

May 6, 1958

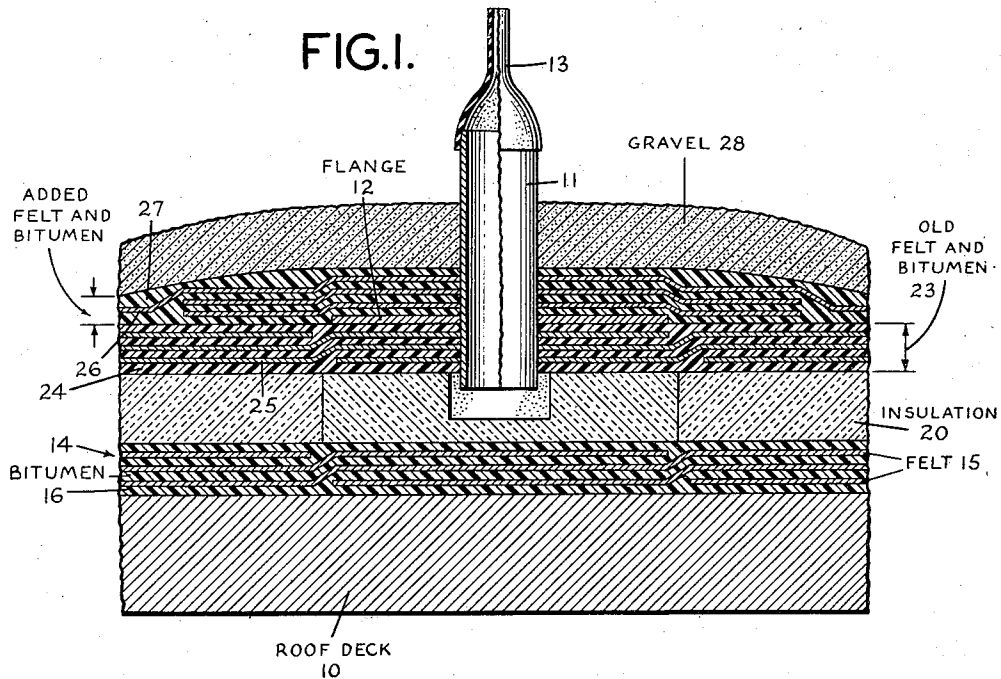
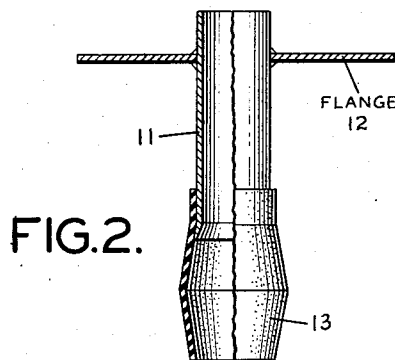
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2,833,229

ROOF CONSTRUCTION

Filed Jan. 17, 1955

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FIG.3.

