

DUPLICAT

TRUSS STRUCTURE

The present invention relates generally to a truss structure used for construction of a building, house or the like and more particularly, a truss structure comprising a multiplicity of substantially spherical nodes, a multiplicity of rods extending between and joined to each adjacent pair of the nodes to thus form any desired configuration, such as a dorm, a plane figure, and a multiplicity of panels enclosing the configuration.

A typical structure of the type described is disclosed in Japanese Utility Model Laid-open Publication No. 2-20614. The disclosed truss structure 501 broadly comprises three distinct elements; a skeleton or supporting foundation framework 501a for bearing the whole burden of the structure 501; a covering structure 501b enclosing the framework and; means 501c for linking the skeleton 501a and the covering structure 501c. The skeleton 501a includes a multiplicity of solid nodes 503 and a multiplicity of solid cylindrical rods 505 extending between and joined to each adjacent pair of the nodes 503 in such a way that relevant radiating rods 505 being joined radially thereto to thus form a lattice like skeleton framework 501a of a desired configuration. The covering structure 501b includes a multiplicity of panel members 501b each comprising an interior and an exterior frame half 507, 509 and a panel 511 clamped therebetween. And, the linking means 501c includes a multiplicity of brackets 501c linking the nodes 503 and the interior frame halves 507.

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This conventional truss structure 501 suffers the following drawbacks:

5 Since the lattice-like skeleton framework 501a, a great number of the brackets 507 and the panel members 501b are arranged and installed at random or without regard to each other in terms of aesthetical design, this provides unsightly, complicated and out-of-order appearance.

10 After setting up the skeleton framework 501a; first one must attach brackets members 501c to the skeleton framework 501a at thousands of positions and then attach a multiplicity of panel members 501b to the bracket members 501c at as many positions. This operation has proved to be very time-consuming and tedious.

15 With the foregoing difficulties in view, it is therefore an object of the invention to provide a truss structure which is simple in structure, thus pleasing to look at and is easy to manufacture and install.

20 According to the present invention, there is provided a truss structure comprising: a multiplicity of substantially spherical nodes; and a multiplicity of rods extending between and joined to each adjacent pair of the nodes in such a way that each node has their relevant rods extending radially therefrom to thereby form a desired lattice configuration; characterized in that: the lattice configuration has a multiplicity of openings
25 each defined by a set of the rods; the truss structure further including a multiplicity of panels each adapted to enclose the opening; each rod including an elongated tube having each end



fastened to the outer periphery of the node and a support member integrally formed on the elongated tube for supporting thereon the panel in the opening in cooperation with the corresponding support members of the other opening-defining rods; and means for retaining the corresponding panel to the support member.

Many other advantages and features of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which preferred structural embodiments incorporating the principles of the present invention are shown by way of illustrative example.

FIG. 1 is a diagrammatical plan view of a dorm construction in which the present invention is embodied.

FIG. 2 is an enlarged fragmentary view of an apex portion of the dorm construction of FIG. 1;

FIG. 3 is a cross-sectional view taken on line III-III of FIG. 2.

FIG. 4 is a cross-sectional view take on line IV-IV of FIG. 2.

FIG. 5 is an enlarged exploded view of the apex portion of the dorm construction, some parts omitted for brevity's sake.

FIG. 6 is a perspective view of a conventional truss structure described in the introductory part of the specification.

FIG. 1 is a diagrammatical plan view of of a dorm construction used for auditorium, stadium etc. in which the present invention is embodied, although the truss structure



according to the present invention may be of any desired figure, such as as circular plane figure, rectangular plane figure, etc.

As seen from FIG. 1, the truss structure broadly comprises a multiplicity of nodes 11; a multiplicity of rods 13 extending between and joined to each adjacent pair of the nodes 11 in such a way that each of the node 11 has their some relevant rods extending radially therefrom to form a dorm-like lattice construction having a plurality of opening each defined by a set of the rods 13; a plurality of panels 12 each adapted to enclose the opening; and means 14 for retaining the corresponding panel to the rod.

Since the node-and-rod system is repeated over entire area of the dorm construction, the explanation will be made by focusing on an apex portion A (FIG. 2) of the dorm construction of FIG. 1. In FIG. 2, a node 11 is partly seen under five elongated cap plates 91 having their isosceles-triangular ends 93 butted together, the corresponding five rods being hidden under the cap plates 91. Although the node-and-rod system is shown to extend over the entire area of the construction in this embodiment, the node-and-rod system may be used as part of a construction, such as a facade, a flat roof and a skylight.

As better shown in FIGS. 4 through 5, each node 11 is substantially spherical and hollow, and comprises a hollow bowl-shaped node body 15, a thin circular cap 17 and a joint bolt 19 joining the node body 15 and the circular cap 17 together. The node body 15 has a circular opening 21 formed in the base thereof. The node body 15 has a plurality of (five



Fig. 3
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in case of the node 11 located on the apex portion A) through holes 23 formed in the periphery in a plane and disposed at uniform intervals from each other. The node body 15 has a threaded hole 25 on the internal periphery at the apex A thereof into which one end of the joint bolt 19 is screwed. The node body 15 has a pair of internal and external flattened surfaces 26, 27 around the internal and external edges, respectively, of each through hole 23 for enabling a head of a bolt 20 and an end of a tube 41 to be seated flatly and stably thereon, as closely described hereinafter.

The circular cap 17 is complementary in diameter to the circular opening 21 of the bowl-shaped hollow node body 15 for fully enclosing the opening 21. A central stud 27 is mounted on the inner side at the center of the circular cap 17. The central stud 28 has a threaded hole 29 formed longitudinally therein.

As better shown in FIGS 3 through 5, each rod 13 is extruded from aluminium or other suitable materials and broadly comprises an elongated circular tube 41 and a support member 43 integrally formed with and mounted longitudinally on the elongated tube 41 for supporting panels thereon.

As better shown in FIG. 4, the elongated tube 41 has a pair of caps 45, 45 plugged and welded one into each end thereof. The cap 45 has therethrough a threaded through hole 47 coaxially with the tube 41. The support member 43 comprises an upright support stem 51 mounted longitudinally on and extending vertically from the tube 41 and a horizontal



crossbar 53 mounted crisscross on the upright support stem 53. The horizontal crossbar 53 has a pair of parallel spaced elongated ridge 55 mounted longitudinally thereon, each of which ridge in turn has a groove 57 formed in the top thereof.

5 An elongated gasket 59 made of rubber or plastics is embedded in each of the ridges 55. An upper part of the upright support stem 51 extending beyond the horizontal crossbar 53 has a plurality of threaded holes 61 formed therein at adequate intervals along its length. As better shown in FIG. 5, each end

10 of the upright support stem 51 extends beyond the corresponding end of the tube 41 and curved to provide a curved lower edge portion 52 and terminates in a vertical tip 52'. As better shown in FIG. 4, when the radiating rods 13 are joined to the central node 11, the curved vertical edge portion

15 52 of each rod 13 fits against the outer periphery of the node body 15 and the vertical tip 52' abuts against the vertical tips 52' of the other radiating rods 13 on an imaginary vertical line 100 running through the center of the node 11. As better shown in FIG. 5, the support member 43 has opposed isosceles-triangular ends 44. When all the radiating rods 13 are joined

20 to the node 11, the complementary isosceles-triangular ends 44 of the support member 43 of the rods are snugly butted together over the node 11 on the imaginary vertical line 100.

As better shown in FIG. 5, an elongated clamping bar 14

25 functioning as the retaining means 14 is substantially equal in length as the support member 43 and comprises an elongated flat plate 71, a pair of ridges 73, 73 longitudinally mounted on



the lower surface of the flat plate 71 and a pair of marginal downward grooves 75, 75 formed in the opposed edges of the elongated flat plate 71. The marginal downward grooves 75, 75 have respective gaskets 77, 77 fitted therein. The opposed ridges 73, 73 is so spaced from each other as to loosely receive the top of the upright support stem 51. The flat plate 71 has a plurality of through holes 79 formed at adequate intervals and disposed between the opposed ridges 73, 73. The elongated clamping bar 14 has opposed isosceles-triangular ends 72, 72 (only one end being seen in the drawings), each of which end is analogous in shape to the isosceles-triangular end 44 of the support member 43. The elongate clamping bar 14 has a pair of marginal ribs 81, 81 mounted one on each marginal edge of the upper side thereof for snapping engagement with corresponding downward-directed ridges 95 of a cap plate 91 described thereafter.

As better shown in FIG. 5, an elongated cap plate 91 is made of any suitable resilient plastic and is coextensive with the clamping bar 14. The elongated cap plate 91 has on its lower side a pair of resilient ridges 96, 96 for resilient engagement with the inner sides of the marginal ribs 81, 81. The elongated cap plate 91 has opposed isosceles-triangular ends 93, 93 (one end being visible in the drawings), each of which is also analogous in shape to the isosceles-triangular end 72 of the elongated clamping bar 14.

The panel 12 may be a glass pane, a honeycomb panel or any other panel. As shown in FIG. 1, each panel 12 is shown



triangular in this embodiment, since the rod-and-node lattice construction provides a multiplicity of triangular openings.

However, the panel 12 may be shaped in other figure depending on what openings the rod-and-node lattice construction provides.

For installing the truss structure according to the present invention, as better shown in FIGS. 3 through 4, each tube 41 is butted at its capped end against the corresponding external flattened surface 26 of the node 11 with the threaded hole 25 of the circular cap 17 disposed in registry with the corresponding through hole 23 of the node 11. With the capped end of the tube 41 held firmly against the flattened surface 26, a bolt 20 is inserted through a washer 20', the through hole 23 of the node 11 and screwed into the threaded hole 25 of the circular end cap 17 of the tube 41. With this process going through all the radiating rods 13, they are all secured to the node 11 with the curved lower edge portions 52 fit snugly against the outer periphery of the node body 15 and the vertical tips abutting 52' abut against each other. At the same time, the complementary isosceles-triangular ends 44 of the support member 43 of all the radiating rods 13 abutted against one another and fill up a space over the node 11.

Then, as shown in FIG. 5, a pair of adjacent panels 12, 12 (triangular in this embodiment) are mounted on the crossbar 53 one on each side of the upright support stem 51; to be precise, the confronting edges 12', 12' of the adjacent panels 12,



12 are mounted on the respective gaskets 59, 59 fitted in the grooves 57, 57 of the crossbar 53 of the rod 13.

5 Subsequently, each clamping bar 14 is placed in place on and fastened to the corresponding support member 43 by the bolts 74 inserted through the through holes 79 and screwed into the threaded holes 61 with the opposed downward-directed ridges 73, 73 of the former 14 receiving the top of the upright support stem 51 of the rod 13, whereupon, as shown in FIG. 3, the confronting edges 12', 12' of the adjacent panels 12,
10 12 are firmly clamped between the gaskets 59 provided on the horizontal crossbar 53 of the rod 13 and the gaskets 77, 77 provided on the the clamping bar 14.

Then, each plate cap 91 is retentively fastened to the upper side of the corresponding clamping bar 14 by bringing
15 the downward-directed ledges 95 of the former into snapping engagement with the upstanding marginal ribs 81 of the clamping bar 14 as shown in FIG. 3.

As better shown in FIG. 5, when installed, the complementary isosceles-triangular ends 72 of all the radiating
20 clamping bars 14 are butted against one another and fill up the space above the node 11. Likewise, the complementary isosceles-triangular ends 93 of all the radiating cap plate 91 are butted against one another and fill up the space above the node 11.

25 The angles of the isosceles-triangular ends 44, 72, 93 of the support member 43, the clamping bars 14 and the cap plates 91, respectively, are equal to each other. But, the angle



of the isosceles-triangular ends 44, 72, 93 of those parts 43, 14, 91 hinges on how many rods 13 go to a central node 11. It could be said that the angle of isosceles-triangular ends 44, 72, 93 of those members 43, 14, 91 is such that, when snugly
5 butted against each other, the isosceles-triangular ends 44, 72, 93 of all the radiating parts 43, 14, 91 fill up the space over the node 11 so as to completely prevent rain from infiltrating through therebetween.

After the cap plates 91 are snapped onto the clamping
10 bars 14, the butted isosceles-triangular ends 93 of all the radiating cap plates 91 are caulked between each adjacent ones for rendering them fully water-tight.

With the construction of the present invention set forth hereinabove, the truss structure according to the present
15 invention enjoys the following advantages:

Since the tubes constituting the skeleton framework and the support members constituting the covering structure are integrally formed on each other, this provides a regular and simple lattice construction which is very pleasing to look at.

20 Absent brackets, the manufacturing cost is saved very much.

Furthermore, dispensing with various operations of attaching brackets, attaching the bracket to skeleton framework and attaching panel members to the brackets would
25 render the whole installation operation very easy and quick.

Obviously, the skilled person would realize that various modifications and variations of the present invention are



possible in the light of the above teaching. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described, and that the invention is not limited to the embodiments described above in detail.

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→ 11a

- 11a -

PARTS LIST
TRUSS STRUCTURE

Prior Art

501	Truss structure
501a	Skeleton
501b	Linking means
501c	Superficial structure
503	Solid node
505	Cylindrical rod
507	Interior frame half
509	Exterior frame half
511	Panel

Present Invention

11	Node
12	Panel
13	Rod
14	Clamping bar (=Retaining means)
15	Node body
17	Circular cap
19	Joint bolt
20	Bolt
20'	Washer
21	Circular opening
23	Through holes
25	Threaded hole

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→ 11b

26, 27	Flattened surfaces
28	Central stud
29	Threaded hole
41	Elongated tube
43	Support member
44	Isosceles-triangular ends (of the support member 43)
45	Cap
47	Threaded through hole
51	Upright support stem
52	Curved edge portion
53	Horizontal crossbar
55	Elongated ridges
57	Groove
59	Elongated gasket
61	Threaded holes
71	Elongated flat plate
72	Isosceles-triangular ends (of the clamping bar 14)
73	Ridges
75	Marginal downward grooves
77	Gasket
81	Upstanding marginal rib
91	Cap plate
93	Isosceles-triangular ends (of plate cap 91)
95	Downward directed ledges
96	Resilient ridges





CLAIMS:

1. A truss structure comprising: a multiplicity of substantially spherical nodes (11); and a multiplicity of rods (13) extending between and joined to each adjacent pair of the nodes (11) in such a way that each node (11) has their relevant rods (13) extending radially therefrom to thereby form a desired lattice configuration; characterized in that: the lattice configuration has a multiplicity of openings each defined by a set of the rods (11); the truss structure further including a multiplicity of panels (12) each adapted to enclose the opening; each rod (13) including an elongated tube (41) having each end fastened to the outer periphery of the node (11) and a support member (43) integrally formed on the elongated tube (41) for supporting thereon the panel (12) in the opening in cooperation with the corresponding support members (43) of the other opening-defining rods (13); and means (14) for retaining the corresponding panel (12) to the support member (43).

2. A truss structure according to claim 1, the support member (43) comprising an upright support stem (51) mounted longitudinally on and extending vertically from tube (41) and a horizontal crossbar (53) mounted crisscross on the upright support stem (51) for each holding the confronting edges (12'), (12') of the adjacent panels (12), the retaining means (14) comprising an elongate clamping bar (14) being substantially equal in length to the support member (43) and fastened to the support member (43) to retain the confronting





edges (12'), (12') of the adjacent panels (12) against the horizontal crossbar (53).

3. A truss structure according to claim 2, each end of the upright support stem (51) extending beyond the corresponding end of the tube (41) and curved so as to fit against the periphery of the node (11); the horizontal crossbar (53) being substantially coextensive to the upright support stem (51), the support member (43) having opposed isosceles-triangular ends (44), when all the radiating rods (13) being joined to the node (11), the complementary isosceles-triangular ends (44) of the support member (43) of the rods (13) being butted together over the node (11).

4. A truss structure according to claim 2, the elongated clamping bar (14) being substantially equal in length as the support member (43) and having opposed isosceles-triangular ends (72), when the rods (13) being joined to the node (11), the complementary isosceles-triangular ends (72) of the elongated clamping bars (14) butted together over the node (11).

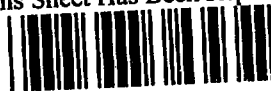
5. A truss structure according to claim 3, the truss structure further including an elongated cap plate (71) being substantially equal in length as the clamping bar (14) and having opposed isosceles-triangular ends (93), the elongated cap plate (91) coming into snapping engagement with the elongated clamping bar (14) for preventing water leakage, when the rods (13) being joined to the node (11), the complementary isosceles-triangular ends (93) of the elongated cap plates (91) butted together over the node (11).



