July 6, 1965 R. G. HAWKINS 3,192,669

SKYLIGHT CONSTRUCTION

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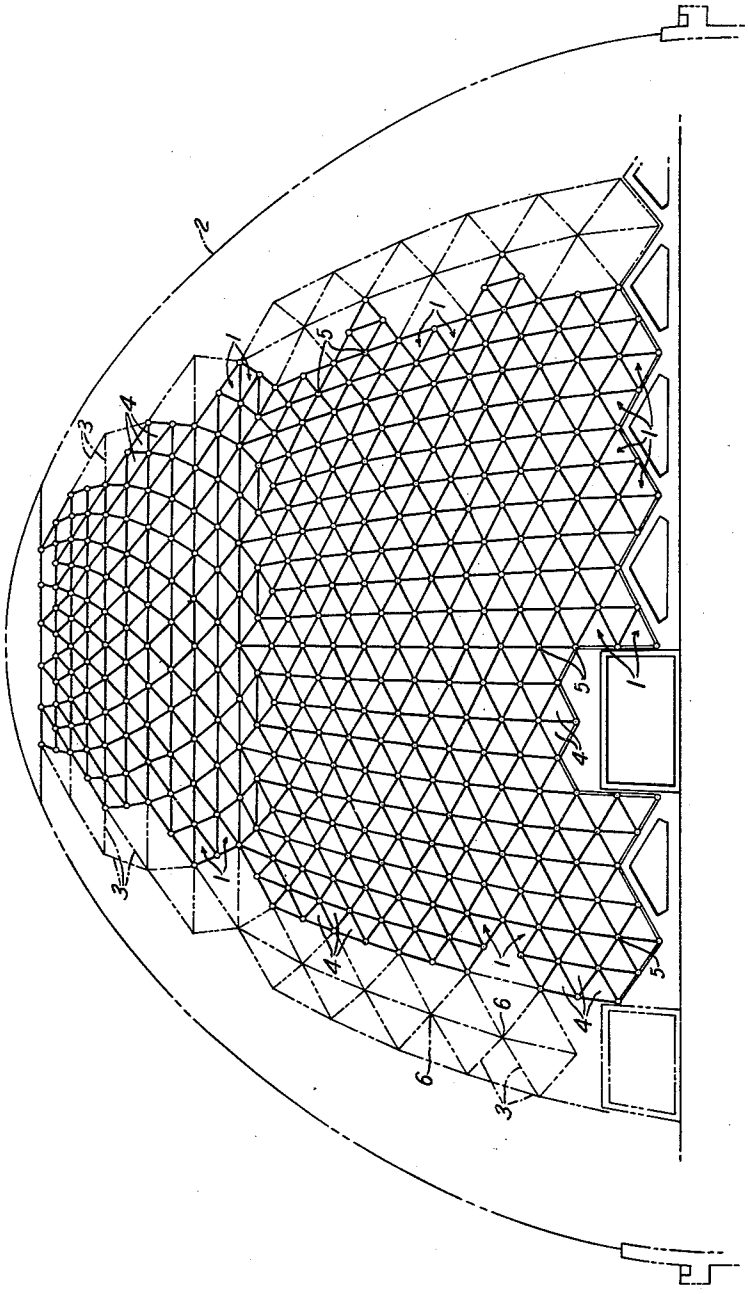


