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Elder

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[54] **AERO-DYNAMIC ROOF**

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[52] **U.S. Cl.** **52/173,** 52/84, 52/199, 98/1.5, 98/29, 98/31

[51] **Int. Cl.** **E04b 7/00**

[58] **Field of Search** 52/173, 94, 93, 95, 63, 52/199, 198, 23, 309, 553, 2, 23; 161/216; 98/1.5, 31, 29

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[57] **ABSTRACT**

In a roofing assembly comprising a roof structure and roofing material disposed thereover, the improvement which comprises generally uniformly disposed air passageways maintained between said roof structure and said roofing material and an air conduit means communicating with said air passageways and the space above said roof; a roof structure comprising a layer of ballast material disposed on said roof at a distance of about 1 meter from the edge of said roof having a width of between about 1 and 3 meters; a roof construction comprising a layer of an elastomeric sheet material secured to the roof only at the edges thereof by a mechanical fastening means or a solvent weld securing said elastomeric sheet initially to a suitably prepared galvanized steel sheet and thence to a building structure.

14 Claims, 5 Drawing Figures

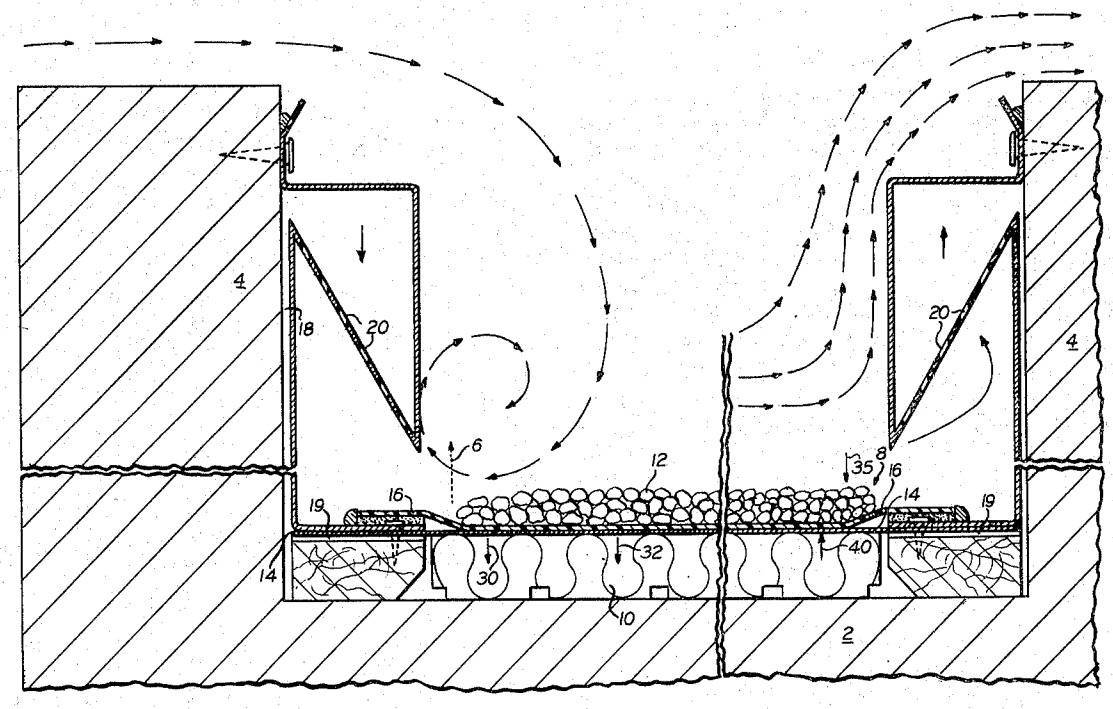
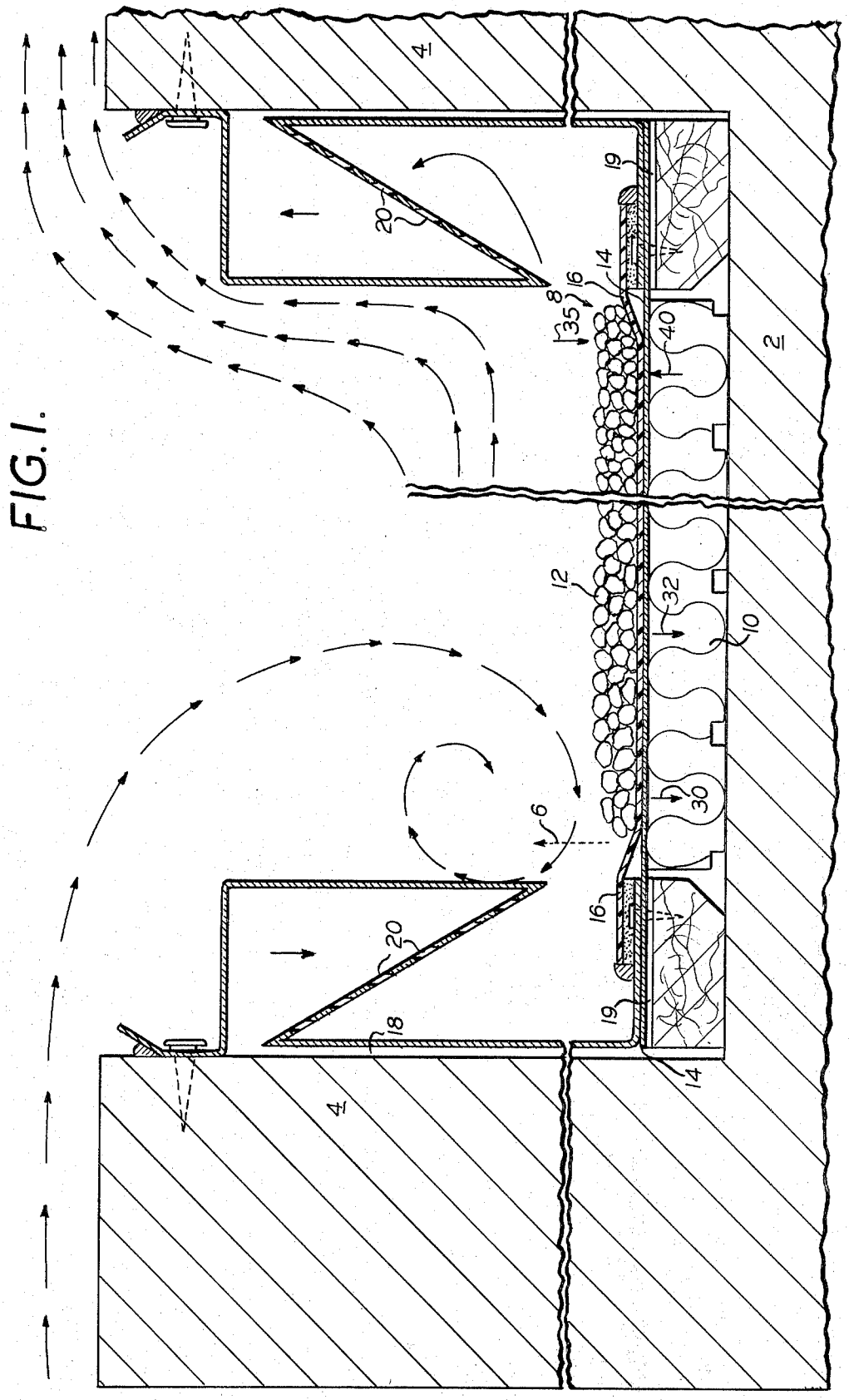


