Feb. 11, 1936. F. WEYERHAEUSER ET AL 2,030,668

MEANS FOR INSULATING WALLS

Filed Aug. 26, 1932 2 Sheets-Sheet 1

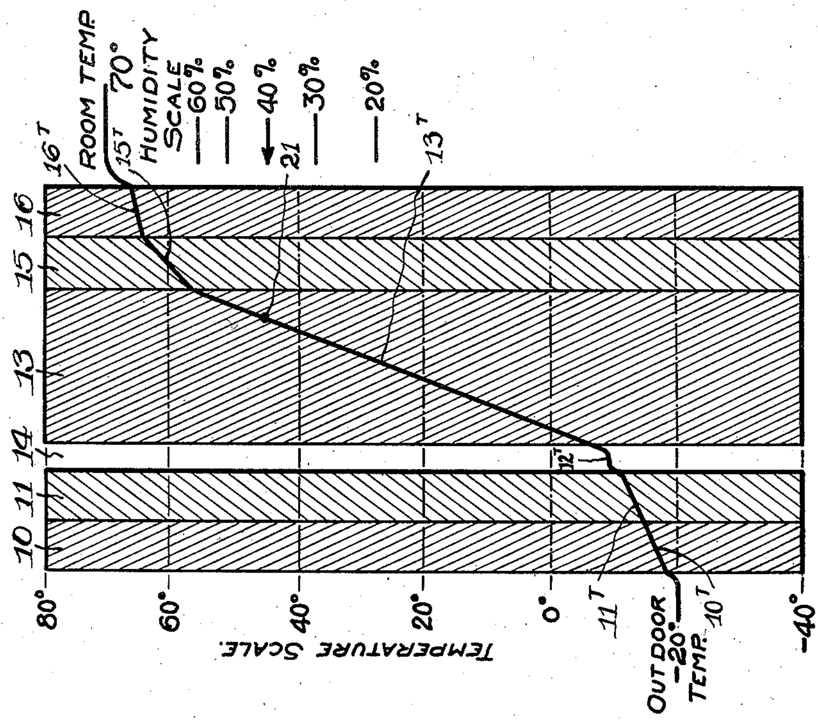
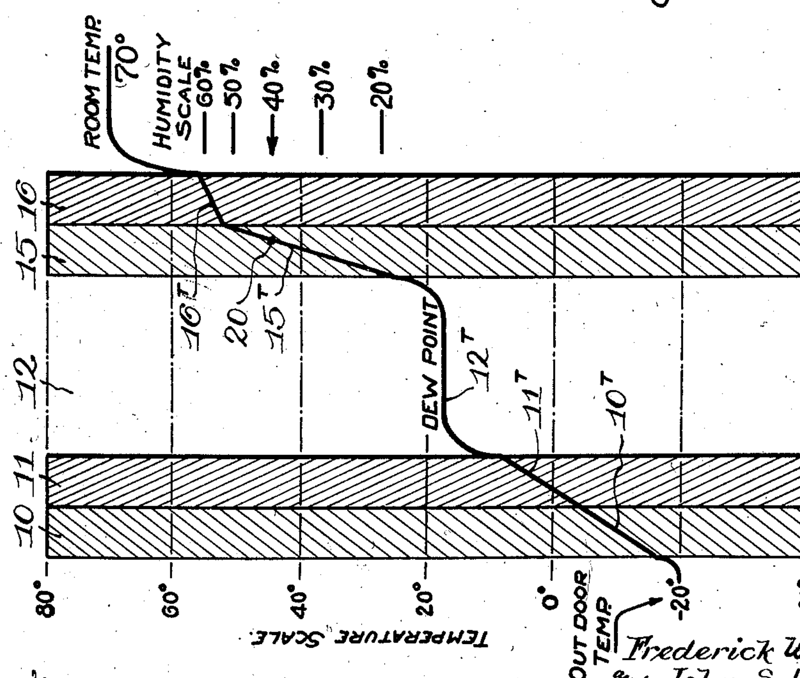


Fig. 2



OLD ART

Fig. 1

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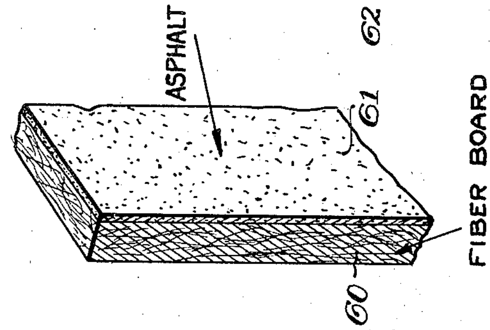

