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FIRE-RESISTANT ASBESTOS VAPOR BARRIER SYSTEM

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Fig. 1.

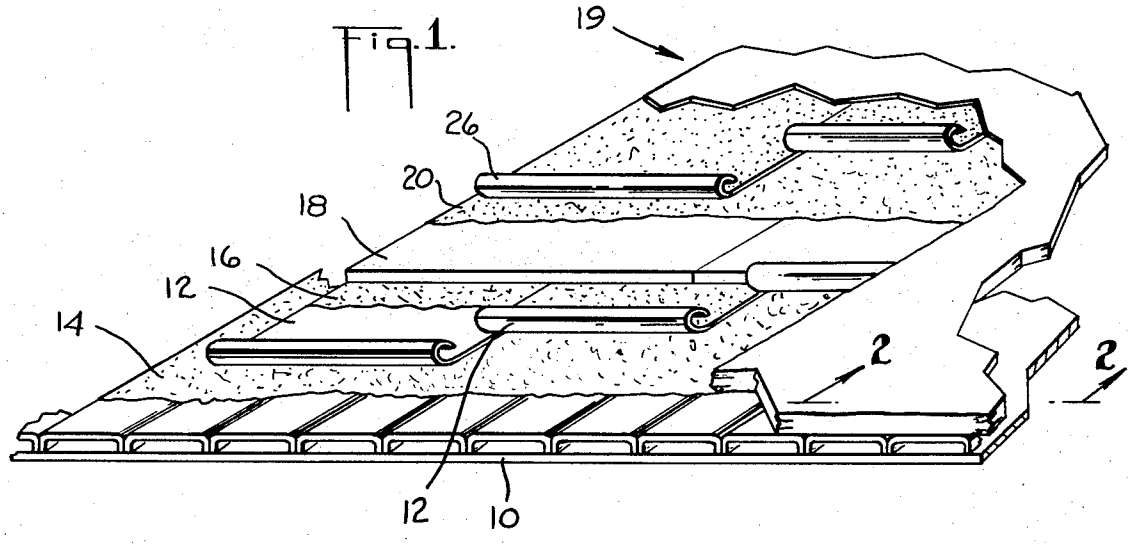
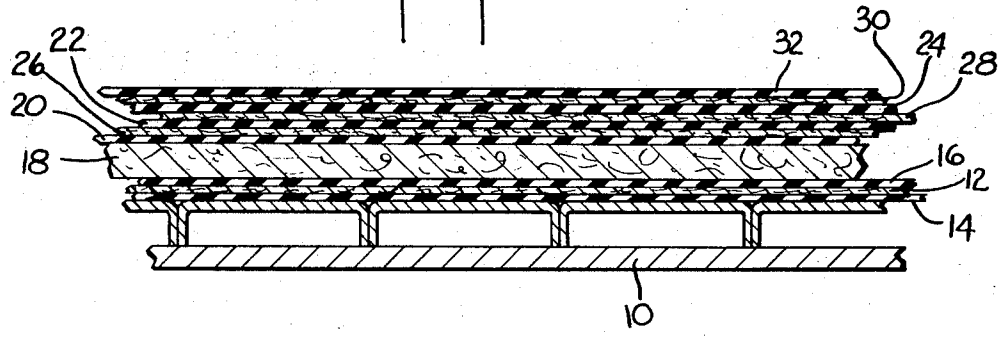


Fig. 2.



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FIRE-RESISTANT ASBESTOS VAPOR BARRIER SYSTEM

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Continuation of abandoned application Ser. No. 711,309, Mar. 7, 1968. This application Mar. 4, 1971, Ser. No. 121,123

Int. Cl. B32b *11/02;* E04c *1/40*

U.S. Cl. 161—205 10 Claims

ABSTRACT OF THE DISCLOSURE

A layer of asphalt impregnated asbestos felt is adhered to a metal roof deck by noncumbustible adhesive and a layer of noncombustible insulating boards is adhered to the asbestos felt by mopping asphalt. A conventional built-up roof can be installed over the insulating boards.

