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ACOUSTICAL AND FIRE RESISTANT COMPOSITION FIBER INSULATING BOARD

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My invention relates to light, porous products which are molded or otherwise formed from fibrous materials and which are especially adapted for thermal insulating purposes and for the absorption and dissipation of sound. More particularly, it relates to products of this character which are highly resistant to fire and to the structural disintegrating effects of high temperatures.

There are at present available very efficient sound deadening and absorbing media formed from wood or mineral fibers, bagasse, etc., which are more or less loosely felted into panel boards on blocks to provide for the formation and retent therein of as many dead air cells as possible.

Due to the difficulty in producing, by any of the present "felting" processes, a board or block of sufficient porosity to function efficiently as a sound absorbing medium, it has been usual to increase their porosity by perforating them with as many small holes as possible. Some of these products, particularly those composed of vegetable fibers, are in no sense fire proof and are only slightly fire resistant. This is true irrespective of the nature of the bonding material which maintains the fibers in structural sheet or block form. Furthermore owing to their very nature and the inadequacy of the equipment upon which they are produced to form a super-porous product, most of these "felted" sheets or boards are not wholly efficient thermal insulators.

The science of acoustics as applied to the correction of sound distortion so common in both large and small rooms discloses the fact that these acoustical defects are due very largely to the inadaptability of the walls and ceilings to absorb sounds which are thus kept in reverberation by being reflected therefrom. I have found that an ideal acoustical material which can be used for covering such surfaces should, in addition to being highly porous, have a rough, irregular or rugose surface and be of a more or less yielding or cushion-like character which will effectively absorb and deaden, rather than reflect, sound waves coming in contact therewith. From an acoustical standpoint, these qualities of maximum sound absorption and minimum sound reflection are the most important features of my invention. In addition it is extremely desirable that such material be substantially fire-proof and that the surface thereof which is exposed to view be susceptible to ornamental treatment without impairing its acoustical or fire-proof characteristics.

The primary objects of my invention therefore are to produce a light, porous product of the character described which will function efficiently not only as a sound absorbing medium, but also as a thermal insulator and which, in addition, will be substantially fire proof and resistant to the structural disintegrating effects of heat of the order generated in house or building conflagrations. Another object is to provide a product of this character which is ornamental as well as utilitarian.

In the preparation of my products I use an aggregate preferably composed partially of mineral fibers and partially of vegetable fibers. The vegetable fibers before being intermixed with the mineral fibers are first treated with a suitable substance whereby they are eventually rendered water proof and highly fire resistant.

While it is to be undestood that my invention is in no sense limited to any particular kind of vegetable fibre, I prefer to use waste fibers of soft wood known as pulp screenings. These vegetable fibers are first subjected to an appropriate treatment, such as described in my copending application Serial No. 703,846, now Patent No. 2,122,192 issued June 28, 1938 whereby they are coated and to a slight degree impregnated with asphalt, and thereafter are given a second film-like coating of mineral matter. The fibers are first thoroughly agitated and mixed in a suitable container with a hot water mixture of asphalt emulsion in a quantity at least sufficient to effect a complete coating of each fiber. The asphalt coated fibers are then super-coated by intermixing therewith colloidal clay of the nature of bentonite, preferably intermixed with water to form a plastic mixture of suitable consistency. With these fibers of soft wood thus pre-treated, and while they are still in a suitable water-wet plastic condition, I intermix a quantity of short waste mineral fibers such as asbestos, keeping the whole suitably plastic by the addition of water if necessary. To this combined fiber mixture I next add an additional quantity of dry colloidal clay, of the character of bentonite, and thoroughly mix the same with the fiber aggregate. Bentonite has the peculiar property of expanding in water to many times its normal volume, and the incorporation of this additional bentonite is not for the purpose of further coating the already pre-treated fibers, but for the purposes of keeping the fibers well separated as it expands, and thereby forming a rugose surface on the finished dry product, and serving as a binding material which imparts additional structural strength thereto. The colloidal clay also assists

to a great extent in keeping the fiber mixture from matting in the molding operation.