Fig.5

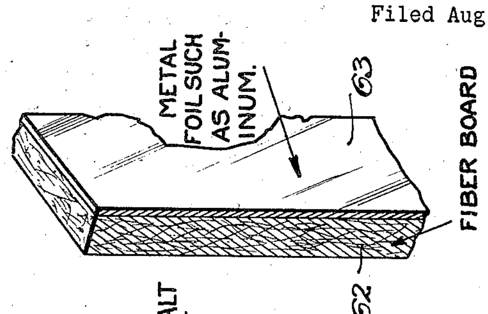

Fig.6

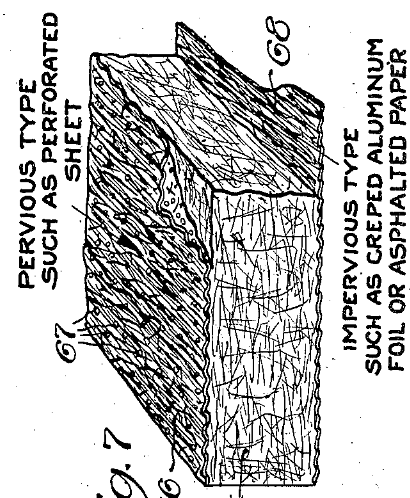

Fig.7

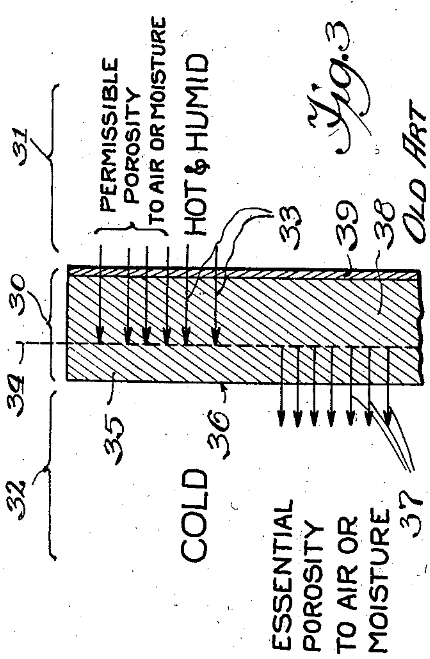

Fig.3

OLD ART

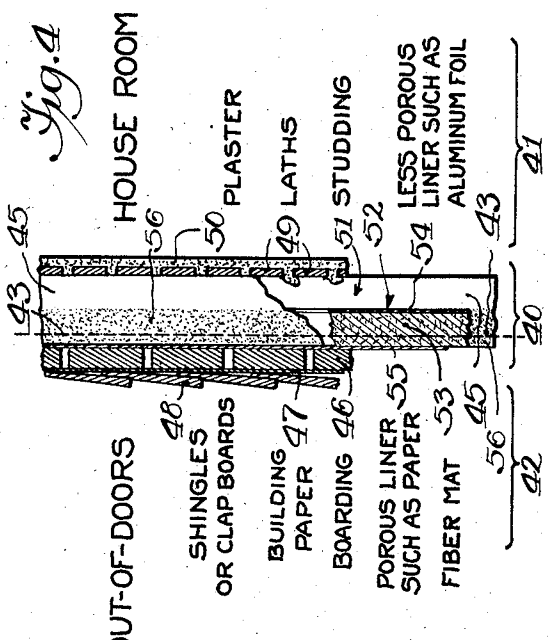

Fig.4

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2,030,668

MEANS FOR INSULATING WALLS

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6 Claims. (Cl. 20—4)

The present invention relates generally to walls for separating heat and cold and to insulation for similar insulated walls. It has special reference to winter insulation of houses and like structures wherein a warm, more or less humid atmosphere normally exists on one side and wherein a freezing temperature may normally occur on a cold side.

In a condition as above referred to which is common in houses in climates experiencing freezing weather, it has been found that warm moist air in a house passes by infiltration into the walls and as it acquires a lower temperature from the outside moisture condenses depositing water. This occurs at the dew-point, and in the event the temperature is freezing ice forms in the wall. At warmer temperatures, as in the day time, the accumulated ice will melt. Audible dripping of water in walls has been observed in so-called uninsulated houses. Water-spots on plaster have been formed. Injury and decay to wood frames and other structural parts have been observed after a number of years of this action. Siding and sheathing in particular deteriorate, and such action is hastened by conventional structures which prevent evaporation of the water which accumulates. These include the use of a porous warm side which permits moist air to enter the wall, the use of building papers on the cold or outside which decrease porosity of the outside of the wall and hence retard exfiltration of air and moisture, and the use of paints on the outside which act similarly to or add to the effects of building paper.

