

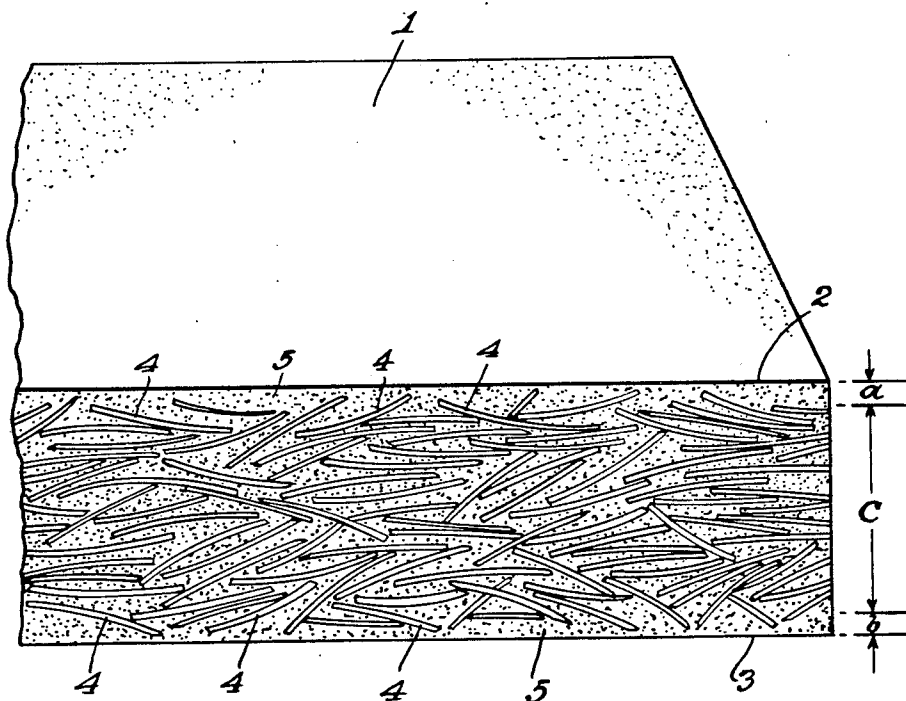
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EMBEDDED FIBER WALLBOARD

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EMBEDDED FIBER WALLBOARD

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The present invention is the result of prolonged research work aimed at overcoming some of the objections and liabilities inherent in the type of fire-resistant wallboard commonly called gypsum board, consisting of two layers of thick paper bonded to a core of gypsum. Such boards are generally $\frac{3}{8}$ -inch or $\frac{1}{2}$ -inch thick, and therefore differ in thickness from the conventional lath and plaster thickness which is about $\frac{3}{4}$ -inch.

In comparison with other types of board, such as plywood, hardboard and insulation board, the gypsum boards are relatively inexpensive, but in order to obtain a wall having a smooth, hard surface it is necessary to apply plaster to gypsum boards after application.

The paper surface is readily scuffed, and it is difficult to make a joint between board edges with a texture similar to that of the paper.

Due to the difference in the strength properties of the paper in the machine and across-the-machine direction, the strength of plaster-board across-the-machine direction of the paper may be less than half the strength in the machine direction of the paper. As such boards are normally applied with the machine direction parallel to the studding they are relatively weak in the direction where strength is most important, namely, across the studding. It would be desirable if such wallboards had the same strength in all directions.

Large-headed nails must be used to hold paper-faced gypsum boards firmly to the wood framing. Such nails disfigure the wall and reduce the value of the board for interior decoration.

Most of the strength of paper-faced gypsum boards lies in the facing sheet. If this has been broken the board has very little residual strength left. When stressed they are therefore readily ruptured, and they fail abruptly and completely. The boards in place are readily bent and are lacking in stiffness.

When subjected to a fire the paper faces are quickly burnt away, thereby exposing the gypsum core, which, upon losing its water of crystallization, shrinks and develops cracks that permit the opposite surface to heat and disintegrate.

As an embodiment of my invention, or as the result of my method, I illustrate, in perspective, with a cross-section, a part of a sheet of material produced in accordance with my invention. The showing is, in a broad sense, diagrammatic, since it is impossible precisely to show in a drawing the specific structure or variety of structure which results from the employment of my method.

With reference to the drawing, as shown, 1 generally indicates a sheet of material having opposite and generally parallel surfaces 2 and 3. The forward face of the figure is a diagrammatic illustration of a typical section. It will be understood, of course, that, in detail, the section may vary widely, but the characteristics of such a section are thought to be properly shown. It will be observed that the surface 1 is completely free of any projecting ends of fibrous material, but that a fibrous material appears scattered throughout the section. The individual fibres, for convenience, are identified by the numeral 4. The surface zones at opposite sides or faces of the sheet are indicated at *a* and *b*, and the central zone, between the zones *a* and *b*, is indicated as *c*.

