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(54) **INSULATED MODULAR ROOF SYSTEM**

(71) Applicant: **Mod Panel Manufacturing Ltd.**,
Edmonton (CA)

(72) Inventor: **David KENNEDY**, Edmonton (CA)

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(57) **ABSTRACT**

In one aspect there is provided an insulated modular roof system for a roof structure. The system comprises a plurality of modular panels suitable for installation onto the roof structure and a water-proof membrane. Each of the plurality of modular panels comprises a first planar member, an insulating layer covering substantially all of the first planar member and a second planar member suitable to cover substantially all of the insulating layer. Preferably, the system further comprises a joint closure member and a joint fill material suitable to fill any empty space between any abutting modular panels. The water-proof membrane may be provided in sections on each of the plurality of modular panels.

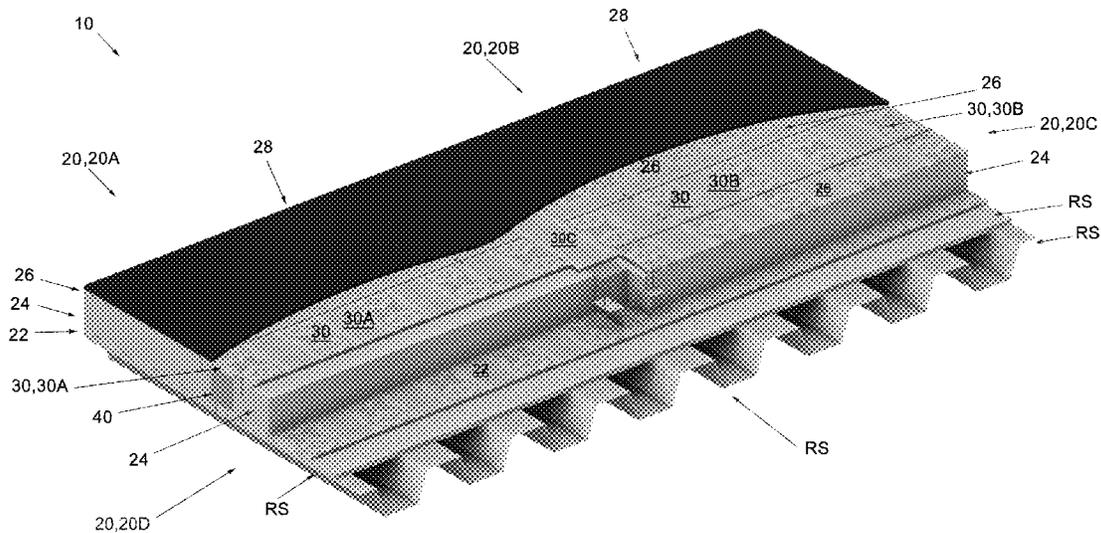
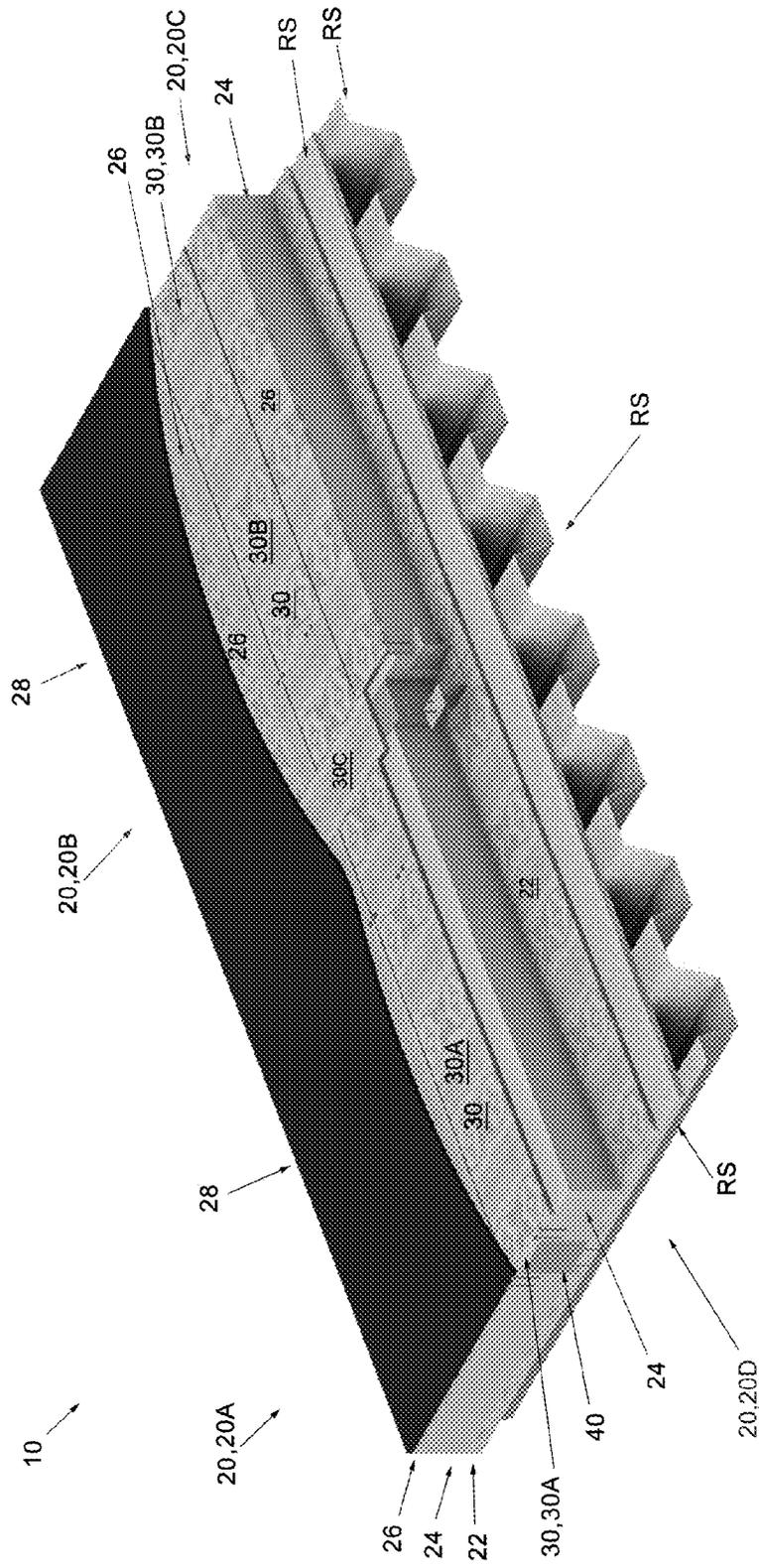