Following the addition of the bentonite, I next add a quantity of asphalt emulsion (water paste basis) and intermix it thoroughly with the other ingredients.

The plastic mixture prepared as pointed out above, or any modification of it will not produce the highly porous, cellular structure required in my product without the addition of some suitable material which will function to prevent the product from becoming too hard and dense in the finished, dry state. In order that the finished product may be of extremely low density, I have developed for incorporation therewith a material of fairly stable frothy consistency which will remain in a spumous or "bubble" condition during the forming and initial drying and hardening thereof, and thus produce therein innumerable dead air cells.

While it is to be understood that I am in no sense limited to the precise proportions hereinbelow set forth, because it is only necessary to provide an aerated binder of fairly stable consistency, the following will give very satisfactory results:

Asphalt emulsion (water paste basis)	grams	40
Rosin size (water soluble)	do	50
Water	cc	1000

The asphalt emulsion and the rosin size are thoroughly mixed with the water and then, by suitable mechanical agitators, the mixture is beaten or whipped into a light aerated froth which, in turn, is added to and thoroughly intermixed with the plastic mass to bring it to a highly aerated condition. Because of the nature of the materials employed therein, the emulsion and rosin size mixture remains in a highly aerated or spumous state not only during its incorporation with the plastic fibrous mixture, but during the rolling or molding operations and throughout most of the period while the product is in the drying ovens. Due to the eventual breaking down of these froth bubbles and the gradual shrinkage of the particles of bentonite in the process of drying, countless voids are formed in the product which accounts for its extreme lightness and porosity.

A typical formula which I have used to produce my invention is as follows:

Soft wood fibers pre-coated with asphalt and colloidal clay (dry basis)	grams	150–200
Waste asbestos fiber	do	700
Bentonite colloidal clay (dry basis)	do	150
Asphalt emulsion (water paste basis)	do	25–50
Asphalt emulsion-water-rosin aerated froth	cc	400
Sufficient water to form a suitably workable plastic.		

It is to be understood that the proportions given in the above formula, and those given below, may be varied considerably. Obviously, the fire resisting characteristics of my product will vary with the proportion of its combustible content, such as the vegetable fibers, and the proportions of the mineral and vegetable fibers may be varied in accordance with the requirements of any case.

Some of the physical characteristics of my product, such as its fire resistance and its coefficient of heat transmission, may be varied by the incorporation therein of other elements, and this without substantially impairing its properties as a sound deadening medium. For example, calcined diatomaceous earth may be incorporated therein with a marked improvement in its fire resisting characteristics.

The following is a typical formula including the last mentioned addition:

Soft wood fibers pre-coated with asphalt and colloidal clay (dry basis)	grams	150
Waste asbestos fiber	do	700
Bentonite colloidal clay (dry basis)	do	150
Calcined diatomaceous earth (passing 200 mesh)	do	200
Asphalt emulsion (paste basis)	do	50
Asphalt emulsion-water rosin aerated emulsion	cc	800
Sufficient water to form a suitably workable plastic.		

Where an extremely light product, or a product having a highly rugose surface is desired, this result can be attained by incorporating in the plastic mixture a small percentage of expanded Vermiculite granules. This mineral when heated, like the colloidal clay when wet, has the peculiar property of expanding to many times its ordinary volume. When expanded it is extremely light and has a very low coefficient of heat conductivity. By incorporating 400 grams of expanded Vermiculite in either of the above formulae the product is improved to the extent that it can successfully withstand direct heat of a relatively high order without any undue structural breakdown.

From the foregoing compositions a comparatively large variety of products may be made, and I find that wide variations in the characteristics of these products can be obtained by slight variations in the procedure employed.