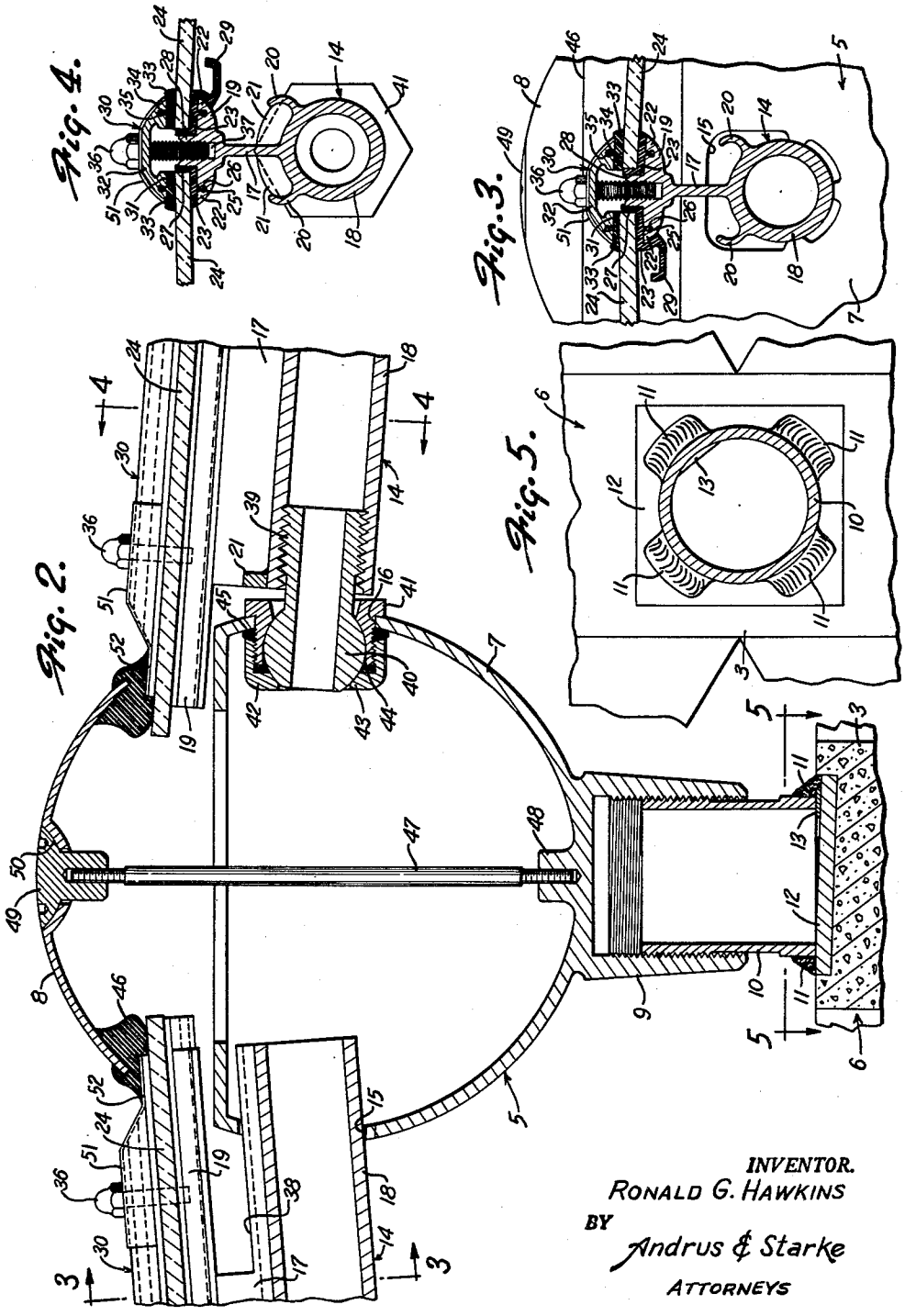
Fig. 1.

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SKYLIGHT CONSTRUCTION

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The present invention relates generally to skylights and more specifically to skylights comprising a series of interfitting assemblies designed for installation over the structural framework of a building and forming a curved or plane surface.

The recent architectural trend towards the use of larger and sometimes curved skylights, as, for example, in the construction of geometric and geodesic domes, has accentuated problems long connected with the design and use of skylights and, in some instances, created new problems.

One problem associated with the use of skylights arises out of condensation of water vapor on the inside of the skylight in cool weather. If allowed to follow its natural course, the condensate collects along the lower portions of each glass pane of the skylight and eventually falls freely from the skylight into the space below. This condition creates an obvious nuisance to the people within the building and below the skylight as well as possibly causing soiling or damage to the furnishings, equipment or the like within the structure. The use of larger skylights has, of course, increased the total condensate and intensified the problem.