Stated briefly, my product consists of a binder, generally indicated as 5, in which are embedded short, strand-like fibres of wood, as indicated at 4. In the surface zones *a* and *b* the volume of the binder 5 exceeds the volume of the fibres. In the central zone *c* the volume of the fibres

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preferably exceeds the volume of the binder. The concentration of the binder increases progressively from the boundaries of the zone *c* to the surface of the board, but many of the fibres of the zone *c* extend into the zones *a* and *b*, there being no exact or rigidly outlined separation between the two zones. As will be clear from the drawing, the average angles of the fibres in the zones *a* and *b*, relative to the plane of the board surface, is less than 45 degrees. Note, also, that, preferably, as shown in the drawing, the thickness of the zone *c* exceeds the sum of the thicknesses of the surface zones *a* and *b*.

In boards made in accordance with my invention the fibres are preferably relatively straight, as contrasted, for example, to the curly excelsior fibres, and they are substantially shorter than excelsior fibres. I employ strand-like wood shavings in which the botanic fibres of the wood are substantially parallel to the surfaces of the shavings throughout the length of the shavings. The length may vary, but I prefer a length of $\frac{1}{2}$ inch to 6 inches, with the width of the shavings preferably very much less than their length. These shavings, for example, may be employed in strands of $\frac{1}{100}$ inch thickness. For the tests below set out I selected Ponderosa pine for the shavings, the sawdust and for what I call the "shaving strands" of the present invention. Comparable low density woods were used for the other fibres.

As a binder I may employ any suitable inorganic cement. I may employ, for example, a matrix of gypsum, but my method is applicable to binders other than gypsum.

In manufacturing my board it will be understood that the binder may be completely opaque, or, if desired, may be partially translucent, or even approach transparency when in a thin layer. Thus the fibres in the surface layers *a* and *b*, which approach but do not reach the surface of the board, may, under some circumstances, be visible through the matrix or binder, or may be traceable by a slight discoloration of the binder or matrix by solubles in the wood of which the fibres or shavings are made. It will be understood that I do not wish to be limited to any specific method of making fibres or shavings, and, in fact, an important purpose of my invention is to permit the use of fibres or shavings which are byproducts. I may employ, for example, such shavings as are produced by a rip-saw tooth of a large saw. The shavings produced by shingle saws may be used advantageously. In considering advantageous materials for my purpose, short, narrow ribbons of wood, not necessarily flat, are advantageous, and may be an inch or more in length, but much shorter than the long, curly strands of excelsior.

A substantial advantage of the board of the present invention includes the fact that the cost of the materials comprising the new board is less than the cost of those used for conventional gypsum boards. The new board is therefore superior to ordinary gypsum board in the following respects:

1. The surface is hard and smooth, and it will not scuff. While wallpaper cannot be removed from ordinary gypsum board without damaging the board surface, the new board acts like a conventional plaster wall in this respect, and old wallpaper can be readily scraped off.

2. Any crack filling that may be required at the joints can be done with a filler similar in hardness and appearance to the board surface so that the change in texture at the joint associated with ordinary paper-faced gypsum board installations is eliminated.

3. The strength properties are the same lengthwise as across the board.

4. Nails with much smaller heads can be used for applying the board, and there is no dipping in of the board around the rim of the nail head; hence, the disfiguring effect of the nails used for applying wallboards is greatly reduced.

5. Fibrous facing sheets are not necessary for strength, and as the composition of the board is substantially the same throughout its thickness, it is not liable to surface injury which would weaken the board.

6. It is stronger and much more resistant to breakage in place, and will absorb a much greater blow than paper-faced gypsum boards.

7. It is much stiffer and therefore deflects much less under a push applied to the wall between studs.

8. It is more fire-resistant than paper-faced gypsum boards.

9. The combined materials cost of the new board is substantially less than that of the paper-faced gypsum boards.

The elimination of the paper facing of conventional gypsum boards and the results described above were achieved by the use of a new strand-like shaving perfected by the inventor, which can be used not only in combination with gypsum but also with other types of inorganic binders, such as Portland cement and magnesite cement, with substantially the same results. The improvements listed are particularly striking when a substantially non-porous board is made in which the binder serves as a matrix to fix the dimensions and surface of the board, and the fibers are interspersed in the matrix.

While the art of combining inorganic binders, such as cement with sawdust and shavings, is old and the art of combining excelsior with the same binders is a well-established practice for the manufacture of porous fibre-boards, no one, to my knowledge, has ever developed a successful solid, non-porous board to date, because no board made with currently known wood particles or fibers has the necessary physical and strength properties which would make it competitively superior to other boards on the market and, in particular, superior to conventional gypsum boards.

