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Radtke

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[54] **METHOD OF ASSEMBLING SKYLIGHT STRUCTURES**

[75] Inventor: **Carl Radtke,** Chicago, Ill.

[73] Assignee: **Paper Corporation,** Kankakee, Ill.

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[52] **U.S. Cl.** **52/741,** 52/474, 52/464, 52/669, 52/395

[51] **Int. Cl.** **A01g 9/14,** EO6b 3/54, EO4 3/28

[58] **Field of Search** 52/208, 209, 475–477, 52/459, 464, 741, 395, 669

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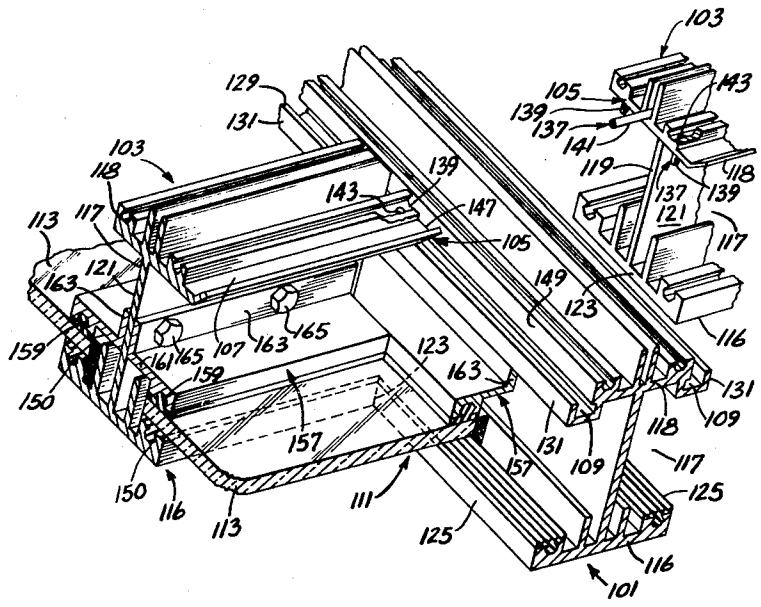
Primary Examiner—John E. Murtagh
Assistant Examiner—James L. Ridgill, Jr.
Attorney, Agent, or Firm—Fitch, Even, Tabin & Luedeka

[57] **ABSTRACT**

A skylight structure having a condensate removal system is constructed by lowering the purlins directly down onto upwardly facing portions of the rafters without having to spread the rafters to admit projecting end portions of the rafters. Also, the rafters and purlins may be joined with vertical and horizontally extending pins providing a hidden interconnection between the rafters and purlins rather than joining the purlins and rafters by exposed brackets and bolts. In the preferred skylight structure, the purlins and rafters are formed of closed tubular members having hidden condensate removal channels on the upper portions thereof with the condensate channels in the purlins extending into curbs resting in notches in the rafters and discharging condensate into underlying condensate collecting channels in the rafters.