FIG. 1.



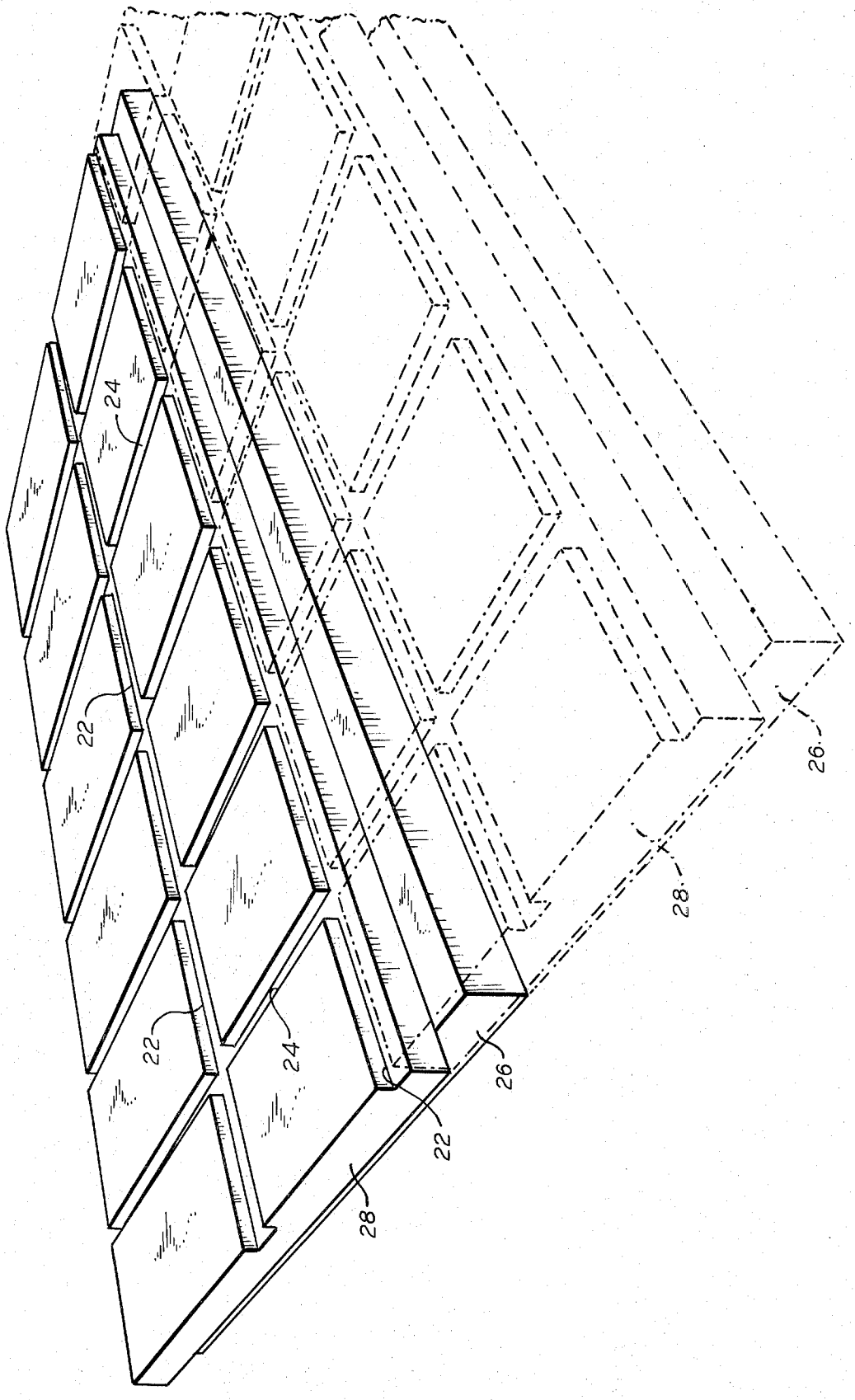


FIG. 2.

FIG. 3.

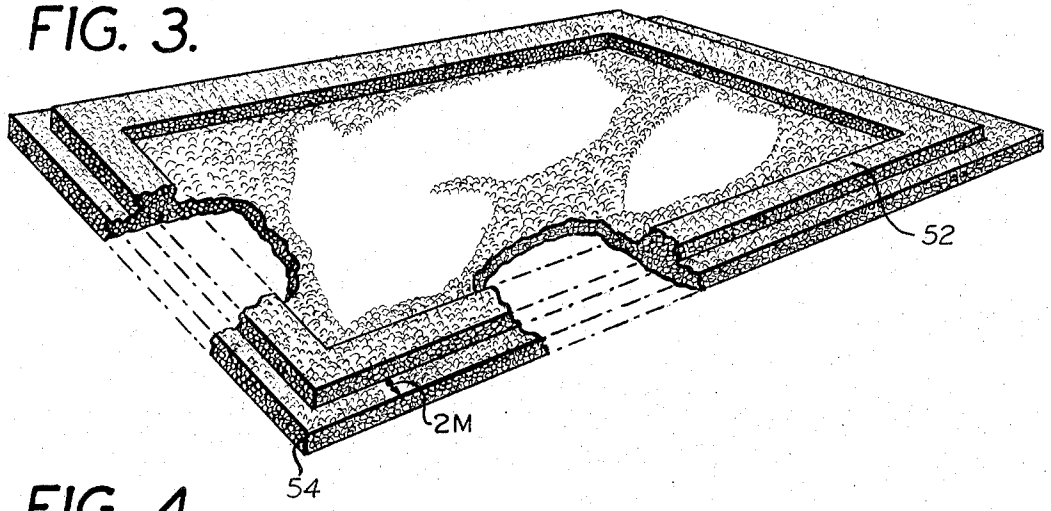


FIG. 4.

