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SURFACE-LAYERED FELTED FIBER SUBSTRATE
AND METHOD OF PRODUCING SAME
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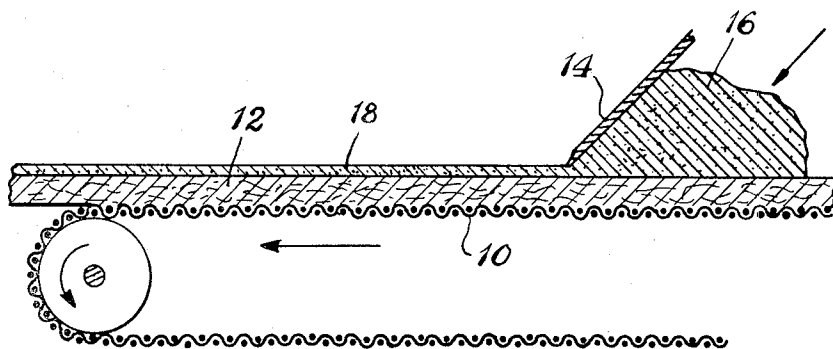


Fig. 1

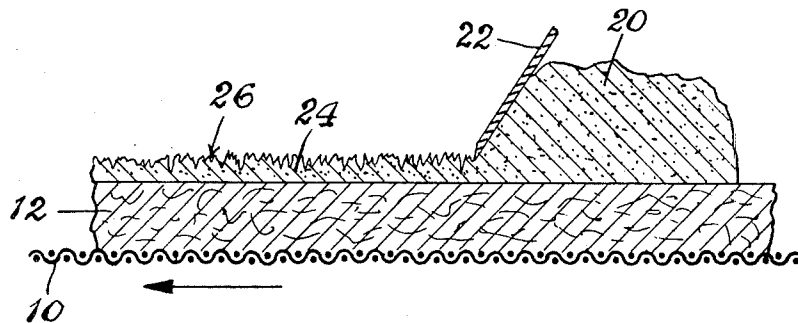


Fig. 2

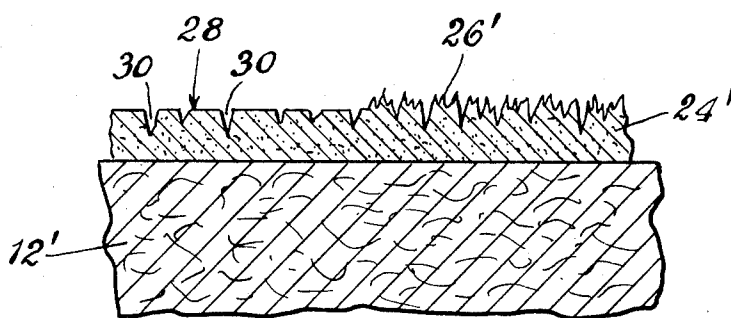


Fig. 3

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1

2

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SURFACE-LAYERED FELTED FIBER SUBSTRATE AND METHOD OF PRODUCING SAME

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**Continuation-in-part of application Ser. No. 464,083,
June 15, 1965. This application Mar. 28, 1969, Ser.
No. 839,740**

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U.S. Cl. 117—8

15 Claims

ABSTRACT OF THE DISCLOSURE

A thick overlay of paste of troweling consistency is applied to a felted substrate which substrate is either a wet board mat in process of formation or a dried felted fiberboard. Various treatments may be made to the applied layer.

This application is a continuation-in-part of my co-pending United States application Ser. No. 464,083 filed June 15, 1965 and now abandoned.

The present invention relates to rigid fiberboard panels such as are used for wall and ceiling coverings to present a functional or decorative effect.

Such fiberboard has heretofore been made of various fibers, such as vegetable fiber, or mineral fiber, or the two mixed. In continuous processes, as on Fourdrinier and cylinder machines, the dried panel has variable thickness and commonly has surface irregularities. It is also known to make certain kinds of fiberboard, especially ceiling tile or panels, in molds by drying a paste containing the fibers and binder, which are most commonly mineral fibers and gelled starch. Such paste-formed or cast products also vary in thickness due in part to shrinkage in drying. Still another practice is to mold an aqueous self-setting mineral mix, such as a magnesium oxychloride cement, preferably containing air bubbles.