In conventional walls of the insulated type the same effects are present and the same conventional structures above described usually exist. In the insulated wall the structure is usually such that the insulating material carries the greatest temperature gradient in the wall. This practically assures that the dew-point lies in the insulation material. Hence the water is deposited, with or without freezing, in the insulating material. This may have a high capacity to hold it, and in a course of time causes its destruction. At least, while it is wet its insulation value is greatly decreased. When it holds moisture it is a reservoir for it and causes damp walls. The extent of holding moisture is determined by the character of the insulating material, whether or not it is lined, and the character of the wall apart from the insulation.

The present invention aims to prevent and to overcome these defects in both insulated and uninsulated walls.

The main object of the invention is to preserve walls from injury due to condensation of water therein.

Another object of the invention is to preserve insulation in walls from injury due to condensation of water therein.

A particular object of the invention is the formation of a wall more porous on the cold side than on the warm side.

Still another object is the formation of a heat insulation material for walls which may be used so as to be more porous on the cold side than on the warm side.

Another object of the invention is the provision of a lining at the warm side in a wall which lining is substantially incapable of transmitting moisture-laden air from the warm side to the cooler side.

Other objects are the independent or combined provisions of a heat insulating wall and a heat insulating material, each with a more air-pervious and/or more moisture-pervious cold side than warm side.

Still another object is the provision of an insulation unit, such as a blanket, tile, board, or other form, flexible or rigid, which is more porous on one side than on the other side, which latter may be practically impervious to air and/or moisture.

Various other and ancillary objects and advantages of the invention will appear from the following explanation of the invention made in connection with the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of a wall of the common uninsulated type, showing the prevalent conditions.

Fig. 2 is a similar diagrammatic view of a so-called insulated wall illustrating the same conditions and the specific effects on the insulation.

Fig. 3 is a diagrammatic illustration of a wall embodying the present invention.

Fig. 4 is a cross section of a wall of the type illustrated in Fig. 3.

Fig. 5 is a perspective view of a piece of insulating fiber board having an impervious face of asphalt.

Fig. 6 is a perspective view of a piece of insulating board having a face rendered impervious by a layer of metal foil.

Fig. 7 is a perspective view of a piece of flexible insulating blanket having an insulating mat between relatively more pervious and less pervious flexible liners.

Referring specifically to Figs. 1 and 2, it is assumed that the walls are employed in a house wherein the inside temperature is normally 70° F. at a 40% relative humidity, and the outside temperature is —20° F. This is representative of ordinary human living quarters. The inside air will contain about 7.2 grams of water as vapor per cubic meter. As air is cooled its capacity for holding moisture decreases. For example at —16° F. one cubic meter of air can hold only .4 grams of water as vapor. Hence as air from the room filters into the wall and cools there may be deposition of water. The point at which this occurs on the temperature scale is called the dew-point. Hence in the wall there is a dew-point. The dew-point is lower according to the lower vapor content of the initial body of air referred to. The dew-point for air over 70° F. and 40% relative humidity is roughly at 45° F. In the walls of Figs. 1 and 2 moisture will condense from infiltrated air from the room at the points in the wall where it attains the temperature of 45° F.

Referring specifically to Figs. 1 and 2 the numeral **10** may represent the outside material such as clapboards, shingles, stucco and the like. Numeral **11** may represent the siding or sheathing. Numeral **12** in Fig. 1 represents air space, as found between the studding of non-insulated houses. Numeral **13** in Fig. 2 may represent a filler of insulation material, either completely or partially filling the air space **12** of Fig. 1. It is specifically shown for convenience as almost completely filling the air space, the remaining unfilled air space being designated **14**. The numerals **15** and **16** respectively designate interior wall structure such as plaster base and plaster.

In the Figs. 1 and 2 the vertical height of the wall is divided by a temperature scale to indicate temperatures for plotting temperatures within the wall. The exemplary materials mentioned have different insulation values and hence different temperature gradients exist from the inside at 70° F. to the outside at —20° F. The temperature gradient is shown by a continuous line of parts designated by the numerals **10T**, **11T**, etc. according to the specific material. In Figs. 1 and 2 there is at the left a humidity scale indicating the vertical position on the temperature gradient line where the dew-point occurs for air at 70° F. at different degrees of humidity.