5 Claims, 7 Drawing Figures



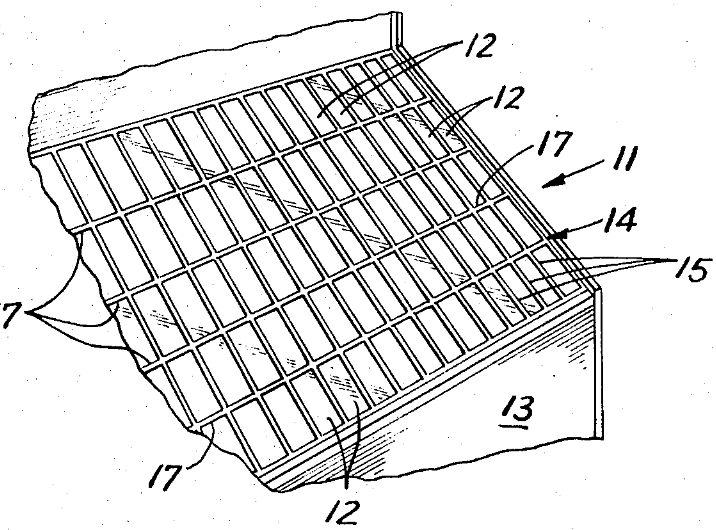

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FIG. 1

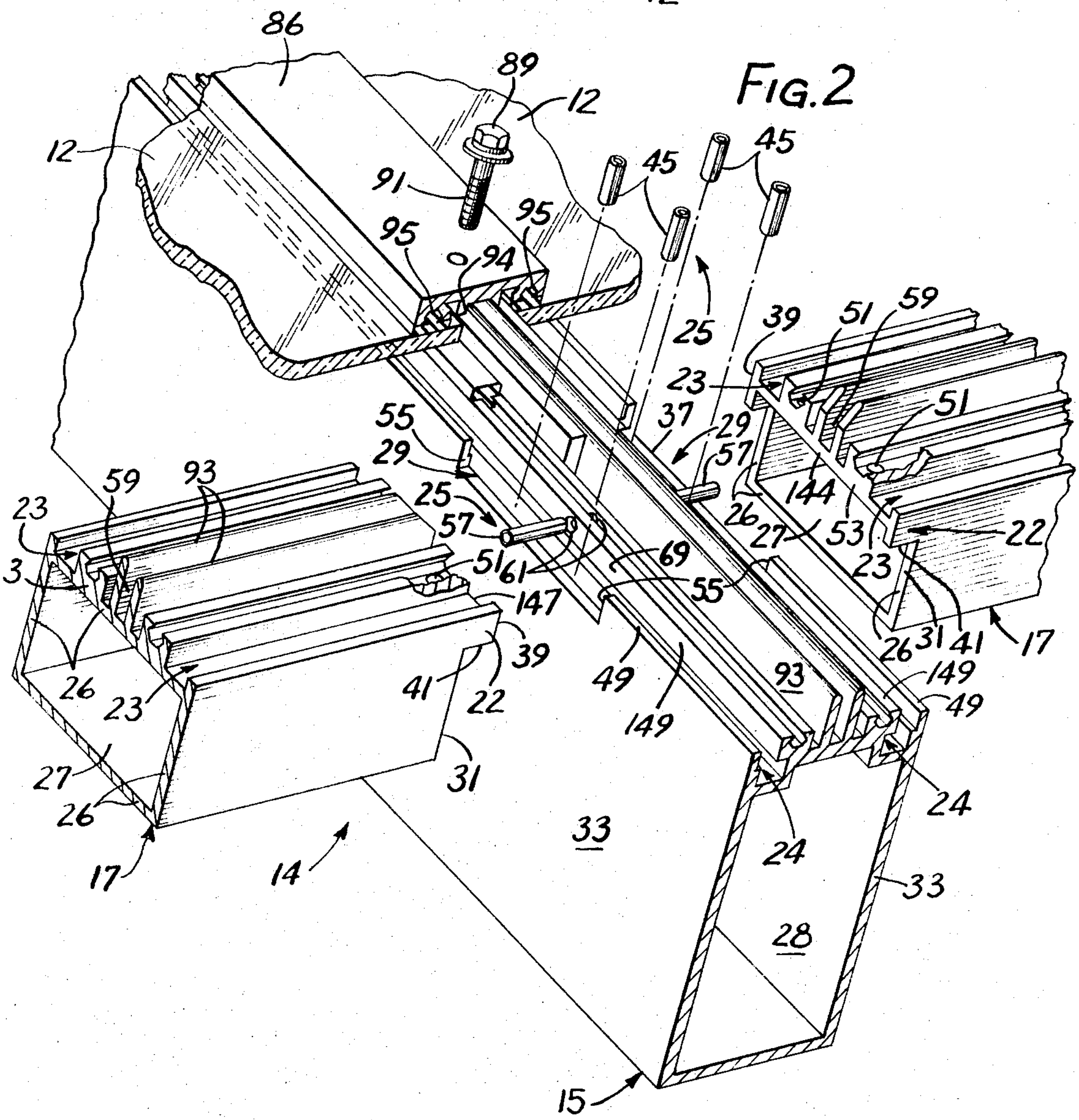
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FIG. 2