It has been proposed in the past to incorporate a drainage system into the skylight by employing channeled rafters to collect and funnel the condensate to suitable condensate receiving means at the skylight edge. Alternately, it has been attempted to provide a skylight which reduces the amount of condensate accumulating on the skylight as for example by employing a double pane of glass enclosing a dead air space. In both cases, however, the end result has been a skylight of unsightly and clumsy appearance, thereby destroying the architectural unity of the resultant building.

Moreover, these proposed devices in many instances were not suitable, from an engineering or economic standpoint, for fabrication in larger sizes or for application to curved surfaces, particularly where a large number of geometrically arranged panes require drainage for substantial distances.

In the design of skylights, it is imperative to maintain a close tolerance between the components of the skylight to insure that the glass plates fit correctly within the framework of the skylight. As this same degree of tolerance is, of course, not practical to achieve in the shell or framework of the building which is to support the skylight, the skylight must be designed with some degree of adjustability. Where the skylight extends over a substantial area and is interconnected at numerous places to the structural framework, a relatively wide degree of adjustment must be provided in the skylight design. Also, in the case of a curved skylight wherein it is necessary to cant the skylight supports relatively of one another, means must be provided for adjusting the angular position of the skylight components both in plan and in elevation.

Insofar as is known, presently existing skylights are not fully capable of adjustment either in degree or kind to meet the various types of dimensional inaccuracies which may exist.

The above problems are overcome in the present invention by a skylight consisting of a series of hub assemblies which are adapted to be supported on and connected to the framework or subceiling of a building and which interconnect with adjacent assemblies in predetermined

manner to provide a skylight of any desired size and in a wide variety of configurations.

Each hub assembly has a hollow, two-piece hub including a lower base and an upper mating cover with the base adjustably connected to the shell of the building and with rafters adjustably extending radially of the hub and supporting the panes of glass. Each hub of a given hub assembly is located generally centrally of a predetermined number of equally spaced surrounding hubs similarly connected to the building shell. Each of the so-called surrounding hubs, in turn, comprises the central hub of an additional series of a corresponding number of surrounding hubs. This pattern is repeated over the course of the framework of the building or that portion thereof which is desired to support the skylight. Necessary adjustments to the pattern are, of course, made at the hubs and at the periphery of the skylight.

Each hub is connected to each of the surrounding hubs by an extruded aluminum rafter having a generally tubular lower section for drainage and a generally flat preferably pitched glass supporting upper section with a separate cap section. The rafters define a series of generally triangular openings for each hub assembly and these openings are enclosed by individual plates or panes of glass or other suitable material, such as synthetic plastic, shaped in general conformity to the opening.

The plates of glass are supported on the upper section of the rafters defining any one particular opening with the edges of adjacent plates to be supported on a given rafter in spaced relation to each other and with a longitudinal groove in the upper surface of the rafter section between the edges. The plates are clamped against the rafters by separate cap sections in the form of rafter bars disposed lengthwise and directly above the rafters on the outer surface of the glass plates. Screws are inserted through the rafter bars and between the spaced edges of each pair of adjoining plates for screw threaded engagement with longitudinal threads formed in the opposite side walls of the groove in the upper rafter section.

Suitable glazing material or rubber sealing members are interposed between the glass plates and the rafters and rafter bars as needed to provide a water-tight assembly. Similar sealing is provided for the hollow hub assemblies at all joints.

The plates of glass are supported generally in the plane between the adjacent hub sections with the vertices of the glass plates being extended inwardly of the hubs to overlie the upper edge of the base of the hub. Suitable sealing rings are placed between the hub sections on either side of the overlying portions of the glass plates to seal the glass to the hub upon assembly of the hub sections and to also seal the hub sections. The rafter bar ends are sealed to the hubs by cap plates which extend under the upper of the sealing rings and also by adjustable connections for each tube end with the corresponding hub.

The rafters are constructed to collect and drain condensate from the inside surfaces of the skylight. For this purpose fins may be provided on the rafter or on the glazing strip for collecting condensate and directing it into a hollow hub, or into the tubular rafter. The lower portion of each rafter is made tubular and enters the hollow hubs at opposite ends to serve as a part of a tubular net work for draining condensate.