Fig. 1



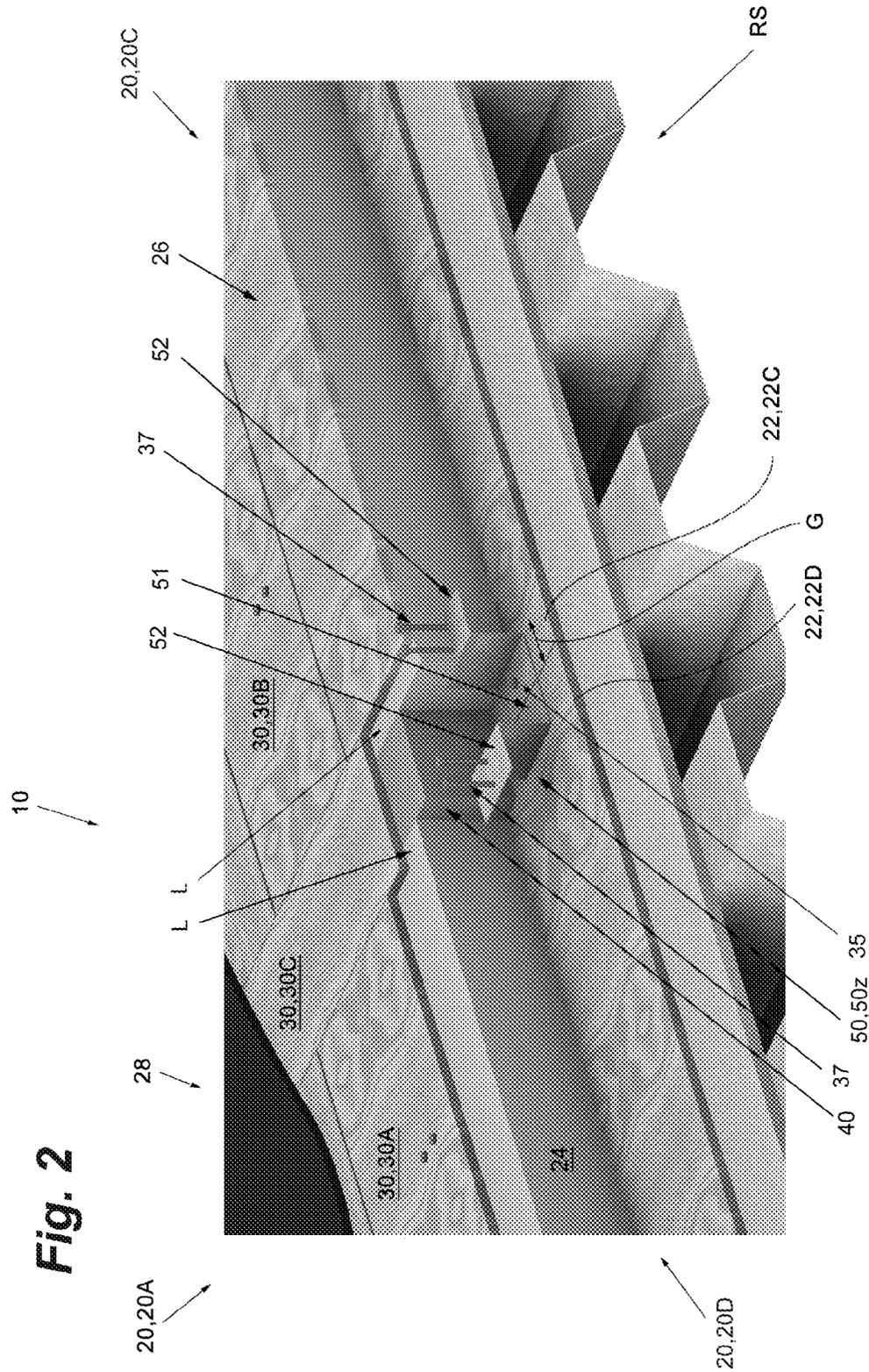


Fig. 2

Fig. 4

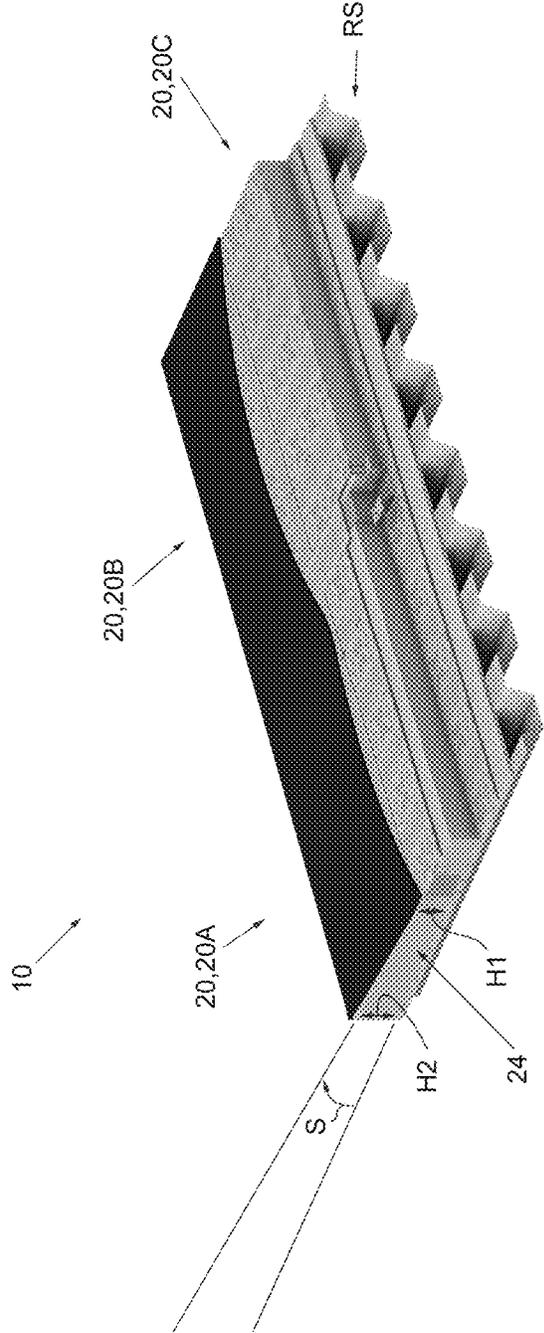


Fig. 5

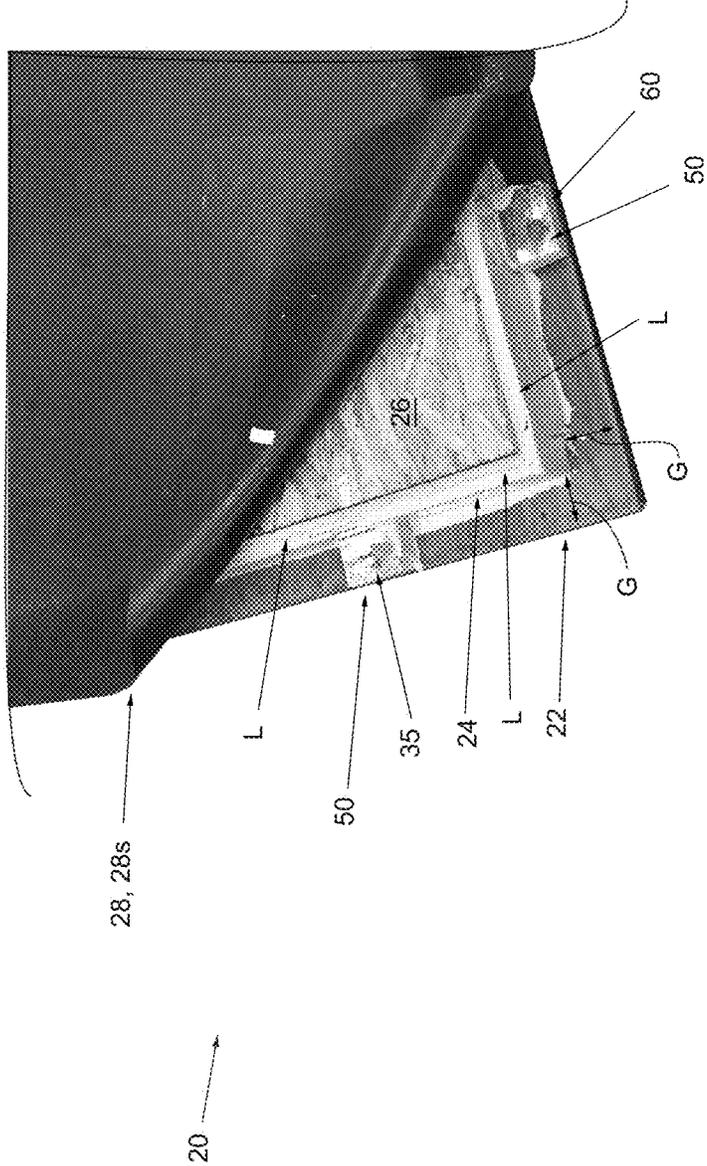


Fig. 6a

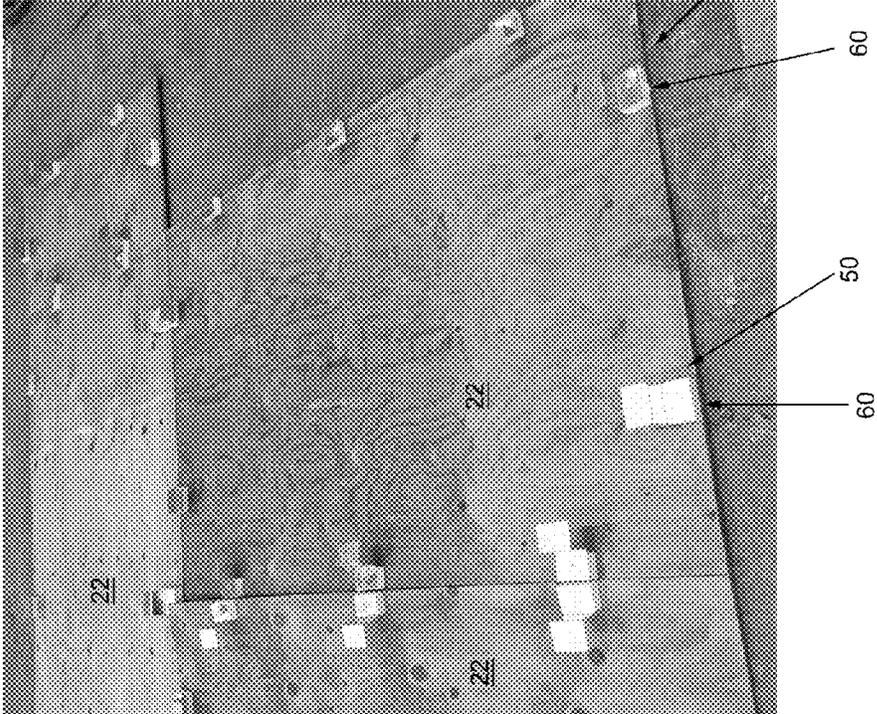
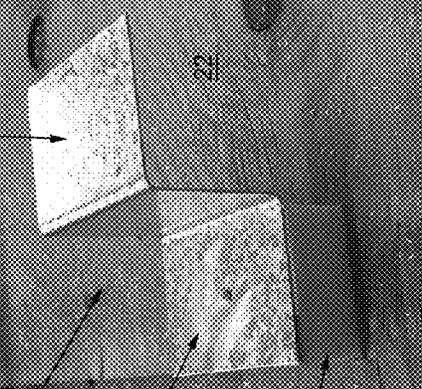


Fig. 6b



INSULATED MODULAR ROOF SYSTEM

FIELD OF THE INVENTION

[0001] This invention relates to roofing systems, in particular insulated roofing systems.

BACKGROUND OF THE INVENTION

[0002] The background information discussed below is presented to better illustrate the novelty and usefulness of the present invention. This background information is not admitted prior art.

[0003] Various roofing systems are known both for flat and sloped roofs to insulate and waterproof the roof. On flat roofs the most common roofing system for waterproofing is a built up laminar structure comprising a plurality of felt layers with each layer or series of layers over-laid