FIG. 3

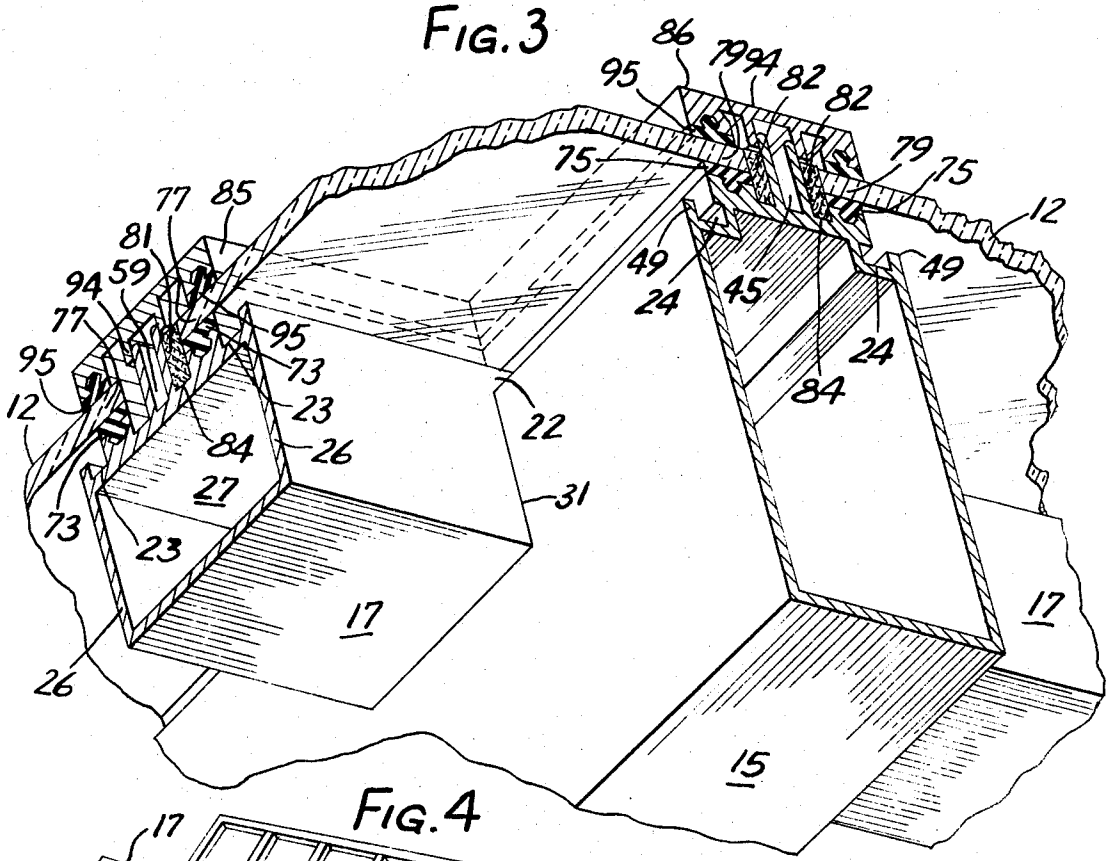

FIG. 4

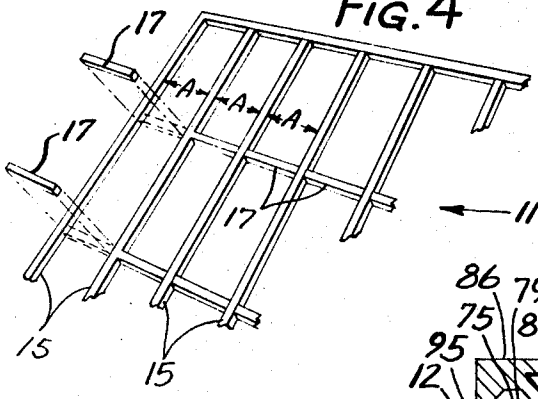

FIG. 5

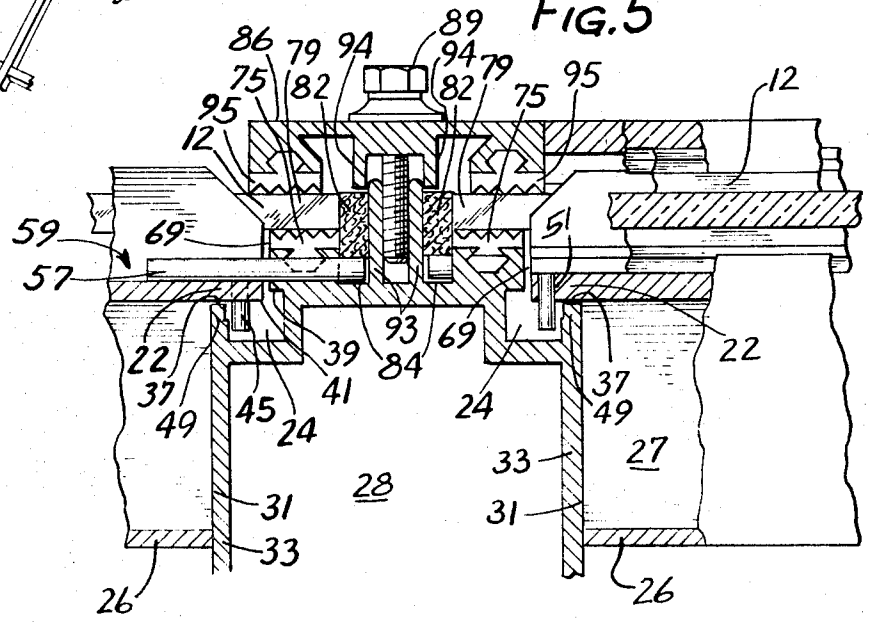

FIG. 6

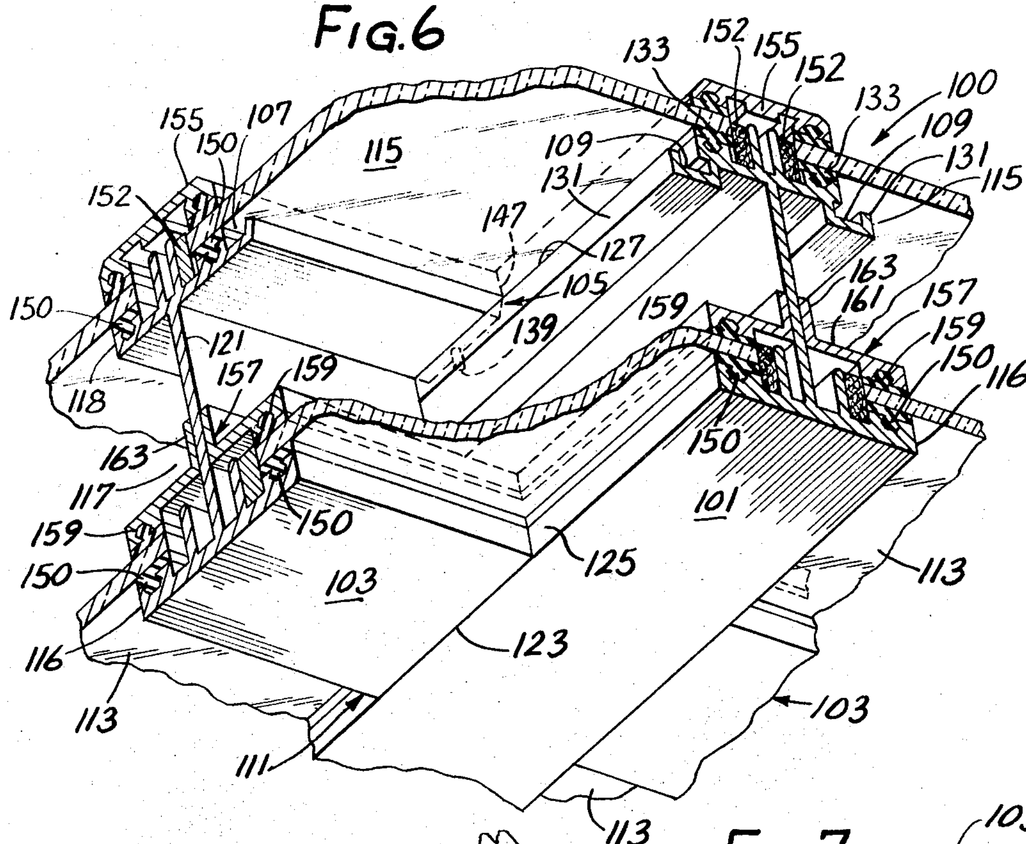
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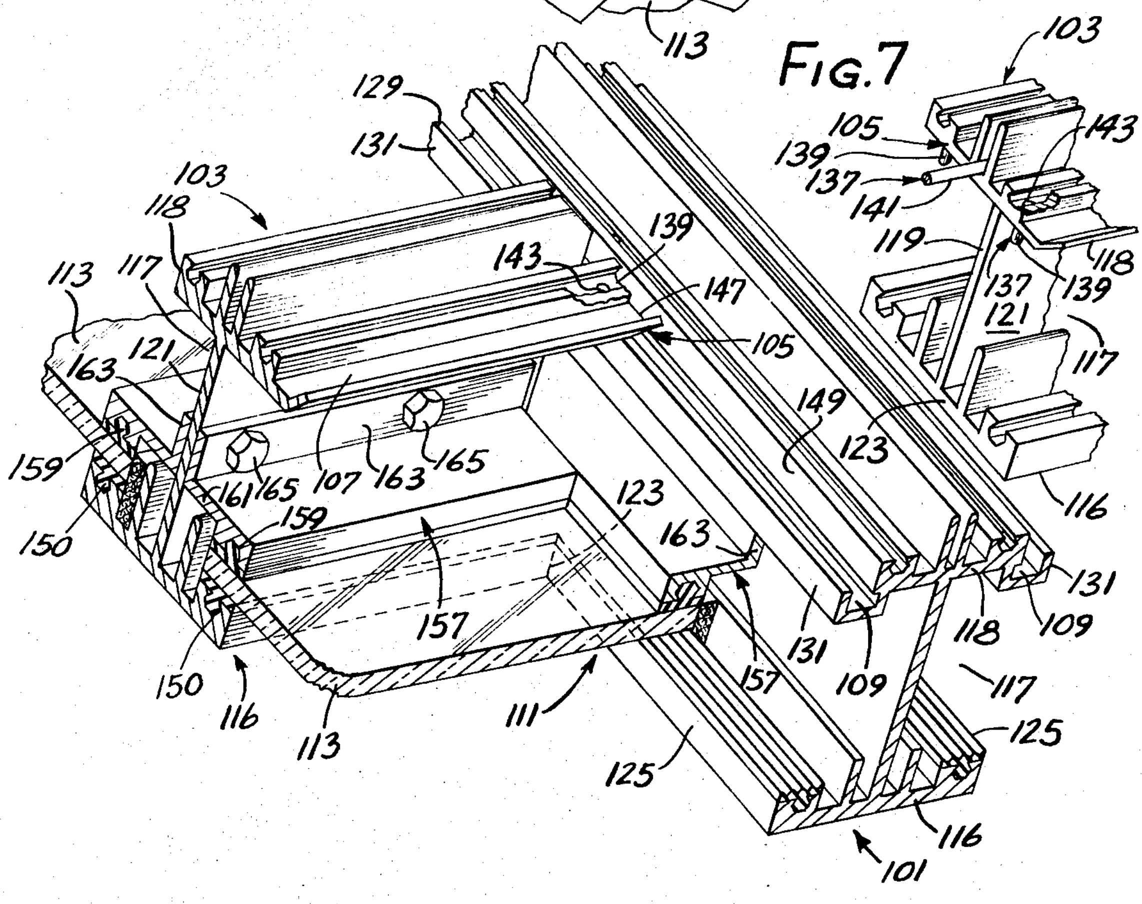
FIG. 7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METHOD OF ASSEMBLING SKYLIGHT STRUCTURES

This invention relates to a skylight structure having purlins and rafters joined into a framework supporting glazing panels of uninsulated glass, plastic, acrylic or the like.

Skylight structures of this general kind are assembled on site or adjacent the location of ultimate use such as in a shopping center, a building, a library, a swimming pool, etc. Such skylight structures are large and cover substantially surface areas with a series of purlins spanning each of a plurality of rows of rafters to form the grid or skeleton framework for supporting the marginal edges of the glazing panels laid upon the assembled grid. In some instances, the skylight structure is assembled on the ground or an adjacent roof and lifted into place by a crane. In other instances, the skylight structure is assembled in situ. In any event, rafters are first positioned and then the individual purlins are fastened to the supporting rafters by various brackets, e.g., angle-shaped brackets having the portions bolted to the respective rafters and purlins.

