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Attorneys for Plaintiff

UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA

T&M INVENTIONS, LLC, Plaintiff, v. R&S MANUFACTURING AND SALES COMPANY, INC., Defendant.	Case No. 2:20-cv-11317 **COMPLAINT FOR PATENT INFRINGEMENT** JURY TRIAL DEMANDED

Plaintiff, T&M Inventions, LLC ("T&M"), files this Complaint for Patent Infringement against Defendant, R&S Manufacturing and Sales Company, Inc. ("R&S"), and alleges as follows:

NATURE OF THIS ACTION

1. This is a civil action alleging patent infringement, in violation of 35 U.S.C. § 271(a).

2. T&M alleges that R&S has infringed and continues to infringe at least three patents: U.S. Patent Nos. 8,438,798 (the '798 Patent"); 8,438,799 (the "'799 Patent"); and 8,438,801 (the "'801 Patent"). Copies of these patents (collectively, the "Patents-in-Suit") are attached to this Complaint as **Exhibits A-C**.

3. R&S infringes the Patents-in-Suit by making, using, offering to sell, and/or selling in the United States products, described more fully in this Complaint below, that practice the inventions claimed in the Patents-in-Suit. R&S directs and controls each relevant aspect of the accused products discussed herein and benefits from the use of each feature that infringes the Patents-in-Suit.

4. T&M seeks permanent injunctive relief, damages, and other relief for R&S's infringement of the Patents-in-Suit.

PARTIES

5. T&M is a limited liability company organized under the laws of the State of Wisconsin with its principal place of business located at 3717 Rivercrest Road, McFarland, Wisconsin 53558.

6. Upon information and belief, Defendant, R&S, is a corporation organized under the laws of the State of California with its principal place of business located at 3575 Old Conejo Road, Newbury Park, California 91320.

JURISDICTION AND VENUE

7. Because this is an action for infringement under the patent laws of the United States, 35 U.S.C. § 271 et seq., this Court has subject matter jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a).

8. This Court has personal jurisdiction over the Defendant because, on information and belief, Defendant is incorporated in the State of California and resides in, regularly transacts business in, and has continuous and systematic

contacts in the State of California. On information and belief, R&S has committed acts of infringement within this district by making, using, selling, and/or offering for sale in the United States products that infringe one or more claims of the Patents-in-Suit.

9. Venue is proper in the Central District of California under 28 U.S.C. §§ 1391(b) and (c) and 1400(b) because, on information and belief, Defendant resides in this district. Further, venue is proper because R&S has committed acts of infringement in the Central District of California and has a regular and established place of business in Newbury Park, which lies within the Central District.

FACTUAL BACKGROUND

10. Timothy Pendley and Michael McLain founded T&M Inventions in July of 2010.

11. By that time, both Mr. Pendley and Mr. McLain had worked more than 30 years in the metal building industry. Each had extensive experience with all aspects and components of metal buildings, including without limitation roofing systems, and support and insulation components for rooftop features such as skylights.

12. On May 14, 2013, U.S. Patent No. 8,438,798 (the "'798 Patent"), entitled "Roof Penetrating Closure Structures and Systems," was duly and legally issued by the United States Patent & Trademark Office, from Application Serial No. 12/932,892, which was filed on March 8, 2011. A true and correct copy of the '798 Patent is attached to this Complaint as **Exhibit A** and incorporated as though fully set forth herein.

13. T&M is the owner by assignment of the '798 Patent and possesses all rights to enforce the '798 Patent.

14. The '798 Patent is directed to, inter alia, a curbless construction system for installing two or more adjacent environment-accessing closure structures, including skylights, onto the major rib elevation of a building's metal roof panel

system.

15. On May 14, 2013, U.S. Patent No. 8,438,799 (the "'799 Patent"), entitled "Support Structures on Roofs," was duly and legally issued by the United States Patent & Trademark Office, from Application Serial No. 13/065,033, which was filed on March 10, 2011. A true and correct copy of the '799 Patent is attached hereto as **Exhibit B** and incorporated as though fully set forth herein.

16. T&M is the owner by assignment of the '799 Patent and possesses all rights to enforce the '799 Patent.

17. The '799 Patent is directed to, inter alia, products and methods to provide a load support structure, optionally a rail and closure structure for use in installing various exterior roof loads, as well as structures that close off apertures in metal roofs.

18. On May 14, 2013, U.S. Patent No. 8,438,801 (the "'801 Patent"), entitled "Support Structures on Roofs," was duly and legally issued by the United States Patent & Trademark Office, from Application Serial No. 13/066,457, which was filed on April 14, 2011. A true and correct copy of the '801 Patent is attached hereto as **Exhibit C**.

19. T&M is the owner by assignment of the '801 Patent and possesses all rights to enforce the '801 Patent.

20. The '801 Patent claims, inter alia, a curbless construction system for installing roof load supports such as roof closure structures, optionally skylights and/or smoke vents, optionally including two or more such roof closure structures in end-to-end relationship, onto the major rib elevations of a building's metal roof panel system.

R&S'S INFRINGING CONDUCT

21. At some point before August 1, 2013, Defendant R&S introduced into the marketplace a product named the "Standing Seam 24 Light," which R&S also referred to as the "SS24 Skylight System" (the "SS24").

22. By letter dated August 1, 2013 (the "2013 Notice"), counsel for T&M notified R&S that T&M owned the Patents-in-Suit and alleged that the SS24 "infringe[d] at least one claim of each of the Patents." A true and correct copy of the 2013 Notice is attached hereto as **Exhibit D**.

23. By letter dated August 9, 2013, (the "2013 Response"), Mr. W. Richard Lippeatt, then-President of R&S, confirmed that R&S received the 2013 Notice. A true and correct copy of the 2013 Response is attached hereto as **Exhibit E**.

24. In the 2013 Response, Mr. Lippeatt stated that R&S had not sold any of the accused product mentioned in the 2013 Notice since May 14, 2013, the issue date for each of the Patents-in-Suit.

25. Also in the 2013 Response, Mr. Lippeatt stated that R&S possessed "no inventory that is unique to" the accused product mentioned in the 2013 Notice.

26. At some point after August 1, 2013, Defendant R&S introduced into the marketplace a product named the RS24 Prismatic Skylight (the "RS24"). Marketing materials for the RS24 include the following image, which appears on the website of R&S at https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-CAP-WAP-v0131.18.pdf :

ACTUAL NOTICE OF INFRINGEMENT

27. Defendant R&S is now making, using, selling, or offering for sale the RS24 (the "Accused Product") in the United States.

28. The 2013 Notice provided R&S with actual notice that the SS24 infringed at least one claim of each of the Patents-in-Suit.

29. The Accused Product is similar to the SS24 in many ways, including the way it supports loads using rails shaped to match the profile of a raised rib on a standing seam roof.

30. Thus, R&S has had actual notice, since at least August 1, 2013, of the Patents-in-Suit and T&M's allegations that the SS24 and any related products, including the RS24, infringed those patents.

COUNT I

INFRINGEMENT OF THE '798 PATENT

31. T&M realleges and incorporates by reference the allegations of paragraphs 1-30 set forth above.

32. Claim 1 of the '798 Patent reads as follows:

> A roof adaptive system configured to be installed about an aperture in a sloping metal roof, such metal roof comprising a plurality of roof panels having lengths and widths, said roof panels being arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof, thereby to define elevated ribs, and panel flats being disposed between such ribs, said roof adaptive system comprising a rail and closure structure having a length, and being configured to be supported by adjacent ones of the elevated ribs and to extend about such aperture and to span the panel flat portion of a single such roof panel, which panel flat is between adjacent ones of such ribs, said rail and closure structure comprising:
>
> (a) first and second rails, having lengths, and being configured to be mounted to respective first and second ones of such adjacent ribs on

opposing sides of such single panel flat;

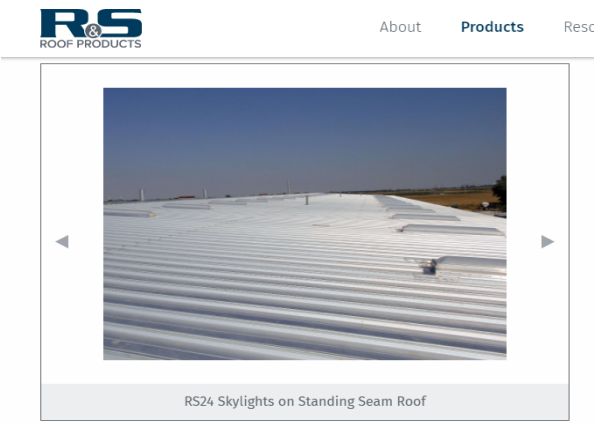
(b) an upper diverter configured to extend from said first rail to said second rail across an upper end of such aperture; and

(c) a lower closure configured to extend from said first rail to said second rail across a lower end of such aperture.

33. Without permission or authorization from Plaintiff, and in violation of 35 U.S.C. § 271(a), R&S infringes the '798 Patent by making, using, offering to sell, and/or selling in the United States the Accused Product, which uses and practices the inventions claimed in the '798 Patent.

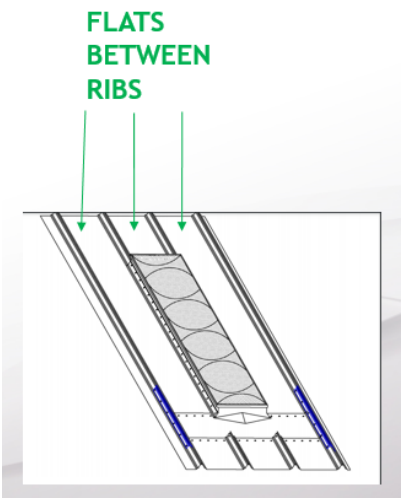
34. R&S infringes at least independent claim 1 of the '798 Patent at least in the exemplary manner described below.

35. As R&S depicts on its website, the Accused Product is a roof adaptive system configured to be installed about an aperture in a sloping metal roof:



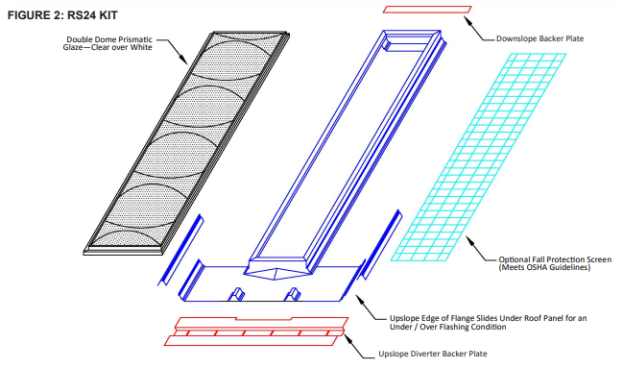
Source: https://www.rsroofproducts.com/metal-building-roof-products/metal-building-skylights-fall-protection/rs24-rs32-metal-building-skylight/

36. The intended metal roof for which R&S designed the Accused Product is a metal roof comprising a plurality of roof panels having lengths and widths, said roof panels being arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof, thereby to define elevated ribs, and panel flats being disposed between such ribs:



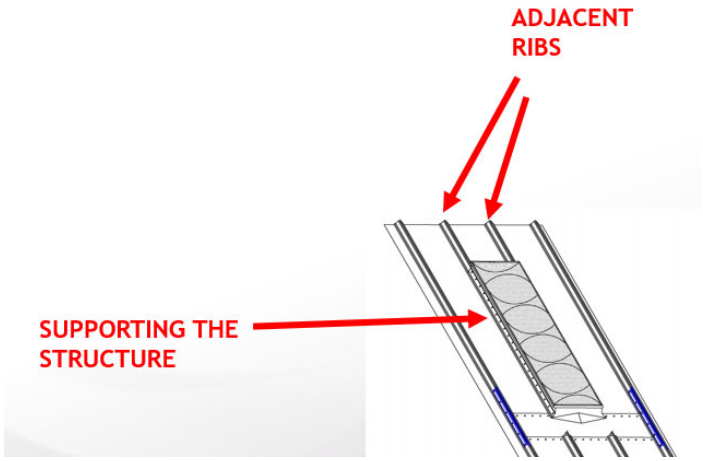
Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf (identifying annotations added).

37. As shown on the R&S website, the Accused Product features a rail and closure structure having a length, and being configured to be supported by adjacent ones of the elevated ribs and to extend about such aperture:

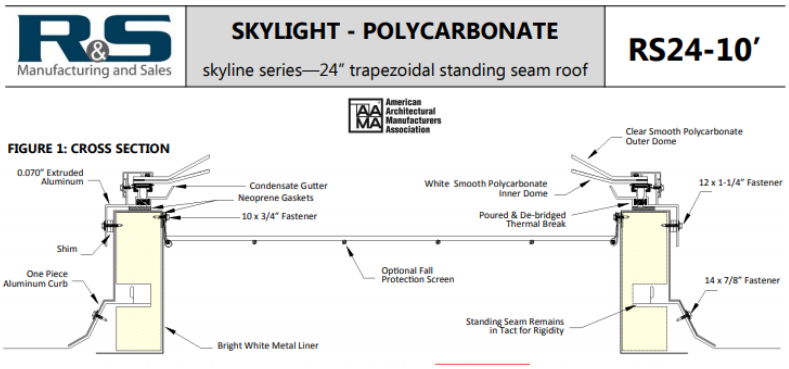


Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-CAP-WAP-v0131.18.pdf

38. Also as shown on the R&S website, the Accused Product is designed to span the panel flat portion of a single such roof panel, which panel flat is between adjacent ones of such ribs, said rail and closure structure:

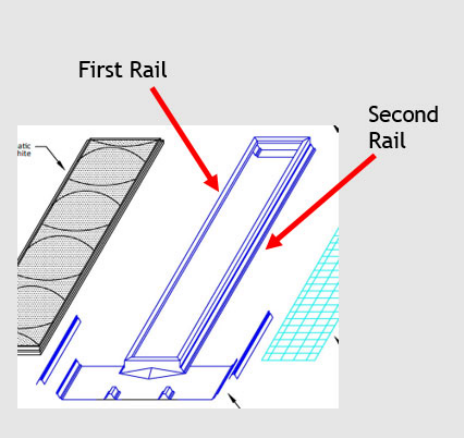


Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf (identifying annotations added); and



Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf

39. Marketing and installation materials available on the R&S website reveal that the Accused Product features first and second rails, having lengths, and being configured to be mounted to (in R&S's words, to "nest with") respective first and second ones of such adjacent ribs on opposing sides of such single panel flat:

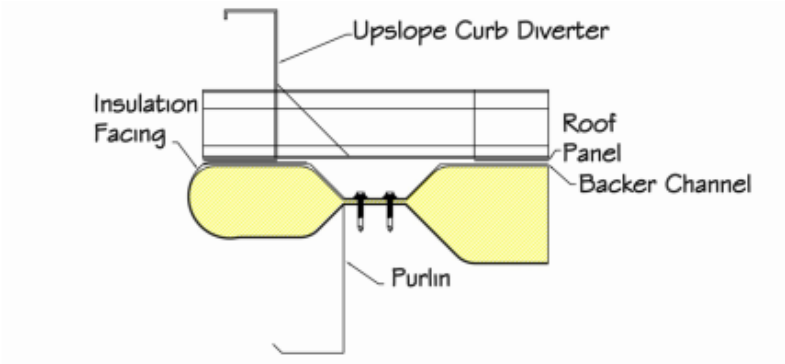


Source: Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf (identifying annotations added); and

3 **RS24 BASE**—0.080" aluminum with full penetration welds for complete weather-tightness. Side flanges nest with the roof panel profile for a seamless integration with any 24" O.C. Standing Seam roof application.

Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-CAP-WAP-v0131.18.pdf

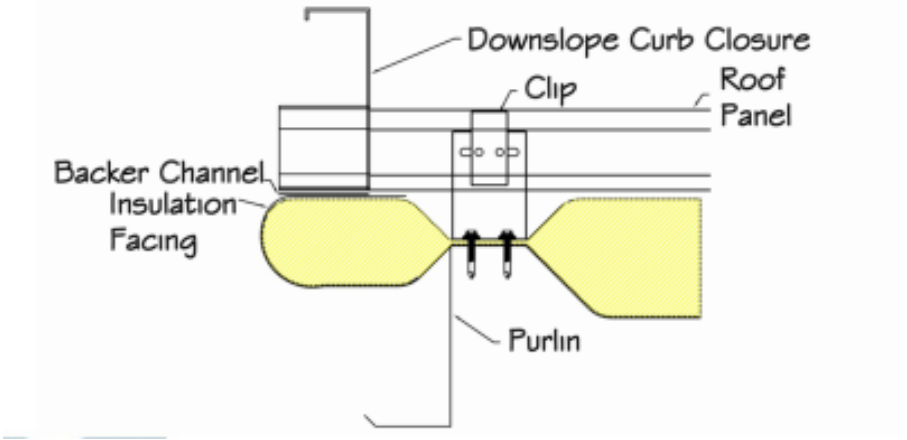
40. The R&S website also reveals that the Accused Product features an upper diverter configured to extend from said first rail to said second rail across an upper end of such aperture:



Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-

10-SINGLE-INSTALL.pdf

41. The R&S website also reveals that the Accused Product features a lower closure (in R&S's words, a "downslope curb") configured to extend from said first rail to said second rail across a lower end of such aperture:



Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf

42. R&S's infringement of the '798 Patent is knowing, willful, and deliberate.

43. As a direct and proximate result of R&S's conduct, T&M has suffered and will continue to suffer substantial injury and damages in an amount to be determined at trial, as well as irreparable harm for which T&M has no adequate remedy at law unless R&S is enjoined from infringing the '798 Patent.

COUNT II

INFRINGEMENT OF THE '799 PATENT

44. T&M realleges and incorporates by reference the allegations of paragraphs 1-43 set forth above.

45. Claim 1 of the '799 Patent reads as follows:

A roof adaptive system configured to be installed about an aperture in a metal roof, such metal roof comprising a plurality of roof panels, having

lengths and widths, such roof panels being arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof thereby to define elevated roof panel ribs, panel flats being disposed between such roof panel ribs, a given such roof panel rib comprising a rib shoulder, and a standing seam extending up from such shoulder, said roof adaptive system comprising a load support structure having a length, and being configured to be supported by first and second ones of the elevated roof panel ribs and to extend about such aperture and across a such panel flat, from rib to rib, between said first and second ribs, said load support structure comprising:

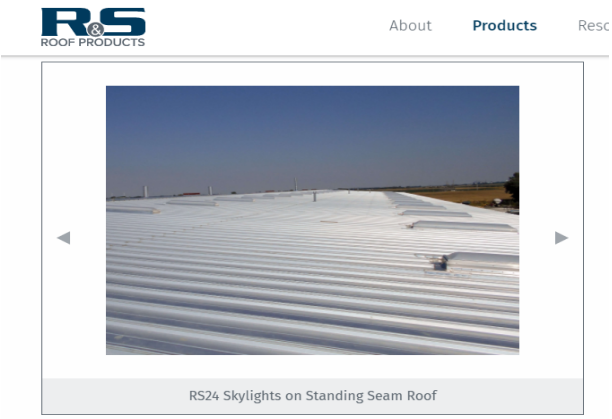
(a) first and second rails, having lengths, and being configured to be mounted to first and second ones of such roof panel ribs at such rib shoulders, and to extend upwardly from such rib shoulders alongside and above such standing seams, thus to define opposing sides of said load support structure; and

(b) end elements configured to extend between adjacent ends of said first and second rails, thus to define ends of said load support structure.

46. Without permission or authorization from Plaintiff, and in violation of 35 U.S.C. § 271(a), R&S infringes the ’799 Patent by making, using, offering to sell, and/or selling in the United States the Accused Product, which uses and practices the inventions claimed in the ’799 Patent.

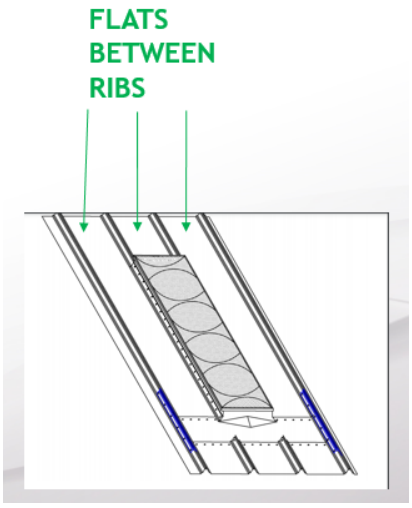
47. R&S infringes at least independent claim 1 of the ’799 Patent at least in the exemplary manner described below.

48. As R&S depicts on its website, the Accused Product is a roof adaptive system configured to be installed about an aperture in a metal roof:

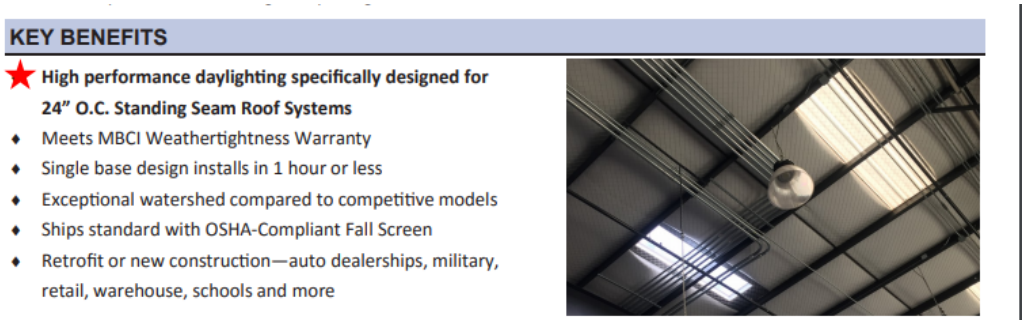


Source: https://www.rsroofproducts.com/metal-building-roof-products/metal-building-skylights-fall-protection/rs24-rs32-metal-building-skylight/

49. The intended metal roof for which R&S "specifically" designed the Accused Product is a metal roof comprising a plurality of roof panels, having lengths and widths, such roof panels being arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof thereby to define elevated roof panel ribs, with panel flats being disposed between such roof panel ribs:

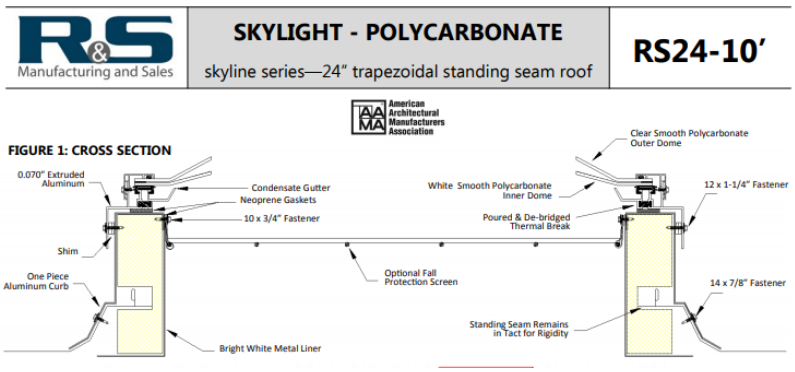


Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf (identifying annotations added); and



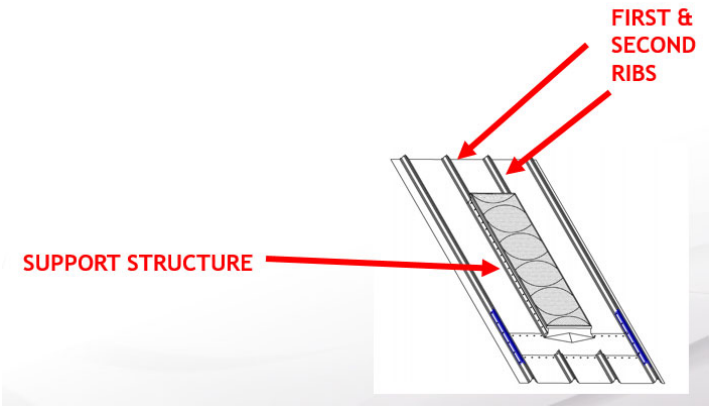
Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-CAP-WAP-v0131.18.pdf

50. Certain of R&S's marketing and installation materials available on R&S's website show a cross-section of the way the Accused Product mounts to a standing seam metal roof, and they illustrate roof panel ribs comprising a rib shoulder, and a standing seam extending up from such shoulder:



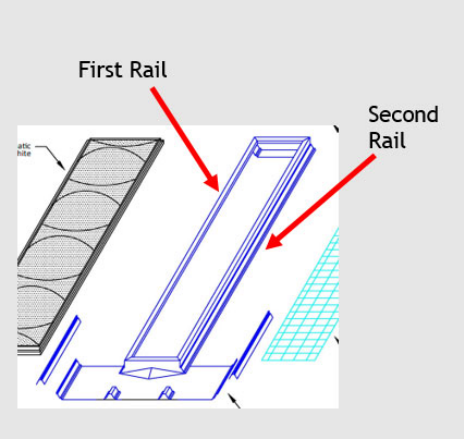
Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf

51. The Accused Product features a load support structure having a length, and being configured to be supported by first and second ones of the elevated roof panel ribs and to extend about an aperture and across a panel flat, from rib to rib, between a first and second rib:

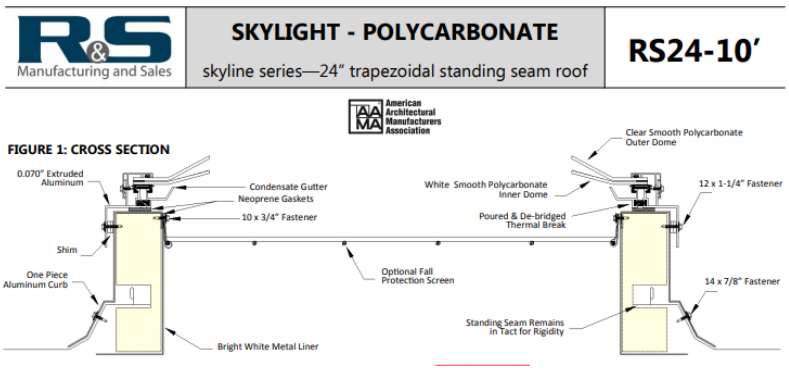


Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf (identifying annotations added)

52. The load support structure of the Accused Product has first and second rails, each having lengths, and being configured to be mounted to first and second ones of the roof panel ribs at the rib shoulders, and to extend upwardly from such rib shoulders alongside and above the standing seams, thus to define opposing sides of said load support structure:

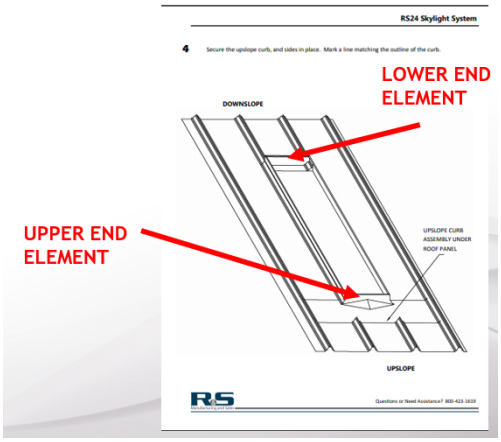


Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf (identifying annotations added); and



Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf

53. The load structure of the Accused Product also has end elements configured to extend between adjacent ends of said first and second rails, thus to define ends of said load support structure:



Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf

54. Defendant's infringement of the '799 Patent is willful and deliberate.

55. As a direct and proximate result of R&S's conduct, T&M has suffered and will continue to suffer substantial injury and damages in an amount to be determined at trial, as well as irreparable harm for which T&M has no adequate remedy at law unless R&S is enjoined from infringing the '799 Patent.

COUNT III

INFRINGEMENT OF THE '801 PATENT

56. T&M realleges and incorporates by reference the allegations of paragraphs 1-55 set forth above.

57. Independent Claim 15 of the '801 Patent reads as follows:

A closure support structure defining an upstanding enclosing wall extending about a perimeter of an aperture, wherein such aperture extends through a roof of a building, such enclosing wall extending up from such roof and closing off access to such aperture from any side of such aperture, said closure support structure comprising a plurality of closure members, having lengths, and being mounted on such roof and about such aperture, said closure members collectively providing said enclosing wall, said enclosure members comprising

(a) a first elongate side rail,

(b) a second elongate side rail,

(c) an upper diverter,

(d) a lower closure,

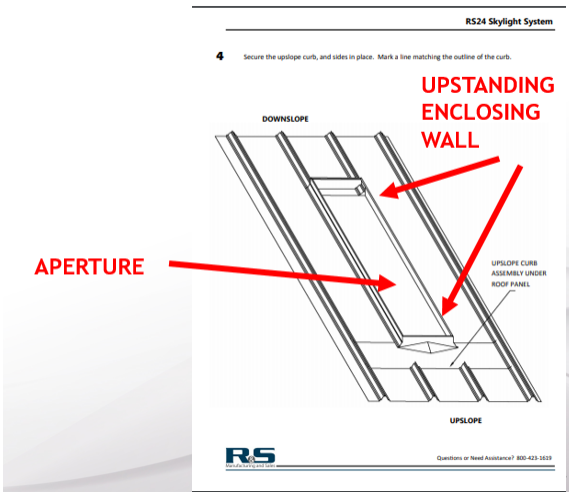
such roof of such building comprising a plurality of elongate metal roof panels which collectively define a plurality of elongate upstanding ribs extending between a ridge and eave of such building, each such roof panel having opposing sides, each such side of each panel defining a rib elevation, the rib elevations of adjacent such roof panels being joined together to form first and second ribs, and a single panel flat extending from the first rib to the second rib, full lengths of said first and second side rails being mounted on the adjacent ribs on opposing sides of such single panel flat.

58. Without permission or authorization from Plaintiff, and in violation of 35 U.S.C. § 271(a), R&S infringes the '801 Patent by making, using, offering to sell, and/or selling in the United States the Accused Product, which uses and

practices the inventions claimed in the ’801 Patent.

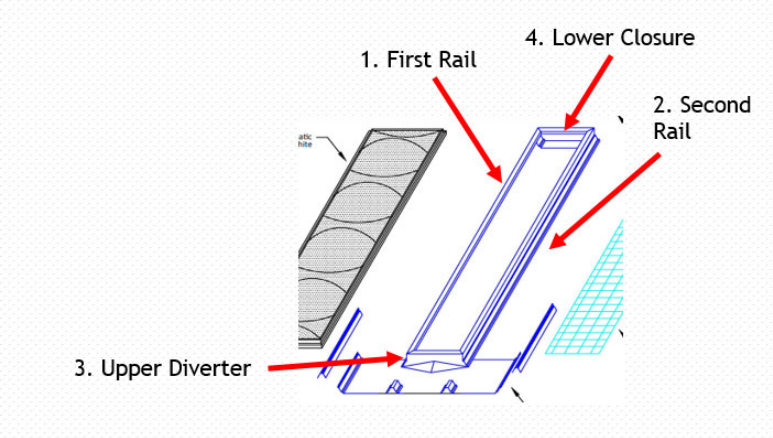
59. R&S infringes at least independent claim 15 of the ’801 Patent at least in the exemplary manner described below.

60. The Accused Product is a closure support structure defining an upstanding enclosing wall extending about a perimeter of an aperture extending through a roof of a building, and the enclosing wall extends up from such roof and closes off access to such aperture from any side of such aperture:



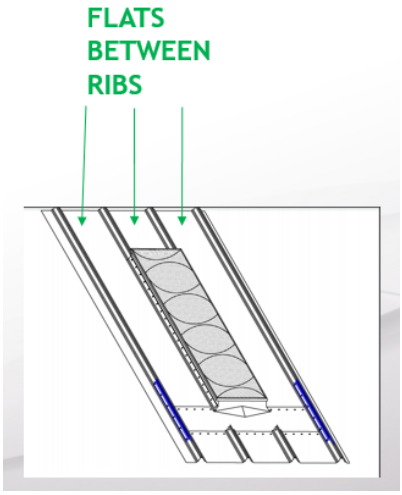
Source: : https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf

61. The closure support structure of the Accused Product has four members: 1) a first elongate side rail; 2) a second elongate side rail; 3) an upper diverter; and 4) a lower closure:

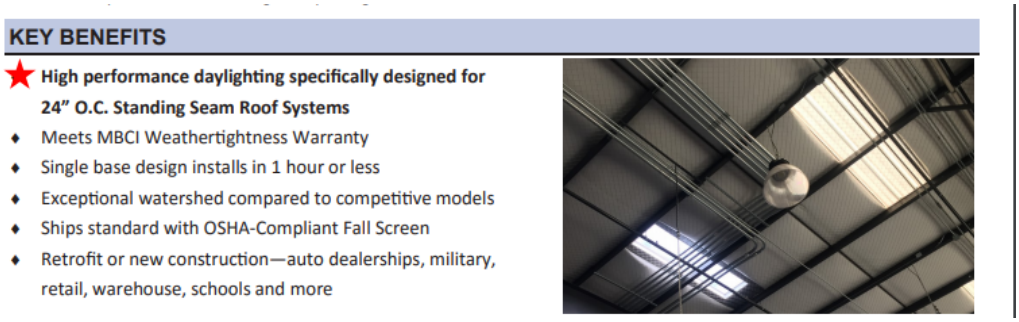


Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf (identifying annotations added).

62. R&S "specifically designed" the Accused Product for standing seam roofs on metal buildings. Such roofs of such building are made of a plurality of elongate metal roof panels which collectively define a plurality of elongate upstanding ribs extending between a ridge and eave of such building, each such roof panel having opposing sides, each such side of each panel defining a rib elevation, the rib elevations of adjacent such roof panels being joined together to form first and second ribs, and a panel flats extending between ribs:

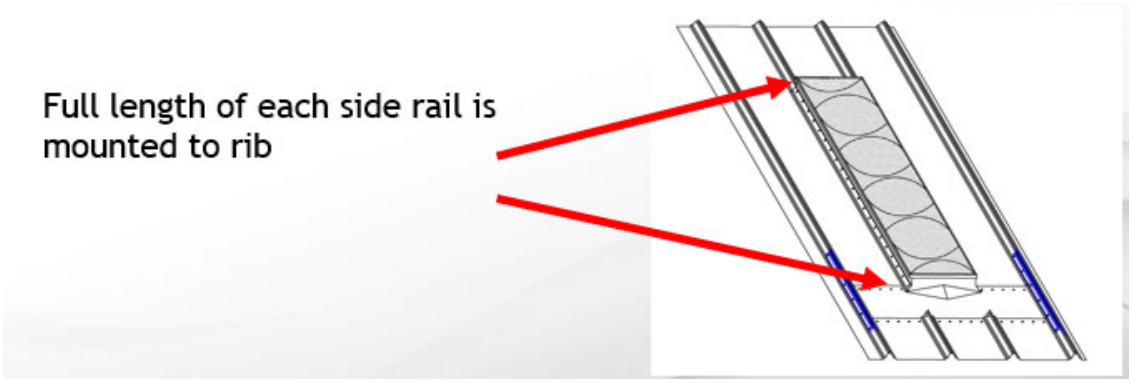


Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf (identifying annotations added); and



Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-CAP-WAP-v0131.18.pdf .

63. In the Accused Device, the full lengths of the first and second side rails are mounted on the adjacent ribs on opposing sides of a single panel flat:



Source: https://www.rsroofproducts.com/wp-content/uploads/2018/04/RS24-10-SINGLE-INSTALL.pdf (identifying annotations added).

64. Defendant's infringement of the '801 Patent is willful and deliberate.

65. As a direct and proximate result of R&S's conduct, T&M has suffered and will continue to suffer substantial injury and damages in an amount to be determined at trial, as well as irreparable harm for which T&M has no adequate remedy at law unless R&S is enjoined from infringing the '801 Patent.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff prays for the following relief:

(a) A judgment in Plaintiff's favor that Defendant has infringed

each of the Patents-in-Suit;

(b) A preliminary and permanent injunction enjoining Defendant and its agents, officers, directors, employees, and all persons in privity or active concert or participation with them, directly or indirectly, from selling or offering for sale the RS24 Skyline Metal Building Skylight product or otherwise infringing the Patents-in-Suit;

(c) A judgment and award that Defendant account for and pay to Plaintiff damages adequate to compensate for its infringement of the Patents-in-Suit in an amount to be proven at trial, but in any event no less than a reasonable royalty;

(d) A judgment and award of any supplemental damages sustained by Plaintiff for continuing post-verdict infringement of the Patents-in-Suit until entry of final judgment;

(e) A judgment that Defendant's infringement of the Patents-in-Suit is willful;

(f) An award of treble damages due to the willful and deliberate nature of Defendant's infringement;

(g) An order finding this case to be exceptional under 35 U.S.C. § 285 and awarding Plaintiff its costs, expenses, and disbursements incurred in this action, including reasonable attorney fees, as permitted by law;

(h) An award of prejudgment interest, post-judgment interests, and costs; and

(i) Such other and further relief as this Court deems just and proper.

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JURY DEMAND

Plaintiff demands a trial by jury on all issues so triable pursuant to Federal Rule of Civil Procedure 38(b).

Dated: December 14, 2020

HOPKINS & CARLEY
A Law Corporation

By: */s/ John V. Picone III*
John V. Picone III
Christopher A. Hohn
Attorneys for Plaintiff
T&M INVENTIONS, LLC

EXHIBIT A

US008438798B2

(12) **United States Patent**
McLain et al.

(10) **Patent No.: US 8,438,798 B2**
(45) **Date of Patent: May 14, 2013**

(54) **ROOF PENETRATING CLOSURE STRUCTURES AND SYSTEMS**

(75) Inventors: **Michael J. McLain**, Green Bay, WI (US); **Timothy Pendley**, Madera, CA (US)

(73) Assignee: **T&M Inventions, LLC**, Green Bay, WI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 102 days.

(21) Appl. No.: **12/932,892**

(22) Filed: **Mar. 8, 2011**

(65) **Prior Publication Data**

US 2011/0252726 A1 Oct. 20, 2011

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/572,176, filed on Oct. 1, 2009, now abandoned.

(60) Provisional application No. 61/102,333, filed on Oct. 2, 2008.

(51) **Int. Cl.**

E04B 7/18	(2006.01)
E04B 7/02	(2006.01)
E04B 7/04	(2006.01)
E06B 3/26	(2006.01)

(52) **U.S. Cl.**
USPC **52/200**; 52/90.2; 52/91.1; 52/202

(58) **Field of Classification Search** 52/200, 52/18, 72, 80.1, 90.1, 90.2, 91.1, 202, 19, 52/536, 537, 545
See application file for complete search history.

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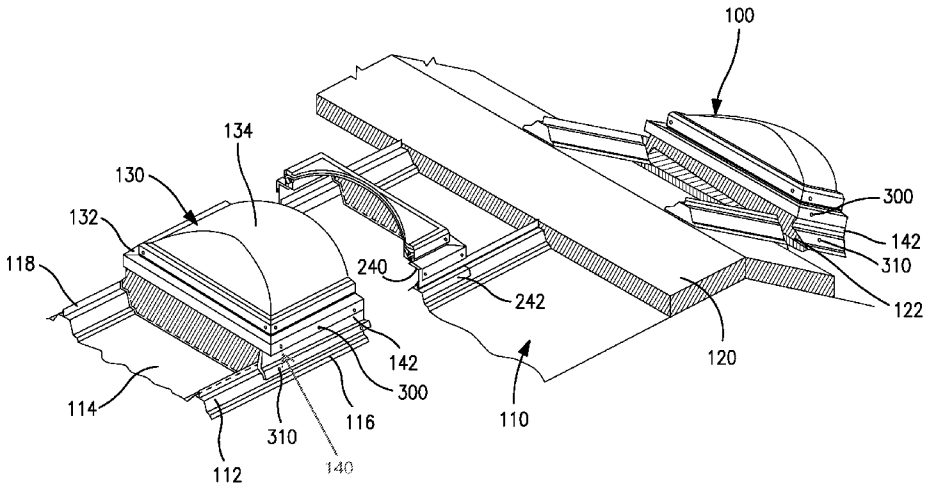
Primary Examiner — Andrew Triggs
(74) *Attorney, Agent, or Firm* — Thomas D. Wilhelm; Wilhelm Law, S.C.

(57) **ABSTRACT**

The invention provides an environment-accessing structure for providing environmental access to the interior of a building through an aperture in the roof. The environment-accessing structure can provide natural day-lighting by use of a skylight lens as the closure member, or a smoke vent which can be opened and closed. Such smoke vent can be transparent or translucent to natural sunlight, or can be opaque. Such environment-accessing structure is installed in an aperture in a metal roof. The system limits opportunity for water leakage from the outside environment. The environment-accessing structure includes a rail and closure structure adapted to be supported by adjacent rib elevations of adjacent roof panels, a closure panel adapted to be supported on the rail and closure structure, and a diverter which seals a cut away portion of the rib structure and diverts water laterally away from the rail and closure structure.