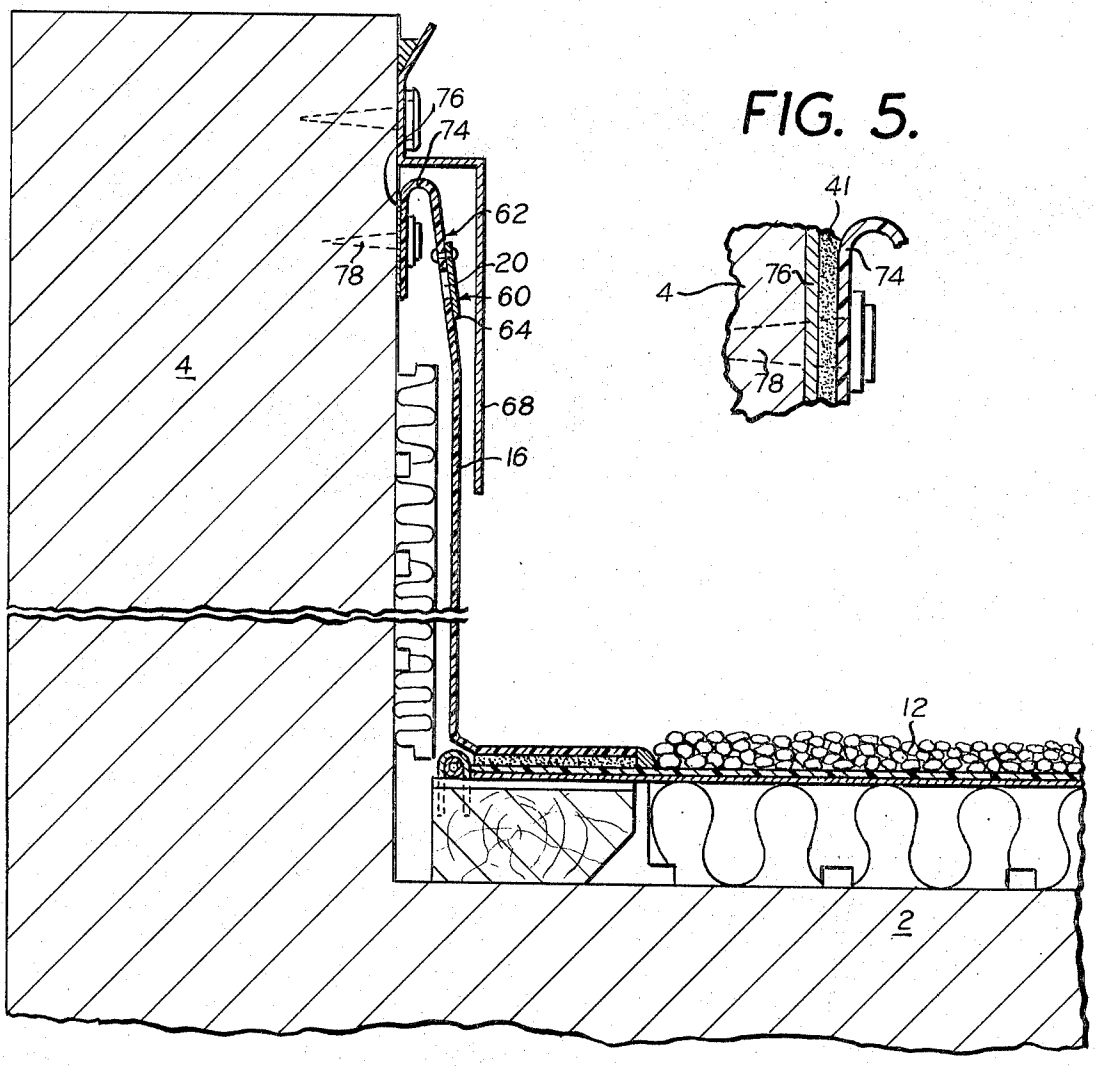


FIG. 5.

AERO-DYNAMIC ROOF

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to improved roofs especially useful for commercial buidling structures. More particularly, this invention is directed to lightweight, wind-resistant, inexpensive construction using beneficial effects of aerodynamic design. This invention is also directed to improved gravel-containing roofing structures wherein by optimum placement of a lamella of gravel or other ballast material, the adverse effect of wind tending to lift roofing material upwards and tear it off the roof is effectively counteracted. This invention is also directed to means of roof construction for affixing a lamella of an elastomeric waterproof layer loosely disposed over a roof to a roofing edge.

DISCUSSION OF THE PRIOR ART

Roofing for commercial buildings, especially those having a height in excess of 35 feet, has provided numerous problems. At these heights the wind velocity across a roof is of such magnitude especially during blizzards and storms, as to cause the roofing material to be torn from the roof structure itself. Once a tear occurs, it tends to run across the entire surface of the building. Eventually, it falls to the ground below and creates a precarious situation. These buildings generally have either a concrete or steel roof structure member. Attempts have been made to provide roofing of such weight as to resist any adverse effects of wind across the surface of the roof. However, recent trends in the construction industry have been toward utilizing lighter weight materials in the construction of the building itself. These lighter weight materials are generally incompatible with prior art methods of roofing involving the use of large quantites of ballast substances. Attempts to utilize built-up roofing involving the use of alternating layers of felt and asphalt have provided a roof having good adhesion in tension, but poor peel resistance. However, it was found that once the adhesive bond was broken by the effects of the elements, the peel adhesion properties were insufficient to resist the effects of the wind. Hence, the roof was ripped off of the structure.

The adverse effects of wind going across a roof is due primarily to aerodynamic considerations which create a negative pressure on the roof and tend to draw it off. This can be magnified should windows break and the wind exert a positive pressure on the inside of the roof structure. Such is particularly acute in steel construction since such steel tends to have a degree of porosity as will permit the air to pass therethrough and bear against the roofing material disposed thereover.

Due to the increased costs in construction industry and the tendency to have larger roofs which are more sensitive to thermal and structural movement, it has become desirable to provide a roof construction which does not have to be thoroughly affixed to the roof structure at all points of the roof structure. More specifically, it has become highly desirable to provide a roof assembly where the roofing material need only be fixed to the roof structure along an edge thereof. It has also become desirable to provide a roof structure utilizing a ballast material optimumly placed at spacific locations on the roof surface which structure has the strength and wind resistance of a roof otherwise the same having a layer of ballast material over the entire surface thereof.

SUMMARY OF THE INVENTION

Broadly, this invention contemplates an improved roofing assembly comprising a roof structure or roof deck and roofing material disposed thereover, the improvement comprising generally uniformly disposed air passageways maintained between the roof structure and the roofing material and an air conduit means communicating with said air passageways and the space above said roof. The "passage-ways" as the term is used herein are channels having walls providing a resistance to air flow laterally thereagainst but permitting air flow through the channels.

This invention also contemplates an improved roofing structure utilizing a ballast material wherein the ballast material is placed in optimum position on said roof to function as resistance to forces tending to uplift the roofing material. In accordance with the present invention, an additional layer of ballast material is positioned around the periphery of the roof beginning approximately 1 meter from the edge of said roof, said ballast having a width of between 1 and 3 meters.