In many of these skylight structures, the ends of the purlins are formed with projections to fit into a central recess in the rafters and the end projections on the purlins are fastened to the central portions of the rafters. However, the total length of the purlin from one end projection to other end projection is greater than open span between the longitudinal top edges of the rafters thereby preventing the purlins from being lowered or dropped directly into position for bolting to the rafters. Particularly, when a series of purlins span each row of rafters, the rafters must be spread, that is, pivoted about one end to provide a sufficient opening therebetween to allow the ends of the purlins to be projected into the central portions of the rafters.

The spreading of the rafters to allow insertion of the projecting ends of the purlins into the rafter recesses is time consuming and hence costly. This is particularly true, if it necessitates, as in some cases, the erection of scaffolding beneath the purlins to support them while the rafters are being spread and returned prior to fastening the purlins to the rafters.

Additionally, as disclosed more fully in co-pending application entitled "Skylight Structure and Structural Members Therefor" of Hans F. Schultz and Carl Radtke, Ser. No. 265,164, filed June 22, 1972 the brackets, bolts and nut fasteners are aesthetically displeasing for some structures and hence are desired to be eliminated. Also, as explained in that co-pending application, a cleaner appearance may be achieved with closed tubular purlins and rafter structural members having a hidden condensate system in contrast to the prior art visible condensate channel flanges and exposed purlin receiving recesses in the rafters.

Accordingly, a general object of the present invention is to provide a new and improved method of assembling a skylight structure.

Another object is to provide a method of assembling a skylight structure having closed tubular purlins joined to closed tubular rafters.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings in which:

FIG. **1** is a fragmentary, diagrammatic elevational view of a skylight structure constructed in accordance with the method of the present invention;

FIG. **2** is a diagrammatic exploded view showing a preferred construction of purlins and rafters joined together with the method of the present invention;

FIG. **3** is a perspective view partially in section showing the rafters and purlins of FIG. **2** joined together;

FIG. **4** is a diagrammatic view showing the lowering of the purlins illustrated in FIGS. **1** and **2** into position on the rafters in accordance with the present invention.

FIG. **5** is a view showing the preferred manner of interlocking the purlin and rafters without the use of nuts and bolts;

FIG. **6** illustrates a double glazed structure assembled in accordance with the method of the present invention; and

FIG. **7** is a partially exploded view showing the double glazed structure of FIG. **6.**

As shown in the drawings for purposes of illustration, the invention is embodied, very generally, in a skylight structure **11,** which may take various shapes other than the rectangular, planar configuration shown in FIG. **1,** for installation in buildings or structures **13** in which a roof or portion of the roof is formed by the skylight structure. Typically, the skylight structure comprises an array of glazing panels **12** usually of a transparent, tinted or transluscent glass or of a plastic such as arcylic plastic mounted in a supporting grid or framework **14** comprised of rows of rafters **15** spanned by purlins **17.** More specifically, the glazing panels **12** are supported along a first pair of marginal edges thereof by the usually vertically extending rafters **15** and along a second pair of marginal edges by the crosswise extending purlins **17.**

In accordance with the present invention, the skylight structure **11** may be assembled in situ or in adjacent area for lifting into place by a crane without having to spread the rafters **15** to allow the lowering of series of purlins **17** into position, as is illustrated in FIG. **4,** there being four such purlins **17** between each pair of adjacent rafters **15** in the skylight structure illustrated herein. More specifically, the method of fabrication of the skylight structure **11** generally comprises the steps of: assembling a plurality of rafters in predetermined and fixed positions relative to one another at which positions the rafters will remain during the further assembly of the skylight structure, lowering the purlins directly down onto the positioned rafters at predetermined longitudinally spaced positions along each row of rafters to span adjacent pairs of the rafters, resting curbs **22** projecting from each end of the purlins onto upwardly facing portions of the rafters, interlocking each of the purlins with its supporting rafters with condensate channels **23** of the purlins being superposed with condensate channels **24** in the rafters to deliver condensate thereto, and securing glazing panels **12** to the purlin abd rafter gridwork **14.** Also, in accordance with another aspect of invention, the fastening of the purlins to the rafters may include the further step of positioning and driving of pin means **25** between portions of the purlins and portions of the rafters to interconnect the rafters and purlins. This latter manner of fastening eliminates the need for fixing angle brackets with nuts and bolts between the purlins and rafters as in the prior art methods. As will be explained in

greater detail hereinafter, the invention may be used with various other forms of purlins **17** and rafters **15** including, for example, non-tubular shaped purlins and rafters as will be described.

Referring now in greater detail to the rafters **15** and purlins **17** illustrated in FIGS. **2–5**, the purlins **17** are closed tubular members formed of a lightweight metal such as aluminum by an extrusion process with four side walls **26** joined together to enclose a hollow interior **27** for each purlin **17** and a hollow interior **28** for each rafter **15.** The extrusions are made in relatively long lengths and are severed and cut the desired length for a purlin or rafter. The curbs **22** are formed by saw cutting portions of purlins **17** to leave the illustrated projecting ends which will rest on a rafter surface **37** located, in this instance, in a notch **29** cut in the rafter. As best seen in FIG. **2**, the curb **22** projects outwardly from a vertical end wall **31** for the purlin which, when assembled to a rafter **15**, abuts a vertical sidewall **33** of the rafter. The curb **22** includes the top one of the four walls **26** of the purlin along with a short portion of the depending side walls **26.**

The purlins **17** are formed so that the distance between their respective end walls **31** thereof is substantially identical to the distance between walls **33** of a pair of adjacent rafters **15.** As the distance between ends **39** of the curbs **22** is greater than the distance between walls **33** of the adjacent pairs of rafters, the curbs **22** may project over and rest on the surfaces **37** of the rafters.

