Sept. 11, 1962 J. A. FINAN 3,053,716

BUILT-UP ROOF

Filed May 20, 1959 3 Sheets-Sheet 1

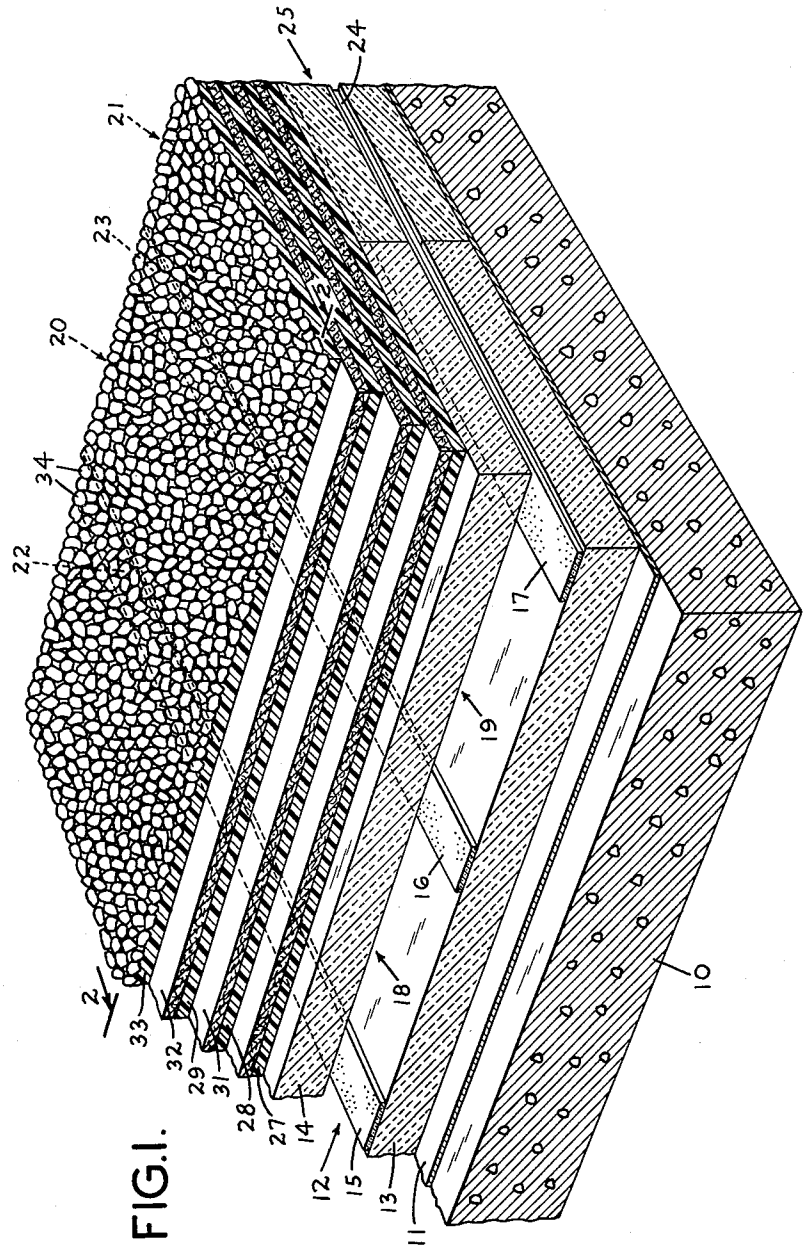


FIG. 1.