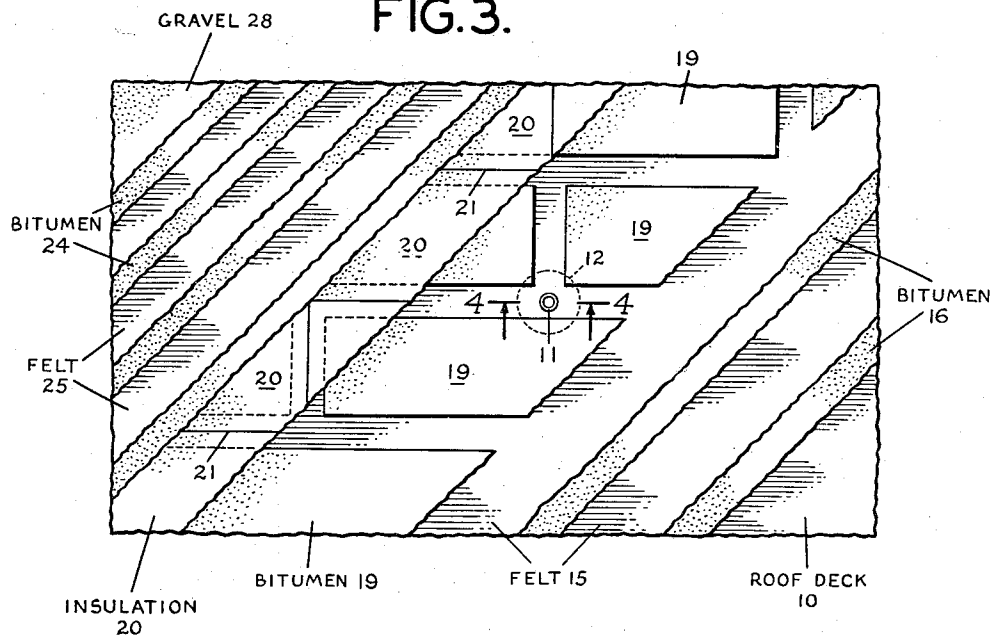
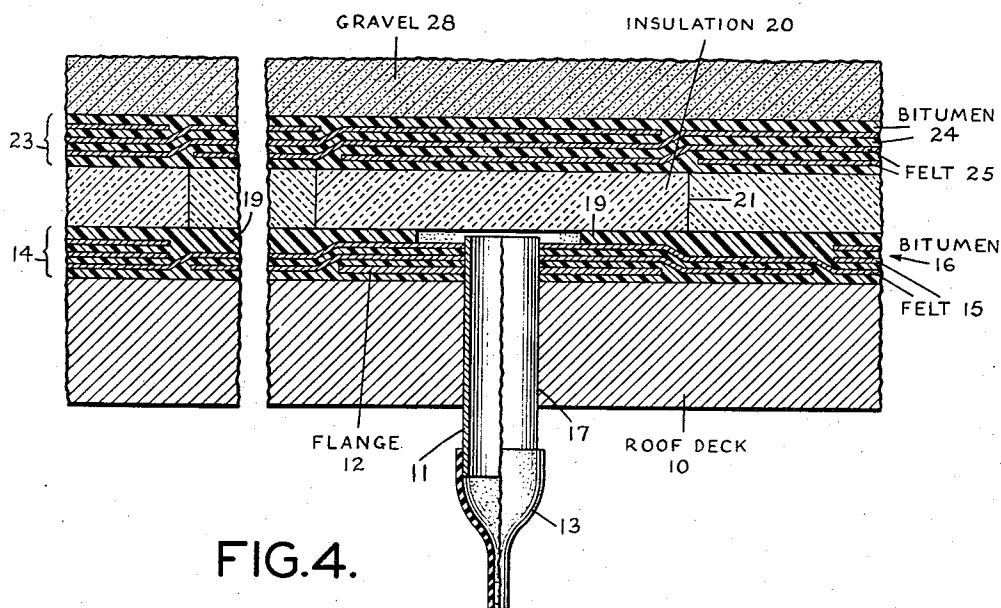


FIG.4.

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2,833,229

ROOF CONSTRUCTION

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Application January 17, 1955, Serial No. 482,168

6 Claims. (Cl. 108—6)

This invention relates to an improved type roof construction. In particular, it relates to an improved membrane type of roof structure.

In provision of membrane type roofs, it is common practice to interpose between a vapor-tight, load-supporting member or deck and the overlying vapor-tight membrane of roofing material a cellular or otherwise porous material having insulating value. The porous insulating materials contain air in quantity of upwards of 60% and often 80% or more of their superficial volumes. The gases present within them, air and water vapor, expand when subjected to the relatively high temperatures encountered upon exposure of the roof to direct sunlight or during the summer months. Consequently, there is created a substantial gas pressure in the volume included between the roof membrane and the deck which tends to destroy the bond between the membrane and supporting structure and to distort or rupture the membrane. Moisture adsorbed on the interior surfaces of the insulation originating from air or the insulation or advantageously, tends to aggravate the expansion of the gases within the heated insulation.