with a hot bituminous (tar) composition to bind the felt to the roof. A layer of gravel tops off the structure. However, this is a very labour intensive process and requires onsite machines and equipment (e.g. to provide the hot tar).

[0004] In recent years, as the advantages of applying insulation on the exterior as opposed to the interior of the roof deck have become known, the built up roof structure has been applied over insulation materials, typically sheets of insulation material. This created new problems as the insulating materials had poor mechanical properties, needed to be fastened to the roof deck, are subject to degradation by UV radiation and absorbed moisture. In addition such built up roof systems are very labour intensive making them less economical.

[0005] Numerous attempts have been made unsuccessfully to solve one or more of these problems. For example, U.S. Pat. No. 6,418,687 is directed for retro-fitting roofs, is field applied and non-modular. In particular, the foamed in place insulation described in this patent is designed to be applied over a roof deck or existing roof substrate and a rubber membrane is then glued over top of the sprayed insulation. Although this addresses some of the problems, a foamed-in place roofing installation is still very labour intensive to apply and requires spray foaming equipment on-site. Furthermore, when one spray-foams a large surface area there are often ripples, localized hills and valleys and other imperfections that are formed and which translate into corresponding ripples, hills, valleys and imperfections in the overlying rubber membrane. These imperfections can then trap water or other precipitation in localized areas, preventing desired run-off, and ultimately resulting in ponding and of such standing water seeping through cracks in the rubber membrane.