This application is a continuation of U.S. application Ser. No. 711,309, filed Mar. 7, 1968 and now abandoned.

BACKGROUND OF THE INVENTION

Roof decks of industrial buildings generally are covered with a built-up roof structure which comprises a number of layers of asphalt saturated roofing felt adhered to each other and to the roof surface by relatively low melting point asphalt, commonly referred to as "mopping asphalt." The membrane formed by the layers of roofing felt is relatively tough and serviceable and adequately waterproofs the roof. Many roofs, however, particularly those with a metal deck construction, require additionally a layer of insulation to help maintain a relatively constant temperature within the building, and in climates where the dew point is normally reached, such roofs may also require a vapor barrier to prevent condensation from entering the insulating material and destroying its insulating effectiveness. The roof structure as a whole should be able to withstand the stresses induced by building movement and high wind velocity in order to maintain water-tightness and vapor barrier effectiveness.

A conventional metal deck roof construction employed up to the early 1950's consisted of a vapor barrier, a layer of wood fiber insulating board and a built-up roof membrane. The vapor barrier was formed generally of one or two plies of asphalt saturated rag felt adhered to the roof deck by a layer of mopping asphalt. Investigation of a disastrous industrial fire that occurred in 1953 revealed that this type of roof construction had actually assisted the spread of fire, even though the fire had started in the interior of the building.

It was found in tests conducted by the Factory Mutual Engineering Division of Associated Factory Mutual Fire Insurance Companies, reported in a 1955 report entitled "Insulated Metal Roof Deck Fire Tests," that the presence of highly combustible materials in the vapor seal and in the adhesive between the insulation and the metal roof deck governed the spread of fire beneath the roof when the underside of the roof was exposed to the fire. This is because flame impingement or flame temperatures on the underside of the deck cause unburned gases in the combustible vapor barrier and combustible adhesives and insulations immediately above the deck to be liberated. Since the gases cannot escape up through the vapor-tight built-up roof covering, they are forced down through the joints of the steel deck and into the building where they are ignited upon contact with the flame or upon exposure to flame temperatures. Asphalt dripping from the roofing components through the joints and into the building was also found to be a possible source of trouble,

which has since been confirmed by other independent tests. The Factory Mutual Engineering Division found that combustible materials above the insulating layer, such as materials in a built-up roof membrane, will not contribute directly to the initial spread of fire under a metal deck and are significant only if the roof itself collapses. They further concluded that vapor seals consisting of felt and asphalt, regardless of whether glass fiber insulation or fiberboard insulation is used, could be expected to contribute to the spread of fire occurring beneath the roof deck. Also, they found that when fiberboard insulation is used, an asphalt adhesive mopping of 12 lbs. or more per 100 square feet of surface will cause fire to spread beneath the roof deck. The only construction mentioned in the report that would not be expected to produce an extensively spreading fire is one consisting of fiberboard insulation mechanically fastened to the steel deck with no as phalt material between the insulation and the deck.

It was found in subsequent trials that constructions including mechanical fasteners were not entirely satisfactory. In a typical mechanically adhered construction comprising asphalt impregnated fibrous felts, laid dry, and insulating boards, both of which were anchored to the roof deck by metal clips, the clips caused unwanted cold-weather transmission and attracted condensation. Subsequently, the vapor barrier system that has since been most extensively used was introduced. This consists of a film of polyvinyl chloride secured to the metal roof deck by a rubber base adhesive, and a layer of insulating boards bonded to the film by the same type of rubber base adhesive. A built-up roof usually is applied over the layer of insulation. This type of structure was awarded a Class I rating by the Factory Mutual Engineering Division after the construction had successfully met Factory Mutual requirements for minimum fire hazards and adequate wind resistance. With respect to fire resistance, the rubber base adhesives are self-extinguishing; they char when exposed to flames but will not themselves support combustion. In addition, they will not become fluid and drip when exposed to flame. The polyvinyl chloride film itself is not flammable, although hot asphalt will melt it and destroy the vapor barrier.