It is an object of this invention to avoid development of vapor pressures within roof structures of the type described. Another object is to improve the insulating value. Other objects will be apparent from the detailed description which follows.

The roof structure of the invention comprises a roof deck providing a gas impermeable membrane or vapor barrier, a layer of porous material above this barrier, and a roof membrane above the porous material. In accordance with the invention, there are provided one or more gas manifolding volumes disposed between the insulating material and the immediately adjacent members of the roof structure. Extending through the roof structure to open into each such volume is a conduit providing communication between that volume and the exterior of the roof structure.

When the improved roof structure of the invention is subjected to direct sun, with resultant heating of the roofing membrane and of the porous material below it, gases, existing or produced within the porous material by evaporation of contained moisture, expand and flow toward the manifolding volume, thence by way of the conduit through the roof structure and into the adjacent atmosphere. Hence, the distorting or disruptive pressures resulting from formation and expansion of gases under the membrane cannot occur.

In preferred construction the conduit provides a one-way or check valve disposed and adapted to permit flow of gas through it only while such gas is being conducted from the porous material. Thus, when the expanding gases have left the conduit, and the roof thereafter cools, as occurs at night, moisture-laden air cannot gain access to the porous material. In fact, after cooling of the previously heated roof, contraction of the residual gases within the porous material results in a positive pressure applied on the weather surface of the membrane tending

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to hold that member against the supporting structure, this pressure augmenting the effect of bonding material used, if any. In order to realize maximum venting of gases from the porous material with resultant development and maintenance of maximum insulating value of that material as well as simultaneous maintenance of the membrane in undistorted close-lying condition, it is preferred that the one-way valve be adapted to open at pressure differentials not over a few ounces per square inch, as of the order of two ounces or less and even one ounce or less.

When, as is desirable, the porous material is bonded by adhesive to the roof deck (or to a vapor barrier disposed over the deck), or to the roofing membrane, the manifolding volume may be provided by leaving a blank or open area in the adhesive, and the venting conduit inserted through the appropriate structure to terminate within that area and between the upper and lower faces of the adhesive. Such manifolding volumes may be conveniently provided by applying the adhesive material, for example a bitumen, to the surface defining the lower boundary of the manifolding spaces, such as the deck, vapor barrier, or porous material, in separated strips of suitable width. Any desired number of the vents may then terminate within each of the spaces between adjacent strips. For venting of the maximum quantity of gas with minimum pressure development within the porous material and surrounding structure, it is preferred to apply the adhesive in discontinuous separate areas or strips, for example as a series of squares or rectangles and to insert vent conduits in a desired number of the areas formed by the intersection of the lateral and longitudinal spaces between the separated areas of adhesive.

Alternatively, the manifolding volume may be provided at least in part within the porous material as by leaving or making a suitable opening between adjacent pieces of the same or in one surface thereof.

In construction of the novel roof of this invention, the manifolding volume may be either below or above the porous material and the vent discharge may be either above or below the roof proper. In constructing a new roof it is preferred, however, in the interest of simplicity and to avoid undue exposure to the elements of the vent and of the valve structure, if present, to insert the conduit through the roof deck to terminate below it and in a manifolding volume below the insulating layer. When insulation or new membrane or both are being applied to an existing roof structure, it may be more economical and convenient to have the vent conduits communicate between manifolding volumes provided adjacent to or in the upper surface of the porous material and the atmosphere above the roof.

In the accompanying drawings Fig. 1 represents in section with parts shown in elevation an existing roof modified in accordance with this invention.

Fig. 2 represents a section with parts in elevation of the valved vent of Fig. 1 shown rotated 90° about its longitudinal axis.