The present invention also contemplates a convenient method for adhering an elastomeric sheet material to a roof structure. In accordance therewith an elastomeric sheet material, generally a water vapor permeable polyvinyl chloride sheet material, preferably having disposed thereover loosely a graval or ballast substance, is secured to the roof structure only at the edges thereover and at points of interruption over the surface of the roof by being solvent welded to an elastomeric sheet itself hot-bonded to a stiff sheet material secured to the building structure by a mechanical fastening means. With respect to this development, it has been found that highly useful roof protection can be provided utilizing a liquid water impermeable sheet material covered with a ballast substance or gravel. In the case of, for instance, a flat roof, it has been found that it is unnecessary to secure the sheet material to the roof deck itself over the major portion of the area to be covered. The adverse uplifting effects of wind can be combatted and the sheet material secured against the roof desk merely by affixing the same at the roof edges and at interruptions along the surface of the roof deck and ballast to stabilize the roof construction. Such securement pursuant to the present invention provides equivalent bonding of the roofing material to the roof deck as would provide if the same were secured over the entire covered surface.

It has also been discovered that a highly advantageous roof structure is provided utilizing, as a roof deck covering material, a sheet of an elastomeric water vapor permeable material. Preferably, such material is porous to the passage of water vapor therethrough but impermeable to liquid water passing therethrough. Such sheet material can be placed over a damp roof deck and covered with other roofing substances such as gravel or ballast. The water beneath the sheet material eventually will be evaporated and as water will pass through the sheet material. Nevertheless, liquid water such as rain does not pass downwardly through the sheet material. Hence, the sheet material can be applied to a roof structure in the most adverse of weather conditions.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a cross sectional elevation of a roof structure showing a layer of insulation disposed over a roof structure which layer is suitably covered with a protective layer of paper or other protective sheet material, a layer of an elastomeric waterproof coating material in sheet form and a layer of ballast material disposed thereover.

FIG. 2 is a perspective view of a lamella of thermal insulation containing intersecting rows of air passageways.

FIG. 3 is a perspective view of a roof structure showing a row of ballast material disposed over an underlay of ballast; the row covering only a portion of the surface of the roof but offset therefrom a distance of about 1 meter.

FIG. 4 is a cross-sectional elevation of a roof construction illustrating the manner in which an elastomeric sheet material can be fastened to the edge of a roof in such a manner that it is unnecessary to mechanically or adhesively secure the major portion of the sheet material to adjoining layers or to the roof structure itself.

FIG. 5 is a magnified or enlarged fragmentary cross-sectional elevation showing a solvent weld **41** securing an elastomeric sheet **74** to a mechanical fastening strip **76.**

DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention, as illustrated in FIG. **1,** is best understood by initially considering the magnitude of the problem of providing a lightweight, inexpensive roof construction which will combat the intense effects of winds at high velocity which tend to aspirate or draw off the roofing material as it passes over the roof. Referring to FIG. **1,** a building structure having an upper surface generally composed of a porous steel or concrete forms the upper surface of a generally flat roof. This is illustrated by reference numeral **2.** The building roof on its upper surface is provided with a barrier or parapet **4** which runs along the periphery of the roof. Winds passing over the roof have a general flow as depicted by the arcuate lines disposed over ballast **12.** Normally, such an aerodynamic flow would create an intense upward draft or negative pressure indicated by dotted arrow **6.** Such winds in and of themselves are sufficient to effectively draw off roofing material generally indicated by arrow **8.**

The building construction suitably contains a layer of insulation **10** which functions as a thermal barrier. The insulation **10** can serve a dual function as more fully discussed below. Over the insulation, there can be placed a layer of paper or other suitable covering material such as mat **14** of glass fibers although the same is not essential to all roof coverings. A liquid water impermeable sheet of an elastomeric substance, suitably a polyvinyl chloride sheet **16** is disposed over the layer or mat **14** to protect the thermal insulation and the roof structure from adverse effects of water. A layer of gravel or other ballast material **12** is suitably disposed over sheet **16.** In such construction, the layers do not have to be adhesively secured together, but can be affixed to the building simply by adhering the sheet **16** to a reinforced stiff metal backed sheet or other stress distributing members mechanically fixed to the building structure by a mechanical means. Sheet **16** is affixed to the reinforced elastomeric sheet by a suitable solvent weld, as shown in FIG. **4.**

It has now been found that the adverse negative pressure on sheet **16** (and sheet **14** if the same is provided) can be overcome utilizing an air channel **18** which communicates with the air conduit openings **20.** In FIG. **1,** a foraminous thermal insulation **10** is provided which has a plurality of air passageways throughout the length and width of the thermal insulation sheet. Suitably, insulation such as that depicted in FIG. **2** can be provided having longitudinally running channels **22** which intersect laterally running channels **24.** The insulation layer **10** as shown in FIG. **2** is provided with a base **26** and an offsetly disposed top layer **28.** By positioning sheets of insulation **10** adjacent one another, longitudinally disposed channels **22** can be defined as shown in phantom. Channels **24** can similarly be defined. These channels **22** and **24** communicate via channel **18** with air conduit openings **20** disposed proximate the parapet **4** of the roof but protected from rain and snow. A plurality of these air inlet conduits **20** are provided around the periphery of the structure.