Such a system has several disadvantages. The polyvinyl chloride film tends to curl and pucker due to the effect of the solvent in the rubber base adhesive, making it less effective as a vapor barrier and reducing its wind resistance. Hot asphalt dripping down between the insulating boards during application of a built-up roof can melt the film and destroy its vapor barrier effectiveness. Further, the structural value of the film is minimal as evidenced by its inability to resist stresses built up over a period of time due to movement of the metal roof deck or roof membrane in response to temperature changes. Because of the low resistance of the film to such movement and because of the tendency of workmen to poorly anchor the insulating boards to the film due to frugal use of such relatively expensive adhesive, the polyvinyl chloride film and/or insulating boards too often are eventually pulled or blown off and the watertightness of the roof destroyed.

The problem in providing a structurally sound roof construction is that the measures normally conceived by one skilled in the art to improve the strength of the construction usually detract from its fire resistance or from the effeciveness of the vapor barrier. For example, the metal clips mentioned above detracted from the effectiveness of the vapor barrier, and attempts to use large quantities of relatively strong organic material generally have resulted in reducing the fire resistance of the roof, as brought out in the Factory Mutual report mentioned above. Roof constructions of increased fire resistance have been proposed, but such constructions generally do not provide an ef-

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fective vapor barrier. For example, U.S. Pat. No. 3,282,-008, issued Nov. 1, 1966, speaks of regulating the flow of combustible roofing materials during a fire by a noncombustible, but water vapor pervious, sheet located between the roof deck and a layer of insulation. Such an arrangement would not be suitable in an environment that requires the use of a water vapor barrier. The need for an improved fire resistant vapor barrier roof constuction which costs no more than, or less than, the well known polyvinyl chloride film arrangement has been recognized by the industry for years, but prior to this invention no satisfactory solution had been developed.

OBJECTS OF THE INVENTION

The main object of the invention is to provide an improved fire resistant vapor barrier roof construction capable of resisting the stresses to which it is exposed during use.

Another object of the invention is to provide such a roof construction at a lesser cost than the commonly employed polyvinyl chloride vapor barrier roof system.

SUMMARY OF THE INVENTION

These objects are accomplished by the present invention which, contrary to the accepted practice in the industry of avoiding the use of a vapor barrier comprised of felt and asphalt, or the use of 12 pounds or more of mopping asphalt per square, can utilize both such features and yet be sufficiently resistant to fire and have enough strength to pass the fire resistance and wind resistance tests of Factory Mutual Engineering Division for a Class I rating, and be much improved over the prior art systems. The strength of the roof construction is substantially greater than that of the arrangement utilizing polyvinyl chloride film and the moisture vapor permeance is substantially lower than that of the conventional 4 mil thick polyvinyl chloride film. In addition, the structure is less costly. The vapor barrier comprises a fibrous sheet containing asbestos fibers and bituminous saturant, adhered to the roof deck by a noncombustible adhesive, that is, an adhesive that will not itself support combustion or flow when exposed to flame. A layer of mopping asphalt, which may be applied liberally in quantities up to about 25 pounds per square, is used to adhere noncombustible insulating board to the vapor barrier. This arrangement is highly satisfactory despite the presence of large amounts of combustible asphalt.

DESCRIPTION OF THE DRAWINGS

The nature of the invention will be more fully understood and other objects may become apparent when the following detailed description is considered in connection with the accompanying drawing, wherein:

FIG. 1 is a pictorial representation of a portion of a roof construction embodying the present invention, the construction being partially cut away to illustrate the various components of the roof structure; and