45 Claims, 13 Drawing Sheets



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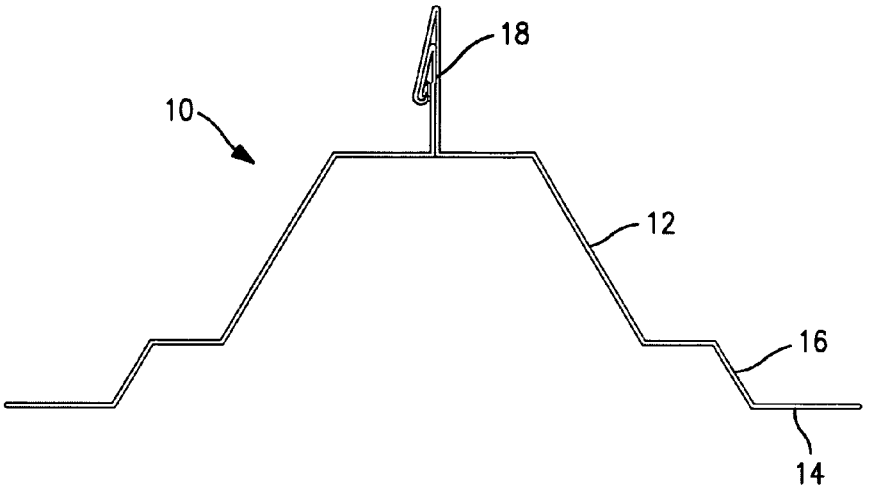


FIG. 1

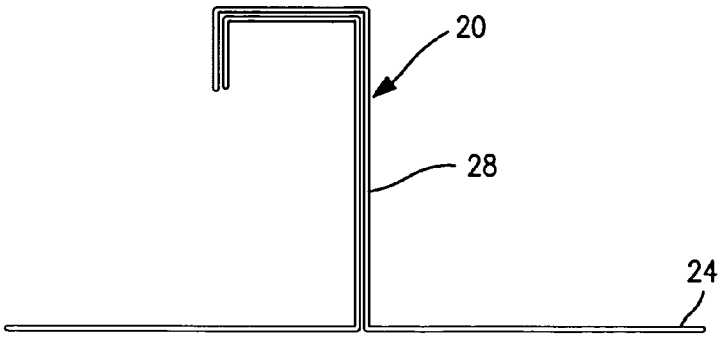
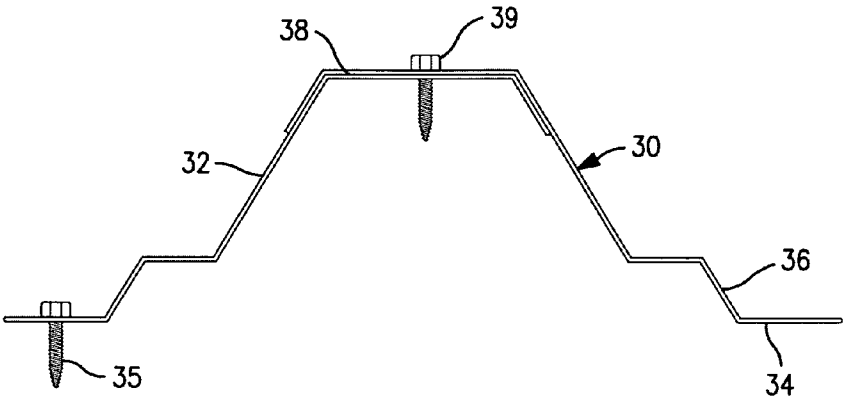


FIG. 2



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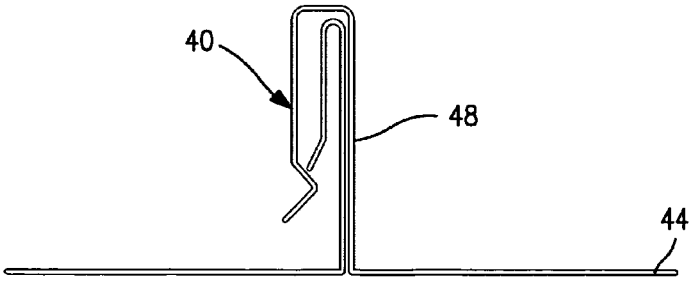

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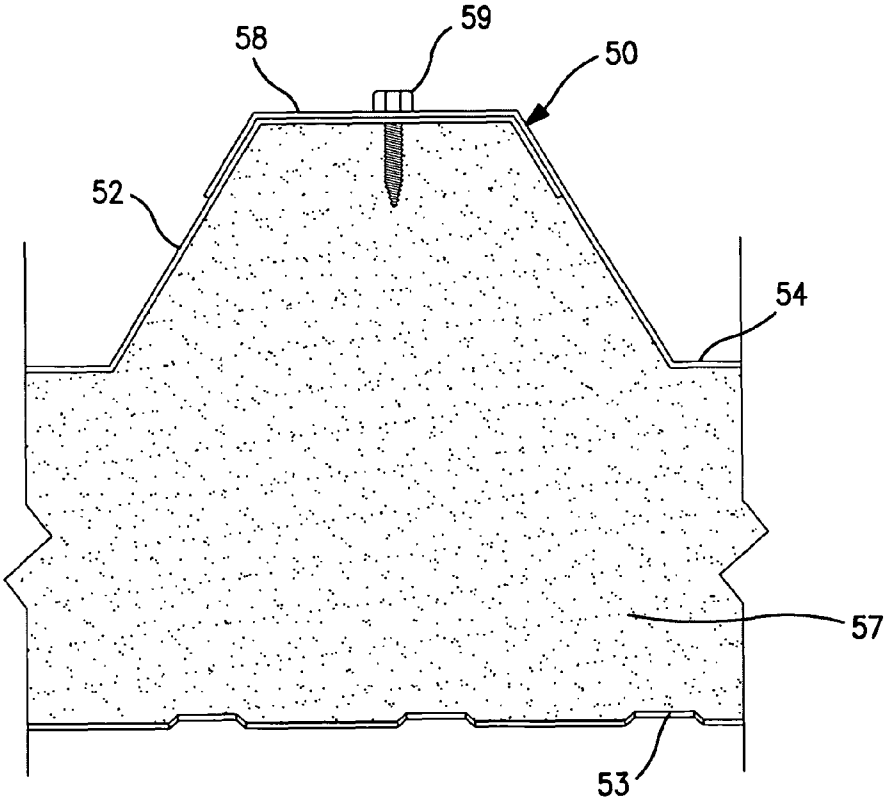

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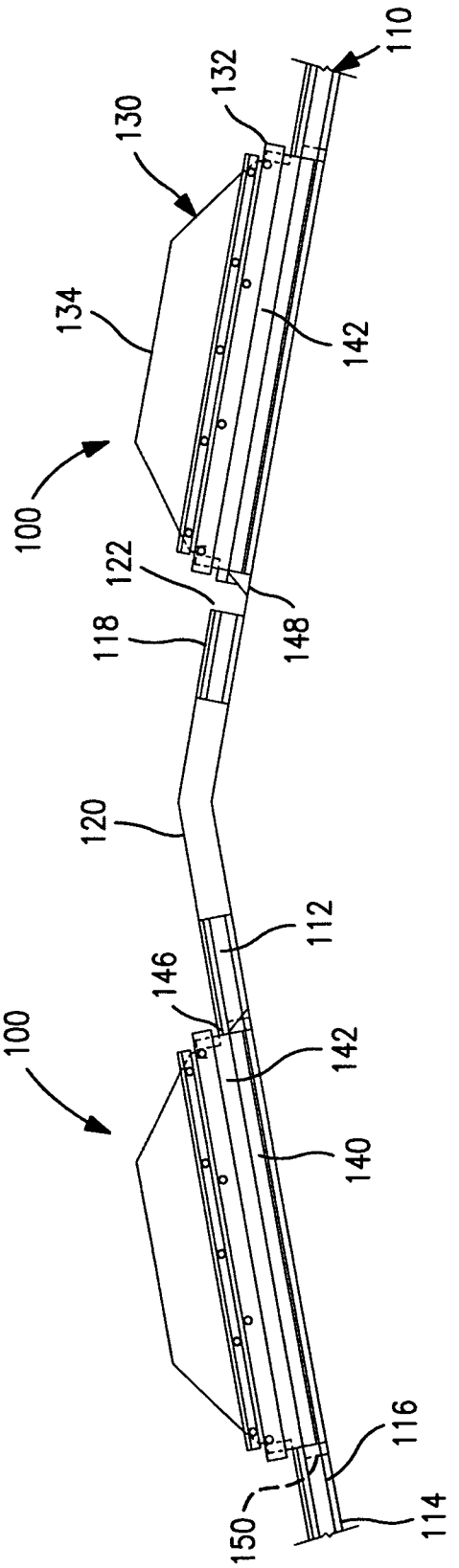
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FIG. 6

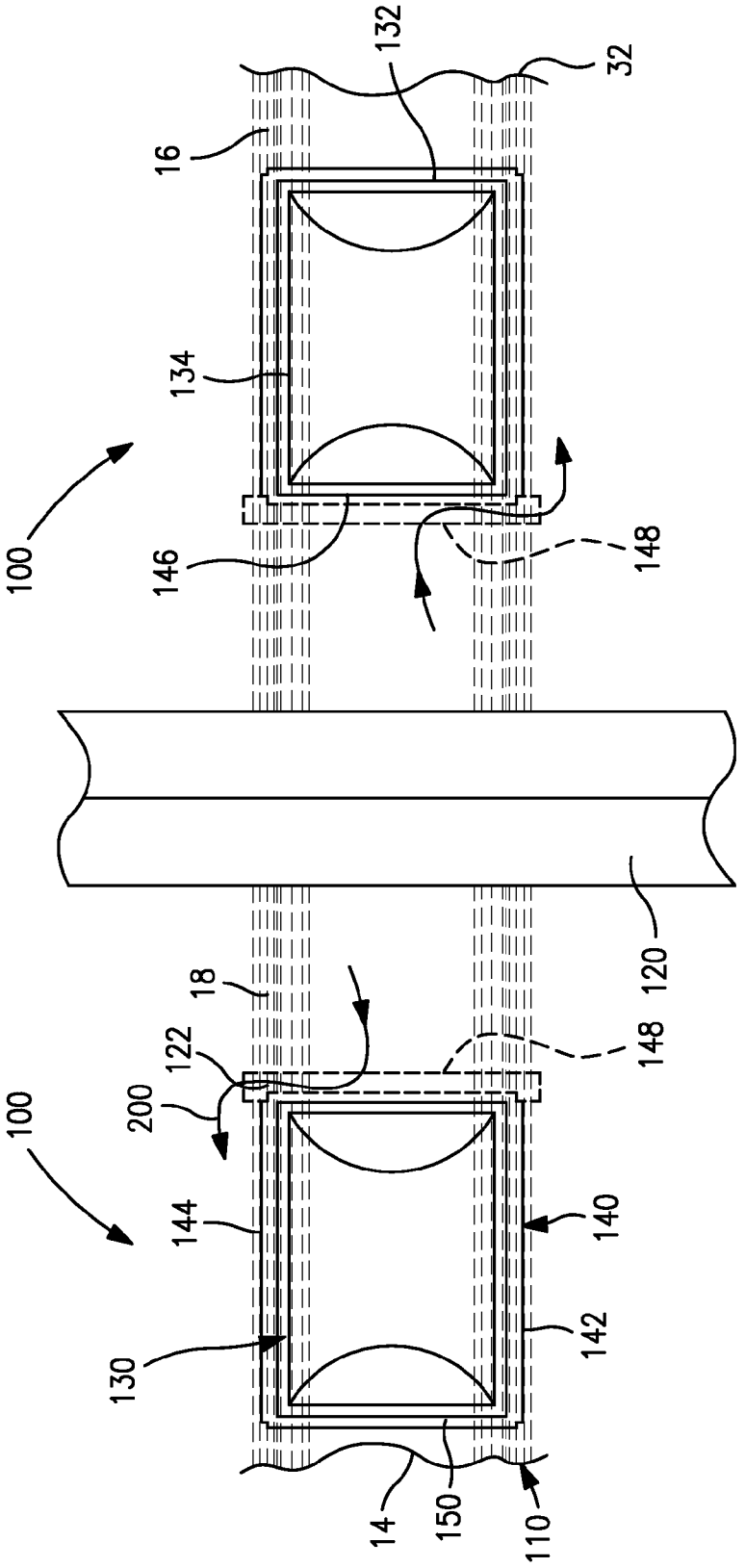
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FIG. 7

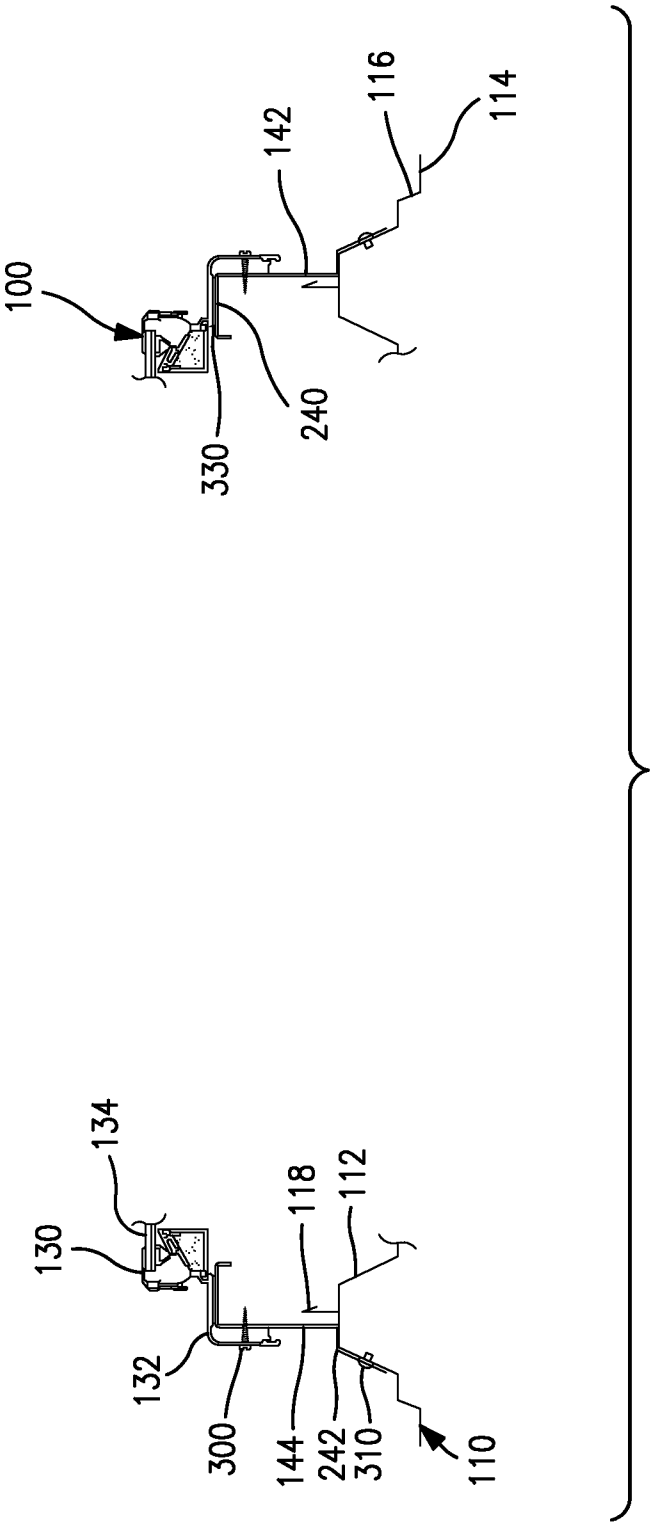

FIG. 8

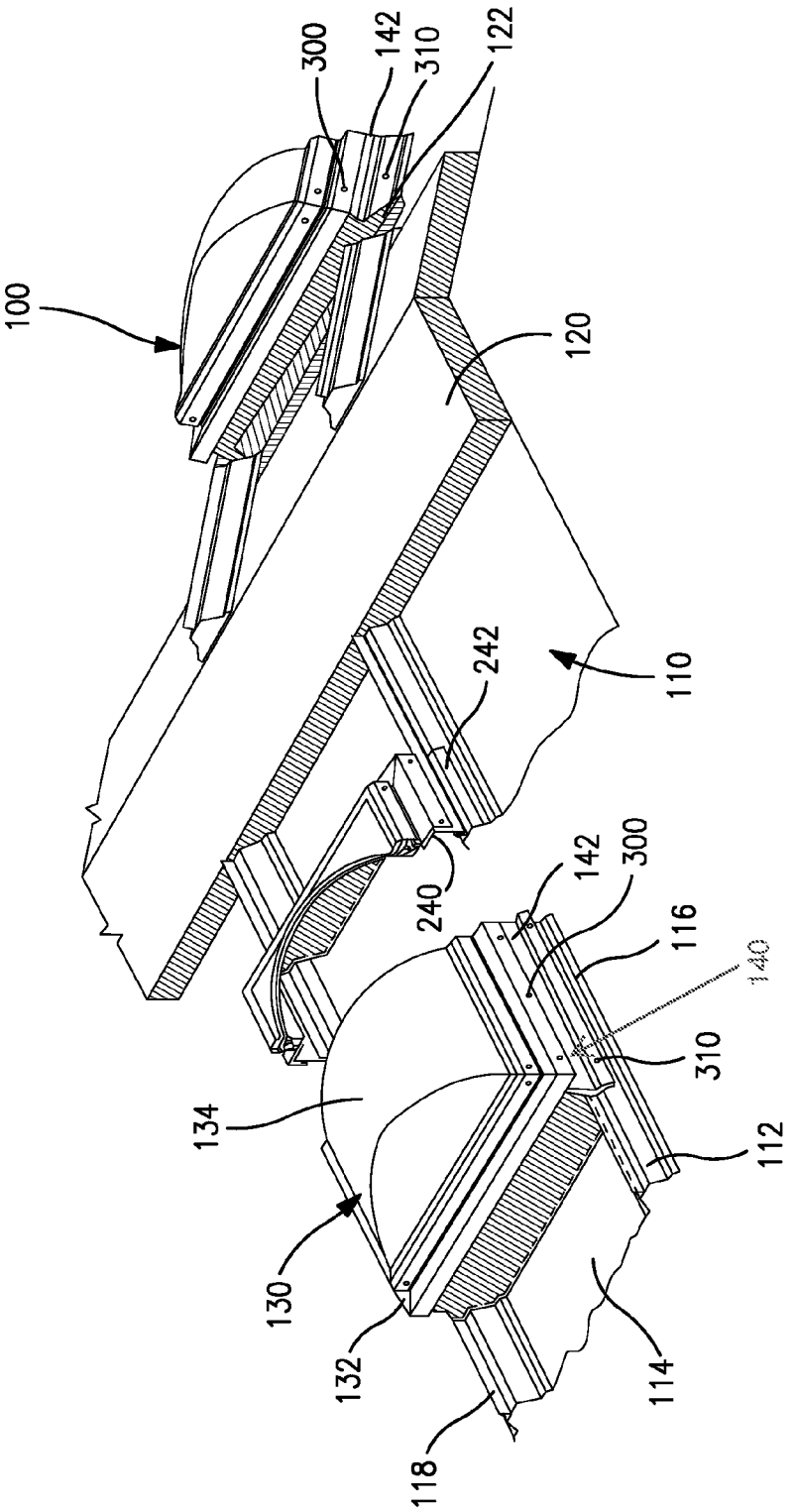
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FIG. 9

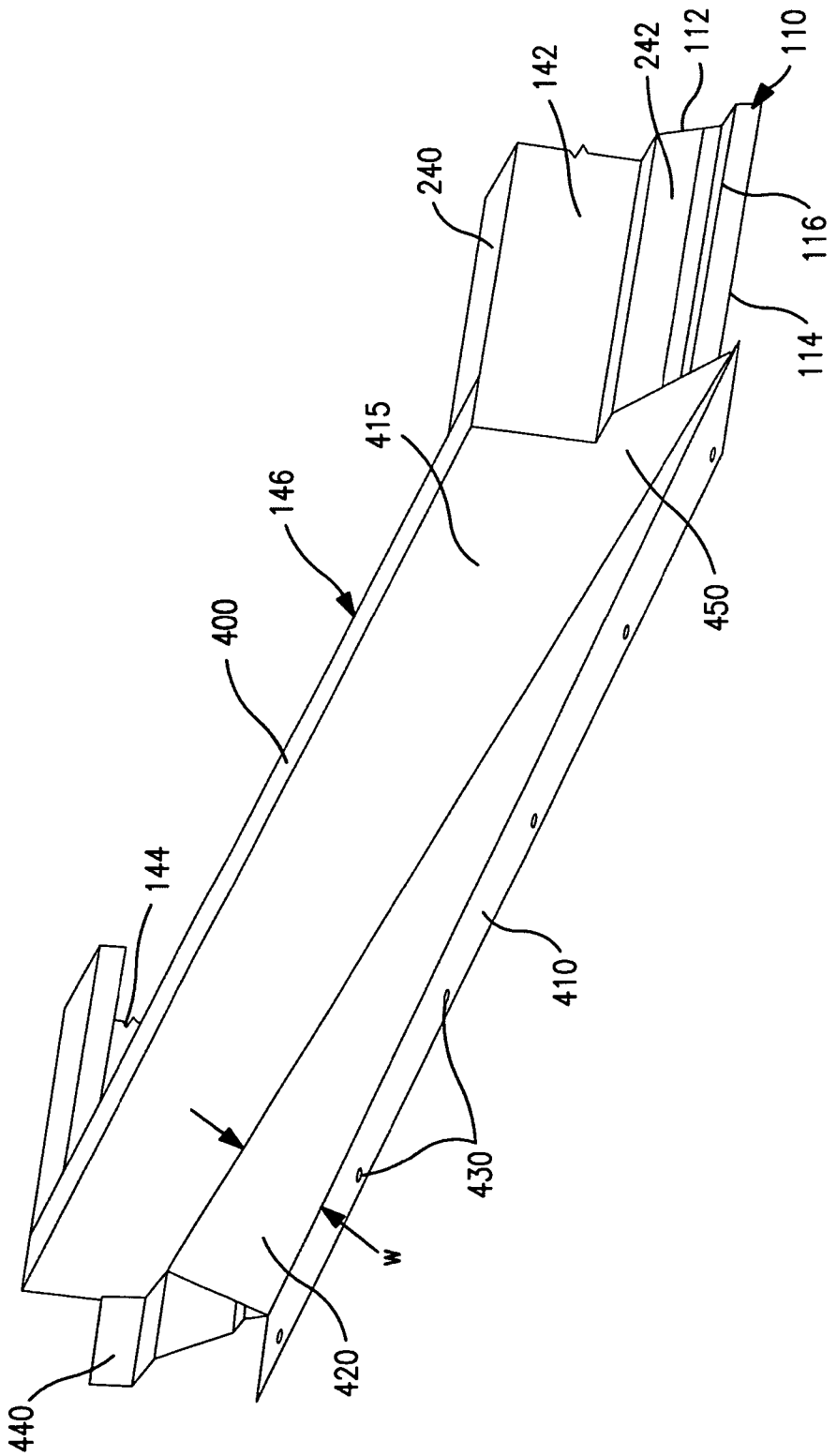
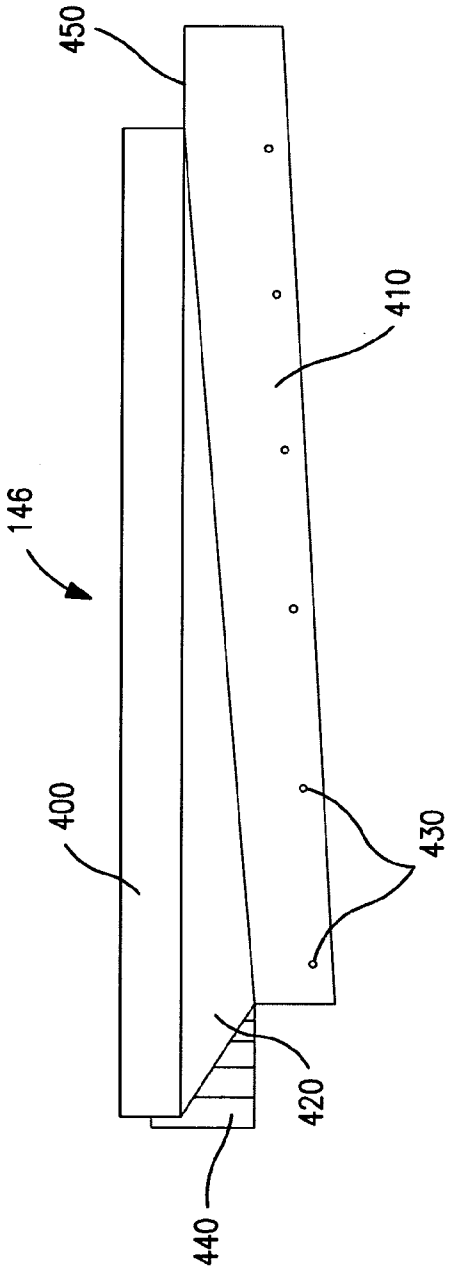


FIG. 10



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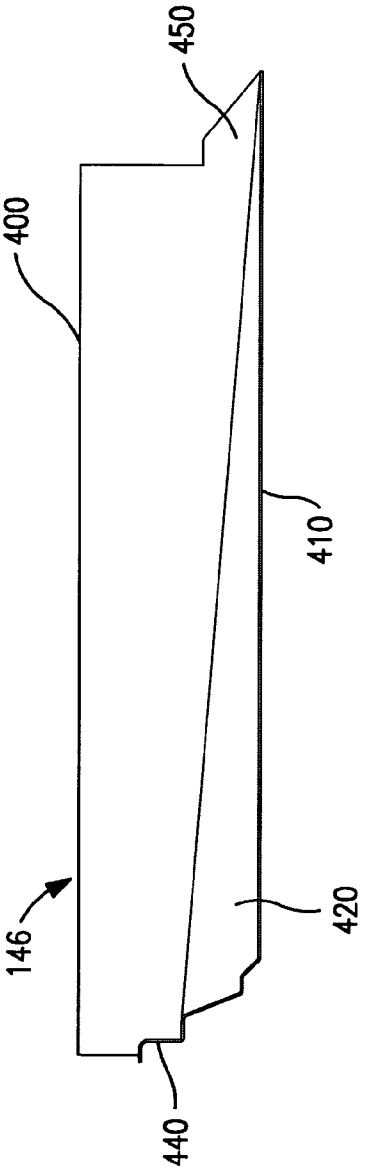

FIG. 12

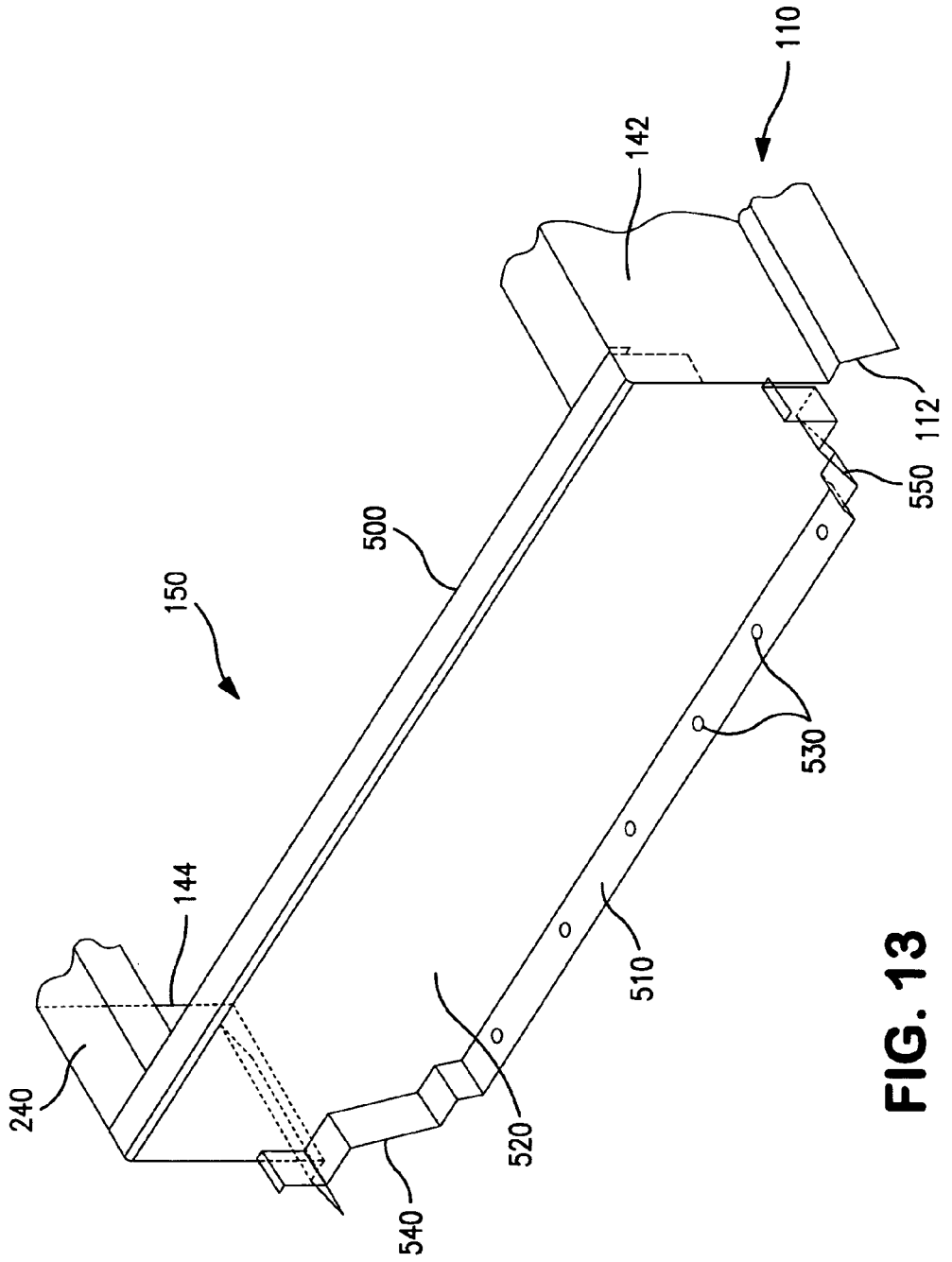

FIG. 13

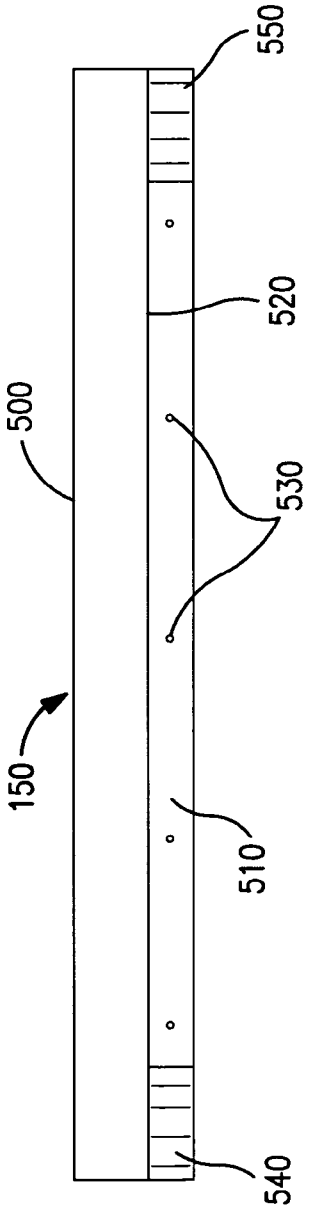

FIG. 14

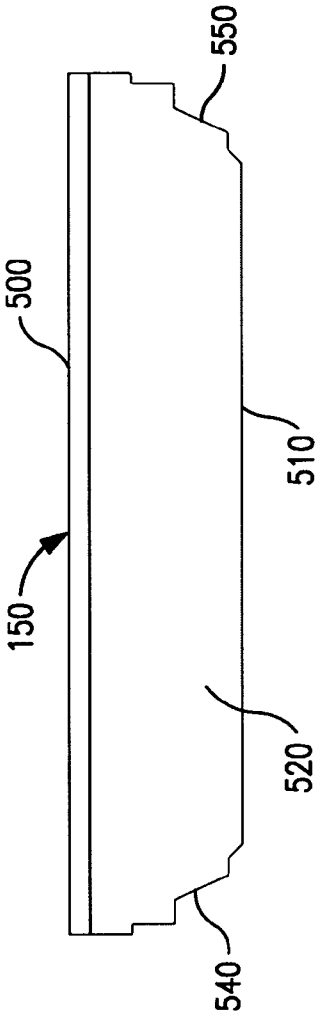

FIG. 15

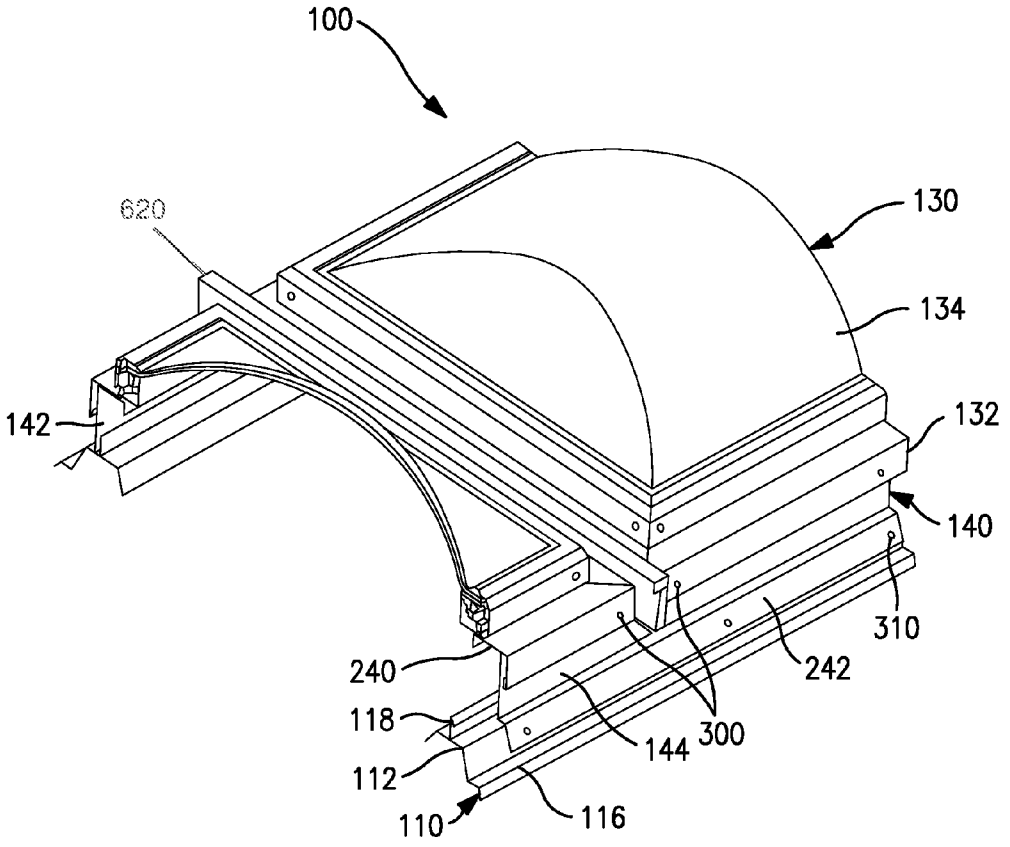

FIG. 16

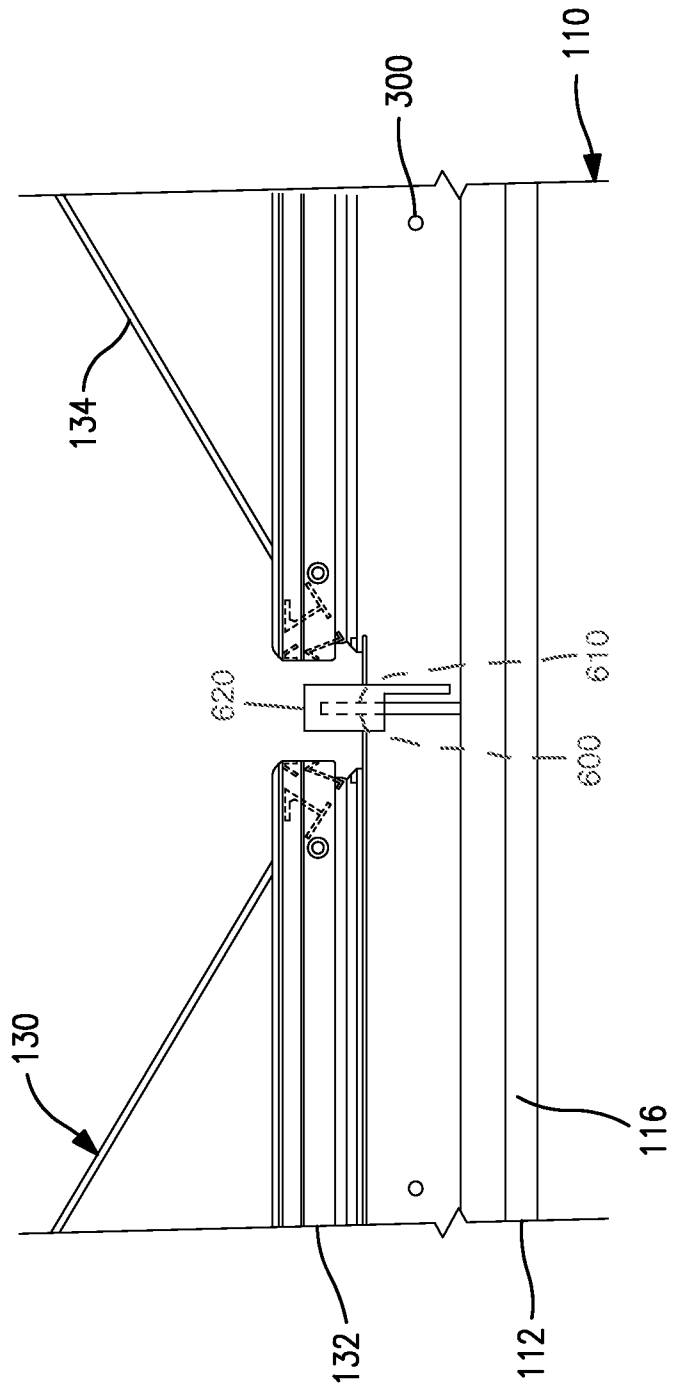

FIG. 17

ROOF PENETRATING CLOSURE STRUCTURES AND SYSTEMS

REFERENCE TO RELATED APPLICATIONS

This application is a Continuation-In-Part patent application Ser. No. 12/572,176, filed Oct. 1, 2009 now abandoned, which is Non-Provisional Application of Provisional Patent Application No. 61/102,333, filed Oct. 2, 2008, the complete disclosures of which are incorporated herein, in their entireties.

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BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of the invention is skylights and skylight systems.

2. Description of Related Art

Various systems are known for installing skylights and/or smoke vents into roofs.

The most commonly used skylighting systems are those that incorporate translucent or transparent layers into a framework that penetrates the roof support structure, so as to allow ambient daylight into the building.

In the past, roof penetrating installations have required a complex structure beneath the exterior roofing panels in order to support a roof curb to which the skylight was attached. Conventional skylight curbs are generally in the form of a preassembled box structure, which is mounted within a roof cutout. The retrofitting of such curb systems into existing roof structure is problematic in that all known conventional structures have a strong tendency to leak water when it rains due to installation details and complexities that are affected by installation, technologies or workmanship.

U.S. Pat. No. 4,296,581, Heckelsberg, issued Oct. 27, 1981, teaches a roof structure having a series of metal panels having flanges that interlock when the panels are laid side by side and which are subsequently tightly seamed together to convert the individual panels into an integrated roof forming membrane. This roofing structure is mounted to the building purlins with clips and permits the panels to expand or contract in response to temperature and pressure changes.

U.S. Pat. No. 4,703,596, to Sandow, issued Nov. 3, 1987, and titled "Grid Skylight System", teaches a grid skylight support apparatus that includes prefabricated grid row frames, each formed of connected beam supports which define a number of bays. Each bay has a skylight curb formed by upper flanges of the beam supports to receive a preassembled skylight unit. The sides of each grid row frame provide mating edges that can register with the mating edges of adjacent other grid row frames during assembly. The skylights have peripheral support skirts that register upon each bay and a light-transmitting skylight panel to cover the peripheral support. Cross gutters on each grid row frame, which are positioned between adjacent skylights, extend at angles toward the respective mating edges of the grid row frame for carrying rainwater to a main gutter channel formed by field-assembly of the mating edges of two adjacent grid row frames. The main gutter channel includes a pair of longitudinally extending gutter sections, each having a main gutter channel surface with a lower elevation than the elevation of the cross flow channel. Fasteners assemble the grid row frame mating edges together and a continuous seal is provided to prevent rainwater leakage at the mating edges of adjacent grid row frames.

U.S. Pat. No. 4,520,604, to Halsey et al., issued Jun. 4, 1985, entitled "Skylight Structure", teaches a curb structure dimensioned to be passed through an opening in a roof and then attached in asserted moisture impervious relation to the roof from within a building interior. A skylight assembly including a frame, and light transmitting member secured to the frame is dimensioned to be passed through the opening and attached in a sealing engagement to the curb structure from within the building interior for covering the opening. The skylight assembly is then secured to the rafters and headers at an interior location. The frame includes upper and lower clamping jaws and spaced fulcrum links attached to the jaws for clamping the light transmitting member thereto. The lower clamping jaws include a channel which engages and is interlocked with the curb structure.

Other skylight systems, as contemplated in U.S. Pat. No. 4,470,230, by Weisner, provide a prefabricated skylight support curb that is formed to be a protective packaging for the skylight during shipment and then used as a curb for mounting the skylight on a roof. A prefabricated skylight support curb for supporting a skylight thereover has a bottom flange angled, upright sides, and a top lip round the top of the sides forming an opening through the curb. A skylight is adapted to cover the opening through the skylight support curb, and has a domed portion and a drip edge on the curb portion. The skylight curb portion is shaped to fit over a portion of the prefabricated skylight support curb angled upright portion and top lip. The skylight support curb is shaped to nest an accompanying skylight therein having the skylight curb portion adjacent to the interior of the skylight support curb angled upright walls to protect the skylight during shipping and storing.

Another skylight system, U.S. Pat. No. 3,791,088, Sandow, et al., teaches prefabricated multiple dome unit or skylights and composite provided, where each multiple dome unit has several domes of transparent or translucent material mounted together on a common frame, and means are provided for assembling a plurality of such dome units into a composite thereof on a building, with the units lapped and interfitted so as to provide a continuous drainage system discharging to the exterior of the units in the composite assembly.

U.S. Pat. No. 4,621,466, by Sonneborn et al., teaches a flashing frame described for roof windows to be installed adjacent to each other with edges facing each other. Connecting flanges of the upper flashing members extend beneath the roofing and, if need be, lower flashing members and intermediary flashing members extend obliquely outwardly.

In today's world of mandated energy efficiency in all types of buildings, the metal building industry needs a more effective way to use skylights and smoke vents to bring daylight into buildings, as well as a more effective way to mount a variety of roof penetrating items. To ensure adequate daylighting, however, typical skylight and smoke vent installations require multiple roof penetrations that cut through and remove plural major elevations in standing seam and other roof panel profiles. These curbs create multiple opportunities for water to enter the interior of the building, due to multiple curb locations and the widths of the curbs, as well as presenting the challenge to effectively seal the roof at the high ends of such curbs.

The traditional curb constructions and methods of attachment in most cases require a complicated support structure to be installed below the roof panel which can restrict movement associated with thermal expansion and contraction of the overlying metal roof due to temperature changes and the like.

None of the prior approaches have been able to provide an installation system for multiple skylights which accomplishes the goals of economy and simplicity of installation and which works equally well for new buildings and as retrofits in existing buildings.

SUMMARY OF THE INVENTION

The invention provides a curbless construction system for installing two or more adjacent environment-accessing closure structures, such as skylights and/or smoke vents, end-to-end, onto the major rib elevation of a building's metal roof panel system thus utilizing the beam strength of the rib elevations in supporting roof-penetrating structures. Numerous roof structures include such rib elevations, sometimes deemed "ribs" or "corrugations", including the standing seam, snap seam and "R" panel roof types. The rail and closure system of the invention is fastened to the rib structures of the metal roof panels above the water line, so that the skylight/vent system can move with the expansion and contraction of the roof.

The invention utilizes the beam strength rib elements of the roof panels as an integral part of the closure support structure.

In a first family of embodiments, the invention comprehends a roof adaptive system configured to be installed as a roof-penetrating, environment-accessing structure on a metal roof, such metal roof comprising a metal roof profile defined by a plurality of roof panels having lengths, and arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof. The roof adaptive system comprises a rail and closure structure configured to be supported by adjacent ones of the elevated rib structures of the respective roof panels; a closure member configured to be supported on said rail and closure structure; and a diverter member configured to seal a cut away portion of such rib structure, thus to divert water away from the rail and closure structure.

In some embodiments, the rail and closure structure comprises an elongate rail configured to conform to at least a portion of a cross-section of such rib structure, along the length of such elevated rib structure.

In some embodiments, the rail and closure structure comprises first and second elongate rails configured to conform to respective first and second rib structure on respective adjacent roof panels.

In some embodiments, the roof adaptive system further comprises an upper end diverter configured to conform to an upper surface profile of such roof panel as is to be spanned by the rail and closure structure, and to close off the rail and closure system at the upper end thereof from intrusion of water.

In some embodiments, the roof adaptive system further comprises a lower end roof panel profile closure configuration to close off the lower end of the rail and closure structure from intrusion of water.

In some embodiments, the lower end roof panel profile closure conforms to the elevated rib structure of a known such roof panel.

In some embodiments, the lens comprises a skylight lens mounted to a skylight frame which extends about a perimeter of the lens, the skylight frame being fastened to the rail structure at spaced locations along the length of the rail structure.

In some embodiments, the aperture closure comprises a skylight lens.

In some embodiments, the aperture closure comprises an operable vent which can be alternatively closed, and opened to the outside environment.

In a second family of embodiments, the invention comprehends a building, comprising a building structural support system; and a roof supported by the structural support system. The roof comprises a plurality of elongate roof panels arranged in side-by-side relationship, the roof panels having first lengths, defining opposing first and second ends thereof, and opposing first and second sides of the roof panels, the sides of the roof panels comprising elongate elevated rib structure, the elevated rib structure on a first such roof panel being joined with the elevated rib structure on adjacent roof panels to form first and second elevated ribs at such joinder, the roof panels further comprising panel flat portions between the elevated ribs, an aperture in the roof, the aperture being confined within the width of a single such roof panel, and a roof-penetrating, environment-accessing structure. The environment accessing structure comprises a rail and closure structure having a second length defining third and fourth ends thereof, and a second width, corresponding directionally to the first lengths and the first widths of the roof panels, first and second elongate rails extend along the length of the rail and closure structure, the first and second rails being attached to the elevated ribs at spaced locations along the lengths of the ribs and the rails, the rail and closure structure spanning the width of a single roof panel plus optionally a rib portion of an adjacent roof panel. A diversion slot has a width corresponding in direction to the length direction of the respective panels. The diversion slot extends across an elevated rib at, and extending away from the upper end of the rail and closure structure, and at an elevation corresponding with an elevation of the respective said panel flat. At least one closure panel is secured to, and supported by, the rails, and a diverter is disposed in the diversion slot, extending the width of the diversion slot and extending across the respective rib, thereby to divert water laterally away from the end of the environment-accessing structure and onto the adjacent roof panel.

In some embodiments, the elongate rails have cross-section profiles which parallel cross-section profiles of the respective elevated ribs such that the rails are in substantial face-to-face contact with the respective ribs along the lengths of the ribs and the rails.

In some embodiments, the environment-accessing structure comprises at least first and second environment-accessing structures in side-by-side relationship to each other and overlying a single aperture.

In some embodiments, the rail and closure structure is secured to and moves with elevated ribs.

In some embodiments, the first and second rails conform to profiles of the first and second ribs along the lengths of the respective roof panels.

In some embodiments, the rails are configured to conform to surfaces of respective ribs, whereby the environment-accessing structure moves with expansion and contraction of the respective ribs.

In some embodiments, the roof comprises a sloped roof, and comprising an upper end diverter configured to conform to a top surface profile of the respective roof panel overlain by the environment-accessing structure at an upper end of the

environment-accessing structure, and closing off the rail and closure structure at such upper end thereof from intrusion of water into the roof aperture.

In some embodiments, the environment-accessing structure further comprises a lower end roof panel profile closure, closing off the lower end of the rail and closure structure from intrusion of water.

In some embodiments, the lower end closure conforms to the outer surfaces of the respective elevated ribs.

In some embodiments, the aperture closure comprises a skylight lens mounted to a skylight frame, the skylight frame extending about a perimeter of the lens, the skylight frame being mounted to the rail structure, at spaced locations along the length of the rail structure.

In some embodiments, the aperture closure panel comprises a skylight lens.

In some embodiments, the aperture closure comprises a smoke vent lens.

These and other features and advantages of this invention are described in, or are apparent from, the following detailed description of various exemplary embodiments of apparatus and methods according to this invention.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention and the attendant features and advantages thereof may be had by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein various figures depict the components and composition of the multiple skylight system.

FIG. **1** is a view showing the roof profile of a metal roof of the type known as the standing seam roof panel.

FIG. **2** is a view showing the roof profile of a metal roof of the type known as an architectural standing seam roof.

FIG. **3** is a view showing the roof profile of a metal roof of the type commonly referred to as a snap seam roof.

FIG. **4** is a view showing the roof profile of a metal roof of the type commonly referred to as an exposed fastener roof panel.

FIG. **5** is a view showing the roof profile of a metal roof of the type commonly known as foam core panel.

FIG. **6** is a side view showing major components of the system as installed in a metal roof.

FIG. **7** is a top plan view of the installed system, showing the placement of skylights and the direction of water flow over the roof.

FIG. **8** is a cross sectional view showing the connections of the skylight frame to the rail and closures structure, and the latter affixed over the surface of adjacent rib elevations of the metal roof.

FIG. **9** is a perspective view partially cut away showing internal structure of the system as installed on the rib elevations of a metal roof.

FIG. **10** is a perspective view of the upper rain pan or diverter of the rail and closure structure.

FIG. **11** is a top view of the upper rain pan or diverter of the rail and closure structure.

FIG. **12** is a front view of the upper rain pan or diverter of the rail and closure structure.

FIG. **13** is a perspective view of the lower end roof panel profile closure or lower closure of the rail and closure structure.

FIG. **14** is a top view of the lower end roof panel profile closure or lower closure of the rail and closure structure.

FIG. **15** is a front plan view of the lower end roof panel profile closure or lower closure of the rail and closure structure.

FIG. **16** is a perspective and partially cut away view showing a connection of adjacent skylights of the system.

FIG. **17** shows additional detail of how the adjacent skylight ends are joined to each other.

The invention is not limited in its application to the details of construction, or to the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various other ways. Also, it is to be understood that the terminology and phraseology employed herein is for purpose of description and illustration and should not be regarded as limiting. Like reference numerals are used to indicate like components.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

The products and methods of the present invention provide a rail and closure system for use in installing various roof penetrating structures in metal roofs. For purposes of simplicity, "roof penetrating structures" and "skylights" will be used interchangeably to mean various forms of roof structures installed for passage of light and/or ventilation air handling, vents, air intake and exhaust to and/or from the interior of the building. In the case of roof ventilation, examples include simple ventilation openings, such as for roof fans, and smoke vents, which are used to allow the escape of smoke through the roof during fires.