For assembling multiple pieces of such products in a wall or ceiling, they must have an overall uniform thickness. To achieve this, the original product is usually made so much thicker than desired that at least some of the surface irregularities may be eliminated from one or both faces, by sanding or otherwise abrading one or both surfaces to effect a standard thickness.

Because the abraded exposable face must be free from certain defects the character of the stock for the entire body of the board must be uniformly of high quality. For example, in a synthetic mineral fiberboard, the body must be free of large shot which might be removed in abrading a face so as to leave undesired pits. Because of these possibilities, even when steps are taken to avoid them, there are imperfections in abraded faces, resulting in much unsaleable cull.

It is presently a practice to paint both mineral and vegetable fiberboard with a pigmented paint, especially to provide a uniform stable color, and to hide the color of the abraded face. The abraded face of a wood fiber panel changes color as it is exposed to light. Such paints effect no appreciable change in the thickness of the abraded board, and in general reflect the underlying texture of the board. One of the best examples of this known to applicant is disclosed in the U.S. patent to Heritage, No. 2,409,628.

In the field of mineral fiber tile, the panels formed by drying a paste in a mold present a highly favored texture, but they are brittle and fragile. Accordingly, large-sized panels are not practicable in the paste process. However, mineral fiber panels made on a Fourdrinier or like machine are of less desirable texture and stronger because of the interfelting and bonding of the fibers, with

the result that continuous wide webs are formed and then cut into smaller pieces, such as conventional sizes of 12-inch squares or 2' x 2' or 2' x 4' panels or larger, which latter are larger than are practicable in the paste process.

The molded paste-formed tile have acquired great aesthetic acceptance in the industry due to the generally randomly arranged fissures formed on their front face by proper screeding during their formation. In recent years, however, the industry has moved to the larger sizes of panels of 2' x 2', 2' x 4', and larger because of economy of manufacture of such panels and greater economy of installation. Such larger-sized panels can be readily provided by the felted fiber products produced from a very dilute slurry on a Fourdrinier or like machine because of the individualizing of the fibers and the interlocking or interfelting of the fibers during the process of manufacture. This interfelting structure gives considerable increase in strength compared to the paste-formed products. Such felted fibrous products, however, must undergo subsequent treatment to provide the aesthetic appearance desired. Platen presses using dies have commonly been pressed into such panels to provide fissures or a pattern of small depressions or other irregularities throughout the surface. Such mechanical formation of the surface aesthetic features has had less aesthetic acceptance than the molded paste-formed products which latter, however, cannot be made in large sizes.

One advantage of the present invention is the formation of the larger commercial panels having a body layer or substrate of the stronger felted form and a surface layer of a paste form, of which the brittleness is overcome by the body layer and of which the desirable texture can be exhibited by the surface layer.

Still another advantage of the present invention is the provision of a top layer upon a strong substrate, which top layer may exhibit new and different aesthetic effects other than the common fissured appearance, or may be treated to achieve such aesthetic effects without effecting the substrate and accordingly without deleteriously effecting the strength.

The present invention in its more generic aspect applies material to provide a variety of structural surface layers to a body layer. The term "surface layer" is used herein to distinguish it from the prior art covering paint, and to indicate that it is a structural part of the panel.

It has now been found that one variety of panels of the present invention may be more economically produced and the process expedited by forming an original felted body layer at a thickness appreciably less than the desired thickness of the final product. Then, without need to abrade a face of such a body layer, the body layer can be upgraded to a desired thickness and surface character by depositing thereon material to provide a structural surface layer. This may be done by applying an aqueous paste in an appreciably thick layer, not only sufficient to hide the surface texture of the body layer, but at least to a thickness sufficient to offer an exposed surface presenting, or capable of treatment to present, an appearance which is in no way visibly related to the underlying body layer on which it is applied.

The aqueous paste is such a one which may be suitably applied, as by spreading or dropping upon the body layer and, if desired, doctored to a precise level for producing uniformly thick products. However, for numerous reasons, it may be desirable to spread or to doctor the aqueous paste to a level slightly higher than required by the final product, and then after drying, to abrade to the final level or thickness.

