION

The erectable building structure according to the present invention comprises expandable trusses interconnected by a junction element and covered by a flexible sheeting. The expandable trusses comprise a plurality of scissors-type mechanical linkages interlocked by the junction elements. The junction elements provide a pivotable and slideable interconnection of a multiplicity of trusses to expand or contract the scissors-type linkages of the trusses comprising a multiplicity of hub elements having pivotable interconnections to the scissors elements of the trusses while operable about a common axis to expand or contract the scissors-type linkages.

It is, therefore, an object of the present invention to provide an enhanced erectable building structure.

It is more particularly an object of the present invention to provide an improved junction element for interconnecting the expandable trusses of an erectable building structure.

It is another object to provide a junction element capable of improved mechanical advantage to operate expandable trusses of erectable building structures.

It is still another object to provide junction elements for expandable trusses for erectable building structures comprising scissors-type mechanical linkages having few parts of simple construction.

It is a further object of this invention to provide junction elements for expandable trusses which are usable in conjunction with previous hubs described in U.S. Pat. No. 3,710,806.

These and other objects of the present invention will become apparent to those skilled in the art as the description proceeds.

BRIEF DESCRIPTION OF THE DRAWING

The various novel features of this invention, along with the foregoing and other objects, as well as the invention itself both as to its organization and method of operation, may be more fully understood from the following description of an illustrated embodiment when read in conjunction with the accompanying drawing, wherein:

FIG. **1** is a perspective view of an expandable truss structure for a dome-shaped building and embodying the present invention;

FIG. **2** is a fragmentary enlarged perspective view of an interconnecting junction element of FIG. **1**;

FIGS. **3, 4** and **5** are further embodiments of the junction elements according to the present invention; and

FIG. **6** is a perspective view of an expandable truss structure and covering for a semi-circular expanded building such as a Quonset hut and embodying the present invention.

FIG. **7** illustrates a further modification of the truss structure shown in FIGS. **1–6** wherein gear means are used for moving one hub relative to the other.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, FIG. **1** discloses a dome-type structure **10** formed of expandable trusses **11.** The dome-type structure **10** can be covered by a flexible sheathing or covering (not shown) to form an enclosed structure.

The expandable trusses **11** or load supporting struts comprise a plurality of scissors-type expandable linkage struts **13** which serve as the erectable and expandable support for the flexible covering. The scissors-type linkages **13,** when inter-locked together by junction elements **14** as shown in FIG. **1** adequately form and support the building configuration. Each expandable linkage structure **13** comprises two linkages **15** and **16** pivotedly connected by a pin **17** at a point at the middle of the linkages. The free end of each linkage pair is pivotedly connected by a pin **18** to the free end of the next linkage pair. The end linkage pairs of each expandable linkage structure is pivotedly connected to the junction element **14,** see FIG. **2.**

The junction elements **14** are placed at the intersection of a plurality of expandable trusses **11** to form the geodesic or dome-type structure **10** collapsible at will

to a small package. The junction elements **14** are spaced around the extended surface of the structure at points depending upon the support required by each expandable truss **11**. The size of the structure and the weight which each expandable truss **11** can support will determine the number of expandable trusses **11** and the number and location of the junction elements **14**.

Each of the junction elements **14** comprises a plurality of axially aligned hubs **19** linking the ends of the linkages of each expandable truss **11** to operate the scissors mechanism to expand or contract the struts. The junction elements **14** can comprise either two hubs **19***a* and **19***b*, as shown in FIG. **3**, three hubs **19***c*, **19***d* and **19***e* as shown in FIG. **2**, four hubs **19***f*, **19***g*, **19***h* and **19***i* as shown in FIG. **4** and a combination of four and two **19***j*–**19***o* as shown in FIG. **5**. There are many different interconnections of the junction elements **14** and the number of hubs **19** should not be taken to limit the coverage of the present invention. Different combinations can be used for greater mechanical leverage to expand the scissors linkages of the struts. The number of hubs and the interconnection with the scissor element depends on the mechanical advantage required, more hubs and combination of hubs such as shown in FIG. **5** could be used for a large building structure. The higher mechanical advantage available with a multiplicity of hubs would ease the expansion of the linkages to erect the building.