6. A truss structure according to claim 1, the node (11) being hollow and having three or more through holes (23) in its periphery, the elongate tube (41) having a pair of caps (45) plugged and welded one into each end thereof, the cap (45) having therethrough a threaded hole (47) coaxially with the tube (41), the rod (13) being secured to the node (11) by a bolt (20) inserted through the through hole (23) of the node (11) and threaded to the threaded hole (47) of the cap (45).

7. A truss structure according to claim 4, the node (11) including a node body (15) having the through holes (23) therethrough and an circular opening (21) formed in the base thereof, and a circular cover (17) releasably attached to the opening (21) for allowing access to the bolts (20).

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ABSTRACT

TRUSS STRUCTURE

Figure 1. to accompany abstract

A truss structure comprises a multiplicity of substantially spherical hollow nodes (11); a multiplicity of rods (13) extending between and joined to each adjacent pair of the nodes (11) in such a way that each node (11) has their relevant rods (13) extending radially therefrom to thereby form a desired lattice configuration having a multiplicity of openings each defined by a set of the rods (11). Each rod (13) includes an elongated tube (41) having each end fastened to the outer periphery of the node (11) and a support member (43) integrally formed on the elongated tube (41) for supporting thereon a panel (12) in the opening in cooperation with the corresponding support members (43) of the other opening-defining rods (13). Since the rod as part of a skeleton incorporates an integral panel-support member, there are dispensed with a separate panel-supporting structure and any linking structure connecting the rod and the separate panel-supporting structure.

(FIG. 5)

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FIG. 1

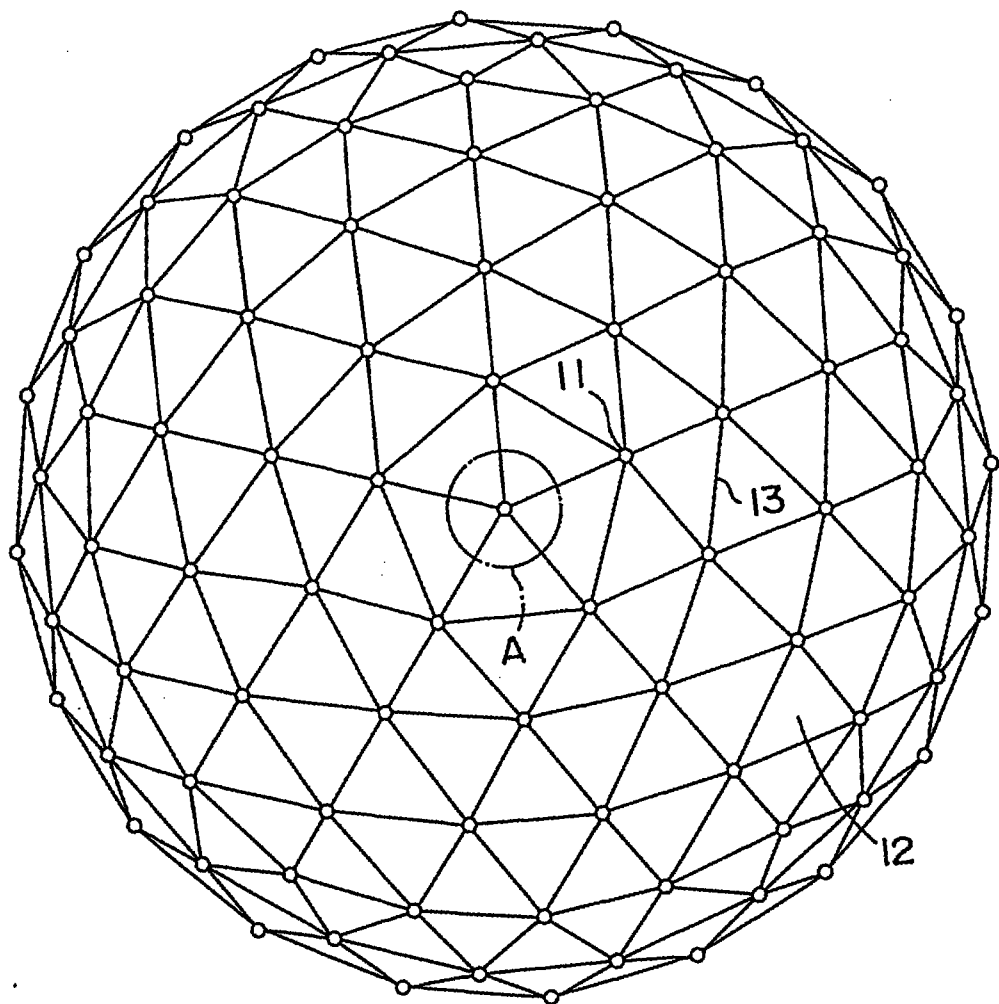
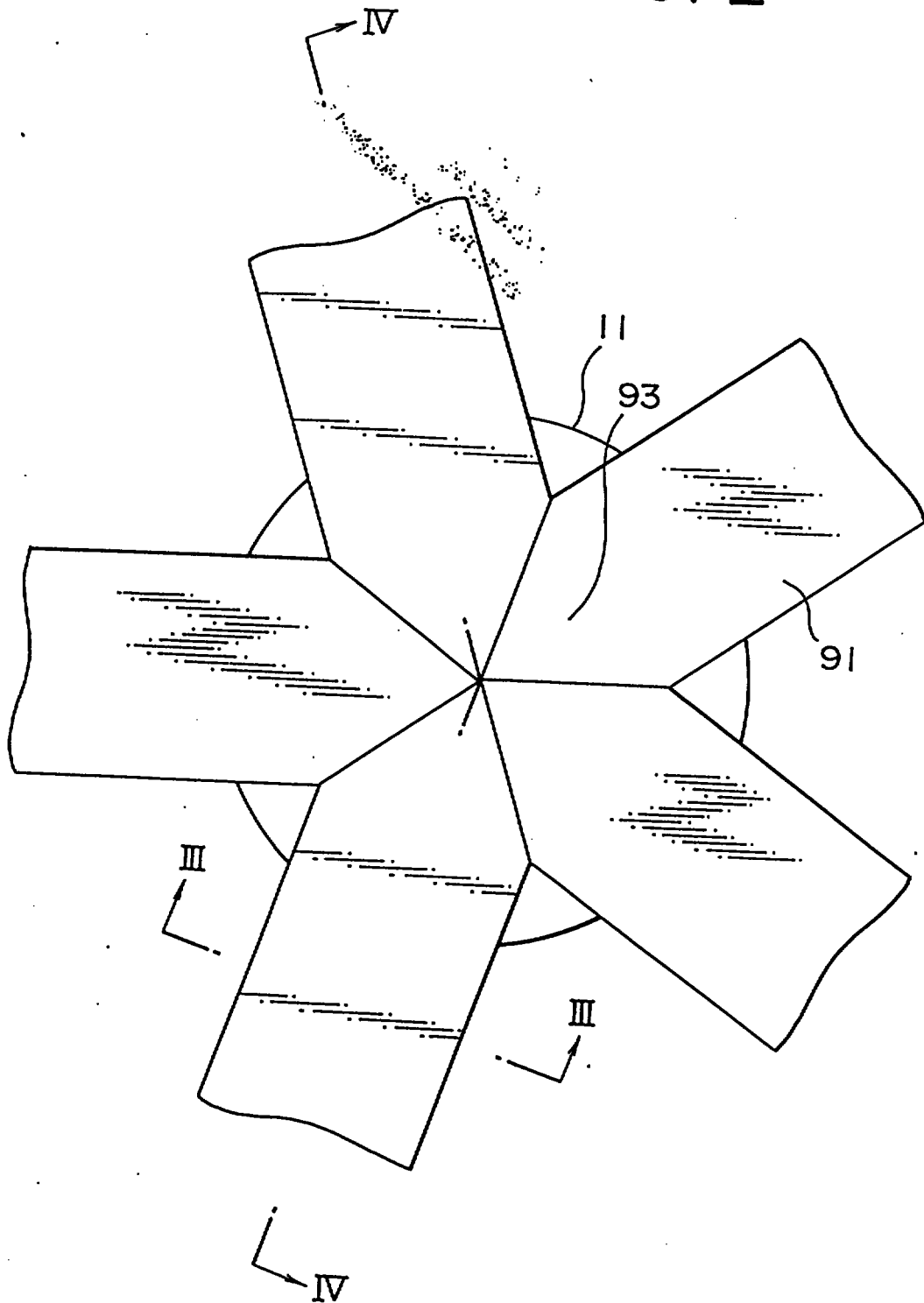


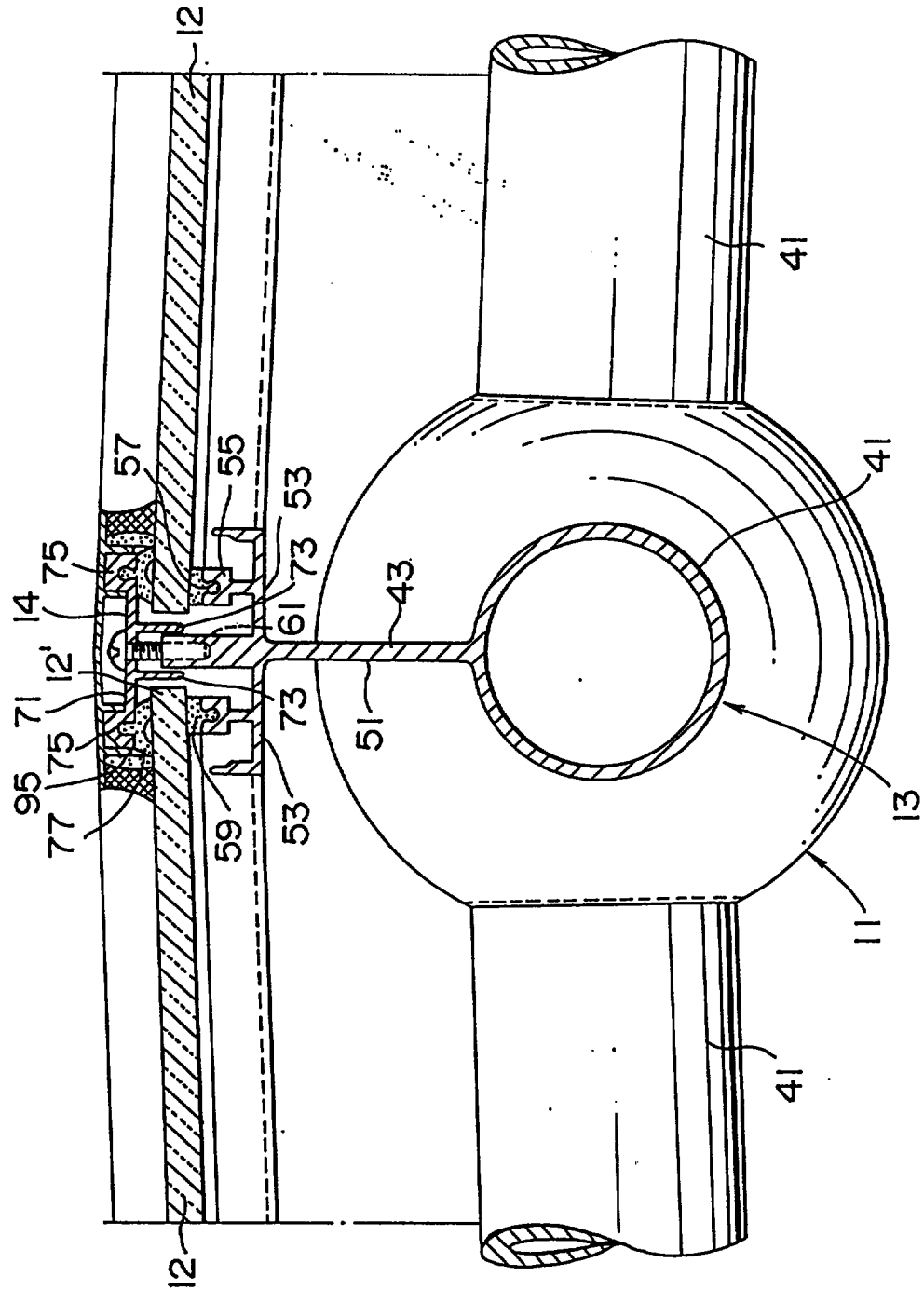
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FIG. 3