The density and surface character of a felted body layer made on a Fourdrinier or cylinder machine, may be such that a poor bond to the surface layer can result, as for

example, when the surface of the body layer has been calendered. In such a case, it is desirable to scratch or otherwise disturb the formed surface of the felted body layer which is to receive the surface layer, so as to effect short projecting fibers to lock into the surface layer. Ordinarily, Fourdrinier felted wet mats have projecting fibers. On applying the aqueous paste projecting fibers become embedded in the inner portion of the surface layer without projecting through the surface layer, the latter being sufficiently thick to such end.

The covering aqueous paste may contain poorly feltable fibers, such as the form of mineral fiber which is used to make paste-form fiberboards; it may also contain individualized mineral fibers or ground mineral fibers or mixtures of the above. It may also be initially an hydraulic cement, or a plaster-of-paris or like gypsum paste, or a cement mix or oxychloride or oxysulfate of magnesium. These pastes may be applied to the felted body layer with or without occluded fine air cells, as a foam, or with occluded gas bubbles resulting from inclusion of a blowing agent to impart acoustical properties or decorative effects, or with a blowing agent to form gas bubbles after application to the body layer.

Such a surface layer may be doctored wet or abraded after drying to a generally uniform level. The face of the paste layer may be disturbed to produce surface irregularities of varying depths in well-known ways, such as by irregular screeding, or be suitably marked with striations inwardly from the desired dimensional thickness. A stationary doctor blade may be used or one or more rolls for effecting such a generally uniform level whether or not it contains irregularities for decorative effect.

As a result of such treatment the body layer of the board need not be of such high quality as heretofore and may be made of less refined stock, with less regard for its thickness in forming it than practiced heretofore. In the case of wood fiber, fiber bundles and so-called match sticks may be present. In the case of mineral wool, such as slag wool and glass wool, more and larger shot may be left with the fiber used to form the felted body layer.

By controlling the degree of compression of a wet mat resulting from dewatering a fiber slurry, the fiberboard base may be suitably dense for structural use, or of relatively lower density for decorative use. In the latter case, it may have sound-absorbing properties by reason of its porosity, and it may have acoustic perforations made into it before depositing the aqueous surfacing layer.

Paste-form panels are employed for decorative effect, and normally are sufficiently porous for sound-absorbency. They lack dimensional stability and strength. By producing a paste-formed surface layer on a felted fiber body layer, these disadvantages may be overcome and new advantages achieved, such as the production of a felted fiberboard with a sound-absorbing surface layer. When the body layer also is sound-absorptive, the two layers function together. Sound absorption may be provided or enhanced by punching holes in the body layer before applying the surface layer, or after the latter is completed.

Because the felted body layer of a two-layered panel of the present invention is not involved in a decorative appearance, it is possible to produce and store a quantity of such board, as basic stock. Stock from such storage may be removed and processed by applying material for a surface layer according to variable specifications, thus avoiding special and short production runs for such specifications as is currently common practice. In applying an aqueous paste to a dry body layer, the surface layer must be dried under conditions predetermined by its composition. For example, a surface layer of magnesium oxychloride or oxysulfate cement must be dried at a relatively low temperature not over about 200° F., in order not to dehydrate and destroy the cement. Other compositions such as the well-known board-forming paste mixtures of mineral fiber and cooked starch, may be dried

at elevated temperatures used for drying wood fiberboards, and starch-bonded mineral wool boards.

Accordingly, in the case of an aqueous paste for a surface layer which can be dried at such elevated temperatures, it is possible to form the felted fiber body layer by conventionally dewatering a board-forming slurry of fibers, which may be vegetable or mineral, or mixtures thereof, pressing the wet mat to a desired density, and then spreading the aqueous paste onto the wet mat. All this may be done on a continuous machine such as a Fourdrinier machine, in which the aqueous paste for the surface layer may be doctored to a smooth level, or disturbed to form irregularities of various depths and heights, for example, by irregular screeding or by use of penetrating elements positioned to form parallel striations. Then, the combined body and surface layers may be dried at the same time in an oven. The face of the surface layer may be abraded to form a panel of uniform overall thickness, whether or not it has been treated to form desirable surface irregularities.