The number of skylights can vary from one to many structures connecting end to end, as many as the building roof structure can support, limited only by the amount of support provided by the surrounding roof surface structure, which is left largely intact during the installation process.

The system utilizes the beam strength of the major rib structure in the roof as the primary support structure, for mounting and fastening the skylight assembly. Typical conventional skylight installations do not allow for skylights to be mounted to each other, end to end, in continuous runs without intervening roof structure along the lengths of such runs. Rather, typical conventional skylight installations use a curb construction surrounding and supporting each skylight lens, the curb structure being typically 2-4 times wider than skylight support structure used in the present invention.

The skylight system of the invention does not require a complex structure underneath the panels or a separate curb construction to support or attach the skylight. Rather, the rail and closure assembly of the invention is overlaid onto the roof system and thereby allows for thermal expansion and contraction of the skylight system members by utilizing major profiles of the e.g. conventional metal roof panel for support. This is accomplished through direct attachment of the rail assembly of a skylight of the invention, and a combination of the panel flat and the major ribs for support and attachment of the skylight lens as part of the closure assembly.

In reference now to the figures, the system allows the installation of two or more adjacent skylights in an end to end fashion along the major rib structure of a building's metal roof panel profile.

The skylight systems may be applied to various types of ribbed roof profiles. FIG. **1** is an end view showing the roof profile of a metal roof of the type known as a standing seam roof. These include the "standing seam" roof, which has trapezoidal major ribs **12** typically 24" to 30" on center. Each panel **10** also includes the panel flat **14**, having a shoulder **16**

and is seamed at adjacent panels forming a standing seam **18**, which is folded over and seamed to prevent water from penetrating the roof at the standing seam.

FIG. **2** is an end view showing the roof profile of a metal roof of the type known as an architectural standing seam roof, which uses a series of overlapping architectural standing seam panels **20**. Each panel **20** comprises a panel flat **24**, with an architectural standing seam **28** formed at the panel interconnections.

FIG. **3** is a view showing the roof profile of a metal roof of the type commonly referred to as an R panel or exposed fastener panel **30**. Each panel has a rib **32**, and a panel flat **34**. Adjacent R panels are secured to the roof through structural fasteners **35**. At shoulder **36**, which is formed from overlapping regions, or at side lap **38**, the adjacent panels are secured through a stitch fastener **39**. The trapezoidal major ribs of the R panel roof are most typically formed at 8 inches to 12 inches on center.

FIG. **4** is a view showing the roof profile of a metal roof of the type commonly referred to as a snap rib seam panel **40**. Snap seam panels **40** have a panel flat **44** and a standing seam or snap seam **48** where the adjacent panels meet.

FIG. **5** is a view showing a roof profile of a metal roof of the type commonly referred to as using a foam core panel **50**. Such roof has a rib **52**, a liner panel **53**, a panel flat **54** and a foam core **57**. Side laps **58** are secured by stitch fasteners **59**. Such roof panels are typically installed from the interior of the building.

A skylight/ventilation access system of the invention includes a rail and closure assembly adapted to be supported by the prominent elevations, seams, rib structures, or other structural elements of conventional such roof profiles, where the standing structure of the roof system e.g. at seams which mount adjoining exterior roof panels to each other, provides the support for the skylight/ventilation assemblies, and the skylight/ventilation assemblies are secured to the conventionally-existing elements of the roof structure, through an opening formed largely in the intervening, non-structural roof flat region and without removing significant portions of the rib/seam/elevation structures.

Turning now to FIG. **6**, there is shown two exemplified rail and closure assemblies **100** attached to a standing seam panel roof **110**. While FIG. **6** depicts such assembly, the components can be adapted, by shaping of the elements, for attachment to any roof system which has a profile which includes elevations which provide places for structural support of the respective skylight assemblies.

Looking again to the figures, particularly FIGS. **6** and **7**, there is shown a portion of such a standing seam panel roof **110**, in dashed outline, having structural and other elements including a raised rib **112**, a panel flat **114**, shoulder **116** and standing seam **118**. Also depicted are the ridge cap **120** of the roof structure, and cutaway region, or gap **122** in the raised rib **112** on one side of each rail and closure assembly, the gaps being formed to accommodate the structure, as described more fully as follows.

Shown as part of the system, and exemplified in this case, is a skylight assembly **130**, generally comprising a skylight frame **132** and skylight lens **134**. While the figures depict a skylight, it will be understood that the system also can be adapted for use with a variety of roof penetrating closure structures, including various types of skylights, smoke vents, other ventilating structures, and/or other roof penetrating structures, all of which can be adapted to be supported on the rail and closure assembly system of the invention.

Again referring to FIGS. **6**, **7** and **9**, the system includes a rail and closure structure **140**, generally comprised of side rails **142** and **144**, and upper diverter **146** disposed at the rib cutaway section, or gap **122**. A plate **148** may be located under gap **122**, and thus under diverter **146**, to prevent the water from leaking through the roof. With lower flange **410** of the diverter overlying the gap, and plate **148** underlying the gap, plate **148** and lower flange **410** can be fastened securely to the roof panel, and to each other, using apertures **430**.

FIG. **7** shows how gap **122** in roof rib **112** allows water flow **200** to move laterally along the roof surface, over plate **148**, and down and away from the roof ridge cap **120** in panel flats **114** of roof panels which are adjacent the roof structures which support the respective e.g. skylights.

Rail and closure assembly structure **140** also includes a lower closure **150** to close the roof penetration from the elements at the lower end of the e.g. skylight.

Referring now to FIG. **8**, a cross section through the rail and closure structure **100** shows the securement of structure **100** to standing rib portions of the standing seam panel roof **110**. FIG. **8** depicts the use of first and second ribs **112** to support the side rails **142** and **144** on opposing sides of the rail and closure structure **100**. Each side rail **142** or **144** has an upstanding web **238** extending upwardly above the respective rib and supporting a rail upper flange or bearing panel **240**, and a rail shoulder **242** extending downwardly from web **238**. The rail **142** or **144** and skylight frame **132** are fastened to each other by fasteners **300**, only one of which is shown, spaced along the length of the rib.

Rail shoulder **242** is shaped to fit closely over the outside of the roof rib **112**, and is secured to roof rib **112** by rivets **310**, only one of which is shown, spaced along the length of the rib. As illustrated in FIGS. **8-9**, the entire length of the rail overlies the corresponding rib **112** and the lower edge of the rail is typically above, and displaced from, panel flat **114**, and is above shoulder **116** of the respective rib. Rail bearing surface **240**, at the top of the rail, supports the skylight frame **132**. A sealant **330** is disposed between bearing surface **240** and skylight frame **132**, to seal against the passage of water or air across the respective joint.

Rail and closure structure **140** of assembly **100** can be produced to fit closely along the contour of the roof **110**, and can be so configured to have end portions that match the contour of the respective ones of ribs **112**. The various mating surfaces of the structure **140** and the roof **110** can be sealed in various ways known to the roofing art, including caulking or tape mastic, or various rubber fittings or inserts can be provided to be used to seal around the open area of the penetration of the panel roof.

In FIG. **9** a partially cut away perspective view of rail and closure structures **100** is used to show support of the rail and closure system by standing seam panel roof **110**, particularly the elevated rib **112** providing the structural support at the standing seams. FIG. **9** illustrates how the rail and closure system incorporates the structural profiles of the roof panels of the metal roof structure above and below the skylights, and incorporates the elevations and ribs used in sealing adjacent panels, to provide the primary support for the skylights. In this fashion, the system adopts various ones of the advantages of a standing seam roof.

Most standing seam roofs are seamed using various clip assemblies that allow the roof panels to float relative to each other, along the major elevations, namely along the joints which are defined at elevated ribs **112**. Typically, the roof is fixed at the eave and allowed to expand and contract relative to a ridge. Very wide roofs can be fixed at midspan and expand and contract relative to both the eave and ridge. The design of the skylight system of the invention takes full advantage of the floating features of contemporary roofing structures, such

that when rail and closure structures of the invention are so secured only to the respective rib elevations and panel flats of the roof panel structures, the rail and closure structures, themselves, are able to draw strength from the structural load bearing capacities of the roof profile, and to float along with the roof panels to which they are mounted.

FIG. **9** shows panel flat **114**, rib **112**, and shoulder **116**, as well as standing seam **118**. The ridge cap **120** is also shown, as well as the gap in the roof at **122**.

Skylight **130** is supported on rail and closure structure **140**, as previously described.

Rail and closure structure **140** is secured, by its side rails **142** and **144**, by a series of fasteners **300**, to overlying skylight frame **132** and is secured to ribs **112** by a series of rivets **310**. FIGS. **8** and **9** illustrate that the skylight lens **134**, as so secured to rail and closure structure **140**, is above ribs **112**.

In application, for each structure **140** a single rib **112** is typically cut away to accommodate drainage at the high end of the closure structure (toward ridge cap **120**). This is an important feature for standing seam, architectural standing seam and snap seam roofs. Two ribs may be cut for roofs having an "R" panel profile.

The retained portions of rib **112** serve as a beam, supporting side rails **142** and **144** and maintaining the conventional watertight seal at the joints between roofing panels, along the length of the assembly. Internal portions of ribs **112** may be removed to allow additional light from skylight lens assembly **130** to reach through the respective roof opening.

A single bearing plate structure **148** is used for sealing to the roof panel and to the rail and closure structure **140** at the respective cut away rib. Bearing plate **148** also provides support to link adjacent rib elevations **112** to each other, and is typically produced of steel or other material sufficient to provide a rigid substructure to the skylight rail and closure structure.

Rail and closure structure **140** is shaped in such a manner that rail and closure structure **140** can be easily fastened directly to the respective underlying rib, with rivets or fasteners such as screws and the like as illustrated at **310** in FIGS. **8-9**. The rail and closure structure **140** may also be designed to ac p safety security guard before the skylight is installed.

Looking now to FIGS. **11** through **13**, upper or high end diverter **146** provides closure of the roof penetration at the upper end of the roof penetration, and diversion of water around the upper end of the assembly, to an adjacent panel flat. Diverter **146** also provides a weather tight seal at the upper end of the assembly, with the plate **148** (not shown in FIGS. **11-13**) in combination with conventional sealant materials. In reference to side rails **142** and **144** of a standing seam panel roof **110**, the diverter **146** generally fits the profile of the rib **112** at the region of the cut away gap **122**. The side rails **142** and **144** abut the diverter **146** and the height of diverter **146** closely matches the side rails in height. Upper flange **400** of diverter **146** acts with upper flanges **240** of side rails **142** and **144** to form the upper surface of the rail and closure structure to which skylight frame **132** is mounted.

Lower flange **410** of diverter **146** runs along, and parallel to, panel flat **114** of the respective roof panel. Diverter **146** also has a diversion surface **420** and fastener holes **430** along the lower flange. Diversion surface **420** is typically a flat surface defining first and second obtuse angles with lower flange **410** and intermediate end panel **415**. Diversion surface **420** has relatively greater width "W" on the side of the closure structure which is against the rib which is not cut, and a relatively lesser width "W", approaching a nil dimension, adjacent rib gap **122**, thus to divert water toward gap **122**.

At the closed rib end is a rib mating surface **440** and at the cut rib end is a rib sealing plate **450** extending through gap **122**.

FIGS. **14** through **16** show the lower closure **150** that is used to maintain a weather tight seal at the lower end of the assembly. Shown again in reference to the side rails **142** and **144** of a standing seam panel roof **110**, the closure **150** is adapted to fit the profile of the rib **112**. Side rails **142** and **144** abut the closure **150** and the height of closure **150** matches the heights of side rails **142**, **144**.

Closure **150** has an upper flange **500** and a lower flange **510**, as well as a closure web **520**. Lower flange **510** includes fastener holes **530**.

Closure **150** also includes rib mating flanges **540** and **550** to provide a tight fit along ribs **112**.

Looking now to FIGS. **17** and **18**, the adaptation of the system for the application of multiple roof penetrating structures is described. A chief aspect of the assembly **100** is the reduction in the number of roof penetrations required to provide daylight to the interior of a structure, as fewer, longer cuts can be made along the roof elevations. This reduced number of openings in the roof can be maintained along a single rib, if desired, with one continuous opening, versus a greater number of smaller openings, providing for an equal or greater quantity of ambient light being brought into the building.

In the case of standing seam roofs, the system provides the ability to remove only a portion of the bottom flat portion of the panel. This maintains the structural integrity of the roof in that multiple sections of major panel elevations in adjacent roof panels are not removed, as is done to accommodate a "typical" curb assembly which spans multiple roofing panels. Thus, the roof's structural integrity is not compromised to that extent and there are fewer potential areas for water infiltration, in that the upper reaches of the skylight panels can be mounted in the roof adjacent the ridge of the building and can extend to the eave, requiring water to be diverted only once near the ridge of roof plane and only across one panel flat.

To the limited extent that cutaways are made to the elevations/ribs, such cutaways extend only a minimal length of the respective roof panels, on the order of a few inches or less, solely for the purpose of allowing drainage past the upper end of the strip skylights.

The rail system of the skylight systems of the invention is designed to be installed to either the inside or outside of the major rib elevation for any of the aforementioned roof panel profiles relative to the included flat portion of the roofing panel.

The rail and closure assembly **100** is particularly useful for continuous runs, where individual skylights are arranged end to end. FIGS. **16** and **17** show how two adjacent skylights of the rail and closure assembly **100** can be affixed along a standing seam roof **110**. Instead of supplying the individual lights with diverters and lower closures, where adjacent lights abut, the rail and closure structures **140** are provided with upper and lower standing rib frames **600** and **610** at adjacent ends of the adjacent structures **140**. A batten **620** is provided to secure closure of the system **100** against the elements at the joinder where frames **600**, **610** meet.

As a non-limiting example, skylights can be produced in units of up to 10 feet long, and connected in this fashion for as long as necessary, as each skylight unit is supported by the primary rib of the profile. The standing rib elevation (the major corrugation) extends longitudinally along the length of the assembly and receives the entire lengths of the sides of the

entire assembly **100**, regardless of the number of adjacent skylight structures **140**. No water can enter over the top of the rail and closure assembly.

Where skylight **130** starts at the ridge of the roof, a simple flashing can be inserted under the ridge cap.

Where the ridge cap has a configuration to fit the rib elevations (major corrugation) in the roofing panels, a portion of the rib may be cut out (approximately 2"), allowing the water from the roof panel above to be diverted laterally, sideways on to the next adjacent panel.

If desired, a simple rail enclosure extension can be used to increase the height or distance between an upper portion of the skylight frame and the roof panel, and can be adapted to simply lay over or attach to the top of the rail and closure assembly. Such an extension can be produced to rest along the upper flange of the rail and closure assembly, to effectively raise the height of the skylight or smoke vent to accommodate different skylight depths or other design features, or to accommodate snow conditions and the like. In this fashion, the rail and closure structure can be produced to a standard height, with varying extensions used to elevate the overall height of the structure for such varied purposes. Various forms for such an extension can be suitable, and the skilled artisan will understand various ways and means of designing and manufacturing such extension to accomplish the goal of added elevation for the skylight lens.

Although the invention has been described with respect to various embodiments, this invention is also capable of a wide variety of further and other embodiments within the spirit and scope of the appended claims.

Those skilled in the art will now see that certain modifications can be made to the apparatus and methods herein disclosed with respect to the illustrated embodiments, without departing from the spirit of the instant invention. And while the invention has been described above with respect to the preferred embodiments, it will be understood that the invention is adapted to numerous rearrangements, modifications, and alterations, and all such arrangements, modifications, and alterations are intended to be within the scope of the appended claims.

To the extent the following claims use means plus function language, it is not meant to include there, or in the instant specification, anything not structurally equivalent to what is shown in the embodiments disclosed in the specification.

Having thus described the invention, what is claimed is:

1. A roof adaptive system configured to be installed about an aperture in a sloping metal roof, such metal roof comprising a plurality of roof panels having lengths and widths, said roof panels being arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof, thereby to define elevated ribs, and panel flats being disposed between such ribs, said roof adaptive system comprising a rail and closure structure having a length, and being configured to be supported by adjacent ones of the elevated ribs and to extend about such aperture and to span the panel flat portion of a single such roof panel, which panel flat is between adjacent ones of such ribs, said rail and closure structure comprising

(a) first and second rails, having lengths, and being configured to be mounted to respective first and second ones of such adjacent ribs on opposing sides of such single panel flat;

(b) an upper diverter configured to extend from said first rail to said second rail across an upper end of such aperture; and

(c) a lower closure configured to extend from said first rail to said second rail across a lower end of such aperture.

2. A roof adaptive system as in claim **1**, wherein each said rail overlies a such rib, and wherein a lower edge of a respective said rail is above, and displaced from, an elevation of the panel flat of an underlying such roof panel, and wherein an upstanding web of said rail extends upwardly above such rib.

3. A roof adaptive system as in claim **2**, further comprising a skylight lens assembly configured to be supported on said rail and closure structure and to overlie such aperture at an elevation above said first and second ribs.

4. A roof adaptive system as in claim **1**, further comprising a closure member configured to be supported on said rail and closure structure, and to overlie such aperture above said first and second ribs.

5. A roof adaptive system as in claim **4** wherein a said rail comprises a rail shoulder adapted to be mounted to an upper surface of such rib, and an upstanding web extending upwardly from said rail shoulder and above such rib.

6. A roof adaptive system as in claim **5**, said upper diverter having first and second opposing ends, the first such end being configured to extend through a gap in the first rib and onto a next adjacent roof panel at an elevation of a respective panel flat of such next adjacent roof panel, the second end of said upper diverter being configured to conform to at least a portion of the rib structure of such second rib.

7. A roof adaptive system as in claim **5**, said closure member being adapted to be mounted to said support structure and wherein said closure member comprises a skylight lens which, when so mounted, is disposed above such first and second ribs.

8. A roof adaptive system as in claim **5** wherein said upstanding web extends upwardly to a bearing surface of said rail, and wherein said closure member is received on said bearing surface.

9. A roof adaptive system as in claim **4** wherein said closure member comprises an operable vent which can be alternatively closed, and opened to the outside environment.

10. A roof adaptive system as in claim **1** wherein said lower closure has a profile which corresponds to at least a portion of a profile of an upper surface of such elevated rib structure.

11. A building, comprising:

(a) a building structural support system;

(b) a sloping roof supported by said building structural support system, said roof comprising a plurality of elongate roof panels arranged side by side and defining a roof panel structure, said roof panels having first lengths and first widths, and opposing first and second sides, said sides of said roof panels comprising elongate elevated rib structure, the elevated rib structure on a given said roof panel being joined with the elevated rib structure on adjacent said roof panels to form first and second elevated ribs at such joinders at the opposing first and second sides of the given said roof panel, said roof panels further comprising panel flats between said ribs, and

(c) a roof adaptive system comprising

(i) an aperture in said roof, such aperture being confined within the given said roof panel,

(ii) a rail and closure structure extending about such aperture, said rail and closure structure having a length and a width and comprising first and second rails mounted to first and second said ribs which border the panel flat of the given said roof panel, said first and second rails being disposed on opposing sides of such aperture,

(iii) a gap extending across said first rib at an up-slope end of said rail and closure structure,

said rail and closure structure further comprising an upper diverter having first and second ends, said upper diverter extending from said second side rail across the width of the given said roof panel to said first side rail, thereby providing an upper end of said rail and closure structure, including said upper diverter extending through the gap, and thus extending across said first rib, at an elevation corresponding with an elevation of the respective said panel flats at such gap, and extending onto a next adjacent said roof panel, to a first end of said upper diverter, and

said rail and closure structure further comprising a lower closure extending from said second side rail, across the given said roof panel to said first side rail, thereby providing a lower end of said rail and closure structure, and

(iv) a closure member secured to, and supported by, said side rails, and overlying such aperture,

a combination of said rail and closure structure and said closure member thus spanning the panel flat portion of a single said roof panel.

12. A building as in claim **11**, the second end of said upper diverter conforming to at least a portion of a profile of the rib structure of said second rib.

13. A building as in claim **11** wherein said rail and closure structure comprises at least first and second said closure members in end-to-end relationship to each other and overlying a single such aperture, said first and second closure members extending along first and second different lengths of such aperture and overlying first and second different portions of an area of such single aperture.

14. A building as in claim **11** wherein a given said rail is fastened only to rib structure of a next adjacent said roof panel, and a lower edge of the given said rail, along an entire length of the respective said rail, is above, and displaced from, the panel flat of such next adjacent roof panel.

15. A building as in claim **11** wherein said rails comprise upstanding webs extending upwardly from said first and second ribs.

16. A building as in claim **11** wherein said lower closure has a profile which corresponds to at least a portion of a profile of a said rib.

17. A building as in claim **11**, said closure member comprising a skylight lens assembly.

18. A building as in claim **11** wherein said first rail comprises a rail shoulder mounted to said first rib, and an upstanding web extending upwardly above said rail shoulder and above said first rib to a bearing surface of said first rail, said closure member being received on said bearing surface.

19. A building as in claim **11** wherein said rail and closure structure is secured only to said roof panel structure, and thus is carried by and moves, in expansion and contraction related to temperature changes, with underlying said roof panel structure.

20. A building as in claim **11** wherein said closure member comprises a skylight lens disposed above said first and second ribs.

21. A building as in claim **11** wherein said rails comprise upstanding webs extending upwardly above said ribs.

22. A building as in claim **11** wherein said lower closure extends to an elevation above said first and second ribs.

23. A building as in claim **11** wherein said upper diverter extends to an elevation above said first and second ribs.

24. A building as in claim **11** wherein a lower edge of a given said rail, along an entire length of the respective said rail, is at an elevation above, and displaced from, the panel flat of the next adjacent said roof panel.

25. A building as in claim **24**, said closure member comprising a skylight lens assembly disposed at an elevation above said first and second ribs.

26. A building, comprising:

(a) a building structural support system;

(b) a sloping roof supported by said building structural support system, said roof comprising a plurality of elongate roof panels arranged side by side and defining a respective roof panel structure, said roof panels having first lengths, first widths, and opposing first and second sides, said sides of said roof panels comprising elongate elevated rib structure, the elevated rib structure on a given said roof panel being joined with the elevated rib structure on adjacent said roof panels to form first and second elevated ribs at such joinders at the opposing first and second sides of said roof panels, and a panel flat between said first and second ribs, and

(c) a roof adaptive system comprising an elongate aperture confined within said given roof panel, such aperture having an aperture length extending along the length of the given said roof panel,

(ii) a rail and closure structure extending about such aperture, and comprising

A. first and second side rails having first and second rail lengths, the entire lengths of said first and second side rails overlying and being mounted to said first and second ribs,

B. an upper diverter extending from said second side rail across the width of the given said roof panel to said first side rail, thereby providing an upper end of said rail and closure structure,

C. a lower closure extending from said second side rail across the given said roof panel to said first side rail, thereby providing a lower end of said rail and closure structure, and

(iii) a closure member secured to said rail and closure structure and disposed above said panel flat, and extending from said first side rail to said second side rail, and from said upper diverter along the length of said aperture.

27. A building as in claim **26**, comprising a plurality of said closure members secured to said rail and closure structure, and extending over such aperture in said given roof panel, said closure members extending from said first side rail to said second side rail, a first said closure member extending from said upper diverter to an intermediate location along the length of the aperture, and a second said closure member extending from such intermediate location away from said upper diverter and toward said lower closure.

28. A building as in claim **26**, beam strength of said rib structure providing primary support to said rail and closure structure, supporting said rail and closure structure above said panel flat.

29. A building as in claim **28**, said closure member extending upwardly above said first and second ribs.

30. A building as in claim **28**, said closure member overlying said rail and closure structure.

31. A building as in claim **26** wherein said rail and closure structure is secured to said roof panel structure, and thus is supported only by, underlying said roof panel structure.

32. A building as in claim **26** wherein a said rail comprises a rail shoulder mounted to a said rib, and further comprises an upstanding web extending upwardly from said rail shoulder, including extending above said rib.

33. A building as in claim **26** wherein a lower edge of a given said rail is at an elevation above, and displaced from, the panel flat of a next adjacent said roof panel.

34. A building as in claim 33, said closure member comprising a skylight lens assembly disposed at an elevation above said first and second ribs.

35. A building, comprising:

(a) a building structural support system;

(b) a sloping roof supported by said building structural support system, said roof comprising a plurality of elongate roof panels arranged side by side, said roof panels having first lengths, first widths, and opposing first and second sides, said sides of said roof panels comprising elongate elevated rib structure, the elevated rib structure on a given said roof panel being joined with the elevated rib structure on adjacent said roof panels to form first and second elevated ribs at such joinders at the opposing first and second sides of the given said roof panel, said roof panel further comprising a panel flat between said first and second ribs, and

(c) a roof adaptive system comprising

(i) an elongate aperture confined within said given roof panel, such aperture having an aperture length extending along the length of the given said roof panel and a width extending across the width of the given said roof panel,

(ii) a rail and closure structure extending about such aperture, and comprising

A. first and second side rails overlying and being mounted to said first and second ribs,

B. an upper diverter extending from said second side rail across the width of the given said roof panel to said first side rail, thereby providing an upper end of said rail and closure structure,

C. a lower closure extending from said second side rail across the given said roof panel to said first side rail, thereby providing a lower end of said rail and closure structure, and

(iii) a plurality of closure members secured to said rail and closure structure and overlying a single such aperture, and extending from said first side rail to said second side rail, a first said closure member overlying a first portion of an area of such confined aperture and extending from said upper diverter to an intermediate location along the length of such confined aperture between said upper diverter and said lower closure, a second said closure member overlying a second different portion of the area of such aperture and extending from such intermediate location away from said upper diverter and toward said lower closure.

36. A building as in claim 35, full lengths of said first and second side rails overlying and being mounted to said first and second ribs.

37. A building as in claim 36, beam strength of said rib structure providing primary support to said rail and closure structure, supporting said rail and closure structure at an elevation above said panel flat.

38. A building as in claim 37, said closure members being disposed at an elevation above said panel flat.

39. A building as in claim 38, said closure members overlying said rail and closure structure.

40. A building as in claim 38, said closure members extending, from said rail and closure structure, upwardly above said first and second ribs.

41. A building as in claim 35 wherein said rail and closure structure is secured only to said roof structure, and thus is supported only by, underlying said roof structure.

42. A building as in claim 35 wherein a said rail comprises a rail shoulder mounted to a said rib, and an upstanding web extending upwardly from said rail shoulder and above said rib.

43. A building as in claim 35 wherein a lower edge of a given said rail is at an elevation above, and displaced from, the panel flat of a next adjacent said roof panel.

44. A building as in claim 43, said closure member comprising a skylight lens assembly disposed at an elevation above said first and second ribs.

45. A roof adaptive system installed about an aperture in a sloping metal roof, such metal roof comprising a plurality of elongate roof panels, said roof panels being arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof, thereby defining elevated ribs, said elevated ribs including folded over standing seams, panel flats being disposed between such ribs, said roof adaptive system comprising a plurality of closure members supported by first and second adjacent ones of the elevated ribs, and extending about such aperture and across such single panel flat portion of a single such roof panel, which panel flat is between the first and second adjacent ones of such ribs.

* * * * *

EXHIBIT B

US008438799B2

(12) **United States Patent**
McLain et al.

(10) **Patent No.: US 8,438,799 B2**
(45) **Date of Patent: May 14, 2013**

(54) **SUPPORT STRUCTURES ON ROOFS**

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(73) Assignee: **T&M Inventions, LLC**, Green Bay, WI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/065,033**

(22) Filed: **Mar. 10, 2011**

(65) **Prior Publication Data**

US 2011/0252727 A1 Oct. 20, 2011

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/932,892, filed on Mar. 8, 2011, which is a continuation-in-part of application No. 12/572,176, filed on Oct. 1, 2009, now abandoned.

(60) Provisional application No. 61/102,333, filed on Oct. 2, 2008.

(51) **Int. Cl.**

E04B 7/18	(2006.01)
E04B 7/02	(2006.01)
E04B 7/04	(2006.01)
E06B 3/26	(2006.01)

(52) **U.S. Cl.**
USPC **52/200**; 52/90.2; 52/90.1; 52/202

(58) **Field of Classification Search** 52/200, 52/18, 72, 80.1, 90.1, 90.2, 91.1, 202, 19, 52/536, 537, 545
See application file for complete search history.

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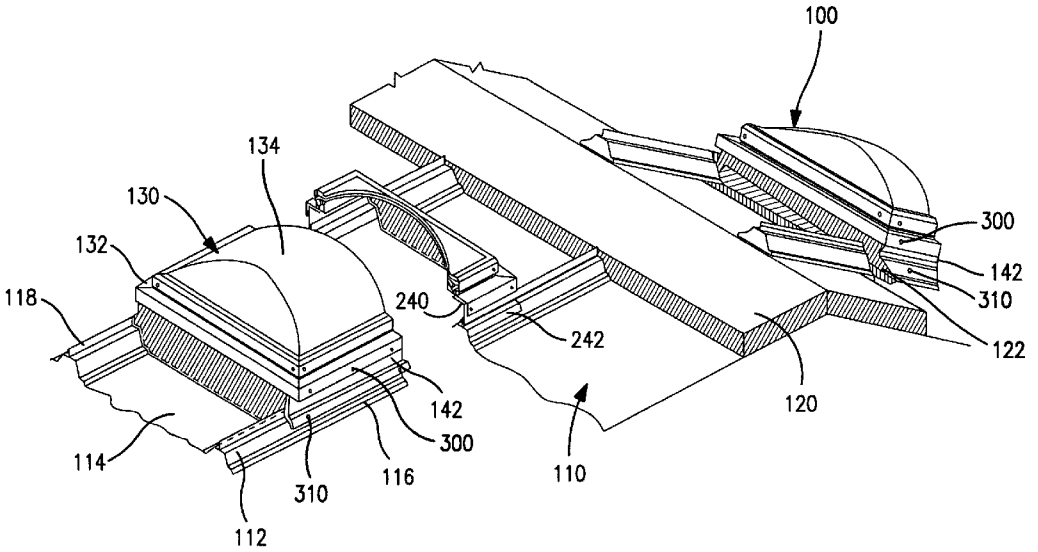
Primary Examiner — Andrew Triggs
(74) *Attorney, Agent, or Firm* — Thomas S. Wilhelm; Wilhelm Law, S.C.

(57) **ABSTRACT**

This invention provides support structures on roofs. Such support structure can be used to support a roof load, or a closure structure which closes an aperture in the roof, thus to provide access to the interior of a building through an aperture in the roof. The support structure can support a skylight to provide natural day-lighting, or a smoke vent, or a variety of other loads optionally relating to matter or energy communication between the inside and outside of the building. The support structure includes rails adapted to be supported by adjacent rib elevations on opposite sides of a flat of a roof panel, elevated above the water line of the panel flat. Where the support structure surrounds an aperture, a diverter seals a cut away portion of the rib structure and diverts water through the rib structure and laterally away from the rail and closure structure.

67 Claims, 13 Drawing Sheets



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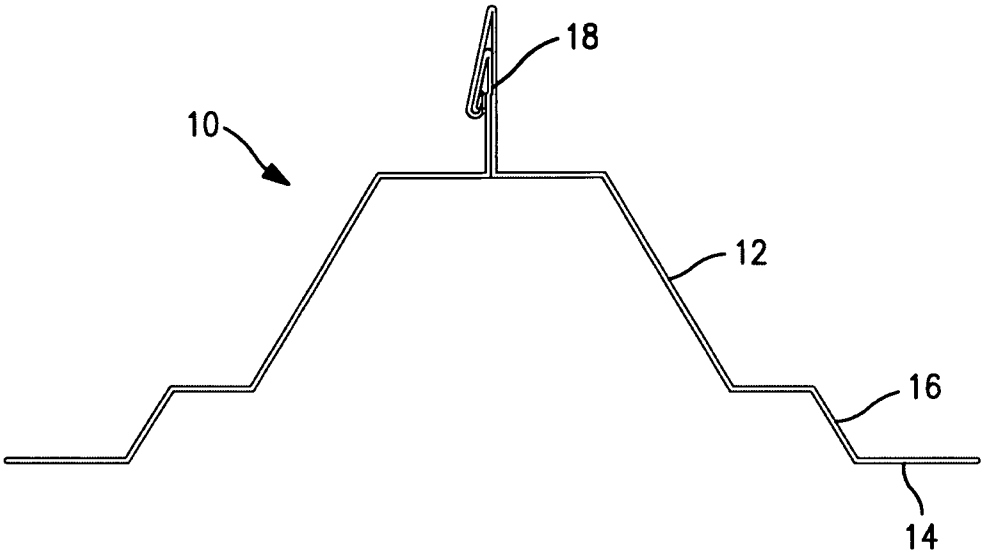


FIG. 1

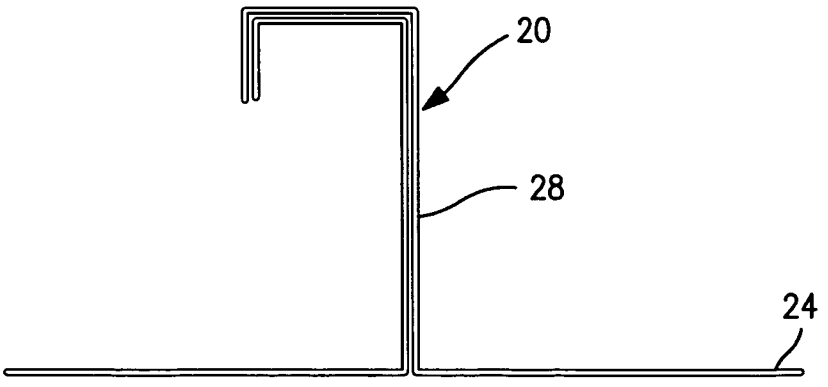


FIG. 2

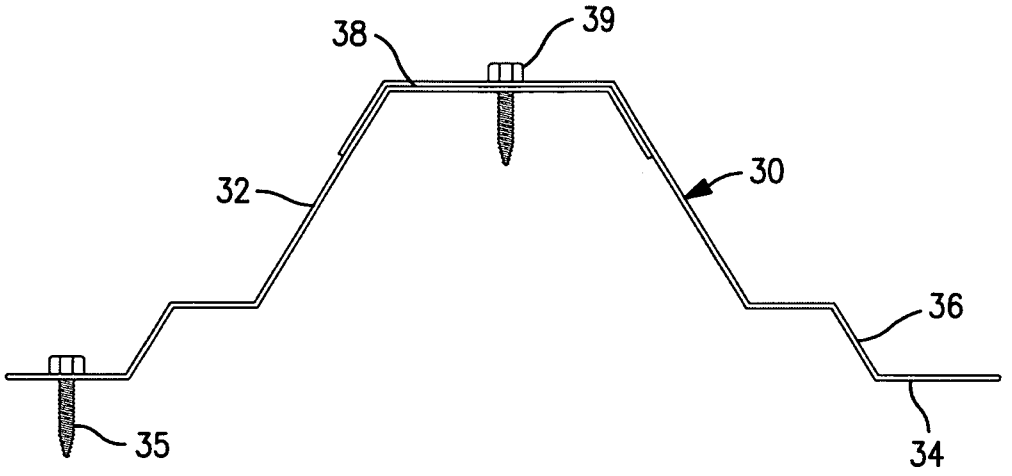
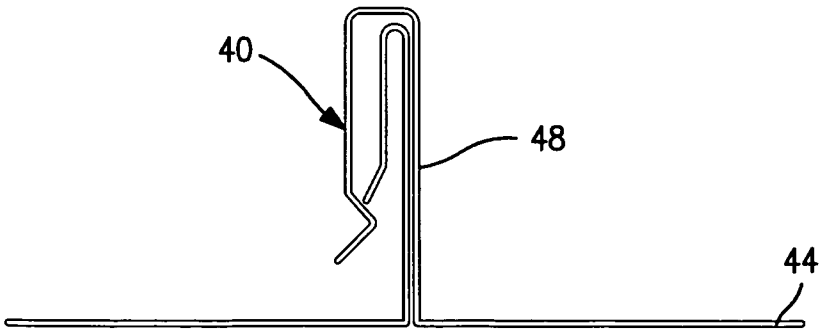


FIG. 3



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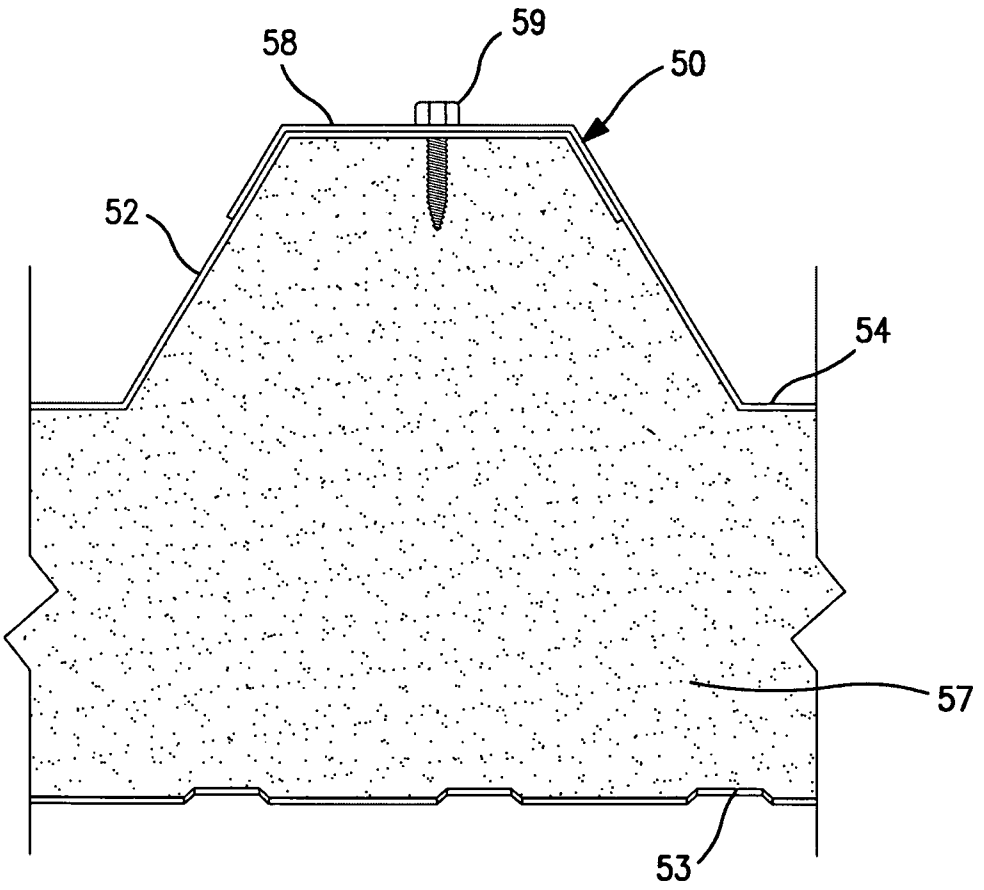

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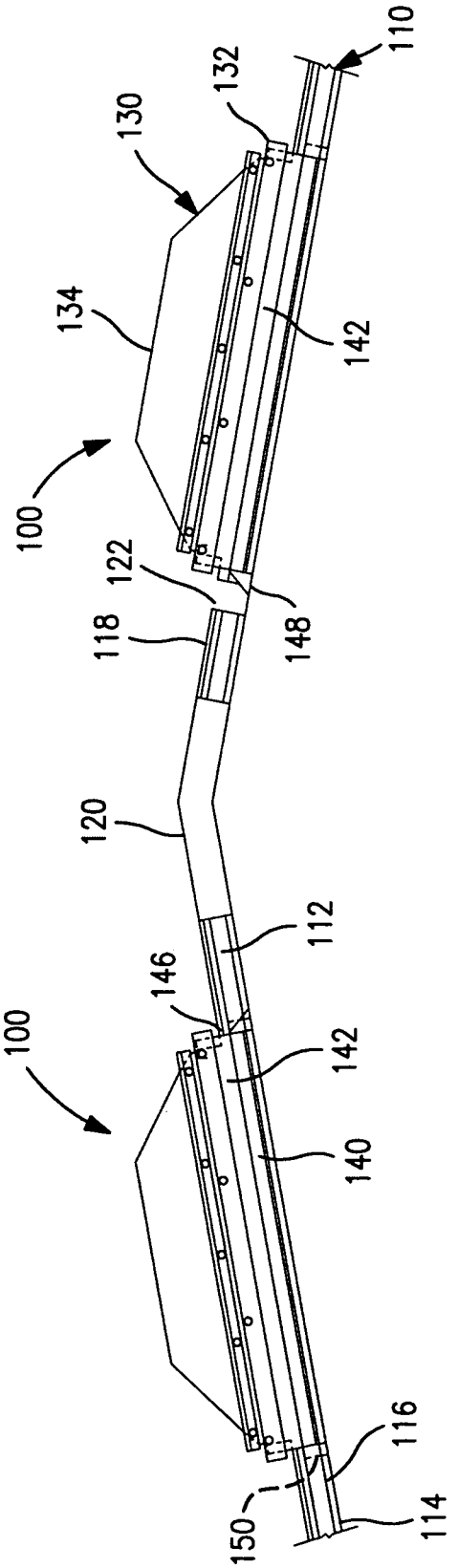
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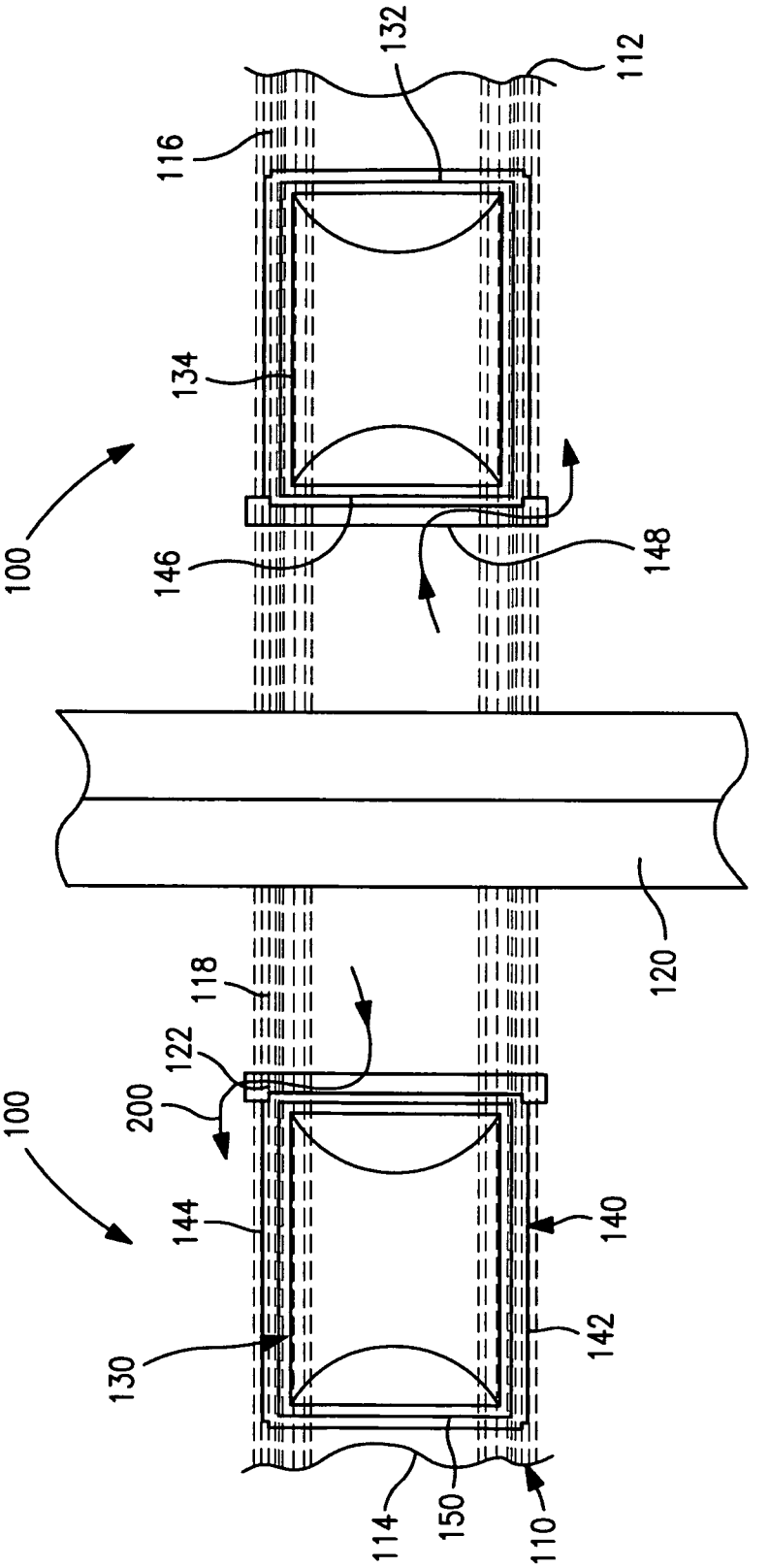
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FIG. 7