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FIG. 4

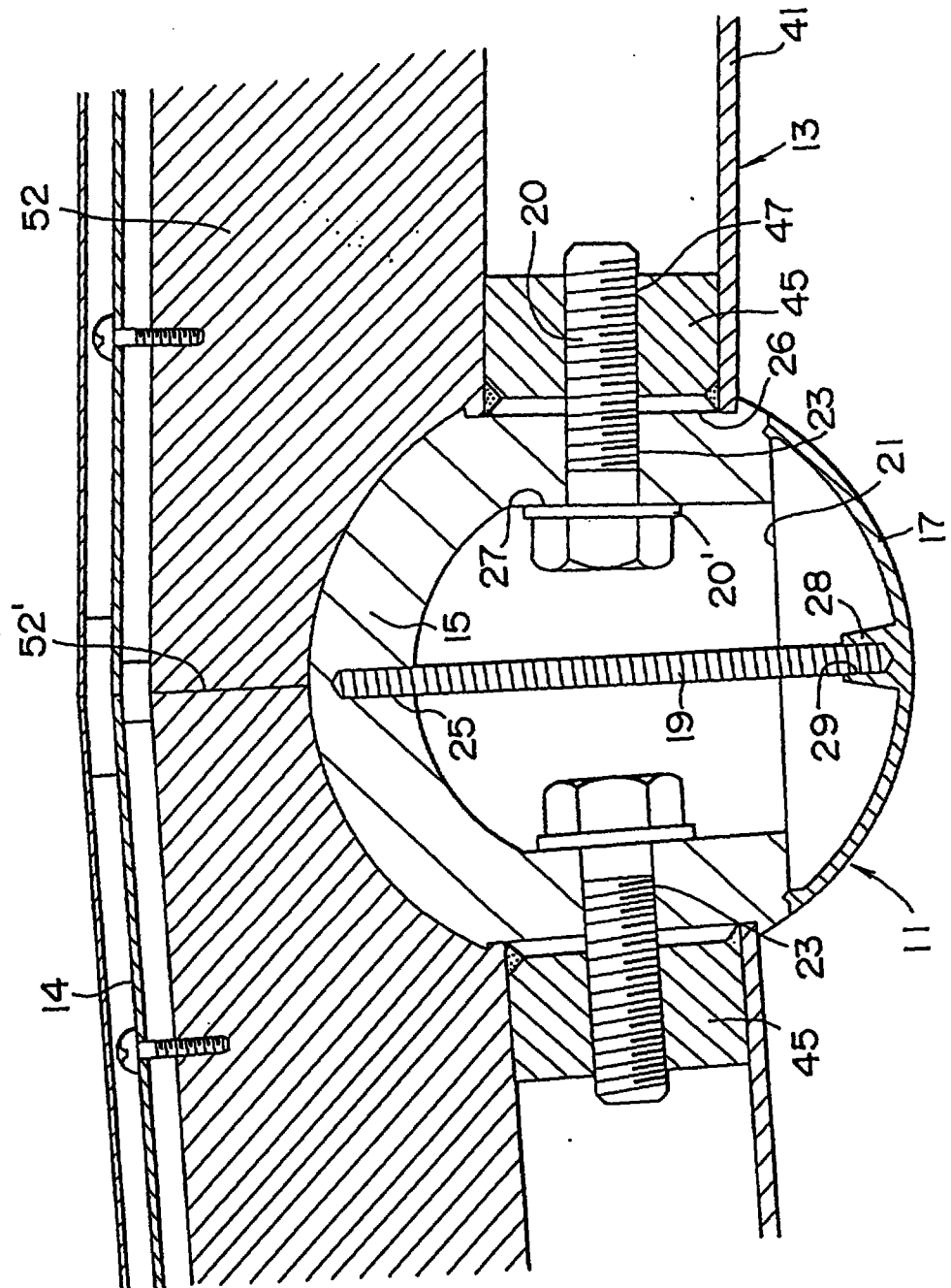
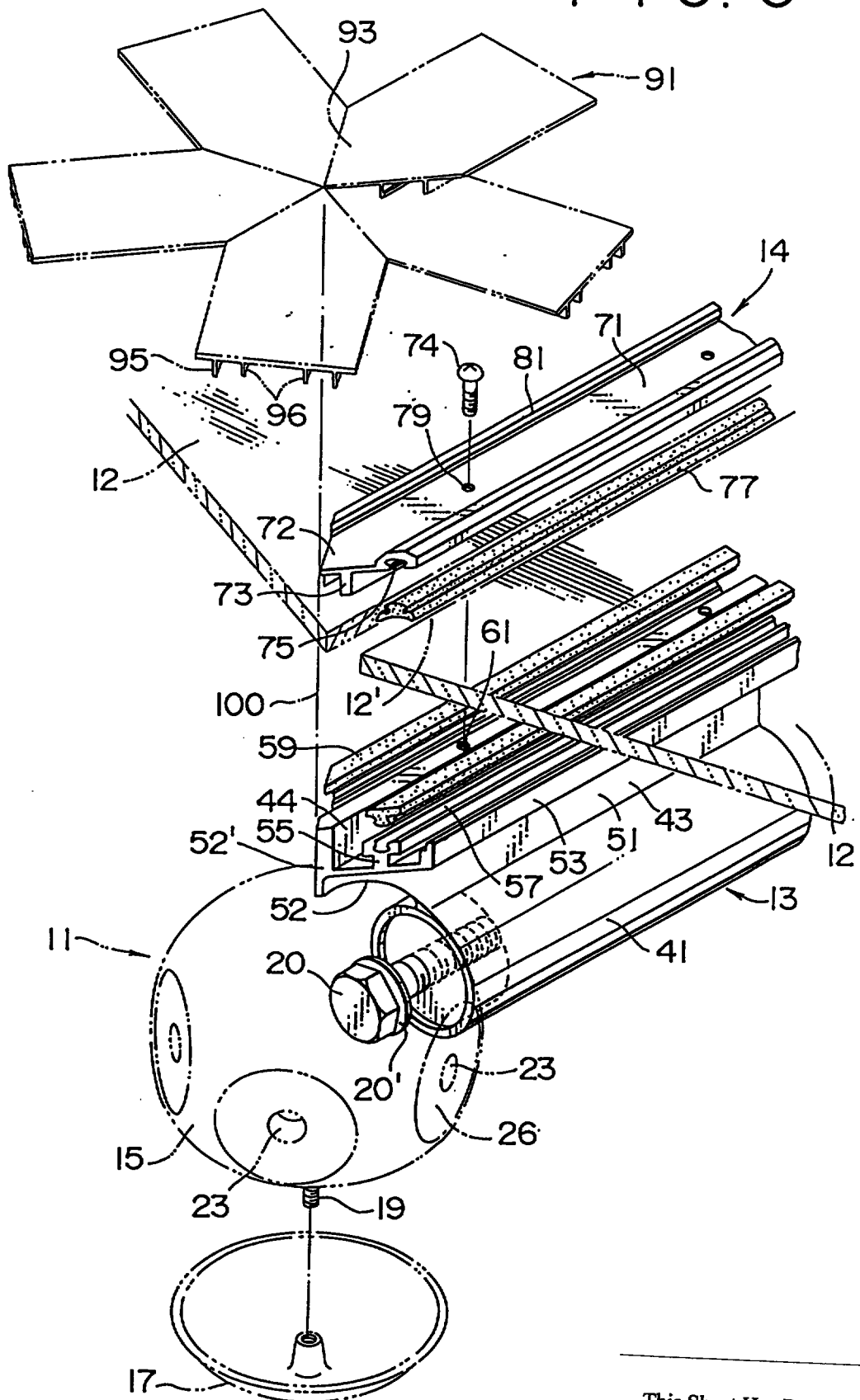


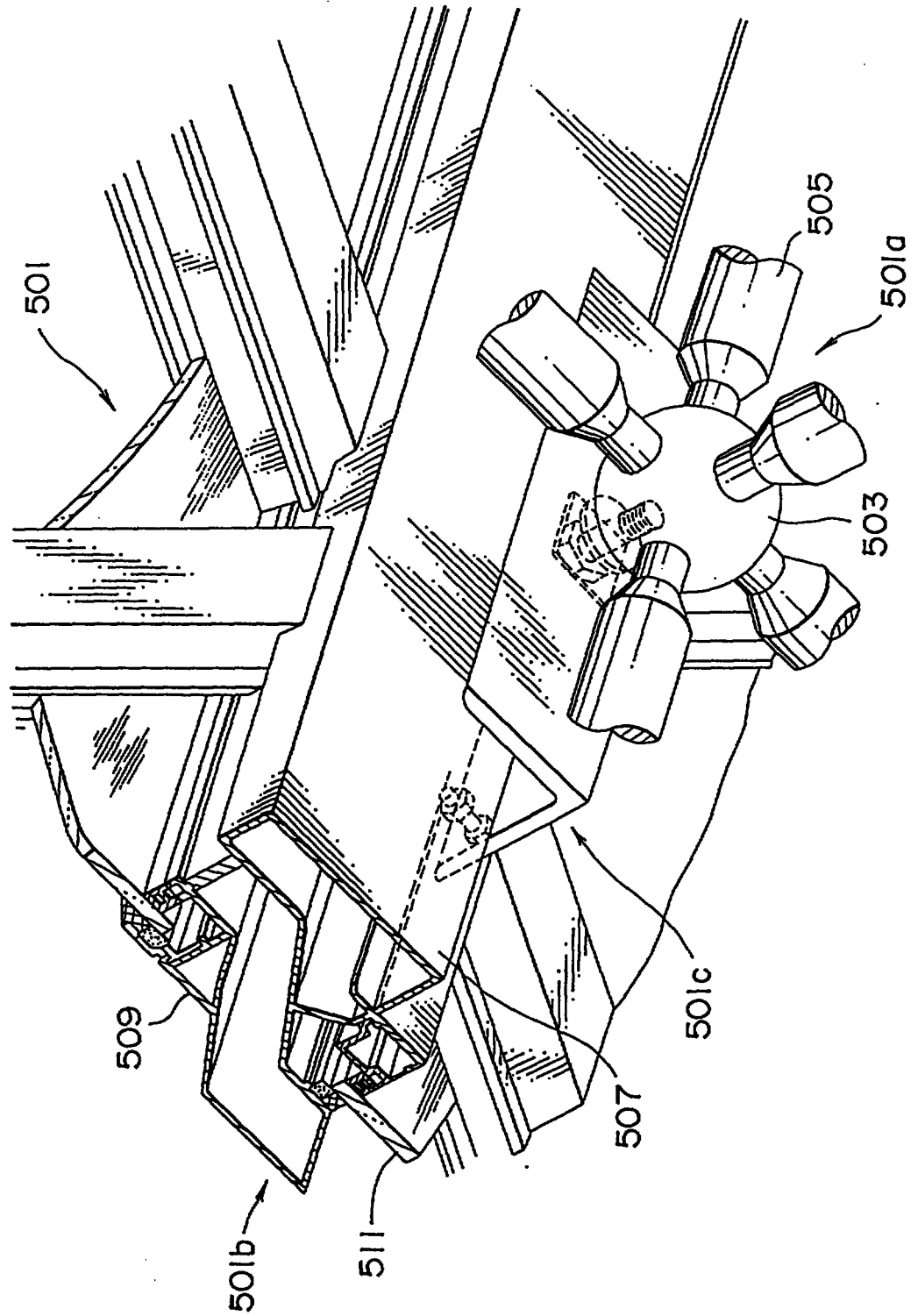
FIG. 5



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FIG. 6



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TRUSS STRUCTURE

The present invention relates generally to a truss structure used for construction of a building, house or the like and more particularly, a truss structure comprising a multiplicity of substantially spherical nodes, a multiplicity of rods extending between and joined to each adjacent pair of the nodes to thus form any desired configuration, such as a dome, a plane figure, and a multiplicity of panels enclosing the configuration.

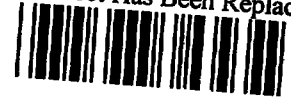
A typical structure of the type described is disclosed in Japanese Utility Model Laid-open Publication No. 2-20614. The disclosed truss structure 501 broadly comprises three distinct elements; a skeleton or supporting foundation framework 501a for bearing the whole burden of the structure 501; a covering structure 501b enclosing the framework and; means 501c for linking the skeleton 501a and the covering structure 501b. The skeleton 501a includes a multiplicity of solid nodes 503 and a multiplicity of solid cylindrical rods 505 extending between and joined to each adjacent pair of the nodes 503 in such a way that relevant radiating rods 505 being joined radially thereto to thus form a lattice like skeleton framework 501a of a desired configuration. The covering structure 501b includes a multiplicity of panel members 501b each comprising an interior and an exterior frame half 507, 509 and a panel 511 clamped therebetween. And, the linking means 501c includes a multiplicity of brackets 501c linking the nodes 503 and the interior frame halves 507.

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This conventional truss structure 501 suffers the following drawbacks:

Since the lattice-like skeleton framework 501a, a great number of the brackets 507 and the panel members 501b are arranged and installed at random or without regard to each other in terms of aesthetical design, this provides unsightly, complicated and out-of-order appearance.

After setting up the skeleton framework 501a; first one must attach brackets members 501c to the skeleton framework 501a at thousands of positions and then attach a multiplicity of panel members 501b to the bracket members 501c at as many positions. This operation has proved to be very time-consuming and tedious.

With the foregoing difficulties in view, it is therefore an object of the invention to provide a truss structure which is simple in structure, thus pleasing to look at and is easy to manufacture and install.

According to the present invention, there is provided a truss structure comprising: a multiplicity of substantially spherical nodes; and a multiplicity of rods extending between and joined to each adjacent pair of the nodes in such a way that each node has their relevant rods extending radially therefrom to thereby form a desired lattice configuration; characterized in that: the lattice configuration has a multiplicity of openings each defined by a set of the rods; the truss structure further including a multiplicity of panels each adapted to enclose the opening; each rod including an elongated tube having each end

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fastened to the outer periphery of the node and a support member integrally formed on the elongated tube for supporting thereon the panel in the opening in cooperation with the corresponding support members of the other opening-defining rods; and means for retaining the corresponding panel to the support member.

Many other advantages and features of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which preferred structural embodiments incorporating the principles of the present invention are shown by way of illustrative example.

FIG. 1 is a diagrammatical plan view of a dorm construction in which the present invention is embodied.

FIG. 2 is an enlarged fragmentary view of an apex portion of the dorm construction of FIG. 1;

FIG. 3 is a cross-sectional view taken on line III-III of FIG. 2.

FIG. 4 is a cross-sectional view take on line IV-IV of FIG. 2.

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FIG. 1 is a diagrammatical plan view of of a dorm construction used for auditorium, stadium etc. in which the present invention is embodied, although the truss structure



according to the present invention may be of any desired fig such as as circular plane figure, rectangular plane figure, etc.

As seen from FIG. 1, the truss structure broadly comprises a multiplicity of nodes 11; a multiplicity of rods 13 extending between and joined to each adjacent pair of the nodes 11 in such a way that each of the node 11 has their some relevant rods extending radially therefrom to form a dorm-like lattice construction having a plurality of opening each defined by a set of the rods 13; a plurality of panels 12 each adapted to enclose the opening; and means 14 for retaining the corresponding panel to the rod.

Since the node-and-rod system is repeated over entire area of the dorm construction, the explanation will be made by focusing on an apex portion A (FIG. 2) of the dorm construction of FIG. 1. In FIG. 2, a node 11 is partly seen under five elongated cap plates 91 having their isosceles-triangular ends 93 butted together, the corresponding five rods being hidden under the cap plates 91. Although the node-and-rod system is shown to extend over the entire area of the construction in this embodiment, the node-and-rod system may be used as part of a construction, such as a facade, a flat roof and a skylight.

As better shown in FIGS. 4 through 5, each node 11 is substantially spherical and hollow, and comprises a hollow bowl-shaped node body 15, a thin circular cap 17 and a joint bolt 19 joining the node body 15 and the circular cap 17 together. The node body 15 has a circular opening 21 formed in the base thereof. The node body 15 has a plurality of (five

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in case of the node 11 located on the apex portion A) through holes 23 formed in the periphery in a plane and disposed at uniform intervals from each other. The node body 15 has a threaded hole 25 on the internal periphery at the apex A thereof into which one end of the joint bolt 19 is screwed. The node body 15 has a pair of internal and external flattened surfaces 26, 27 around the internal and external edges, respectively, of each through hole 23 for enabling a head of a bolt 20 and an end of a tube 41 to be seated flatly and stably thereon, as closely described hereinafter.

The circular cap 17 is complementary in diameter to the circular opening 21 of the bowl-shaped hollow node body 15 for fully enclosing the opening 21. A central stud 27 is mounted on the inner side at the center of the circular cap 17. The central stud 28 has a threaded hole 29 formed longitudinally therein.

As better shown in FIGS. 3 through 5, each rod 13 is extruded from aluminium or other suitable materials and broadly comprises an elongated circular tube 41 and a support member 43 integrally formed with and mounted longitudinally on the elongated tube 41 for supporting panels thereon.

As better shown in FIG. 4, the elongated tube 41 has a pair of caps 45, 45 plugged and welded one into each end thereof. The cap 45 has therethrough a threaded through hole 47 coaxially with the tube 41. The support member 43 comprises an upright support stem 51 mounted longitudinally on and extending vertically from the tube 41 and a horizontal



crossbar 53 mounted crisscross on the upright support stem 51. The horizontal crossbar 53 has a pair of parallel spaced elongated ridge 55 mounted longitudinally thereon, each of which ridge in turn has a groove 57 formed in the top thereof. An elongated gasket 59 made of rubber or plastics is embedded in each of the ridges 55. An upper part of the upright support stem 51 extending beyond the horizontal crossbar 53 has a plurality of threaded holes 61 formed therein at adequate intervals along its length. As better shown in FIG. 5, each end of the upright support stem 51 extends beyond the corresponding end of the tube 41 and curved to provide a curved lower edge portion 52 and terminates in a vertical tip 52'. As better shown in FIG. 4, when the radiating rods 13 are joined to the central node 11, the curved vertical edge portion 52 of each rod 13 fits against the outer periphery of the node body 15 and the vertical tip 52' abuts against the vertical tips 52' of the other radiating rods 13 on an imaginary vertical line 100 running through the center of the node 11. As better shown in FIG. 5, the support member 43 has opposed isosceles-triangular ends 44. When all the radiating rods 13 are joined to the node 11, the complementary isosceles-triangular ends 44 of the support member 43 of the rods are snugly butted together over the node 11 on the imaginary vertical line 100.

As better shown in FIG. 5, an elongated clamping bar 14 functioning as the retaining means 14 is substantially equal in length as the support member 43 and comprises an elongated flat plate 71, a pair of ridges 73, 73 longitudinally mounted on



the lower surface of the flat plate 71 and a pair of marginal downward grooves 75, 75 formed in the opposed edges of the elongated flat plate 71. The marginal downward grooves 75, 75 have respective gaskets 77, 77 fitted therein. The opposed ridges 73, 73 is so spaced from each other as to loosely receive the top of the upright support stem 51. The flat plate 71 has a plurality of through holes 79 formed at adequate intervals and disposed between the opposed ridges 73, 73. The elongated clamping bar 14 has opposed isosceles-triangular ends 72, 72 (only one end being seen in the drawings), each of which end is analogous in shape to the isosceles-triangular end 44 of the support member 43. The elongate clamping bar 14 has a pair of marginal ribs 81, 81 mounted one on each marginal edge of the upper side thereof for snapping engagement with corresponding downward-directed ridges 95 of a cap plate 91 described thereafter.

As better shown in FIG. 5, an elongated cap plate 91 is made of any suitable resilient plastic and is coextensive with the clamping bar 14. The elongated cap plate 91 has on its lower side a pair of resilient ridges 96, 96 for resilient engagement with the inner sides of the marginal ribs 81, 81. The elongated cap plate 91 has opposed isosceles-triangular ends 93, 93 (one end being visible in the drawings), each of which is also analogous in shape to the isosceles-triangular end 72 of the elongated clamping bar 14.

