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COMPOSITE SHEET MATERIAL.

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My invention relates to the construction of fibrous sheet material, and has for its principal object the provision of a composite sheet material, fire resistant, mechanically strong, and better adapted to roofing purposes than the asphalt-impregnated asbestos roofing material which is now and has been heretofore, very extensively used.

While the principal utility of the sheet material herein described and claimed is believed to be in roof covering, the use of the term "roofing" is intended to include and connote any use of the described material as a protective covering.

The composite of asbestos fibre roofing paper and an asphalt impregnant possesses in fair measure the qualities required for fire resistant roof coverings, but is subject to sundry inherent limitations which have heretofore imposed limits to improvement. The fibrous body, composed of asbestos fibres felted together in a paper-machine, contributes indispensable heat resisting qualities, but is inferior in strength and capacity to resist puncture or endure abrasion, as contrasted with wool felts, which, however, though used for roofing and sheathing purposes, are not sufficiently resistant to heat to meet the stipulated specifications for many structures. Both wool felts and asbestos felts or papers have for a long time been impregnated with asphalt which acts as a binder for the felted fibres, strengthens the sheet, and is to an inferior degree fire-resistant.

In the case of asbestos-fibre felts and papers of sufficient hardness to remain solid, but ductile and flexible, at normal temperatures, however, as heretofore made, the quantity of melted asphalt which can be absorbed is limited. Asbestos roofing papers or felt, of the usual quality, will, when immersed in melted asphalt at about 400° F. (at which temperature asphalt of suitable quality is freely fluid) absorb not much m re than thirty per cent. (30%) of the weight of the felt. This maximum absorption is reached after about two minutes immersion, and extension of the immersion time does not substantially increase the amount absorbed. Close study of the physical conditions which produce this limitation of absorptive capacity of an asbestos-fibre felt or paper leads to the conclusion that it is due in part to the surface-characteristics of the asbestos fibres themselves, and in part to the intimacy with which these fibres, when felted in the paper machine, compact themselves together. The space available for occupation by an impregnating liquid is that afforded by, or consisting of, the voids between the assembled fibres. In asbestos felt or paper the fibres apparently lie snugly together, and leave comparatively little available space or voids; as contrasted, for instance, with a wool-felt, wherein the curly fibres when matted together, and even when "fulled" or compacted by shrinking, have between them relatively large voids. Moreover, asbestos fibres are, individually, of such surface characteristics that they resist wetting by a liquid. Were there a strong surface attraction for fluid asphalt manifested by asbestos fibres, immersion of an asbestos felt or paper in hot, fluid asphalt would be followed by a swelling of the felt, an increase in the voids between the solid fibres, due to induction of liquid by surface, or capillary action.

The limitation of the quantity of impregnating binding material which can be absorbed by an asbestos sheet is and has been a limitation imposed on its strength and durability. As the principal object of the invention herein described is to increase the strength and durability of protective sheeting, while conserving fire-resistant qualities, and the means to attain this object being an increase in the asphalt absorption capacity of an asbestos felted sheet, it follows that the object is to be attained by a mode which increases the voids or spaces between the asbestos fibres, provided this does not involve any substantial degradation of the fire-resistant property of the felted sheet.

I have attained this object, and my invention is characterized by, the incorporation with the asbestos fibres of a felted sheet, of a sufficient number of stiff, elastic, hair-like bodies, which hold the asbestos fibres from each other, loosen or expand the felted body and thus increase the ratio of interstitial space to space occupied by asbestos fibres. Since the object is to render the asbestos felted sheet more absorptive of fluid asphalt, these stiff, elastic, hair-like bodies should be so constituted that they will resist temperatures of the order of 400° Fahrenheit, without decomposition or material alteration.

These hair-like bodies may be of material in itself inferior to asbestos in the quality of heat

resistance, without degrading the heat resistant quality of the felted sheet as a whole, provided they be not used in too large proportion.

The material which I have found to answer my purpose best, and in the most practical manner, is the hair of neat cattle. These fibres in lengths not much exceeding a half inch, are stiff, springy bodies; do not curl or kink, do not tend to collect together in knots or balls, and distribute themselves uniformly through the asbestos-fibres, both in the beater and cylinder machines; so that an asbestos fibre felt, with cattle hair incorporated in it, is of uniform structure throughout.