Recapitulating, and with reference to FIG. **4**, with the rafters **15** positioned in place at a fixed distance A therebetween which is equal to the distance between end walls **31** of a purlin **17**, the purlins **17** may be dropped straight downwardly with the walls **31** of the purlins traveling downwardly along the pair of facing vertical rafter walls **33** until an underside **41** of the curb **22** abuts the horizontal supporting surfaces **37** in the notches **29** in the rafters. In this manner, the purlins **17** may be lowered into position without having to spread the rafters, that is, to pivot the end of one of the pair of rafters to accommodate the purlins as with prior art skylight structures.

Also, in accordance with another aspect of the invention, the purlins **17** may be fastened and interconnected to the rafters **15** with hidden pin means **25** rather than the exposed nuts, bolts and angle brackets as is common in prior art methods of construction. For this purpose, the purlins **17** carry a pair of downwardly projecting roll pins **45** which have lower free ends projecting beneath the curb **22** for insertion into the rafter condensate channels **24**, as best seen in FIG. **5**, when the curb **22** rests on the surfaces **37** of the rafters **15.** As best seen in FIG. **5**, the lower ends of the roll pins **45** extend downwardly along and will abut an upstanding rafter channel wall **49** should the purlin **17** tend to move laterally and try to separate from the rafter. Preferably, the roll pins **45** are split longitudinally and experience a slight compression and decrease in diameter when driven into vertically extending holes **51** in a thickened portion **53** in the top wall **26** of the purlin **17.** The pins **45** are thus flexed, i.e., tensioned, into engagement with the walls of the holes **51** and are thereby held against dropping through the holes **51.** While the pins are preferably inserted into the holes **51** prior to placing the purlin **17** into position on the rafters **15**, the pins **45** may be driven into the holes **51** after the purlin is lowered onto the supporting rafters.

Although the purlins **17** are generally located at the desired spacings along the rafters **15** when their curbs **22** are inserted into the notches **29** in the rafter and their movement longitudinally of the rafter is generally limited by vertical sidewalls **55** of the notches, the pin means **25** more precisely locates and holds the purlins against shifting on the rafters and from lifting therefrom due to uplift forces caused by a wind. To this end, the pin means **25** further comprises pins **57** which extend generally horizontally between the rafters and purlins with one end of each pin positioned in a channel **59** in the purlin and an opposite end within an aperture **61** in the rafter **15.** The horizontally disposed pins **57** are also split longitudinally to have a tight fit at its receiving aperture **61.** Whereas the vertically disposed pins **45** are preferably located in apertures **51** prior to lowering the purlin **17** onto the rafter, the horizontally extending pins **57** are installed after the purlins are placed on the rafters. The pins **57** are placed adjacent the bottom of and at opposite ends of the channels **59** in the purlin **17** and then moved along the channel **59** and inserted at one end thereof into an aperture **61.** The pins **57** are usually tapped into the apertures **61** which may be drilled into the rafters either at the site of erection or prior to shipping to the erecting site.

With the purlin curbs **22** positioned on the rafters **15**, condensate collected in the purlin condensate channels **23** will flow and drop into the underlying rafter condensate channels **24** along paths designated by the directional arrows shown in FIG. **5.** The curb end **39** extends adjacent to but is spaced from an upstanding wall **69** on the rafter **15** to allow the water to flow across the end of the purlin curb and to drop through the space and into the underlying rafter condensate channel **24.** This space is assured by dimensioning the distance between the curb end **39** and the vertical end wall **31** of the purlin **17** to be less than the distance between the exterior surface of the rafter sidewall **33** and the upstanding glazing channel wall **69.**

With the framework **14** assembled, the glazing panels **12** may then be placed on the framework and secured in place. The glazing panels **12** are lowered onto longitudinally extending glazing strips **73** (FIG. **3**) carried by the purlins **17** and the longitudinally extending glazing strips **75** carried by the rafters **15**, the glazing strips **73** and **75** being in a common plane. That is, a pair of marginal edges **77** for each of the glazing panels **12** rest on the purlin glazing strips **73** and the other pair of marginal edges **79** for each of the glazing panels **12** rest on the glazing strips **75.**

Preferably, each of the glazing strips **73** and **75** are formed of an elastomeric resilient material such as neoprene to resiliently support the glazing panels. As best seen in FIG. **5**, the preferred glazing strips **73** and **75** have lower dovetailed portions fitted into dovetailed shaped grooves in similarly shaped channels on the top walls of the purlins and rafters. The upper edges of the glazing strips are sawtoothed and flattened slightly by exterior clamping bars or caps to provide moisture-proof and airproof seals with the marginal edges of the glazing panels **12.**

The end edges of the glazing panels **12** may be cushioned, particularly on the downhill side of the glazing panels **12** by glazing blocks **81** and **82** carried in channels **84** formed in the top walls in the rafters **15** and

purlins **17.** The glazing blocks **81** and **82** are formed of resilient material such as neoprene. The channels **84** in the purlins also serve to collect any moisture by passing the glazing strips and to deliver this moisture to the condensate channels **24** in the rafters **15.** In the rafters **15,** the channels **84** also serve to collect by-pass water, but they deliver the water to the lower ends of the rafters for collection in a suitable gutter or discharge system (not shown).