FIG. 2 is an enlarged transverse sectional view taken on line **2—2** of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 1 and 2 of the drawing, a metal roof deck of typical construction is indicated at **10** and a layer of asbestos felt **12**, saturated with bituminous material, such as, for example, asphalt or tar pitch, is adhered to the metal deck by a layer of fire resistant adhesive **14**. The adhesive may be a rubber base adhesive of the type commonly used in the vapor barrier system utilizing polyvinyl chloride film, such as, for example, "Vaporgard" adhesive sold by Johns-Manville Corporation, or it can be any other suitable type of noncombustible adhesive. A "noncombustible adhesive," as used in the specification and claims, means an adhesive that does not support combustion, that is, one which will not flow when exposed to flame or propagate the fire. An example

of another suitable adhesive is a tacky asphalt emulsion containing clay, which will char when exposed to fire but will not support combustion itself and will not flow or propagate the fire. It is preferred that a full layer of adhesive be used to adhere the asbestos felt to the roof deck so that as much strength as possible can be built into the system. It has been found that application of adhesive at a rate of about 0.25 to 0.40 gallon per 100 square feet will satisfactorily adhere the vapor barrier felt to a metal roof deck at an acceptable cost. It is preferred that the adhesive be fairly viscous, but pourable for convenience of application, say in the range of 4000–10,000 centipoise, in order to minimize absorption of the adhesive into the vapor barrier. The viscosity may be less than that, however, say down to about 2000 centipoise, and still permit satisfactory adhesion. Alternatively, the adhesive may have a very low viscosity if used in connection with a felt, the undersurface of which is coated, as by polyethylene or wax or asphalt, for example, to prevent or reduce absorption of the adhesive into the felt. Also, adhesives of considerably greater viscosity than 10,-000 centipoise can be used if the ability to be poured is not essential. Such thick adhesives could be troweled into place, for example.

The vapor barrier should be sufficiently strong to withstand the stresses to which it will be subjected on the roof deck; it should be fire resistant and should provide an effective barrier to the passage of water vapor. An exemplary material for use as the vapor barrier layer is asphalt saturated asbestos felt. Such a felt is strong, yet the asbestos fibers are non-combustible. The asphalt itself is a good vapor barrier material and functions additionally as a binder to reinforce the felt. A preferred material is asbestos felt the thickness of which typically is about 15–30 mils, weighing approximately 6–12 pounds per 100 square feet, and saturated with about 25–55 percent asphalt, by weight. The asphalt used to saturate the felt can be any suitable commonly employed saturating asphalt, such as, for example, asphalt having a penetration (ASTM D–5) of about 90–110 dmm. and a softening point (ASTM D–36) of about 100° F.–120° F. If the asbestos fibers are relatively short, it may be desirable to strengthen the felt with glass fiber reinforcing strands, used in minor amounts. Glass fiber felts alone are unsuitable for use as a vapor barrier material because the felt would be so porous that the saturating asphalt would not be held in place. The same is true with respect to mineral wool felts. Rag felts are not satisfactory because of their high combustibility. In addition to, or instead of, utilizing glass fibers as a reinforcing material in asbestos felt, organic fibers can be used in combination with asbestos fibers, but only in small amounts which would have little, if any, effect on the combustibility of the entire roof structure. The felt should be comprised mainly of asbestos fibers, regardless of the reinforcing material employed in conjunction with the asbestos. Preferably, the dry unsaturated felt should contain at least approximately 85 percent, by weight, of asbestos fibers, although the invention is not limited to use of a felt of that particular composition.

Referring again to the drawing, a layer of mopping asphalt **16** adheres the insulating board **18** to the felt **12**. The mopping asphalt, which can be any suitable conventional type, such as, for example, an asphalt having a melting point in the approximate range of 140° F.–230° F., may be used in rather large quantities, as great as about 25 pounds per 100 square feet, in order to provide maximum benefits with respect to strength and vapor barrier effectiveness, and should be applied at least at the rate of about 10 pounds per 100 square feet. Because the layer of asphalt itself is an excellent vapor barrier and contributes significantly to the overall strength of the construction, liberal use of mopping asphalt, despite its highly flammable nature, is desirable. A built-up roof or other suitable roof membrane is provided over the

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upper surface of the insulating board, but the roof membrane forms no part of the present invention and, as mentioned previously, is not taken into account in determining whether a particular roof structure should be classified as fire resistant. In the arrangement shown in the drawing, the roof membrane consists of a built-up roof **19**, formed of alternate layers of mopping asphalt adhesive and roofing felt, which may be comprised of either inorganic fibers or organic fibers, or a combination of both. The alternate layers of asphalt **20**, **22** and **24** secure the felts **26**, **28** and **30** to the insulating boards **18**. The upper bituminous coating **32** is provided as a further waterproofing coating. The built-up roof has been illustrated as comprising three plies of felt, although more or less than three are also commonly employed.