[0006] Additionally, even on roofs that are classified as being "flat" it may desirable to have a slight roof slope for water to run off. A typical minimum roof slope is 1% ($\frac{1}{8}$ " per 1'). However, minimum slope for a "flat" roof is often set by building code to 2%. However, even for an experienced and skilled spray-foam application worker, it is difficult to create a flat non-ponding surface using an on-site, foamed-in place insulation method. Moreover, it is very difficult, if not impossible, to create a slightly sloped roofing surface (from one side of the roof to another) using such an on-site, foamed-in place insulation method; especially in new construction wherein there is no pre-existing, pre-sloped roof deck. In such cases, the system and method of U.S. Pat. No. 6,418,687 will simply not work.

[0007] Therefore, what is needed is a modular roofing system which can be applied in new buildings, reduces on-site installation time, does not require a pre-existing, pre-sloped roof deck, does not require (or reduces the need for) on-site spray-foaming equipment, can be installed by unskilled laborers and can provide for an overall slope to the resulting roof structure.

SUMMARY OF THE INVENTION

[0008] In one aspect, the invention provides an insulated modular roof system for a roof structure, comprising a plurality of modular panels suitable for installation onto the roof structure, and a water-proof membrane. Each of the plurality of modular panels comprises a first planar member, an insulating layer covering substantially all of the first planar member and a second planar member suitable to cover substantially all of the insulating layer. Preferably, the insulated modular roof system further comprising a joint closure member and, when at least one pair of modular panels is placed in a generally abutting arrangement, the system further comprising a joint fill material, suitable for filling any empty space between a pair of abutting modular panels.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Referring to the drawings, several aspects of the present invention are illustrated by way of example, and not by way of limitation, in detail in the figures, wherein:

[0010] FIG. 1 is a perspective, partial cut-away view of a first embodiment of the insulated modular roof system;

[0011] FIG. 2 is a close-up perspective view of the embodiment of the insulated modular roof system of FIG. 1;

[0012] FIG. 3 is a close-up side view of the embodiment of the insulated modular roof system of FIG. 1;

[0013] FIG. 4 is a perspective view of another embodiment of the insulated modular roof system, illustrating a slight slope to the overall roof;

[0014] FIG. 5 is a perspective view of one corner of a modular panel of yet another embodiment of the insulated modular roof system, the remaining corners being substantially mirror or flipped images thereof; and

[0015] FIGS. 6a and 6b are perspective views of some of the components of the embodiment of the insulated roof system of FIG. 5.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] The following description is of preferred embodiments by way of example only and without limitation to the combination of features necessary for carrying the invention into effect. Reference is to be had to the Figures in which identical reference numbers identify similar components. The drawing figures are not necessarily to scale and certain features are shown in schematic or diagrammatic form in the interest of clarity and conciseness.

[0017] A first preferred embodiment of the insulated modular roof system 10 of the present invention is shown in FIGS. 1-3. The system 10 is comprised of a plurality of modular panels 20 and a water-proof member 28. The water-proof member 28 may be provided in sections on each modular panel 20 (e.g. the embodiment of FIG. 5) or it may be provided separately and placed (or sprayed) over a plurality of adjacent panels 20 (e.g. the embodiment of FIG.

1). The system 10 preferably further comprises at least one planar fill, or joint closure, member 30 and joint fill material 40 suitable for filling or packing any empty space between adjacent modular panels 20 (e.g. the embodiments of FIGS. 1-6).

[0018] FIG. 1 illustrates four modular panels 20, labelled individually as 20A, 20B, 20C and 20D, and three joint closure members 30, labelled individually as 30A, 30B and 30C. Each modular panel 20 preferably comprises a first planar member 22, an insulating layer 24 covering substantially all of the first planar member 22, a second planar member 26 suitable to cover substantially all of the insulating layer 24. As mentioned, in some embodiments of the invention a water-proof member 28 portion is provided pre-assembled on each panel (see FIG. 5). When installed on a building or roof structure RS, the modular panel 20 may be referred to as a roofing panel 20, the first planar member 22 may be referred to a bottom planar member 22 and the second planar member 26 may be referred to as a top planar member 26; with the insulating layer 24 being generally sandwiched between the bottom and top planar members 22, 24.

[0019] The use of “roofing”, “top,” and “bottom” are used herein as respective references to the orientation of the modular panel 20 on a substantially flat roofing structure RS, but there may be uses of the present disclosure where the modular panel 20 may be used in different orientations or on other parts of a building, such as in a substantially vertical orientation on the side of a building, used as siding. The term “up” and “down” may be used with respect to the ground. More specifically, the term “up” may be used to describe a vector that is normal to the ground and away from the ground. More specifically, the term “down” may be used to describe a vector that is normal to the ground and pointing toward the ground. A normal is a vector that is perpendicular to a surface such as the ground surface. In one embodiment, normal may be defined as a constituent being at +/-90 degrees with respect to a plane.