While strong boards can be made of excelsior fibres when they are compacted under pressure with a suitable binder, it is, for all practical purposes, impossible to disentangle the long, curly excelsior fibres and then to distribute them evenly in a form so that the resultant board will be of uniform density. Moreover, the cost of cutting excelsior fibres is competitively prohibitive.

On the other hand, while boards of uniform density and relatively uniform surface texture can be made when certain wood granules, such as fine sawdust and shavings, are used, the mechanical properties of the resultant boards are so deficient that they have no commercial value.

Certain special fibres, such as those obtained by the Asplund process of debibration, and fibres cut on a MacMillan machine, as well as mechanical and chemical paper pulp, have been suggested from time to time, but all boards made with these lack the necessary strength in competition with established products.

The following table gives the results of strength tests made on 3/4-inch boards in which three parts of gypsum, by weight, were combined with one part of fibre, and the same quantities were used for all boards. The surfaces of all the boards were faced with a thin layer of gypsum to obtain perfect smoothness. The tests were made on specimens 5 inches wide and 12 inches long, supported on a span of 10 inches and loaded progressively with a center load. Load-deflection curves were plotted, and the area under these curves was measured to obtain the work done to produce complete failure. The latter measures the toughness of the board and its ability to absorb a blow.

Type of fibre in board	Maximum load in pounds	Toughness in inch-pounds
Sawdust, 20 mesh	40	0.5
Shavings, fine	50	1.6
MacMillan fibres	67	10.9
Asplund fibres	25	2.0
Shaving strands of the present invention	163	39.0

It will be seen from this table that the boards made with the shaving strands are several times as strong as those made with any of the other fibre types, and that they are about ten times as tough as the average toughness of the other boards.

Careful analysis of the results showed that thorough mixing of the Asplund fibres to obtain complete separation and coating of all the fibres is difficult to obtain. Such fibres tend to clump in tufts. Sawdust particles are short and broken granules lacking in fibre strength but readily lending themselves to even spreading and coating. Shavings and MacMillan fibres have a common characteristic which apparently reduces their strength in comparison with the shaving strands, a characteristic of all shavings produced by a rotating cutting edge, namely, weakness due to the fact that the direction of the knife

cut in the arc of the shaving is seldom more than in part parallel to the direction of the botanical wood fibres of which the shavings are composed. Most of the cut is diagonally across the grain of the wood fibres, with the result that the full strength of the wood is lost. This is less true of the MacMillan fibre, on account of the larger radius of the swing of the cutting edge, and, as will be seen from the data, the resultant MacMillan fibre-boards are also stronger than those made of ordinary fine planer shavings. I have found that, for maximum strength, the cut must be substantially parallel to the botanic wood fibres throughout the strand length, and that the average length of the resultant strand-like shavings must be at least 1/2 inch. The shaving strands should preferably be straight in order to obtain uniform reinforcement and distribution, and they should preferably be very thin to obtain a good bonding area for a given weight of fibres. Such strands have practically the full tensile strength of the wood, which ordinary shavings do not.

Excessively long strands also result in non-uniformity. An average length greater than 6 inches should be avoided. Strands 1/100-inch thick, with parallel surfaces, give good results. The edges of the strands need not be parallel.

Various ratios of binder or matrix weight to strand weight may be used, ranging from about 2 to 1 up to about 10 to 1. On account of greater facility of cutting the resultant board, and its lightness, the lower ratios are preferred for boards intended for interior use. Boards having Portland cement as the matrix, and intended for exterior use, where they are exposed to the weather, are preferably made with the higher ratios.

The following table shows the results of tests made to compare the strength and stiffness of the gypsum shaving strand board with ordinary gypsum paper-faced board of about the same thickness:

Transverse test

[Zest specimen 3" wide tested on 4" span. Ordinary gypsum board tested across the grain of the paper facings (as applied to studding).]

Product	Weight in pounds per square foot	Thickness in inches	Maximum load in pounds	Stiffness, lb./0.01" deflection	Toughness in inch pounds
Gypsum strand board; No paper facing	2.04	0.45	180	130	15.4
Ordinary gypsum board; Paper-faced	1.70	0.37	40	15	3.1

Tests were made to compare the fire resistance of the gypsum strand board with conventional paper-faced gypsum board. Specimens 3 inches wide were supported on a 5-inch span with a small center load of less than 1 pound, and a broad Bunsen burner flame was allowed to play on the bottom of the specimen directly under the load. The time required for collapse to take place was noted. Ordinary paper-faced boards collapse in this test in less than 4 minutes, whereas the gypsum strand boards hold up for 13 minutes.