The insulating board is not limited to any particular type of material, but should be noncombustible, which term, as used in the specification and claims, means an insulating board that does not itself support combustion or propagate fire. It should be of sufficient strength to resist wind blow-off. For example, boards comprised of a substantial amount of expanded perlite, such as insulating board sold by Johns-Manville Corporation under the name of "Fesco" board, are well suited for use in the construction of this invention. An example of another insulating material is an insulating board formed of glass fibers. Insulating boards which themselves are combustible, such as, for example, wood fiber boards and combustible foam material, are unsuitable.

A roof structure constructed in accordance with the invention was tested by Factory Mutual and found to successfully pass their fire resistance test and wind uplift test, and was awarded a Class I rating.

The Factory Mutual test procedure to determine the fire resistance of a roof structure consists of constructing a test panel of the roof and using the panel as the horizontal cover of a test furnace. The furnace is fired and the excess heat given off by the sample is measured. Excess heat is produced when the rate of heat liberation from combustion exceeds the rate of heat losses by radiation, conduction and convection, and is responsible for the spread of fire. If there is no excess heat, the fire will go out. The test is more fully described in National Fire Prevention Association Quarterly of January 1959, reprints of which are available from Factory Mutual.

The wind uplift test conducted by Factory Mutual utilizes a steel pressure vessel, 9 feet long, 5 feet wide and 2 inches deep, arranged to apply air pressure at preestablished standard rates to the underside of a test panel which forms the top of the pressure vessel. This is to simulate the effects of "negative perssure" tending to push up on a roof as the result of high velocity winds moving over the top of a roof. The details of the test are set forth in a Factory Mutual publication entitled, "Factory Mutual Standards for the Approval of Insulated Metal Roof Deck Constructions, 1961."

In another test performed under controlled laboratory conditions, the permeance of the system with respect to water vapor was determined. This test consisted of the desiccant method using calcium chloride at a test temperature of 90° F., described as procedure C in ASTM Designation E–96–63T. The permeance unit used herein is a "perm," which measures the number of grains of water to pass through a square foot of the material being tested in one hour under a pressure of one inch of mercury.

It was found that asbestos felt reinforced with glass fiber and weighing about 6½ pounds per square, impregnated or saturated with asphalt having a melting point of 110° F. in amounts of about 2½ pounds per square, and having a coating of 190° M.P. asphalt which had been applied over the top surface of the felt at the rate of about 25 pounds per square, had a permeance rating of 0.063 perm. The same felt, but with a coating applied at the rate of about 15 pounds per square, had a rating of 0.076 perm, and with a coating applied at the rate of about 10 pounds per square had a permeance rating of 0.152 perm. A control sample, identical to the other samples except that it had no asphalt coating, had a rating of 0.50 perm. Thus, the permeance rating of the vapor barrier felt alone is superior to that of a 4 mil thick polyvinyl chloride film, which has a permeance of about 0.60 perm, and the addition of the asphalt adhesive makes it many times better.

As an example of a roof construction applied in accordance with the present invention, an asbestos felt reinforced with glass fibers, and weighing about 6½ pounds per square, containing asphalt saturating the felt at the rate of about 2½ pounds per square, was adhered to a steel roof deck comprised of steel channels each having a span of 2⅜ inches, by "Vaporgard" rubber base adhesive. The adhesive was applied to the roof deck by a 12-inch wide roller mop and the asbestos felt was unrolled into the adhesive with adjacent courses being lapped about 2 inches. This was followed by a hot mopping of 190° M.P. asphalt, at a rate of about 25 pounds per square. "Fesco" insulating board comprising expanded perlite, organic fibers and binder, was then laid in the hot asphalt and the roof was finished by application of an asbestos base felt adhered to the upper surface of the insulating board by a layer of mopping asphalt, followed by asbestos finishing felts. It was found that even though the roof was applied in a steady wind of about 15 miles per hour, the roof components could be applied with ease, and later inspection proved that the roof was performing satisfactorily in every respect. Under similar conditions, it would have been highly impractical to attempt to apply polyvinyl chloride film because the wind conditions would have made application extremely difficult.