[0020] When installed on a building or roof structure RS, a plurality of modular panels 20 will be placed in a generally abutting arrangement so as to substantially cover the desired surface area of the roof structure RS with the first planar members 22; see the arrangement of panels 20A, 20B, 20C and 20D in FIG. 1. Preferably, the first planar member 22 of each modular panel 20 is in abutting relation with the first planar member 22 of an adjacent modular panel 20; see panels 22 labeled 22C and 22D in FIG. 2. The first and second planar members 22, 26, as well as the planar joint closure member(s) 30, may be rigid members constructed from oriented strand board (OSB), plywood, gypsum board or other suitably strong material typically used for sheathing in the roof construction industry. Advantageously, second planar member 26 provides additional support and protection to the system 10 as compared to U.S. Pat. No. 6,418,687 where a rubber membrane is simply applied over top of sprayed insulation.

[0021] In one embodiment of a modular panel 20, first planar member 22 is preferably made up 3/8 inch thick oriented strand board (OSB) sheets, measuring approximately 96 inches×48 inches (8 feet×4 feet) in length and width. The insulating layer 24 preferably has slightly smaller length and width dimensions than the first planar member 22, preferably measuring approximately 92 inches×44 inches in length and width. More preferably, the insulating

layer 24 is mounted or placed substantially centered on the first planar member 22, thereby providing a circumferential space or gap region G around the insulating layer 24, revealing a portion of the first planar member 22 and preferably measuring approximately 2 inches wide, as illustrated in FIGS. 2 and 5.

[0022] Advantageously, modular panel 20 can be fastened or mounted to the roof structure RS via one or more fasteners 35 driven, mounted or screwed through first planar member 22 at a desired position along said gap region G, as illustrated in FIGS. 1-3. Advantageously said gap region G providing ease of access to an installer to fasten modular panel 20 to the roof structure RS. Fastener(s) 35 may be any suitable fastener, e.g. those types of fasteners used in the roofing industry to fasten sheathing to a roofing structure RS. For example, fasteners 35 may be self-tapping metal screws driven through the gap region G each approximately 12 inches apart from any adjacent fastener. Alternatively, modular panels 20 may be mounted to the roofing structure using a glue or construction adhesive.

[0023] Preferably, joint fill material 40 is subsequently provided or applied to the system 10, so as to substantially fill-in all of the gap region G between adjacent modular panels, once said panels have been fastened to the roofing structure RS; see FIGS. 2 and 3. Advantageously, joint fill material 40 provides further insulating and vapour barrier features to the system 10. More advantageously, since only a small proportion of the overall system 10 will require application of joint fill material 40 (the bulk of the insulating properties coming from the insulating layer 24 of the pre-assembled modular panels 20) onsite labour is significantly reduced as compared to cases where sprayfoam is applied onsite to the entire roofing surface.

[0024] Advantageously, a roof or roofing structure RS may quickly be covered by a plurality of modular panels 20 arranged in abutting relation, each panel 20 mounted to the roofing structure via fasteners 35 in the gap region G and without the need for hot bituminous (tar) composition to bind the panels 20 to the roof. More advantageously, by mounting the modular panels 20 to the roof structure via the first planar member 22, and by closing the gap space G (and covering the fasteners 35) with joint fill material 40 the amount of heat loss through the system 10 is minimized as compared to cases where a modular panel 20 is mounted to the roof structure RS via a fastener that penetrates the first planar member 22, the insulating layer 24 and the second planar member 24. Instead, in the embodiment of FIGS. 1-3, any thermal bridging that might otherwise occur across fastener(s) 35 is significantly reduced or eliminated by having the fastener(s) 35 driven through the first planar member 22 only.

[0025] The second planar member is preferably made up 3/8 inch thick oriented strand board (OSB) sheets and preferably has slightly smaller length and width dimensions than the insulating layer 24 to which it is mounted, preferably measuring approximately 90 inches×42 inches in length and width. More preferably, the second planar member 26 is mounted or placed substantially centered on the insulating layer 24, thereby providing a circumferential ledge or shoulder region L (of exposed insulating layer 24) there-around, preferably measuring approximately 1 inch wide, as illustrated in FIGS. 2, 3 and 5. Advantageously, planar joint closure member(s) 30 may be mounted or placed between adjacent modular panels 20 by being positioned on a desired

section of the circumferential ledge region L, prior to being fastened to one or more modular panels 20; see FIGS. 2 and 3 showing closure member 30C resting on ledges L of modular panels 20C and 20D.

[0026] The insulating layer 24 and the joint fill material 40 are preferably a polyurethane foam insulation and, more preferably, is a closed cell foam. In other embodiments, the insulating layer 24 and joint fill material 40 may be comprised of a foamed synthetic resin made of polystyrene, polyethylene, acrylic resin, phenol resin, urea resin, epoxy resin, diallylphthalate resin, urethane resin and the like. Advantageously, the use of closed cell foam insulation in the insulating layer 24 and joint fill material 40 provides an air/vapor barrier inherent in the modular panel 20 and system 10, so as to efficiently insulate roofs and roof structures RS. More advantageously, if the same closed cell foam material is used for both the insulating layer 24 and the on-site applied joint fill material 40, the resulting system 10 will then have a monolithic type insulation formation from one modular panel (e.g. 20A) to the next panel (e.g. 20B). The invention thereby provides an insulated modular modular roofing system 10 that can be quickly installed on a roofing structure RS, with minimal on-site labour, with a desired slope S pre-manufactured in each modular panel 20 and with a continuous (inherent) vapour barrier across the modular panels 20 on the roofing structure RS. Advantageously, the invention may allow for the roofing of a building without the need for additional vapour control, such as separate polyethylene sheets that are typically used between a roof deck or roof structure and any overlying insulating material.