In Fig. 1 the numeral **20** indicates the dew-point for the room air at about 45° F. It lies within the plaster-base **15**. Water deposited here may readily spot the plaster and cause other damage. In Fig. 2 the numeral **21** shows the dew-point 45° for the room air. It lies in the insulation material **13**. Careful study of the two figures shows that the insulation material **13** bears the heavy duty in insulating and includes practically all the fall in temperature. Under wide variations from the specified conditions the dew-point tends to fall within the special insulation. Hence the insulation will accumulate moisture if room air gets into it, and more so if the water is trapped there and cannot get out of the insulation.

From the foregoing the objects of the invention should be very clear, and the various aspects of the invention can be readily understood.

In practice it is difficult to prevent entirely the infiltration of air and moisture into the wall, although that is the ideal objective. Therefore, failing in this ideal, it is possible to effect satisfactory results by permitting the removal of any water which may condense in the wall, by constructing the same porous to air and/or moisture on the cold or outer side. In any event it is made more porous than the warmer or inner side.

In insulated walls the insulation material is usually porous and air can circulate quite freely. But there are obstructions to such circulation which may act as dams, behind which, on the warm side, moisture may accumulate. In considering any structure the perviousness of the obstructions must be considered for successful elimination of moisture accumulation.

Referring again to Figs. 1 and 2 it is to be understood that deposition of moisture begins at the dew-point. The air is then saturated, and as it cools further, the excess moisture is deposited. So the wall structure on the cool side of the dew-point tends always to be moist, and at the freezing point will contain ice. For an outside temperature of —20° F., it is seen that practically all of the moisture content of the room air can be left in the wall. At —16° F. the air in the wall will contain about .4 grams of moisture per cubic meter. If the wall has a uniform porosity, one cubic meter of air entering from the warm side carries about 7.2 grams of water, and one cubic meter leaving the wall carries out only about .4 grams of water. In order, under any circumstances, to maintain an even balance of moisture in the wall, the air must be taken out on the cold side at for example from 15 to 20 times as fast as it enters. Otherwise moisture must accumulate.

Since a greater porosity is desirable on the outside, it is further desirable, in order not to have an open screen-like outer side in the wall, to limit the porosity of the inner side. Accordingly, the low-porous inner side serves in the dual capacities of limiting the introduction of moisture, and of lowering the porosity requirements of the outer side.

In practice the invention may be carried out by placing on the warm side of the dew-point a relatively impervious material. In a non-insulated wall it may be a sheet of aluminum foil, or a layer of asphalt, or a layer of impervious paper such as asphalted paper, which may be two sheets of paper adhesively united with an asphalt layer. Under the conditions of Fig. 1, this would necessarily be within the plaster base **15**. It may be between the plaster base **15** and the plaster **16**, or it may be a coating on the plaster. Sealing the joints, cracks and spaces should not be overlooked.

Under the conditions of Fig. 2 where the dew-point is beyond the plaster-base and plaster, the impervious or low-porosity zone may advantageously be in the form of an impervious sheet, either adjacent the plaster-base, or between it and the insulation, or as a lining on the insulation itself. The other side of the insulation is preferably left more open and porous, and even a perforated liner may be used. If a building paper is used in the wall, it ought to be a porous, or a perforated one if placed toward the cold side in the customary manner. A building paper may be used in the usual location on the cold side with advantage when it is both porous to moisture and also waterproof. Such papers are preferred in this invention and are readily available. If it is an impervious sheet, it ought to be placed toward the inner side, as for example between the plaster base and the insulating body. A coating of impervious character, such as asphalt could advantageously be used over the outer side of the plaster base. Aluminum or other impervious metal foil may be used on the plaster base, or between it and the insulation body, or as a liner on an insulation unit, whether it be a rigid or flexible unit. The duplex paper above described may be used in like manner.

In order to be more specifically illustrative we refer to Fig. 3. This shows diagrammatically a wall **30** separating a humid gaseous body **31** from a relatively colder body, such as a gaseous body **32**. The structure of the wall **30** and the conditions of humidity and of temperature of the two bodies **31** and **32** for the functioning of the invention may be such that the moist air in the wall, or moisture and air derived from body **31** which may enter the wall as shown by arrows **33**, is cooled to the dew-point.