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Sept. 11, 1962 J. A. FINAN 3,053,716

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Filed May 20, 1959 3 Sheets-Sheet 2

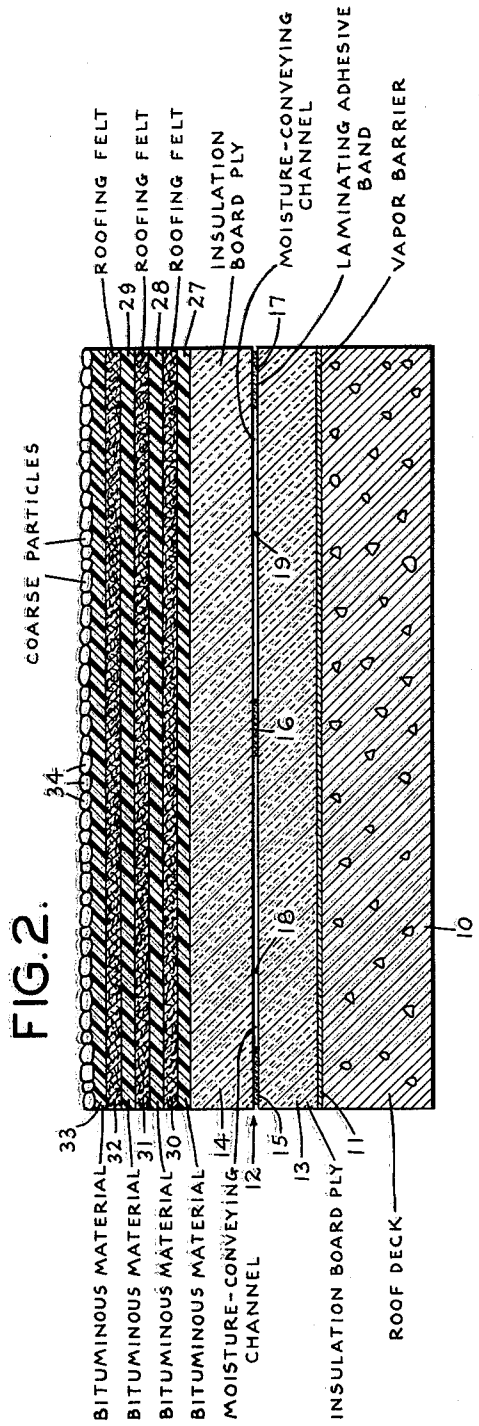


FIG. 2.

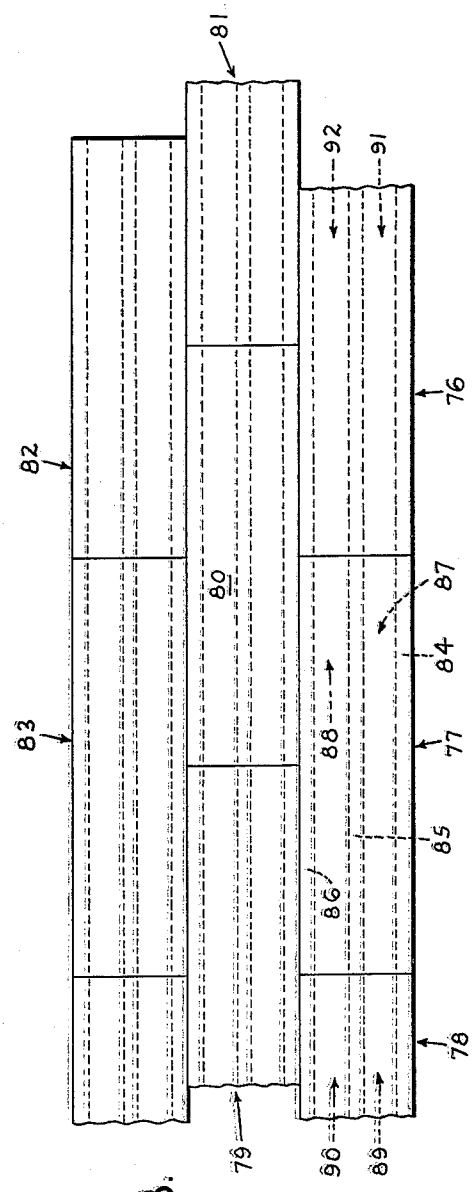


FIG. 3.

