April 16, 1946. O. W. FROST ET AL 2,398,632

BUILDING ELEMENT

Filed May 8, 1944 2 Sheets-Sheet 1

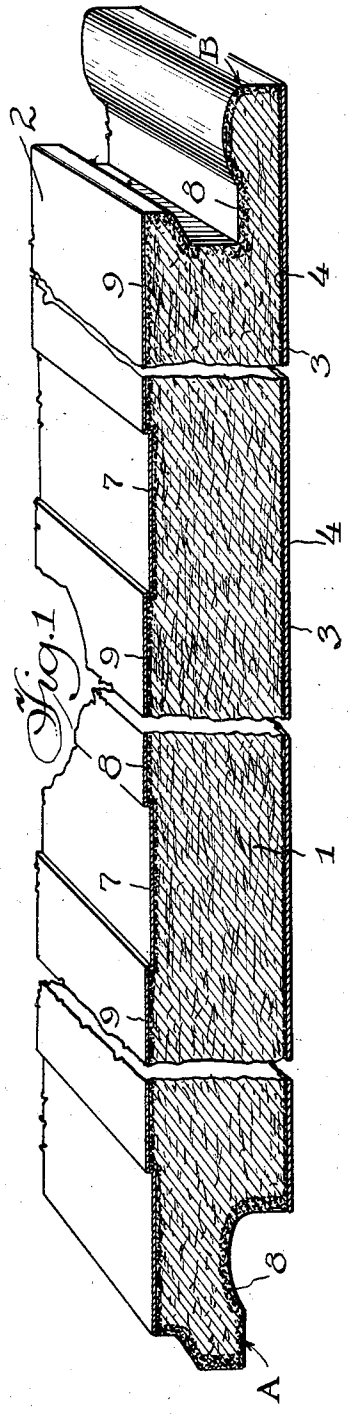


Fig. 1

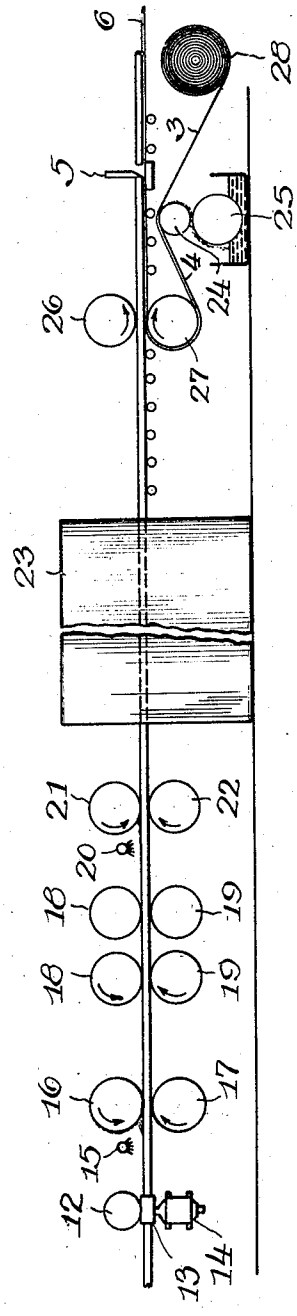


Fig. 4

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BUILDING ELEMENT

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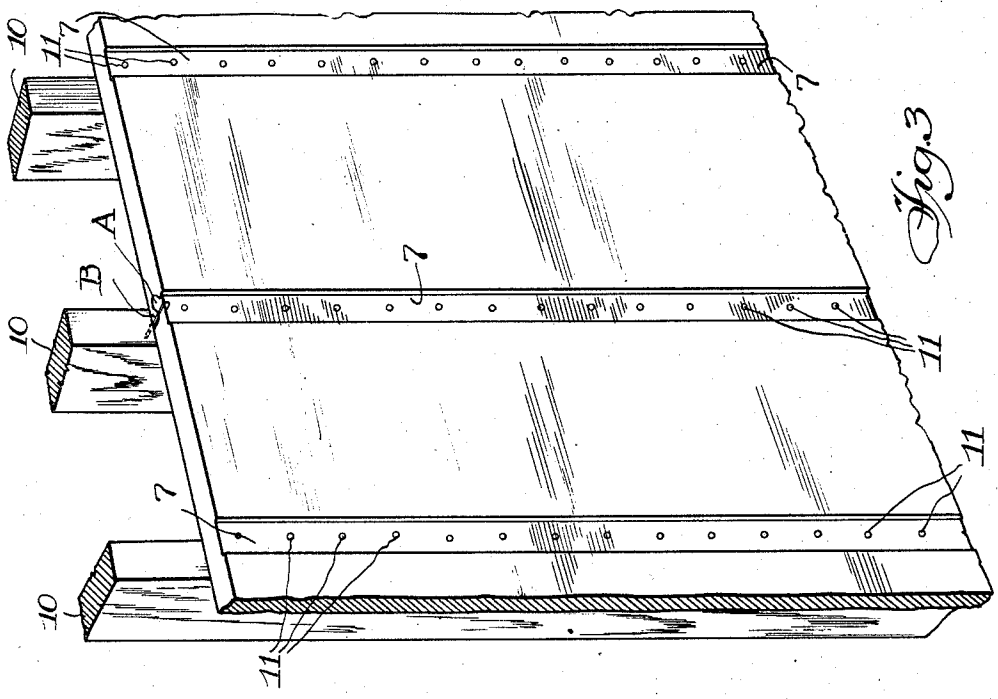


Fig. 3

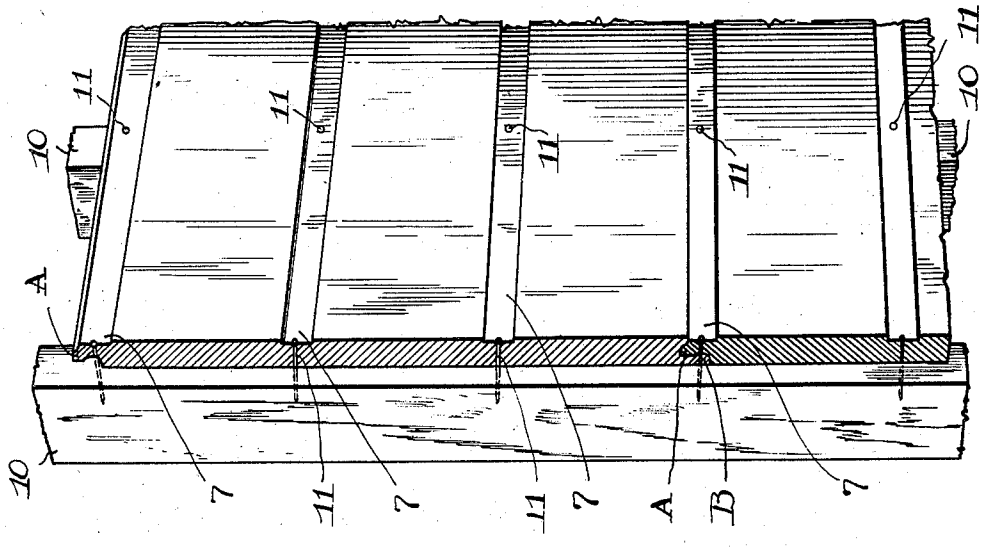


Fig. 2

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UNITED STATES PATENT OFFICE

2,398,632

BUILDING ELEMENT

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Application May 8, 1944, Serial No. 534,566

5 Claims. (Cl. 154—45.9)

This invention relates to an improved fibrous sheet material and means for its manufacture. More particularly it relates to a surface treatment of fibre material in sheet form to improve its utility especially for exterior purposes.