The panel 12 may be a glass pane, a honeycomb panel or any other panel. As shown in FIG. 1, each panel 12 is shown

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triangular in this embodiment, since the rod-and-node lattice construction provides a multiplicity of triangular openings. However, the panel 12 may be shaped in other figure depending on what openings the rod-and-node lattice construction provides.

For installing the truss structure according to the present invention, as better shown in FIGS. 3 through 4, each tube 41 is butted at its capped end against the corresponding external flattened surface 26 of the node 11 with the threaded hole 25 of the circular cap 17 disposed in registry with the corresponding through hole 23 of the node 11. With the capped end of the tube 41 held firmly against the flattened surface 26, a bolt 20 is inserted through a washer 20', the through hole 23 of the node 11 and screwed into the threaded hole 25 of the circular end cap 17 of the tube 41. With this process going through all the radiating rods 13, they are all secured to the node 11 with the curved lower edge portions 52 fit snugly against the outer periphery of the node body 15 and the vertical tips abutting 52' abut against each other. At the same time, the complementary isosceles-triangular ends 44 of the support member 43 of all the radiating rods 13 abutted against one another and fill up a space over the node 11.

Then, as shown in FIG. 5, a pair of adjacent panels 12, 12 (triangular in this embodiment) are mounted on the crossbar 53 one on each side of the upright support stem 51; to be precise, the confronting edges 12', 12' of the adjacent panels 12,

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12 are mounted on the respective gaskets 59, 59 fitted in the grooves 57, 57 of the crossbar 53 of the rod 13.

Subsequently, each clamping bar 14 is placed in place on and fastened to the corresponding support member 43 by the bolts 74 inserted through the through holes 79 and screwed into the threaded holes 61 with the opposed downward-directed ridges 73, 73 of the former 14 receiving the top of the upright support stem 51 of the rod 13, whereupon, as shown in FIG. 3, the confronting edges 12', 12' of the adjacent panels 12, 12 are firmly clamped between the gaskets 59 provided on the horizontal crossbar 53 of the rod 13 and the gaskets 77, 77 provided on the the clamping bar 14.

Then, each plate cap 91 is retentively fastened to the upper side of the corresponding clamping bar 14 by bringing the downward-directed ledges 95 of the former into snapping engagement with the upstanding marginal ribs 81 of the clamping bar 14 as shown in FIG. 3.

As better shown in FIG. 5, when installed, the complementary isosceles-triangular ends 72 of all the radiating clamping bars 14 are butted against one another and fill up the space above the node 11. Likewise, the complementary isosceles-triangular ends 93 of all the radiating cap plate 91 are butted against one another and fill up the space above the node 11.

The angles of the isosceles-triangular ends 44, 72, 93 of the support member 43, the clamping bars 14 and the cap plates 91, respectively, are equal to each other. But, the angle



of the isosceles-triangular ends 44, 72, 93 of those parts 43, 14, 91 hinges on how many rods 13 go to a central node 11. It could be said that the angle of isosceles-triangular ends 44, 72, 93 of those members 43, 14, 91 is such that, when snugly butted against each other, the isosceles-triangular ends 44, 72, 93 of all the radiating parts 43, 14, 91 fill up the space over the node 11 so as to completely prevent rain from infiltrating through therebetween.

After the cap plates 91 are snapped onto the clamping bars 14, the butted isosceles-triangular ends 93 of all the radiating cap plates 91 are caulked between each adjacent ones for rendering them fully water-tight.

With the construction of the present invention set forth hereinabove, the truss structure according to the present invention enjoys the following advantages:

Since the tubes constituting the skeleton framework and the support members constituting the covering structure are integrally formed on each other, this provides a regular and simple lattice construction which is very pleasing to look at.

Absent brackets, the manufacturing cost is saved very much.

Furthermore, dispensing with various operations of attaching brackets, attaching the bracket to skeleton framework and attaching panel members to the brackets would render the whole installation operation very easy and quick.

Obviously, the skilled person would realize that various modifications and variations of the present invention are

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possible in the light of the above teaching. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described, and that the invention is not limited to the embodiments described above in detail.

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PARTS LIST
TRUSS STRUCTURE

Prior Art

501	Truss structure
501a	Skeleton
501b	Linking means
501c	Superficial structure
503	Solid node
505	Cylindrical rod
507	Interior frame half
509	Exterior frame half
511	Panel

Present Invention

11	Node
12	Panel
13	Rod
14	Clamping bar (=Retaining means)
15	Node body
17	Circular cap
19	Joint bolt
20	Bolt
20'	Washer
21	Circular opening
23	Through holes
25	Threaded hole

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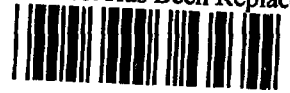
26, 27	Flattened surfaces
28	Central stud
29	Threaded hole
41	Elongated tube
43	Support member
44	Isosceles-triangular ends (of the support member 43)
45	Cap
47	Threaded through hole
51	Upright support stem
52	Curved edge portion
53	Horizontal crossbar
55	Elongated ridges
57	Groove
59	Elongated gasket
61	Threaded holes
71	Elongated flat plate
72	Isosceles-triangular ends (of the clamping bar 14)
73	Ridges
75	Marginal downward grooves
77	Gasket
81	Upstanding marginal rib
91	Cap plate
93	Isosceles-triangular ends (of plate cap 91)
95	Downward directed ledges
96	Resilient ridges

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CLAIMS:

1. A truss structure comprising: a multiplicity of substantially spherical nodes (11); and a multiplicity of rods (13) extending between and joined to each adjacent pair of the nodes (11) in such a way that each node (11) has their relevant rods (13) extending radially therefrom to thereby form a desired lattice configuration; characterized in that: the lattice configuration has a multiplicity of openings each defined by a set of the rods (11); the truss structure further including a multiplicity of panels (12) each adapted to enclose the opening; each rod (13) including an elongated tube (41) having each end fastened to the outer periphery of the node (11) and a support member (43) integrally formed on the elongated tube (41) for supporting thereon the panel (12) in the opening in cooperation with the corresponding support members (43) of the other opening-defining rods (13); and means (14) for retaining the corresponding panel (12) to the support member (43).

2. A truss structure according to claim 1, the support member (43) comprising an upright support stem (51) mounted longitudinally on and extending vertically from tube (41) and a horizontal crossbar (53) mounted crisscross on the upright support stem (51) for each holding the confronting edges (12'), (12') of the adjacent panels (12), the retaining means (14) comprising an elongate clamping bar (14) being substantially equal in length to the support member (43) and fastened to the support member (43) to retain the confronting

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edges (12'), (12') of the adjacent panels (12) against the horizontal crossbar (53).

3. A truss structure according to claim 2, each end of the upright support stem (51) extending beyond the corresponding end of the tube (41) and curved so as to fit against the periphery of the node (11); the horizontal crossbar (53) being substantially coextensive to the upright support stem (51), the support member (43) having opposed isosceles-triangular ends (44), when all the radiating rods (13) being joined to the node (11), the complementary isosceles-triangular ends (44) of the support member (43) of the rods (13) being butted together over the node (11).

4. A truss structure according to claim 2, the elongated clamping bar (14) being substantially equal in length as the support member (43) and having opposed isosceles-triangular ends (72), when the rods (13) being joined to the node (11), the complementary isosceles-triangular ends (72) of the elongated clamping bars (14) butted together over the node (11).

5. A truss structure according to claim 3, the truss structure further including an elongated cap plate (71) being substantially equal in length as the clamping bar (14) and having opposed isosceles-triangular ends (93), the elongated cap plate (91) coming into snapping engagement with the elongated clamping bar (14) for preventing water leakage, when the rods (13) being joined to the node (11), the complementary isosceles-triangular ends (93) of the elongated cap plates (91) butted together over the node (11).



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6. A truss structure according to claim 1, the node (11) being hollow and having three or more through holes (23) in its periphery, the elongate tube (41) having a pair of caps (45) plugged and welded one into each end thereof, the cap (45) having therethrough a threaded hole (47) coaxially with the tube (41), the rod (13) being secured to the node (11) by a bolt (20) inserted through the through hole (23) of the node (11) and threaded to the threaded hole (47) of the cap (45).

7. A truss structure according to claim 4, the node (11) including a node body (15) having the through holes (23) therethrough and an circular opening (21) formed in the base thereof, and a circular cover (17) releasably attached to the opening (21) for allowing access to the bolts (20).

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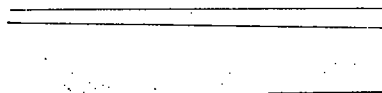
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ABSTRACT
TRUSS STRUCTURE

A truss structure comprises a multiplicity of substantially spherical hollow nodes (11); a multiplicity of rods (13) extending between and joined to each adjacent pair of the nodes (11) in such a way that each node (11) has their relevant rods (13) extending radially therefrom to thereby form a desired lattice configuration having a multiplicity of openings each defined by a set of the rods (11). Each rod (13) includes an elongated tube (41) having each end fastened to the outer periphery of the node (11) and a support member (43) integrally formed on the elongated tube (41) for supporting thereon a panel (12) in the opening in cooperation with the corresponding support members (43) of the other opening-defining rods (13). Since the rod as part of a skeleton incorporates an integral panel-support member, there are dispensed with a separate panel-supporting structure and any linking structure connecting the rod and the separate panel-supporting structure.

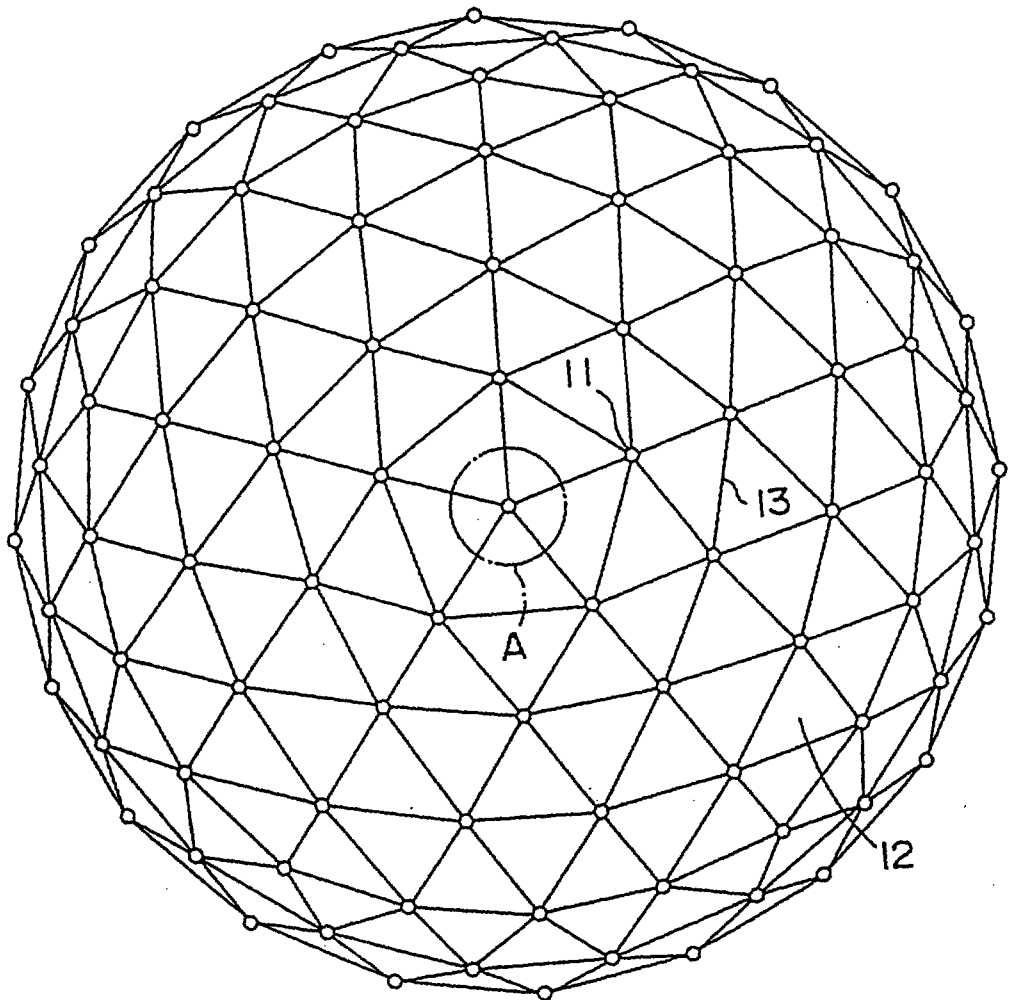
(FIG. 5)



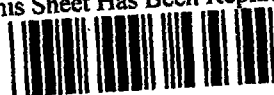
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FIG. 1