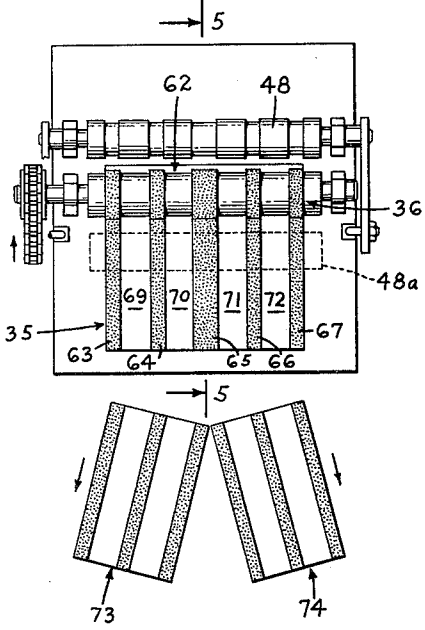
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BUILT-UP ROOF

Filed May 20, 1959 3 Sheets-Sheet 3

FIG.4.



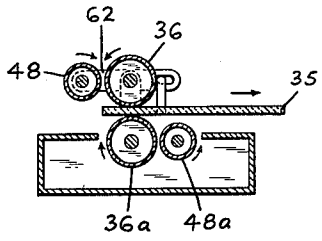


FIG.5.

FIG.7.

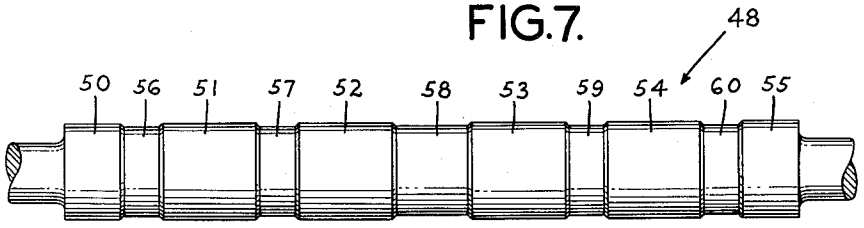
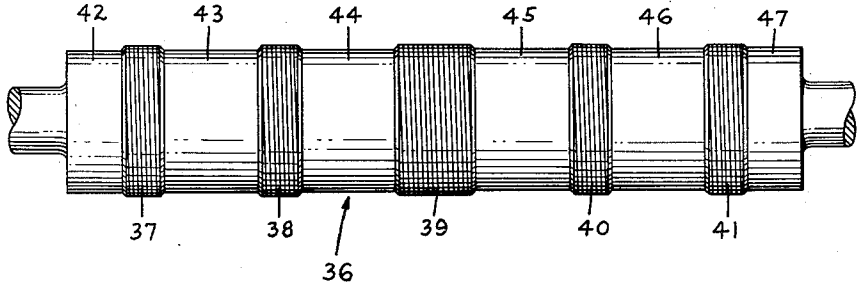


FIG.6.



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3,053,716

BUILT-UP ROOF

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2 Claims. (Cl. 154—51)

This invention relates to built-up roofs and more particularly to a built-up roof constructed with laminated insulation boards having communicating moisture-conveying channels.

Roof insulation board is usually one-half inch thick. Greater thicknesses are obtained by laminating or bonding together two or more of the one-half inch boards, the one-half inch board typically containing about 4–5 percent water by weight and having a moisture equilibrium point at 50 percent relative humidity about 4.5–5.5 percent by weight. Laminating adhesives used for bonding the boards such as pearl starch and soybean paste adhesives generally contain from about 50–80 percent water. Consequently, when the porous boards are bonded together using such adhesives, the water content of the laminated board is increased locally from about 4–5 percent to about 9–10 percent by absorption. During installation of this laminated board of increased water content on the roof supporting structure, water evaporates from the upper surface of the board, particularly when the temperature of the roof deck is above 120° F., a common condition in summer sunny days. As the moisture is drawn up to the surface of the board and evaporates, the board lifts at the ends or warps. Such warping makes it difficult and at times impossible to apply built-up roofing over the uneven surface.