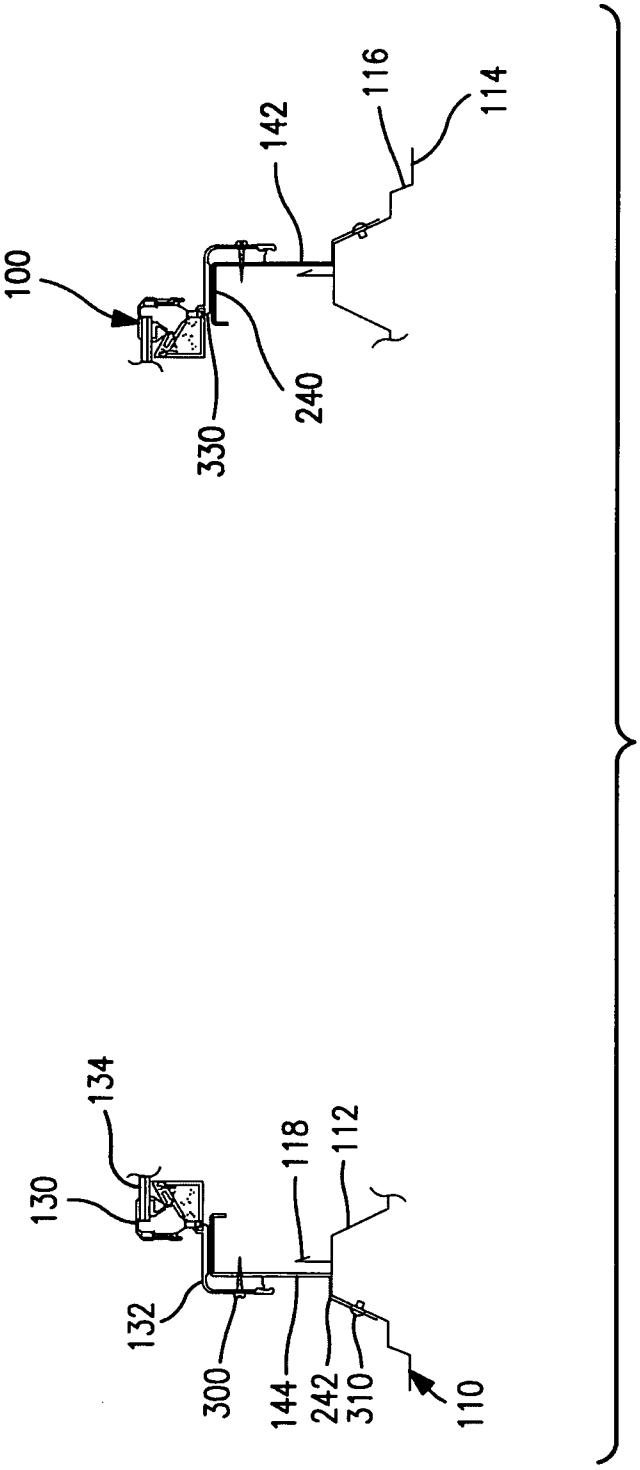

FIG. 8

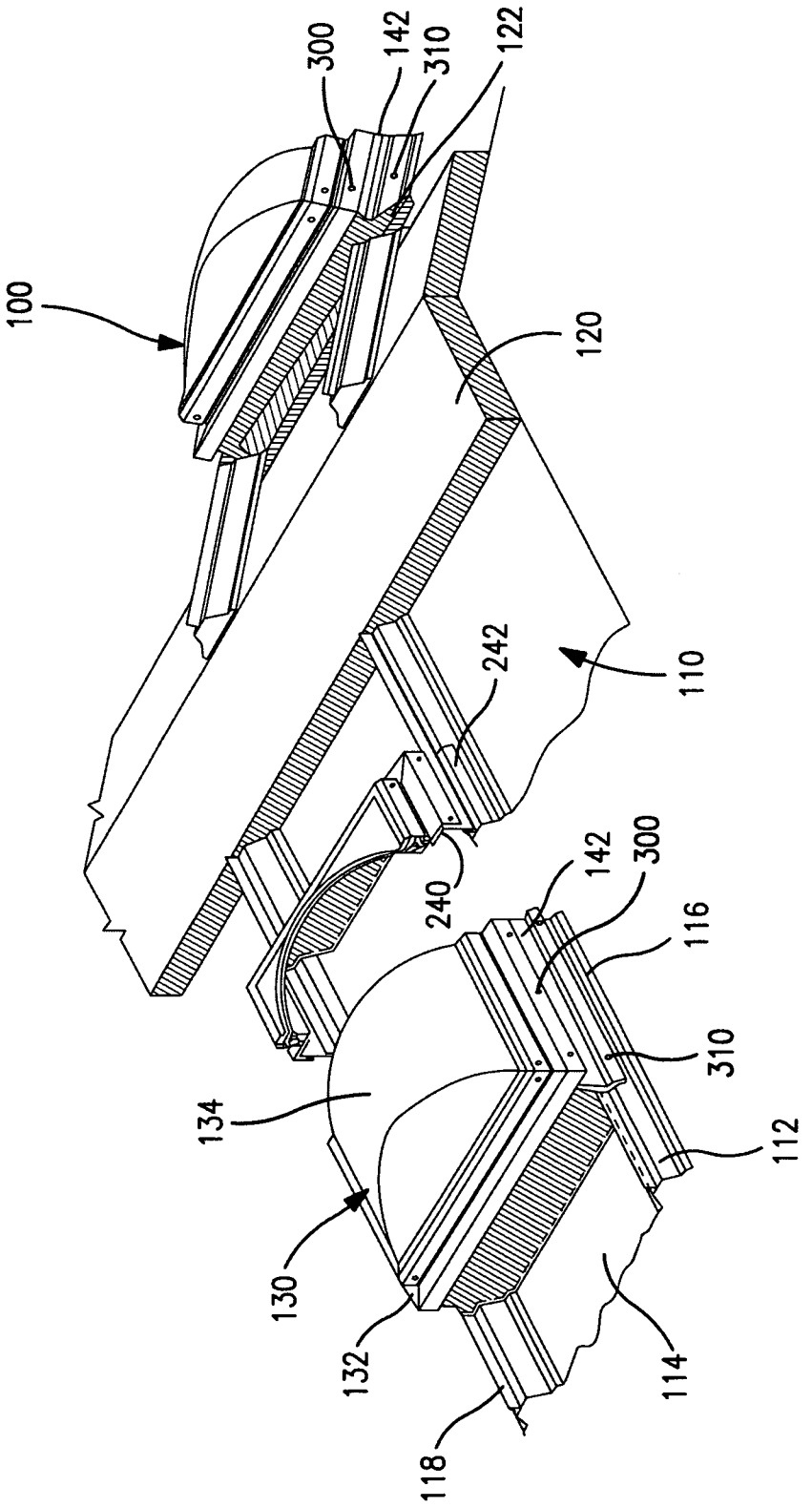
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FIG. 9

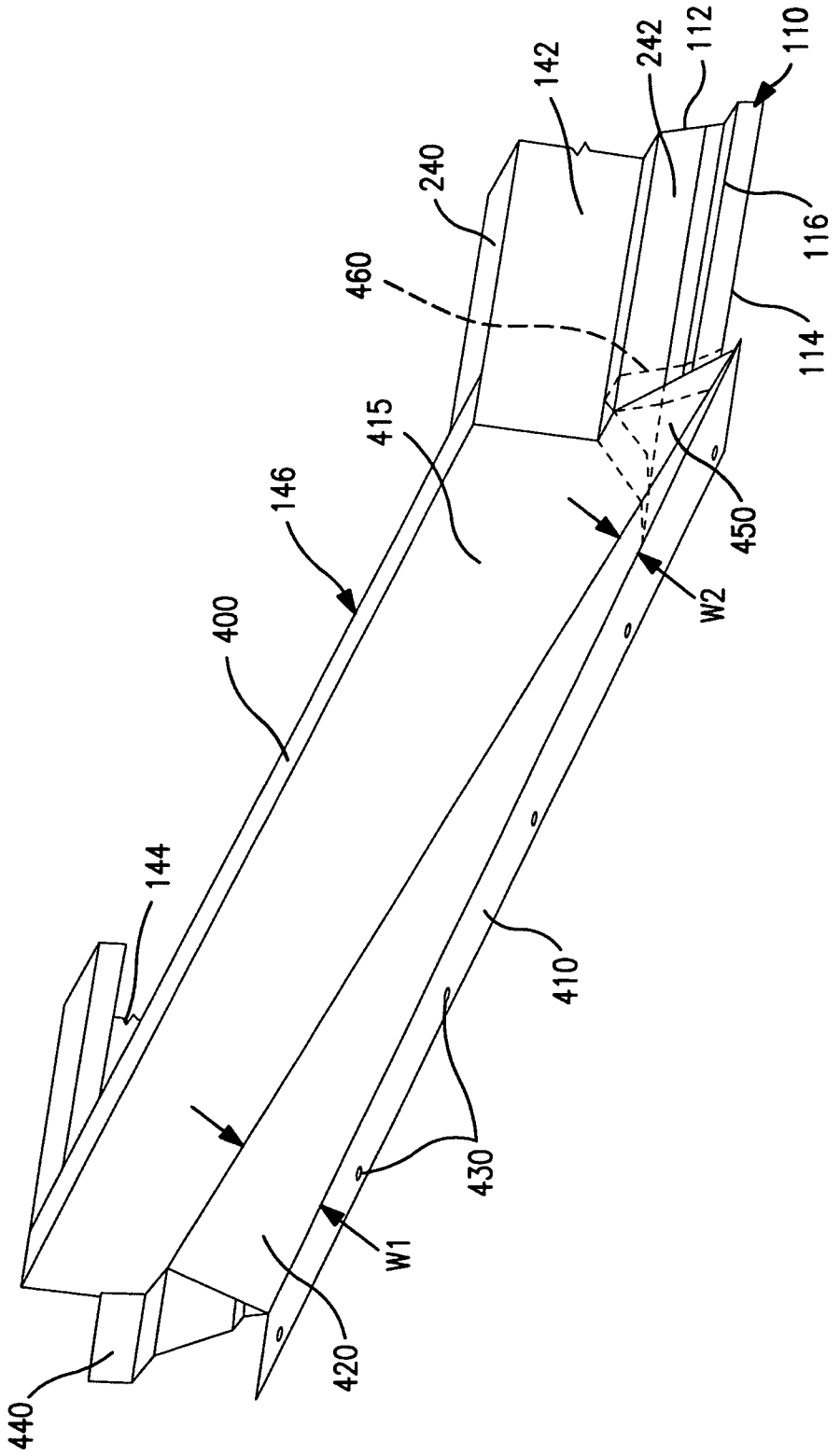
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FIG. 10

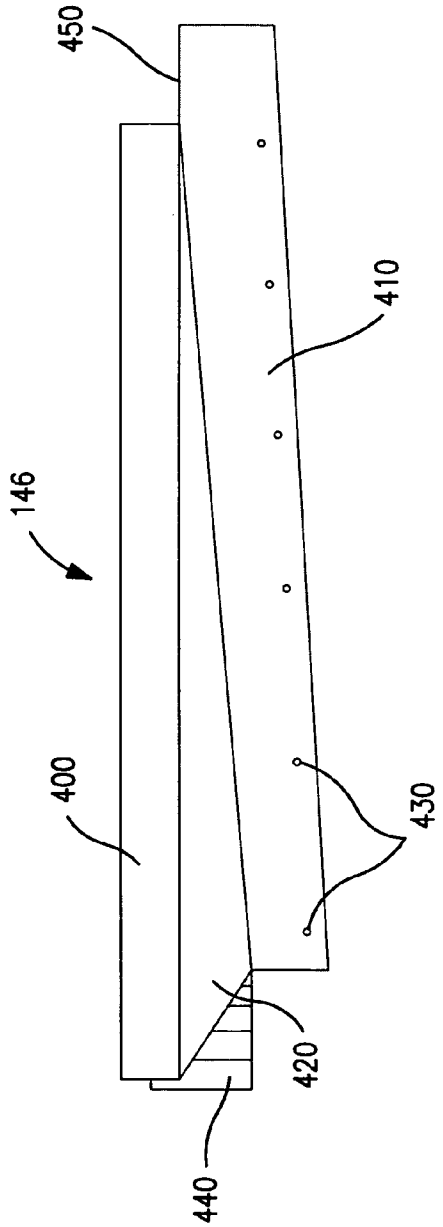

FIG. 11

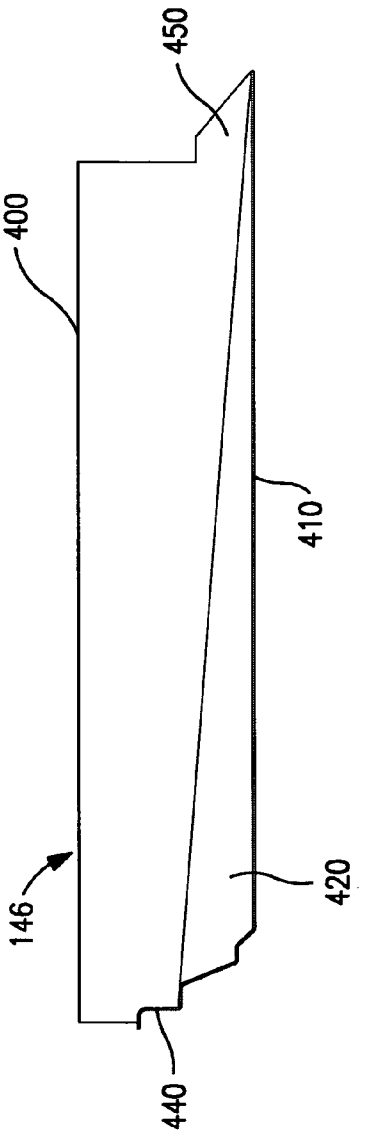

FIG. 12

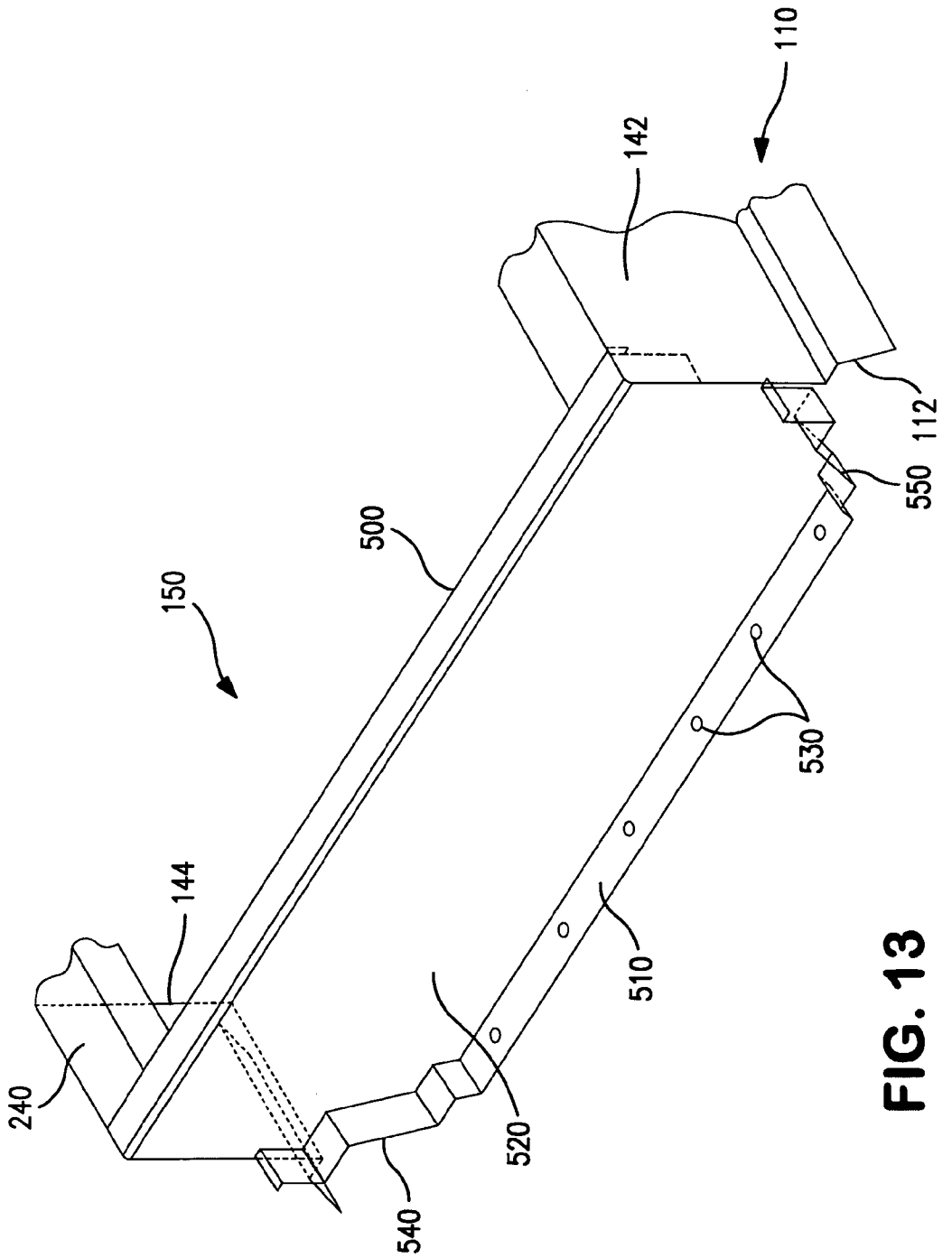

FIG. 13

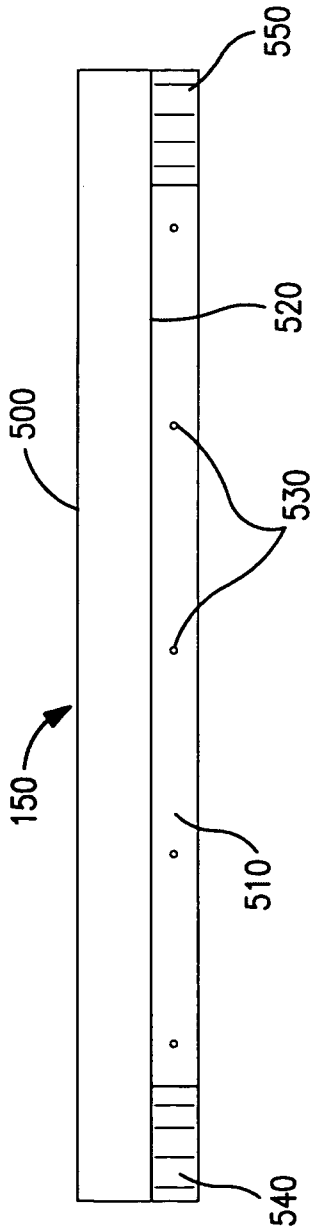

FIG. 14

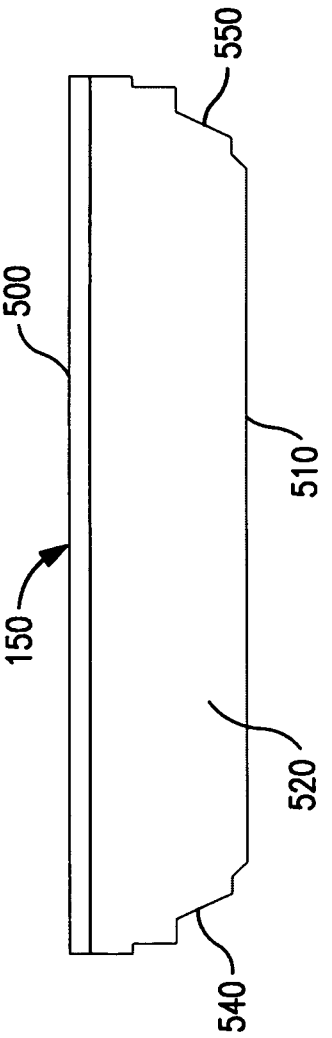

FIG. 15

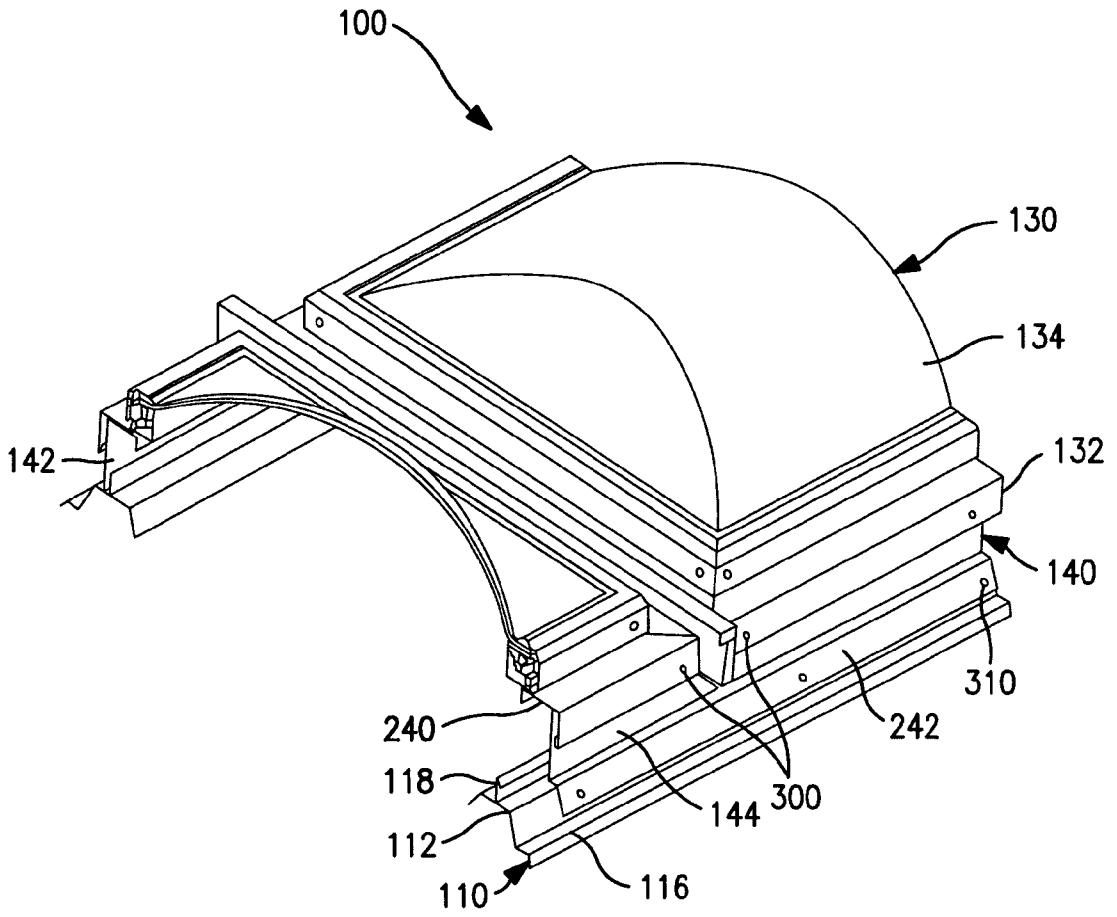

FIG. 16

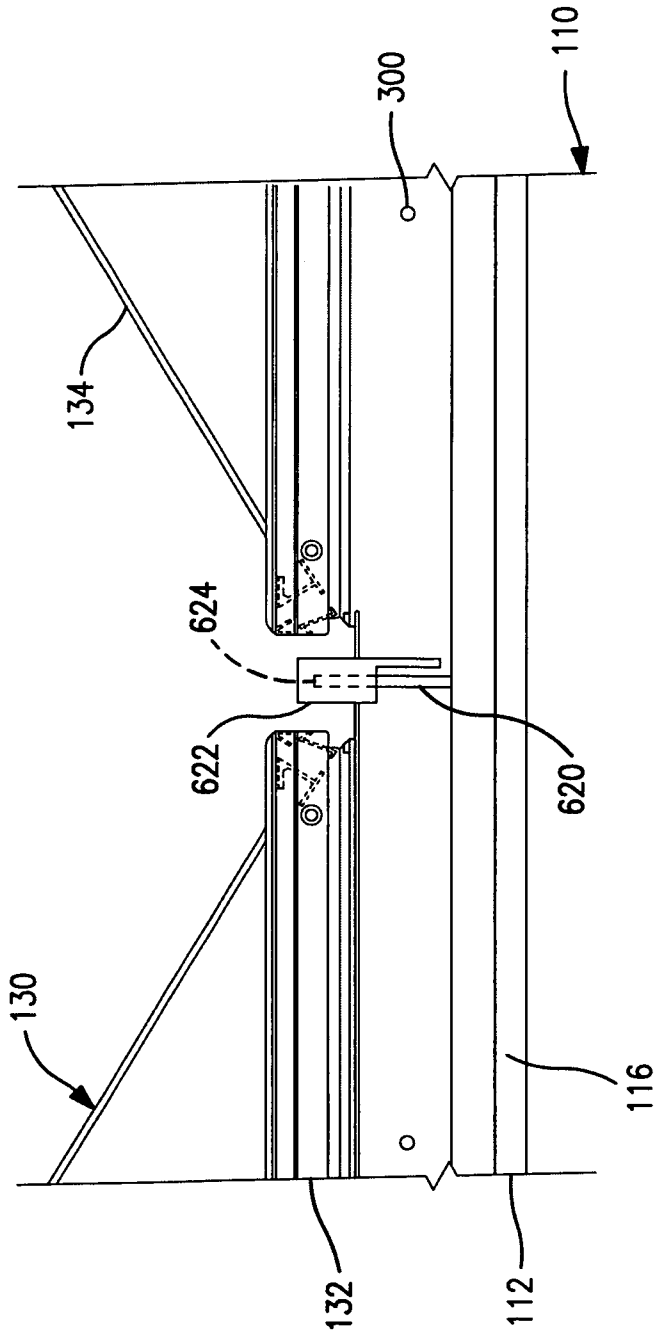

FIG. 17

SUPPORT STRUCTURES ON ROOFS

REFERENCE TO RELATED APPLICATIONS

This application claims the priority benefit of U.S. Provisional Patent Application No. 61/102,333, filed Oct. 2, 2008, and is a Continuation-In-Part of U.S. Non-Provisional patent application Ser. No. 12/572,176, filed Oct. 1, 2009, and is a Continuation-In-Part of U.S. Non-Provisional patent application Ser. No. 12/932,892, filed Mar. 8, 2011, the complete disclosures of which are incorporated by reference herein, in their entireties.

BACKGROUND OF THE INVENTION

Various systems are known for supporting loads on roofs, and for installing skylights and/or smoke vents into roofs.

The most commonly used skylighting systems are those which incorporate translucent or transparent closure members, also referred to herein as lenses, into a framework which penetrates the roof support structure and may be supported from within the building, with the result that the skylight closure member transmits ambient daylight into the building.

In the past, roof penetrating installations have required a complex structure beneath the exterior roofing panels and inside the building enclosure in order to support a roof curb to which the skylight lens was attached. Conventional skylight curbs are generally in the form of a preassembled box structure, which is mounted within a roof aperture. The retrofitting of such curb systems into an existing roof structure is problematic in that all known conventional structures have a tendency to leak water when subjected to rain due to installation details and complexities which are affected by installation techniques or workmanship.

U.S. Pat. No. 4,296,581, Heckelsberg, issued Oct. 27, 1981, teaches a roof structure having a series of metal panels having flanges that interlock when the panels are laid side by side and which are subsequently tightly seamed together to convert the individual panels into an integrated roof forming membrane. This roofing structure is mounted to the building purlins with clips and permits the panels to expand or contract in response to temperature and pressure changes.

U.S. Pat. No. 4,703,596, to Sandow, issued Nov. 3, 1987, and titled "Grid Skylight System", teaches a grid skylight support apparatus that includes prefabricated grid row frames, each formed of connected beam supports which define a number of bays. Each bay has a skylight curb formed by upper flanges of the beam supports to receive a preassembled skylight unit. The sides of each grid row frame provide mating edges that can register with the mating edges of adjacent other grid row frames during assembly. The skylights have peripheral support skirts that register upon each bay and a light-transmitting skylight panel to cover the peripheral support. Cross gutters on each grid row frame, which are positioned between adjacent skylights, extend at angles toward the respective mating edges of the grid row frame for carrying rainwater to a main gutter channel formed by field-assembly of the mating edges of two adjacent grid row frames. The main gutter channel includes a pair of longitudinally extending gutter sections, each having a main gutter channel surface with a lower elevation than the elevation of the cross flow channel. Fasteners assemble the grid row frame mating edges together and a continuous seal is provided to prevent rainwater leakage at the mating edges of adjacent grid row frames.

U.S. Pat. No. 4,520,604, to Halsey et al., issued Jun. 4, 1985, entitled "Skylight Structure", teaches a curb structure

dimensioned to be passed through an opening in a roof and then attached in asserted moisture impervious relation to the roof from within a building interior. A skylight assembly including a frame, and light transmitting member secured to the frame is dimensioned to be passed through the opening and attached in a sealing engagement to the curb structure from within the building interior for covering the opening. The skylight assembly is then secured to the rafters and headers at an interior location. The frame includes upper and lower clamping jaws and spaced fulcrum links attached to the jaws for clamping the light transmitting member thereto. The lower clamping jaws include a channel which engages and is interlocked with the curb structure.

Other skylight systems, as contemplated in U.S. Pat. No. 4,470,230, by Weisner, provide a prefabricated skylight support curb that is formed to be a protective packaging for the skylight during shipment and then used as a curb for mounting the skylight on a roof. A prefabricated skylight support curb for supporting a skylight thereover has a bottom flange angled, upright sides, and a top lip round the top of the sides forming an opening through the curb. A skylight is adapted to cover the opening through the skylight support curb, and has a domed portion and a drip edge on the curb portion. The skylight curb portion is shaped to fit over a portion of the prefabricated skylight support curb angled upright portion and top lip. The skylight support curb is shaped to nest an accompanying skylight therein having the skylight curb portion adjacent to the interior of the skylight support curb angled upright walls to protect the skylight during shipping and storing.

Another skylight system, U.S. Pat. No. 3,791,088, Sandow, et al., teaches prefabricated multiple dome unit or skylights and composite provided, where each multiple dome unit has several domes of transparent or translucent material mounted together on a common frame, and means are provided for assembling a plurality of such dome units into a composite thereof on a building, with the units lapped and interfitted so as to provide a continuous drainage system discharging to the exterior of the units in the composite assembly.

U.S. Pat. No. 4,621,466, by Sonneborn et al., teaches a flashing frame described for roof windows to be installed adjacent to each other with edges facing each other. Connecting flanges of the upper flashing members extend beneath the roofing and, if need be, lower flashing members and intermediary flashing members extend obliquely outwardly.

In today's world of mandated energy efficiency in all types of buildings, the metal building industry needs a more effective way to support skylights and smoke vents, thus to bring daylight into buildings, as well as a more effective way to support a variety of other loads on roofs which have ribs extending the lengths of the metal panels which serve as the outer surfaces of such roofs.

To ensure adequate daylighting, conventional skylight and smoke vent installations require multiple roof apertures which cut through and remove plural major elevations, also referred to herein as ribs, in standing seam and other roof panel profiles to make room for a corresponding multiple curbs which are conventionally used to support such skylight or smoke vent installations. These multiple curbs, each around a separate roof aperture, create multiple opportunities for water to enter the interior of the building, due to multiple apertures and the widths of the curbs, thus the cuts through the multiple ribs, as well as presenting the challenge to effectively seal the roof at the high ends of such curbs.

The traditional curb constructions and methods of attachment in most cases thus require that a complicated support structure be installed below the roof panel and inside the

building enclosure, which can restrict the relative movement of the roof panels and the curb, as associated with thermal expansion and contraction of the overlying metal roof due to temperature changes and the like.

None of the prior approaches have been able to provide an installation system for multiple skylights which accomplishes the goals of economy and simplicity of installation and which works equally well for new buildings and as retrofits in existing buildings.

SUMMARY OF THE INVENTION

The invention provides a curbless construction system for installing roof load supports such as roof closure structures, optionally skylights and/or smoke vents, optionally including two or more adjacent roof closure structures, end-to-end, onto the major rib elevations of a building's metal roof panel system, thus utilizing the beam strength of the rib elevations in supporting such loads. Numerous roof structures include such rib elevations, sometimes deemed "ribs" or "corrugations", including the standing seam, snap seam and "R" panel roof types. The roof support and/or closure structures of the invention are fastened to the rib structures of the metal roof panels above the water line. By mounting the loads above the water line, the number of incidents of water leaks is greatly reduced. By mounting the loads on the roof panels, themselves, the supported loads, such as skylights or vents, can move with the respective roof panels as the roof panels expand and contract.

The invention utilizes the beam strength of the rib elements of the roof panels as an integral part of the closure support structure.

In a first family of embodiments, the invention comprehends a roof adaptive system configured to be installed as a roof-penetrating, environment-accessing structure on a metal roof, such metal roof comprising a metal roof profile defined by a plurality of roof panels having lengths, and arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof. The roof adaptive system comprises a rail and closure structure configured to be supported by adjacent ones of the elevated rib structures of the respective roof panels; a closure member configured to be supported on said rail and closure structure; and a diverter member configured to seal a cut away portion of such rib structure, thus to divert water away from the rail and closure structure.

In some embodiments, the rail and closure structure comprises an elongate rail configured to conform to at least a portion of a cross-section of such rib structure, along the length of such elevated rib structure.

In some embodiments, the rail and closure structure comprises first and second elongate rails configured to conform to respective first and second rib structure on respective adjacent roof panels.

In some embodiments, the roof adaptive system further comprises an upper end diverter configured to conform to an upper surface profile of such roof panel as is to be spanned by the rail and closure structure, and to close off the rail and closure system at the upper end thereof from intrusion of water.

In some embodiments, the roof adaptive system further comprises a lower end roof panel profile closure configuration to close off the lower end of the rail and closure structure from intrusion of water.

In some embodiments, the lower end roof panel profile closure conforms to the elevated rib structure of a known such roof panel.

In some embodiments, the lens comprises a skylight lens mounted to a skylight frame which extends about a perimeter of the lens, the skylight frame being fastened to the rail structure at spaced locations along the length of the rail structure.

In some embodiments, the aperture closure comprises an operable vent which can be alternatively closed, and opened to the outside environment.

In a second family of embodiments, the invention comprehends a building, comprising a building structural support system; and a roof supported by the structural support system. The roof comprises a plurality of elongate roof panels arranged in side-by-side relationship, the roof panels having first lengths, defining opposing first and second ends thereof, and opposing first and second sides of the roof panels, the sides of the roof panels comprising elongate elevated rib structure, the elevated rib structure on a first such roof panel being joined with the elevated rib structure on adjacent roof panels to form first and second elevated ribs at such joinder, the roof panels further comprising panel flat portions between the elevated ribs, an aperture in the roof, the aperture being confined within the width of a single such roof panel, and a roof-penetrating, environment-accessing structure. The environment accessing structure comprises a rail and closure structure having a second length defining third and fourth ends thereof, and a second width, corresponding directionally to the first lengths and the first widths of the roof panels, first and second elongate rails extend along the length of the rail and closure structure, the first and second rails being attached to the elevated ribs at spaced locations along the lengths of the ribs and the rails, the rail and closure structure spanning the width of a single roof panel plus optionally a rib portion of an adjacent roof panel. A diversion slot has a width corresponding in direction to the length direction of the respective panels. The diversion slot extends across an elevated rib at, and extends away from the upper end of the rail and closure structure, and at an elevation corresponding with an elevation of the respective said panel flat. At least one closure panel is secured to, and supported by, the rails, and a diverter is disposed in the diversion slot, extending the width of the diversion slot and extending across the respective rib, thereby to divert water laterally away from the end of the environment-accessing structure and onto the adjacent roof panel.

In some embodiments, the elongate rails have cross-section profiles which parallel cross-section profiles of the respective elevated ribs such that the rails are in substantial face-to-face contact with the respective ribs along the lengths of the ribs and the rails.

In some embodiments, the environment-accessing structure comprises at least first and second environment-accessing structures in side-by-side relationship to each other and overlying a single aperture.

In some embodiments, the rail and closure structure is secured to and moves with elevated ribs.

In some embodiments, the first and second rails conform to profiles of the first and second ribs along the lengths of the respective roof panels.

In some embodiments, the rails are configured to conform to surfaces of respective ribs, whereby the environment-accessing structure moves with expansion and contraction of the respective ribs.

In some embodiments, the roof comprises a sloped roof, and comprising an upper end diverter configured to conform to a top surface profile of the respective roof panel overlain by the environment-accessing structure at an upper end of the

environment-accessing structure, and closing off the rail and closure structure at such upper end thereof from intrusion of water into the roof aperture.

In some embodiments, the environment-accessing structure further comprises a lower end roof panel profile closure, closing off the lower end of the rail and closure structure from intrusion of water.

In some embodiments, the lower end closure conforms to the outer surfaces of the respective elevated ribs.

In some embodiments, the aperture closure comprises a skylight lens mounted to a skylight frame, the skylight frame extending about a perimeter of the lens, the skylight frame being mounted to the rail structure, at spaced locations along the length of the rail structure.

In some embodiments, the aperture closure panel comprises a skylight lens.

In some embodiments, the aperture closure comprises a smoke vent lens.

These and other features and advantages of this invention are described in, or are apparent from, the following detailed description of various exemplary illustrated embodiments of apparatus and methods according to this invention.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention and the attendant features and advantages thereof may be had by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein various figures depict the components and composition of the multiple skylight system.

FIG. **1** is a view showing the roof profile of a metal roof of the type known as the standing seam roof panel.

FIG. **2** is a view showing the roof profile of a metal roof of the type known as an architectural standing seam roof.

FIG. **3** is a view showing the roof profile of a metal roof of the type commonly referred to as an exposed fastener roof panel.

FIG. **4** is a view showing the roof profile of a meta of he type commonly referred to as a snap seam roof.

FIG. **5** is a view showing the roof profile of a metal roof of the type commonly known as foam core panel.

FIG. **6** is a side view showing major components of the system as installed in a metal roof.

FIG. **7** is a top plan view of the installed system, showing the placement of skylights and the direction of water flow over the roof.

FIG. **8** is a cross sectional view showing the connections of the skylight frame to the rail and closures structure, and the latter affixed over the surface of adjacent rib elevations of the metal roof.

FIG. **9** is a perspective view partially cut away showing internal structure of the system as installed on the rib elevations of a metal roof.

FIG. **10** is a perspective view of the upper rain pan or diverter of the rail and closure structure.

FIG. **11** is a top view of the upper rain pan or diverter of the rail and closure structure.

FIG. **12** is a front view of the upper rain pan or diverter of the rail and closure structure.

FIG. **13** is a perspective view of the lower end roof panel profile closure or lower closure of the rail and closure structure.

FIG. **14** is a top view of the lower end roof panel profile closure, or lower closure, of the rail and closure structure.

FIG. **15** is a front plan view of the lower end roof panel profile closure or lower closure of the rail and closure structure.

FIG. **16** is a perspective and partially cut away view showing a connection of adjacent skylights of the system.

FIG. **17** shows additional detail of how the adjacent skylight ends are joined to each other.

The invention is not limited in its application to the details of construction, or to the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various other ways. Also, it is to be understood that the terminology and phraseology employed herein is for purpose of description and illustration and should not be regarded as limiting. Like reference numerals are used to indicate like components.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

The products and methods of the present invention provide a load support structure, optionally a rail and closure structure for use in installing various exterior roof loads, as well as structures which close off apertures in metal roofs. For purposes of simplicity, "roof penetrating structures" and "skylights" will be used interchangeably to mean various forms of roof structures installed on the upper surface of the roof and closing off roof apertures while providing for passage of light and/or ventilation, air handling, vents, air intake, air or other gaseous exchange to and/or from the interior of the building. In the case of roof ventilation, examples include simple ventilation openings, such as for roof fans, and smoke vents, which are used to allow the escape of smoke through the roof during fires. In the case of exterior loads on the roof, there can be mentioned, without limitation, such loads as air conditioners, air handlers, solar panels and other equipment related building utilities, and/or to controlling water or air temperatures inside the building. The only limitation regarding the loads to be supported is that the magnitude of a load must be within the load-bearing capacity of the roof panel or panels to which the load is mounted.

The number of skylights or other roof loads can vary from one structure, to as many structures as the building roof structure can support, limited only by the amount of support provided by the surrounding roof surface structure, and with the support capabilities, e.g. at the ribs, being left largely intact during the installation process.

The closure system of the invention utilizes the beam strength of the major rib structure in the roof panels as the primary support structure for mounting and fastening the e.g. skylight assembly to the roof. Typical conventional skylight installations use a curb construction surrounding and supporting each skylight lens, the curb structure being typically 2-4 times wider than skylight support structure used in the present invention and 2-4 times wider than the roof panels on the roof.

The skylight system of the invention does not require any structure underneath the roofing panels inside the building enclosure. Neither does the skylight system of the invention require a separate curb construction to support or mount or attach each skylight to the roof. Rather, the load support system of the invention is overlaid onto, and mounted to, the roof panels at the standing ribs, and thereby allows for thermal expansion and contraction of the load support system along with thermal expansion and contraction of the respective roof panel or panels by utilizing major profiles of the e.g. conventional metal roof panels for support. This is accom-

plished through direct attachment of the load support system of a skylight of the invention to the underlying ribs.

In reference now to the figures, the system allows the installation of two or more adjacent skylights in an end to end relationship along the major rib structure of a metal roof panel on the building.

The skylight systems of the invention can be applied to various types of ribbed roof profiles. FIG. **1** is an end view showing the roof profile of a metal roof of the type known as a standing seam roof. These include the "standing seam" roof, which has trapezoidal major ribs **12** typically 24" to 30" on center. Each roof panel **10** also includes a panel flat **14**, and a shoulder **16** between the rib elevations on the respective elongate sides of the panel, and the rib elevations cooperate with corresponding rib elevations on next-adjacent panels, thus forming standing seams **18**. The rib elevations on respective adjacent panels are folded over to collectively create the standing seams, thus to prevent water from penetrating the roof at the standing seams.

FIG. **2** is an end view showing the roof profile of a metal roof of the type known as an architectural standing seam roof, which uses a series of overlapping architectural standing seam panels **20**. Each panel **20** comprises a panel flat **24**, with an architectural standing seam **28** formed at the panel interconnections.

FIG. **3** is a view showing the roof profile of a metal roof of the type commonly referred to as an R panel or exposed fastener panel **30**. Each panel has a rib **32**, and a panel flat **34**. Adjacent R panels are secured to the roof through structural fasteners **35**. At shoulder **36**, which is formed from overlapping regions, or at side lap **38**, the adjacent panels are secured through stitch fasteners **39**. Trapezoidal major ribs of the R panel roof are most typically formed at 8 inches to 12 inches on center.

FIG. **4** is a view showing the roof profile of a metal roof of the type commonly referred to as a snap rib seam panel **40**. Snap seam panels **40** have a panel flat **44** and a standing seam or snap seam **48** where the adjacent panels meet.

FIG. **5** is a view showing a roof profile of a metal roof of the type commonly referred to as using a foam core panel **50**. Such roof has a rib **52**, a liner panel **53**, a panel flat **54** and a foam core **57**. Side laps **58** are secured by stitch fasteners **59**. Such roof panels are typically installed from the interior of the building.

A skylight/ventilation support structure is illustrative of roof-penetration closure structures of the invention, and includes a rail and closure structure adapted to be supported by the prominent elevations, seams, rib structures, or other structural elements of conventional such roof profiles, where the standing structure of the roof system, namely structure which extends above the panel flat, e.g. at seams which mount adjoining exterior roof panels to each other, provides the support for the load support structures, and the roof-penetration closure structures, e.g. skylight/ventilation assemblies, are secured to the conventionally-existing elements of the roof structure, namely to the conventional metal roofing panels, and overlie an opening formed largely in the intervening, non-structural roof flat region and without removing significant portions of the rib/seam/elevation structures.

Turning now to FIG. **6**, there is shown two exemplified load support structures **100**, overlain by skylight lens subassemblies, and attached to a standing seam panel roof **110**. While FIG. **6** depicts such assembly, the components of the load support structures can be adapted, by shaping of the elements, for attachment to any roof system which has a profile which includes elevations, above the panel flat, which provide places for structural support of the respective skylight or other roof-mounted assemblies or other roof-mounted loads.

Looking again to the figures, particularly FIGS. **6** and **7**, there is shown a portion of such a standing seam panel roof **110**, in dashed outline, having structural and other elements including a raised rib **112**, a panel flat **114**, shoulder **116** and standing seam **118**. Given that water generally seeks the lowest level available, rib **112**, shoulder **116**, and standing seam **118** are all generally above the water line. Also depicted in FIGS. **6** and **7** are ridge cap **120** of the roof structure, and a cutaway region, or gap, also referred to as a slot, **122** in the raised rib **112** on one side of each rail and closure assembly, the gaps being formed to accommodate the closure structure, as described more fully following.

Shown as part of the system, and exemplified in this case, is a skylight lens subassembly **130**, generally comprising a skylight lens frame **132** extending about the perimeter of an aperture in the roof, and a skylight lens **134**. An exemplary such skylight lens is that taught in U.S. Pat. No. 7,395,636 Blomberg and available from Sunoptics Prismatic Skylights, Sacramento, Calif.

While the figures depict a skylight, the rail structure, with or without end closures, can be used to mount a wide variety of loads on such roof, including various types of skylights, smoke vents, air conditioning, other vents, air intakes, air and other gaseous exhausts, electrical panels or switching gear, and/or other roof loads, including roof-penetrating structures, all of which can be supported on rail structures of the invention.

Again referring to FIGS. **6** and **7**, the load support structure of the invention, as applied to a skylight installation, includes a rail and closure structure **140**, generally comprised of side rails **142** and **144**, an upper diverter **146** disposed adjacent the rib cutaway section, or gap **122**, and a lower end closure. A sealing portion of the upper diverter may be located in gap **122**, sealing the sides and bottom of the gap against water leakage into the building and carrying water laterally across the width of the respective rib, to the panel flat **114** of the adjacent roof panel, thus to transport the water away from the upper end of the skylight and to prevent the water from leaking through the roof opening.

FIG. **7** shows how gap **122** in roof rib **112** provides for water flow, as illustrated by arrow **200**, causing the water to move laterally along the roof surface, over the sealing portion of the upper diverter, and down and away from the roof ridge cap **120** in panel flats **114** of roof panels which are adjacent the roof structures which support the respective e.g. skylights.

Lower end closure **150** closes off the roof aperture from the outside elements at the lower end of the e.g. skylight, thus to serve as a barrier to water leakage at the lower end of the roof opening.

Referring now to FIG. **8**, a cross section through the load support structure **100** shows the securement of structure **100** to standing rib portions of the standing seam panel roof **110**. FIG. **8** depicts the use of ribs **112** to support the side rails **142** and **144** on opposing sides of the panel flat **114**. Each rail **142** or **144** has a rail upper flange or bearing panel **240** and a rail lower shoulder **242**. Skylight frame **132** is secured to rails **142**, **144** by fasteners **300**, only one of which is shown, spaced along the length of the rib.