At the present time comminuted fibrous material, particularly those from wood, are formed into sheets, coated with asphalt and applied to various framing members as part of the exterior walls of buildings. This type of material has received wide acceptance and in some localities has replaced wood sheathing in practically all new homes. Some of the advantages of such a material are lower erection cost, as the sheets are light in weight; ease in application, as one sheet covers a considerable area; and good heat insulating value, being much better than wood sheathing in this respect.

While the asphalt coated fibrous sheets are extensively used as a sheathing material in frame construction it has certain limitations and disadvantages which if they were overcome would greatly enhance the utility of this type of material. Some of these disadvantages are (1) no controlled vapor permeability of the sheets, especially when this sheet-like material is the exterior surface itself; (2) this type of material is limited to replacing sheathing and requires further surface protection and additional strengthening materials in order to furnish satisfactory durable exterior construction by itself. Hence, the fibrous sheets as used in the present state of the art can not be used alone as an exterior material which will stand up for any length of time. In addition, if it were so used its drab black appearance would be very unattractive and would not lend itself to painting, as asphalt bleeds through oil paints very markedly. Also, its soft surface would rapidly deteriorate under the ordinary wear to which an exterior material is subjected.

It is the purpose of this invention to disclose an improved fibrous sheet material which not only has the economy of erection and heat insulating properties of the material now used so extensively, but the additional improvements of vapor permeability control and a surface treatment which will enable the sheets to be used as the exterior surface itself. This treatment is such that the appearance will be pleasing and also resistant to the weather and to the ordinary wear received by exterior surface.

In preparing this material a disintegrated fibrous material such as cottonwood pulp is formed into sheets; the sheets can be prepared by suction from a wet pulp-like slurry. Water is pressed from these sheets which are then subsequently dried and cut into the desired sizes, such as 2 or 4 feet wide and 6, 8, 10, or 12 feet long. It is more desirable from the commercial standpoint, especially when sheets greater than ½'' are used, to laminate 2 or more thinner sheets together to obtain the required thickness. It is preferred in practicing this invention to use sheets of at least 1'' in thickness to give the insulation and strength desired in this type of product. Two or three sheets can be laminated together to obtain this thickness. After the sheet has been prepared a novel surface treatment is applied, which is a subject of this invention.

For a clearer understanding of this invention reference should be made to the accompanying drawings forming a part of the description of this invention. In the drawings:

Figure 1 is a sheet material made in accordance with this invention.

Figure 2 illustrates an application of this material in a horizontal direction to vertical framing members.

Figure 3 is similar to Figure 2, with the exception that the sheets are applied vertically or parallel with the studs.

Figure 4 illustrates an apparatus for carrying out the process of this invention.

In Figure 1, 1 is a fibrous base sheet which can be homogeneous, or preferably laminated; 2 is the exposed or exterior side of the base sheet showing the treatment applied following the principle of this invention; 3 is a paper-like sheet preferably asbestos, adhered to the unexposed surface by the water impervious film 4. A and B illustrate a novel type of edge which permits an interlocking joining of adjacent sheets together along the edges. This method of joining boards at their edges is the subject of another application Serial No. 534,575 filed simultaneously by one of the inventors whose name appears upon this application. 7 are indentations made in the surface of the sheets to improve the appearance, to facilitate nailing, and to a certain extent conceal the exposed nail heads.

A tough and strong surface is formed upon the exposed or exterior surface 2. This is preferably accomplished by applying a heat hardenable material in liquid form, such as a drying oil 8, to this surface and to the edges of the sheet. Owing to the position of the fibers in the board or base sheet, it will be found that the penetration of the treating material is much greater along the edges than on the surface of

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the sheet. The heat hardenable material and fiber are kneaded together with heated rolls resulting in a tough film. An exterior aqueous emulsion paint layer 9 is then applied to this surface and the composite layer is then baked. The entire process of forming the product of this invention will be subsequently more clearly set forth.

In Figure 2 the individual sheets are shown applied horizontally to 2'' x 4'' studs marked 10. This figure shows the method of nailing the sheets particularly along the lock type joints described in detail in the copending application referred to above. The nails 11 are shown passing through this point. Note that the nails are driven into the recess 7, provided for the purpose, until flush, thus providing a part concealment of the nail heads.