The aqueous paste, applied to a wet mat, either in a mold or on a Fourdrinier screen, or to a dry mat, may contain additives for special purposes. One may be a fire-retardant agent such as well-known borate compositions. Another may be color agents for uniform or mottled color effects. When the surface layer is disturbed as by irregular screeding, subsequent abrasion to a predetermined thickness results in a plane face with depressions, such as fissures and holes therein of decorative value or other irregular surface effects. Depending upon the treatment (whether screeding, dimpling with bars or rolls or the like) the surface effects, though irregular may be varied, with or without subsequent abrading, to include fissures, dimples, striations, or various stippled effects varying from coarse stipples to light stippling.

Acoustical properties may be provided by controlling the character of the aqueous paste. By including large quantities of exfoliated vermiculite or of pearlite, a lightweight surface layer can be formed with high acoustical porosity.

It is well-known to whip air into plastic cements, such as magnesium oxychloride cements, as described in U.S. No. 2,702,753, so that air cells remain in the dried cement. Also, air cells may be provided by including water-insoluble volatile liquid blowing agents to gasify in drying the cement. By controlling the sizes of the liquid bodies in the paste, the size of the blown air-cells may be varied from fine to large. Such air-containing surface layers, when dried, may be abraded to a uniform level to exhibit acoustical porosity.

It is known to screed a wet board-forming fiber mat so as to disturb the surface by producing depressions and elevations, then drying the mat, and then abrading the rough surface to exhibit remaining depressions as fissures or other forms of depressions. Such practice weakens the entire felted structure of the wet mat, thereby producing dried panels weaker than would result by not so screeding. According to the present invention, the screeding disturbance is limited to the applied surface layer, which will then exhibit the depressions or elevations in the form of fissures, stipples, or the like, and the underlying fiber body layer retains its original felting, thus to produce stronger panels with such surface effects.

The invention may be practiced in numerous ways, such as those exemplified in the accompanying drawing, in which:

FIG. 1 represents a conveyed felted fiber mat, wet or dry, receiving an aqueous paste doctored to provide a surface layer,

FIG. 2 is similar to FIG. 1 in which the aqueous paste is screedable and is screeded to form an irregular surface, and

FIG. 3 shows the dried product from FIG. 2 with a portion of the screeded layer abraded to a generally level, though irregular plane.

5

In FIG. 1, a conveyor 10 is shown carrying a felted fiber mat 12, which may be a dry board or a wet board-forming mat ready to be dried. Ahead of a doctor blade 14 an aqueous paste 16 is continuously supplied to cover the mat 12 at a level determined by the doctor. The doctor blade 14 doctors the paste 16 to a layer 18 of any of said beforementioned pastes. The assembly 12-18 is allowed to dry, or dried by applied heat as the layer 18 permits.

In FIG. 2, the aqueous paste 16 of FIG. 1 is shown as a paste 20 on the wet or dry body layer 12. The paste 20 has troweling consistency which permits it to be screeded by screeding blade 22 or other screeding means, exerting a controlled drag on the paste moving under it. The presence of fibers mobile in the paste 20 is one way to control the character of the screeded surface by contributing to the drag. Numeral 24 shows the wet screeded layer with its surface 26 having elevations and depressions therein extending generally across the direction of advance. Then the assembly 12-24 is dried. A suitable screedable paste, for example, is a mixture of short mineral fibers and starch paste, such as is used to mold paste-form tiles. When fibers are mixed into a plastic aqueous paste, the technique used for paste-form tiles may be employed to prevent matting or balling of the fibers in the mixing operation.

FIG. 3, at the right, represents the dried assembly 12-24, having felted fiber core 12' and roughened surface layer 24', with irregular surface 26'. The left end of FIG. 3 shows the layer 24' abraded to a plane surface 28 to give the assembly an overall uniform thickness. As a result, some depressions remain in the plane face 28 as recesses and fissures 30.

The invention may be carried out as illustrated in the following examples:

EXAMPLE 1

A wood fiber slurry such as is used to form conventional insulation board is dewatered on a Fourdrinier screen and pressed to a density producing a dry felted body layer of 1/2-inch thickness and of 10 to 20 pounds density per cu. ft.

Onto the wet pressed mat is deposited to a depth in excess of a depth which is reduced by abrading after drying, the applied depth being about 1/8 to 3/16-inch, a paste as follows:

COMPOSITION 1

	By weight	
	Parts	Percent
Mineral fiber*-----	96	23
Water-----	269	67
Starch (gelled in the water)-----	9	2.2
Gypsum-----	31	7.4
Wax emulsion (15% wax)-----	2	0.03

*Nodulated or short lengths.