Each rafter is secured at the upper end and sealed to the corresponding hub and is loose to freely slide into the hub at the lower end to provide for necessary expansion and contraction of the rafters without distortion of the skylight. A universal connection preferably in the form of a ball and socket joint secures the rafters and has a pair of sealing gaskets to close the opening in the hub.

To collect the condensate, the glazing strip beneath and

along the edges of the glass toward which condensate tends to run, is provided with a gutter which receives the condensate and conducts the same downwardly along the rafter and into the hub at its lower end. If desired the rafter may have an extruded gutter on each side and which may catch any overflow from the glazing strip gutter should there be any.

The hubs of the skylight in addition to acting as a distribution center for water flowing thereto serve as reservoirs in case of a high condensate runoff rate to prevent the condensate from backing up and overflowing the troughs along the rafters.

The radial position of the rafters relative to the hubs may be adjusted within limits to permit the rafter to be shifted as needed to adjust for minor errors in the spacing and location of the hub supports in the skylight system.

A further adjustment is possible to correct errors occurring in the elevation of the supports by adjusting the hub to base relatively upwardly or downwardly and universally as by a tapered shim.

The invention has found particular adaptation and is herein illustrated as applied to a large dome for a botanical conservatory. In this use it is desired to provide transmission of better than 90% of the light and it is estimated that the present invention provides for transmission of as high as 94% of the total light.

The skylight of the invention provides a very striking, simple appearance as is particularly befitting modern day architecture. At the same time, the skylight provides a very effective condensate collection and drainage system fully capable of handling momentary high runoff rates as may be required in buildings used for horticultural purposes.

The skylight may be fabricated in any size and shape desired by utilizing any selected number of hub assemblies in any suitable arrangement. The design is such that errors arising in the lay-out of the framework of the building may be adjusted for within the usual tolerance limits required in the field.

If desired, the number of rafters connected to any particular hub may be varied to provide for any selected geometric pattern.

The drawings furnished herewith illustrate the best mode presently contemplated of carrying out the invention.

In the drawings:

FIGURE 1 is an elevation with parts broken away of a horticultural dome to which the skylight of the invention has found particular application;

FIG. 2 is a vertical section of an individual hub assembly comprising the skylight of FIG. 1;

FIG. 3 is a section of rafter and adjacent glass taken along the line 3—3 of FIG. 2;

FIG. 4 is a section of the rafter and adjacent glass taken along the line 4—4 of FIG. 2; and

FIG. 5 is a section taken on line 5—5 of FIG. 2.

In FIGURE 1 the skylight **1** is applied over a framework or shell **2** of concrete that is constructed to provide a series of vertical, diagonal and horizontal struts **3** intersecting one another in a manner to define a network of adjacent geometric patterns preferably defining individual triangular openings **4** to be covered by individual panes of glass.

The skylight **1** is supported upon the shell **2** by a series of individual hollow hubs **5**, each mounted upon an individual intersection **6** of the struts **3**.

Each hub **5** comprises a bowl-shaped base **7** open at the top, and a cover **8**. The base **7** is adjustably and universally supported by an internally threaded column **9** integrally depending from the bottom of the bowl and carried by an upstanding externally threaded post **10** which in turn is welded as at **11** to a metal plate **12** embedded in the concrete intersection **6** and secured to the metal re-enforcing in the concrete. In erecting the skylight the angular positioning of post **10** is adjusted by means of a tapered shim **13** driven between the post **10** and the plate **12**, and the height of the bowl **7** is adjusted by threading of the post **10** in or out of the column **9**, before the post is welded to plate **12**.

The hubs **5** may be of any desirable shape for appearance, the generally spherical shape shown being illustrative and having some advantage in reducing the amount of shadow cast by the hubs, while providing adequate depth for collection of water run off from condensation.