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FIG. 2

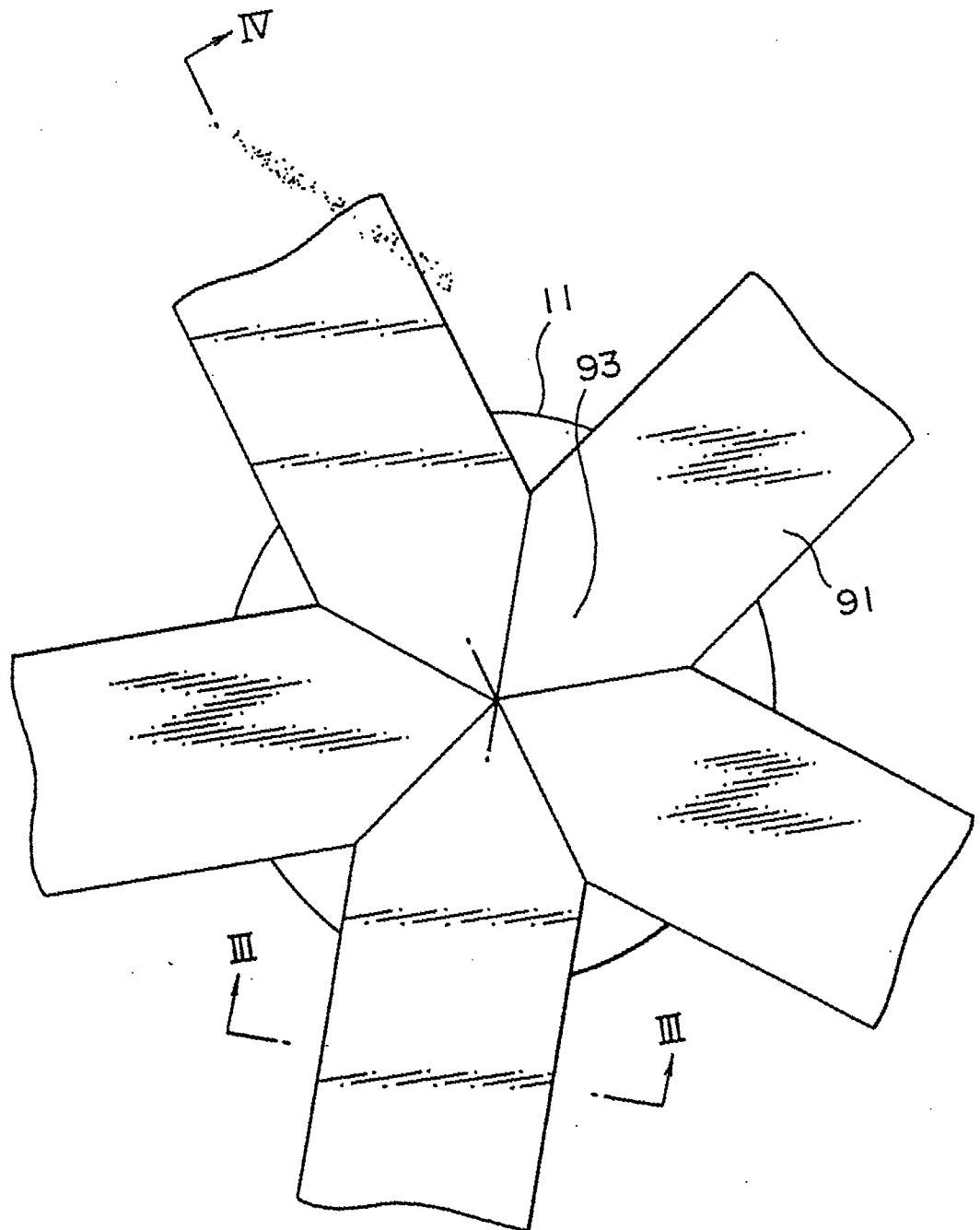




FIG. 3

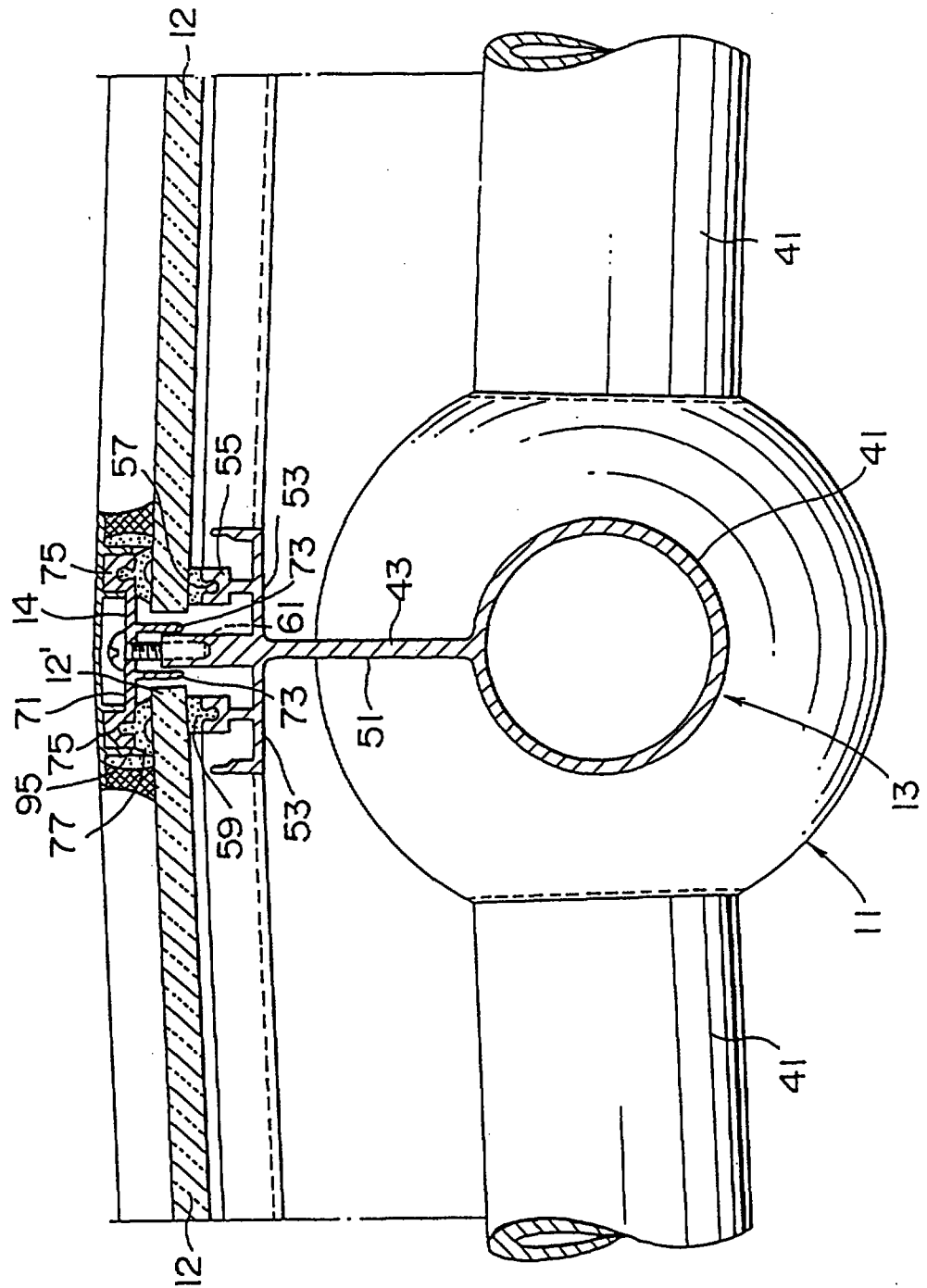
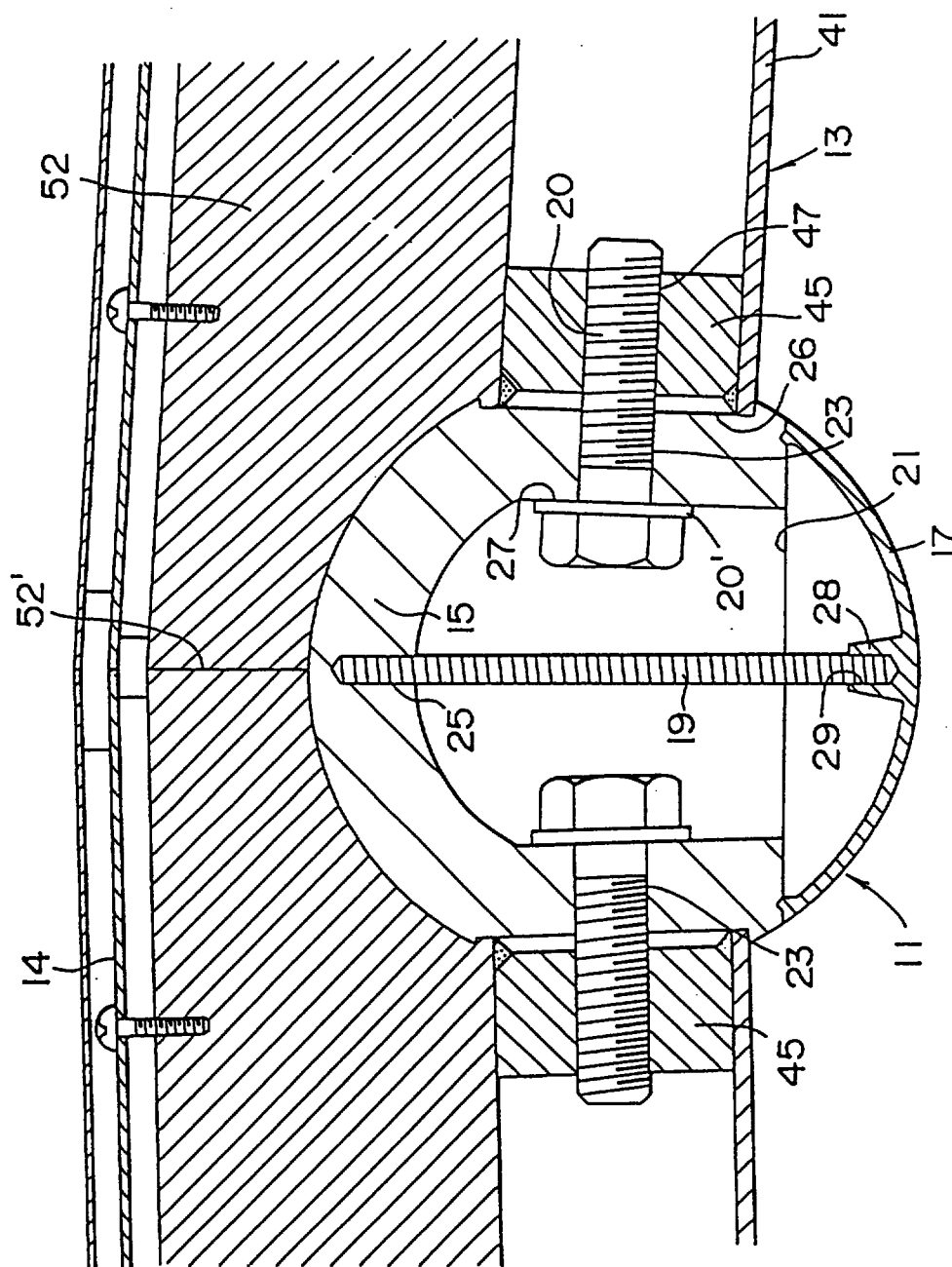


FIG. 4



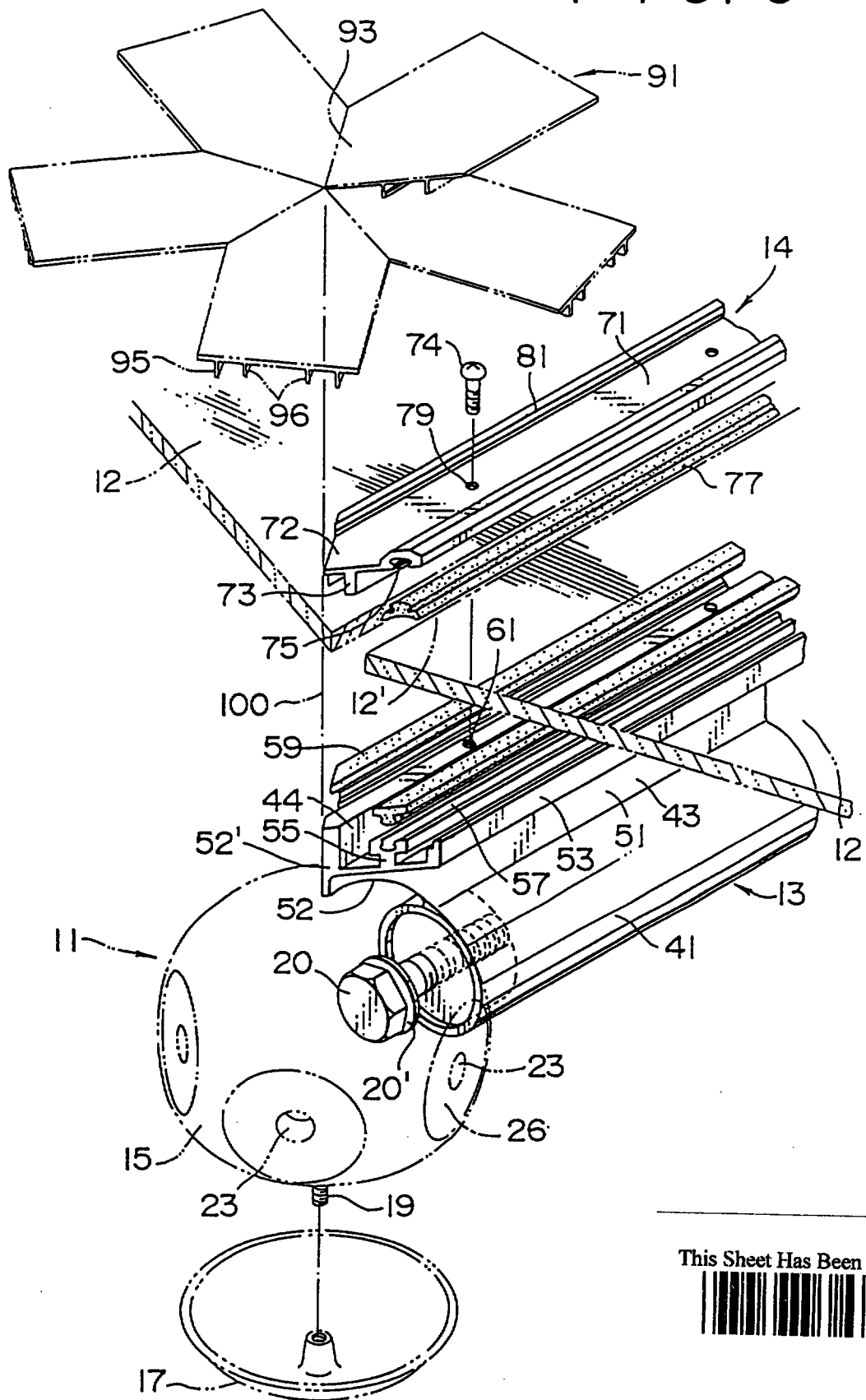
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FIG. 5

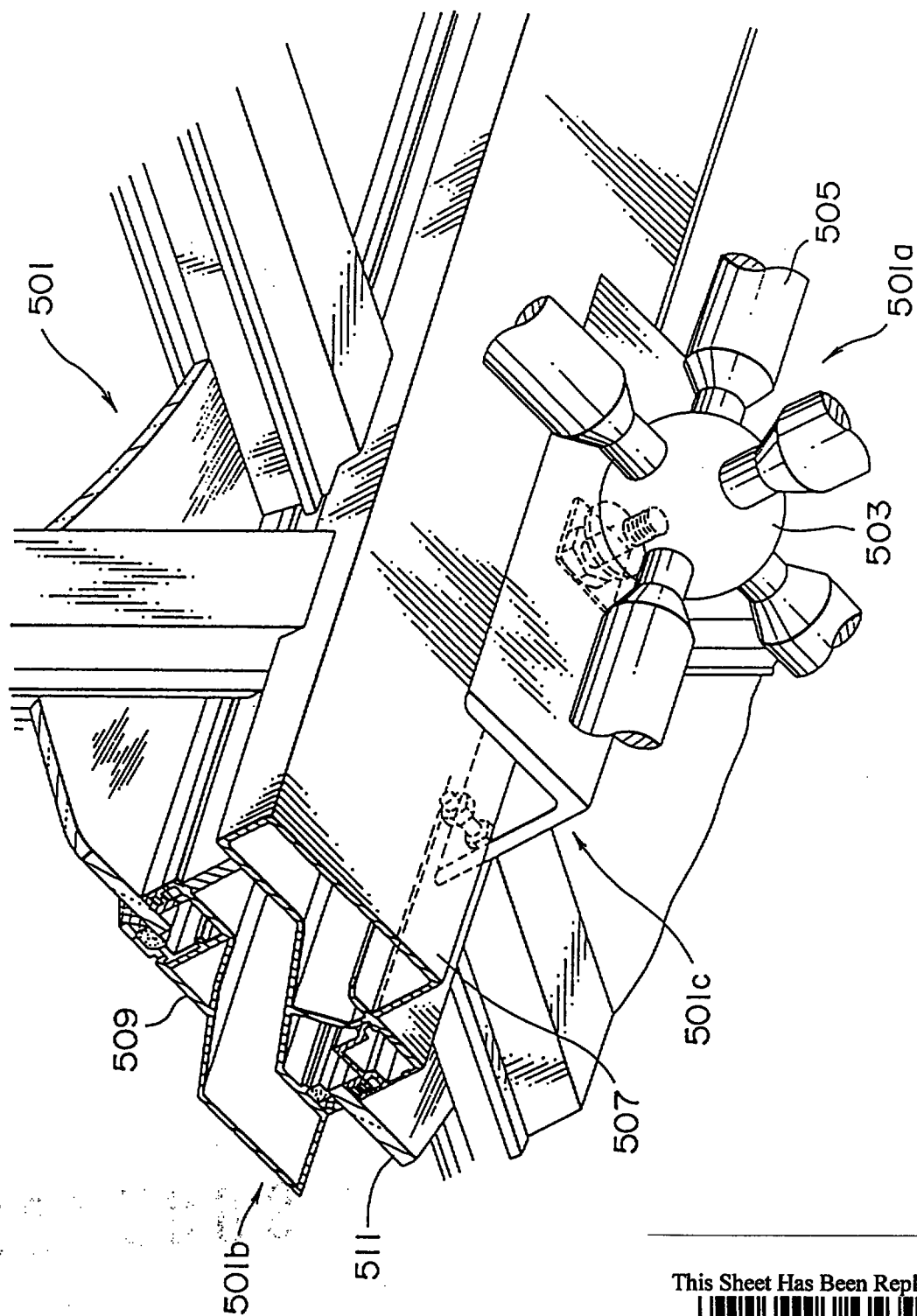


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REPLACED SHEETS	SG
☒ Description : paged 1-5 to paged 7	
☒ Claim(s) : paged 4 to paged 4	
☐ Drawing(s) : paged to paged	
☐ Abstract : paged to paged	
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TRUSS STRUCTURE

REPLACEMENT SHEETS	SG
☒ Description : paged 1... to paged 13..	
☒ Claim(s) : paged 4... to paged 4..	
☒ Drawing(s) : paged 4... to paged 4..	
☐ Abstract : paged to paged	
DATE OF RECEIPT 20/5/97	

The present invention relates generally to a truss structure used for construction of a building, house or the like and more particularly, a truss structure comprising a multiplicity of substantially spherical nodes, a multiplicity of rods extending between and joined to each adjacent pair of the nodes to thus form any desired configuration, such as a ^{dome,} ~~dome,~~ a plane figure, and a multiplicity of panels enclosing the configuration.