Tests were made to determine the resistance of the boards to the pull of nails, by measuring the force required to pull a nail down into the board to submerge the nail head. The pull in pounds is given in the following table.

Product	4d Box Nail Head Diameter = 0.21 inch	Cadmium Coated Nail Head Diameter = .095 inch
Gypsum strand board	302	86
Ordinary gypsum board	83	35

Thus the gypsum strand board of the present invention can be applied with a much smaller headed nail, eliminating disfigurement, and obtaining, meanwhile, the same holding strength as is obtained with the large headed nail used with commercial paper-faced gypsum board.

I also obtain a cost saving. The shaving strands produced in a machine built for the purpose cost only about one-sixth as much per ton as the thick paper faces used for ordinary gypsum boards. The cost of all materials per square foot of board is substantially less than the

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total cost of the materials that go into ordinary gypsum boards.

It will be realized that whereas I have described a practical and operative embodiment of my invention, nevertheless many changes may be made without departing from the spirit of my invention. The species of the strands and their length and width may be widely varied. They may be made of various woods. The inorganic binder or matrix in which the fibres are embedded may be of a wide variety of materials. The thickness of the board and also the thickness of the smooth plaster coating may be varied. Some variation in density may be tolerated without deviating from the spirit of the invention. Whereas an advantage of my invention is that a paper covering or outer layer is unnecessary, I may still find it advantageous for manufacturing to apply a paper coating to one or both exterior surfaces. It will be understood, also, that I may make my board by a variety of methods, as by continuous pressing between moving belts, or by means of stationary plate pressure. Nor do I limit myself to any particular method or mechanism for producing the strands themselves. However, it is essential that the strands be cut with the botanic fibres substantially parallel to the surface of the strands themselves throughout their length.

It will be understood that when I employ the term "cement" I wish it to be interpreted with sufficient breadth to include any inorganic binder, including those which set due to the formation of crystals from a supersaturated aqueous solution, for example, Portland cement, gypsum and magnesite cement.

This application is a continuation-in-part of my application Serial No. 218,862, filed April 2, 1951, for "Embedded Fibre Wallboard," now abandoned.

I claim:

1. A nonporous wallboard structure having a body formed of a relatively solid, nonporous matrix of a material selected from the class of inorganic cements including gypsum, Portland cement and magnesite cement, said matrix having a plurality of wood strands embedded therein, each strand having the botanic fibres thereof substantially parallel to the surfaces of the strand and generally parallel to the strand length, the weight of said matrix exceeding the weight of said strands, the length of the strands, on an average, exceeding one-half inch while being less than six inches.

2. A nonporous wallboard structure having a body formed of a relatively solid, nonporous matrix of a material selected from the class of inorganic cements including gypsum, Portland cement and magnesite cement, said matrix having a plurality of wood strands embedded therein, each strand having the botanic fibres thereof substantially parallel to the surfaces of the strand and generally parallel to the strand length, the weight of said matrix exceeding the weight of said strand, the length of the strands, on an average, exceeding one-half inch while being less than six inches, and the width of the strands, on an average, being substantially less than their length.

3. A nonporous wallboard structure having a body formed of a relatively solid, nonporous matrix of material selected from the class of inorganic cements includ-

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ing gypsum, Portland cement and magnesite cement, said matrix having a plurality of wood strands embedded therein, each strand having the botanic fibres thereof substantially parallel to the surfaces of the strands and generally parallel to the strand length, the weight of said matrix exceeding the weight of said strands, said body portion having opposed generally parallel surfaces, said body portion having a central zone and surface zones adjacent said surfaces, said strands in said surface zones being inclined to the planes of said body portion surfaces at an average included angle less than 45 degrees, the length of the strands, on an average, exceeding one-half inch while being less than six inches.

4. A nonporous wallboard structure having a body formed of a relatively solid, nonporous matrix of a material selected from the class of inorganic cements, including gypsum, Portland cement and magnesite cement, said matrix having a plurality of wood strands embedded therein, each strand being substantially straight and having the botanic fibres thereof substantially parallel to at least one surface of the strand and generally parallel to the strand length, the weight of said matrix exceeding the weight of said strands, said body portion having opposed generally parallel surfaces, said body having a central portion in which the volume of the strands exceeds the volume of the cement, and outer portions near the surfaces in which the volume of said cement exceeds the volume of said strands, the length of the strands, on an average exceeding one-half inch while being less than six inches.

5. A nonporous wallboard as set forth in claim 4 wherein at least one face of the wallboard is surfaced with a thin layer of cement completely free from fibres.

6. A nonporous wallboard as set forth in claim 4 characterized by and including one surface of the wallboard having a thin layer of cement completely free from strands, some of said strands extending with sufficient proximity to said surface that they are visible through said surface.

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