Further, presence of air within the laminated insulation boards and the built-up roof may result in formation of roof blisters. When the roof is subjected to prolonged exposure to solar heat, the air within the insulation boards tends to expand greatly producing gas volumes and pressures which tend to produce undesirable blistering of the roof.

One object of this invention is to provide a built-up roof structure having improved discharge means for release of moisture from its thermal insulation layer.

Another object is to provide a built-up roof structure which eliminates buckling or warping of the roof insulation boards during and after installation.

Another object is to provide a built-up roof which will vent air pressures from the roof structure under conditions of prolonged exposure thereby reducing the likelihood of blistering of the roofing material.

Additional objects and advantages will be apparent as the invention is hereafter described in more detail.

In accordance with the present invention, the built-up roof structure comprises a supporting structure, a layer of thermal insulation comprising juxtaposed rigid porous laminated insulation boards on the supporting structure, the laminated boards each comprising bonded plies of porous fibrous insulation board having substantial moisture and gas absorptive characteristics, a plurality of spaced bands of adhesive material extending between and bonding adjacent plies together with the bands separating the plies to form moisture-air conveying channels between the spaced bands, the adhesive material of the bands being selected from the group consisting of soybean protein and starch adhesives and containing from about 50–80 percent of water when the plies are bonded whereby the water content of the laminated boards is materially increased by absorption, each channel having height of about 0.03–0.06 inch as installed, the channels communicating with similar channels in adjoining laminated boards to permit the moisture to escape from the

laminated boards during their installation and subsequent exposure at elevated roof deck temperature without material distortion and warping of the boards, and superposed layers of adhesive bituminous material and roofing felt overlying the layer of thermal insulation, the felt being bonded to the even outer surface of the insulation layer by the bituminous material. The communicating channels result in reduction of the water content of the laminated boards, enable moisture to escape without passing through the substantial entirety of the boards, and prevent substantial warping and distortion transmitted to the lower layers of the boards. Such reduction of the water or moisture content of the laminated boards by the communicating channels will continue on prolonged exposure of the roof to the atmosphere in the event water or moisture gains access to the interior of the laminated boards. Further the communicating channels considerably lessen or reduce the likelihood of blistering of superposed roofing material when subjected to solar heat by venting air pressures from the roof structure.

The built-up roof structure is constructed by preferably first superimposing a vapor barrier film of water vapor impervious material over the supporting structure. Such vapor barrier film is typically four mils thick and is formed of asphalt, pitch, polyethylene, aluminum, cellulose acetate, a plasticized polyvinyl chloride composition, polyester film or rubber like materials. The rigid laminated insulation boards having the moisture-air conveying channels and prepared as hereafter described are then laid over the vapor barrier film in juxtaposition to one another in manner such that the channels of the laminated board communicate wtih similar moisture-air conveying channels in adjoining laminated boards. Such boards have typical thickness of about 1 inch.

The spaced adhesive bands located between and bonding faces of adjacent plies of the laminated boards typically have widths of about 3–5 inches and heights of about 0.06–0.12 inch. The bands are spaced apart a minimum distance of 4 inches to about 8 inches whereby the channels have widths of from 4 to about 8 inches and heights of about 0.03–0.06 inch as installed. Such bands can be formed of suitable laminating adhesive materials or compositions well known in the art. Examples of such laminating adhesive compositions, which may contain a major amount, e.g. from about 50–80% water, are aqueous compositions containing, when applied to the board ply, by weight, (1) soybean meal—15.4%, lime—4.6% and water—80% and (2) pearl starch—31.3%, diatomaceous earth—1.5% and water—67.2%.

The moisture-air conveying channels of the laid down insulation boards permit the absorbed moisture to escape from the boards at roof deck temperatures above 120° F. without substantial warping or lifting of the boards at their ends. Consequently layers of adhesive bituminous material and roofing felt can be applied onto the outer surfaces of the laminated boards forming the insulation layer, which application was heretofore difficult and at times impossible due to the outer surfaces of the boards being uneven and warped caused by evaporation of water from the outer board surfaces. Additionally the channels reduce the likelihood of blistering of superposed roofing material by venting air pressures from the roof structure. Such air pressures tend to be destructive if not released or vented from the insulating material, and are caused by expansion of occluded air in the porous insulation material (due to solar heat) upon prolonged exposure of the roof to direct sunlight, such as during the summer months.