The broken line **34** represents a boundary line in the wall where the dew-point is reached. Hence water will be deposited at the line **34**. This may creep to either side of the line **34** depending on the structure. Unless the water can be removed it will accumulate. The portion of the wall designated **35** which is at the left of the line **34** in Fig. 3, must be such that evaporation of water may take place. The wall may be open at fixed points to provide for draft therein, as from the gaseous body **32**, or it may be generally porous for circulation of evaporating gas therein, or be pervious to moisture so that moisture is transmitted through the wall, and dissipated as vapor at the surface **36**. The course of such water or vapor is indicated generally by the arrows **37**, either in direct lines of the arrows or tortuously between the extremities of the arrows. The porosity should be about ten times greater on the cold side than on the warm side.

According to the present invention the portion **38** of the wall to the right (Fig. 3) of the dew-point line **34** is less pervious to moisture, or less porous to moisture laden air, than the portion **35** of said wall lying to the left of said line. This may be effected by the character of the material in the wall **38**. It may be effected for any porous wall by using in the wall portion **38**, either within it, or on a surface thereof, a specific layer, such as an air-proof, and/or moisture-vapor-proof sheet **39**, for example a sheet of aluminum foil, suitably impregnated paper, or suitably coated paper.

Given any specific structure, knowing the insulating values and the pertinent properties of the materials, and given the prevailing temperature differences and relative humidities, an engineer in the art may calculate with considerable accuracy the location of the dew-point line **34**. He may therefore ascertain the correctness of the structure, or modify it, so that it meets the requirements of the invention for prevailing conditions.

In general practice, as in house insulation, the wall may be of standard type of construction, into which insulation is incorporated. The insulation may be of standard manufactured brand. Many of these brands use fibrous material. It is therefore important that such manufactured insulation be properly designed to prevent the accumulation of water therein, or in the wall, and that it be designed to permit elimination of what water may be condensed therein. In considering the facts, it should be remembered that ideal conditions are never realized commercially, and that there are unavoidable air leaks in structures and materials. Therefore, although it would be ideal to use an absolute vapor insulation on the warm humid side of the wall, such perfection cannot be depended upon, and the structures and relations herein described as characterizing the invention must be observed in practice.

A practical application is shown in Fig. 4 representing a house wall **40**, a warm house room **41**, and the cold out-of-doors **42**. A standard type wall construction is shown into which is incorporated manufactured insulation which may need to be protected against accumulation of water therein. In the structure it is assumed that a dew-point line **43** exists in the body of insulation.

The standard structure is merely illustrative, and it is to be understood that many other types might be chosen for illustration. It shows wall studding **45**, covered on the outside with boarding or sheathing **46**, on which building paper **47** is secured. External covering may be stucco, shingles, clapboarding, and the like, as indicated at **48**.

On the interior side any standard finish may be employed such as wall board, or laths and plaster. The latter structure is chosen as exemplary, and numerals **49** and **50** represent laths and plaster respectively.

Within the space **51** between the studding, insulation is employed. A blanket **52** is illustrated as a typical usage. With the dew-point line **43** residing inside the body of insulation, water may condense therein. The insulation may be of water-proofed and fire-proofed wood fibers, adhesively united into a mat **53**, and said mat may be secured to two liners which may or may not be sealed together at the edges of the unit. Moisture, or air containing moisture from the room **41**, may pass into the insulation, and there condense. To minimize the entry of such vapor, and to expedite removal of such water, liner **54** on the room side is made more impervious to moisture than the other liner **55**. Liner **54** may be moisture and air-proof. A sheet of creped aluminum foil, which may be on a paper base is quite ideal, but an asphalt impregnated paper sheet may be used. The latter sheet is generally waterproof, but not perfectly moisture-vapor proof. The liner **55** may be paper, perforated with holes, or it may be an open scrim net, or merely a porous sheet of paper through which moisture may be transmitted. Building paper **47** is preferably one which is capable of transmitting moisture, but even though it is not, the ordinary rough installation of it leaves such openings that sufficient filtration of air takes place to permit drying out of water.

The insulation should be so sealed in the wall that air cannot pass alongside the studding or through cracks to a point beyond and possibly into the insulation. Any suitable sealing means may be employed. The stippling **56** on the studding **45** indicates a seal, such as may be made of asphalt between the studding and the edges of the insulation unit. Similar sealing should be made throughout the entire wall structure.

An entire wall should have the properties herein described. It is not necessary that the required relation of the parts obtain wholly in the insulation unit. It is preferred to have the unit so made, that by embodying the unit properly in a standard or other wall, the entire wall embodies the invention. Other types of units may be used.