In addition to the excellent performance of the roof in the areas of fire resistance, wind resistance, strength and effectiveness as a vapor barrier, the components themselves are easily applied to a roof deck, and the resulting roof is less expensive, when considering both the cost of the components and the cost of application, than the vapor barrier roof system this invention was designed to replace. The asbestos vapor barrier felt, including the asphalt saturant, is considerably less costly than polyvinyl chloride film and the mopping asphalt used to adhere the insulating boards to the asbestos felt, even at the high rate of application of up to 25 pounds per square, is considerably less costly than the rubber base adhesive used in the prior art arrangement.

Modifications to the roof structure disclosed herein may be made without departing from the spirit of the invention, the scope of which is to be interpreted only in accordance with the appended claims when read in the light of the foregoing disclosure.

What I claim is:

1. A roof structure, comprising:

(a) a metal roof deck;

(b) a fibrous sheet comprising asbestos fibers and bituminous saturant distributed substantially uniformly throughout the sheet;

(c) the fibrous sheet being adhered directly to the roof deck by a noncombustible adhesive;

(d) a layer of noncombustible thermal insulation adhered directly to the fibrous sheet by a layer of bituminous adhesive present in amount in the order of about 10 to 25 pounds per 100 square feet of roof surface;

(e) the bitumen saturated fibrous sheet and the bituminous adhesive functioning together as a highly effective water vapor barrier of low permeance; and

(f) a roof membrane covering and protecting the insulation from the weather.

2. A roof structure as recited in claim **1**, wherein the fibrous sheet has a weight of approximately 6 to 12 pounds per 100 square feet and contains, by weight of the dry

fibrous material therein, about 25% to 55% bituminous saturant.

3. A roof structure as recited in claim 2, wherein the bituminous saturant is saturating asphalt having a penetration in the approximate range of 90 to 110 dmm. and a softening point in the approximate range of 100° F. to 120° F.

4. A roof structure as recited in claim 1, wherein the bituminous adhesive is asphalt having a melting point in the approximate range of 140° F. to 230° F.

5. A roof structure as recited in claim 1, wherein the permeance rating of the bitumen saturated fibrous sheet and the layer of bituminous adhesive combined is substantially less than 0.50 perm.

6. A roof structure as recited in claim 1, wherein the fibrous sheet contains at least about 85% asbestos fibers, by weight of the dry unsaturated sheet.

7. A roof structure as recited in claim 1, wherein the permeance rating of the bitumen saturated fibrous sheet is not significantly greater than about 0.50 perm.

8. In a roof construction comprising a metal deck, a water vapor barrier, a layer of thermal insulation and a roof membrane, the improvement comprising:

(a) a fibrous sheet, compirsed predominately of asbestos fibers and saturating asphalt, adhered directly to the metal deck by a layer of noncombustible adhesive; and

(b) a layer of noncombustible thermal insulation adhered directly to the fibrous sheet by a layer of mopping asphalt present in amount in the order of about 10 to 25 pounds per 100 square feet of roof surfaces; and

(c) the asphalt saturated fibrous sheet and layer of mopping asphalt combined, being a highly effective vapor barrier and having water vapor permeance value substantially less than 0.50 perm.

9. A roof construction as recited in claim 8, wherein the fibrous sheet has a weight of about 6 to 12 pounds per 100 square feet and contains, by weight of the dry fibrous material therein, about 25% to 55% saturating asphalt.

10. A roof construction as recited in claim 8, wherein the noncombustible adheshive is a rubber base adhesive.

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