The paste-covered wet mat is dried in an oven having a temperature of 350° F. The dried board is then sanded to a uniform thickness, as by reducing the thickness of the 3/16-inch applied layer to 1/4-inch. The sanded face may then be painted with a pigmented paint composition in a conventional manner as by spraying or by roll application.

EXAMPLE 2

In Example 1, the paste-covered wet mat is passed under a screeding bar, resulting in generally parallel irregular elevations and depressions. After drying the disturbed face, it is sanded to a uniform overall thickness thus presenting a planar face with fissure-like recesses therein.

6

EXAMPLES 3 and 4

In Examples 1 and 2, the paste is changed to

COMPOSITION 2

	Parts by weight
Mineral fiber-----	500
Wood fiber ¹ -----	250
Water-----	3000
Starch (gelled in water)-----	50
Gypsum-----	100

¹ Board-forming fiber or sawdust.

EXAMPLES 5 AND 6

In Examples 1 and 2, the paste is changed to

COMPOSITION 3

	Parts by weight
Wood sawdust-----	1000
Felted wood fibers-----	1000
Water-----	2000
Pearl starch (gelled in the water)-----	120

In the foregoing composition the water content may require adjustment, due to the dryness or wetness of the sawdust and the felted fibers, to produce a paste of creamy but troweling consistency. In Composition 3 the fibers may be replaced by natural or exfoliated vermiculite, perlite, sand, and like material, with adjustment of the water content to provide a paste with a troweling consistency, as distinguished from the flowability of a paint coating composition.

EXAMPLE 7

Onto a dry felted fiber body layer, such as a mineral fiberboard of 20 to 25 pounds per cu. ft., or a wood fiberboard of 10 to 20 pounds per cu. ft., is spread a conventional or aerated magnesium oxychloride cement:

COMPOSITION 4

	Parts by weight
Calcined dolomite-----	34.3
Magnesium oxide ¹ -----	8.5
Magnesium chloride solution (10%)-----	56.4
Foaming agent ² -----	0.3
Blowing agent ³ -----	0.5

¹ Iodine No. 25-30.

² Cationic or nonionic surfactant.

³ Freon 11 (CFCl₃), B.P. 74.8° F.

Air is whipped into the composition in mixing so that small air cells are formed in part as the effect of the foaming agent. The Freon 11 is added after the air is mixed in so as to leave bodies thereof sparsely spaced as distinguished from the close minute air cells. As is known, when dealing with magnesium oxide compositions the mix must be held for a shorter or longer period of time, to a large degree determined empirically, due to the variation in the particular oxide being used and to other factors. When the mix has reached a paste of troweling consistency, it is spread to a level or doctored smooth in any manner described above. As the composition sets during a period of about 30 minutes, the Freon 11 volatilizes and forms bubbles of size much greater than the air cells. After setting the paste is dried, as in 8 hours by blowing air over it. On sanding the face, the air bubbles present easily visible recesses into the face, and the air cells present minute recesses of a generally uniform porosity to provide sound-absorbency.

EXAMPLE 8

In Example 7, the magnesium chloride solution may be changed to magnesium sulfate solution, or a mixture of the two salts may be employed.

In practicing the invention on a Fourdrinier machine, the paste for the surface layer may be produced by continuously feeding the ingredients into conventional mixing apparatus and continuously discharging the mixture onto the moving mat 12, wet or dry, as shown in the drawings.

Reference has been made herein to the need for the paste to be of a troweling consistency. This term is generally descriptive of the character and consistency of the paste used, being neither so thin as to run nor so thick as to be unworkable to produce and hold the irregular surface characteristics that may be desired. Attempts have been made to better define the consistency and character of the paste and it has been found very difficult to do. However, a standard testing procedure of the American Society for Testing Materials is useful for this purpose. This is a "slump" test having ASTM designation C 143-58. Briefly, this test uses a metal frusto-conical mold with a base 8" in diameter and a top 4" in diameter and a 12" height. The mold is open at both ends. The mold is moistened and placed on a flat, moist nonabsorbent surface and filled with the sample in a prescribed procedure and then the mold is immediately removed smoothly upwardly. The sample mound is then measured by determining the height at the center of the sample to the nearest $\frac{1}{4}$ ". This figure is then subtracted from 12" to give the slump in inches.