Fig. 3 represents a plan of a new roof construction in accordance with this invention in which portions of structure are cut away.

Fig. 4 represents a section through line 4—4 of the roof of Fig. 3 with parts shown in elevation.

According to one of its specific embodiments, this invention may be employed in connection with an existing built-up roof which may or may not be insulated. Fig. 1 of the drawing illustrates an existing insulated structure. In this figure, existing roof deck 10, which may be made of wood, concrete, or the like, is covered with a moisture-impermeable vapor barrier 14 composed of a plurality of alternate layers of felt 15 and bitumen 16.

Resting on top of vapor barrier 14 are, respectively, a

layer of porous insulating material 20 and a vapor impermeable built-up roofing membrane generally designated 23, formed from a plurality of alternative layers of felt 25 and bitumen 24, and surfaced with a layer of gravel, slate, or other mineral surfacing (which is partially removed as hereinafter described to permit application of vent 11 in accordance with the invention). Insulation 20 is a plurality of blocks of cork or other suitable porous material having adequate strength to support the overlying membrane. At intervals over the area of the roof there may also be a plurality of water cut-offs (not shown), extending between the vapor barrier 14 and the built-up roof 23, dividing the roof into a plurality of square or rectangular sections and forming within each section an enclosed space or volume.

In order to modify the old roof in accordance with this invention, a vent conduit provided with unidirectional check valve, such as the conduit and rubber exhalation valve shown in Fig. 2, may be provided to extend through membrane 23 at one or more intervals, as, for example, spaced by distances of 25 to 50 feet.

The vent assembly may include a conduit 11 of any convenient cross-sectional area, for example 0.5 to 2 inch I. D. galvanized iron, copper or bronze tubing, bearing adjacent to one end thereof a mounting flange 12. The other end of conduit 11 bears the unidirectional valve comprising in this embodiment collapsed rubber tube 13, the walls of which in static rest position are in contact with each other by reason of the resiliency of the rubber aided by external atmospheric pressure when that pressure is above that of the roof interior, and which during venting are forced apart by low pressure differentials of the order of two ounces per square inch or less when the interior pressures are higher.

At the chosen locations the mineral surfacing is removed over an area of 2 to 4 feet in diameter as by spudding the same. The built-up roof membrane 23 is perforated by drilling a hole therein of diameter equal to or just slightly greater than the outside diameter of conduit 11, typically 0.75 to 2.5, say 1 inch diameter, and somewhat into but preferably not entirely through insulation 20. Conduit 11 is fitted within the perforation so that the flange 12 rests on membrane 23 and its lower end lies within the manifolding volume represented by the hole in the insulation. Preferably a bituminous layer is applied between flange 12 and membrane 23. A plurality of layers of felt pieces 26, each provided with a perforation to accommodate conduit 11, and of bitumen 27 are then deployed to completely seal conduit 11 and flange 12 to the upper surface of built-up roof 23. Mineral surfacing 28, such as gravel, may then be deposited on top of the flashed flange.

Construction of a new roof in accordance with this invention is exemplified in Figs. 3 and 4. As set forth therein, structural roof deck 10, made of concrete, wood, etc., supports lower vapor barrier of felt 15 and bitumen 16. This barrier, in turn, supports insulating layer 20 and built-up membrane 23 of felt 25 and bitumen 24. Perforation 17 in deck 10 receives conduit 11 bearing valve 13. Flange 12 may be similarly flashed to roof deck 10, or when the deck has, as shown, an overlying vapor barrier such as alternate strips of bitumen 15 and felt 16, generally designated 14, by bonding the flange 12 within that barrier.