[0027] The thickness of the insulating layer 24 may be determined by the insulation value that is desired to be achieved by the system 10. For example, a 3.33 inch thick insulating layer 24 comprised of 2-pound polyurethane foam insulation, with the first and second planar member 22, 26 comprising $\frac{3}{8}$ inch thick OSB sheets will typically provide an insulating value of R-20 to the modular panel 20 and the system 10. A 5.83 inch thick insulating layer 24 comprised of 2-pound polyurethane foam insulation, with the first and second planar member 22, 26 comprising $\frac{3}{8}$ inch thick OSB sheets will typically provide an insulating value of R-35.

[0028] During manufacture of the modular panel 20, the insulating layer 24 may be mounted to the first planar member 22 using a suitable glue or adhesive. Or the insulating layer 24 may be sprayfoam-applied onto the first planar member 22 and then such sprayfoamed insulating layer 24 may be cut or shaped to the desired thickness and slope S. This may be accomplished using a horizontal band saw or a horizontal fastwire foam cutter. The CUTLAST™ horizontal blade foam splitter is designed for slicing polyurethane foam into sheets of desired thickness and would be suitable for this application.

[0029] For example, a partially assembled modular panel 20, with a first planar member 22 measuring 4 feetx8 feet may have the insulating layer 24 sprayfoamed thereon to a minimum thickness (e.g. of at least 3.5 inches). This partially assembled modular panel 20 can then be moved through a CUTLAST™ horizontal blade foam splitter which is then set to cut off a thin top section of the sprayfoamed insulating layer 24 (e.g. to a height of 3.33 inches), thereby providing a smooth top surface, suitable to receive the second planar member. Alternatively, where a roof slope is desired, the CUTLAST™ horizontal blade foam splitter can be

adjusted to cut the insulating layer 24 at a pre-set slope, resulting in a modular panel 20 that has that desired slope S with the insulating layer 24 having a first thickness (or height) H1 at one end of the panel 20a and a second thickness (or height) H2 at an opposing end 20b of the panel (see the embodiment of FIG. 4).

[0030] Advantageously, by having a smoothly cut insulating layer 24, and by utilizing the second planar member 26, the water-proof member 28 on outside or top surface of the system 10 of modular panels 20 will be substantially smooth, thereby reducing or fully eliminating ponding or pooling of trapped water or other precipitation in localized areas. Furthermore, if a slight slope S has been provided by the modular panels 20, then water or other precipitation will generally be directed to quickly run off of the outside or top surface of the system 10.

[0031] One or more support members 50 may be provided in the modular panel 20, preferably between first and second planar member 22, 26, so as to offer additional structural support and/or mounting points for the second planar member 26. Support members 50 may be made of metal, galvanized metal, plastic, wood or other suitable material. Preferably, support members 50 are z-girts 50z. Advantageously, z-girt style support members 50, 50z provide anchor points for any fasteners 37 that may be used to mount second planar member 26 adjacent to the insulating layer 24. More advantageously, z-girts 50z provide anchor points for any fasteners 39 that may be used to mount or place any planar joint closure member(s) 30 between adjacent modular panels 20.

[0032] More preferably, z-girt support members 50z have a first end 51 and a second end 52, wherein first end 51 is positioned substantially in the gap space G adjacent first planar member 22, so that any fasteners 35 used to mount the modular panel 20 to the roof structure RS may be driven there-through; while second end 52 is spaced away from the gap space G and positioned substantially within the insulating layer 24. Advantageously, first end 51 provides additional support or backing for fasteners 35, while second end 52 provides a mounting point for fasteners 37 or fasteners 39, while also providing a thermal break between fasteners 35 and 37/39 (see FIGS. 2 and 3). In one embodiment (e.g. see FIGS. 5-6b) an insulating member 60 is provided for each support member 50 between the first end 51 and planar member 22, to further increase such thermal break and prevent thermal bridging between first planar member 22 and second planar member 26 (see FIGS. 6a-6b). Insulating member 60 may be comprised of rigid insulation.

[0033] The water-proof membrane 28 is preferably an ethylene-propylene diene mar (EPDM) rubber membrane, but it may also be made of other suitable water-proof roofing material such as a membrane made from a variety of materials such as styrene-butadiene rubber, acrylonitrile-butadiene rubber, chloroprene rubber, butadiene rubber, isoprene rubber, butyl rubber, ethylene-propylene rubber, polyisobutylene, styrene-butadiene-styrene block copolymer, styrene-isoprene-styrene block copolymer, chlorinated polyethylene, polyurea coating, ethylene-vinyl acetate copolymer, or SBS modified bitumen roofing membrane.