A rail shoulder **242** is shaped to fit closely over the outside of the roof rib **112**, and is secured to roof rib **112** by e.g. rivets **310**, only one of which is shown, spaced along the length of the rib. An upstanding web extends upwardly from shoulder **242** alongside, and spaced above, standing seam **118**, to rail bearing surface **240**. Rail bearing surface **240**, at the top of the rail, supports skylight frame **132**. A sealant **330** is disposed

between bearing surface **240** and skylight frame **132**, to seal against the passage of water or air across the respective joint.

Rail and closure structure **140** is representative of load support structure **100** and can be produced to fit closely along the contour of roof **110**, and can be so configured to have end portions that match the cross-panel contours of the respective ribs **112**. The various mating surfaces of structure **140** and roof **110** can be sealed in various ways known to the roofing art, including caulking or tape mastic, or various rubber fittings or inserts can be used to seal around the open area of the aperture in the roof.

In FIG. **9** a partially cut away perspective view of rail and closure structures **140** is used to show support of the rail and closure structure by standing seam panel roof **110**, particularly the elevated rib **112** providing the structural support at the standing seams. FIG. **9** illustrates how the rail and closure structures incorporate the structural profiles of the roof panels of the metal roof structure above and below the skylights, and incorporate the elevations and ribs used in sealing adjacent ones of the panels, to provide the primary support, by the roof panels, for the loads imposed by the skylights. In this fashion, the load support structures of the invention adopt various ones of the advantages of a standing seam roof, including the beam strength features of the ribs at the standing seam, as well as the water barrier features of the standing seam.

Most standing seam roofs are seamed using various clip assemblies that allow the roof panels to float/move relative to each other, along the major elevations, namely along the joints between the respective roof panels, such joints being defined at, for example, elevated ribs **112**, whereby each roof panel is free to expand and contract according to e.g. ambient temperature changes irrespective of any concurrent expansion or contraction of the next-adjacent roof panels. Typically, a roof panel is fixed at the eave and allowed to expand and contract relative to a ridge. In very wide roofs, the panels can be fixed at midspan, whereby the panels expand and contract relative to both the eave and ridge.

The design of the skylight system of the invention takes advantage of the floating features of contemporary roofing structures, such that when skylight assemblies of the invention are secured to respective rib elevations as illustrated in e.g. FIGS. **8** and **9**, the skylight assemblies, themselves, are supported by the roof panels at ribs **112**, and thus move with the expansion and contraction of the roof panels to which they are mounted.

FIG. **9** shows panel flat **114**, rib **112**, and shoulder **116**, as well as standing seam **118**. Ridge cap **120** is also shown, as well as the gap **122** in a rib **112**.

Skylight subassembly **130** is supported by ribs **112**, on rail and closure structure **140**, as previously described.

Skylight frame **132** is secured by a series of fasteners **300** to rail and closure structure **140** at side rails **142** and **144** and rails **142** and **144** are secured to ribs **112** by a series of rivets **310**.

In application, for each rail and closure structure **140**, a short length of a single rib **112** is typically cut away, forming a gap **122** in the respective rib, to accommodate drainage at the high end of the rail and closure structure (toward ridge cap **120**). Such gap is typically used with standing seam, architectural standing seam and snap seam roofs. Two ribs may be cut for roofs having an "R" panel profile.

The retained portions of rib **112**, namely along the full length of the skylight as disposed along the length of the respective roof panel, provide beam-type structural support, supporting side rails **142** and **144** and maintaining the conventional watertight seal at the joints between roofing panels, along the length of the assembly, Internal portions of ribs **112** may be removed to allow additional light from skylight lens assembly **130** to reach through the respective roof opening.

A bearing plate structure **148**, illustrated in FIG. **7** and following the width dimension contour of the roof panel, is placed under the respective roof panel at or adjacent the upper end of the aperture in the roof. Fasteners are driven through a high end diverter, described further hereinafter, through the roof panel and into bearing plate structure **148**, drawing the diverter, the roof panel, and the bearing plate structure close to each other and thus trapping the roof panel closely between the bearing plate and the diverter and closing off the interface between the panel and the diverter. Caulk or other sealant can be used to further reinforce the closure/sealing of that interface.

Bearing plate **148** can also be used to provide lateral support to link adjacent rib elevations **112** to each other, and is typically produced of steel or other material sufficient to provide a rigid substructure support to the skylight rail and closure structure at the high end of the rail and closure structure.

Rail and closure structure **140** is shaped in such a manner that the skylight subassembly can be easily fastened directly to the rails with rivets or other fasteners such as screws and the like as illustrated at **310** in FIG. **8**. The rail and closure structure **140** may also be designed to accept a safety security guard before the skylight lens subassembly is installed.

Looking now to FIGS. **10** through **12**, upper or high end diverter **146** provides end closure of the roof aperture at the upper end of the roof aperture, and diverts water around the upper end of the assembly, to the flat portion **114** of an adjacent panel. Diverter **146** also provides a weather tight seal at the upper end of the assembly, as used with plate **148** (shown in FIG. **6**) in combination with conventional sealant materials. In reference to side rails **142** and **144** of a standing seam panel roof **110**, diverter **146** generally fits the profile of the uncut rib **112** across the panel flat from the cut away gap **122**. The upper ends of side rails **142** and **144** abut the downstream side of diverter **146** and the height of diverter **146** closely matches the height of the side rails. Upper flange **400** of diverter **146** acts with upper flanges **240** of side rails **142** and **144** to form the upper surface of the rail and closure structure, to which skylight frame **132** is mounted, as well as surrounding a top aperture in the rail and closure structure, which is disposed above the corresponding aperture in the roof panel.

Lower flange **410** of diverter **146** runs along, and parallel to, panel flat **114** of the respective roof panel. Diverter **146** also has a diversion surface **420**, and fastener holes **430** along lower flange **410**. Diversion surface **420** is, without limitation, typically a flat surface defining first and second obtuse angles with lower flange **410** and intermediate end panel **415**. Diversion surface **420** has relatively greater width "W1" on the side of the closure structure which is against the rib which is not cut and a relatively lesser width "W2", approaching a nil dimension, adjacent rib gap **122**, thus to divert water toward gap **122**. As illustrated b the combination of FIGS. **6**, **9**, and **10**, and given the slope on the roof, the lower edge of diversion surface **420** extends at a downward slope from rib **144** to slot/gap **122**.

At the end of lower flange **410** which is closer to the closed rib is a rib mating surface **440**. At the end of lower flange **410** which is closer to the cut rib is a rib sealing portion **450** of the end panel **415**, which functions to divert water across the respective rib **112** and onto the flat portion of the adjacent roof panel. Rib sealing portion **450** extends through gap **122** in the respective rib at the panel flat elevation. Optionally, a rib plug **460**, along with suitable sealant, is inserted into the rib on

both the upstream side, and optionally on the downstream side, of the rib at gap **122**, thus to provide a closure in the cut end of the rib. Accordingly, water which approaches the high end diverter is diverted by diversion surface **420** and flange **410** toward sealing portion **450**, thence through the gap **122** in the rib, away from the high end of load support structure **100** and onto the flat portion of the next laterally adjacent roof panel.

FIGS. **13** through **15** show lower closure **150** which is used to maintain a weather tight seal at the lower end of rail and closure structure **140**. Shown again in reference to side rails **142** and **144** of a standing seam panel roof **110**, the bottom of closure **150** is contoured to fit the profiles of the ribs **112** as well as to fit the contour of panel flat **114**. Side rails **142** and **144** abut bottom closure **150** and the height of closure **150** matches the heights of side rails **142**, **144**.

Lower closure **150** has an upper flange **500** and a lower flange **510**, as well as a closure web **520**. Lower flange **510** includes fastener holes **530**. Collectively, the top flanges of side rails **142**, **144**, bottom closure **150**, and high end diverter **146** form a common top surface of the rail and closure structure, which receives the skylight lens subassembly.

Closure **150** includes rib mating flanges **540** and **550** to provide tight fits along ribs **112**.

Looking now to FIGS. **16** and **17**, the adaptation of load support structures **100** of the invention for supporting multiple skylight units over a single aperture in the roof, is shown. A chief aspect of load support structures **100** is the reduction in the number of roof penetrations, namely roof apertures, required to provide daylight lighting to the interior of e.g. a building, as multiple skylight assemblies can be mounted along the length of a single elongate aperture in the roof, whereby fewer, though longer, apertures can be made in the roof. Namely, a single opening in the roof can extend along substantially the full length of a single rib, if desired, rather than cutting multiple smaller openings along that same length, and thereby providing for an equal or greater quantity of ambient light being brought into the building through a smaller number of roof apertures.

In the case of standing seam roofs, the load support structures of the invention provide the ability to remove only a portion of the bottom flat portion of a given metal roof panel. This maintains the structural integrity of the roof panel by avoiding removal of multiple sections of major panel elevations in adjacent roof panels, as is done to accommodate a "conventional" curb assembly which spans multiple roofing panels. Thus, the structural integrity of the roof, as defined by the roof panels, is not as greatly compromised and there are fewer potential openings for water infiltration, in that the upper reaches of the skylight panels can be mounted in the roof adjacent the ridge of the building and can extend to the eave, requiring water to be diverted only once near the ridge of the roof plane and only across one panel flat.

To the limited extent that gaps are cut in the elevations/ribs, such gaps extend only a minimal length of the respective ribs, on the order of a few inches or less, solely for the purpose of allowing drainage around the upper ends of the rail and closure structures.

The rails, with or without the high end diverter or the lower closure, can be installed on major rib elevations for any of the aforementioned roof panel profiles relative to the included flat portion of the respective roofing panel, so long as the rib structure can adequately support the contemplated load.

The load support structures of the invention are particularly useful for continuous runs of e.g. skylights, where individual skylights are arranged end to end between the ridge and the eave of a roof. FIGS. **16** and **17** show how two adjacent skylight assemblies **100** can be affixed to each other along a standing seam roof **110**. Instead of installing a high end diverter and a lower closure with each of multiple skylight assemblies, the adjacent rail and closure structures, which support adjacent ones of the skylight assemblies, abut each other. Each skylight assembly has a male flange **620** extending across the width of the skylight assembly at one end of the assembly and a female flange **622** at the opposing end of the assembly. For runs of multiple skylight assemblies, disposed end to end as illustrated in FIGS. **16** and **17**, female flange **622** is mounted over male flange **620**, whereby male flange **620** is received inside cavity **624** of the female flange. Caulk or other sealant can be used to seal such closure/cavity.

As a non-limiting example, skylights can be produced in units of up to 10 feet long, and connected end to end for as long a distance as necessary to cover the aperture in the roof, as each skylight unit is supported by the ribs **112** of the respective roof panel. The standing rib elevation (the major corrugation) extends longitudinally along the full collective lengths of the sides/rails of the respective rail and closure assemblies **140**, regardless of the number of skylight assemblies which are used to close off a given aperture in the roof. Water cannot enter over the top of the rail and closure assembly because of the sealant at **330**. Water cannot enter at the high end diverter because of the seal properties provided by the high end diverter, by bearing plate **148**, and by the respective sealants, as well as because of the diversion of water away from the high end through gap **122**. Similarly, water cannot enter at the lower end because of the seal properties provided by the lower closure and by the sealants between the lower closure and the respective roof panel.

Where the skylight assembly starts at the ridge of the roof, a flashing can be inserted under the ridge cap and extended to the high end diverter.

Where the ridge cap has a configuration to fit the rib elevations (major corrugation) in the roofing panels, a portion of the rib, in the ridge cap, may be cut out (approximately 2 inches as in all rib cutting discussed elsewhere herein), allowing the water from the roof above the cut to be diverted laterally, sideways onto the next adjacent roof panel, as across sealing portion **450** and thus across the rib.

If desired, side-by-side rails **142**, **144** can be increased in height to increase the distance/height between an upper portion of the rail and closure structure and the respective underlying roof panel. In the alternative, a height extension rail can be laid over or attached to the top of the rail and closure structure to provide a corresponding height increase. Such an extension can be produced to rest along the upper flange of the rail and closure assembly, to effectively raise the height of the skylight or smoke vent to accommodate different depths or other design features of the respective skylights, smoke vents, or other roof loads, or to accommodate snow conditions, anticipated snow depths, and the like. In this fashion, the rail and closure structure can be produced to a standard height, with varying extensions used to elevate the overall height of the structure for such varied purposes. Various forms for such an extension can be suitable, and the skilled artisan will understand various ways and means of designing and manufacturing such extension to accomplish the goal of added elevation for the skylight lens.

As indicated above, the weight of the loads transferred by rails **142**, **144** is transferred directly to ribs **112** of the respective underlying roof panels along the full lengths of the load support structures; and only a minor portion of that weight is borne by the panel flat, and only at the high end and at the lower end of a load which overlies an aperture in the roof, and wherein such aperture can underlie e.g. multiple skylight

units. Thus, the weight of the rails, or the rail and closure assembly, is borne by the strongest elements of the roof panels. Specifically because the weight is borne directly by the panel ribs, a wide variety of roof-mounted loads, in addition to skylights and smoke vents, is contemplated to be mounted on rails **142**, **144**. Where the load overlies an aperture in the roof, the rail system provides for fewer apertures. Where the load does not overlie an aperture in the roof, the rail system allows the roof to carry the weights of a variety of loads without penetrating the roof for the purpose of extending the support path through openings in the roof to the underlying building structural members, also without adding framing or other bracing under the roof panels to support the weight of such roof-mounted hardware, and thus avoiding water leaks associated with such openings, so long as the weight of such roof-mounted loads do not exceed the allowable load on the ribs. And where a roof-mounted load is e.g. an air conditioner, namely a load which does not require a roof opening, the high end diverter and the lower end closure can be omitted.

The primary reason why the disclosed rail and closure structures do not leak is that a great portion of the perimeter of the closure, namely that which is defined by side rails **142**, **144**, is above the panel flat, namely above the water lines on the roof panels. With no standing water at the joints between the rails and the roof panels, even if the sealant fails at the joint, the heights of those joints above the water line means that no water routinely enters such failed joint.

As a general statement, rail and closure structures of the invention close off the roof aperture from unplanned leakage of e.g. air or water through the roof aperture. The rail and closure structure **140** extends about the perimeter/sides of the roof aperture and extends from the roofing panel upwardly to the top opening in the rail and closure structure. The lens subassembly overlies the top opening in the rail and closure structure and thus closes off the top opening to complete the closure of the roof aperture.

Load support structure **100** thus is defined by rail and closure structure **140** about the perimeter of the roof opening and by skylight lens subassembly **130**, or the like, over the top of the rail closure structure and thus over the top of the roof aperture.

Although the invention has been described with respect to various embodiments, this invention is also capable of a wide variety of further and other embodiments within the spirit and scope of the appended claims.

Those skilled in the art will now see that certain modifications can be made to the apparatus and methods herein disclosed with respect to the illustrated embodiments, without departing from the spirit of the instant invention. And while the invention has been described above with respect to the preferred embodiments, it will be understood that the invention is adapted to numerous rearrangements, modifications, and alterations, and all such arrangements, modifications, and alterations are intended to be within the scope of the appended claims.

To the extent the following claims use means plus function language, it is not meant to include there, or in the instant specification, anything not structurally equivalent to what is shown in the embodiments disclosed in the specification.

Having thus described the invention, what is claimed is:

1. A roof adaptive system configured to be installed about an aperture in a metal roof, such metal roof comprising a plurality of roof panels, having lengths and widths, such roof panels being arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof thereby to define elevated roof panel ribs, panel flats being disposed between such roof panel ribs, a given such roof panel rib comprising a rib shoulder, and a standing seam extending up from such shoulder, said roof adaptive system comprising a load support structure having a length, and being configured to be supported by first and second ones of the elevated roof panel ribs and to extend about such aperture and across a such panel flat, from rib to rib, between said first and second ribs, said load support structure comprising:

(a) first and second rails, having lengths, and being configured to be mounted to first and second ones of such roof panel ribs at such rib shoulders, and to extend upwardly from such rib shoulders alongside and above such standing seams, thus to define opposing sides of said load support structure; and

(b) end elements configured to extend between adjacent ends of said first and second rails, thus to define ends of said load support structure.

2. A roof adaptive system as in claim **1**, said load support-structure comprising an elongate rail having a first cross-section profile, a respective roof panel rib having a second cross-section profile, a portion of the first cross-section profile of said rail being in substantial fact-to-face contact with a portion of the second cross-section profile of the respective said roof panel rib.

3. A roof adaptive system as in claim **2**, said load support structure comprising first and second said elongate rails being configured to extend parallel to respective first and second rib structure on respective sides of a such panel flat.

4. A roof adaptive system as in claim **1** wherein said elongate rails are configured to extend parallel to outer surfaces of such roof panels at such rib structures on opposing sides of a such panel flat, with the respective said roof panel ribs being disposed between the aperture and lower shoulders of the respective said ribs.

5. A roof adaptive system as in claim **1**, one said end element comprising an upper diverter having a first cross-section profile of a such roof panel as is to be spanned by said load support structure having a second cross-section profile, a portion of the first cross-section profile of said upper diverter being in substantial face-to-face contact with a portion of the second cross-section profile of such roof panel, and which upper diverter, when said roof adaptive system is so installed, closes off said load support structure, at an upper end of said load support structure, from intrusion of water inwardly, through said load support structure and toward such aperture in such metal roof.

6. A roof adaptive system as in claim **5**, a second said end element comprising a lower closure, adapted to close off a lower end of said load support structure from intrusion of water.

7. A roof adaptive system as in claim **6** wherein, when said load support structure is so installed on said roof, said lower closure extends parallel to an elevated rib structure of a known such roof panel.

8. A roof adaptive system as in claim **6**, further comprising a skylight, said skylight being configured to be mounted to said load support structure along the length of said load support structure.

9. A roof adaptive system as in claim **5**, said upper diverter comprising a lower flange and an end panel, and a diversion surface between said lower flange and said end panel, the diversion surface defining first and second obtuse angles with said lower flange and said end panel.

10. A roof adaptive system as in claim **9** wherein the diversion surface has an upper edge and a lower edge, and a

relatively greater width on a first side of said load support structure and a relatively lesser width on a second side of said load support structure.

11. A roof adaptive system as in claim **1**, further comprising an operable vent which can be alternatively closed, and opened to the outside environment, said vent being configured to overlie, and to be supported by, said load support structure.

12. A roof adaptive system as in claim **1**, further comprising a closure member configured to be supported on, and to overlie, said load support structure, an opening being defined in said closure member, such opening being configured to cooperate in conveying a gas through an aperture in such roof.

13. A roof adaptive system as in claim **1** wherein said load support structure extends parallel to such elevated rib structure such that said rails, at such rib structure, are spaced above such panel flats of respective such roof panels.

14. A metal roof on a building, such metal roof comprising a plurality of metal roof panels, having lengths and widths, such roof panels being arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof thereby to define elevated ribs, panel flats being disposed between such ribs, a given such rib comprising a rib shoulder, and a standing seam extending up from such shoulder, said metal roof comprising a roof adaptive system as in claim **1**, such aperture extending through said roof, and defining a passage between an interior of such building and an outside environment outside such building, said load support structure being supported by first and second ones of the elevated ribs and extending about such aperture, said first and second rails being mounted to said first and second ones of said ribs at said rib shoulders, and extending upwardly from said rib shoulders alongside and above said standing seams, thus defining opposing sides of said load support structure; and said end closures extending between adjacent ends of said first and second rails and thus defining ends of said load support structure.

15. A roof adaptive system as in claim **1** wherein said load support structure, when so installed on such roof, overlies a single such roof panel between adjacent such ribs.

16. A building, comprising:

(a) a building structural support system;

(b) a sloping roof supported by said building structural support system, said sloping roof comprising a plurality of elongate roof panels arranged side by side, said roof panels having lengths, edges of adjacent said roof panels meeting at elevated rib structure portions thereof, thereby to define elevated ribs, having lengths, panel flats being disposed between said elevated ribs; and

(c) a roof adaptive system comprising

(i) an aperture in said roof, such aperture having a length and being confined within a given said roof panel,

first and second ones of said ribs extending alongside such aperture, and

(ii) a load support structure extending about such aperture, said load support structure comprising

A. first and second elongate rails extending alongside such aperture, said first and second rails being mounted, to said first and second on opposing sides of such aperture, at multiple locations along the lengths of said ribs, and

B. end closures at upper and lower ends of said load support structure, said end closures extending between said first and second rails.

17. A building as in claim **16**, further comprising a diversion slot extending across a said rib adjacent a such panel flat at, and extending away from an end of said load support structure, and at an elevation of the respective panel flat.

18. A building as in claim **16**, said end closure at said upper end of said load support structure comprising an upper diverter extending across the respective such panel flat from said first rail to said second rail, and closing off said load support structure above the respective such panel flat, between the respective said ribs, and extending from such panel flat upwardly to an upper opening in said load support structure.

19. A building as in claim **18**, further comprising a diversion slot extending across one of said first and second ribs adjacent a such panel flat at, and extending away from, an end of said load support structure, and at an elevation of the respective panel flat.

20. A building as in claim **19** wherein the diversion surface has an upper edge and a lower edge, and a relatively greater width on a first side of said load support structure and a relatively lesser width on a second side of said load support structure.

21. A building as in claim **20** wherein the lower edge of the diversion surface extends at a downward slope from the first side of said load support structure toward the diversion slot.

22. A building as in claim **16**, further comprising a diversion slot cut through, and extending across, a said elevated rib adjacent a respective such panel flat, and a diverter in the diversion slot, diverting water laterally away from the upper end of said load support structure and onto the adjacent said roof panel.

23. A building as in claim **16**, said elongate rails having first cross-section profiles, said elevated ribs having second cross-section profiles, a portion of the first cross-section profiles of said rails being in substantial face-to-face contact with portions of the second cross-section profiles of said ribs.

24. A building as in claim **16** wherein said load support structure comprises at least first and second said skylights in end-to-end relationship over a single such aperture.

25. A building as in claim **16** wherein said load support structure, at said rib structure, is above, and spaced from, such panel flat of said given roof panel.

26. A building as in claim **16**, said end closures comprising an upper diverter which extends parallel to a top surface profile of a respective roof panel at the upper end of said load support structure, and closing off said load support structure at such upper end of said load support structure from intrusion of water into the roof aperture.

27. A building as in claim **16**, said end closure, at the lower end of said load support structure, closing off the lower end of said load support-structure from intrusion of water.

28. A building as in claim **27** wherein said lower end closure extends along outer surfaces of the respective said elevated ribs.

29. A building as in claim **16**, said load support structure defining a top opening extending therethrough, said roof adaptive system further comprising a closure panel closing off the top opening.

30. A building as in claim **29**, said closure panel comprising a skylight lens mounted to a skylight frame, said skylight frame extending about a perimeter of said lens, said skylight frame being mounted to said first and second rails, at multiple locations along the length of said rail structure.

31. A building as in claim **30** wherein said skylight frame is mounted to said rails above the respective said ribs.

32. A building as in claim **29** wherein said closure panel comprises a smoke vent panel.

33. A building comprising:

(a) a building structural support system;

(b) a sloping roof supported by said building structural support system, said sloping roof comprising a plurality of elongate roof panels arranged side by side, said roof panels having lengths, edges of adjacent said roof panels meeting at elevated rib structure portions thereof, whereby said roof panels thereby define elevated roof panel ribs, having lengths, panel flats being disposed between said elevated roof panel ribs, and

(c) a load support structure, having a length, extending along the lengths of first and second ones of said roof panel ribs, said load support structure comprising first and second rails having lengths extending in a same direction as the lengths of said roof panel ribs, first and second ones of said roof panel ribs underlying, and supporting, said first and second rails on opposing sides of a given said panel flat.

34. A building as in claim **33** wherein said first and second rails are attached to adjacent ones of said ribs which extend along opposing sides of a single one of said roof panels.

35. A building as in claim **33**, said ribs

underlying and supporting said rails at multiple locations along the lengths of said ribs whereby the respective said first and second ribs receive and support substantially all of said load, and provide primary support, by said ribs, of said load support structure, and said overlying load, whereby beam strength of said first and second ribs provides primary support of said load.

36. A building as in claim **33**, further comprising a load mounted to said rails above the respective said ribs.

37. A building, comprising:

(a) a building structural support system;

(b) a sloping roof supported by said building structural support system, said sloping roof comprising a plurality of elongate roof panels arranged side by side, said roof panels having lengths, edges of adjacent said roof panels meeting at elevated rib structure portions thereof, thereby to define elevated ribs, having lengths, panel flats being disposed between said elevated ribs; and

(c) a roof adaptive system comprising

(i) an aperture in said roof, such aperture having a length and being confined within a given said roof panel,

first and second ones of said ribs extending alongside such aperture, and

(ii) a load support structure extending about such aperture, said load support structure comprising

A. first and second elongate rails extending alongside such aperture, first and second ones of said ribs underlying, and supporting, said first and second rails on opposing sides of such aperture, and

B. end closures at upper and lower ends of said load support structure, said end closures extending between said first and second rails.

38. A building as in claim **37**, further comprising a diversion slot extending across a said elevated rib adjacent a such panel flat at, and extending away from, an end of said load support structure, at an elevation of the respective panel flat.

39. A building as in claim **37**, said end closure at said upper end of said load support structure comprising an upper diverter extending across the respective such panel flat from said first rail to said second rail, and closing off said load support structure above the respective such panel flat, between respective said first and second ribs, and extending from such panel flat upwardly to an upper opening in said load support structure.

40. A building as in claim **39**, said upper diverter comprising a lower flange and an end panel, and a diversion surface between said lower flange and said end panel, the diversion surface defining first and second obtuse angles with said lower flange and said end panel.

41. A building as in claim **40** wherein the diversion surface has an upper edge and a lower edge, and a relatively greater width on a first side of said load support structure and a relatively lesser width on a second side of said load support structure.

42. A building as in claim **41** wherein the lower edge of the diversion surface extends at a downward slope from the first side of said load support structure toward the diversion slot.

43. A building as in claim **37**, further comprising a diversion slot extending across a said rib adjacent a respective such panel flat, and a diverter in the diversion slot, diverting water laterally away from the upper end of said load support structure and onto the adjacent said roof panel.

44. A building as in claim **37**, said first and second rails having first cross-section profiles, said ribs having second cross-section profiles, a portion of the first cross-section profiles of said rails being in substantial face-to-face contact with portions of the second cross-section profiles of said ribs.

45. A building as in claim **37** wherein said load support structure comprises at least first and second skylights in end-to-end relationship over a single such aperture.

46. A building as in claim **37** wherein said load support structure, at said rib structure, is above, and spaced from, such panel flat of said given roof panel.

47. A building as in claim **37**, further comprising a load mounted to said rails above the respective said ribs.

48. A building, comprising:

(a) a building structural support system;

(b) a sloping roof supported by said building structural support system, said sloping roof comprising a plurality of elongate roof panels arranged side by side, edges of adjacent said roof panels meeting at elevated rib structure portions thereof, thereby to define elevated ribs, panel flats being disposed between said elevated ribs; and

(c) a roof adaptive system comprising

(i) an aperture in said roof, such aperture having a length, first and second ones of said ribs extending alongside such aperture, and

(ii) a load support structure extending about such aperture, said load support structure comprising

A. first and second elongate rails extending alongside such aperture, said first and second rails being mounted to said first and second ribs on opposing sides of such aperture, and

B. end closures, at upper and lower ends of said load support structure, extending between said first and second rails, a diversion slot extending across one of said first and second ribs adjacent a such panel flat at, and extending away from, an end of said load support structure, and at an elevation of the respective panel flat.

49. A building as in claim **48**, said end closure at said upper end of said load support structure comprising an upper diverter extending across the respective such panel flat from said first rail to said second rail, and closing off said load support structure above the respective panel flat, between the respective said ribs, and extending from such panel flat upwardly to an upper opening in said load support structure.

50. A building as in claim **49**, said upper diverter comprising a lower flange and an end panel, and a diversion surface between said lower flange and said end panel, the diversion surface defining first and second obtuse angles with said lower flange and said end panel.

51. A building as in claim 50 wherein the diversion surface has an upper edge and a lower edge, and a relatively greater width on a first side of said load support structure and a relatively lesser width on a second side of said load support structure.

52. A building as in claim 48, said end closure at said upper end of said load support structure comprising an upper diverter extending across the respective such panel flat from said first rail to said second rail, said upper diverter extending through the diversion slot, thereby diverting water laterally away from the upper end of said load support structure and onto the adjacent said roof panel.

53. A building as in claim 52, said upper diverter comprising a lower flange and an end panel, and a diversion surface between said lower flange and said end panel, the diversion surface defining first and second obtuse angles with said lower flange and said end panel, and wherein the lower edge of the diversion surface extends at a downward slope from the first side of said load support structure toward the diversion slot.

54. A building as in claim 48, said rails having first cross-section profiles, said ribs having second cross-section profiles, portions of the first cross-section profiles of said rails being in substantial face-to-face contact with portions of the second cross-section profiles of said ribs.

55. A building as in claim 48 wherein said load support structure, at said rib structure, is above, and spaced from, such panel flat of respective said roof panels.

56. A building as in claim 48, further comprising a load mounted to said rails above the respective said ribs.

57. A building, comprising:

(a) a building structural support system;

(b) a sloping roof supported by said building structural support system, said sloping roof comprising a plurality of elongate roof panels arranged side by side, said roof panels having lengths, edges of adjacent said roof panels meeting at elevated rib structure portions thereof, thereby to define elevated roof panel ribs, panel flats being disposed between said elevated roof panel ribs; and

(c) a roof adaptive system comprising

(i) an aperture in said roof, such aperture having a length, first and second ones of said ribs extending alongside such aperture, and

(ii) a load support structure extending about such aperture, said load support structure comprising

A. first and second elongate rails extending alongside such aperture, first and second ones of said roof panel ribs underlying, and supporting, said first and second rails along full lengths of said first and second rails, and

B. end closures, at upper and lower ends of said load support structure, extending between said first and second rails.

58. A metal roof, such metal roof comprising a plurality of metal roof panels, having lengths and widths, such roof panels being arranged side by side, edges of adjacent such roof panels meeting at elevated rib structure portions thereof thereby to define elevated roof panel ribs, panel flats being disposed between such roof panel ribs, each such roof panel rib extending in a first direction and comprising a rib shoulder, and a standing seam extending up from such rib shoulder and extending in the first direction, said metal roof comprising a roof adaptive system, said roof adaptive system comprising:

(a) an aperture extending through said roof, and defining a passage between an interior of such building and an ambient environment outside such building, first and second ones of said ribs extending alongside, and on opposing sides of, such aperture; and

(b) a load support structure, said load support structure being supported by ones of said elevated roof panel ribs and extending about such aperture, said load support structure comprising

(i) first and second rails, mounted to first and second ones of said roof panel ribs at the respective said first and second rib shoulders, and extending upwardly from said first and second rib shoulders and extending in the first direction alongside and above the respective said first and second standing seams; and

(ii) end closures extending between adjacent ends of said first and second rails and thus defining ends of said load support structure.

59. A metal roof as in claim 58, further comprising a diversion slot extending across one of said first and second elevated ribs adjacent a such panel flat at, and extending away from, an end of said load support structure, and at an elevation of the respective panel flat.

60. A metal roof as in claim 58, said end closure at said upper end of said load support structure comprising an upper diverter extending across the respective such panel flat from said first rail to said second rail, and closing off said load support structure above the respective such panel flat, between the respective said ribs, and extending from such panel flat upwardly to an upper opening in said load support structure.

61. A metal roof as in claim 60, said upper diverter comprising a lower flange and an end panel, and a diversion surface between said lower flange and said end panel, the diversion surface defining first and second obtuse angles with said lower flange and said end panel.

62. A metal roof as in claim 61 wherein the diversion surface has an upper edge and a lower edge, and a relatively greater width on a first side of said load support structure and a relatively lesser width on a second side of said load support structure.

63. A metal roof as in claim 58, said end closure at an upper end of said load support structure comprising an upper diverter extending across the respective such panel flat from said second rail, further comprising a diversion slot cut through, and extending across, a said elevated rib adjacent a respective such panel flat, said upper diverter extending through the diversion slot, thereby diverting water laterally away from the upper end of said load support structure and onto the adjacent said roof panel.

64. A metal roof as in claim 63, said upper diverter comprising a lower flange and an end panel, and a diversion surface between said lower flange and said end panel, the diversion surface defining first and second obtuse angles with said lower flange and said end panel, and wherein the lower edge of the diversion surface extends at a downward slope from the first side of said load support structure toward the diversion slot.

65. A metal roof as in claim 58 wherein said load support structure, at said rib structure, is above, and spaced from, such panel flat of a given said roof panel.

66. A building as in claim 58, further comprising a load mounted to said rails above the respective said ribs.

67. A metal roof as in claim 58, portions of opposing sides of said load support structure extending above said first and second standing seams and extending parallel to said standing seams.

* * * * *

EXHIBIT C

US008438801B2

(12) **United States Patent**
McLain et al.

(10) **Patent No.: US 8,438,801 B2**
(45) **Date of Patent: May 14, 2013**

(54) **SUPPORT STRUCTURES ON ROOFS**

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E06B 3/26	(2006.01)

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(58) **Field of Classification Search** 52/200, 52/18, 72, 80.1, 90.1, 90.2, 91.1, 202, 19, 52/536, 537, 545
See application file for complete search history.

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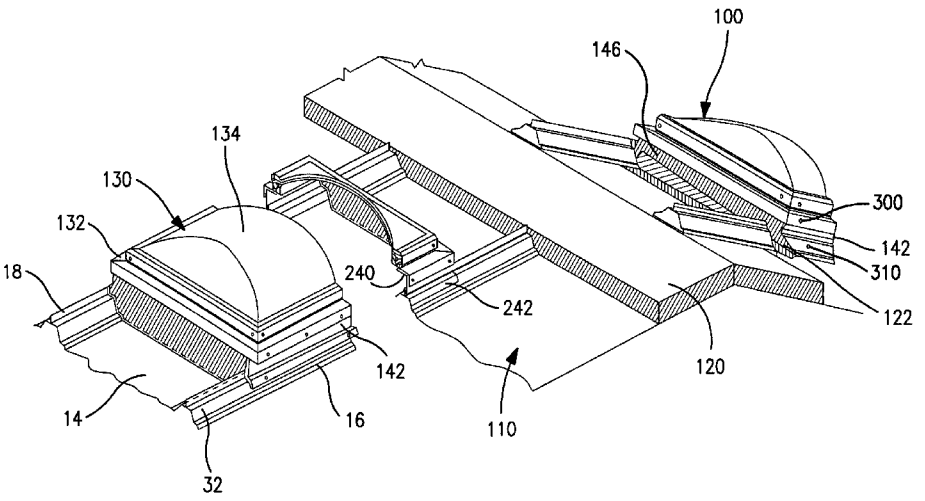
(57) **ABSTRACT**

Roof load supports support e.g. skylights and/or smoke vents, optionally including two or more closures in end-to-end relationship, from ribs of a metal roof. Where skylights are end-to-end over an aperture, mating strips support the skylights between upper and lower ends of the support structure. Supports of the invention are mounted above the water line whereby the number of water leaks about the mounting structure is greatly reduced. Water leakage is further reduced by re-designing the upper diverter and the lower closure, and providing for a second installation step. Condensation is further reduced by lifting the insulation inside the building to cover the sides of the closure support structure and providing a no-fastener securement of the insulation at an upper location in the closure support structure, and by providing thermally insulating materials as barriers to penetrating portions of fasteners, penetrating from outside the climate controlled building envelope.

34 Claims, 21 Drawing Sheets



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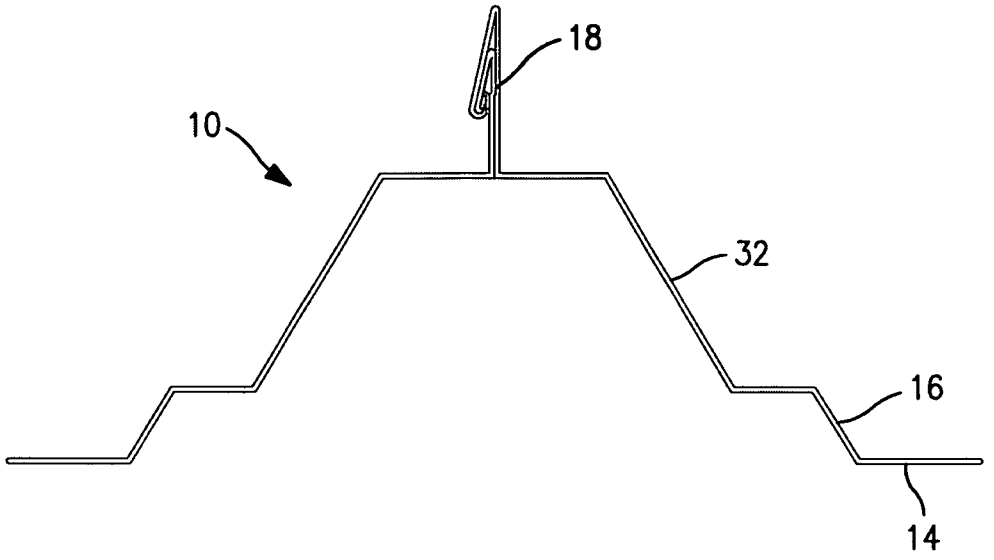


FIG. 1

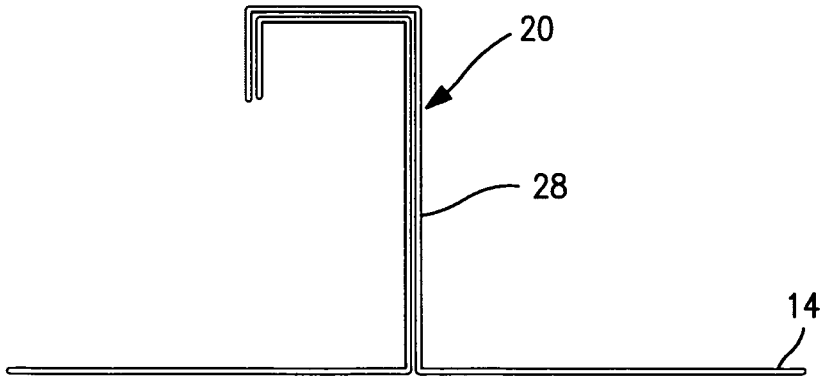


FIG. 2

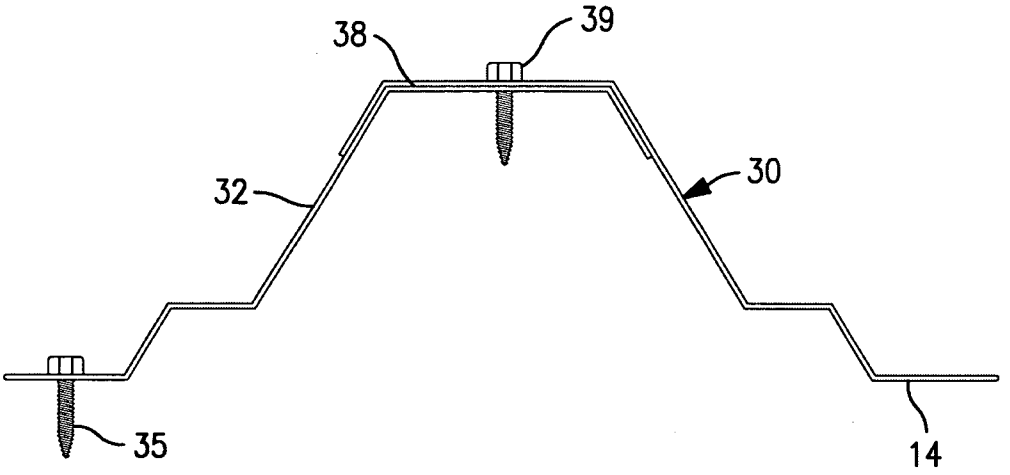


FIG. 3

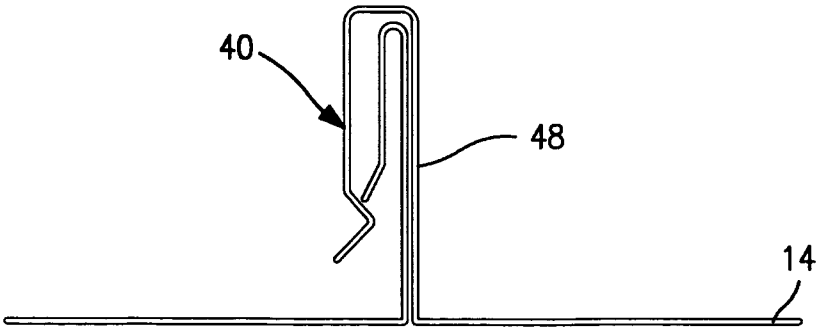


FIG. 4

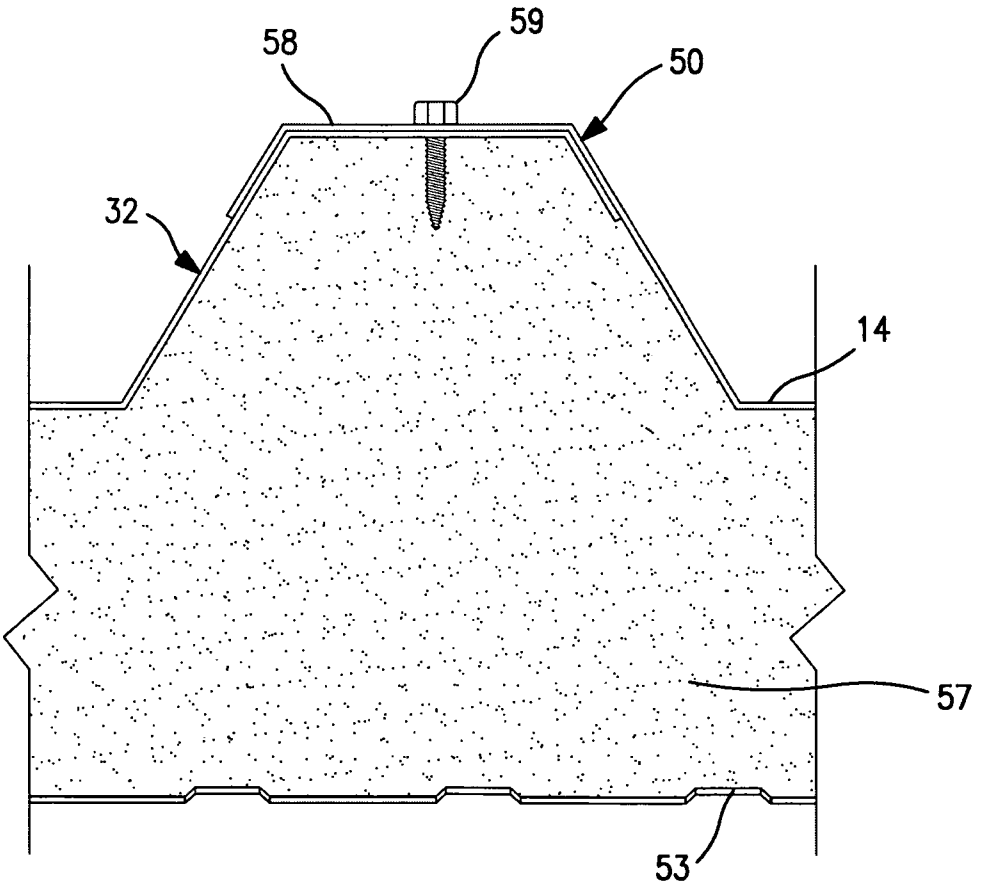
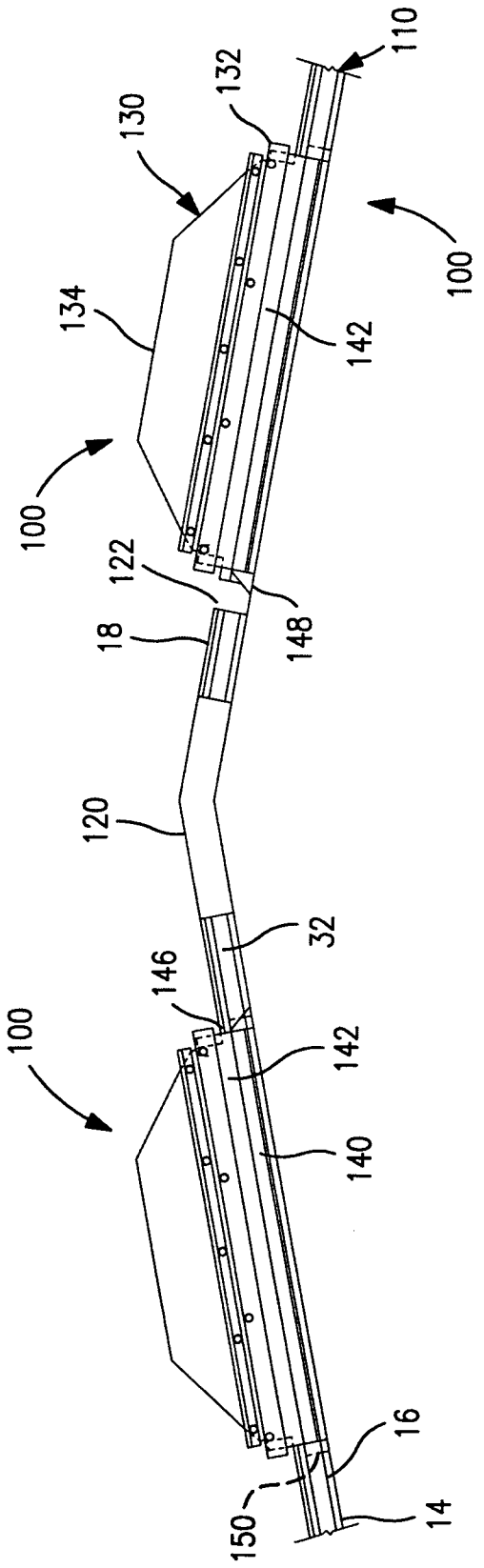