The improvement attained may be qualitatively and quantitatively estimated by the following comparison.

A standard asbestos roofing paper weighs ten pounds per one hundred square feet. Its average thickness is twenty thousandths of an inch. By Mullen test it shows a strength of 10 pounds. Immersed in asphalt at 400° F. for three minutes, it will absorb 3.5 pounds of asphalt per 100 square feet, and no more. After impregnation it shows a strength of twenty pounds by Mullen test. When a paper is made, composed of asbestos fibre 85% and cattle hair 15%, the whole weighing when finished and dry, ten pounds per 100 square feet, this asbestos-hair paper has an average thickness of 27 thousandths of an inch, and strength, by Mullen test of 17 pounds. Immersed in asphalt at 400° F. for two minutes, it takes up 5.2 pounds of asphalt per 100 square feet. And if left immersed in the hot asphalt for eight minutes, it takes up 7.5 lbs. of asphalt for 100 square feet. Impregnated to 5.2 lbs. of asphalt, its strength by Mullen test is 37 lbs.

The increase in thickness, due to the incorporation of the stiff and elastic hairs, demonstrates that the sheet as a whole is of looser texture than that of plain asbestos fibre. The increase in the volumetric capacity of the voids between fibres, accounts in large part for the larger absorptive capacity of the sheet. In some measure, the surface-characteristics of bodies of which stiff hairs are representative, contributes to the absorbtive capacity of the sheet as a whole, since these bodies, being susceptible to wetting by a liquid like melted asphalt, serve as points of induction of the liquid and promote its penetration into the felted structure, whereas asbestos fibres are indifferent or even repellant, to such liquid.

The practical maximum absorption of asphalt is not far from the 52% on the weight of the felt, obtained by a two minute immersion in hot asphalt. If more than this ratio is allowed to go into the paper, it is liable to cause sticking of one layer to another in the rolls in which such material is shipped. Less than this proportion reduces the valuable qualities of the impregnated paper toward those of the asphalt-impregnated asbestos paper heretofore made and used.

Fire-tests on asbestos-and-cattle-hair paper, show that this composite felt endures the standard tests as well as plain asbestos paper of the same weight, until the proportion of hair exceeds 15% of the weight of the paper. This degradation of fire resistance is not serious until the hair reaches about 60% of the weight of the paper. As 15% of hair produces an asphalt absorption up to, and even beyond, the practicable degree without degrading the fire-resistance, it is recommended as a proper proportion.

The above mentioned demonstration of the increase in the content of an asphalt or similar substance, by a fibrous structure comprising asbestos fibres in large part, shows a qualitative difference between my new article of manufacture and the previously produced asphalt-treated asbestos paper or felt, to be the reception and retention in the felted body, of a proportion of asphalt large enough to exude from the body on the application of heat. The instrumentality by which this increased receptiveness and retentiveness of the felted material is secured, is, as described, the incorporation with mineral fibres of interspersed material which loosens and opens the texture of the general fibrous aggregate, increasing the volume of the voids between fibres; if as in the case of cattle-hair, this interspersed material is more capable of being wetted by the absorbed liquid than the mineral fibres, the composite felted material becomes more bibulous.

In addition to the increase in strength and resistance to wear, afforded by the high asphalt-absorptiveness of the composite fibrous felt above described, other and further advantages accrue. Roofing paper of the general type to which this invention relates, is frequently laid in several superposed layers. First, the roof base is coated with hot asphalt and the asbestos-asphalt roofing paper laid on the coating while the latter is still hot and fluid. When the first layer of roofing paper is thus laid, another is placed on it, the first layer being liberally coated with hot asphalt and so on.

With the asphalt-impregnated asbestos paper heretofore used, which contains not over 35% of asphalt on the weight of the paper, the heat of the asphalt coatings does not bring out any asphalt from the paper. This may be tested by applying a flame to the surface of a piece of such roofing paper; no asphalt comes out of the paper, there is not enough in the paper to exude. Therefore, when such roofing paper is laid on a coat of hot asphalt, the asphalt coat will not soak into the paper, which has already absorbed its maximum; nor will the asphalt in the paper come out to unite with the hot

coating. The asphalt coatings act adhesively, but when a laminated roof covering of the character described is tested by pulling one sheet away from its neighbor, the separation is made easily, and except for spots of superficially adhering asphalt, the surfaces of the separated sheets are as they were before they were laid.