In the embodiment of Figs. 3 and 4, the manifolding volume is provided below the porous insulating material 20 and within the layer of adhesive with which the insulation is bonded to vapor barrier 14. In particular, as shown in Fig. 3, this may be accomplished by depositing bitumen upon the uppermost layer of felt 16 of vapor barrier 14 in a plurality of spaced interrupted strips to leave open spaces or channels between the sides of the mopped areas or strips, a plurality of insulating blocks, e. g. cork boards, with edges abutting may be placed on

top of the channel mopped strips of bitumen 19, the spacing between these strips and the size and position of the insulating blocks 20 will be such that the bitumen does not seal the openings 21 between the abutting edges or faces in order to facilitate flow of expanding gases or generated vapors from each individual block into the manifolding volumes. With an insulating layer 2 inches thick made of 2 feet by 4 feet cork board, adequate manifolding space is provided when each board is mopped completely except for a margin of 3 inches at each side. With this mopping one vent conduit 11 disposed in one of the channels at intervals of each 2500 square feet of roof provides adequate venting. Preferably, the vent conduits are located within the intersection of two or more of the channels as shown in Fig. 3.

It will be understood that the number and spacing of the vents, as well as the location and spacing of the manifolding volumes employed in either a new or an existing roof structure may vary, depending upon the nature of the insulating material used, its thickness, porosity, whether or not it be laid as a continuous layer or as slabs and, if the latter, their dimensions. When practice of the invention involves application of insulation to either a new or existing roof, manifolding volumes may conveniently be supplied adjacent to both the upper and lower surfaces of the layer of insulation by application of spot or channel mopping, preferably with the upper and lower manifolding volumes being interconnected by suitable perforations through the insulation.

In large area roofs, at suitable intervals vapor-tight partitions or water cut-offs extending from the roof deck or lower vapor barrier through the layer of insulation to the roof membrane or upper vapor barrier, divide the insulation into separate sections or compartments. With this construction moisture which penetrates into the insulation by reason of roof damage is prevented from migrating as vapor or liquid to all portions of the insulation. Such partitions (not shown) may be provided, for example, between adjacent slabs of insulating material by one or more layers of felt and bitumen applied to the edge of one of the adjacent slabs to lap over both its upper and lower faces or one of those faces and the opposite face of the adjacent slab. When the compartment construction is used, at least one vent is provided within each compartment in practice of the invention.

In the completed roof structure of either Fig. 1 or Figs 3 and 4 containing the conduit 11 and the valve 13, there is formed an insulating volume enclosed between vapor barrier 14 and membrane 23 and defined by the roof edges or, if they are used, the water cut-offs. This volume is vented to a point outside of the roof proper by means of conduit 11 and valve 13. Although conduit 11 is shown as passing downwardly through the deck 10 of a new roof or upwardly through membrane 23 of a modified existing roof, it may, if desired, communicate with either side of the roof structure in either case.

Although in each of the embodiments of the invention specifically described herein the one-way valve provided in the vents is shown to be a tubular rubber exhalation valve, it will be understood that other suitable valves capable of permitting flow at low pressure differentials may be employed. For example, suitably designed flap or ball check valves may be employed. A satisfactory check valve is that disclosed in copending application of Joseph W. Donegan and Benjamin S. Penley, Serial No. 555,966, filed December 28, 1955. Further, any suitable vapor barrier may be used in lieu of the built-up construction shown. The lower vapor barrier, which may be considered to include the deck may be the deck proper when suitably sealed against passage of vapor therethrough, by reason of the material of its construction or by application of bitumen or other material to its upper, as shown, or to its lower

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side, and the membrane may be of metal or a single layer of roll roofing sealed at overlap.

Within each vented volume, the porous insulating material contiguous to each manifolding volume provides a system of passageways or channels terminating at the manifolding volumes so that each of the latter serves as a collecting zone for air or vapor originating within a multiplicity of points within the insulation. Each of these zones, whether in the form of separate or interconnected chambers or channels discharges through the escape or vent conduit. When the manifolding volumes are provided as a unidirectional attenuated space or channel or as a reticular system of interconnected channels, they serve the additional purpose of providing passageways for conducting the gases from the points of its discharge into them and over relatively long paths to the vent conduits. Thus, when channel type manifolding volumes are employed each vent may serve a relatively large area of roof without danger of development within that area of internal pressures adequate to cause blistering or other distortion of the membrane.