In many cases, it is preferred to apply the sheets vertically to the studs, see Figure 3, as there is reinforcing back of and along the joint. The vertical lines appear more pleasing to some observers.

Figure 4 shows an apparatus by which this invention can be carried out. In the figure, 12 and 13 are cutting and trimming saws to form the edges of the sheets, which can be of the interlocking type, such as A and B in Figure 1. Saws similar to 12 also are used to form the shallow grooves 7 in the face of the sheet. 14 is a motor for the purpose of driving the saws and are connected thereto by suitable means. The surface treating and waterproofing material, which is a heat hardenable liquid, preferably some type of drying oil, is applied to the top of the sheet from the pipe 15. This liquid material forms a pool before the top applicating roll 16. This roll, along with the bottom roll 17, assures an even distribution of the oil upon the surface. The liquid for the edges can be applied by spray or by suitable roll applicators.

After the oil has been applied, the board then passes through a series of two or more heated, pressing or kneading rolls 18 and 19. The top rolls 18 revolve at such a rate that its peripheral speed is about 2½ times that of the speed of the board passing through the machine and in the same direction. The purpose of this is to iron the surface smooth and to knead the oil into the surface. It is within the scope of this invention to use other relative speeds, or other means of accomplishing this ironing action. It has been found desirable to knurl the bottom roll 19 in order that they will grip the board and force it through. After the surface treatments, an aqueous emulsion primer is then applied to the surfae from line 20. The applicating rolls 21 and 22 are used to assure a uniform distribution. The surface is then dried and baked in an oven 23, for example, for 2 hours at 300° F. After the heat treatment the reinforcing paper sheet 3 is adhered to the bottom by means of an adhesive 4, which can be molten asphalt applied to the paper by the roll 24 which is fed by the pick-up roll 25. The asphalt can be fairly soft at room temperature, as long as a reinforcing sheet is used. The rolls 26 and 27 are used to adhere the coated sheet to the board. Paper for the purpose is unwound from the roll 28. The knife 5 cuts the paper, and if necessary the sheet into the proper lengths whence it passes to the roller section 6 to be bundled or otherwise prepared for shipping.

For purpose of illustrating a method by which this invention can be carried out, a description of a preferred embodiment will be subsequently given. It is not the intention to be limited to the particular example set forth for obviously many modifications can be made by those skilled in the art, in which this invention is a part, and still not depart from the ambit of this invention.

In carrying out this invention it is preferred to take cottonwood pulp, which can be made by disintegrating cottonwood chips by attrition between moving steel plates or by the use of revolving stones, and wet form such pulp into sheets such as on a revolving suction filter. It is preferred to add rosin size to the pulp before forming into the wet mat in order to improve the water resistance of the sheet as a whole. After forming, the wet lap is pressed between rolls to remove extraneous moisture and then dried free from moisture to a strong porous sheet. It is more desirable from the manufacturing standpoints to form thinner sheets, such as ⅜'' and laminate several together to form the thickness desired. It is preferred to form three layers each of ⅜'' thickness as a total thickness of 1⅛'' has been found very satisfactory for use as an exterior facing material as it has the proper strength and heat insulation value needed for practical utility. Most any type of waterproof or water resistant glue can be used for laminating, such as those from soya bean, casein, resin, etc.