Compositions 1 and 2 above have been tested by the slump test above described and found to have slump values of 1.5" and 1.0" respectively which are relatively stiff. Other similar compositions with varying water contents have been used successfully having slump values as high as 11.5". It has been found, however, that compositions having slump values of 12" are too thin to permit much build-up of material on the substrate or working of the applied compositions. That is, that while some of the composition may remain on the substrate, say $\frac{1}{8}$ " or less, the reported slump is 12" and such compositions are generally too thin. On the other hand, slump values of much less than 1.0" are too stiff for ready working in commercial quantities to produce the desired surface irregularities. Accordingly, any paste having a slump value on this test of from about 1.0" to less than 12" is generally of useful troweling consistency. In some compositions, however, other factors apparently come into play which may give slump test results outside of the above range for a composition that otherwise has troweling consistency. It is not known exactly what all these factors may be; however, it is believed that with some compositions there is a chemical change (as, for example, in Composition 4 above) which is not reflected in the slump test because the mold must be removed immediately thus providing no time for the reaction to proceed. Accordingly, while the slump test is often helpful in most compositions (such as simple mixtures) which will fall in the above-described range, certain useful compositions cannot be satisfactorily described by this test. The troweling consistency required is essentially a paste that (1) permits a build-up of the composition on the substrate to a depth to be worked with a bar, roller, or like device to produce and hold irregularities without running off the substrate, while (2) not being so stiff as to preclude such working to form the irregularities.

I claim:

1. The method comprising applying surface layer of an aqueous paste of troweling consistency having a slump value of from about 1.0 to less than 12 onto the face of a board-form felted fiber body layer moving in a linear direction and thereby forming a two-layered article, and drying the applied surface layer, said surface layer being of a thickness of about $\frac{1}{8}$ to about $\frac{3}{16}$ inch whereby it is treatable to produce textured aesthetic effects without effecting the fiber body layer.

2. The method of claim 1 in which said board-form felted fiber body layer is a dried board.

3. The method of claim 1 in which said body layer is

a wet mat and in which said drying serves to dry both said layers.

4. The method comprising applying a surface layer of an aqueous paste of troweling consistency having a slump value of from about 1.0 to less than 12 onto the face of a board-form felted fiber body layer moving in a linear direction and thereby forming a two-layered article, said surface layer being of a thickness of about $\frac{1}{8}$ to about $\frac{3}{16}$ inch, creating irregularities in the upper face of said applied surface layer of paste, and drying the applied surface layer.

5. The method of claim 4 in which said board-form felted fiber body layer is a dried board.

6. The method of claim 4 in which said body layer is a wet mat and in which said drying serves to dry both said layers.

7. The method of claim 4 including abrading away at least a portion of the tops of said irregularities after drying.

8. The method comprising applying a surface layer of an aqueous paste of troweling consistency having a slump value of from about 1.0 to less than 12 onto the face of a board-form felted fiber body layer moving in a linear direction and thereby forming a two-layered article, said surface layer being of a thickness of about $\frac{1}{8}$ to about $\frac{3}{16}$ inch creating irregularities in the upper face of said applied surface layer of paste, controlling the thickness of the applied surface layer so that the two-layered article has a substantially uniform thickness, and drying the applied surface layer.

9. The method of claim 8 in which said board-form felted fiber body layer is a dried board.

10. The method of claim 8 in which said body layer is a wet mat and in which said drying serves to dry both said layers.

11. The method of claim 8 including abrading away at least a portion of the tops of said irregularities after drying.

12. A panel board comprising a rigid body layer of felted fibers, a binder for said fibers, on said body layer a surface layer of about $\frac{1}{8}$ to about $\frac{3}{16}$ inch in thickness of the solid constituents of an aqueous paste dried in situ, and said panel board having a uniform overall thickness.

13. The article of claim 12 in which said solid constituents include particulate material selected from the group consisting of mineral fibers, mineral particles, and mixtures thereof.

14. The article of claim 12 in which the outer face of said dried paste surface layer has a plurality of irregularities of varying depth.

15. The article of claim 12 in which said dried paste surface layer has a smooth outer face.

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117—126, 140; 161—164; 181—33; 162—114