FIG. 5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132
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134
142
100
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148
18
120
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146
100
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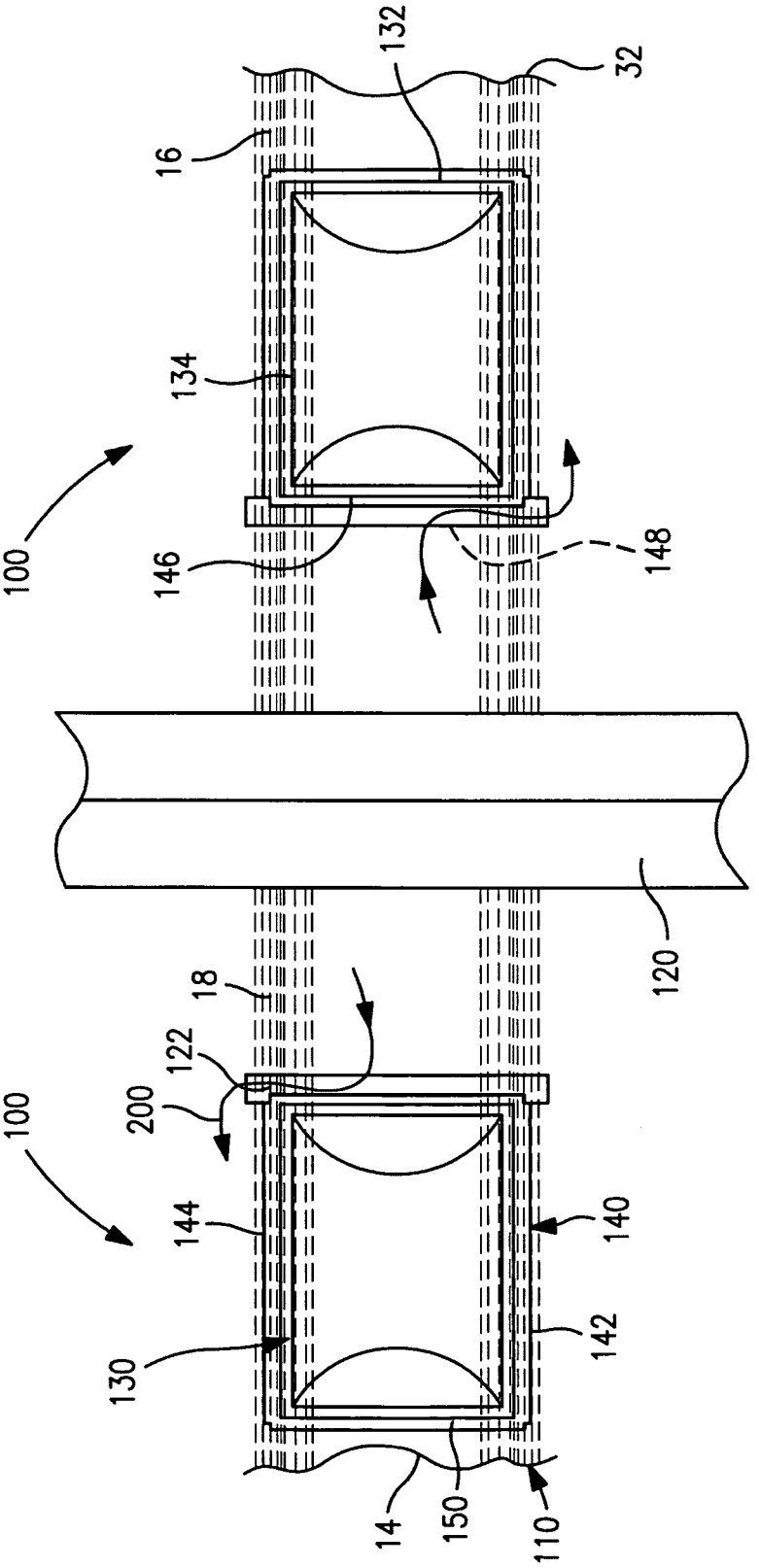
16
150
14

FIG. 6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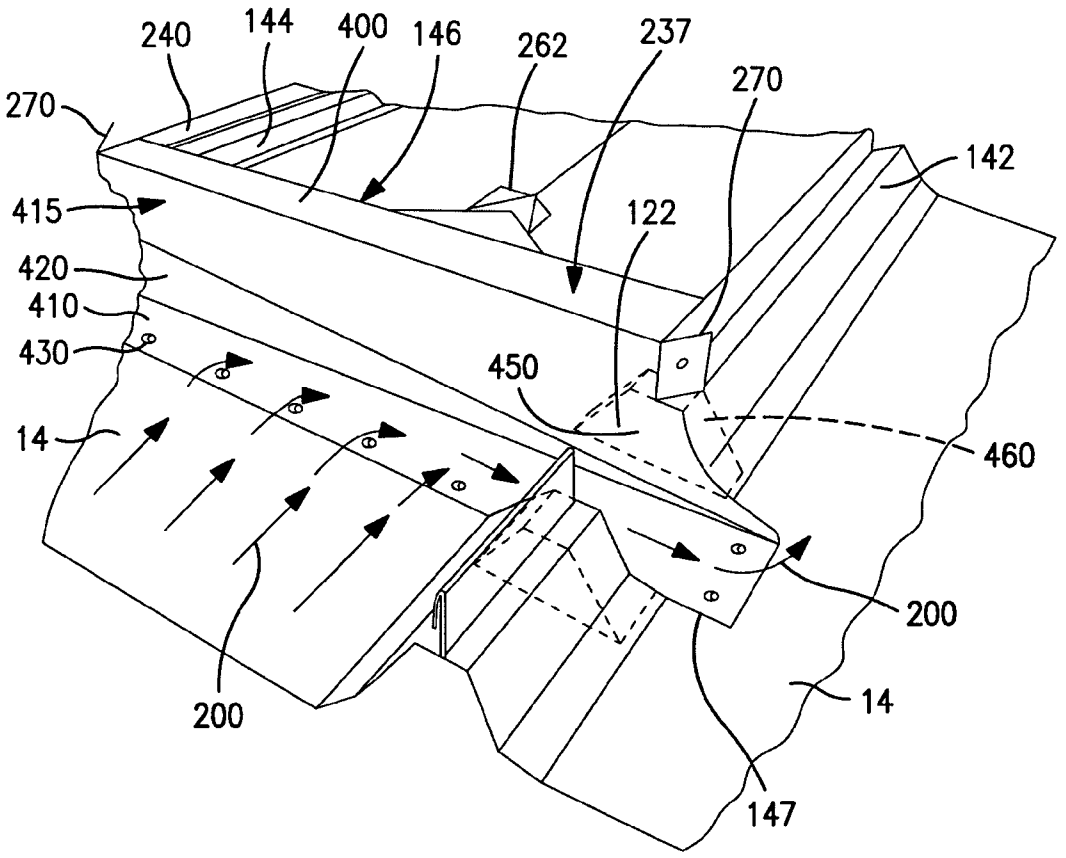
150
110

FIG. 7


240
144
400
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142
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410
430
450
14
460
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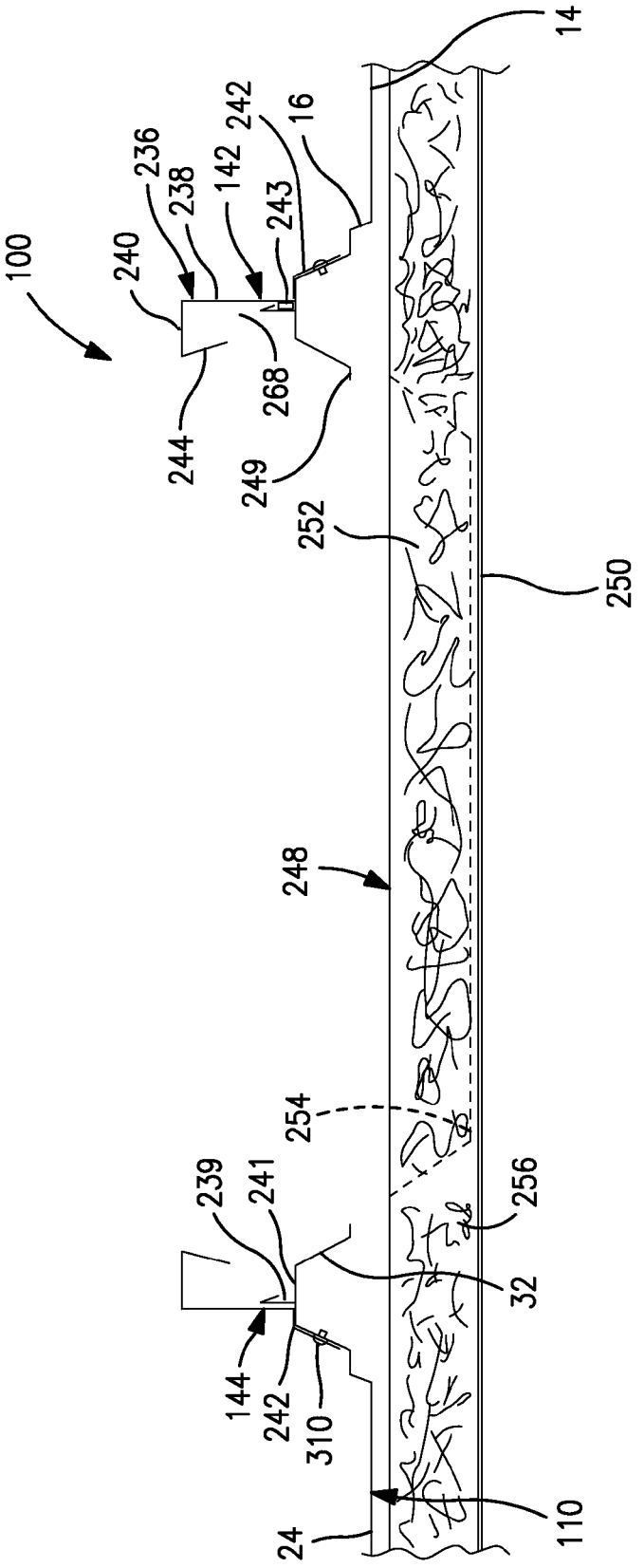
200
14
147

FIG. 7A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243
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254
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32
144
242
310
24
110

FIG. 8A

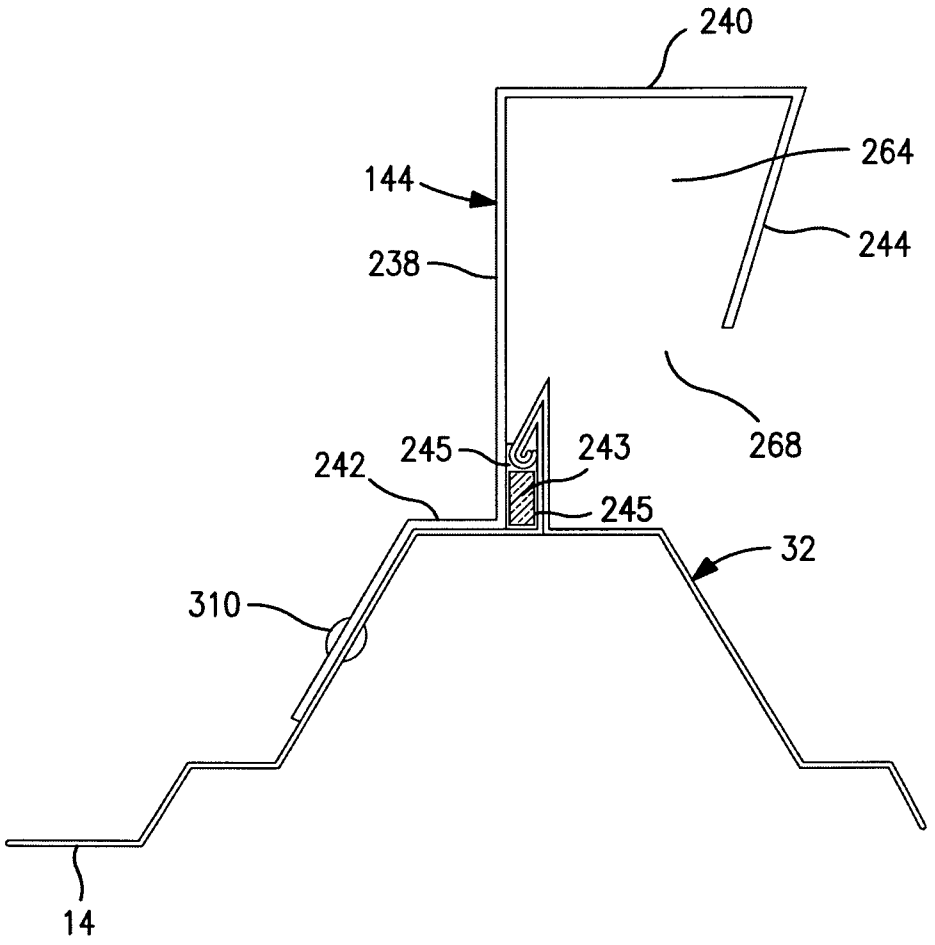


FIG. 8A1

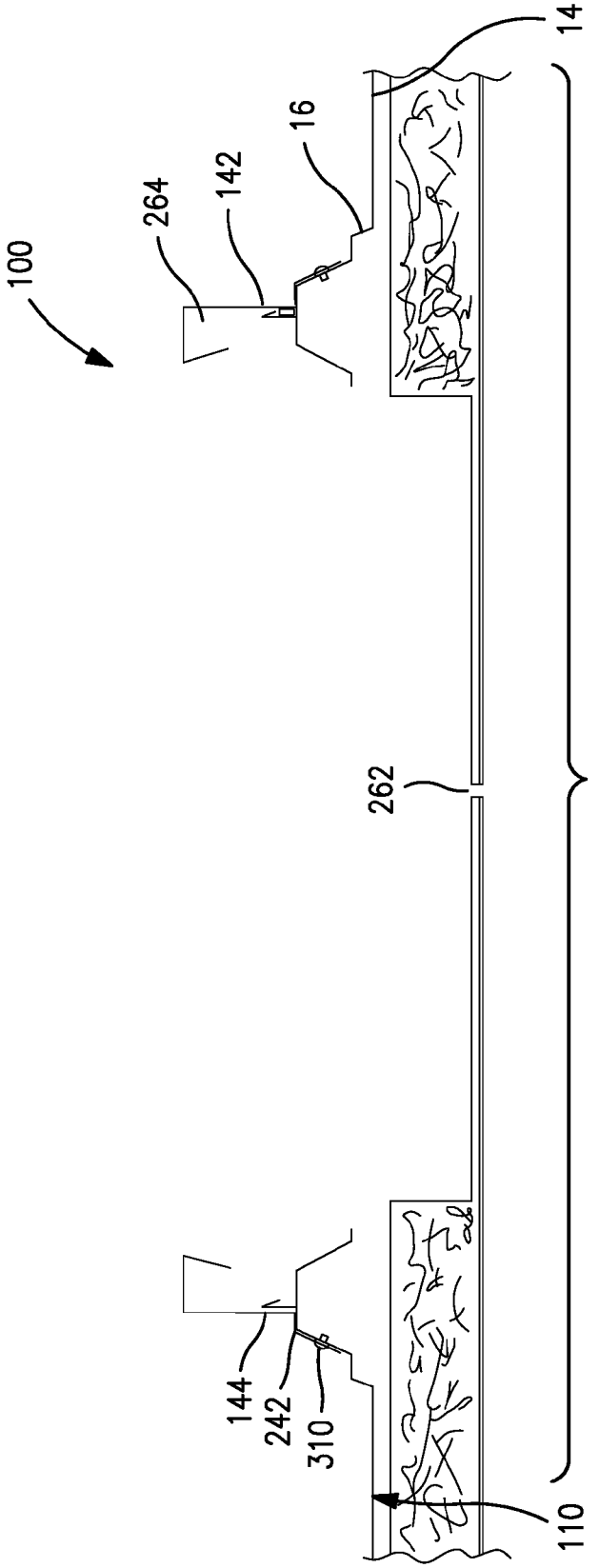
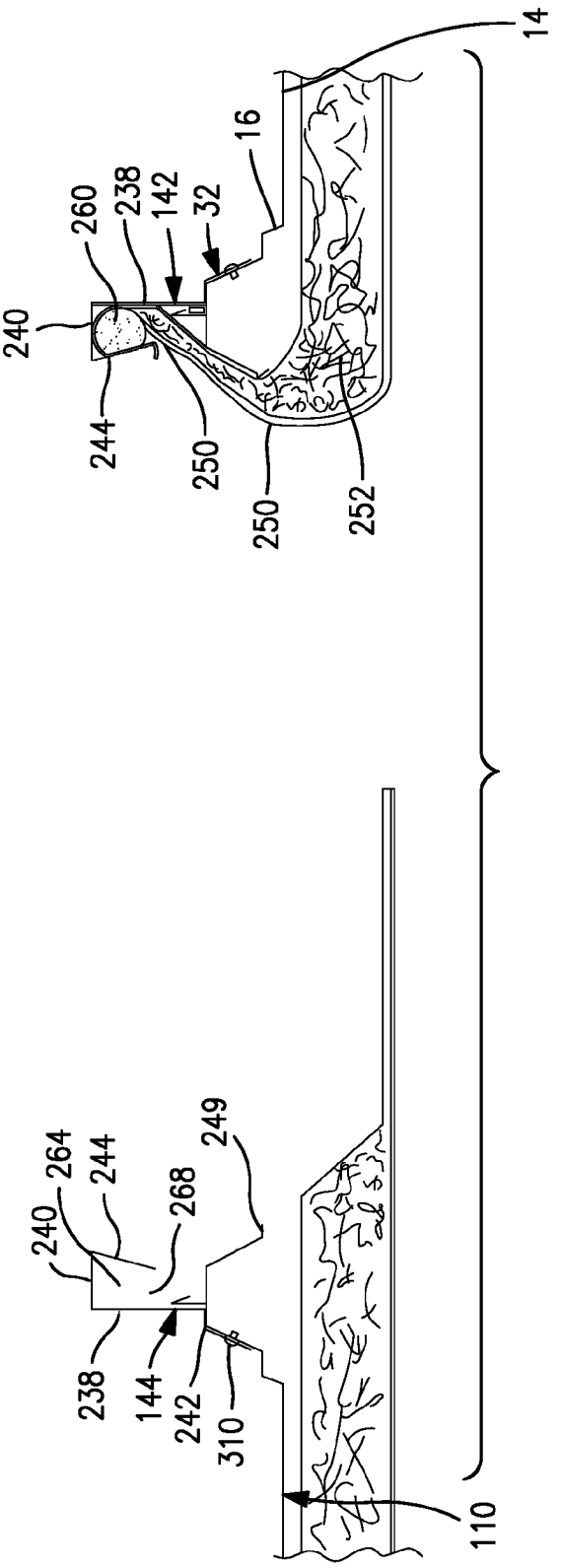


FIG. 8B


14
16
260
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249
264
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240
268
238
144
242
310
110

FIG. 8C

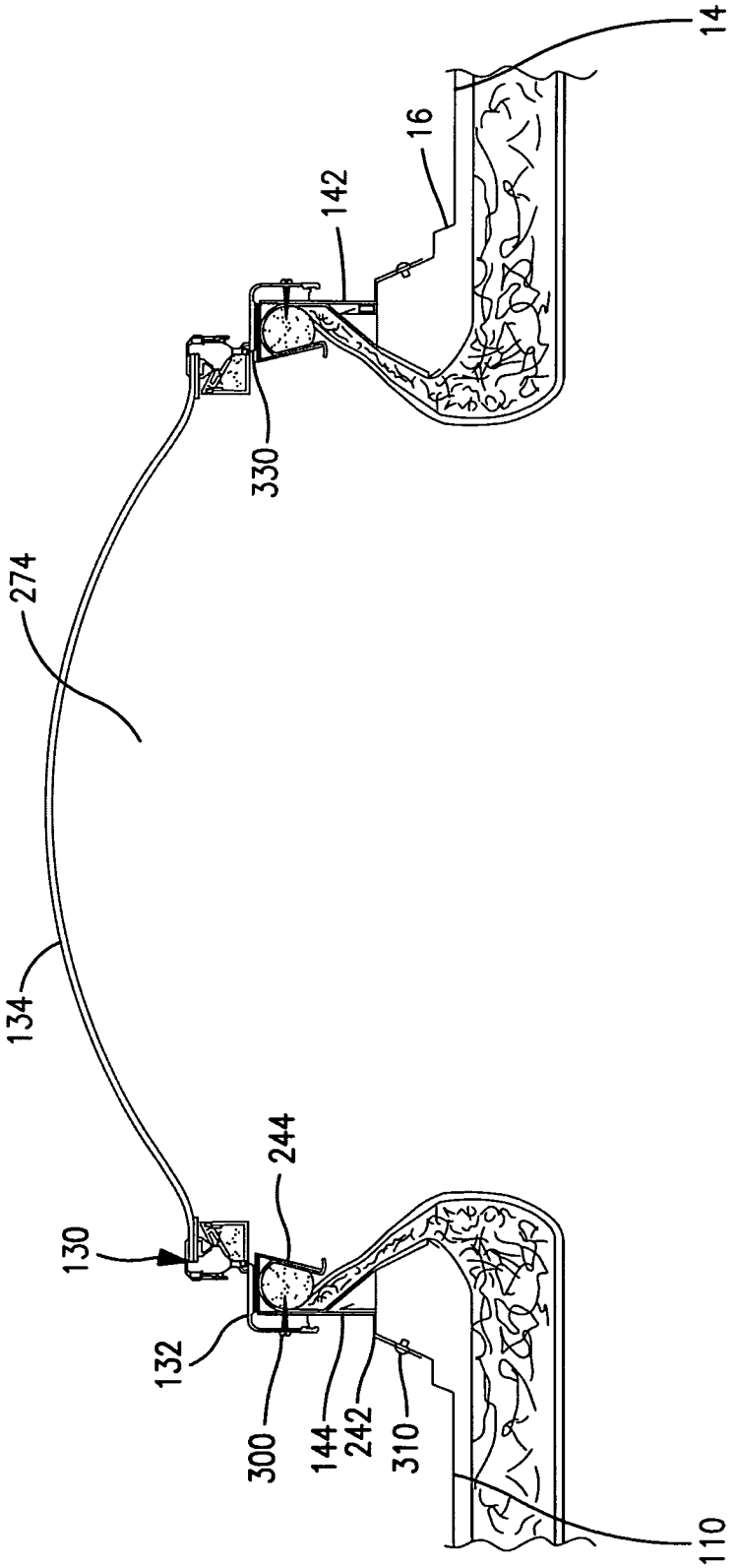
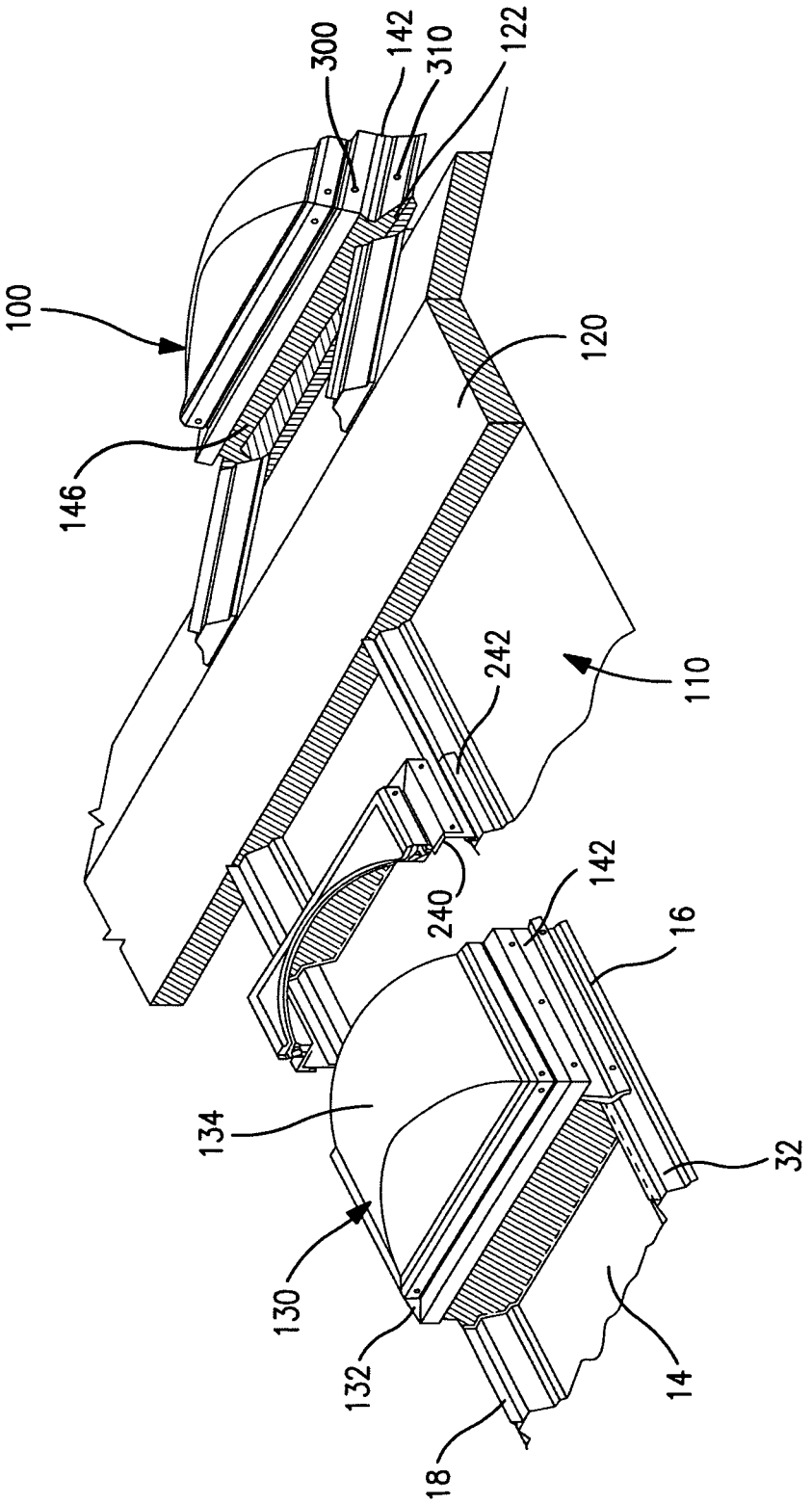


FIG. 8D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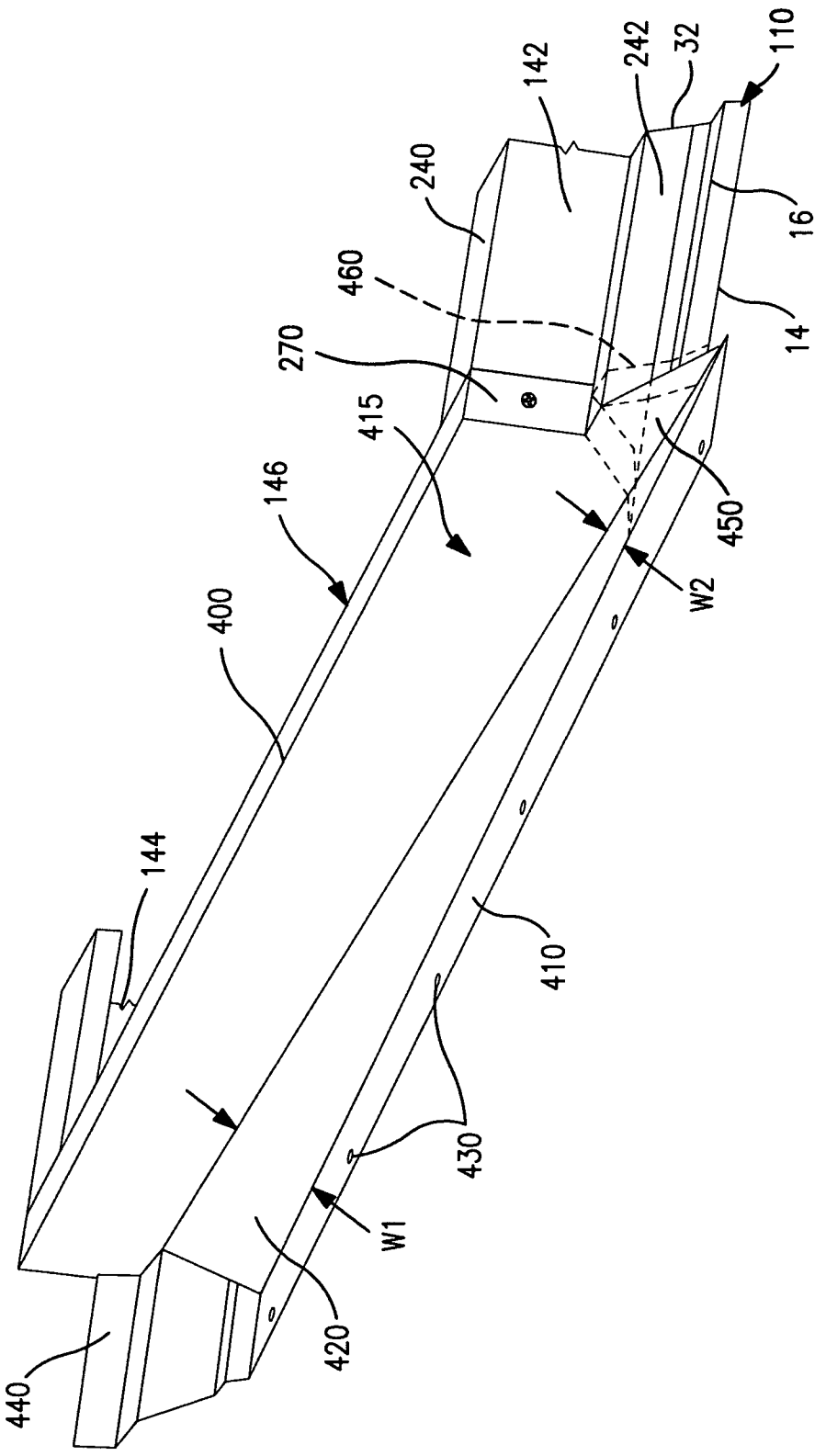
18

FIG. 9


110
242
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16
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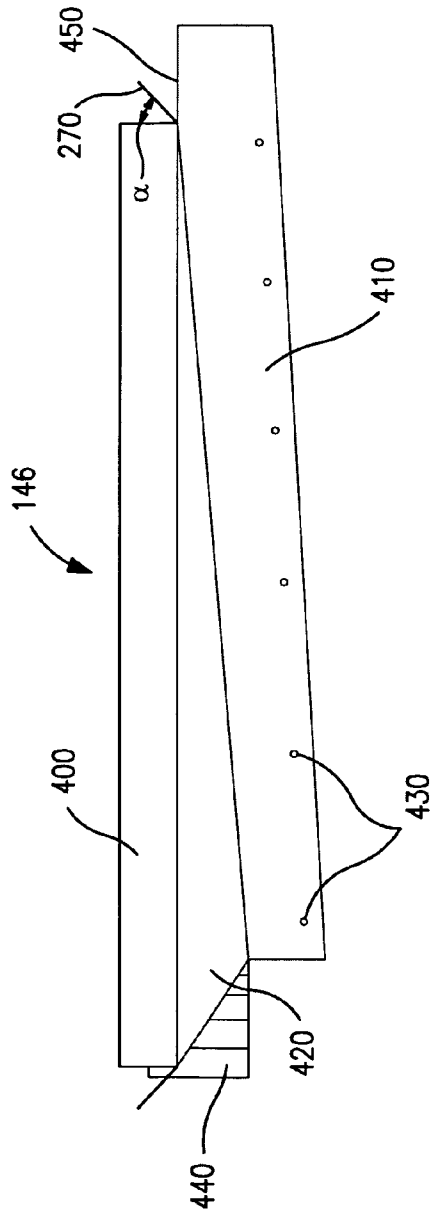
146
450
400
W2
144
410
430
W1
420
440

FIG. 10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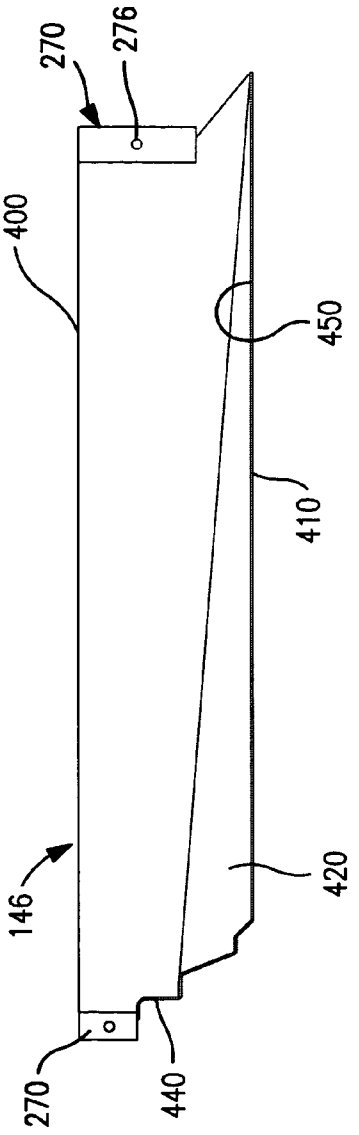
α
410
146
400
430
420
440

FIG. 11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420
270
440

FIG. 12

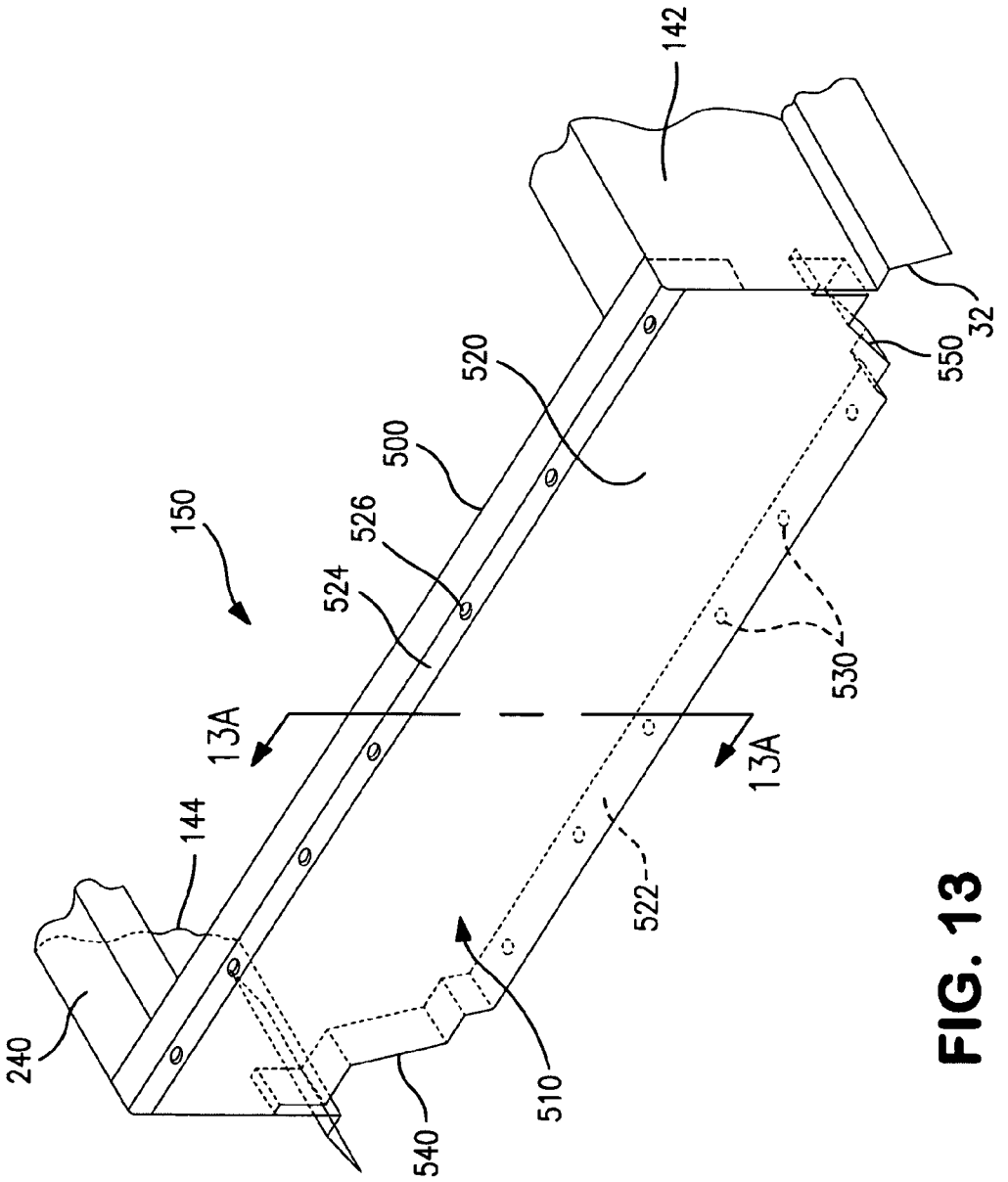
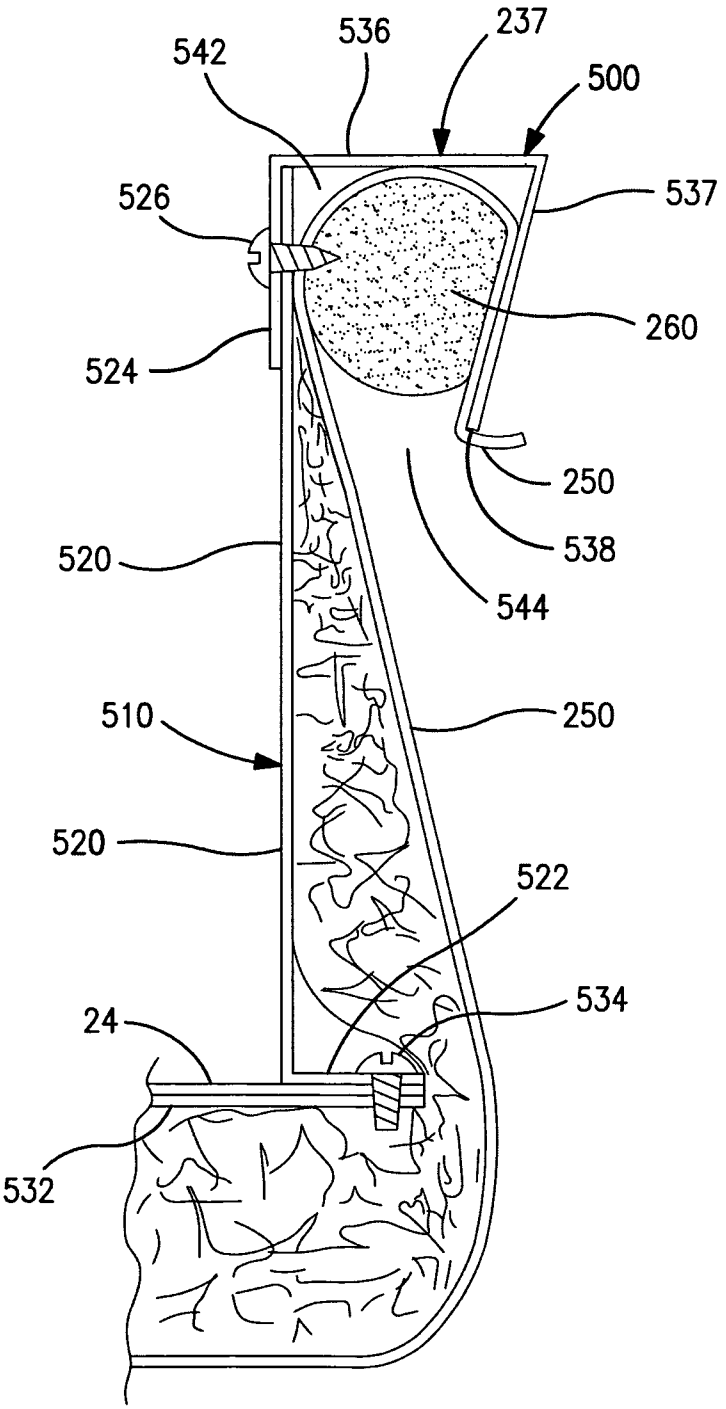


FIG. 13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544
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510
250
520
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534
24
532

FIG. 13A

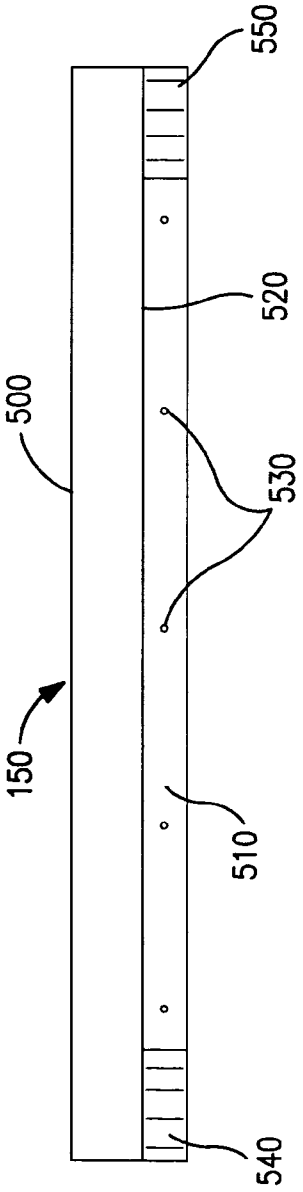


FIG. 14

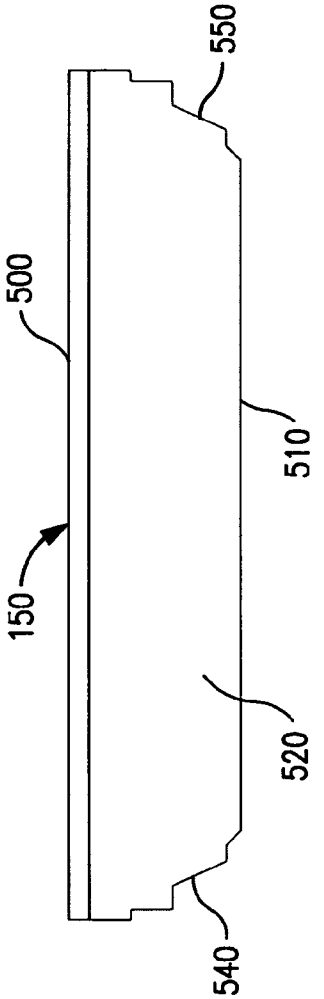


FIG. 15

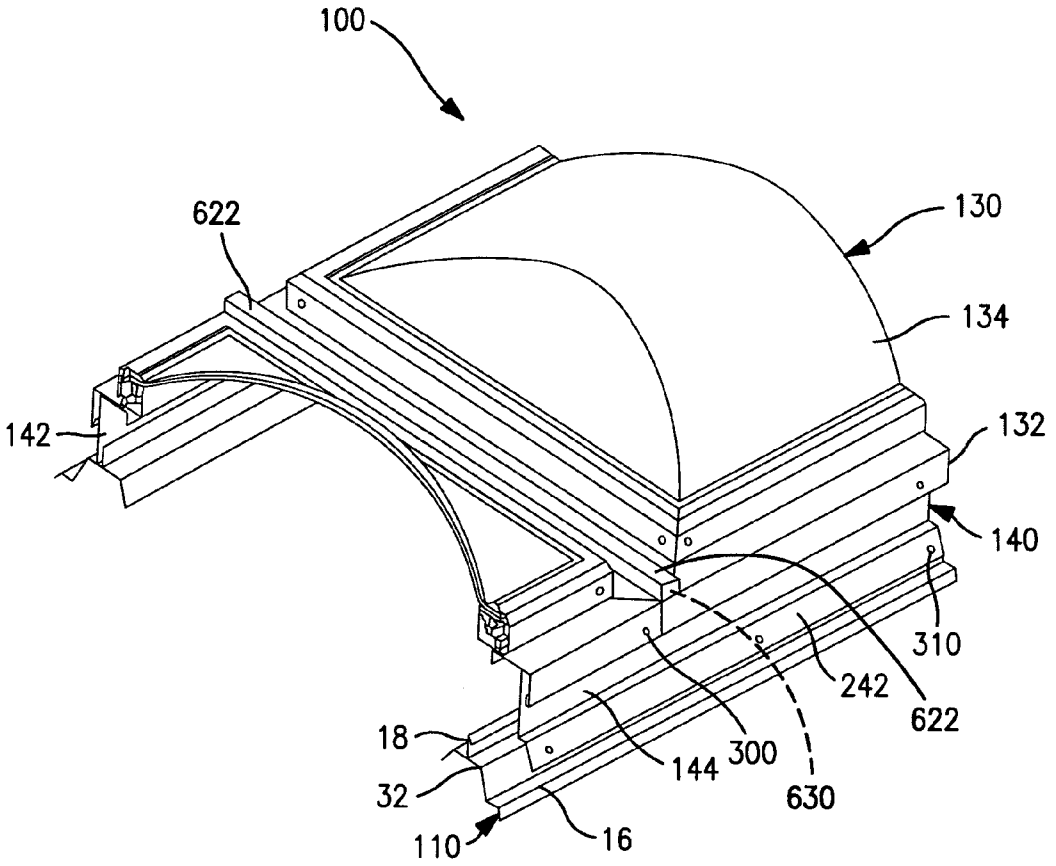


FIG. 16

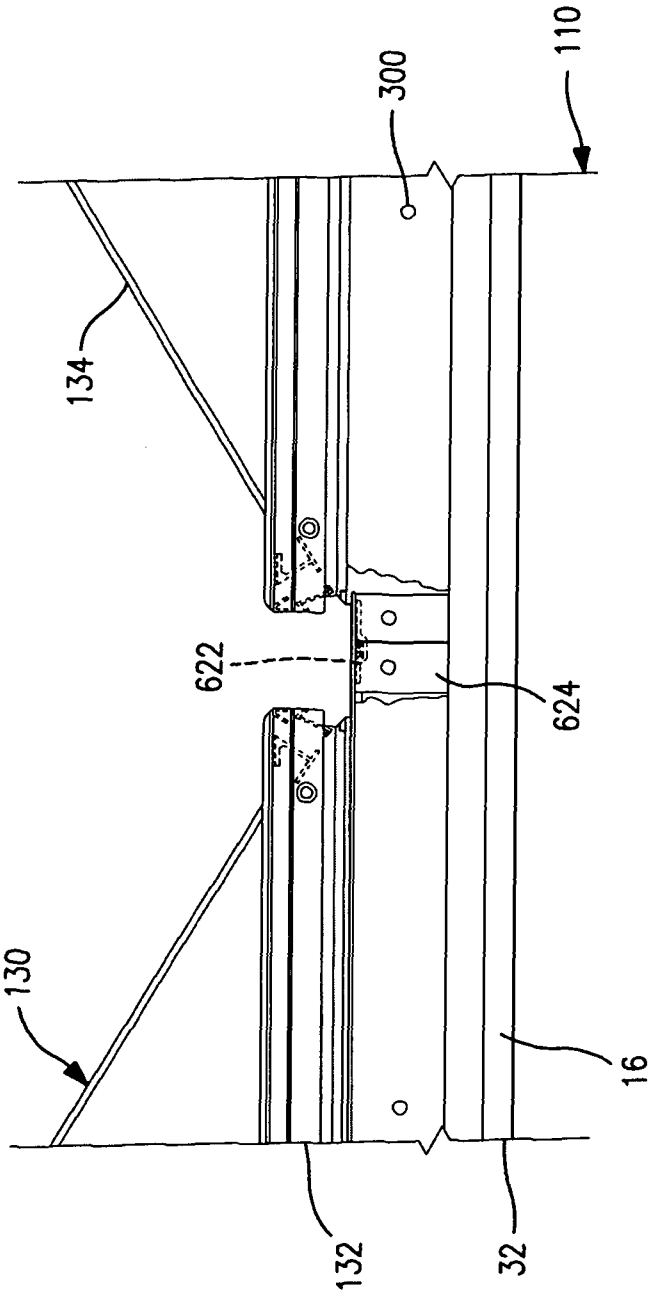
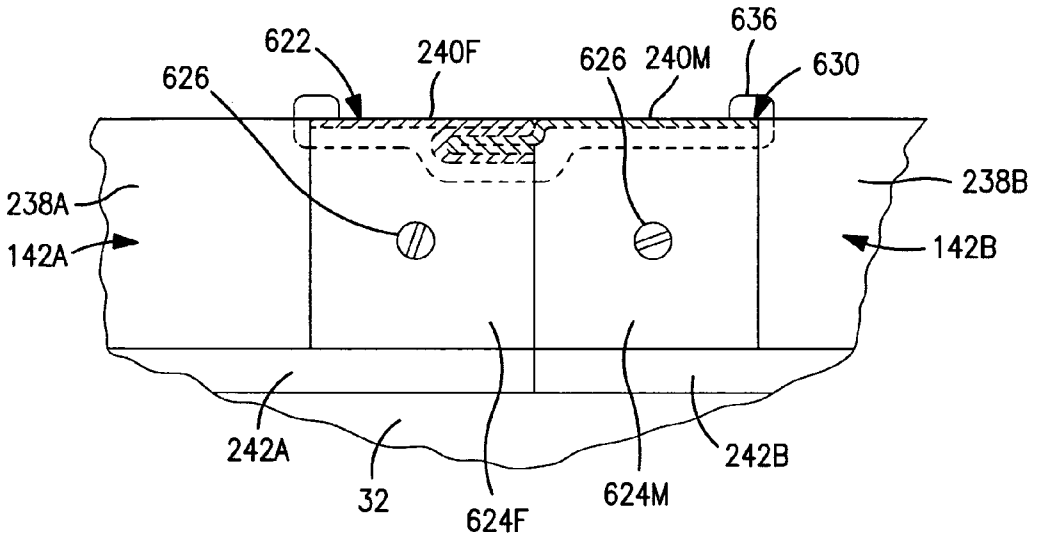


FIG. 17


622
240F
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636
630
238A
142A
238B
142B
242A
32
624F
624M
242B

FIG. 17A

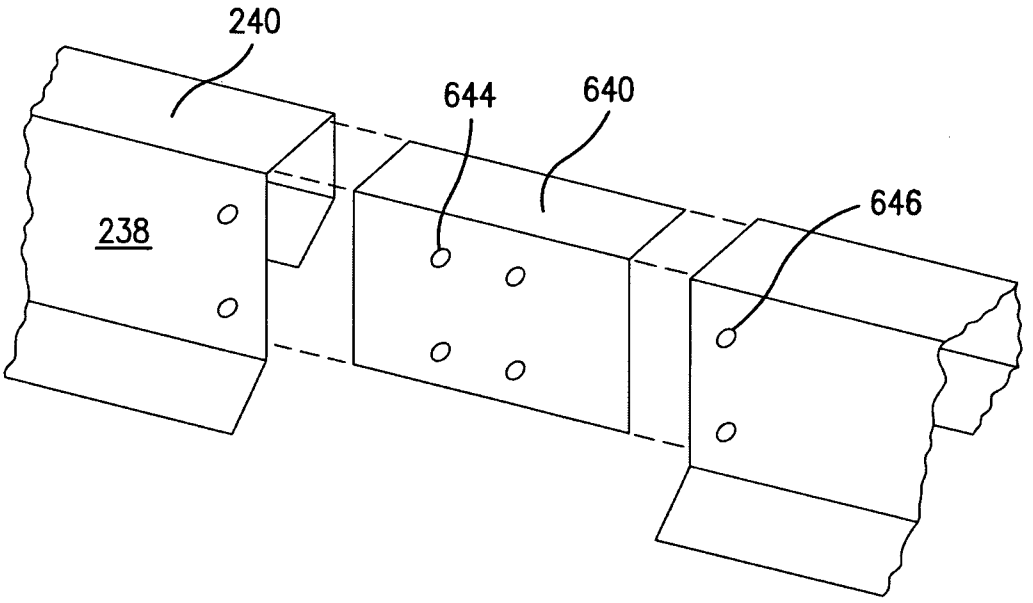

FIG. 18

SUPPORT STRUCTURES ON ROOFS

CROSS-REFERENCE TO RELATED APPLICATION

This application is a Continuation-In-Part application which claims priority under 23 U.S.C. §120 to application Ser. No. 13/065,172, filed Mar. 14, 2011.