An adhesive layer of heat-liquefied bituminous material, e.g. asphalt or pitch is then applied to the outer surfaces of the laminated boards forming the insulation layer, the board outer surfaces being substantially even

and non-warped. Thereafter a layer of bituminous material-saturated felt is applied or laid over the adhesive bituminous layer while the adhesive layer is in a soft and tacky condition, and the steps of applying the adhesive bituminous layer and then the bituminous material-saturated felt are repeated until a plurality of alternate superposed layers of the bituminous material and saturated felt have been applied. Typically 4 layers of adhesive bituminous material and 3 layers of saturated felt are applied, although the number of layers applied may be varied as desired. Coarse mineral or aggregate particles, e.g. slag particles are preferably partially embedded in the surface of the outermost layer of bituminous material. The bituminous material layers typically each have thicknes of about 0.03–0.06 inch and the roofing felt layers typically each have thickness of about 0.06–0.12 inch.

In the drawings:

FIG. 1 is a perspective view with parts broken away of a built-up roof of the present invention.

FIG. 2 is a section on line 2—2 of FIG.1.

FIG. 3 is a top plan view of laminated insulation boards of the present invention laid in juxtaposition on a roof deck, the boards having communicating moisture-conveying channels.

FIG. 4 is a top plan view of apparatus for preparation of the laminated insulation board of this invention.

FIG. 5 is an elevational section taken on line 5—5 of FIG. 4.

FIGS. 6 and 7 are enlarged detail views of the adhesive transfer or applicator roll and gauge roll respectively of the apparatus of FIG. 3.

With reference to FIGS. 1 and 2, a supporting structure or roof deck of wood, steel or concrete is designated at **10**, and vapor barrier film **11** is superimposed on the roof deck. Laminated insulation board **12** comprises two plies **13** and **14** each of ½ inch thickness of porous cellulose fiber insulation board, the plies being bonded together by spaced approximately parallel bands **15**, **16** and **17** of the soybean meal laminating adhesive composition previously disclosed.

Moisture-air conveying channels or passages **18** and **19**, substantially rectangular shaped in cross section, are partially defined by and extend between adhesive bands or strips **15**, **16** and **17**, such channels communicating with similar moisture-air conveying channels **20** and **21** extending between substantially parallel bands **22**, **23** and **24** in adjoining laminated insulation board **25**. When the aqueous laminating adhesive composition is applied to the face of an insulation board ply in preparing the laminated board, the water or moisture content of the laminated board is increased from typically about 4–5% to about 9–10% by absorption. Such relatively high water content tends to be retained by the laminated boards prior to their installation when the boards are laminated at the plant or, if such is the case, at the job site. By reason of the communicating channels, the moisture escapes from the laminated boards during and after their installation at the elevated roof deck temperatures without causing substantial warping and distorting of the boards as discussed. The channels also vent air pressures from the roof structure which, if not vented, may cause roof blistering. Vent conduits provided with unidirectional check valves, e.g. tubular rubber exhalation or ball check valves, may be so disposed in the insulating structures as to communicate the intercommunicating channels with either the interior or exterior of the building thereby to complete escape or venting of the moisture and destructive pressures. Such unidirectional check valves are more fully described in U.S. Patents 2,833,229 and 2,849,018, issued May 6, 1958 and August 26, 1958, respectively.

Thin adhesive layers **27**, **28** and **29** of coal-tar pitch bond waterproofing layers **30**, **31** and **32** of tar-saturated felt respectively to the upper surface of laminated insulation board **12** and to one another. Outer layer **33** of coal-tar pitch has coarse particles **34** of slag partially embedded therein.