Referring now to the three-hub junction element **14** as shown in FIG. **2**, the linkages **15** and **16** comprising the scissors-type struts are pivotedly connected at the central pivot point of the struts by a bolt **20**, washer **21** and nut **22** combination to lugs **23** firmly fastened around the peripheral of the center hub **19***d*. Four lugs are shown connected to each hub in FIG. **2**, but it is obvious that a greater or lesser number of lugs may be fastened to each hub, depending upon the number of expandable truss interconnections required of the junction element **14**. It should be recognized that some or all of the lugs may be pivotally connected to one or more of the hubs disclosed.

A linkage arm **24** is shown in FIG. **2** pivotedly fastened to a lug **25** of the top-most hub **19***c* of the junction element **14**. The other end of the linkage arm **24** is pivotally fastened to the upper linkage **15** of the scissors-type strut **13**. A second linkage arm **26** is pivotally fastened to a lug **27** of the bottom hub **19***e* of the group of hubs. The other end of the linkage arm **26** is pivotally fastened to the lower linkage **16** of the scissors-type strut **13**. The lugs **23**, **25** and **27** of the group of hubs are in alignment to operate each of the plurality of expandable trusses connected to the junction element **14**.

A center rod **28** is shown passing through the axial center of the hubs **19***c*, **19***d* and **19***e*. Rod **28** is not entirely necessary for the operation of the junction element **14** since the linkages of each of the expandable trusses could provide a centralizing force to keep the hubs in axial alignment. The no-rod hub assembly could provide other than axial alignment when required. However, the rod could be used to support the flexible or rigid covering for the building structure while assisting the axial alignment of the hubs. The covering could be fastened to the uppermost end of rod **28** as shown in FIG. **2** by a suitable fastener (not shown). If rod **28** is used, it could be fastened to any one of the hubs such as **19***c* and journaled to the remaining two hubs **19***d* and **19***e* of the junction element shown in FIG. **2**. Rod **28** would hold the two free hubs in axial alignment while operating the scissors linkages **15** and **16** of the struts by expanding or contracting the distance between the hubs along the axial alignment. Therefore, to expand the building the hubs must be forced more adjacent each other to cause the scissor-type linkages to expand. It is obvious, therefore, that by separating the hubs, the scissors-type linkages will cause the struts to contract to collapse the building structure for easy removal to another site.

Referring now to FIG. **3**, the simplest form of the junction element **14** according to the present invention is shown. The last linkages of the scissors-type struts **13** are pivotally fastened to lugs **29** extending from the hubs **19***a* and **19***b*. Similarly with this embodiment, the rod **28** may or may not be used to provide axial alignment of the hubs. If rod **28** is used, either the top hub **19***a* or the bottom hub **19***b* may be fastened to rod **28** or neither hub may be fastened, with both hubs being journaled to the rod for slidable movement thereon. Again, bringing the hubs together will expand the trusses **11** of the building by causing the scissor linkages **13** to be placed closer together and to contract or shorten the lengths of the expandable trusses **11** by expanding the distance between the mated ends of the linkages.

A connection for a double scissors-type expandable truss **11** for extra support is shown in FIG. **4**. Again the hubs will operate the linkages of the expandable trusses and again an axial alignment rod **28** may or may not be used. Only one side or one lug is shown fastened to each hub. It is obvious that more lugs are placed around the peripheral of each hub to support several expandable trusses as shown in the structure of FIG. **1**.

For further mechanical advantage, the junction elements **14** may be fastened as shown in FIG. **5**. The four-hub junction element **14***a* can be used to operate the two-hub junction element **14***b*, which in turn operates the scissors-type linkages **15** and **16** of the struts **13**. Operating the four-hub junction element **14***a* will provide a mechanical advantage for ease of expansion of the linkages of the struts **13**, and thus provide an easy expansion of the expandable trusses **11**.

Referring again to FIG. **1**, the expandable trusses **11** forming the framework of the dome-type structure **10** are a repetition of components having scissors-type linking struts **13** and junction elements **14**. Thus, it is inherent that the operating characteristic of each junction element and linkage arrangement are repetitive, since the load should be evenly distributed through the framework of the dome-type structure. There is no one strong point such as a central hub in the dome structure shown, but there may be use of a central hub configuration in other structures embodying the inventive concept disclosed. Each of the junction elements **14** structural intersect points is a support point and load applied directly to any of these points is distributed throughout the structure along numerous structural paths, the expandable trusses **11**. Accordingly, a high degree of structural integrity is provided.

The junction elements **14** according to the present invention may be located at strategic points around the circumference of the base of the structure at the intersection of the supporting expandable trusses for mechanical advantage and the covering of the building. These junction elements can be used to expand the circumference of the structure while the junction ele-

ments in the dome portion of the structure are expanding the trusses supporting a flexible covering for the structure.