BACKGROUND OF THE INVENTION

Various systems are known for supporting loads on roofs, and for installing skylights and/or smoke vents into roofs.

Commonly used skylighting systems have translucent or transparent closure members, also known as lenses, mounted on a support structure which extends through an aperture in the roof and is mounted to building support members inside the building. Ambient daylight passes through the lens and thence through the roof aperture and into the building.

Thus, conventional skylight and smoke vent installations use a complex structure beneath the exterior roofing panels and inside the building enclosure, in order to support a curb which extends through the roof and supports the skylight lens. Conventional skylight curbs, thus, are generally in the form of a preassembled box structure surrounding an aperture which extends from the top of the box structure to the bottom of the box structure. Such box structure is mounted to building framing members inside the building enclosure, and extends through a respective aperture in the roof, similar in size to the aperture which extends through the box structure. The skylight assembly thus mounts inside the building enclosure, and extends through an aperture in a separately mounted roof structure. Fitting skylight assemblies into such roof aperture, in a separately-mounted roof structure, presents problems. All known conventional structures have a tendency to leak water when subjected to rain.

In light of the leakage issues, there is a need for a more effective way to support skylights and smoke vents, thus to bring daylight into buildings, as well as a more effective way to support a variety of other loads, on roofs.

To achieve desired levels of daylighting, conventional skylight installations use multiple roof apertures spaced regularly about the length and width of a given roof surface through which daylight is to be received. Each skylight lens is installed over a separate such aperture; and the aperture for each such skylight assembly, each representing a single lens, extends across multiple elongate metal roof panels.

The opposing sides of conventional metal roof panels, to which skylight assemblies of the invention are mounted, are raised above elongate centralized panel flats which extend the lengths of the panels, whereby the sides of adjacent such roof structures are joined to each other in elongate joints, referred to herein as ribs. The aperture for a conventional skylight cuts across multiple such ribs in order to provide a large enough aperture to receive conventionally-available commercial-grade skylight assemblies. The skylight assembly, itself, includes a curb which is mounted inside the building and extends, from inside the building, through the roof aperture and about the perimeter of the aperture, thus to support the skylight lens above the flats of the roof panels, as well as above the ribs. Conventional pliable tube construction sealants are applied about the perimeter of the roof aperture, between the edges of the roof panels and the sides of the skylight assembly curb, including at the cut ribs. Typically, substantially all of such sealant is applied in the panel flats, which means that such sealant is the primary barrier to water leakage about substantially the entire perimeter of the skylight curb. One of the causes of roof leaks around the perimeter of conventional roof curbs which attach primarily through the panel flat at the water line are due to foot traffic, such as heel loads or other dynamic loads imposed by workers wheeling gas cylinders or other heavy equipment on the roof panel e.g. with dollies. This type of dynamic loading can cause high levels of stress on the joints that rely solely on mastic to provide seals in the wet areas, namely in the panel flats. Such leaks are common around fastener locations as the panels flex under load and cause the sealant to deform, such that in time passages develop through the sealant, which allows for the flow of water through such passages.

Such multiple curbs, each extending through a separate roof aperture, each sealed largely in the panel flats, create multiple opportunities for water to enter the interior of the building. Applicants have discovered that such opportunities include, without limitation,

(i) the number of individual apertures in the roof,

(ii) the widths of the apertures, which require cuts through the multiple ribs,

(iii) the tendency of water to collect and stay at the upper ends of the aperture,

(iv) the disparate expansion and contraction of the roof panels relative to the skylight curb; and

(v) the length of sealed seams in the panel flats.

The traditional curb constructions and methods of attachment in most cases thus require that a complicated support structure be installed below the metal roofing and inside the building enclosure, which allows disparate/discordant movement of the metal roof panels and the skylight assembly relative to each other, as associated with thermal expansion and contraction of the metal roof e.g. in response to differences in temperature changes inside and outside the building.

In addition, conventional curb-mounted skylights tend to accumulate condensation, especially about fasteners which extend from the outside of the building to the inside of the climate-controlled building envelope.

Thus, it would be desirable to provide a skylight system which provides a desired level of daylight in a commercial and/or industrial building while substantially reducing the incidence/frequency of leaks occurring about such skylights, as well as reducing the incidence/frequency of condensate accumulation in the areas of such skylights.

It would also be desirable to provide a smoke vent system while substantially reducing the incidence/frequency of leaks occurring about such smoke vents, as well as reducing the incidence/frequency of condensate accumulation in the areas of such smoke vents.

It would further be desirable to provide a support system, suitable for supporting roof loads, up to the load-bearing capacity of the metal roof while substantially controlling the tendency of the roof to leak about such support systems, as well as reducing the incidence/frequency of condensate accumulation in the areas of such closure support systems.

SUMMARY OF THE INVENTION

The invention provides a curbless construction system for installing roof load supports such as roof closure structures, optionally skylights and/or smoke vents, optionally including two or more such roof closure structures in end-to-end relationship, onto the major rib elevations of a building's metal roof panel system, thereby utilizing the beam strength of the roof rib elevations on the surface of the roof, as the support for such loads. Where skylight assemblies are placed in end-to-end relationship over a common roof aperture, the upper diverter and lower closure at the facing ends of such skylight

assemblies are replaced with male and female mating strips, thus to simplify such joinder while providing substantial barrier to water leakage at the abutting ends of the adjacent skylight assemblies. Numerous roof structures include such ribs and rib elevations, sometimes deemed "ribs" or "corrugations", including the standing seam, snap seam and "R" panel roof types. The roof support and/or closure structures of the invention are fastened to the rib structures of the metal roof panels above the water line. By mounting the loads above the water line, the number of incidents of water leaks, especially leaks about the mounting structure, is greatly reduced. By mounting the loads on the roof panels, themselves, the supported loads, such as skylights or vents, can move with the respective roof panels as the roof panels expand and contract.

The invention thus utilizes the beam strength of the rib elements of the roof panels as an integral part of the closure support structure.

In addition, the invention further improves control of water leakage and condensation formation inside the climate-controlled building envelope. Water leakage is reduced by redesigning the upper diverter and the lower closure, and providing for a second installation step, and by providing a male/female intermediate joint where skylight assemblies meet end to end intermediate the length of the roof aperture. Condensation is reduced by lifting the insulation inside the building to cover the sides of the closure support structure and providing a no-fastener securement of the insulation at an upper location in the closure support structure, and by providing thermally insulating materials as barriers to penetrating portions of fasteners, penetrating from outside the climate controlled building envelope, preventing such fasteners from entering the climate-controlled building envelope.

In a first family of embodiments, the invention comprehends apparatus adapted to be assembled to form a closed-perimeter closure support structure about a perimeter of an aperture extending through a roof of a building, such closure support structure extending up from such roof of such building and closing off access to such aperture from any side of the aperture, and wherein a passage extends, from a climate-controlled space inside such building, upwardly through such roof aperture and through the closure support structure, the apparatus comprising a plurality of closure members adapted to be mounted on the roof and about the aperture in the roof thereby to provide the closing off of access to the aperture from any side of the aperture. Each such closure member comprises one or more closure member panels, including one or more cavity panels which define an elongate cavity extending the length of the closure member, and an elongate slot defining an access path into the respective elongate cavity. The closure members, when assembled to each other, end to end, to thereby define the closed-perimeter closure support structure, defining the outer perimeter of the closure support structure about the roof aperture, and an outer surface of the outer perimeter. The plurality of closure members collectively define a single generally continuous elongate cavity about the perimeter of the closure support structure and inwardly of the outer surface of the outer perimeter, and a single generally continuous elongate slot providing a generally continuous elongate path into the single elongate cavity, the cavity having a generally continuous cavity length, a cavity height, and a cavity width, a dimension of at least one of the cavity height and the cavity width being less than a width dimension of the elongate slot.

In some embodiments, the closure members comprise (i) a first elongate side rail, comprising one or more elongate rail panels which define a first elongate such cavity, (ii) a second elongate side rail, comprising one or more elongate rail panels which define a second elongate such cavity, (iii) an upper diverter, comprising one or more diverter panels which define a third elongate such cavity, and (iv) a lower closure, comprising one or more lower closure panels which define a fourth elongate such cavity, the generally continuous elongate cavity about the outer perimeter of the closure support structure comprising the first, second, third, and fourth elongate cavities.

In some embodiments, the apparatus is assembled into such closure support structure and is mounted on a roof of a building about an aperture in the roof, a layer of insulation product being disposed below the roof, the layer of insulation product comprising a vapor barrier sheet, and a layer of thermally-insulating batt material, the vapor barrier sheet being drawn upwardly about the perimeter of the roof aperture and trapped inside the continuous elongate cavity about the perimeter of the roof aperture.

In some embodiments, the vapor barrier sheet traps a portion of the thermally-insulating batt material between itself and one or more of the closure member panels.

In some embodiments, the roof of the building comprises a plurality of elongate upstanding ribs extending between a ridge and an eave of the building roof, the ribs terminating in upstanding edges having folded-over terminal ends of the respective adjacent roof panels, the width dimension of the elongate slot being defined between a first cavity panel and one of a second cavity panel and the upstanding edge of the respective rib, the apparatus further comprising an elongate resilient rod, having a cross-section dimension greater than the width of the elongate slot, the elongate rod being disposed in the elongate cavity and trapping the vapor barrier sheet inside the elongate cavity, a closure panel optionally being mounted over the closure support structure and closing off access to the roof aperture.

In some embodiments fasteners which mount the closure panel to the closure support structure terminate in the elongate resilient rod.

In some embodiments, the apparatus is assembled into a closure support structure and is mounted on a roof of a building about an aperture in the roof, the closure members comprising (i) a first elongate side rail, comprising one or more elongate rail panels which define a first elongate cavity, (ii) a second elongate side rail, comprising one or more elongate rail panels which define a second elongate cavity, (iii) an upper diverter, comprising one or more diverter panels which define a third elongate cavity, and (iv) a lower closure, comprising one or more lower closure panels which define a fourth elongate cavity, the generally continuous elongate cavity about the outer perimeter of the closure support structure comprising the first, second, third, and fourth elongate cavities, the roof of the building comprising a plurality of elongate upstanding ribs extending between a ridge and an eave of the building, and panel flats between the ribs, the first and second side rails being mounted on adjacent ones of the ribs on opposing sides of a single panel flat and above the panel flat, the upper diverter extending between the first and second side rails and across the respective panel flat and providing closure, and sealing, of the closure support structure, across the panel flat at an upper end of the closure support structure, the lower closure extending between the first and second side rails and across the respective panel flat and providing closure, and sealing of the closure and support structure, across the panel flat at a lower end of the closure support structure.

In some embodiments, the side rails comprise outer rail panels extending upwardly from the ribs, the ribs terminating in upstanding edges having folded-over terminal ends of the respective adjacent roof panels, a space being disposed

between the folded-over terminal ends and underlying portions of the ribs, further comprising, where the space is adjacent an outer rail panel, a closely-fitting rib plug in the space at a joint between the respective side rail and a respective one of the upper diverter and the lower closure, further comprising tube sealant extending about the rib plug and closing off a remainder of the space between the rib plug and the outer rail panel and between the rib plug and the folded-over terminal ends.

In some embodiments, the upper diverter comprises an upstanding end panel extending between the first and second side rails, and diverter ears extending from the end panel and folded over, and secured to, the side rails, such that the side rails are between the diverter ears and the roof aperture.

In some embodiments, the apparatus is assembled into a such closure support structure and mounted on a roof of a building about an aperture in the roof, the closure members comprising (i) a first elongate side rail, (ii) a second elongate side rail, (iii) an upper diverter, and (iv) a lower closure comprising a bottom portion and an upper rail, the bottom portion comprising (A) a closure web extending upwardly from a panel flat, and (B) a lower flange extending, from the closure web, toward the roof aperture, the lower flange being secured to the roof panel at the panel flat, optionally through an underlying stiffener plate, the upper rail being mounted to the closure web and extending, as a bearing panel, from the closure web toward the roof aperture, and extending, from the bearing panel, downwardly as an inside panel of the respective cavity.

In some embodiments, the apparatus is assembled into a closure support structure and mounted on a roof of a building about an aperture in the roof, the closure members comprising (i) a first elongate side rail, (ii) a second elongate side rail, (iii) an upper diverter, (iv) a lower closure, (v) first and second mating strips extending across the roof aperture between the first and second side rails, and disposed between the upper diverter and the lower closure, the first and second mating strips being mounted to the first and second side rails and being mated to each other so as to close a joint therebetween.

In some embodiments, the first and second mating strips further comprise bearing panels adapted to receive closure structure thereon, overlying portions of the roof aperture.

In some embodiments, the apparatus is assembled into a closure support structure and mounted on a roof of a building about an aperture in the roof, the closure structure support structure comprising (i) first and second elongate side rails mounted to the roof in end-to-end relationship, and a first connecting plate extending between, and mounted to, both of the first and second side rails, (ii) third and fourth elongate side rails mounted to the roof in end-to-end relationship, and a second connecting plate extending between, and mounted to, both of the third and fourth side rails, (iii) an upper diverter, and (iv) a lower closure.

In a second family of embodiments, the invention comprehends apparatus adapted to be assembled to form a closed-perimeter closure support structure about a perimeter of an aperture extending through a roof of a building, the closure support structure extending up from the roof and closing off access to the aperture from any side of the aperture, and wherein a passage extends, from a climate-controlled space inside the building, upwardly through the roof aperture and through the closure support structure, the apparatus comprising a plurality of closure members adapted to be mounted on the roof and about the aperture in the roof thereby to provide the closing off of access to the aperture, the closure members comprising (i) a first elongate side rail, (ii) a second elongate side rail, (iii) an upper diverter, (iv) a lower closure, comprising a bottom portion and an upper rail, the bottom portion comprising (A) a closure web adapted to extend upwardly from a panel flat, and (B) a lower flange extending generally perpendicularly from the closure web in a first direction, the upper rail being mounted to the closure web and extending, as a bearing panel, from the closure web in a direction in common with the lower flange.

In some embodiments, the apparatus is assembled into a closure support structure and mounted on a roof of a building about an aperture in the roof, the lower flange extending, from the closure web, toward the roof aperture, the upper rail lying in overlying relationship with respect to the lower flange and extending, from the closure web, toward the roof aperture.

In some embodiments, the apparatus is assembled into a closure support structure and mounted on a roof of a building about an aperture in the roof, and further comprises a closure panel, such as, without limitation, a skylight lens or lens assembly, or a smoke vent, mounted over the closure support structure and closing off access to the roof aperture.

In a third family of embodiments, the invention comprehends a method of mounting a load to a metal roof of a building, the method comprising mounting a closure support structure to the metal roof about an aperture in the roof, the metal roof having upstanding ribs at joints between respective metal roof panels, and panel flats between the ribs, and further comprising mounting first and second side rails in side-by-side relationship to adjacent ones of the ribs across a single panel flat and beside the roof aperture; mounting an upper diverter between the first and second side rails, across the panel flat and closing off access to the roof aperture at an upper end of the roof aperture; mounting a lower closure between the first and second side rails, across the panel flat and closing off access to the roof aperture at a lower end of the roof aperture, the lower closure comprising a bottom portion and an upper rail, the bottom portion comprising a closure web and a lower flange extending transversely to the closure web, the method further comprising (i) mounting the lower closure to the roof panel by driving fasteners through the lower flange and into the roof panel in the panel flat, with the lower flange extending from the closure web toward the roof aperture, and (ii) subsequently mounting the upper rail to the closure web, with a bearing panel of the upper rail extending from the closure web toward the roof aperture such that the bearing panel is in an overlying relationship over the lower flange.

In some embodiments, the method further comprises mounting a closure structure over the closure support structure and thereby closing off access to the roof aperture from outside the building.

In a fourth family of embodiments, the invention comprehends apparatus adapted to be assembled to form a closed-perimeter closure support structure and mounted on a roof of a building about a perimeter of an aperture extending through the roof of the building, the closure support structure extending from a first upper end thereof on the roof to a second lower end thereof on the roof, and extending in an upwardly direction from the roof of the building and closing off access to the aperture from any side of the aperture, and wherein a passage extends, from a climate-controlled space inside the building, upwardly through the roof aperture and through the closure support structure, the apparatus comprising (i) first and second elongate side rails adapted to be mounted to the roof in end-to-end relationship as a first side of the closure support structure, with the first side rail being disposed toward the first upper end of the closure support structure and the second side rail being disposed toward the second lower end of the closure support structure, and with a first joint being defined between

the first and second side rails, (ii) third and fourth elongate side rails adapted to be mounted to the roof in end-to-end relationship as a second opposing side of the closure support structure, with the third side rail being disposed toward the first upper end of the closure support structure and the fourth side rail being disposed toward the second lower end of the closure support structure, and with a second joint being defined between the third and fourth side rails, (iii) an upper diverter adapted to extend between the first and third side rails at the first upper end of the closure support structure, (iv) a lower closure adapted to extend between the second and fourth side rails at the second lower end of the closure support structure, and (v) first and second mating strips adapted to extend across the roof aperture, from side rail to side rail, between the upper end and the lower end of the closure support structure, the first and second mating strips being adapted to be mounted to respective ones of the side rails and to be mated to each other so as to close a joint therebetween.

In some embodiments, the first and second mating strips further comprise bearing panels adapted to receive closure structure thereon, overlying portions of the roof aperture.

In some embodiments, the apparatus is assembled into a closure support structure and mounted on a roof of a building about an aperture in the roof, a first side of the closure support structure comprising the first and second elongate side rails, a second opposing side of the closure support structure comprising the third and fourth elongate side rails, the upper diverter extending between the first and second sides at the first upper end of the closure support structure, the lower closure extending between the first and second sides at the second lower end of the closure support structure, the first and second mating strips extending across the roof aperture between the first upper end and the second lower end, the first and second mating strips being mounted to respective ones of the side rails and being mated to each other so as to close a joint therebetween.

In some embodiments, the side rails, the upper diverter, and the lower closure, define bearing panels which collectively extend about an outer perimeter of the closure support structure in a common imaginary plane, first and second mating strips extending across the roof aperture intermediate the upper and lower ends of the closure support structure and also including bearing panels in the same imaginary plane, thereby to define a first bearing panel perimeter adapted to receive a first closure panel over a first portion of the roof aperture, and a second bearing panel perimeter adapted to receive a second closure panel over a second portion of the roof aperture.

In some embodiments, the apparatus further comprises first and second closure panels over the respective first and second portions of the roof aperture.

In some embodiments, the first and second closure panels, collectively with minor portions of the closure support structure, overlie the entirety of the single roof aperture.

The present invention will be further appreciated and understood when considered in combination with the following description and accompanying drawings. It will be understood, however, that the following description is by way of illustration and not of limitation. Certain changes and modifications can be made within the scope of the invention without departing from the spirit of the invention, and the invention includes all such changes and modifications.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a roof profile of a metal roof of the type known as the standing seam roof.

FIG. **2** is a roof profile of a metal roof of the type known as an architectural standing seam roof.

FIG. **3** is a roof profile of a metal roof of the type commonly referred to as a snap seam roof.

FIG. **4** is a roof profile of a metal roof of the type commonly referred to as an exposed fastener roof.

FIG. **5** is a roof profile of a metal roof of the type commonly known as a foam core roof.

FIG. **6** is a side view showing major components of a skylight system of the invention, installed on a metal roof.

FIG. **7** is a top plan view of the installed skylight system of FIG. **6**, showing placement of the skylights and the direction of water flow around the skylights.

FIG. **7**A is a cut-away pictorial view showing the upper diverter mounted in the rail gap.

FIG. **8**A is a cross sectional view showing the connections of the rails to the rib elevations of a metal panel roof where the panel flat has been removed; the rail structure being affixed to the surfaces of adjacent rib elevations, wherein the portion of the underlying insulation which is to be removed is shown above a dashed outline, and a gap plug has been installed between the standing seam and the rail on the right side of the drawing, providing relatively solid mass in the gap between the folded-over standing seam and the side of the rail.

FIG. **8A1** is an enlarged end view of a rail mounted at a standing seam, and illustrating a gap plug in the space between the outer panel of the rail and the metal roof seam, under the turned-over edges of the seam.

FIG. **8**B shows a cross-section as in FIG. **8**A, after removal of that portion of the insulation which was to be removed, and the insulation facing sheet cut down the middle along the length of the aperture/opening in the metal roof.

FIG. **8**C shows a cross-section as in FIGS. **8**A and **8**B wherein the insulation facing sheet on one side of the aperture/opening has been raised and tucked into the cavity in the rail, and is being held in the cavity by a thermally-insulating compressible foam retainer rod.

FIG. **8**D shows a cross-section as in FIGS. **8**A-**8**C wherein the facing sheet on both sides of the aperture/opening has been tucked into the rail cavity and is being held in the cavity by the foam retainer rod shown in FIG. **8**C; and the skylight lens subassembly has been mounted to the rails, serving as a closure of the aperture in the metal roof.

FIG. **9** is a perspective view partially cut away showing internal structure of the system as installed on the rib elevations of a metal roof.

FIG. **10** is a perspective view of the upper diverter showing trailing closure flaps extending from the ends of the intermediate end panel, and closed over the upright sides of the respective side rails.

FIG. **11** is a top view of the upper diverter wherein trailing closure flaps extend from of the ends of the intermediate end panel and define acute angles with upright sides of respective side rails, before the trailing closure flaps are closed over the upright sides of the side rails.

FIG. **12** is a front elevation view of the upper diverter.

FIG. **13** is a perspective view of the lower closure.

FIG. **13**A is a cross-section taken at **13**A-**13**A of FIG. **13**, showing the relationships between the bottom portion of the lower closure and the overlying flange, showing the insulation facing sheet being held in the flange cavity by the thermally-insulating foam retainer rod, with the screws which mount the overlying flange to the bottom portion being embedded in the thermally insulating foam retainer rod, and showing a reinforcing plate under the flat of the metal roof panel at the lower closure, whereby the joint between the

bottom flange of the bottom portion of the lower closure and the flat of the roof panel is supported by the reinforcing plate.

FIG. **14** is a top view of the lower closure.

FIG. **15** is a front plan view of the lower closure.

FIG. **16** is a perspective view, partially cut away, showing an end joint between facing ends of adjacent skylights of the system.

FIG. **17**A show additional detail of the joint between facing ends of adjacent skylights.

FIG. **18** shows an exploded pictorial view of a rail connector aligned with abutting rail ends and wherein the connector bridges the butt joint between rails which adjoin each other end to end, thus providing both reinforcement of the joint and enhanced sealing of the joint against intrusion of water.

The invention is not limited in its application to the details of construction, or to the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various other ways. Also, it is to be understood that the terminology and phraseology employed herein is for purpose of description and illustration and should not be regarded as limiting. Like reference numerals are used to indicate like components.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

The products and methods of the present invention provide a load support structure, for use in installing various exterior roof loads, including structures which close off apertures in metal roofs. For purposes of simplicity, "closure support structure" will be used interchangeably to mean various forms of closed-perimeter structures which are mounted on ribs of raised elevation metal roof structures, including across the flat of a roof panel, and which collectively define an upstanding enclosing wall which defines a surrounded space about an aperture in a roof, and supports either a closure over the aperture, or a conduit which extends through the roof aperture. Skylight assemblies and smoke vents are non-limiting examples of closures over such roof apertures. Air handling operations such as vents, air intake, and air or other gaseous exchange to and/or from the interior of the building are non-limiting examples of operations where conduits extend through the roof aperture. In the case of roof ventilation, examples include simple ventilation openings, such as for roof fans, and smoke vents, which are used to allow the escape of smoke through the roof during fires. In the case of exterior loads on the roof, where no substantial roof aperture is necessarily involved there can be mentioned, without limitation, such loads as air conditioners, air handlers, solar panels and other equipment related building utilities, and/or to controlling water or air temperatures inside the building. The only limitation regarding the loads to be supported is that the magnitude of a load must be within the load-bearing capacity of the roof panel or panels to which the load is mounted.

The number of skylights or other roof loads can vary from one load structure, to as many load structures as the building roof can support, limited only by the amount of support available from the respective roof panels to which the load is attached.

The invention provides structure and installation processes, as a closure system which utilizes the beam strength of the major rib structures, in the roof panels, as the primary support structure for mounting and fastening the e.g. skylight assembly to the roof. Typical conventional skylight installations do not allow for skylights to be mounted to each other, end to end, in continuous runs without intervening roof structure along the lengths of such runs. Rather, typical conventional skylight installations use a curb construction surrounding and supporting each skylight lens, the curb structure being typically 2-4 times wider than the metal roof panels and extending through the roof aperture from mounting locations inside the climate-controlled building envelope. The widths of skylights of the invention generally correspond to the widths of the metal roof panels to which such skylights are mounted. Thus, such conventional skylight curb structures are typically 2-4 times wider than the skylight support structure used in the present invention.

One family of closure support systems of the invention comprehends a skylight system which does not require support from the building framing inside the climate-controlled building enclosure for the purpose of supporting the skylight installation. Neither does the skylight system of the invention require a separate curb construction surrounding each skylight lens to separately support or mount or attach each skylight to the roof. Rather, the closure support structure of the invention, which supports such skylights, is overlaid onto, and mounted to, the roof panels, and exposes the closure support structure to the same ambient weather conditions which are experienced by the surrounding roof panels, whereby the closure support structure experiences approximately the same thermal expansions and contractions as are experienced by the respective roof panel or panels to which the closure support structure is mounted. This is accomplished through direct attachment of the closure support structures of a skylight of the invention to the underlying metal roofing panels. According to such roof mounting, and such ambient weather exposure, expansion and contraction of the closure support structure generally coincides, at least in direction, with concurrent expansion and contraction of the metal roof panels.

Referring now to the drawings, a given metal roof panel generally extends from the peak of the roof to the respective eave. Skylight systems of the invention contemplate the installation of two or more adjacent skylight assemblies in an end to end relationship along the major rib structure of a given such metal roof panel on the building whereby the individual skylight assemblies are installed in strips over a continuous, uninterrupted aperture in the metal roof, the aperture extending along a line which extends from the roof ridge to a corresponding eave.

Skylight systems of the invention can be applied to various types of ribbed roof profiles. FIG. **1** is an end view showing a roof profile of a metal roof of the type known as a standing seam roof. These include the "standing seam" roof, which has trapezoidal elevated elongate major ribs **32** typically 24" to 30" on center. Each roof panel **10** also includes a panel flat **14**, and may include a shoulder **16** between a rib **32** and the panel flat. The elevated ribs on a given panel cooperate with corresponding elevated elongate ribs on next-adjacent panels, thus forming standing seams **18**. Seams **18** represent the edges of adjacent roof panels, folded one over the other, to form elongate joints at the side edges of the respective roof panels. The rib elevations on respective adjacent panels are folded over such that the standing seams function as folded-over raised joints between the respective panels, thus to inhibit water penetration of the roof at the standing seams/joints.

FIG. **2** is an end view showing the roof profile of a metal roof of the type known as an architectural standing seam roof, which uses a series of overlapping architectural standing seam panels **20**. Each panel **20** comprises a panel flat **14**, and a rib element of an architectural standing seam **28** on each side of the panel.

FIG. **3** is an end view showing the roof profile of a metal roof of the type commonly referred to as an "R panel" or exposed fastener panel **30**. Each panel has elements on opposing sides of a panel flat **14** which, with the rib elements of adjacent panels, form ribs **32**. Adjacent R panels are secured to the roof by fasteners **35**. At side lap **38**, overlapping regions of adjacent panels are secured to each other by stitch fasteners **39**. Trapezoidal major ribs of the R panel roof are most typically formed at 8 inches to 12 inches on center.

FIG. **4** is an end view showing the roof profile of a metal roof of the type commonly referred to as a snap rib seam panel **40**. Snap seam panels **40** have a panel flat **14** and a standing seam or snap seam **48** where the adjacent panels meet.

FIG. **5** is an end view showing a roof profile of a metal roof of the type commonly referred to as a foam core panel **50**. Such roof has a rib **32**, a liner panel **53**, a panel flat **14** and a foam core **57**. Overlapping regions **58** of adjacent panels are secured to each other by fasteners **59**.

A skylight/ventilation closure support structure is illustrative of closure structures of the invention which close off roof-penetrating apertures. Such closure support structure includes a rail and closure structure which surrounds the aperture in the roof, and which is adapted to be mounted on, and supported by, the prominent standing elevations, standing rib structures, or other upstanding elements of conventional such roof panels, where the standing structures of the roof panels, namely structure which extends above the panel flats, e.g. at seams/joints where adjoining metal roof panels are joined to each other, provides the support for the closure support structures. A such closure structure is secured to the conventional metal roofing panels, and surrounds a roof aperture formed largely in the intervening flat region of a single metal roof panel.

FIG. **6** shows first and second exemplary closure support structures **100**, mounted to a sloping metal standing seam panel roof **110**, and overlain by closures defined by first and second skylight lens assemblies **130**.

FIG. **7** shows a portion of the roof **110** of FIG. **6**, in dashed outline. The roof has a raised rib **32**, a panel flat **14**, shoulder **16** and standing seam **18**. Given that water generally seeks the lowest level available at any given location, any water on a given roof panel tends to congregate/gather on the panel flat whereby, except for any dams across the panel flat, the water line is generally limited to the panel flat. Thus, rib **32**, shoulder **16**, and standing seam **18** are all typically above the water line. Also depicted in FIGS. **6** and **7** are ridge cap **120** of the sloping metal panel roof structure, and cutaway regions, or gaps **122** in the raised ribs **32**, the gaps being formed to facilitate installation of the closure system, as described more fully following.

Skylight assembly **130**, which is part of the aperture closure system, generally comprises a skylight lens frame **132** mounted to the closure support structure and extending about the perimeter of a given closure support structure, in combination with a skylight lens **134** mounted to, and overlying, frame **132**. An exemplary such skylight lens is that taught in U.S. Pat. No. 7,395,636 Blomberg and available from Sunoptics Prismatic Skylights, Sacramento, Calif.

Still referring to FIGS. **6**, **7**, and **7**A, closure support structure **100** of the invention, as applied to a skylight installation, includes a rail and closure structure **140**. Such rail and closure structure includes one or more first side rails **142** and one or more second side rails **144** (FIGS. **8**A, **8**A**1**), an upper diverter **146** disposed at an up-slope end of the enclosing wall of support structure **140**, adjacent rib cutaway section, or gap **122**, and a lower closure **150** at a down-slope end of the enclosing wall. As shown in FIG. **7**A, a lateral leg **147** of the upper diverter is located in gap **122**, filling the bottom and lower side of the gap and carrying water laterally across the width of the respective rib, to the panel flat **14** of the adjacent roof panel, thus to transport the water away from the upper end of the skylight and to prevent the water from leaking through the roof opening. Rail and closure structure **140** also includes support plates, connectors, bridging members, and rubber or plastic plugs to make various connections to the rail and closure structure elements as well as to close gaps/spaces between the various rail and closure structure elements, and between the roof panels and the rail and closure structure elements, thus to complete the seals which prevent water leakage about the skylight and its associated aperture in the roof.

FIGS. **7** and **7**A show how gap **122** in rib **32**, in combination with upper diverter **146**, provides for water flow, as illustrated by arrows **200**, causing the water to move laterally along the roof surface, over lateral leg **147** of the upper diverter, and down and away from the roof ridge cap **120** in panel flat **14** of the roof panel which is next adjacent the roof structures which support the respective e.g. skylight.

Lower closure **150** closes off the roof aperture from the outside elements at the lower end of the e.g. skylight or strip of skylights, thus to serve as a barrier to water leakage at the lower end of the aperture in the roof.

Referring now to FIGS. **8**A and **8**A**1**, a cross section through rib **32**, and associated closure support structures **100** shows securement of the closure support structures **100** to standing rib portions of the standing seam panel roof **110**. FIG. **8**A depicts the use of ribs **32** to support side rails **142** and **144** on opposing sides of the panel flat **14**. Each rail **142** or **144** has a lower rail shoulder **242** and a rail upper support structure **236**. Rail upper support structure **236** has a generally vertically upstanding outer panel **238**, a generally horizontal rail upper flange or bearing panel **240**, and a rail inside panel **244**. Inside panel **244** extends toward outer panel **238** at an included acute angle of about 75 degrees between panel **240** and panel **244**. Outer panel **238**, bearing panel **240**, and inside panel **244** each define a cavity wall, and such cavity walls collectively define a cavity **264** in the upper portion of the respective side rail.

Rail shoulder **242** is shaped to fit closely over the outside of the roof rib **32**, and is secured to roof rib **32** by fasteners **310** spaced along the length of the rib.

In each rib joint, the edges of the two roof panels are folded together, one over the other, leaving a space **239** between the bottom edges of the folded over panel edges and the underlying top flat surface **241** of the rib. Where the space **239** faces the outer panel of the rail, as at the right side of FIG. **8**A, and as shown in FIG. **8**A**1**, a gap plug **243** is disposed in space **239** between the turned-over edge of the standing seam and the outer panel of the rail. Gap plugs **243** are used both where the upper diverter meets the side rails and where the lower closure meets the side rails.

Where space **239** faces away from outer panel **238** of the side rail, as at the left side of FIG. **8**A, the flat surface of outer panel **238** can be brought into a close enough relationship with the standing seam that any spaces between the standing seam and the outer panel can be closed by pliable tube sealants. Thus, no gap plug is typically used between outer panel **238** and the standing seam where the edge of the seam is turned away from the outer panel.

Gap plug **243** is relatively short, for example about 1.5 inches to about 2.5 inches long, and has a width/height cross-section, shown in FIG. **8**A**1**, which loosely fills space **239**. The remainder of the space **239**, about plug **243**, namely between plug **243** and outer panel **238**, and between plug **243**

and the standing seam, is filled with e.g. a pliable construction sealant **245**. Such sealant is shown in FIG. **8**A**1** as a solid dark outline about plug **243**. Plug **243** thus provides a solid fill piece at spaces **239** where there is some risk of water entry into the aperture, and where the space **239** is too large for assurance that a more pliable sealant can prevent such water entry.

A gap plug **243** is made of a relatively solid, yet resilient, e.g. EPDM (ethylene propylene diene monomer) rubber, which provides relatively solid e.g. relatively non-pliable mass in space **239** between the folded-over standing seam and outer panel **238** of the rail, and relatively pliable, putty-like, tape mastic and tube caulk or the like are used to fill the relatively smaller spaces which remain after the gap plug has been inserted in the respective gap/space. Bearing panel **240**, at the top of the rail, is adapted to support skylight frame **132**, seen in FIG. **8**D. Inside panel **244** of the rail extends down from the inner edge of bearing panel **240**. Capture panel **246** extends at an obtuse included angle, illustrated at about 135 degrees, from the lower end of inside panel **244**.

Referring back to FIG. **8**A, insulation **248** is shown below the aperture **249** in the metal roof panel. Insulation **248** has a facing sheet **250** underlying a layer of e.g. fiberglass batt material **252**. Dashed line **254** outlines the approximate portion of the fiberglass batt material which is to be removed. An edge portion **256** of batt material is left extending into aperture **249** for use described e.g. with respect to FIG. **8**C.

Rail and closure structure **140** is representative of closure support structure **100**. Rails **142**, **144** fit closely along the contours of ribs **32**. Upper diverter **146** and lower closure **150** have contours which match the cross-panel contours of the respective ribs **32** as well as flats **114**. The various mating surfaces of structure **140** and roof **110** can be sealed in various ways known to the roofing art, including caulk or tape mastic. Plastic or rubber fittings or inserts such as plugs **243** and **460** can be used to fill larger openings at the rails and ribs.

FIG. **8**B shows the insulation batt material, marked with a dashed outline in FIG. **8**A, removed from its position under the central portion of the aperture in the metal roof panel, cleaning substantially all of the batt material from that portion of the facing sheet. The facing sheet is then cut the full length of the roof-penetrating aperture **249** over which the one or more skylight lenses are to be installed. At the ends of aperture **249**, the cut is spread to the corners of the aperture. A such "Y"-shaped cut **262** is illustrated at the upper end of the aperture in FIG. **7**A, wherein the ends of the "Y" extend to approximately the upper corners of the aperture.

FIG. **8**C shows one side of the facing sheet lifted out of the aperture **249**. The facing sheet and edge portion **256** of the insulation batting have been raised. A resilient foam retaining rod **260** has been forced into cavity **264** in the rail, with the insulation product extending up alongside, and contacting, the outer panel and captured, and being held, between the retaining rod and the rail surfaces which define cavity **264**, which holds the insulation batting of edge portion **256** against the respective rib **32**. Facing sheet **250** enters cavity **264** against outer panel **238** of the rail, extends up and over/about rod **260** in the cavity, and thence extends back out of cavity **264** to a terminal end of the facing sheet outside cavity **264**. Thus, rod **260** positions edge portion **256**, as thermal insulation, against rib **32**, and also positions the facing sheet vapor barrier between the climate-controlled space **266** inside the building and the perimeter of the closure support structure.

The uncompressed, rest cross-section of rod **260** in cavity **264** is somewhat greater than the slot-shaped opening **268** between inside panel **244** and outer rail panel **238**. Thus retainer rod **260** necessarily is deformable, and the cross-section of the rod is compressed as the rod is being forced through opening **268**. After passing through opening **268**, rod **260** expands against panels **238**, **240**, **244** of the cavity while remaining sufficiently compressed to urge facing sheet **250** against panels **238**, **240**, **244**, and **246** of the cavity whereby facing sheet **250** is assuredly retained in cavity **264** over the entire length of the rail or rails. A highly resilient, yet firm, polypropylene or ethylene propylene copolymer foam is suitable for rod **260**. A suitable such rod, known as a "backer rod" is available from Bay Industries, Green Bay, Wis.

Upper diverter **146** and lower closure **150**, discussed in more detail hereinafter, extend across the flat of the metal roof panel adjacent the upper and lower ends of roof aperture **249** to complete the closure of closure support structure **100** about the perimeter of the skylight aperture. The upper diverter and the lower closure have upper support structures **237** having cross-sections corresponding to the cross-sections of upper support structures **237** of rails **142**, **144**. Those upper support structures thus have corresponding flange cavities which are used to capture facing sheet **250** at the upper diverter and lower closure. Thus, the facing sheet is trapped in a cavity at the upper reaches of the rail and closure structure about the entire perimeter of the rail and closure structure. Bridging tape or the like is used to bridge between the side portions and end portions of insulation facing sheet **250**, such that the facing sheet completely separates the interior of skylight cavity **274** from the respective elements of closure support structure **100**.

FIG. **8**D shows facing sheet **250** trapped in the rail cavities on both sides of the roof aperture. FIG. **8**D further shows the skylight subassembly, including frame **12** and lens **134**, mounted to rails **142**, **144**. A sealant **330** is disposed between bearing panel **240** and skylight frame **132**, to seal against the passage of water or air across the respective joint. A series of fasteners **300** extend through outer panel **238** of the rail and extend into resilient rod **260**, whereby rod **260** insulates the inside of the roof aperture from the temperature differential, especially cold, transmitted by fasteners **300**, thereby to avoid fasteners **300** being a source of condensation inside the skylight cavity **274**, namely below the skylight lens. In addition, frame **132** provides a thermal break between the inside of the frame and the ambient environment.

In FIG. **9** a partially cut away perspective view of rail and closure structures **140** is used to show support of the rail and closure structure by standing seam panel roof **110**, particularly the elevated rib **32** providing the structural support at the standing seams. FIG. **9** illustrates how the rail and closure structures cooperate with the structural profiles of the roof panels of the metal roof structure above and below the skylights, including following the elevations and ribs in adjacent ones of the panels, and thereby providing the primary support, by the roof panels, for the loads imposed by the skylights. In this fashion, the closure support structures of the invention adopt various ones of the advantages of a standing seam roof, including the beam strength features of the ribs at the standing seam, as well as the water flow control features of the standing seam.

Most standing seam roofs are seamed using various clip assemblies that allow the roof panels to float/move relative to each other, along the major elevations, namely along the joints between the respective roof panels, such joints being defined at, for example, elevated ribs **32**. By accommodating such floating of the panels relative to each other, each roof panel is free to expand and contract according to e.g. ambient temperature changes irrespective of any concurrent expansion or contraction of the next-adjacent roof panels. Typically, a roof panel is fixed at the eave and allowed to expand

and contract relative to a ridge. In some roofs, the panels are fixed at midspan, whereby the panels expand and contract relative to both the eave and ridge.