A typical structure of the type described is disclosed in Japanese Utility Model Laid-open Publication No. 2-20614. The disclosed truss structure 501 broadly comprises three distinct elements; a skeleton or supporting foundation framework 501a for bearing the whole burden of the structure 501; a covering structure 501b enclosing the framework and; means 501c for linking the skeleton 501a and the covering structure 501c. The skeleton 501a includes a multiplicity of solid nodes 503 and a multiplicity of solid cylindrical rods 505 extending between and joined to each adjacent pair of the nodes 503 in such a way that relevant radiating rods 505 being joined radially thereto to thus form a lattice like skeleton framework 501a of a desired configuration. The covering structure 501b includes a multiplicity of panel members 501b each comprising an interior and an exterior frame half 507, 509 and a panel 511 clamped therebetween. And, the linking means 501c includes a multiplicity of brackets 501c linking the nodes 503 and the interior frame halves 507.

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This conventional truss structure 501 suffers the following drawbacks:

Since the lattice-like skeleton framework 501a, a great number of the brackets 507 and the panel members 501b are arranged and installed at random or without regard to each other in terms of aesthetical design, this provides unsightly, complicated and out-of-order appearance.

After setting up the skeleton framework 501a; first one must attach brackets members 501c to the skeleton framework 501a at thousands of positions and then attach a multiplicity of panel members 501b to the bracket members 501c at as many positions. This operation has proved to be very time-consuming and tedious.

With the foregoing difficulties in view, it is therefore an object of the invention to provide a truss structure which is simple in structure, thus pleasing to look at and is easy to manufacture and install.

According to the present invention, there is provided a truss structure comprising: a multiplicity of substantially spherical nodes; and a multiplicity of rods extending between and joined to each adjacent pair of the nodes in such a way that each node has the relevant rods extending radially therefrom to thereby form a desired lattice configuration; characterized in that: the lattice configuration has a multiplicity of openings each defined by a set of the rods; the truss structure further including a multiplicity of panels each adapted to enclose the opening; each rod including an elongated tube having each end

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fastened to the outer periphery of the node and a support member integrally formed on the elongated tube for supporting thereon the panel in the opening in cooperation with the corresponding support members of the other opening-defining rods; and means for retaining the corresponding panel to the support member.

Many other advantages and features of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which preferred structural embodiments incorporating the principles of the present invention are shown by way of illustrative example.

FIG. 1 is a diagrammatical plan view of a ^{dome}/~~dorm~~ construction in which the present invention is embodied.

FIG. 2 is an enlarged fragmentary view of an apex portion of the ^{dome}/~~dorm~~ construction of FIG. 1;

FIG. 3 is a cross-sectional view taken on line III-III of FIG. 2.

FIG. 4 is a cross-sectional view take on line IV-IV of FIG. 2.

FIG. 5 is an enlarged exploded view of the apex portion of the dorm construction, some parts omitted for brevity's sake.

FIG. 6 is a perspective view of a conventional truss structure described in the introductory part of the specification.

FIG. 1 is a diagrammatical plan view of of a ^{dome}/~~dorm~~ construction used for auditorium, stadium etc. in which the present invention is embodied, although the truss structure



according to the present invention may be of any desired figure such as as circular plane figure, rectangular plane figure, etc.

As seen from FIG. 1, the truss structure broadly comprises a multiplicity of nodes 11; a multiplicity of rods 13 extending between and joined to each adjacent pair of the nodes 11 in such a way that each of the node 11 has the ~~relevant~~ ^{dome-like} relevant rods extending radially therefrom to form a ~~dorm-like~~ lattice construction having a plurality of opening each defined by a set of the rods 13; a plurality of panels 12 each adapted to enclose the opening; and means 14 for retaining the corresponding panel to the rod.

Since the node-and-rod system is repeated over entire area of the ~~dorm~~ ^{dome} construction, the explanation will be made by focusing on an apex portion A (FIG. 2) of the ~~dorm~~ ^{dome} construction of FIG. 1. In FIG. 2, a node 11 is partly seen under five elongated cap plates 91 having their isosceles-triangular ends 93 butted together, the corresponding five rods being hidden under the cap plates 91. Although the node-and-rod system is shown to extend over the entire area of the construction in this embodiment, the node-and-rod system may be used as part of a construction, such as a facade, a flat roof and a skylight.

As better shown in FIGS. 4 through 5, each node 11 is substantially spherical and hollow, and comprises a hollow bowl-shaped node body 15, a thin circular cap 17 and a joint bolt 19 joining the node body 15 and the circular cap 17 together. The node body 15 has a circular opening 21 formed ^{(preferably three or more; five} in the base thereof. The node body 15 has a plurality of ~~the~~

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the
in case of the node 11 located on the apex portion A) through
holes 23 formed in the periphery in a plane and disposed at
uniform intervals from each other. The node body 15 has a
threaded hole 25 on the internal periphery at the apex A
thereof into which one end of the joint bolt 19 is screwed. The
node body 15 has a pair of internal and external flattened
surfaces 26, 27 around the internal and external edges,
respectively, of each through hole 23 for enabling a head of a
bolt 20 and an end of a tube 41 to be seated flatly and stably
thereon, as closely described hereinafter.

The circular cap 17 is complementary in diameter to the
circular opening 21 of the bowl-shaped hollow node body 15
for fully enclosing the opening 21. A central stud²⁸ ~~is~~ is
mounted on the inner side at the center of the circular cap 17.
The central stud 28 has a threaded hole 29 formed
longitudinally therein.

As better shown in FIGS 3 through 5, each rod 13 is
extruded from aluminium or other suitable materials and
broadly comprises an elongated circular tube 41 and a support
member 43 integrally formed with and mounted longitudinally
on the elongated tube 41 for supporting panels thereon.

As better shown in FIG. 4, the elongated tube 41 has a
pair of caps 45, 45 plugged and welded one into each end
thereof. The cap 45 has therethrough a threaded through hole
47 coaxially with the tube 41. The support member 43
comprises an upright support stem 51 mounted longitudinally
on and extending vertically from the tube 41 and a horizontal

crossbar 53 mounted crisscross on the upright support stem 51. The horizontal crossbar 53 has a pair of parallel spaced elongated ridge 55 mounted longitudinally thereon, each of which ridge in turn has a groove 57 formed in the top thereof. An elongated gasket 59 made of rubber or plastics is embedded in each of the ridges 55. An upper part of the upright support stem 51 extending beyond the horizontal crossbar 53 has a plurality of threaded holes 61 formed therein at adequate intervals along its length. As better shown in FIG. 5, each end of the upright support stem 51 extends beyond the corresponding end of the tube 41 and curved to provide a curved lower edge portion 52 and terminates in a vertical tip 52'. As better shown in FIG. 4, when the radiating rods 13 are joined to the central node 11, the curved vertical edge portion 52 of each rod 13 fits against the outer periphery of the node body 15 and the vertical tip 52' abuts against the vertical tips 52' of the other radiating rods 13 on an imaginary vertical line 100 running through the center of the node 11. As better shown in FIG. 5, the support member 43 has opposed isosceles-triangular ends 44. When all the radiating rods 13 are joined to the node 11, the complementary isosceles-triangular ends 44 of the support member 43 of the rods are snugly butted together over the node 11 on the imaginary vertical line 100.

As better shown in FIG. 5, an elongated clamping bar 14 functioning as the retaining means 14 is substantially equal in length as the support member 43 and comprises an elongated flat plate 71, a pair of ridges 73, 73 longitudinally mounted on

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the lower surface of the flat plate 71 and a pair of marginal downward grooves 75, 75 formed in the opposed edges of the elongated flat plate 71. The marginal downward grooves 75, 75 have respective gaskets 77, 77 fitted therein. The opposed ridges 73, 73 is so spaced from each other as to loosely receive the top of the upright support stem 51. The flat plate 71 has a plurality of through holes 79 formed at adequate intervals and disposed between the opposed ridges 73, 73. The elongated clamping bar 14 has opposed isosceles-triangular ends 72, 72 (only one end being seen in the drawings), each of which end is analogous in shape to the isosceles-triangular end 44 of the support member 43. The elongate clamping bar 14 has a pair of marginal ribs 81, 81 mounted one on each marginal edge of the upper side thereof for snapping engagement with corresponding downward-directed ridges 95 of a cap plate 91 described thereafter.

As better shown in FIG. 5, an elongated cap plate 91 is made of any suitable resilient plastic and is coextensive with the clamping bar 14. The elongated cap plate 91 has on its lower side a pair of resilient ridges 96, 96 for resilient engagement with the inner sides of the marginal ribs 81, 81. The elongated cap plate 91 has opposed isosceles-triangular ends 93, 93 (one end being visible in the drawings), each of which is also analogous in shape to the isosceles-triangular end 72 of the elongated clamping bar 14.

The panel 12 may be a glass pane, a honeycomb panel or any other panel. As shown in FIG. 1, each panel 12 is shown



triangular in this embodiment. since the rod-and-node lattice construction provides a multiplicity of triangular openings. However, the panel 12 may be shaped in other figure depending on what openings the rod-and-node lattice construction provides.

For installing the truss structure according to the present invention, as better shown in FIGS. 3 through 4, each tube 41 is butted at its capped end against the corresponding external flattened surface 26 of the node 11 with the threaded ^{through - 47} hole ~~35~~ of the circular ^{end 45} cap ~~35~~ disposed in registry with the corresponding through hole 23 of the node 11. With the capped end of the tube 41 held firmly against the flattened surface 26, a bolt 20 is inserted through a washer 20', the ^{through -} through hole 23 of the node 11 and screwed into the threaded ⁴⁷ hole ~~35~~ of the circular ⁴⁵ end cap ~~35~~ of the tube 41. With this process going through all the radiating rods 13, they are all secured to the node 11 with the curved lower edge portions 52 fit snugly against the outer periphery of the node body 15 and the vertical tips abutting 52' abut against each other. At the same time, the complementary isosceles-triangular ends 44 of the support member 43 of all the radiating rods 13 abutted against one another and fill up a space over the node 11.

Then, as shown in FIG. 5, a pair of adjacent panels 12, 12 (triangular in this embodiment) are mounted on the crossbar 53 one on each side of the upright support stem 51; to be precise, the confronting edges 12', 12' of the adjacent panels 12,

12 are mounted on the respective gaskets 59. 59 fitted in the grooves 57. 57 of the crossbar 53 of the rod 13.

Subsequently, each clamping bar 14 is placed in place on and fastened to the corresponding support member 43 by the bolts 74 inserted through the through holes 79 and screwed into the threaded holes 61 with the opposed downward-directed ridges 73, 73 of the former 14 receiving the top of the upright support stem 51 of the rod 13, whereupon, as shown in FIG. 3, the confronting edges 12', 12' of the adjacent panels 12, 12 are firmly clamped between the gaskets 59 provided on the horizontal crossbar 53 of the rod 13 and the gaskets 77, 77 provided on the the clamping bar 14.

Then, each plate cap 91 is retentively fastened to the upper side of the corresponding clamping bar 14 by bringing the downward-directed ledges 95 of the former into snapping engagement with the upstanding marginal ribs 81 of the clamping bar 14 as shown in FIG. 3.

As better shown in FIG. 5, when installed, the complementary isosceles-triangular ends 72 of all the radiating clamping bars 14 are butted against one another and fill up the space above the node 11. Likewise, the complementary isosceles-triangular ends 93 of all the radiating cap plate 91 are butted against one another and fill up the space above the node 11.

The angles of the isosceles-triangular ends 44, 72, 93 of the support member 43, the clamping bars 14 and the cap plates 91, respectively, are equal to each other. But, the angle

of the isosceles-triangular ends 44, 72, 93 of those parts 43, 14, 91 hinges on how many rods 13 go to a central node 11. It could be said that the angle of isosceles-triangular ends 44, 72, 93 of those members 43, 14, 91 is such that, when snugly butted against each other, the isosceles-triangular ends 44, 72, 93 of all the radiating parts 43, 14, 91 fill up the space over the node 11 so as to completely prevent rain from infiltrating through therebetween.

After the cap plates 91 are snapped onto the clamping bars 14, the butted isosceles-triangular ends 93 of all the radiating cap plates 91 are caulked between each adjacent ones for rendering them fully water-tight.

With the construction of the present invention set forth hereinabove, the truss structure according to the present invention enjoys the following advantages:

Since the tubes constituting the skeleton framework and the support members constituting the covering structure are integrally formed on each other, this provides a regular and simple lattice construction which is very pleasing to look at.

Absent brackets, the manufacturing cost is saved very much.

Furthermore, dispensing with various operations of attaching brackets, attaching the bracket to skeleton framework and attaching panel members to the brackets would render the whole installation operation very easy and quick.

Obviously, the skilled person would realize that various modifications and variations of the present invention are

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possible in the light of the above teaching. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described, and that the invention is not limited to the embodiments described above in detail.

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→ 11a

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PARTS LIST
TRUSS STRUCTURE

Prior Art

501	Truss structure
501a	Skeleton
501b	Linking means
501c	Superficial structure
503	Solid node
505	Cylindrical rod
507	Interior frame half
509	Exterior frame half
511	Panel

Present Invention

11	Node
12	Panel
13	Rod
14	Clamping bar (=Retaining means)
15	Node body
17	Circular cap
19	Joint bolt
20	Bolt
20'	Washer
21	Circular opening
23	Through holes
25	Threaded hole

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26, 27	Flattened surfaces
28	Central stud
29	Threaded hole
41	Elongated tube
43	Support member
44	Isosceles-triangular ends (of the support member 43)
45	Cap
47	Threaded through hole
51	Upright support stem
52	Curved edge portion
53	Horizontal crossbar
55	Elongated ridges
57	Groove
59	Elongated gasket
61	Threaded holes
71	Elongated flat plate
72	Isosceles-triangular ends (of the clamping bar 14)
73	Ridges
75	Marginal downward grooves
77	Gasket
81	Upstanding marginal rib
91	Cap plate
93	Isosceles-triangular ends (of plate cap 91)
95	Downward directed ledges
96	Resilient ridges

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CLAIMS:

1. A truss structure comprising: a multiplicity of substantially spherical nodes (11); and a multiplicity of rods (13) extending between and joined to each adjacent pair of the nodes (11) in such a way that each node (11) has the relevant rods (13) extending radially therefrom to thereby form a desired lattice configuration; characterized in that: the lattice configuration has a multiplicity of openings each defined by a set of the rods (11); the truss structure further including a multiplicity of panels (12) each adapted to enclose the opening; each rod (13) including an elongated tube (41) having each end fastened to the outer periphery of the node (11) and a support member (43) integrally formed on the elongated tube (41) for supporting thereon the panel (12) in the opening in cooperation with the corresponding support members (43) of the other opening-defining rods (13); and means (14) for retaining the corresponding panel (12) to the support member (43).

2. A truss structure according to claim 1, the support member (43) comprising an upright support stem (51) mounted longitudinally on and extending vertically from tube (41) and a horizontal crossbar (53) mounted crisscross on the upright support stem (51) for each holding the confronting edges (12'), (12'') of the adjacent panels (12), the retaining means (14) comprising an elongate clamping bar (14) being substantially equal in length to the support member (43) and fastened to the support member (43) to retain the confronting





edges (12'), (12') of the adjacent panels (12) against the horizontal crossbar (53).

3. A truss structure according to claim 2, each end of the upright support stem (51) extending beyond the corresponding end of the tube (41) and curved so as to fit against the periphery of the node (11); the horizontal crossbar (53) being substantially coextensive to the upright support stem (51), the support member (43) having opposed isosceles-triangular ends (44), ^{formed by} ~~when~~ all the radiating rods (13) being joined to the node (11), the complementary isosceles-triangular ends (44) of the support member (43) of the rods (13) being butted together over the node (11).

4. A truss structure according to claim 2, the elongated clamping bar (14) being substantially equal in length as the support member (43) and having opposed isosceles-triangular ends (72), ^{formed by} ~~when~~ the rods (13) being joined to the node (11), the complementary isosceles-triangular ends (72) of the elongated clamping bars (14) butted together over the node (11).

5. A truss structure according to claim 3, the truss structure further including an elongated cap plate (71) being substantially equal in length as the clamping bar (14) and having opposed isosceles-triangular ends (93), the elongated cap plate (91) coming into snapping engagement with the elongated clamping bar (14) for preventing water leakage, ~~when~~ the rods (13) being joined to the node (11), ~~the~~ complementary isosceles-triangular ends (93) of the elongated cap plates (91) ^{being} ~~butted~~ together over the node (11).