Further, the repetetive nature of the structure using the scissors-type linkages **13** and the junction elements **14** provides almost unlimited design flexibility, i.e., any desired profile shape can be obtained by simply matching the structure to the desired shape. It should be stated that triangular, elongated, polyagonal and angular configurations are possible with the disclosed junction element and linkage configuration.

A dome-type structure has been shown and described. However, other structural uses can be made of the inventive concept disclosed herein such as helical antennae structures for space and earth use, non-dome shaped structures for housing or product sheltering purposes, and any other needs for coverage of a permanent or a temporary nature. For instance, a "Quonset Hut" type of building **30** is shown in FIG. **6** using the junction element **14** and scissors-type linkage expandable trusses **11** according to the present invention. Each end of the Quonset hut can comprise a quarter sphere or one half of the dome structure shown in FIG. **1**. Similarly the length of the Quonset hut can comprise either scissors-type expandable trusses or supporting rods interconnecting the quarter sphere ends. The covering **31** may be of a plastic or rubber material or it may be simply a flexible netting formed of any desirable material capable of supporting other materials to form a flexible or rigid covering, or a rigid panel covering attached after the framework has been raised.

A further modification of the junction elements can be made by the use of a worm gear **32** as shown in FIG. **7** journaled for fixedly rotating within one hub **19'** while being threadedly connected to each of the remaining hubs **19''**. Thus upon rotating the worm gear **32**, the hubs **19''** will be forced together by causing the hubs threadedly fastened to the worm gear to be drawn toward the hub **19'** into which the worm gear is fastened for rotation without axial movement. The worm gear may be rotated by a simple hand operated crank **34** or a motor **35** could be connected at the end of the worm gear to rotate the worm gear when energized. Each of the junction elements shown in FIG. **1** can be operated by a worm gear and motor construction as shown in U.S. Pat. No. 3,710,806 to cause the expansion or contraction of the building structure by the actuation of switches supplying power to the motors. The motor will rotate the worm gear which will cause the hubs of the junction elements to be drawn together, thereby extending the length of the struts formed by the scissors-type linkages.

The motor may comprise an electrical, common pneumatic, or hydraulic means which may be operated by one or more gear trains. Further the worm gear may comprise a right and left handed thread meeting at a central location between the hubs of the junction element. Rotating the worm gear will cause the hubs of the junction element to be drawn together by the worm gear towards the thread change-over position.

The principles of the present invention have now been made clear in an illustrated embodiment. There will be immediately obvious to those skilled in the art many modifications of structure, arrangement, proportions, the elements, materials and components used in the practice of the invention. For instance, circular hubs are shown in the Figures comprising a part of the junction element. It is obvious that a square for interconnecting four struts could be used. Likewise a hexagonal hub could be used for interconnecting six struts in the junction element. The appended claims are, therefore, intended to cover and embrace any such modifications, within the limits only of the true spirit and scope of the invention.

What is claimed is:

1. A junction element for interconnecting a plurality of expandable trusses forming a portion of an erectable framework for a building structure, each expandable truss comprised of a scissor-type mechanical strut having at least one pair of linkages pivotally connected at a point between their ends, said junction element comprising:

a plurality of substantially axially aligned hubs positioned along a rod, the number of said hubs grouped into sets of three;

a plurality of lugs fastened around the periphery of each hub;

means for pivotally fastening the pivot point of the paired scissors-type linkage at the end of one expandable strut to one lug of the central hub of a group of hubs;

a first and second arm pivotally fastened respectively at one end to a lug of the first and third hub of the group, the other ends of the arms being each pivotally fastened to one linkage of the scissor-type mechanical truss at a position between the pivot point of the linkage and the pivot connection to the next linkage;

the relative position of the first and third hubs to the central hub of one junction element determining the distance between the common ends of the linkages of the scissors-type struts and thus determining the length of said expandable trusses,

said central hub of each group being fastened to said rod while the first and third hubs are slidably fastened thereto.

2. A junction element as defined by claim **1**, wherein each of said plurality of axially aligned hubs is slideably fastened to said rod such that the axial center of said rod is parallel to the axial center of said hubs.

3. A junction element as defined by claim **1** wherein said rod comprises a gear means fastened to said groups of hubs such that selectively rotating said gear means causes said hubs of each group to be drawn adjacent each other and to be separated from each other.

* * * * *