[0034] In the embodiments where the water-proof membrane 28 is provided in sections on each modular panel 20 (e.g. FIG. 5), the length and width dimensions of the section 28s of the water-proof member 28 is preferably larger than the length and width of the first planar member 22, so as to allow adjacent section 28s to overlap once any adjacent

modular panels **20** are placed in abutting relation, or to overlap with any adjacent roofing flashing. Advantageously, such overlapping section **28s** of water-proof member **28** can be taped and sealed (e.g. with seam tape and/or a solvent adhesive), after installation of the modular panels **20**, so as to provide an overall water-proof member **28** to the system **10**. For example, an installer can apply 75 mm (3") wide EPDM seam tape to membrane **28** overlaps using a solvent adhesive.

[0035] Those of ordinary skill in the art will appreciate that various modifications to the invention as described herein will be possible without falling outside the scope of the invention. In the claims, the word “comprising” is used in its inclusive sense and does not exclude other elements being present. The indefinite article “a” before a claim feature does not exclude more than one of the features being present.

1. An insulated modular roof system for a roof structure, comprising:

- a plurality of modular panels suitable for installation onto the roof structure; and
- a water-proof membrane,

wherein each of said plurality of modular panels comprises:

- a first planar member suitable to accept at least one fastener therethrough so as to allow at least one of the plurality of modular panels to be mounted to the roof structure;
- an insulating layer covering substantially all of the first planar member; and
- a second planar member suitable to cover substantially all of the insulating layer;

wherein the water-proof membrane is provided in sections on each of said plurality of modular panels, each of said membrane sections having length and width dimensions larger than the length and width of the first planar member so as to allow adjacent membrane sections to overlap.

2. The insulated modular roof system of claim **1** further comprising a joint closure member.

3. The insulated modular roof system of claim **2**, wherein said plurality of modular panels comprises at least one pair of modular panels placed in a generally abutting arrangement, further comprising a joint fill material, suitable for filling any empty space between said at least one pair of abutting modular panels.

4. (canceled)

5. A modular roofing panel suitable for installation onto a roof structure, the modular roofing panel comprising:

- a first planar member suitable to accept at least one fastener therethrough so as to allow the modular roofing panel to be mounted to the roof structure;
- an insulating layer covering substantially all of the first planar member; and
- a second planar member suitable to cover substantially all of the insulating layer.

6. The modular roofing panel of claim **5**, wherein the insulating layer is placed substantially centered on the first planar member so as to provide a circumferential gap region around said insulating layer, said gap region revealing a portion of the first planar member.

7. The modular roofing panel of claim **6**, wherein the first planar member measures at least 8 feet in length and at least 4 feet in width and wherein the gap region measures at least 2 inches.

8. (canceled)

9. The insulated modular roof system of claim **3**, wherein the insulating layer of each of said plurality of modular panels is placed substantially centered on the first planar member so as to provide a circumferential gap region around said insulating layer, said gap region revealing a portion of the first planar member.

10. The insulated modular roof system of claim **9**, wherein the first planar member measure at least 8 feet in length and at least 4 feet in width and wherein the gap region measures at least 2 inches.

11. (canceled)

12. The insulated modular roof system of claim **9**, wherein said plurality of modular panels comprises at least one pair of modular panels placed in a generally abutting arrangement, further comprising a joint fill material placed in at least a portion of a gap region between said at least one pair of abutting modular panels.

13. The insulated modular roof system of claim **12**, wherein the joint closure member covers said joint fill material.

14. The modular roofing panel of claim **6**, wherein the second planar member is substantially centered on the insulating layer, and is of such dimensions to provide a circumferential ledge.

15. The insulated modular roof system of claim **12**, wherein the second planar member of each of said plurality of modular panels is substantially centered on the insulating layer, and is of such dimensions to provide a circumferential ledge.

16. The modular roofing panel of claim **14**, wherein the insulating layer is a closed cell foam.

17. The insulated modular roof system of claim **15**, wherein the insulating layer and the joint fill material are each a closed cell foam.

18. The modular roofing panel of claim **5** wherein the insulating layer has a pre-set slope having a first thickness at one end of said panel and a second thickness at an opposing end of said panel.

19. The insulated modular roof system of claim **1**, wherein the insulating layer of each of said plurality of modular panels has a pre-set slope having a first thickness at one end of each of said panel and a second thickness at an opposing end of each of said panel.

20. The modular roofing panel of claim **6** further comprising at least one support member provided between the first planar member and the second planar member, wherein said at least one support member is a z-girt.

21. The insulated modular roof system of claim **9**, wherein each of said plurality of modular panels further comprises at least one support member between the first planar member and the second planar member, wherein the at least one support member is a z-girt.

22.-23. (canceled)

24. The modular roofing panel of claim **20** wherein said at least one support member has a first end and a second end, wherein said first end is positioned substantially in the gap region, and wherein said second end is positioned substantially within the insulating layer.

25. The insulated modular roof system of claim **21**, wherein the at least one support member has a first end and a second end, wherein said first end is positioned substantially in the gap region, and wherein said second end is positioned substantially within the insulating layer.

26. The modular roofing panel of claim **24** further comprising an insulating member between the first end of the support member and the first planar member.

27. The insulated modular roof system of claim **25**, wherein each of said plurality of modular panels further comprises an insulating member between the first end of the support member and the first planar member.

28. The modular roofing panel of claim **5** further comprising a section of water-proof membrane provided on the second planar member, each of said sections having length and width dimensions being larger than the length and width of both the first planar member and the second planar member.

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