The laminated sheet is then passed through the apparatus shown in Figure 4. The proper type of edge is formed which should, but not necessarily so, be of the interlocking type, as this type of board can best be used when adjacent boards are locked together. The bracing strength is thus improved, as well as the appearance. The edges and also the grooves placed in the surface of the sheet are formed by suitable rotary saws or grinders, such as are well known in the art. After the edges are formed, which can be done elsewhere if desired, the top or exterior exposed surface is flooded with a liquid heat hardenable type of waterproofing material preferably an oil of the drying or semi-drying type, as well as fatty acids, fatty acid esters, tall oil, drying oil derivatives, etc. Linseed oil, plus driers such as lead or manganese or both has been found very satisfactory. Applicating rolls are used to prevent the use of an excessive quantity of the oil, and also to aid in providing a greater uniformity of application. The oil is also applied to the edges by any of the means known in the art such as by rolls or spray. It will be found that the oil penetrates much deeper along the edges than upon the surface due to the predominance of fibers parallel to the face of the sheet. The surface is then kneaded or ironed by passing through a series of heated revolving pressure rolls. The top rolls, which contact the oil treated surface revolve faster than the forward speed of the sheet and in the same direction. A peripheral speed for these rolls of about 2½ times that of the board speed has given good results, though other relative speeds can be used if desired. The bottom rolls are not heated and rotate at the same speed and in the same direction as that of the insulation board. In order to prevent slippage the bottom rolls should be knurled. This ironing action of the top heated rolls forces the oil well into the surface of the sheet and kneads the oil and fibers together to form an oil and fiber mixture of the desired depth. The surface thus becomes smoother and tougher than formerly and reinforced to an appreciable depth. A series

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of two rolls may be used as shown or only one can be used, and if necessary the board may be passed several times through the same set of rolls. The amount of this kneading or ironing action depends upon the quality desired. The usual temperature of the rolls is 350° F., though they may be heated to a temperature as high as 600° F. or more, though too high a heating may cause blotching. Various methods of heating can be used such as applying heat from a gas flame either to the inside or the outside of the roll, circulating hot oil, or electrical heating elements. The temperature of the rolls and the amount of rolling depends upon the type of heat hardenable material used for the surface treatment. If a very heavily bodied drying oil is used a higher temperature and more rolling are necessary to get the depth of material desired than with a less viscous type. It is not necessary to iron the edges forming the joints as the excess heat hardenable liquid which penetrates into this area gives sufficient toughening action.

After the above ironing or kneading action the exterior surfaces are flooded with an exterior aqueous resin-casein emulsion paint or other water type paints. This paint can be of any desirable color but an off-white appears to be preferred by the public in general. Again applicating rolls are used to insure an even film over the entire surface. This emulsion paint containing both a resin and a casein, or other protein type of binder can be readily obtained in the open market. It will be found desirable to dilute the paint before using. The following formula in parts by weight is given to guide those famaliar with the art in formulating a suitable paint for the purpose.

Vehicle:	
Bodied type drying oil	266
Oil modified alkyd resin	133
Naphthenate driers	12
Casein and alkali solvents	109
Water	587
Pigments:	
Lithopone	1700
Silicates as clays	100
Pine oil	10
Water to form a paste	470

The solvents for the casein can be an alkali such as caustic soda or ammonia used in sufficient amounts to dissolve the casein. The water is the vehicle to form the casein solution and this solution is emulsified with the oil and resin. The pigments and other powdered material along with the remaining water are then mixed in with the emulsion followed by grinding in a three roller or similar type of mill.

The board is then heat treated in an oven. During this time a hard smooth surface is formed upon the exterior exposed surface. It is important to not overbake, for otherwise a brittle film will form, which is undesirable. This surface is unexpectedly strong, smooth and tough; and it is believed that because of the kneading of the fibers and oil together there is a joint reinforcement of the surface fibers with each other resulting in a film stronger than each fiber would supply individually and stronger than would be obtained with the oil film alone without such treatment. Also the rolling or kneading action tends to aid in making the surface flexible and tough, rather than hard and brittle, which is very important for products exposed to abuse.

The time of heat treating or baking is determined by the type of oil or resin and the temperature used. This is gauged to bring out a tough resilient surface rather than a brittle one. The usual limits for baking are from 225° F. to 375° F., and from ½ to 7 hours. For example, a bodied linseed oil treated surface may be baked for 2½ hours at 300° F., and yields a tough surface. If baked 6 hours it becomes brittle which is undesirable. While in the preferred example the baking is carried out in an oven, it is possible to bake by other means such as by the application of heat from infra-red lamp or high frequency electrical heating to the surface.