The design of the skylight systems of the invention takes advantage of such floating features of contemporary roof structures, such that when skylight assemblies of the invention are secured to respective rib elevations as illustrated herein, the skylight assemblies, themselves, are supported by the roof panels at ribs **32**. Thus, the skylight assemblies, being carried by the roof panels, move with the expansion and contraction of the respective roof panels to which they are mounted.

FIG. **9** shows panel flat **14**, rib **32**, and shoulder **16**, as well as standing seam **18**. Ridge cap **120** is shown at the roof peak. Gap **122** in a rib **32** is shown at upper diverter **146**.

As seen in FIG. **8**D, skylight frame **132** is secured by a series of fasteners **300** to rail and closure structure **140** at side rails **142** and **144**, and rails **142** and **144** are secured to ribs **32** by a series of fasteners **310**.

In the process of installing a skylight system of the invention, a short length of one of the ribs **32**, to which the closure support structure is to be mounted, is cut away, forming gap **122** in the respective rib, to accommodate drainage at the upper end of the rail and closure structure (toward ridge cap **120**). Such gap **122** is typically used with standing seam, architectural standing seam, and snap seam roofs, and can be used with any other roof system which has elevated elongate joints and/or ribs. In some instances, the ribs on both sides of the skylight may be cut.

The retained portions of rib **32**, namely along the full length of the skylight as disposed along the length of the respective roof panel, provide beam-type structural support, supporting side rails **142** and **144** and maintaining the conventional watertight seal at the joints between roofing panels, along the length of the assembly. Portions of ribs **32**, inside cavity **274**, may be removed to allow additional light from skylight lens **130** to reach through the respective roof opening/aperture.

As part of the installation of upper diverter **146**, a stiffening plate structure **148**, illustrated in FIG. **7** and following the width dimension contour of the roof panel, is placed against the bottom surface of the respective roof panel at or adjacent the upper end of the aperture in the roof. Self-drilling fasteners **430** (FIG. **7**A) are driven through a lower flange of upper diverter **146**, described more fully hereinafter, through the metal roof panel and into stiffening plate structure **148**, drawing the diverter, the roof panel, and the stiffening plate structure into facing contact with each other and thus trapping the roof panel between the stiffening plate and the diverter and closing off the interface between the panel and the diverter. Thus, stiffening plate structure **148** acts as a nut for tightening fasteners **430**. Caulk or other sealant can be used to further reinforce the closure/sealing of the diverter/roof panel interface.

Stiffening plate **148** can also be used to provide lateral support, connecting adjacent ribs **32** to each other. Stiffening plate **148** is typically steel or other material sufficient to provide a rigid support to the skylight rail and closure structure at diverter **146**.

Rail and closure structure **140** is configured such that the skylight subassembly can be easily fastened directly to the rails with rivets or other fasteners such as screws and the like as illustrated at **310** in FIG. **8**D. The rail and closure structure **140** may also be designed to accept a safety/security guard, which acts as fall protection in the skylight aperture, before and/or while the skylight lens subassembly is installed.

Looking now to FIGS. **7**A, and **10** through **12**, upper end diverter **146** extends between rails **142**, **144**, and provides end closure, and a weather tight seal, of the rail and closure structure, at the upper end of the roof aperture, and diverts water around the upper end of the aperture, to the flat portion **114** of an adjacent panel. Diverter **146** generally fits the profile of the uncut rib **32**, and thus generally overlies the uncut rib as suggested by rib mating surface **440** in FIG. **10**, across the panel flat from the cut away gap **122**. The upper ends of side rails **142** and **144** abut the downstream side of diverter **146** and the height of diverter **146** closely matches the height of the side rails. Bearing panel **400** of diverter **146** thus acts with bearing panels **240** of side rails **142** and **144**, and an upper surface of lower closure **150**, to form the upper surface of the rail and closure structure, to which the skylight lens frame **132** is mounted, as well as surrounding a channel which extends upwardly from the corresponding aperture in the roof panel.

Lower flange **410** of diverter **146** runs along, and parallel to, panel flat **14** of the respective roof panel. Diverter **146** also has a diversion surface **420**, and fastener holes **430** along lower flange **410**. Diversion surface **420** is, without limitation, typically a flat surface defining first and second obtuse angles with lower flange **410** and intermediate end panel **415**. As indicated in FIG. **10**, diversion surface **420** has relatively greater width "W1" on the side of the closure structure which is against the rib which is not cut, and a relatively lesser width "W2", approaching a nil dimension, adjacent rib gap **122**, thus to divert water toward gap **122**.

At the end of lower flange **410**, which is closer to the closed rib, is a rib mating surface **440**. At the end of lower flange **410** which is closer to the cut rib is a rib sealing portion **450** of the end panel **415**, which functions as an end closure of the rib **32** on the lower side of gap **122**, and further functions to divert water across the respective rib **32** and onto the flat **14** portion of the roof panel. Rib sealing portion **450** extends through gap **122** and across the respective otherwise-open end of the rib. Hard rubber rib plugs **460**, along with suitable tape mastic and caulk or other sealants, are inserted into the cut ends of the rib on both the upstream side and the downstream side of the rib at gap **122**. The upstream-side plug, plus tube sealants, serve as the primary barrier to water entry on the upstream side of gap **122**. Sealing panel portion **450** serves as the primary barrier to water entry on the downstream side of gap **122**, with plug **460**, in combination with tube sealant, serving as a back-up barrier.

The cross-section profiles of plugs **460** approximate the cross-section profiles of the cavities inside the respective rib **32**. Thus plugs **460**, when coated with tape mastic and tube caulk, provide a water-tight closure in the upstream side of the cut rib, and a back-up water-tight closure in the downstream side of the cut rib. Accordingly, water which approaches upper diverter **146** is diverted by diversion surface **420** and flange **410** and secondarily by flange **415**, toward sealing portion **450**, thence through gap **122** in the rib, away from the high end of closure support structure **100** and onto the flat portion of the next laterally adjacent roof panel. Accordingly, so long as the flow channel through gap **122** remains open, water which approaches the skylight assembly from above upper diverter **146** is directed, and flows through, gap **122** and away from, around, the respective skylight assembly.

FIGS. **7**A, **10**, and **11** show diverter ears **270** on opposing ends of the upper diverter. Ear **270** is shown in FIG. **11**, in top view, at an angle α of about 45 degrees to the end of bearing panel **400** of the diverter. FIG. **10** shows an ear **270** after the upper diverter has been assembled to a rail, and the ear has been bent flat against the respective outer panel **238** of the rail.

After the ear has been bent flat against the rail outer panel, ear **270** is secured to outer panel **140** by driving a screw through aperture **276** and into the outer panel.

FIGS. **9**, **13**, **13**A, **14**, and **15** show lower closure **150**. The lower closure is used to establish and maintain a weather tight seal at the lower end of rail and closure structure **140**, namely at the lower end of roof aperture **249**. As illustrated in FIGS. **9**, **13**, and **15**, the bottom of closure **150** is contoured to fit the profiles of ribs **32** as well as to fit the contour of panel flat **14**. Bottom closure **150** abuts the lower ends of side rails **142** and **144**, and the height of closure **150** matches the heights of side rails **142**, **144**.

Referring to FIGS. **13**, **13**A, lower closure **150** has a bottom portion **510** and an upper rail **500** secured to the bottom portion. Bottom portion **510** has a lower flange **522**, as well as a closure web **520**. Lower flange **522** is in-turned, namely flange **522** extends inwardly of closure web **520**, toward the roof aperture and includes fastener holes **530**. A stiff, e.g. steel, stiffener support plate **532** extends the width of the panel flat under lower flange **522**. Self-drilling screws **534** extend through holes **530**, through the panel flat, and into the stiffener support plate. Stiffener support plate **532** acts as a nut for the respective screws **534**, whereby the screws can firmly secure the lower flange to the panel flat and providing support to that securement. Tube sealants can be used to enhance such closure.

Upper rail **500** is an elongate inverted, generally U-shaped structure. A first downwardly-extending leg **524** has a series of apertures spaced along the length of the rail, and screws **526** or other fasteners which extend through leg **524** and through closure web **520**, thus mounting rail **500** to bottom portion **510**.

Rail **500** extends, generally horizontally, from leg **524** inwardly and across the top of closure web **520**, along bearing panel **536** to inside panel **537**. Inside panel **537** extends down from bearing panel **536** at an included angle, between panels **536** and **537**, of about 75 degrees to a lower edge **538**.

Thus, the upper rail of the lower closure, in combination with the upper region of closure web **520**, defines a cavity **542** which has a cavity cross-section corresponding with the cross-sections of cavities **264** of rails **142**, **144**. As with cavities **264** of the side rails, foam retaining rod **260** has been compressed in order to force the rod through slot **544**, capturing the facing sheet **250** between the retaining rod and the surfaces which define cavity **542**. The facing sheet has been raised. Facing sheet **250** traverses cavity **542** along a path similar to the path through cavities **264**. Thus, facing sheet **250** enters cavity **542** against the inner surface of lower flange **520**, extends up and over/about rod **260** in the cavity, against panels **536** and **537**, and back out of cavity **542** to a terminal end of the facing sheet outside cavity **542**. The tension on facing sheet **250** holds edge portion **256** of the batting against bottom portion **510** of the lower closure.

The uncompressed, rest cross-section of rod **260** in cavity **542** is somewhat greater than the cross-section of slot-shaped opening **544** between inside panel **537** and closure web **520**, whereby rod **260** is necessarily compressed while being inserted through slot **544** and into cavity **542**. After passing through opening **544**, rod **260** expands against panels **524**, **536**, and **537** of the cavity while remaining sufficiently compressed to urge facing sheet **250** against panels **524**, **536**, and **537** whereby facing sheet **250** is assuredly retained in cavity **542**.

As with screws **300** which mount the skylight assembly to side rails **142**, **144**, upper diverter **146**, and lower closure **150**, screws **526** extend through rail **500**, through closure web **520**, and into rod **260**, whereby rod **260** insulates the inside of the roof aperture from temperature differentials transmitted by screws **526**, thereby to avoid the fasteners being a source of condensation inside space **274** below the skylight lens.

Upper rail **500** of the lower closure extends inwardly of closure web **520** at a common elevation with bearing panels **240** of the side rails. Collectively, the bearing panels of side rails **142**, **144**, lower closure **150**, and upper diverter **146** form a common top surface of the rail and closure structure, which receives the skylight lens subassembly.

Closure **150** includes rib mating flanges **540** and **550**, as extensions of lower flange **522**, to provide tight fits along ribs **32**.

A salient feature of closure support structures **100**, relative to conventional curb-mounted skylights, is the reduction in the number of roof penetrations, namely roof apertures, required to provide daylight lighting to the interior of e.g. a building, as multiple skylight assemblies can be mounted along the length of a single elongate aperture in the roof, whereby fewer, though longer, apertures can be made in the roof. Namely, a single opening in the roof can extend along substantially the full length of a roof panel, if desired, rather than cutting multiple smaller openings along that same length, and wherein the single aperture can provide for an equal or greater quantity of ambient light being brought into the building through a smaller number of roof apertures.

Another salient feature of closure support structures **100**, relative to conventional curb-mounted skylights, is the fact that the full lengths of the entireties of the sides, namely the side rails, are above the panel flats, namely above the water lines of the respective metal roof panels.

Yet another salient feature of closure support structures **100**, relative to conventional curb-mounted skylights, is the provision of lateral leg **147** of the upper diverter, which diverts water laterally away from the upper end of the skylight installation/closure support structure.

Closure support structures of the invention are particularly useful for continuous runs of e.g. skylights, where individual skylights are arranged end to end between the ridge and the eave of a roof. FIGS. **16**, **17**, and **17**A show how the ends of two adjacent skylight assemblies can be joined to each other, end to end, in a strip of such skylight assemblies. Instead of installing an upper diverter and a lower closure with each of multiple skylight assemblies, rail **142**A under the relatively up-slope skylight represents an upper end of a first side rail structure relatively up-slope on the roof, and abuts rail **142**B under the relatively down-slope skylight and represents a lower end of the first side rail structure relatively down-slope on the roof. Rails **142**A, **144**A are mounted by rail shoulders **242**A, **242**B to rib **32**. A female mating strip **622** extends across aperture **249** at the lower ends of a first pair of rails **142**, **144**, between rail **142**A and the corresponding rail **144** on the other side of the aperture, including an intermediate portion of mating strip **622** displaced from both of side rails **142**A and the corresponding side rails **144**, in a constant cross-section illustrated in dashed outline in FIG. **17**A. The extension of female mating strip **622** across the aperture includes a bearing panel **240**F which extends between the opposing rails generally designated **142**, **144**. Securing panels **624**F extend beyond both ends of bearing panel **240**F and down over outer rail panels **238**, only one panel **624**F being shown, on the opposing rails **142**, **144**. Securing panels **624**F extend down from bearing panel **240**F and are secured to outer rail panels **238** by screws **626**.

A male mating strip **630** extends across aperture **249** at the upper ends of a second pair of abutting rails **142**B and a corresponding opposing rail **144**, on the other side of the aperture in a constant cross-section illustrated in dashed out-

line in FIG. **17**A. The extension of male mating strip **630** across the aperture includes a bearing panel **240**M which extends between the opposing rails generally designated **142**, **144**. Securing panels **624**M extend beyond both ends of bearing panel **240**M and down over outer rail panels **238**B, only one panel **238**B being shown, on the opposing rails **142**, **144**. Securing panels **624**M extend down from bearing panel **240**M and are secured to outer rail panels **238** by screws **626**.

Female mating strip **622** has a generally horizontally oriented elongate receptacle/slot **632** under the trailing edge of bearing panel **240**F. Male mating strip **630** has a generally horizontally oriented elongate protuberance **634** stepped down from bearing strip **240**F and extending from the leading edge of bearing panel **240**M. Protuberance **634** is received in receptacle **632**, thus to make the joint across aperture **249** for receiving the end members of the frame **132** of the relatively upstream and relatively downstream, skylight assemblies in the respective skylight strip assembly. A bead of tube sealant is laid in female receptacle **632** before protuberance **634** is mated with receptacle **632**. Additional tube sealant is applied along the tops of mating strips **622** and **630** where bearing panels **240**F and **240**M meet.

A thin strip of thermally insulating foam **636** can be applied to the bottom surfaces of mating strips **622** and **630**, bridging the joint at receptacle **632** and secured temporarily to the tops of bearing panels **240**F, **240**M. Placement of first and second skylight assembly frames **132** on the respective bearing panels **240**F, **240**M then secures the ends of the foam on the tops of the mating strips.

Mating strips **622** and **630** have been shown with the female slot/receptacle and the male protuberance in horizontal orientations. Similar mating strips can as well be designed wherein the male protuberance extends upwardly from bearing panel **240**M; and the female receptacle is defined by a wall which extends upwardly from bearing panel **240**F to a top, and then downwardly in defining a downwardly-opening elongate slot, both as illustrated in FIG. **16**. Once again, the female mating strip is typically on the relatively upstream side of the joint and the male mating strip is on the relatively downstream side of the joint.

In the process of installing the closure support structure, the upper diverter is installed first, after cutting a small portion of the aperture near the diverter. Then the remainder of the roof aperture is cut in the respective roof panel and the rails are installed. The lower closure and mating strips are then installed, which defines the perimeter bearing surfaces for each skylight assembly. The skylight assemblies are then mounted on their perimeter bearing surfaces and secured to the rails. Tube sealant and tape mastic are applied, as necessary, at the respective stages of the process, including between the facing surfaces of the rails and the ribs, to achieve leak-free joints between the respective elements of the closure assembly. As an additional benefit, such sealant/mastic between the rails and the ribs inherently operates as a thermal break between the rails and the ribs.

The rails, with or without the upper diverter or the lower closure, depending on the presence, or not, of an aperture in the roof, can be installed on major rib elevations for any of the aforementioned roof panel profiles relative to the included flat portion of the respective roofing panel, so long as the rib structure can adequately support the contemplated load.

Skylight assemblies of the invention can be connected end to end for as long a distance as necessary to cover a roof aperture, as each skylight assembly unit is supported by the ribs **32** of the respective roof panel through respective rails **142**, **144**. The standing rib elevations extend longitudinally along the full collective lengths of the respective rails, regardless of the number of skylight assemblies which are used to close off a given aperture in the roof. Water cannot enter over the tops of the rails because of the sealant at **330**. Water cannot enter at the upper diverter at the uppermost skylight assembly because of the seal properties provided by the upper diverter, by bearing plate **148**, and by the respective sealants, as well as because of the diversion of water away from the upper end of the strip of skylights through gap **122**. Water cannot enter at the lower end because of the seal properties provided by the lower closure and by the sealants between the lower closure and the respective roof panel. Water cannot enter between the ends of the skylight subassemblies because of the tortuous path through receptacle slot **632** in combination with the sealants applied at the end-to-end joint

FIG. **18** shows an exploded pictorial view of the ends of first and second rails in abutting relationship, which abutting relationship is also illustrated in part in FIG. **17**A, such as where first and second skylights are arranged in a straight line direction in end-to-end relationship over a single roof aperture. Connecting plate **640** is configured to fit closely inside the cavity cross-sections defined by the respective rails, against the outer rail panels **238** and against the rail bearing panels **240**. Connecting plate **640** is shown aligned with the abutting rail ends. The connecting plate is inserted into the cavities in the rails, bridging the butt joint between the rails. Apertures **644** in the connecting plate align with apertures **646** in the rails when the ends of the rails are in abutting relationship. Screws or other known aperture-to-aperture fasteners are used to securely fasten connecting plate **640** to both of the rails. Tape mastic and tube caulk are used, as known in the art for water seal closures, to fill the joint between the rail panels and the reinforcing connecting plate. As illustrated in FIG. **18**, the length of connecting plate **640** is limited to the area of the joint between the two side rails, and provides both reinforcement of the joint and enhanced seal of the joint against intrusion of water.

If desired, rails **142**, **144**, upper diverter **146**, and lower closure **150**, can be increased in height to increase the distance/height between an upper portion of the rail and closure structure and the respective underlying roof panel. In the alternative, a height extension rail can be laid over or attached to the top of the rail and closure structure to provide a corresponding height increase. Such an extension can be produced to interface with the upper flange of the rail and closure assembly, to effectively raise the height of the skylight or smoke vent to accommodate different depths or other design features of the respective skylights, smoke vents, or other roof loads, or to accommodate snow conditions, anticipated snow depths, and the like. Where increased height is achieved by adding extensions to the rails, the upper diverter, and the lower closure, the elements of the rail and closure structure can be produced to a standard height, with extensions being used to elevate the overall height of the structure for such varied purposes. Various forms for such extensions can be suitable, and the skilled artisan will understand various ways and means of designing and manufacturing such extensions to achieve the goal of added elevation for the skylight lens.

As indicated above, the weight of the loads transferred by rails **142**, **144** is transferred directly to ribs **32** of the respective underlying roof panels along the full lengths of the closure support structures; and only a minor portion, if any, of that weight is borne by the panel flat, and only at the high end and at the lower end of a load which overlies an aperture in the roof. Thus, the weight of the rails, or of the rail and closure assembly, is borne by the strongest elements of the roof panels, namely the ribs.

A wide variety of roof-mounted loads, in addition to skylights and smoke vents, is contemplated to be mounted on rails **142**, **144**. Where the load overlies an aperture in the roof, the rail system provides for fewer apertures. Where the load does not overlie an aperture in the roof, the rail system allows the roof to carry the weights of a variety of loads without penetrating the roof for the purpose of extending the support path through openings in the roof to the underlying building structural members, also without adding framing or other bracing under the roof panels to support the weight of such roof-mounted hardware, and thus avoiding water leaks associated with such openings, so long as the weight of such roof-mounted loads does not exceed the allowable load on the ribs. And where a roof-mounted load is e.g. an air conditioner, namely a load which does not require a roof opening, the upper diverter and the lower closure can be omitted. Further, in such instance, the rails can extend intermittently along the lengths of ribs **32**, or shorter lengths of rails **142**, **144**, such as about 6 inches to about 12 inches length of such rails, can underlie only the left and right sides of upper and lower ends of the load.

The primary reason why the disclosed rail and closure structures do not leak is that a great portion of the perimeter of the closure, namely that which is defined by side rails **142**, **144**, is above the panel flat, namely above the water line on the roof panel; and all associated roof penetrations, such as screws **310** which mount the rails to the ribs, are above the water line. With little or no standing water at the surface-to-surface joints between the rails and the roof panels, even if the sealant fails at the joint, no substantial quantity of water routinely enters such failed joint because of the heights of those joints above the water line.

As a general statement, rail and closure structures of the invention close off the roof aperture from unplanned leakage of e.g. air or water through the roof aperture. The rail and closure structure **140** extends about the perimeter/sides of the roof aperture and extends from the roofing panel upwardly to the top opening in the rail and closure structure. The lens subassembly overlies the top opening in the rail and closure structure and thus closes off the top opening to complete the closure of the roof aperture.

Closure support structure **100** thus is defined at least in part by rail and closure structure **140** about the perimeter of the roof opening, and skylight lens subassembly **130**, or the like, overlies the top of the rail closure structure and thus closes off the top of the closure support structure over the roof aperture.

Rail and closure structure **140** has been illustrated in detail with respect to one or more variations of the standing seam roofs illustrated in FIGS. **1**, **3**, and **5**. In light of such illustrations, those of skill in the art can now adapt the illustrated rail and closure structures, by modifying, shaping of the structure elements, to support loads from any roof system which has a profile which includes elevations, above the panel flat, using standing joints or other raised elevations, such as, without limitation, those illustrated in FIGS. **2** and **4**, as the locus of attachment to the roof.

While the figures depict a skylight, the rail structure, with or without end closures, can be used to mount a wide variety of loads on such roof, including various types of skylights, smoke vents, air conditioning, other vents, air intakes, air and other gaseous exhausts, electrical panels or switching gear, and/or other roof loads, including roof-penetrating structures, all of which can be supported on rail structures of the invention.

Although the invention has been described with respect to various embodiments, this invention is also capable of a wide variety of further and other embodiments within the spirit and scope of the appended claims.

Those skilled in the art will now see that certain modifications can be made to the apparatus and methods herein disclosed with respect to the illustrated embodiments, without departing from the spirit of the instant invention. And while the invention has been described above with respect to the preferred embodiments, it will be understood that the invention is adapted to numerous rearrangements, modifications, and alterations, and all such arrangements, modifications, and alterations are intended to be within the scope of the appended claims.

To the extent the following claims use means plus function language, it is not meant to include there, or in the instant specification, anything not structurally equivalent to what is shown in the embodiments disclosed in the specification.

Having thus described the invention, what is claimed is:

1. Apparatus adapted to be assembled to form a closure support structure, wherein said closure support structure defines an upstanding enclosing wall having a top and extending about a perimeter of an aperture, wherein such aperture extends through a roof of a building, such roof of such building comprising a plurality of elongate metal roof panels which collectively define a plurality of elongate upstanding ribs extending between a ridge and an eave of such building, such ribs defining upstanding seams which have folded over terminal edges of the respective adjacent roof panels, such enclosing wall extending up from such roof and closing off access to such aperture from any side of such aperture, said apparatus comprising:

a plurality of closure members, having lengths, and being adapted to be mounted on such roof and about such aperture, said closure members, when assembled to each other on such roof, collectively providing said enclosing wall, the assembled closure members defining an outer perimeter of said enclosing wall which separates a surrounded space, over such aperture, from an ambient environment outside such enclosing wall,

said enclosing wall comprising an upstanding outer panel, one or more cavity walls extending from said upstanding outer panel toward such aperture and defining respective cavity portions in the respective said closure members, said upstanding outer panel being disposed outwardly, away from the aperture, relative to such cavity portions,

a layer of insulation being generally disposed under a such metal roof panel about such aperture, edge portions of said layer of insulation insulation extending upwardly through such aperture, further comprising a rod holding said layer of insulation in such cavity portion.

2. Apparatus as in claim **1**, said closure members comprising

(i) a first elongate side rail, comprising one or more elongate rail panels which define a first such cavity portion disposed, from the outer perimeter of said enclosing wall, toward such aperture,

(ii) a second elongate side rail, comprising one or more elongate rail panels which define a second such cavity portion,

(iii) an upper diverter, comprising one or more diverter panels which define a third such cavity portion, and

(iv) a lower closure, comprising one or more lower closure panels which define a fourth such cavity portion.

3. Apparatus as in claim **1**, a closure panel being mounted over said closure support structure and closing off access to such surrounded space, and one or more fasteners mounting said closure panel to said closure support structure, said fasteners terminating inside said rod.

4. Apparatus as in claim 1, said apparatus being assembled into a said closure support structure and mounted on such roof of such building about such aperture, such roof of such building comprising a sloping metal roof comprising a plurality of metal roof panels, each such roof panel having opposing sides, each such side of each panel defining a rib elevation, and a single panel flat between such ribs,

said closure members comprising

(i) a first elongate side rail,

(ii) a second elongate side rail,

(iii) an upper diverter, and

(iv) a lower closure comprising a bottom portion and an upper rail,

the bottom portion comprising

(A) a closure web extending upwardly from the panel flat, and

(B) a lower flange extending along, and generally at an elevation of, the respective panel flat of a given such metal roof panel, from said closure web, toward the roof aperture, said lower flange being secured to such roof panel at the panel flat,

said upper rail being mounted to said closure web and extending, as a bearing panel, from said closure web toward the roof aperture, and extending, from said bearing panel, downwardly as an inside panel of the respective cavity portion, spaced from said closure web.

5. Apparatus as in claim 4, further comprising a stiffener support plate underlying said lower flange of said bottom portion of said lower closure, and self-drilling fasteners extending through said bottom portion, through the panel flat of the respective roof panel and into said underlying stiffener support plate, said stiffener support plate acting as a nut for the respective self-drilling fasteners whereby said self-drilling fasteners hold said lower flange, such roof panel, and said stiffener support plate firmly against each other, with such roof panel between said lower flange and said stiffener support plate.

6. Apparatus as in claim 1, said apparatus being assembled into a said closure support structure and mounted on a sloping such roof of such building about such aperture,

said closure support structure comprising

(i) first and second elongate side rails extending in a first straight-line direction mounted to such roof in end-to-end relationship, and a first connecting plate extending between and mounted to both of said first and second side rails,

(ii) third and fourth elongate side rails extending in a second straight-line direction mounted to such roof in end-to-end relationship, and a second connecting plate extending between and mounted to both of said third and fourth side rails,

(iii) an upper diverter extending between said first and third side rails at an up-slope end of said upstanding enclosing wall, and

(iv) a lower closure.

7. A building, comprising a plurality of upright walls and a roof, apparatus as in claim 1 being mounted on said roof of said building.

8. Apparatus as in claim 1 wherein the cavity extends about substantially the entirety of the outer perimeter of said enclosing wall, and is disposed inwardly of the outer perimeter such that the cavity path is between the outer perimeter and such aperture.

9. Apparatus as in claim 1, said closure member elements extending, from the inner surface of said enclosing wall, into the surrounded space.

10. Apparatus as in claim 1, said one or more cavity walls and the respective upstanding seam defining a slot, and a corresponding access path, along a full length of the respective said closure member.

11. Apparatus as in claim 1, a layer of insulation being generally disposed under a such metal roof panel about such aperture, such layer of insulation comprising a vapor barrier sheet, and a layer of thermally-insulating batt material, edge portions of said vapor barrier sheet extending upwardly through such aperture, inwardly of the inner surface of said enclosing wall and up alongside said outer panel and being held inside a such cavity portion.

12. A closure support structure as in claim 11, further comprising a rod engaging said insulation in a such cavity portion.

13. A closure support structure mounted on a metal panel roof of a building, such roof comprising a plurality of elongate metal roof panels extending between a ridge and an eave of such building, said closure support structure defining an upstanding enclosing wall extending about a perimeter of an aperture in such roof, such aperture extending through such roof of such building, said closure support structure comprising

a plurality of closure members, having lengths, mounted on such roof about such aperture, said closure members collectively providing said enclosing wall,

said enclosing wall comprising an upstanding outer panel,

one or more cavity walls extending from said upstanding outer panel toward such aperture and defining respective cavity portions in the respective said closure members,

said upstanding outer panel being disposed outwardly, away from the aperture, relative to such cavity portions,

one or more of said cavity walls collectively at least in part defining a slot portion, which slot portion defines an access path into at least one of the respective cavity portions,

a layer of insulation being generally disposed under a such metal roof panel about such aperture, such layer of insulation comprising a vapor barrier sheet, and a layer of thermally-insulating batt material,

edge portions of said vapor barrier sheet extending upwardly through such aperture, inwardly of the inner surface of said enclosing wall and up alongside said outer panel and being held inside a such cavity portion.

14. Apparatus as in claim 13, an upwardly-extending portion of such thermally-insulating batt material extending upwardly through such aperture inwardly of said enclosing wall and being disposed between said vapor barrier sheet and one or more of said closure members.

15. A closure support structure defining an upstanding enclosing wall extending about a perimeter of an aperture, wherein such aperture extends through a roof of a building, such enclosing wall extending up from such roof and closing off access to such aperture from any side of such aperture, said closure support structure comprising a plurality of closure members, having lengths, and being mounted on such roof and about such aperture, said closure members collectively providing said enclosing wall,

said closure members comprising

(i) a first elongate side rail,

(ii) a second elongate side rail,

(iii) an upper diverter,

(iv) a lower closure,

such roof of such building comprising a plurality of elongate metal roof panels which collectively define a plurality of elongate upstanding ribs extending between a ridge and an eave of such building, each such roof panel having opposing

sides, each such side of each panel defining a rib elevation, the rib elevations of adjacent such roof panels being joined together to form first and second ribs, and a single panel flat extending from the first rib to the second rib,

full lengths of said first and second side rails being mounted on the adjacent ribs on opposing sides of such single panel flat.

16. Apparatus adapted to be assembled to form a closure support structure, wherein said closure support structure defines an upstanding enclosing wall having a to and extending about a perimeter of an aperture, wherein such aperture extends through a roof of a building, such roof of such building comprising a plurality of elongate metal roof panels which collectively define a plurality of elongate upstanding ribs extending between a ridge and an eave of such building, such ribs defining upstanding seams which include folded over terminal edges of the respective adjacent roof panels, such enclosing wall extending up from such roof and closing off access to such aperture from any side of such aperture, said apparatus comprising:

a plurality of closure members, having lengths, and being adapted to be mounted on such roof and about such aperture, said closure members, when assembled to each other on such roof, collectively providing said enclosing wall, the assembled closure members defining an outer perimeter of said enclosing wall which separates a surrounded space, over such aperture, from an ambient environment outside such enclosing wall,

said enclosing wall comprising an upstanding outer panel, one or more cavity walls extending from said upstanding outer panel toward such aperture and defining respective cavity portions in the respective said closure members, said upstanding outer panel being disposed outwardly, away from the aperture, relative to such cavity portions, one or more of said cavity walls collectively at least in part defining a slot portion, which slot portion defines an access path into at least one of the respective cavity portions,

said side rails comprising outer rail panels extending upwardly from such ribs, a rib space being disposed below the folded-over terminal ends and above underlying portions of such ribs, and between a such upstanding seam and a respective panel of a said side rail, further comprising a cut-away gap (**122**) extending through one of such first and second ribs, cut ends of the respective such rib being disposed on opposing sides of such gap, exposing such rib space at such gap, further comprising, at such cut-away gap through such rib which exposes such rib space, a closely-fitting short rib plug (**243**) disposed in one of the cut ends, in the rib space, between the folded-over terminal ends and the respective panel of the respective said side rail.

17. Apparatus adapted to be assembled to form a closure support structure, wherein said closure support structure defines an upstanding enclosing wall having a to and extending about a perimeter of an aperture, wherein such aperture extends through a roof of a building, such roof of such building comprising a plurality of elongate metal roof panels which collectively define a plurality of elongate upstanding ribs extending between a ridge and an eave of such building, such enclosing wall extending up from such roof and closing off access to such aperture from any side of such aperture, said apparatus comprising:

(i) a first elongate side rail, comprising one or more elongate rail panels which define a first such cavity portion,

(ii) a second elongate side rail, comprising one or more elongate rail panels which define a second such cavity portion,

(iii) an upper diverter, comprising one or more diverter panels which define a third such cavity portion, and

(iv) a lower closure, comprising one or more lower closure panels which define a fourth such cavity portion,

said upper diverter comprising an upstanding end panel (**415**) extending between said first and second side rails and facing such ridge of such building, and diverter ears extending from said end panel and folded over said side rails, on a fold line which is generally perpendicular to such panel flat, and secured to, said side rails.

18. Apparatus adapted to be assembled to form a closure support structure wherein such closure support structure extends about a perimeter of an aperture, wherein such aperture extends through a sloping metal roof of a building, such sloping metal roof of such building comprising a plurality of elongate metal roof panels, each such roof panel having opposing sides, each such side of each panel defining a rib elevation, the rib elevations of adjacent such roof panels being joined together to form ribs, and a single panel flat being disposed between adjacent ones of such ribs, such closure support structure extending up from such roof and closing off access to such aperture from any side of such aperture, said apparatus comprising:

(a) a plurality of closure members adapted to be mounted on such roof and about such aperture in such roof thereby to provide such closing off of access to such aperture, said closure members comprising

(i) a first elongate side rail,

(ii) a second elongate opposing side rail,

(iii) an upper diverter extending from such roof, and

(iv) a lower closure extending from such roof, said lower closure comprising a bottom portion and a separate and distinct upper rail,

the bottom portion comprising, as a single element,

(A) a closure web adapted to extend upwardly from such roof, and

(B) a lower flange connected to said closure web, said lower flange, when mounted to an underlying such metal roof panel as part of said lower closure, extending from said closure web, generally at an elevation of the panel flat of such underlying metal roof panel, and toward such aperture,

said upper rail being disposed at the top of said lower closure, and being mounted to said bottom portion by fasteners, and extending, as a bearing panel, from said closure web toward such aperture.

19. Apparatus as in claim **18**, said apparatus being assembled into a said closure support structure and mounted on such sloping roof of such building about such aperture, said lower flange extending along, and generally at an elevation of the respective panel flat of a given such metal roof panel, from said closure web, toward such roof aperture, said upper rail being mounted to said bottom portion and lying in overlying relationship with respect to said lower flange and extending, across open space from said closure web, toward such roof aperture, and downwardly at a location spaced from said closure web.

20. Apparatus as in claim **18**, said apparatus being assembled into a said closure support structure and mounted on such roof of such building about such aperture, further comprising a closure panel mounted over said closure support structure and closing off access to such surrounded space.

21. Support structure apparatus adapted to be assembled to form a closure support structure mounted on a sloping roof of a building, wherein said support structure comprises a plurality of closure members which, when assembled to each other,

extend from said sloping roof to a top of said closure support structure, and which closure members collectively further define an outer perimeter of said closure support structure, which separates a surrounded space, over an aperture, from an ambient environment outside such closure support structure, such aperture extending through such roof of such building, said closure support structure extending from an up-slope end thereof on such roof to a down-slope end thereof on such roof, and extending in an upward direction from such roof of such building and closing off access to such aperture from any side of such aperture, said apparatus comprising

(i) first and second side rails adapted to be mounted to such roof, extending in a first straight-line direction, and in end-to-end relationship, with a first joint between said first and second side rails, as a first side of such closure support structure,

(ii) third and fourth side rails adapted to be mounted to such roof, extending in a second straight-line direction, and in end-to-end relationship, with a second joint between said third and fourth side rails, as a second opposing side of such closure support structure,

(iii) an upper diverter adapted to extend between said first and third side rails at the up-slope end of such closure support structure, and

(iv) a lower closure,

the combination of said first and second side rails, said third and fourth side rails, said upper diverter, and said lower closure, when so assembled on such roof, collectively defining an opening through such support structure above, and axially aligned with such aperture.

22. Support structure apparatus as in claim **21**, further comprising, as part of said support structure apparatus, at least one mating strip adapted to extend across such opening, from side rail to side rail, and being disposed between, and displaced from, the up-slope end and the down-slope end of such closure support structure, so as to divide the surrounded space at a top of said closure support structure into first and second distinct elements of such space,

said at least one mating strip further comprising a bearing panel extending across such surrounded space and being adapted to receive closure structure thereon, overlying respective elements of such surrounded space.

23. Support structure apparatus as in claim **21**, said apparatus being assembled into a said closure support structure and mounted on such roof of such building about such aperture, a first side of said closure support structure comprising said first and second elongate side rails extending in the first straight-line direction and in end-to-end relationship, with a first joint between said first and second side rails, a first connecting plate extending between said first and second side rails across the first joint and being limited in length to the area of the first joint, and mechanical fasteners extending through the first connecting plate and through the first and second side rails, and thereby connecting respective end portions of the first and second side rails to each other, a second opposing side of said closure support structure comprising said third and fourth elongate side rails extending in the second straight-line direction and in end-to-end relationship, with a second joint between said third and fourth side rails, a second connecting plate extending between said third and fourth side rails across the second joint and being limited in length to the area of the second joint, and mechanical fasteners extending through the second connecting plate and through the third and fourth side rails, and thereby connecting respective end portions of the third and fourth side rails to each other, said upper diverter extending between said first and second sides at the up-slope end of said closure support structure, said lower closure extending between said first and second sides at the down-slope end of said closure support structure.

24. Support structure apparatus as in claim **23**, said side rails, said upper diverter, and said lower closure, defining bearing panels which collectively extend about a perimeter of said closure support structure in a common imaginary plane, and defining a top of said support structure, and as part of said support structure apparatus, at least one mating strip adapted to extend across the roof aperture and across such opening, from side rail to side rail, said at least one mating strip being adapted to be mounted to respective first and second ones of said side rails, with an intermediate portion of said at least one mating strip being displaced from all of said side rails, said upper diverter and said lower closure, said at least one-mating strip extending across the opening, starting from a location intermediate the up-slope and down-slope ends of said closure support structure and ending at a location intermediate the up-slope and down-slope ends of said closure support structure, said mating strip also including a mating strip bearing panel in the same imaginary plane, thereby to define a first bearing panel perimeter at the top of said support structure, adapted to receive a first closure panel which thereby closes off a first portion of the opening, and a second bearing panel perimeter, separate and distinct from the first bearing panel perimeter, adapted to receive a second different closure panel which thereby closes off a second different portion of the opening, the collective closure panels closing off the entirety of the opening.

25. Support structure apparatus as in claim **24**, further comprising first and second closure panels overlying, and closing off the respective first and second portions of the opening, including over said at least one mating strip.

26. Support structure apparatus as in claim **25** wherein the first and second closure panels comprise first and second skylight lenses.

27. Support structure apparatus as in claim **26** wherein said first and second skylight lenses, collectively with portions of said closure support structure, overlie the entirety of the single roof aperture.

28. Apparatus adapted to be assembled to form a closure support structure, wherein said closure support structure extends about a perimeter of an aperture, wherein such aperture extends through a roof of a building, said closure support structure extending up from such roof and closing off access to such aperture from any side of such aperture, said apparatus comprising:

a plurality of closure members, having lengths, and being adapted to be mounted on such roof and about such aperture, said closure members, when assembled to each other on such roof, collectively defining an outer perimeter of said closure support structure which outer perimeter separates a surrounded space, over such aperture, from an ambient environment outside the outer perimeter,

a said closure member comprising an upstanding outer panel, a rail upper flange extending from said upstanding outer panel toward such aperture, and a rail inside panel extending from said rail upper flange at an included acute angle with said rail upper flange.

29. Apparatus as in claim **28**, said apparatus being assembled into a said closure support structure and mounted on a metal panel roof of such building about such aperture, such roof of such building comprising a plurality of elongate metal roof panels, each having an elongate panel flat, and elongate rib elements on opposing sides of such panel flat, such rib elements on adjacent ones of such roof panels coop-

erating with each other to define elongate upstanding ribs extending between a ridge and an eave of such building roof, said closure support structure comprising

(a) a first elongate side rail structure mounted on a first such rib, said first side rail structure having a first upper end relatively up-slope on said roof and a first lower end relatively down-slope on said roof,

(b) a second elongate side rail structure mounted on a next adjacent rib across a single panel flat from said first side rail structure, said second side rail structure having a second upper end relatively up-slope on said roof and a second lower end relatively down-slope on said roof,

(c) an upper diverter extending between the first and second upper ends of said first and second rail structures, and

(d) a lower closure extending between the first and second lower ends of said first and second rail structures,

said upper diverter comprising

(i) a lower flange, said lower flange engaging a first such rib, and extending from the first such rib across the respective single panel flat, in general surface-to-surface alignment with, and in contact with, such panel flat, to a next adjacent second such rib, and across a gap in such second rib and onto a next adjacent panel flat, and

(ii) an upstanding panel extending generally upwardly from said lower flange, and extending generally from the first rib to the second rib, and across the second rib at the gap, said upstanding panel having a lower edge and an upper edge, said lower edge extending at an angle which proceeds down the slope of such roof between such first rib and such second rib.

30. A closure support structure defining an upstanding enclosing wall having a top and extending about a perimeter of an aperture, wherein such aperture extends through a metal panel roof of a building, said enclosing wall comprising an upstanding outer panel extending up from such roof to a to of said enclosing wall, said enclosing wall closing off access to such aperture from any side of such aperture, said closure support structure comprising:

a plurality of closure members, having lengths, and mounted on such roof about such aperture, said closure members collectively providing said enclosing wall, said enclosing wall having an inner surface and an outer surface, said enclosing wall separating a surrounded space, over such aperture, from an ambient environment outside said enclosing wall,

a layer of insulation being disposed under, and proximate, a such metal roof through which such aperture extends, an upstanding portion of said layer of insulation extending up from under such metal roof, through the aperture, and up alongside, and contacting, said outer panel and thereby providing thermal insulation between the surrounded space and said enclosing wall.

31. A closure support structure as in claim **30**, said layer of insulation comprising a vapor barrier layer and said layer of thermally-insulating material, said layer of thermally-insulating material being disposed between said vapor barrier layer and at least a lower portion of said outer panel.

32. A closure support structure as in claim **31**, a portion of said vapor barrier layer being disposed against an upper portion of said enclosing wall.

33. A closure support structure mounted on a metal panel roof of a building, such roof comprising a plurality of elongate metal roof panels extending between a ridge and an eave of such building, said closure support structure defining an upstanding enclosing wall extending about a perimeter of an aperture in such roof, such aperture extending through such roof of such building, said closure support structure comprising

a plurality of closure members, having lengths, mounted on such roof about such aperture, said closure members collectively providing said enclosing wall,

said enclosing wall comprising an upstanding outer panel,

one or more cavity walls extending from said upstanding outer panel toward such aperture and defining respective cavity portions in the respective said closure members,

said upstanding outer panel being disposed outwardly, away from the aperture, relative to such cavity portions,

one or more of said cavity walls collectively at least in part defining a slot portion, which slot portion defines an access path into at least one of the respective cavity portions,

a layer of insulation being generally disposed under a such metal roof panel about such aperture,

edge portions of said layer of insulation extending upwardly through such aperture, inwardly of the inner surface of said enclosing wall and up alongside, and contacting, said outer panel.

34. A closure support structure as in claim **33**, said layer of insulation comprising a vapor barrier and a layer of thermally-insulating batt material, further comprising a rod engaging said vapor barrier sheet in a such cavity portion.

* * * * *

EXHIBIT D

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August 1, 2013

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SENT BY E-MAIL AND FIRST CLASS MAIL

R & S Manufacturing and Sales Company, Inc.
3575 Old Conejo Road
Newbury Park, CA 91320

Dear Sir/Madam: Re: Patent Infringement

We represent T&M Inventions, LLC ("T&M"), the owner of four United Sates patents:

- U.S. Patent No. 8,438,798,
- U.S. Patent No. 8,438,799,
- U.S. Patent No. 8,438,800, and
- U.S. Patent No. 8,438,801.

I am enclosing copies of all four patents (the "Patents"). The Patents generally claim a system for installing support structures, including skylights, on the rib elevations of metal roofs.

We have learned that R & S Manufacturing and Sales Company, Inc. ("R&S") is using, making, offering to sell, or selling a product identified as "Standing Seam 24 Light" (the "Infringing Product") in the United States. I have also enclosed a copy of a "SS24 Skylight System Quick Installation Instructions" (the "Installation Guide") R&S offers its customers. The Installation Guide shows that the Infringing Product infringes at least one claim of each of the Patents.

T&M thus demands that R&S immediately cease and desist any manufacture, use, sale or offering for sale of the Infringing Product and any similar product in the United States. T&M also demands that R&S immediately provide us with an accounting of all sales of the Infringing Product and destroy any inventory of the Infringing Product, including unassembled parts.

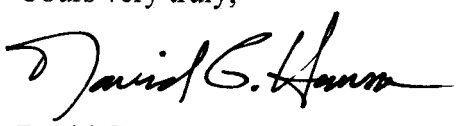
To protect T&M's patent rights, and to ensure that R&S will comply with T&M's demands, we request a response to this letter no later than 5:00 p.m. Central Time, Friday, August 9, 2013. The writing should be signed by a person with authority to bind R&S, and it must state both the extent to which R&S intends to comply with T&M's demands and the date by which R&S will comply.

If R&S fails to respond, either to this letter or to T&M's demands, T&M will consider all available options, including litigation, where it will seek injunctive relief and monetary damages, attorney fees, and court costs. Please also be advised that counsel for BlueScope Buildings North America ("BBNA"), the exclusive licensee of T&M's patented technology, is aware of your infringing activity, and has authorized me to state that BBNA joins in T&M's demand that you cease and desist and T&M's demand for a full accounting.

Nothing in this letter shall be deemed to be a waiver of any claims or remedies that T&M Inventions, LLC may have against R&S, either at law or in equity.

We look forward to a prompt, full response.

Yours very truly,



David G. Hanson

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Encs.

EXHIBIT E

R & S Manufacturing and Sales Company, Inc.

August 9, 2013

Mr. David Hanson
Reinhart Boerner Van Deuren s.c.
PO Box 2965
Milwaukee, WI 53201

Dear Mr. Hanson:

This will confirm our receipt of your August 1, 2013 letter.

Thank you for informing us of your client's patent awards. Our company policy is to fully respect the intellectual property rights of other companies.

We have not sold any of the mentioned products since your patent issue date of May 14, 2013.

We have no inventory that is unique to the aforementioned product.

Sincerely,

W. Richard Lippeatt
President

3575 Old Conejo Road, Newbury Park, CA 91320
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