I prefer to form my finished products by molding them from any of the plastic mixtures given above although it is to be understood that these mixtures may be rolled out into shape with suitable equipment provided no such excessive pressure is exerted in the rolling operation as will effect a breaking down of the aerated "bubble" structure. In making a molded product, the plastic material is discharged into a bottomless mold which rests upon a smooth, oiled steel sheet. The material in the mold may be leveled off with a suitable screed or roller. The skeleton mold is then removed and the formed plastic sheet or block is immediately placed in a suitable drying oven where it is left until it is dry and hard. When the molded sheet or block is permitted to dry in contact with the smooth, oiled steel plate, the surface in contact with the plate becomes quite irregular or rugose. Furthermore, this surface is apparently covered with a very thin film which although quite pervious, nevertheless appears, for the most part, to be substantially continuous and unbroken. Portions of the sheet or block in contact with the oiled plate shrink irregularly away from the plate in the drying process and the rough wrinkled surface not only has a particularly pleasant ornamental apearance, but its rugosity adds appreciably to its acoustical value. Where a fine wire mesh screen (say 900 to the square inch) is substituted for the smooth, oiled plate, and the sheet or block is permitted to dry in contact therewith, no such rugosity of the surface is obtained, but instead, a surface having a smooth,

unbroken texture. By drying in contact with a screen a more closely felted structure is obtained, and although extremely light and highly porous, the air cells therein appear to be much smaller than is the case where the product is dried in contact with the oiled plate. For these reasons a product having an extremely low coefficient of heat conductivity is produced. When the modified formula containing diatomaceous earth is employed the resulting fiber board is not only fire proof to all ordinary temperatures of house conflagrations but at the same time possesses high acoustical and sound deadening properties.

That my products are substantially fire proof is evidenced by the fact that when subjected to prolonged applications of direct heat at temperatures running well over 900 degrees F. no structural disintegration is noted although there may be a slight carbonization extending from the exposed surface partly through the cross section. It should be noted, however, that the thermal insulating properties of the product are substantially improved by the application of such high heat, due to the partial carbonization of the non-mineral fibers in the product whereby the number of voids is increased.

If desired for ornamental, heat reflecting or other purposes, my products may be coated with a film of aluminum or other lacquer which will be found to adhere very tenaciously thereto.

While I have described my invention in its preferred embodiments with considerable detail, it is to be understood that the words which I have used are words of description rather than of limitation and that changes within the purview of the appended claims may be made without departing from the true scope and spirit of my invention in its broader aspects.

By the expressions "composed principally of fibrous material", and "the principal constituent of said product being fibrous material", as used in the claims, I mean that the weight of the fibrous material in the product substantially exceeds the combined weight of all the other ingredients therein.

What I claim is:

1. Those steps in the method of making a low density, molded porous product of the character described adapted for use as a heat insulating and sound absorbing medium which comprises precoating vegetable fibers with an asphalt emulsion, intermixing bentonite therewith in a quantity at least sufficient to coat the asphalt covered fibers, intermixing mineral fibers with the coated vegetable fibers, intermixing therewith additional quantities of bentonite and asphalt emulsion and water sufficient to form a plastic composition, and thereafter adding and intermixing a sufficent amount of an aerated mixture of asphalt emulsion and size to reduce the composition to a light, fluffy consistency.

2. The method of making a light, porous product of the character described adapted for use as a heat insulating and sound absorbing medium which comprises forming a water plastic mixture from an aggregate comprising principally fibrous material, incorporating with said plastic mixture expanded vermiculite and a binder of frothy consistency adapted to maintain its spumous condition during the forming and initial drying-hardening of the product, and then molding the product from said plastic mixture.

3. A light, porous, board-like product of the character described adapted for use as a heat insulating and sound absorbing medium and composed principally of fibrous material of which a major portion is mineral fiber and a minor portion vegetable fiber; said board also containing calcined diatomaceous earth, and a binder of bentonite, asphalt and size.

4. A light, porous, board-like product of the character described adapted for use as a heat insulating and sound absorbing medium and composed principally of fibrous material the major portion of which, by weight, is mineral fiber and a minor portion vegetable fiber; said product also containing expanded granules of vermiculite and minor proportions of bentonite, asphalt and size as a binder for said fibers.

5. A light, porous product of the character described adapted for use as a heat insulating or sound absorbing panel board and composed principally of fibrous material the major portion of which, by weight, is mineral fibers; said product also containing expanded granules of vermiculite, calcined diatomaceous earth, and a binder of bentonite, asphalt and size.

CLEMENTS BATCHELLER.