It is important not to apply too much heat during the pressing or kneading by the hot rolls, especially over irregular areas, for blotching may take place during baking due to irregular blending of the two coating layers. This blending of the oil and resin emulsion films into a tough film is an important part of this invention. It will be found that this composite film, though highly resistant to weathering, will permit the passage of vapor from within the sheets to the exterior. This passage of moisture from the inside of the sheet to the exterior on the exposed face of the sheet is very desirable, as it prevents condensation or accumulation of moisture from taking place within the sheet.

It is preferred, however, to have as nearly as possible a complete vapor seal upon the inside face in order to prevent moisture from migrating from the inside of the building into the interior of the board and causing damage before it has an opportunity to pass through the semi-impervious exterior layer.

In order to obtain a substantially impervious film on the inside surface of the product of this invention a vapor barrier of several types may be used; such vapor barriers may comprise one or preferably two layers of asphalt, drying oil, or other paint products applied in such a manner as to be free from pinholes or a sheet of paper, as reinforcing may be adhered to the board with a moistureproof adhesive preferably asphalt. The paper can be applied by suitable applicating rolls to the interior, or undersurface as it is located upon the machine, shown in Figure 4. The paper is unwound continuously from the roll 28 (see Figure 4); the asphalt is then applied in a moltened condition from an application roll 24 to the paper, forming an adhesive layer as described previously. Before the asphalt cools the adhesive side is applied to the fibrous sheets. Upon cooling a strong moistureproof bond is obtained, as well as a vapor tight film. While a wide range of asphalt can be used for the purpose, an asphalt having a melting point range of between 130 to 160° F. is preferred. The exact melting point depends upon the particular purpose for which the board is to be used. It is better to use an asphalt which is somewhat soft at room temperature, since the reinforcing layer of paper, or the like, prevents it from sticking to other surfaces. Kraft or a multi-ply kraft paper sheet containing an intermediate layer of asphalt can also be applied. If desired, an asbestos paper can be laminated with consequent increase in fire protection. Any paper-like layer which gives reinforcement to an impervious film can be used, or a paper may be used which has been processed with a vapor tight coating. Also metal foils might be used. Though, if the vapor impervious film is sufficiently strong of itself no paper-like reinforcement is necessary.

An example of the effect of various surface

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treatments upon the vapor transmission is as follows:

Vapor transmission in grains per sq. ft. per hr. per 1" of mercury vapor pressure difference—

1. Unprocessed insulation board	28.4
2. Same as No. 1 but a kneaded, baked, drying oil-exterior emulsion surfacing applied to one surface following the principles of this invention	10.72
3. Same as 2, only oil painted, rather than emulsion painted	1.4
4. No. 2 in which a vapor barrier of paper and a vapor tight adhesive film is applied to the back as described above	.5

From the above table it will be observed that while the surface treatment shown in No. 2, above, is very resistant to water penetration and weathering it still will permit the passage of water vapor from the inside of the sheet to the outside. Thus the weather protection of an oil film is obtained without the disadvantage of practically complete resistance to vapor transmission as shown in No. 3. No. 4 is the finished board which is practically completely resistant to vapor penetration from within the wall yet any moisture which may be in the board itself can escape to the exterior, through the previous surface similar to 2 in the above table.

All of the pressing and application rolls are made to conform to the contour of the board, hence, projections are provided to fit into the wide groove formed in the surface of the sheets so that the treatment within the groove will be substantially the same as that over the remainder of the face of the sheet. It is preferred to use guides to engage the grooves formed in the edges of the boards to assure that the sheets follow a continuous straight path throughout the machine. The guides, of course, must open to permit the surfacing material to be applied to the edges in the vicinity of the applicating roll.