Each hub **5** serves to carry and connect a plurality of rafters **14**, the exact number depending upon the pattern for the skylight and the location of the hub. For this purpose each hub base **7** is provided with an opening **15** for receiving each of the lower ends of rafters **14** which drain into the hub, and an opening **16** for receiving the fastening means for each of the upper ends of rafters **14** which drain from the hub.

Each rafter **14** is preferably of extruded aluminum alloy or other suitable material, and is of uniform section throughout its length.

Referring to FIGS. 3 and 4 the rafters **14** have a vertical web **17** joining a lower closed tubular conduit member **18** and an upper glass support body member **19**. The conduit member **18** preferably has overflow gutters **20** on opposite sides for conducting condensate into the hub at the lower end. The end of the gutter **20** on the high side of the rafter is plugged at the fixed end of the rafter by a filler piece **21** which is sealed with suitable mastic.

The body member **19** for each rafter comprises a flat laterally extending ledge **22** on each side of the rafter for supporting a lower glazing strip **23** which in turn supports a corresponding edge portion of a pane of glass **24**.

The lower glazing strip **23** is interlocked with the body member **19** by any suitable means such as the bead-shaped longitudinal tongue **25** of the glazing strip fitting in a complemental groove **26** in the upper supporting face of the member.

The glazing strip **23** has an upward flange **27** at its inner edge which is normally confined between the edge of the glass pane **24** and a central ridge **28** extending longitudinally of member **19** and separating ledges **22**.

The glazing strip **23** on the high side of a diagonal or horizontal rafter is provided with an integral gutter **29** formed at its outer edge and extending beneath the glass **24** to collect condensate therefrom and conduct it downwardly along the rafter. For vertically disposed rafters it is well to have gutters **29** formed on both glazing strips **23** carried by the rafter.

For the purpose of the skylight illustrated in FIGURE 1 the plane of the upper surface of the ledge **22** on one side of each rafter is disposed at a slight angle to the plane of the upper surface of the ledge **22** on the other side of the rafter to accommodate the necessary angular positioning of the adjacent panes of glass on the dome.

Each rafter **14** is provided with a rafter cap **30**, which is preferably an extruded aluminum body having a flat lower face **31** generally complemental to the upper faces of the ledges **22** and a central crown **32** to space the cap from ridge **28**.

An upper glazing strip **33** is positioned between the face of each side of cap **30** and the corresponding glass pane **24**. A suitable interlock is provided between the upper glazing strips **33** and cap **30**, and may comprise the beaded tongue **34** extending longitudinally on each strip **33** and disposed in the corresponding complemental groove **35** in the face of the cap.

The cap **30** is secured to the corresponding rafter **14** by suitable bolts **36** spaced longitudinally of the cap and which extend down through it and are threaded into the ridge **28**. For this purpose an upwardly facing groove **37** is provided in ridge **28** and has serrated side walls to simulate and receive the threaded bolts at any location along the rafter.

Referring to FIGS. 2 and 3, the openings 15 on the upper side of hub base 7 are sufficiently large to receive the conduit 18 and gutters 20 of the lower end of the corresponding rafters. For this purpose each rafter web 17 is cut away at the lower end of the rafter to provide a slot 38 to receive the upper inwardly flanged edge of base 7. The body member 19 extends inwardly over the top of base 7 and the conduit 18 extends into the base through the corresponding opening 15.

The openings 16 on the lower side of the hub base 7 are generally circular and receive the body of corresponding bolts 39 which are threaded into the conduits 18 of the upper ends of the corresponding rafters. For this purpose the conduit 18 and web 17 of the upper end of each rafter is cut away so that the body member 19 may extend inwardly over the top inwardly flanged edge of base 7.

The inner end 40 of each bolt 39 is spherical and bears universally against a compression collar 41 extending through opening 16 and having a flange engaging the outside of the base 7. A compression nut 42 is threaded onto the inner end of collar 41 and has an inward flange 43 confining the spherical end 40 of bolt 39 between it and the collar 41. Suitable sealing gaskets 44 and 45 are provided between flange 43 and spherical end 40 and between nut 42 and the inner wall of the base 7, respectively, to prevent leakage around the fastening.