In operation, wind in the direction indicated passes over the barrier or parapet **4,** enters openings **20.** Air is withdrawn from channels **18,** via channel **19** formed in the block used to secure the edge of the roofing to the deck and channels **22** and **24.** This creates in the channels **22** and **24** a distribution of negative downwardly directed forces as indicated by the arrows **30** and **32.** These downward forces partially offset the upward negative forces imposed upon the roofing material **8** and serve to prevent removal of the roofing material by the adverse effects of wind.

On the opposite edge of the building structure, a similar but opposite phenomenon is occurring. Here, as shown in FIG. **1,** the wind traveling in the direction of left to right as shown in the drawings strikes the parapet **4** and forms a high pressure stagnation zone causing positive downward force as represented by arrow **35.** Air enters the openings **20** and exerts a positive upward pressure as shown by the vector **40.** Such counteracts the effects of the wind swirling about close to the parapet **4.** Since the force **35** is directly proportional to the velocity of the wind, the compensating forces **40** are similarly proportionate thereto. Hence it is seen that through utilization of a dynamically designed roof adapted to distribute forces caused by wind velocity that a roof structure which does not necessitate an adhesive over its major portion is provided.

The above description with respect to the dynamic roof construction is illustrative of the principle of the present invention. The above description is in respect of a preferred embodiment of the invention comprising an elastomeric sheet, preferably a polyvinyl chloride sheet over which is loosely disposed a loosely laid ballast material. The principle of the present invention resides in the utilization of dynamic forces to counteract the negative pressure on a roof surface which tends to withdraw the roofing material from the surface of the roof structure. As such, the present invention can be used in respect of built-up roofs such as roofs comprising alternating layers of asphalt and felt. Additionally, roofs containing other types of sheet materials such as rubber, butyl rubber, EPDM rubbers, chromosulfonated polyethylene rubber, and Neoprene rubber alone or with other substances such a bitumen and gravel can be modified by the present invention to pro-

vide lightweight, inexpensive, effective wind-resistant roofing.

The description above with respect to the channels **22** and **24** has been limited to a preferred embodiment shown in FIG. **2.** It will be apparent that numerous constructions which provide a generally uniform distribution of channels are suitable. In fact, it is not necessary that insulation be provided in the roof structure. Insulation and channels of insulation constitute a desirable embodiment since most commercial roofs contain a layer of thermal insulation. Since this thermal insulation can be a porous material and since it is placed on the roof, in most instances, it provides a convenient means for defining channels **22** and **24.** The insulation layer of a roof structure generally has a thickness which defines channels of appropriate Size. Air passing over the inlet can have the appropriate negatively downwardly directing forces which offset the upwardly directed negative pressure caused by the flowing winds.

In FIG. **2** the channels **22** and **24** have been shown as criss-crossing parallel and perpendicular running channels. It should be apparent that these channels in and of themselves are not necessary in the case of a certain foraminous insulating material because individual discrete uniformly disposed air channels are present in such an insulation material. These serve to distribute equally the flow of air through the foraminous material and to provide the desired counteracting pressure. Additionally, and as an alternative, an insulating layer having diagonally running intersecting channels can be provided. Other suitable means for distributing the flow of air entering through openings **20** can be provided. For instance, a series of generally concentric circular channels intersected by crossing channels can be provided.

Indeed, the practice of the present invention does not necessitate the utilization of any insulated layer. What is the essence of the present invention is that there be a series of air channels beneath the waterproof membrane or elastomeric substance in sheet form generally represented by the reference numeral **16.** This can be accomplished in many different ways. It is important, however, that the structure underneath the sheet material have some resistance to the flow of air therethrough. If no resistance to the flow of air in the space beneath sheet **16** is provided, the desired downward negative forces counteracting the upward negative forces are not provided. In such a case since the roof construction is adhered to the roof structure only at its edges, the force of wind passing over the structure can reach such a magnitude as to cause withdrawal of the roofing material. It was stated above that a particular advantage of the present invention is that a lightweight structure is provided wherein it is unnecessary to secure the roofing material to the roof structure over a major portion of the area of the roof.

As illustrated in FIG. **4,** the sheet material **16** is secured to the structure at the edge utilizing a layer of galvanized steel or other still metal hot-bonded to an elastomeric sheet. Sheet **16** is solvent-welded to that elastomeric sheet. A nail or other suitable fastening means such as a roofing nail or screw is passed through the layer of galvanized steel and elastomeric sheet and enters the structure. Such construction is of particular advantage from a cost consideration bearing in mind that the costs of applying a roof to a roof structure are considerable. Hence the present invention provides a significant breakthrough from a cost standpoint in roof construction. Moreover, such breakthrough is provided utilizing lightweight materials completely compatible with modern lightweight construction.

Another improvement provided by the present invention involves discovery that ballast material, either in the form of gravel, stone or tile, can be placed on a roof in an optimum position. Such discovery as more fully described below has enabled the construction of a roof utilizing significantly less ballast than heretofore believed necessary. Specifically, it has been found that if a layer of ballast material is placed around a roof structure commencing a distance of 1 meter from the edge of the roof and terminating about 3 meters from said edge, i.e., said ballast having a width of 2 meters, maximum upward wind resistance is provided. Specifically, it has been discovered that the point of maximum negative pressure caused by the wind passing over a roof is generally somewhere between one meter and three meters from the edge of the roof. Such is contrary to long established beliefs in the roofing industry that have held that the point of maximum negative pressure caused by the wind and the point of greatest likelihood for roof failure was at the edge. Thus, it has been found that if a weight is applied to a strip around the circumference of the roof, a distance of between 1 and 3 meters from the edge thereof, the entire roof can be adequately weighted to counteract the forces exerted by wind tending to peel the roofing material off of the roof structure. Such a structure is shown in FIG. **3.**

FIG. **3,** a perspective view, shows an entire section of roofing. Simply stated, it is seen that an additional layer of ballast material **52** situated 1 meter from edge **54** is positioned around the periphery of the roof structure. The ballast material **52** has a width of 2 meters as seen.