Where an insulating porous fiber board as in Fig. 5, is used in a wall, or as a wall, one side of the board **60** may have a layer, such as asphalt **61** thereon, which is less pervious to moisture than the board. Metal foil is suitable. Fig.

6 shows a porous fiber board **62** with a sheet of aluminum foil **63** cemented thereto. Where both surfaces of a board have coatings or sheets thereon, one of them, such as an aluminum foil sheet, is less pervious to moisture than the other one, which may be a felted paper, or even an asbestos sheet. It is preferred that one of the board faces be porous to moisture. It may be uncoated.

Fig. 7 represents an insulation blanket suitable for the wall in Fig. 4. It has a flexible fiber mat **65**, such as wood fibers loosely felted and adhesively united, a liner adhesively united to the mat, such as flexible creped asphalted paper **66** made porous by perforations **67**, and a second adhesively united flexible liner **68** of more impervious character, such as creped aluminum foil, or creped asphalted paper.

In theory the warm side of the wall should be absolutely impervious. But in practice such perfection cannot be economically obtained, so we recommend that the cold side be several times more porous to moisture than the warm side is porous to moist air or the moisture thereof. For general usage for living quarters in temperate climates we believe it should be at least ten times as porous, but a larger ratio may be desirable, and a lesser ratio may be permissible, depending upon specific conditions.

In the accompanying claims we aim to set forth the invention in its various aspects and to include other embodiments of it and such deviations from and modifications of the forms herein disclosed, as may fall within the scope of the invention as expressed in said claims.

We claim:

1. A flexible heat insulating blanket for use in house walls and the like in position to include the dew point in cold weather, comprising a flexible insulating core, a flexible creped sheet liner impervious to moisture or moist air, said liner being secured to one face of said core for use on the warm side of said wall, and a flexible creped moisture-pervious sheet on the other face of said core.

2. A flexible heat insulating blanket for use in house walls and the like in position to include the dew point in cold weather, comprising a flexible insulating core, a flexible creped sheet liner impervious to moisture or moist air, said liner being secured to one face of said core for use on the warm side of said wall, and a flexible foraminous sheet on the other face of said core.

3. An outside wall structure for heated buildings comprising upright wall-forming studs, an inside wall finishing structure on the inner side of the wall formed by said studs, an air-porous finishing structure on the outer side of the wall formed by said studs, air porous heat insulation material in the spaces between the studs and between the said wall finishing structures, the insulation being positioned to include the normal average position of the dew-point, said insulation being air porous on the surface next to the outer side of the wall, and sealing means between said insulation and the interior wall finish for retarding the entry of moist air into the insulation, said sealing means forming a barrier on the inner side of the insulation with a porosity of not greater than about one-tenth the porosity existing from the other side of the insulation to the atmosphere outside the outer finishing structure.

4. An outside wall structure for heated buildings comprising upright wall-forming studs, an inside wall finishing structure on the inner side of the wall formed by said studs, an air-porous finishing structure on the outer side of the wall formed by said studs, air porous heat insulation material in the space between the studs and between the said wall finishing structures, the insulation being positioned to include the normal average position of the dew-point, said insulation being in sheet form, and a liner carried by said insulation on the inner side, having such porosity that the insulation is air-vented to the exterior atmosphere with about ten times the porosity of said liner, and sealing means between said liner and the studs whereby to retard the entry of moist air into the insulation at the edges.

5. A partition structure for separating cold and warm atmospheres comprising wall-forming supports in spaced relation, finishing wall structure on the cold side of said partition, finishing wall structure on the warm side of said partition, said finishing wall structures being secured to said spaced supports and providing between said supports an intervening air space extending from one wall structure to the other, air-porous heat insulation material in said space, said insulation being positioned to include the normal average position of the dew-point, and a sealing sheet located in said partition between said insulation and the warm side finishing structure, said sealing liner being not more than one-tenth as porous to moist air than the porosity of the material extending from said liner through the insulation and through the cold side finishing structure.

6. A partition for separating cold and warm atmospheres comprising a finishing wall structure on the cold side, a finishing wall structure on the warm side, said structures being substantially entirely separated by intervening space for heat insulation, air-porous heat insulation in said space, said insulation being positioned to include the normal average position of the dew-point, and a sealing sheet located in said partition between said insulation and the warm side finishing structure, said sealing liner being not more than one-tenth as porous to moist air than the porosity of the material extending from said liner through the insulation and through the cold side finishing structure.

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