6. A truss structure according to claim 1, the node (11) being hollow and having three or more through holes (23) in its periphery, the elongate tube (41) having a pair of caps (45) plugged and welded one into each end thereof, the cap (45) having therethrough a threaded hole (47) coaxially with the tube (41), the rod (13) being secured to the node (11) by a bolt (20) inserted through the through hole (23) of the node (11) and threaded to the threaded hole (47) of the cap (45).

7. A truss structure according to claim 4, the node (11) including a node body (15) having the through holes (23) therethrough and an circular opening (21) formed in the base thereof, and a circular cover (17) releasably attached to the opening (21) for allowing access to the bolts (20).



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FIG. 1

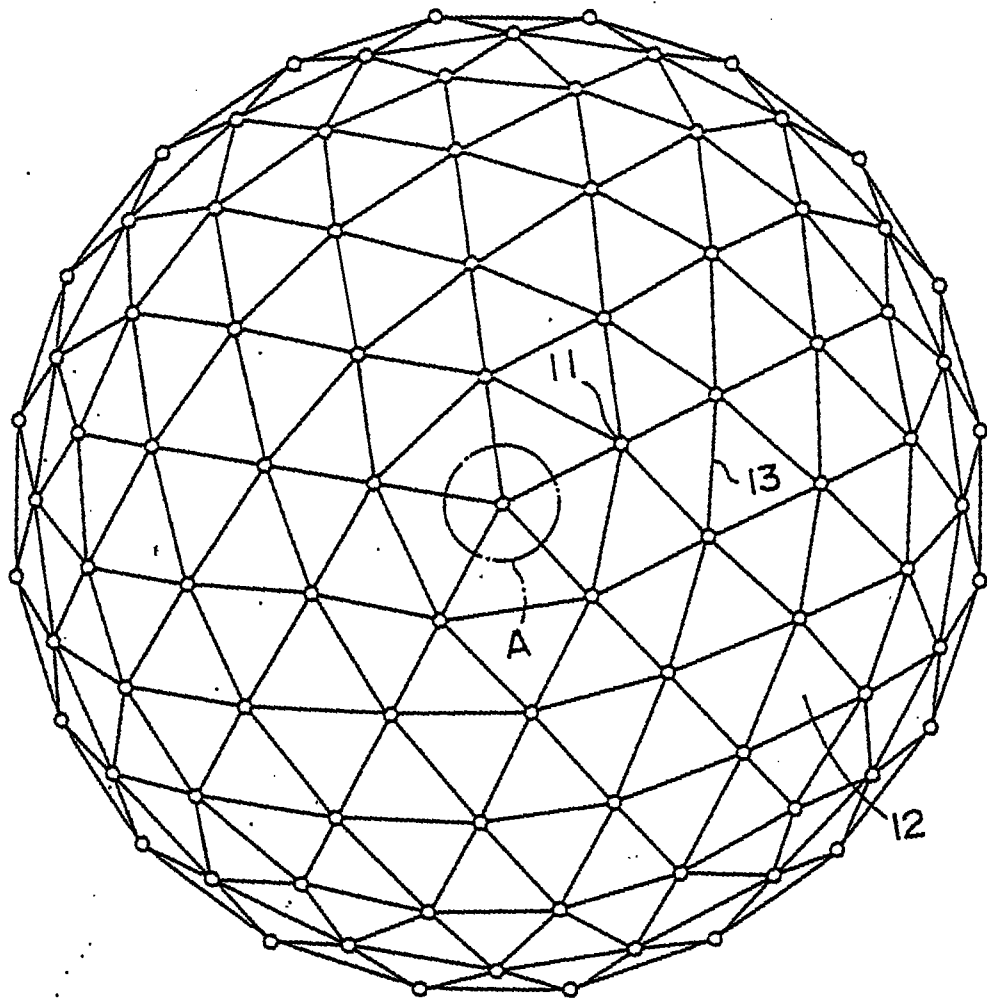
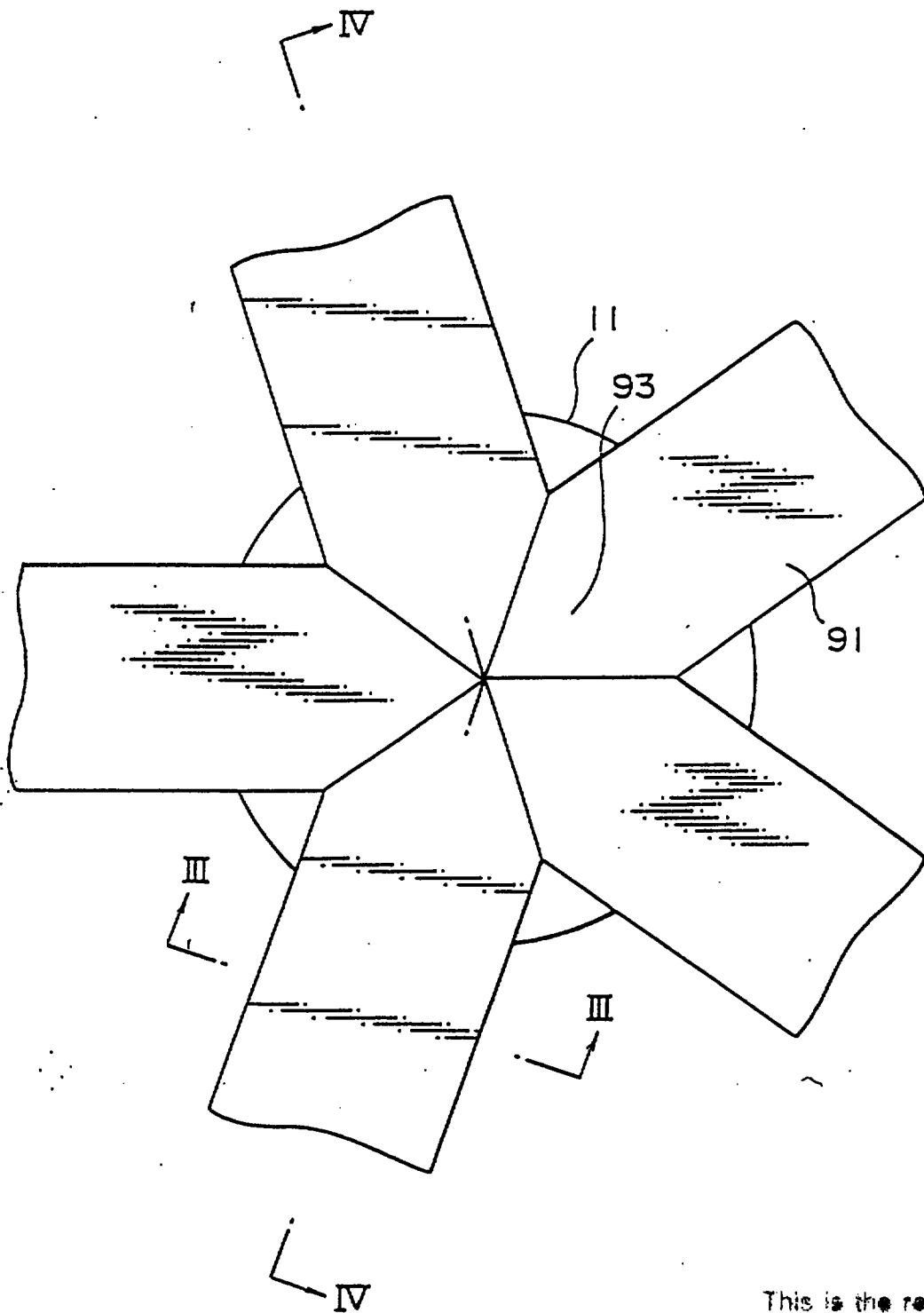


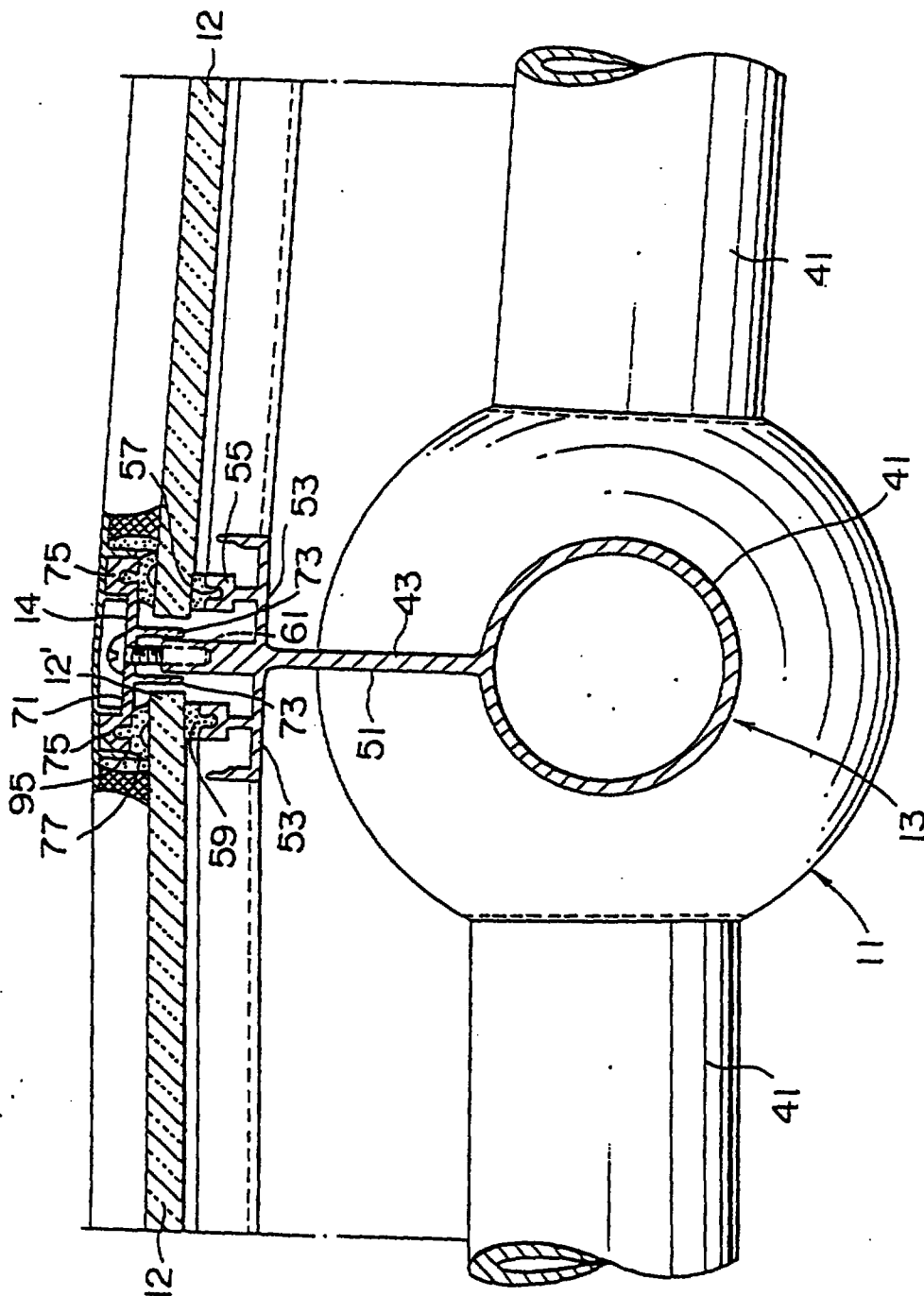
FIG. 2



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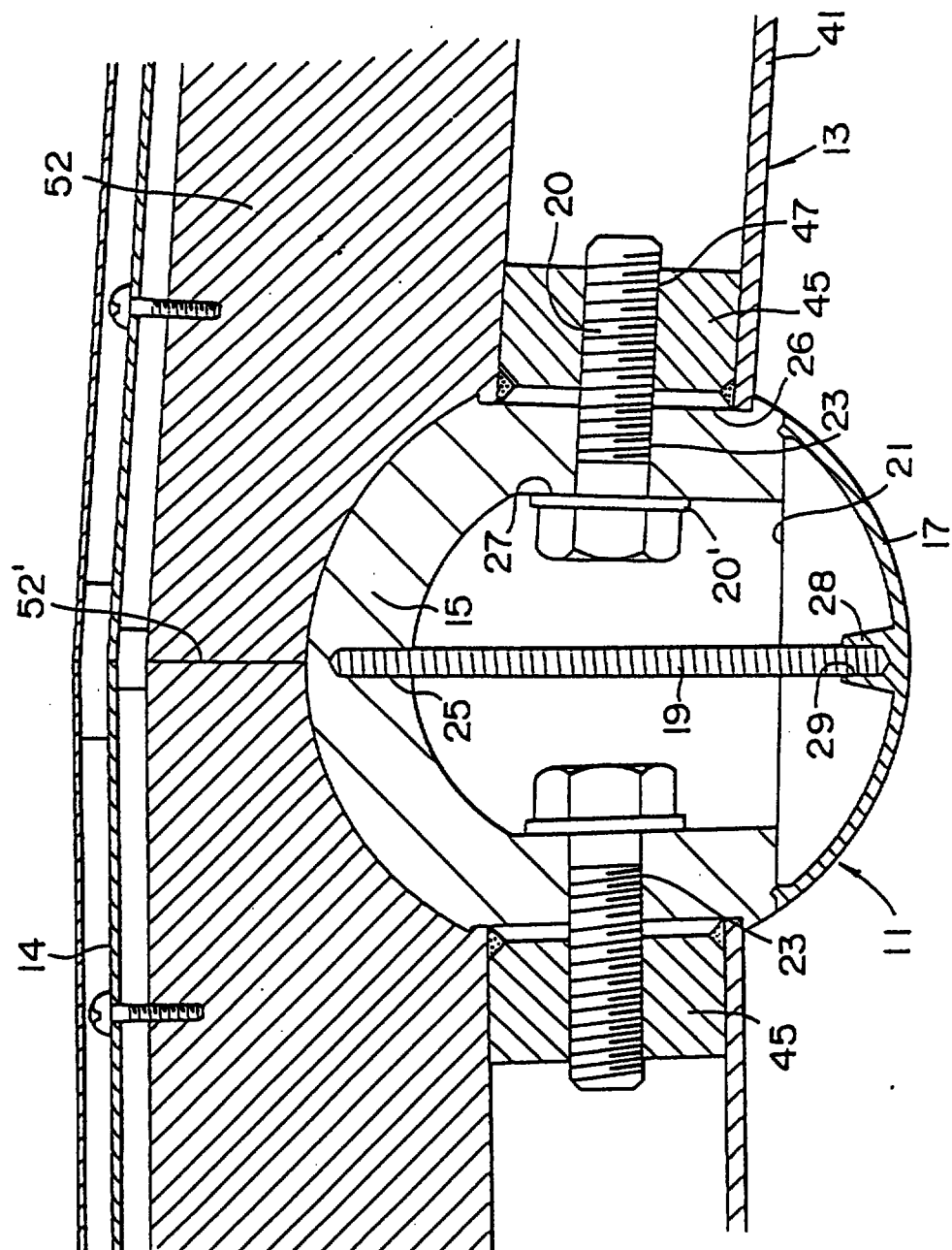
FIG. 3