Surfacing material prepared in accordance with the principles set forth in this invention will be found to have many outstanding advantages for exterior purposes over those materials now used for the purpose. The 1⅛" thick sheets, especially in combination with the locked joint, the subject of another application, has very high rigidity, higher than that obtained by ordinary wood sheathing. In addition, the surface is already decorated so that no further painting is necessary. However, if redecorating is desired the surface is already in an excellent primed condition for either a water or oil type paint. The tough leather-like surface is very resistant to scuffing and resists the ordinary wear of exterior exposure. Likewise, it also is resistant to injury due to handling and erection. In addition to being stronger in bracing strength than horizontal wood sheathing and also presenting a decorated surface, the product also has greater heat insulating value. When used in frame construction with a gypsum lath and plaster, the wall overall heat transmission rate is .19 B. t. u. per square foot per hour per °F. compared with .25 when replaced with wood sheathing and siding. This additional insulation is sufficient for ordinary purposes in wall construction.

The sheets can be applied either vertically or horizontally. Because of its light weight much larger sheets can be applied at one time than with wood. This greatly reduces the cost of application and minimizes the problem of joints. Sheets applied horizontally can have a size about 24" by 96" while those applied vertically can be 48" wide and from 8 to 12 feet long, depending upon the height of the building.

Where properly applied and with the surface treatments forming part of this invention such sheets will withstand weathering for many years. It need not be limited only to temporary structure, but rather can form part of any permanent exterior architectural scheme. The wide, shallow, recessed bands in the board give a pleasing appearance and when used either horizontally or vertically, it breaks the monotony of a continuous smooth wall by forming a shadow line. In addition, these grooves provide nailing points so nail heads are recessed and concealed as they are somewhat shadowed and do not extend out beyond the primary wall surface.

While in the above example certain specific materials and dimensions have been named, they are given solely for the purpose of a clear and accurate description of a preferred embodiment of this invention, so that one skilled in the art in which this invention is a part may carry out this invention by the exercise of ordinary mechanical skill. Various modifications can be made, for example, various types of fibrous materials can be used to form the body of the sheet. Such materials as waste paper, bagasse, straw, hard woods, soft woods, spent pine waste from rosin extraction, licorice roots, etc., can be formed into a sheet by a variation in the process which are well known in the art. The fibers need not be formed wet, as it is possible to dry form these fibers into a sheet, preferably with some sort of an adhesive or binding material. Various waterproofing material can be used within the sheet to increase the internal water resistance, though not enough to destroy vapor permeability. The thickness can be varied greatly, but should not be less than ½". Two layers of ½" board can be laminated together in place of the preferred 3 layers of ⅜" board. A single-ply can be used, but the production cost of a thick single sheet will be greater than the ones laminated together to give the same thickness. It is possible to replace the paper on the interior face with a thin metal sheet such as aluminum. Other equivalent materials, even a smooth continuous layer of oil paint, can be used as long as there is a substantially complete barrier to vapor at this point.

While casein is used in the above example of a resin-emulsion paint, other proteins such as alpha protein derived from soya beans, as well as other vegetable proteins may be used. Also, it is not the intention to limit this invention to an alkyd resin, for other water resistant film forming material may be incorporated. In fact any type of emulsion paint can be used, for its purpose is to supply a decorative surface without a vapor impervious film being formed. Emulsion paints appear to have the property of permitting the transmission of water vapor and still give the appearance of a continuous film. This combination of vapor permeability, coupled with a continuous decorative appearance is an important part of this invention. If the appearance of the ironed oil surface is sufficient then it is possible to dispense with the emulsion paint, with consequent decrease in quality.

Another important phase of this invention is the production upon the face of a fibrous sheet, such as an insulation board, a surface which is highly weather resistant, uniform in appearance,

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but still permits water vapor to pass through. This is accomplished in part by the kneading or ironing of the oil into the fibrous surface.