This ballast material is shown in FIG. **3** as a gravel material. However, it should be understood that any ballast material is suitable. For instance, tile is an exceptionally good ballast material having desirable thermal properties as well as providing the desired weight per unit volume. When placed around the periphery of a roof structure, the roof is held as firmly to the roof structure as would be the case if the entire surface of the roof were covered with ballast. The cost advantages in the use of roof structure, pursuant to this invention, are obvious. It is noticeable that, depending upon the size of the roof, far less than 25 percent of the roof is covered with a second layer of ballast. Bearing in mind the cost of placing ballast on a roof and the time involved in the same, this is a significant cost advantage. In other words, such advantage resides not only in the utilization of substantially less material, but perhaps more significantly, the saving of a substantial period of manhours of labor.

A particular advantage apparent to those skilled in the art from the above-described roof construction is that it is capable of installation independent of weather considerations. Specifically, roof constructions of the prior art necessitated ideal weather conditions and an absolutely dry surface. The present roof construction can be applied at any temperature on surfaces which are wet. Since the roof is a loose laid roof and there are no adhesives or bituminous agents, the cost of roof construction is markedly diminished. The roof can be applied at a substantially greater rate and does not re-

quire, nor is it dependent upon, the availability of personnel in a busy season to apply the roofing material under optimum weather conditions. Moreover, the fastening that is required, in the case of a water impermeable membrane of an elastomeric substance, is of relatively minor nature and machines are available to effect roofing material lay-down at substantially greater rates than required by prior art roofing construction.

Test of the roof construction depicted in FIG. 1 have revealed that no lifting of the roofing surface occurred at the maximum velocity of the test facility corresponding to a wind velocity of approximately 135 miles per hour in turbulent wind. Normally, with a building having a shape factor 1.5, the roof would have failed at a wind velocity of approximately 70 miles per hour. The embodiment described above was tested and revealed no failure at speeds of up to 135 miles per hour.

Roof structures employed in the present invention can be concretious materials, steel, wood or other common roof deck materials. Advantageously, the deck is relatively impermeable to the passage of air through the deck being of such construction or being sealed by common caulking materials polyurethane foam. It should be understood that such caulking or airtightness is not a necessary component of the present invention. However, porous, i.e., air porous, substances are generally undesirable should, during a hurricane or storm, wind enter through the space or floor beneath the roof. This wind would pass through the roof deck material and cause a substantial pressure upwardly on the roofing material disposed thereover. When coupled with the negative upward pressure caused by the wind over the roof, undesirable forces are provided. However, the magnitude of these forces is still insufficient to cause the removal of the roofing material when the roof is constructed in accordance with the dynamic construction herein disclosed.

The preferred construction of the present invention utilizes an elastomeric water impermeable membrane. Desirably, a roof is provided with such membrane which is porous to water vapor. This allows the disposition of the sheet material **16** over a damp roof. When the heat of the day is sufficient, the liquid water beneath the liquid impermeable vapor-permeable membrane **16** will vaporize and escape through the membrane into the atmosphere. Thus, the net result is a dry construction impermeable to liquid water which can be assembled while the roof deck is damp.

The mats such as paper or glass fiber mats **14** need not be impervious to the flow of water or air.

It has been found that lightweight roof construction according to one embodiment of the present invention can comprise a layer of polystyrene foam insulation having a density between one and two pounds per cubic foot which has disposed thereover a layer of elastomeric sheet material over which is disposed a layer of a suitable ballast material. Preferably the polystyrene foam insulation has a density between 1 and 1.5 pounds per cubic foot.

It has been found that since the roof layers in such light weight roof construction are not adhered to each other and since the top layer of the roof is water vapor permeable, that light weight insulation not ordinarily suited to roofs can be used as a part of this system. For example, all over the world the standard density for polystyrene foam insulation used for roofs is about 2.5 pounds per cubic foot density. With the light weight roof construction utilizing the elastomeric sheet, e.g., the polyvinyl chloride sheet, due to lower roof surface temperatures and lower interroof humidities low density polystyrene foam can be used. Such polystyrene foam can have a density as low as 1 each per cubic foot. This permits a cost saving of 30 percent and provides the resultant assembly with a lower flame spread and fuel contribution than would be possible with normal roof density polystyrene insulations wherein polystyrene has a density of, for example, 2.5 lbs. per cubic foot.