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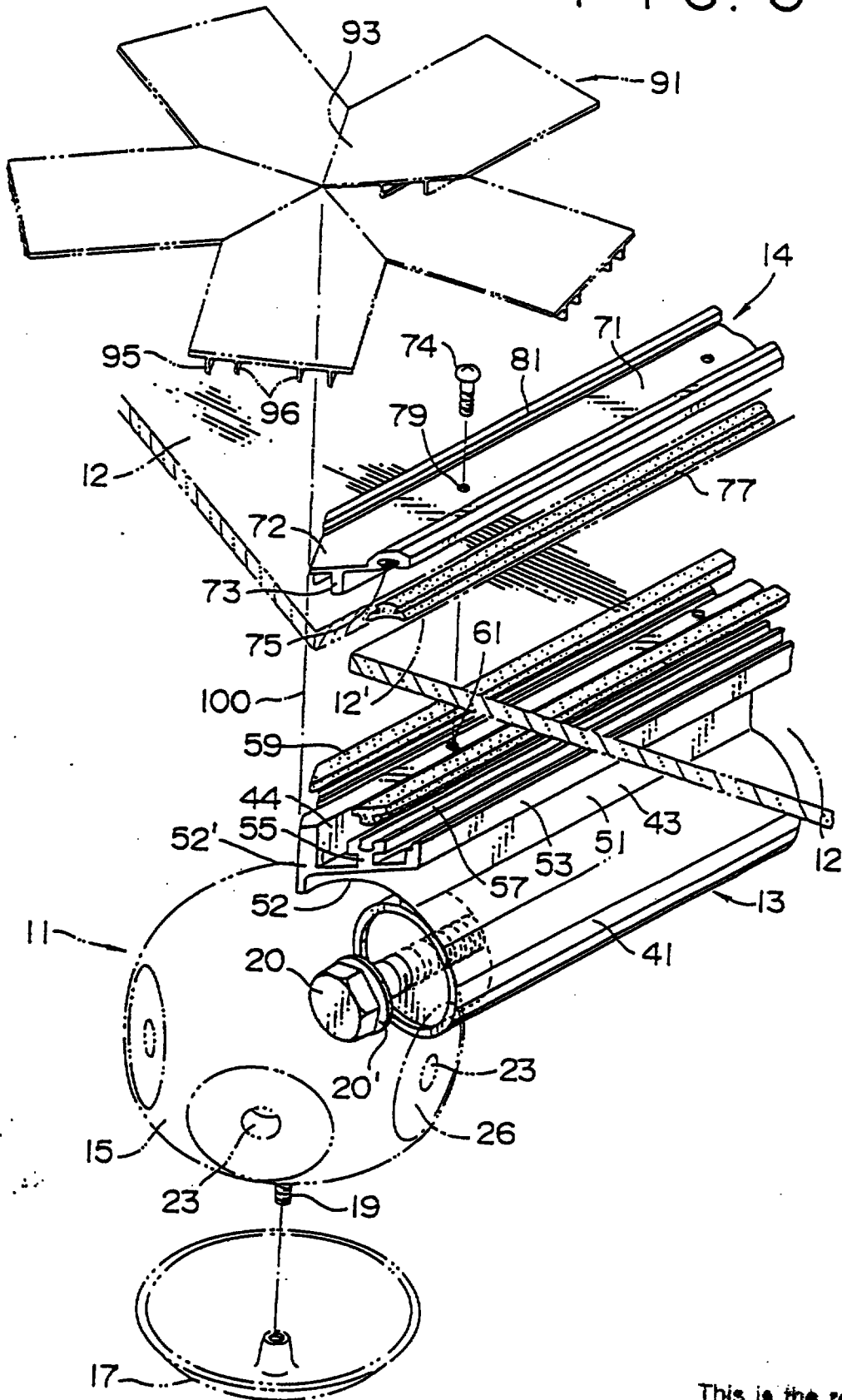
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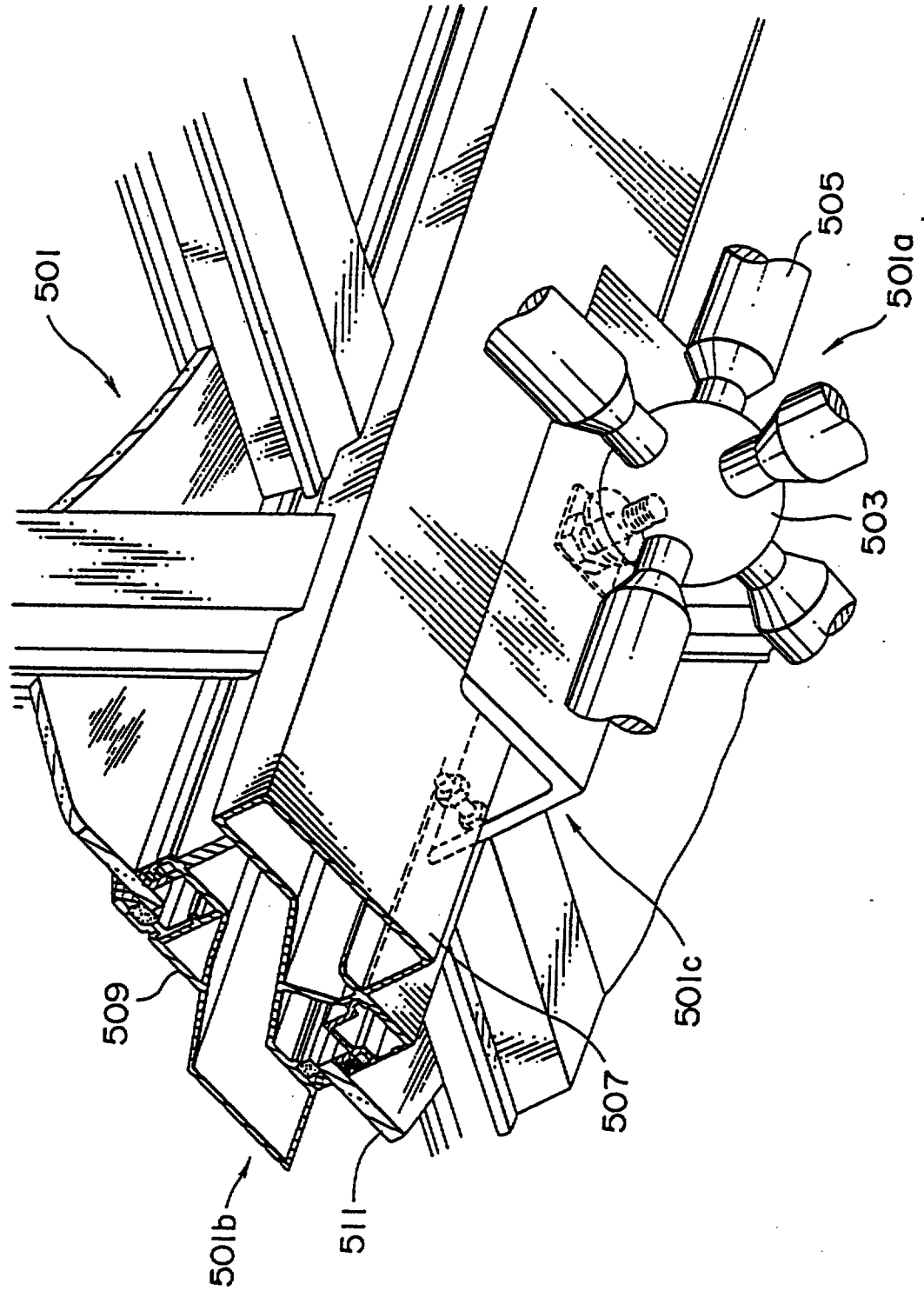
FIG. 5



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FIG. 6



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REPLACEMENT SHEETS SG

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REPLACEMENT SHEET

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TRUSS STRUCTURE

The present invention relates generally to a truss structure used for construction of a building, house or the like and more particularly, a truss structure comprising a multiplicity of substantially spherical nodes, a multiplicity of rods extending between and joined to each adjacent pair of the nodes to thus form any desired configuration, such as a dome, a plane figure, and a multiplicity of panels enclosing the configuration.

A typical structure of the type described is disclosed in Japanese Utility Model Laid-open Publication No. 2-20614. The disclosed truss structure 501 broadly comprises three distinct elements; a skeleton or supporting foundation framework 501a for bearing the whole burden of the structure 501; a covering structure 501b enclosing the framework and; means 501c for linking the skeleton 501a and the covering structure 501c. The skeleton 501a includes a multiplicity of solid nodes 503 and a multiplicity of solid cylindrical rods 505 extending between and joined to each adjacent pair of the nodes 503 in such a way that relevant radiating rods 505 being joined radially thereto to thus form a lattice like skeleton framework 501a of a desired configuration. The covering structure 501b includes a multiplicity of panel members 501b each comprising an interior and an exterior frame half 507, 509 and a panel 511 clamped therebetween. And, the linking means 501c includes a multiplicity of brackets 501c linking the nodes 503 and the interior frame halves 507.

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This conventional truss structure 501 suffers the following drawbacks:

Since the lattice-like skeleton framework 501a, a great number of the brackets 507 and the panel members 501b are arranged and installed at random or without regard to each other in terms of aesthetical design, this provides unsightly, complicated and out-of-order appearance.

After setting up the skeleton framework 501a; first one must attach brackets members 501c to the skeleton framework 501a at thousands of positions and then attach a multiplicity of panel members 501b to the bracket members 501c at as many positions. This operation has proved to be very time-consuming and tedious.

With the foregoing difficulties in view, it is therefore an object of the invention to provide a truss structure which is simple in structure, thus pleasing to look at and is easy to manufacture and install.

According to the present invention, there is provided a truss structure comprising: a multiplicity of substantially spherical nodes; and a multiplicity of rods extending between and joined to each adjacent pair of the nodes in such a way that each node has the relevant rods extending radially therefrom to thereby form a desired lattice configuration; characterized in that: the lattice configuration has a multiplicity of openings each defined by a set of the rods; the truss structure further including a multiplicity of panels each adapted to enclose the opening; each rod including an elongated tube having each end

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fastened to the outer periphery of the node and a support member integrally formed on the elongated tube for supporting thereon the panel in the opening in cooperation with the corresponding support members of the other opening-defining rods; and means for retaining the corresponding panel to the support member.

Many other advantages and features of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which preferred structural embodiments incorporating the principles of the present invention are shown by way of illustrative example.

FIG. 1 is a diagrammatical plan view of a dome construction in which the present invention is embodied.

FIG. 2 is an enlarged fragmentary view of an apex portion of the dome construction of FIG. 1;

FIG. 3 is a cross-sectional view taken on line III-III of FIG. 2.

FIG. 4 is a cross-sectional view take on line IV-IV of FIG. 2.

FIG. 5 is an enlarged exploded view of the apex portion of the dorm construction, some parts omitted for brevity's sake.

FIG. 6 is a perspective view of a conventional truss structure described in the introductory part of the specification.

FIG. 1 is a diagrammatical plan view of of a dome construction used for auditorium, stadium etc. in which the present invention is embodied, although the truss structure

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according to the present invention may be of any desired figure such as as circular plane figure, rectangular plane figure, etc.

As seen from FIG. 1, the truss structure broadly comprises a multiplicity of nodes 11; a multiplicity of rods 13 extending between and joined to each adjacent pair of the nodes 11 in such a way that each of the node 11 has the relevant rods extending radially therefrom to form a dome-like lattice construction having a plurality of opening each defined by a set of the rods 13; a plurality of panels 12 each adapted to enclose the opening; and means 14 for retaining the corresponding panel to the rod.

Since the node-and-rod system is repeated over entire area of the dome construction, the explanation will be made by focusing on an apex portion A (FIG. 2) of the dome construction of FIG. 1. In FIG. 2, a node 11 is partly seen under five elongated cap plates 91 having their isosceles-triangular ends 93 butted together, the corresponding five rods being hidden under the cap plates 91. Although the node-and-rod system is shown to extend over the entire area of the construction in this embodiment, the node-and-rod system may be used as part of a construction, such as a facade, a flat roof and a skylight.

As better shown in FIGS. 4 through 5, each node 11 is substantially spherical and hollow, and comprises a hollow bowl-shaped node body 15, a thin circular cap 17 and a joint bolt 19 joining the node body 15 and the circular cap 17 together. The node body 15 has a circular opening 21 formed in the base thereof, The node body 15 has a plurality of preferably three or more; five

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in the case of the node 11 located on the apex portion A) through holes 23 formed in the periphery in a plane and disposed at uniform intervals from each other. The node body 15 has a threaded hole 25 on the internal periphery at the apex A thereof into which one end of the joint bolt 19 is screwed. The node body 15 has a pair of internal and external flattened surfaces 26, 27 around the internal and external edges, respectively, of each through hole 23 for enabling a head of a bolt 20 and an end of a tube 41 to be seated flatly and stably thereon, as closely described hereinafter.

The circular cap 17 is complementary in diameter to the circular opening 21 of the bowl-shaped hollow node body 15 for fully enclosing the opening 21. A central stud 28 is mounted on the inner side at the center of the circular cap 17. The central stud 28 has a threaded hole 29 formed longitudinally therein.

As better shown in FIGS 3 through 5, each rod 13 is extruded from aluminium or other suitable materials and broadly comprises an elongated circular tube 41 and a support member 43 integrally formed with and mounted longitudinally on the elongated tube 41 for supporting panels thereon.

As better shown in FIG. 4, the elongated tube 41 has a pair of caps 45, 45 plugged and welded one into each end thereof. The cap 45 has therethrough a threaded through hole 47 coaxially with the tube 41. The support member 43 comprises an upright support stem 51 mounted longitudinally on and extending vertically from the tube 41 and a horizontal

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triangular in this embodiment, since the rod-and-node lattice construction provides a multiplicity of triangular openings. However, the panel 12 may be shaped in other figure depending on what openings the rod-and-node lattice construction provides.

For installing the truss structure according to the present invention, as better shown in FIGS. 3 through 4, each tube 41 is butted at its capped end against the corresponding external flattened surface 26 of the node 11 with the threaded through-hole 47 of the circular end cap 45 disposed in registry with the corresponding through hole 23 of the node 11. With the capped end of the tube 41 held firmly against the flattened surface 26, a bolt 20 is inserted through a washer 20', the through hole 23 of the node 11 and screwed into the threaded through hole 47 of the circular end cap 45 of the tube 41. With this process going through all the radiating rods 13, they are all secured to the node 11 with the curved lower edge portions 52 fit snugly against the outer periphery of the node body 15 and the vertical tips abutting 52' abut against each other. At the same time, the complementary isosceles-triangular ends 44 of the support member 43 of all the radiating rods 13 abutted against one another and fill up a space over the node 11.

Then, as shown in FIG. 5, a pair of adjacent panels 12, 12 (triangular in this embodiment) are mounted on the crossbar 53 one on each side of the upright support stem 51; to be precise, the confronting edges 12', 12' of the adjacent panels 12,

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CLAIMS:

1. A truss structure comprising: a multiplicity of substantially spherical nodes (11); and a multiplicity of rods (13) extending between and joined to each adjacent pair of the nodes (11) in such a way that each node (11) has the relevant rods (13) extending radially therefrom to thereby form a desired lattice configuration; characterized in that: the lattice configuration has a multiplicity of openings each defined by a set of the rods (11); the truss structure further including a multiplicity of panels (12) each adapted to enclose the opening; each rod (13) including an elongated tube (41) having each end fastened to the outer periphery of the node (11) and a support member (43) integrally formed on the elongated tube (41) for supporting thereon the panel (12) in the opening in cooperation with the corresponding support members (43) of the other opening-defining rods (13); and means (14) for retaining the corresponding panel (12) to the support member (43).

2. A truss structure according to claim 1, the support member (43) comprising an upright support stem (51) mounted longitudinally on and extending vertically from tube (41) and a horizontal crossbar (53) mounted crisscross on the upright support stem (51) for each holding the confronting edges (12'), (12') of the adjacent panels (12), the retaining means (14) comprising an elongate clamping bar (14) being substantially equal in length to the support member (43) and fastened to the support member (43) to retain the confronting



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edges (12'), (12') of the adjacent panels (12) against the horizontal crossbar (53).

3. A truss structure according to claim 2, each end of the upright support stem (51) extending beyond the corresponding end of the tube (41) and curved so as to fit against the periphery of the node (11); the horizontal crossbar (53) being substantially coextensive to the upright support stem (51), the support member (43) having opposed isosceles-triangular ends (44), formed by the radiating rods (13) being joined to the node (11), the complementary isosceles-triangular ends (44) of the support member (43) of the rods (13) being butted together over the node (11).

4. A truss structure according to claim 2, the elongated clamping bar (14) being substantially equal in length as the support member (43) and having opposed isosceles-triangular ends (72), formed by the rods (13) being joined to the node (11), the complementary isosceles-triangular ends (72) of the elongated clamping bars (14) butted together over the node (11).

5. A truss structure according to claim 3, the truss structure further including an elongated cap plate (71) being substantially equal in length as the clamping bar (14) and having opposed isosceles-triangular ends (93), the elongated cap plate (91) coming into snapping engagement with the elongated clamping bar (14) for preventing water leakage,

the rods (13) being joined to the node (11), complementary isosceles-triangular ends (93) of the elongated cap plates (91) being butted together over the node (11),

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