By way of summary, this invention comprises a building unit suitable for exterior use and a process and apparatus for its manufacture in which a fibrous type of insulation board, preferably over ½'' in thickness and preferably trimmed along the edges to form an interlocking joint when adjacent sheets are placed edge to edge, is coated with a polymerizable or heat hardenable fluid such as drying oil on the weather, or exposed face of the sheet, as well as the edges. The coating and the fibers are kneaded or ironed together forming the face of the sheet, and an aqueous emulsion paint preferably containing an oleoresinous and a protein material is then applied to this kneaded surface followed by baking to form a tough weather resistant surface continuous in appearance, which is also pervious to water vapor. In addition a substantially vapor impervious film, preferably one reinforced with wood or asbestos paper adhered with a suitable vapor resistant type of adhesive, such as asphalt, is applied to the interior face of the sheet.

Although there has been disclosed a practical embodiment of this invention and specific examples, theories, and uses which are given to insure a clear understanding of the essence of this invention, it is not the intention to be limited thereby for obviously many variations may be made by those skilled in the art and still be within the scope of this invention which is only limited in extent by the forthcoming claims.

It is claimed:

1. An exterior insulation board unit comprising a fibrous base sheet, a smooth tough water vapor permeable weather resistant decorative surface upon the exterior exposed face of said sheet comprising a smoothened commingled mass of a heat hardenable drying oil material and the fibers of said base sheet, and a surface decorative coating of an emulsion paint over said smoothened commingled mass, said surface coating and said smoothened commingled mass partially and mutually heat interspersed into each other, and a substantially water vapor impervious film upon the interior face of said sheet.

2. The product of claim 1 in which said heat hardenable drying oil material is a polymerizable liquid of the fatty acid type.

3. An exterior insulation board unit comprising a low density ligno-cellulosic fibrous base sheet, a smooth, tough, water vapor permeable surface upor the exterior exposed face of said base sheet comprising a layer of a smoothened commingled mass of an oil having drying properties and the fibers of said sheet and a coating over said smoothened commingled mass comprising the dried film of an aqueous emulsion paint, said smoothened commingled mass and said coating being partially and mutually heat interspersed into each other, and a reinforced substantially vapor impermeable film upon the interior face of said base sheet comprising a paper sheet adhered to said base sheet with a vapor impervious bitumen film.

4. The process of producing a primed, decorative, smooth, tough, leatherlike and water vapor permeable surface upon an insulating fibrous base sheet comprising applying a heat hardenable liquid selected from the group consisting of semi-drying oil fatty acids, drying oil fatty acids, semi-drying oils, drying oils, and tall oil, to the surface of said fibrous base sheet, ironing and kneading said surface with heat thereby commingling said liquid with the fibers of said base sheet, applying an aqueous emulsion paint containing a protein and an oleoresinous material to said kneaded surface before said heat hardenable liquid has hardened and baking said treated surface at a temperature and for a sufficient length of time until a tough, leatherlike film has been formed, but insufficiently to produce a brittle film substantially as described.

5. An apparatus for producing a tough, weather resistant leather-like decorative surface upon an insulating fibrous base sheet comprising means for conveying said sheet in a forward direction, means for applying a heat hardenable fluid to the surface of said base sheet, a pair of top and bottom rolls through which said sheet is conveyed, said rolls adjustable to form substantially a uniform film of said fluid upon the surface of said base sheet, at least one pair of ironing rolls, the peripheral speed of the top roll being substantially greater than the forward speed of said sheet through said rolls and in the same direction, said top roll provided with heating means for providing heat from said roll to the surface of said sheet, during said ironing action, the bottom roll of said sheet being provided with means to grip said surface to prevent slippage and to assure passage of said base sheet beyond said ironing roll, means for applying aqueous emulsion type paint to said smoothed surface, a pair of top and bottom rolls through which said sheet is conveyed, said rolls adjustable to form substantially a uniform film of said emulsion paint upon said smooth surface, and means for baking said surface, whereby a tough resilient and substantially non-brittle layer is formed.

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