The hub cover 8 for each hub is of dome-shape and is sealed upon the glass panes 24 by means of a circular hub gasket 46 of suitable glazing material. The cover 8 is held in place, clamping the glass 24 and rafters in position, by a connecting rod 47 threaded into a tapped opening in an upstanding boss 48 in the bottom of base 7, and a nut 49 threaded upon the upper end of the rod and received in a recess 50 in the cover so that the nut is flush with the cover on the outside.

When the nut 49 is tight the cover 8 clamps the glass 24 and rafters 14 tightly in place, and effects a seal across the top of the juncture between the panes of glass at the hub 5.

In order to complete the seal betwen two adjacent panes of glass as they enter beneath gasket 46, a cap end 51 is applied over the end of the rafter cap 30 and has a flat tongue 52 which extends under the gasket 46. One of the bolts 36 secures the cap end 51 in place.

In service the skylight is so constructed that expansion and contraction by temperature differences and wind pressures are provided for. Each rafter is secured only at one end and is free to expand or contract longitudinally as may be required. The rafters provide means to collect all condensate and to conduct it to the closed drainage system comprised of the hollow hubs 5 and the conduit members 18 of the rafters.

Various modes of carrying out the present invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter regarded as the nature of the invention.

I claim:

1. A dome skylight construction comprising a substantial number of skylight panes arranged in spaced edge-to-edge relation with adjacent panes disposed in angularly related planes, said panes being disposed in a predetermined pattern thus providing a plurality of spaced hub centers adjacent the corners of said panes, individual rafters disposed between the edges of adjacent panes, hub members at said hub centers and carrying the ends of said rafters, means securing at least one end of each rafter to a corresponding hub member, and means beneath and supporting individual hub members thereby supporting said dome skylight construction.

2. The construction of claim 1 and means separately and adjustably securing each hub member to said last named support means thereby supporting the skylight rigidly and substantially free of the necessary dimensional tolerance of the supporting structure.

3. The construction of claim 1 in which said hub members are hollow with adjacent hubs disposed at different heights and said rafters comprise in part hollow tubular conduit means for draining water from upper hubs to lower hubs and to discharge, and means on each rafter to collect condensate and discharge the same into the hubs.

4. The construction of claim 1 in which said rafter securing means is at the upper end of each rafter, and the lower end of each rafter extends freely into a corresponding hub, said rafters being individually free to expand and contract longitudinally with temperature changes.

5. The construction of claim 1 in which each hub member comprises a base portion and a cap portion and the skylight panes extend to between said portions, and means clamping and sealing said cap portion upon the top of the skylight panes.

6. The construction of claim 5 in which said clamping means comprises a stud bolt connecting said base portion and said cap portion centrally.

7. The construction of claim 3 in which each rafter is of extruded aluminum alloy and comprises a closed tubular base, a vertical web, pane supporting flanges at the upper edge of said web, and a cap for the rafter.

8. A skylight construction comprising a plurality of spaced substantially closed hollow hubs individually supported at spaced intervals and at different elevations, tubular rafters radiating from each hub and extending to adjacent hubs and communicating with the interior thereof, inclined gutter means carried by selected rafters, said gutter means communicating with the interior of the hubs at the lower ends of said gutter means, and skylight panes supported in spaced edge to edge relation upon said rafters above said gutter means, whereby condensation is drained from said panes into said gutters and from thence into said hollow hubs and then from said hubs through said tubular rafters and corresponding lower hubs and rafters to a point of discharge.

9. The construction of claim 8 and means securing each rafter to its uppermost hub in substantially sealed relation thereto to receive drainage water therefrom, the lower end of each said rafter extending freely into its corresponding lower hub to deliver drainage water thereto.

10. The construction of claim 9 and openings in said hubs to receive the corresponding ends of said rafters with a tolerance variation in angular adjustment for the rafters, said openings for the upper ends of the rafters receiving a sealed coupling having a tubular member threaded to the tubular portion of the rafter, and said openings for the lower ends of the rafters receiving both the tubular portion of the rafter and the gutter thereon.

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