After positioning the glazing panels **12** on the respective glazing strips **73** and **75,** the glazing panels may be secured to the purlin and rafter framework **14** by means of glazing caps **85** and **86** which are clamped against the outer marginal edges of the glazing panels **12** by suitable screw fasteners **89.** In this instance, the screw fasteners **89** are in the form of self-tapping screws having an exterior head and a shank with a screw thread **91** which is centered between and screwed into the pair of upstanding channel defining walls **93** integral with the top walls for the purlins and rafters. The walls **93** define therebetween the channel **59** into which the roll pins **57** were inserted. On the underside of the glazing caps are formed depending, longitudinally extending flanges **94** which straddle the upstanding screw receiving walls **93** of the purlins and rafters to center the caps on the purlins and rafters. This aligns the resilient glazing strips **95** on the undersides of glazing caps over the glazing strips **73** and **75** supporting the marginal edges of the glazing panels **12.** By tightening the self-tapping screws **89,** the glazing caps **85** and **86** apply clamping forces through their glazing strips to panels **12** and also serve to clamp the purlins **17,** the latter being held against lifting from the notches **29** in the rafters **15** by the pins **57.**

Thus, it will be seen that skylight structure has been assembled without the use of a scaffolding under the purlins or a spreading of the rafters to admit the purlins.

In accordance with the invention, a double glazed structure **100,** as best seen in FIGS. **6** and **7,** may be assembled with the method steps of: assembling a plurality of rafters **101** in predetermined and fixed positions relative to one another at which positions the rafters will remain during further assembly of the skylight structure, lowering purlins **103** directly down onto the positioned rafters at predetermined and longitudinally spaced positions along each row of rafters to span adjacent pairs of the rafters, resting curbs **105** projecting from each end of the purlins onto upwardly facing portions of the rafters, interlocking each of the purlins to its supporting rafters to form a framework **111** with condensate channels **107** of the purlins being superposed with condensate channels **109** in the rafters to deliver condensate thereto, and securing a first set of glazing panels **115** to the framework **111** and securing a second set of glazing panels **113** to the framework **111.**

Referring now in greater detail to the illustrated elements of double glazed skylight structure **100,** the lower set of glazing panels **113** are secured to lower sections **116** of generally I-shaped purlins **103** and rafters **101** while separated via air space **117** from the upper set of glazing panels **115** carried by upper sections **118** of the rafters **101** and purlins **103.**

The rafters **101** and purlins **103** are formed of aluminum extrusions which are generally severed to size. The upper ends of the purlins **103** are each cut to leave projecting curbs **105** projecting outwardly from an end **119** of a central web **121** extending between the upper and lower sections of the purlin. The curb **105** also projects outwardly of an end wall **123** for the lower sections of the purlin. When the lower end **123** of the purlin abuts a longitudinally extending side wall **125** of the rafter, the curb **105** will extend over and be resting on an upper edge **129** of an upstanding wall **131** forming the other side of the condensate channel **109** for the rafter **101.** In this instance, the purlin supporting surface **129** is sufficiently beneath the plane of glazing panel supporting strips **133** on the rafter **101,** as best seen in FIG. **6,** that there is no need to cut a notch similar to the notch **29** used in the above-described embodiment of the invention as illustrated in FIGS. **1–5** to receive the curb.

The preferred manner of interconnecting the purlins **103** to the rafters **101** is by a hidden pin means **137** which includes a pair of downwardly extending pins **139** and a horizontally extending pin **141** at each end of the purlin **103.** More specifically, the pins **139** are fastened at upper ends within vertically extending holes **143** drilled within the top wall of the purlin leaving the lower free ends thereof projecting downwardly and into the rafter condensate channels **109.** The pins **139** will abut the upstanding condensate channel walls **131** on the rafters should the purlins move laterally outwardly from their supporting purlins.

To assure the flow of condensate from the purlin condensate channels **107** into rafter condensate channels **109,** the ends **147** of the curbs **105** are spaced from an upstanding wall **149** on the rafter **101** to allow condensate to drop in the manner described above in connection with FIGS. **1–5.** In this instance, the rafter **101** is provided with two condensate channels **109** whereas the purlins **103** are provided with only one condensate channel **107.**

Each of the purlins **103** and rafters **101** has an upper and lower pair of glazing strips **150** formed of neoprene to support the marginal edges of the respective glazing panels **113** and **115** in the manner hereinbefore described. Likewise, glazing blocks **152** may be provided in channels formed in the respective rafters and purlins to cushion the marginal edges of the glazing panels abutting these glazing blocks.

Preferably, the upper set of glazing panels **115** are secured to the purlin and rafter framework **111** as by clamping with glazing caps **155** similar to the glazing caps **85** and **86** previously described. However, the lower set of glazing panels **113** are clamped by brackets **157** to the lower rafter and purlin sections **116** and on their supporting glazing strips **150** by means of clamping brackets **157.** The latter have a downwardly facing glazing strip **159** for alignment with and for clamping the marginal edges of the glazing panels **113** to the underlying glazing strips **150** on lower sections of the purlins and rafters. The clamping brackets **157** also include a central web **161** which extends to an upstanding flange **163** fastened by nuts and bolts **165** to the upstanding webs for the respective purlins and rafters.