As shown in FIG. 3, laminated insulation boards **76**, **77**, **78**, **79**, **80**, **81**, **82** and **83** are juxtaposed to form a layer of thermal insulation on a roof deck. Each board has two edge bands and one central band of laminating adhesive of substantial height bonding together the two plies of the laminated board. Moisture-air conveying channels are located between the bands of each board and communicate with moisture-air conveying channels of adjoining laminated boards by reason of boards being laid end to end, for permitting moisture and also air pressures to escape from the boards. As shown, adhesive bands **84**, **85** and **86** of laminated board **77** have moisture conveying channels **87** and **88** therebetween. Channels **87** and **88** communicate with moisture-air conveying channels **89** and **90** and **91** and **92** respectively in adjoining laminated boards **78** and **76** by reason of boards **76**, **77** and **78** being laid end to end. The moisture-air conveying channels of boards **78** and **76** and the other boards are located between adhesive bands (designated by the broken lines) similar to those of board **77**.

Referring now to FIGS. 4 and 5, laminating adhesive material is applied to the upper surface of porous fibrous insulation board **35** in bands by passing board **35** beneath and in direct contact with rubber transfer or applicator roll **36**. As shown in more detail in FIG. 6, transfer roll **36** has spaced raised surfaces **37**, **38**, **39**, **40** and **41** and depressed or lowered surfaces **42**, **43**, **44**, **45**, **46** and **47** between the raised surfaces. Transfer roll **36** has steel gauge roll **48** closely adjacent thereto. As shown in more detail in FIG. 7, gauge roll **48** has spaced raised surfaces **50**, **51**, **52**, **53**, **54** and **55** and depressed surfaces **56**, **57**, **58**, **59** and **60** which register with respectively the depressed surfaces and the raised surfaces of transfer roll **36**. The raised surfaces of transfer roll **36** are grooved for retention of laminating adhesive until applied to board **35**. Laminating adhesive material is pumped from a suitable source of supply to region **62** between gauge roll **48** and transfer roll **36**, the distance between gauge roll **48** and and transfer roll **36** being adjusted to regulate the amount of adhesive deposited or applied on raised surfaces **37**, **38**, **39**, **40** and **41** of the transfer roll. Rotating transfer roll **36** continuously deposits the adhesive material as spaced bands **63**, **64**, **65**, **66** and **67** of substantial height on the surface of board **35**, the raised surfaces of gauge roll **48** registering with the depressed surfaces of transfer roll and serving as wipers for the depressed surfaces to prevent appliction of adhesive to board ply **35** in the regions between the spaced bands.

Channels **69**, **70**, **71** and **72** are partially defined by and located between the spaced bands. Central adhesive band **65** is approximately twice as wide as adjacent bands **64** and **66**, so that when board **35** is cut into boards of predetermined widths, the adhesive bands will be of approximately equal widths. The board with applied adhesive bands is then cut into two boards **73** and **74** of about equal widths by a saw (not shown). A second adhesive-free porous fiber insulation board of substantially identical dimensions as those of board **73** and **74** is then positioned or laid over each of board **73** and **74** in contact with the adhesive bands thereof, and maintained thereon for a typical assembly time of about 3 minutes. The resulting laminated boards are then ready for use in preparation of the built-up roof structure of this invention.

If desired to bond three board plies together to form a three ply laminated board, a second rubber transfer roll **36***a* similar to transfer roll **36** is used in the apparatus of FIGS. 4 and 5. This second transfer roll is located directly below transfer roll **36** and on the opposite side of insulation board **35** in contact with the board lower surface. Such second transfer roll also has a steel gauge roll **48***a* associated therewith similar to steel gauge roll **48**,

and would operate and apply spaced adhesive bands to the lower surface of the board in manner and of dimensions similar to the bands applied to the board upper surface.

The insulation board can be fabricated of wood, bagasse, ground wood, chemical wood pulp, or flax straw fibers.