Roof structures of the present invention are undamaged by thermal or structural movement and can be quickly applied or prefabricated on or off the site. The utilization of an elastomeric sheet material in a roof construction provides several advantages. Such a material will not rot under standing water and is not subject to adverse effects of snow or ice nor is it attacked by micro-organisms. It is generally flexible and withstands the highest possible resistance of ultraviolet light while retaining flexibility at extreme temperatures. PVC (polyvinyl chloride) sheet materials provide extremely good mechanical properties of elasticity, high tensile strength, and are resistant to tear, puncture and abrasion. They are available at moderate prices and, when utilized in accordance with the dynamic roof construction of the present invention, provide the most overall inexpensive method of roof assembly from a cost plus labor standpoint. Such is provided, it must be remembered, not merely without sacrifice in resistance to wind uplift, but at almost twice the resistance to wind uplift characterized by existing roof assemblies. Roof constructions of the present invention have been found to surpass the wind and fire resistance levels intended by all internationally known industrial standards for roof construction such as DIN 1055 and DIN 4102.

FIG. **4** shows how the elastomeric polyvinyl chloride sheet **16** is secured to the parapet **4.** FIG. **4** also depicts a desirable embodiment of the invention wherein the openings **20** are situated within a valve assembly **60** hingedly secured at **62** to the outer side of sheet **16** by a flexible number **64** overlying opening **20** and serving to regulate the flow of air inwardly such that the reduced pressure under the elastomeric sheet **16** outwardly balances the vacuum pulling on this sheet tending to remove it. Suitably, a series of check valves maintained under shield **68** around the periphery of the roof can be employed to limit the flow of air through the roof assembly and to maintain the proper balance of pressures upon the sheet **16.**

Sheet **16** is secured to the building or parapet **4** by being solvent-welded to a second piece of elastomeric sheet which has been previously hot-bonded to a relatively stiff metallic sheet. In FIGS. **4** and **5** the second elastomeric sheet is sheet **74** hot-bonded at **41** to stainless steel sheet **76,** all of which are fastened to the building utilizing roofing nail **78.** This assembly is highly efficient for effecting the minor amount of fastening required in such a system to the building structure itself.

The terms and expressions used herein have been used as terms of description and not of limitation as there is no intention, in the use of such terms and expressions, of excluding any equivalents, or portions thereof, as various modifications and departures will become apparent to one skilled in the art from the above disclosure.

What is claimed is:

1. In a roofing assembly comprising a roof structure and roofing material disposed thereover, the improvement which comprises generally uniformly disposed air passageways defined by material creating a resistance to air flow, said passageways maintained between said roof structure and said roofing material and an air conduit means communicating with only said air passageways and the space above the said roof only at the roof perimeter within the space defined by a roof parapet, said roofing material comprising an elastomeric material, said elastomeric material having a loosely laid ballast disposed thereover.

2. An improvement according to claim 1 wherein said elastomeric sheet is secured to the roof structure only at the edges of the roof within a vertical riser on the edge of said roof and around the periphery of interruptions along the roof surface.

3. An improvement according to claim 2 wherein air passageways are provided in an insulation lamella disposed over said roof structure.

4. An improvement according to claim 2 wherein insulation is provided over said roof structure to define air passageways and a layer or mat is disposed over said insulation and beneath said elastomeric sheet.

5. An improvement according to claim 2 wherein said elastomeric sheet is a polyvinyl chloride sheet disposed beneath a layer of loose ballast material, said polyvinyl chloride sheet being loosely disposed over the major portion of the roof surface.

6. An improvement according to claim 3 wherein said insulation is in the form of foraminous material containing air passageways therein.

7. An improvement according to claim 3 wherein said insulation contains criss-crossing defined air channels across the length and width of said insulation.

8. An improvement according to claim 1 wherein there are a plurality of air conduit means disposed along a portion of said elastomeric sheet, said air conduit means being protected from rain, snow and other precipitation.

9. An improvement according to claim 8 wherein said air conduit means are in the form of check valves which regulate the relative pressures upon the elastomeric sheet.

10. An improvement according to claim 2 wherein said elastomeric sheet is secured to said building by being initially solvent-bonded to a second elastomeric sheet itself hot-bonded to a stiff metal sheet, said second elastomeric sheet and said stiff metal sheet being mechanically secured to the roof structure.

11. An improvement according to claim 1 wherein said elastomeric sheet is a liquid impermeable but vapor permeable continuous sheet.

12. An improvement according to claim 1 wherein there are oppositely disposed air conduit means on either side of the roof structure.

13. In a roofing assembly comprising a roof structure and roofing material disposed thereover, the improvement which comprises generally uniformly disposed air passageways defined by material creating a resistance to air flow, said passageways maintained between said roof structure and said roofing material and an air conduit means communicating with only said air passageways and the space above the said roof only at the roof perimeter whithin the space defined by a roof parapet, said roofing material comprising an elastomeric sheet of butyl rubber, said butyl rubber sheet having disposed thereover loosely laid ballast material.

14. In a roofing assembly comprising a roof structure and roofing material disposed thereover, the improvement which comprises generally uniformly disposed air passageways defined by material creating a resistance to air flow, said passageways maintained between said roof structure and said roofing material and an air conduit means communicating with only said air passageways and the space above the said roof only at the perimeter within the space defined by a roof parapet, said roofing material comprising an elastomeric sheet of neoprene rubber, said sheet having disposed thereover loosely laid ballast material.

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