In assembly of the double glazed structure, the lower glazing panels **113** are secured to the framework **111** prior to placing the upper panels **115** into position and securing them in place with the glazing caps **155.** Thus, the double glazed skylight structure may be assembled without spreading the rafters or using an underlying

scaffolding to support the purlins during spreading of the rafters.

From the foregoing, it will be seen that the present invention provides a method of constructing skylights with lowering purlins directly into supporting positions on the rafters without having to spread the rafters or to provide an underlying scaffolding to support the purlins while the rafters are being spread. Also, in accordance with the preferred embodiment of the invention, the rafters and purlins are interconnected with hidden pins rather than the use of angle brackets and nuts and bolts as in the prior arts. Also, in the illustrated constructions, the curbs on the purlins have condensate channels therein to deliver condensate to underlying condensate channels in the rafters in a hidden condensate system.

While a preferred embodiment has been shown and described, it will be understood that there is no intent to limit the invention by such disclosure but, rather, it is intended to cover all modifications and alternate constructions falling within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A method of assembling a skylight structure having purlins with integral condensate channels thereon joined to rafters having integral condensate channels thereon, said rafter having notches therein in a framework supporting glazing panels and providing a condensate removal system, said purlins having projecting ends thereon, said method comprising the steps of: assembling a plurality of rafters in predetermined and fixed positions relative to one another with said notches facing upwardly and at distances to be spanned within said projecting ends at which positions the rafters will remain during and after further assembling of the skylight structure, lowering the purlins directly down onto upwardly facing notches of said rafters at predetermined longitudinally spaced positions along each pair of adjacent rafters to span the same with glazing supporting portions of said purlins facing upwardly, resting curbs projecting from each end of the purlins onto upwardly facing notches of the rafters with said upwardly facing glazing supporting portions aligned to support a glazing panel and simultaneously forming said condensate drainage system with the ends said integral condensate channels in said purlins being superimposed over the integral condensate channels in said rafters to form said condensate removal system without adding additional separate condensate gutters therebetween, interlocking each of the purlins to its supporting rafters with condensate channels in the purlins extending into said projections and superposed over condensate channels in the rafters for discharging condensate to the latter, lowering glazing panels onto said upwardly facing portions of said rafters and purlins, and securing glazing panels in said purlin and rafter framework to fabricate said skylight structure having a condensate removal system.

2. A method of assembling a skylight structure having closed tubular purlins with integral condensate channels on the upper portions thereof joined to rafters with integral condensate channels on the upper portions thereof and having notches therein in a framework supporting glazing panels and providing a condensate removal system, said purlins having projecting end portions thereon, said method comprising the steps of: assembling at least three rafters in predetermined and fixed parallel positions relative to one another each with said notches facing upwardly and at distances to be spanned by said projecting ends with inner ones of said rafters having pairs of opposed pairs of notches for supporting ends of pairs of purlins adjacent each other and at which positions the rafters will remain during and after further assembling of the skylight structure, lowering onto a first pair of said rafters a series of purlins spaced longitudinally of the rafters without spreading the first rafter pair with the projecting end portions of each of the purlins of the series directly down into said upwardly facing notches of said rafters at predetermined longitudinally spaced positions along said first pair of rafters to span the same with glazing supporting portions of said purlins facing upwardly, resting said end portions projecting from each end of the purlins onto upwardly facing notches of the rafters with said upwardly facing glazing supporting portions aligned to support a glazing panel and simultaneously superimposing the integral condensate channels in said end portions of said purlins over the integral condensate channels in said rafters without spreading said rafters thereby forming said condensate removal system, without spreading an adjacent third rafter and without spreading an adjacent rafter which was one of said first pair of rafters lowering a series of purlins into the notches of this common center rafter and said third rafter with said purlins in each series being aligned, interlocking each of the purlins to its supporting rafters with condensate channels in the purlins extending into said ends thereof and superposed over condensate channels in the rafters for discharging condensate to the latter by pins extending horizontally and vertically between the ends of the purlins and into portions of the rafters to interlock the purlins and rafters with hidden pins, lowering glazing panels onto said upwardly facing portions of said rafters and purlins, and securing glazing panels in said purlin and rafter framework to fabricate said skylight structure having a condensate removal system.

3. A method in accordance with claim **2** in which the step of securing said glazing panels to said framework comprises laying a lower set of glazing panels in position on said framework and securing them to said framework and laying an upper set of glazing panels at positions on said framework spaced above said lower glazing panels and securing said upper glazing panels to said framework.

4. A method in accordance with claim **2** in which the step of resting the purlin curbs on the rafters comprises the further steps of: depositing the purlin curbs on a vertically extending outer wall of a condensate channel and spacing the terminal portions of said condensate channel in said curbs from said rafters and over said rafter condensate channels to allow the condensate to flow from the terminal ends of the purlin condensate channels and to drop into the underlying condensate channels.

5. A method in accordance with claim **4** in which said interlocking of said purlins and rafters comprises the steps of inserting depending pins on said curbs into said rafter condensate channels and inserting an horizontally extending pin between adjacent portions of said purlins and said rafters.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,844,086 Dated October 29, 1974

Inventor(s) Carl Radtke

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Cover page, change the name of the Assignee from "Paper Corporation" to --Roper Corporation.

Signed and sealed this 29th day of April 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

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