Cellulose fiber insulation boards were prepared each having 3 spaced bands of the aforementioned soybean meal adhesive composition extending lengthwise on one face thereof. Each band was of 3 inch width and 0.06 inch height and the bands were located at each edge of the board and at the center of the board extending lengthwise of the board, channels being provided between the bands. Each board had length of 48 inches, width of 24 inches and thickness of ½ inch. When boards of substantially identical dimensions were bonded to the boards having the spaced adhesive bands, generally rectangular shaped moisture-air conveying channels each of 7½ inch width and 0.03 inch height were formed between the bands. Installation of such laminated insulation boards on a roof deck at roof deck temperatures above 120° F. results in no substantial warping and distorting of the laminated boards during the installation. Consequently, alternate layers of coal-tar pitch and roofing felt can be applied to the even, unwarped surface of the insulation layer, moisture normally causing warping of the boards at elevated roof deck temperature and air pressures being released from the boards through the channels.

Although certain preferred embodiments of the invention have been disclosed for purposes of illustration, it will be evident that various changes and modifications may be made therein without departing from the scope and spirit of the invention.

What is claimed is:

1. A built-up roof comprising a roof deck, a layer of thermal insulation comprising juxtaposed rigid porous laminated insulation boards on said roof deck, each laminated board comprising bonded plies of fibrous insulation board, a plurality of spaced continuous bands of adhesive material extending lengthwise between and bonding the adjacent plies together with the bands separating the plies to form moisture-air conveying channels between the spaced bands, each moisture-air conveying channel having height of about 0.03–0.06 inch as installed, said adhesive material of the bands being selected from the group consisting of soybean protein and starch adhesives and containing from about 50%–80% of water when the plies are bonded whereby the water content of the laminated boards is materially increased by absorption, said channels communicating with similar moisture-air conveying channels in adjoining laminated boards for permitting the moisture to escape from the laminated boards during installation and subsequent exposure thereof on the roof deck without substantial warping of said boards and also air pressures from said boards, and superposed alternate layers of adhesive bituminous material and bituminous material-saturated felt overlying the thermal insulation layer, the lowermost felt layer being bonded to the outer surface of the insulation layer and the felt layers being bonded to one another by the adhesive bituminous material.

2. A built-up roof comprising a roof deck, a continuous film of water vapor impervious material superimposed on said roof deck, a layer of thermal insulation comprising juxtaposed rigid porous laminated insulation boards on said vapor impervious film, each laminated board comprising two bonded plies of cellulose fiber insulation board, a plurality of spaced continuous bands of adhesive material extending lengthwise between and bonding the plies together with the bands separating the plies to form moisture-air conveying channels between the spaced bands, each moisture-air conveying channel having height of about 0.03–0.06 inch as installed, said adhesive material of the bands being selected from the group consisting of soybean protein and pearl starch adhesives and containing from about 50%–80% of water when the plies are bonded whereby the water content of the laminated boards is materially increased by absorption, said channels communicating with similar moisture-air conveying channels in adjoining laminated insulating boards for permitting the moisture to escape from the laminated boards during installation and subsequent exposure thereof on the roof deck without substantial warping of said boards and also air pressures from said boards, and superposed alternate layers of adhesive bituminous material and bituminous material-saturated felt overying the thermal insulation layer, the lowermost felt layer being bonded to the outer surface of the insulation layer and the felt layers being bonded to one another by the adhesive bituminous material.

References Cited in the file of this patent

UNITED STATES PATENTS

1,931,066	Eckert	Oct. 17, 1933
2,215,811	Figge	Sept. 24, 1940
2,358,550	Williams	Sept. 19, 1944
2,390,697	Eason	Dec. 11, 1945
2,518,281	Camp et al.	Aug. 8, 1950
2,651,588	Bruce et al.	Sept. 8, 1953
2,833,229	Donegan	May 6, 1958
2,849,018	Donegan et al.	Aug. 26, 1958
2,932,589	Meyer et al.	Apr. 12, 1960

FOREIGN PATENTS

269,730	Switzerland	1950