When, on the other hand, a roof is laid in the same manner, but with composite sheets, (containing asbestos or similar fibres, and stiff, elastic, hair-like bodies, which open up the felt-structure) and asphalt in the larger proportion made possible by the composite character of the felt itself, the heat of each asphalt coating remelts the asphalt in the sheet, which exudes from the sheet and becomes integrally united with the asphalt of the coating. The behavior of the materials may be tested and illustrated by applying a flame to one side of the impregnated sheet. The asphalt boils out of the felted sheet on both sides.

Thus, when several layers of the heavily impregnated composite felted sheets are laid on a roof, by the successive applications of hot asphalt coatings, the asphalt of the coatings and that with which the sheets are impregnated unites and forms a continuously solid matrix, from one exterior of the composite laminated roof covering to the other, in which the fibrous materials are embedded. The felted sheets can be separated, but with far more difficulty than is encountered with asphalt-asbestos sheets of the earlier structure, and when separated, disclose the vitreous or conchoidal fracture of solid asphalt, uniformly over the entire separated surfaces. For all practical purposes, such a laminated covering is a unit, and possesses far greater strength and durability than laminated coverings heretofore made.

As heretofore mentioned, the preferred inclusion in the asbestos felt or paper, typified by the described kind of cattle-hair, may be defined as consisting of a proportion of any discrete elongate bodies having the requisite resistance to destruction by heat, elasticity, strength, stiffness and compatibility of surface to wetting by and capillary attraction for asphalt of such a grade of hardness as to be fluid and to flow freely in contact with said bodies at a temperature of the order of 400° F., the said bodies also being capable of substantially uniform distribution in admixture with mineral fibres such as asbestos in a water-laid felt or paper. Fibers in general, whether vegetable, animal or mineral, do not, so far as I am aware, possess the said characteristics of the said bodies, which are defined and referred to in the claims as texture-opening capillary bodies.

I claim:

1. Sheet-roofing comprising a felt in which mineral fibres of the asbestos class predominate in quantity with a minor proportion by weight of stiff hair-like bodies interspersed therethrough, and an asphalt, substantially solid at normal weather-temperatures, occupying the interfibre voids.

2. Sheet-roofing, comprising a felt in which mineral fibres of the asbestos class predominate in quantity with a minor proportion by weight of stiff hair-like bodies interspersed therethrough, and an asphalt, substantially solid at normal weather-temperatures, occupying the interfibre voids and constituting at least one-third of the thus combined materials.

3. Sheet-roofing comprising a felt in which asbestos fibres predominate in quantity with cattle hair in minor proportion by weight interspersed therethrough, and an asphalt substantially solid at normal weather temperatures occupying the interfibre voids.

4. Laminated sheet material, containing in combination a plurality of felted fibrous sheets comprising mineral fibres of the asbestos class and stiff elastic void-producing hair-like bodies interspersed among the mineral fibres, and a body of asphaltic material impregnating the said felted sheets and forming a continuous matrix from one surface to the other of the material.

5. Sheet roofing comprising a felt in which mineral fibres of the asbestos class predominate in quantity with a minor proportion by weight of void-producing stiff hair-like bodies interspersed therethrough, and an asphalt absorbed into and filling the interfibre voids.

6. Sheet roofing comprising a felt in which mineral fibres of the asbestos class predominate in quantity with a minor proportion by weight of void-producing stiff hair-like bodies interspersed therethrough, and an asphalt absorbed into and occupying the interfibre voids and constituting at least one-third of the thus combined materials.

7. Sheet roofing comprising a felt in which asbestos fibres predominate in quantity with cattle hair in minor proportion by weight interspersed therethrough, and an asphalt absorbed into and occupying the interfibre voids.

Signed by me at New York city, N. Y., this 23rd day of September, 1921.

WILLIAM R. SEIGLE.