It will also be apparent to those skilled in the art that various other modifications and changes may be made without departing from the scope of this invention.

When in this specification and claims the term "vapor" is used, it refers to gases discharged from the insulating material when the roof is heated, regardless of the actual water vapor content of such gases.

I claim:

1. A roof construction comprising a layer of porous insulating material disposed between upper and lower vapor impermeable membranes, a manifolding space defined by said material and one of said membranes, and a conduit extending from said manifolding space and through one of said membranes, said conduit having therein a unidirectional valve arranged and adapted to permit passage of vapor from said insulating material and said space through said membrane and to prevent return of gases into the interior of the roof structure.

2. A roof construction comprising a lower vapor impermeable membrane including a deck, a layer of porous insulating material disposed on said deck, a roofing membrane covering said insulating material, a manifolding space defined by said insulating material and one of said membranes, and a conduit extending from said manifolding space through the membrane adjacent thereto adapted to permit passage of vapor from said insulating material and said manifolding space through said last-named membrane, said conduit having a unidirectional valve therein arranged and adapted to permit the aforesaid passage of vapor and to prevent return of gases into the interior of the roof structure.

3. A roof construction comprising a membrane providing lower vapor barrier, a layer of porous insulating material, a roofing membrane, a layer of adhesive material having an opening therein bonding said insulating material to one of said membranes to provide at said opening a manifolding volume defined by said adhesive, said insulating material, and the adjacent membrane, a conduit extending into said manifolding space to leave

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an open end therein and through one of said membranes, and a unidirectional valve in said conduit arranged and adapted to permit flow of vapor from said manifolding volume and to prevent return of gases into the interior of the roof structure.

4. A blister-proof, built-up roof section comprising a supporting roof deck, a membrane providing a vapor barrier on the upper surface of said roof deck, a layer of porous insulating material, a plurality of alternate layers of felt and bitumen resting on said layer of insulating material and providing a roof membrane thereabove, a layer of adhesive material having an opening therein bonding said insulating material to one of said membranes to provide at said opening a manifolding volume defined by said adhesive, said insulating material, and the adjacent membrane, a conduit extending into said manifolding space to leave an open end therein and through one of said membranes, and a unidirectional valve in said conduit arranged and adapted to permit flow of vapor from said manifolding volume and to prevent return of gases into the interior of the roof structure.

5. A blister-proof, built-up roof section comprising a supporting roof deck, a vapor barrier on said roof deck, a plurality of spaced interrupted strips of bitumen on said vapor barrier, a layer of insulating material contacting said strips of bitumen, secured thereby to said vapor barrier and forming therewith a manifolding volume bounded by the said layer of insulating material, said strips of bitumen, and said vapor barrier, a plurality of alternate strips of felt and bitumen on said insulating material forming a roof membrane thereover, a conduit extending from said manifolding volume through said vapor barrier to the space below said roof section, and a one-way valve in said conduit to permit passage of fluid from said manifolding volume and through said conduit and to prevent return of gases into the interior of the roof structure.

6. A blister-proof, built-up roof section comprising a supporting roof deck, a vapor barrier on said roof deck, a layer of insulating material on said roof deck, a plurality of alternate layers of bitumen and felt on said insulation forming roof membrane, a plurality of spaced interrupted strips of bitumen on said layer of insulating material forming a manifolding volume bonded by said layer of insulating material, said strips of bitumen, and said membrane, a conduit extending from said manifolding volume through said membrane to the space above said roof section, and a one-way valve in said conduit adapted to permit passage of fluid from said manifolding volume and through said conduit and to prevent return of gases into the interior of the roof structure.

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