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METHOD OF PRODUCING INORGANIC
FIBROUS MATERIAL

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The present invention relates to a method of producing mineral wool bats, especially those comprising glass wool, slag wool, rock wool or the like, and particularly to a method of treating and binding mineral fibers to form an unusually light weight, strong, self-sustaining, resilient bat having fixed dimensions. The invention has special applications to glass wool, heat or sound insulating bats made in accordance with the teachings of the patent to Slayter and Thomas 2,133,236.

This application is a division of our copending application, Serial Number 221,460, filed July 26, 1938, now Patent No. 2,252,157, dated August 12, 1941.

An object of the present invention is to provide a method for forming a fibrous bat having the aforementioned properties of strength, high resilience and fixed dimensions, combined with unusually light densities of about 1 lb. per cubic ft. and ranging up to any density, such, for example, $3\frac{1}{2}$ or 9 lbs. per cubic ft., according to the particular purposes to which the bat is to be put. Ordinarily, for house insulation material, a light density of about $1\frac{1}{2}$ lbs. per cubic ft. is desirable. Such bat may have sufficient structural rigidity so that the bats may be handled, assembled into place without reinforcing members such as a cardboard core, or outer wrappings of paper, or reinforcing stitchings.

For better heat insulating qualities desirable for use in refrigerators, stoves, bottle coolers and the like, a $3\frac{1}{2}$ lb. density, more or less, is generally desirable. Higher densities of about 5 to 7 lbs. per cubic ft. are preferable for boiler insulation, industrial ovens, board or sheet type of material or the like.

The present invention is particularly suitable for producing railroad insulation where the lightest density possible is desired coupled with high structural strength capable of withstanding the jolting and vibration incident to railroad car use. A bat made in accordance with the present invention may have an extremely light density of about $1\frac{1}{2}$ lbs. per cubic ft., and sufficient structural strength that it may be mounted inside the railroad car wall panel and not settle or gradually break up due to the destructive vibration of the train.

Another object of the present invention is to provide a method of producing a heat and sound insulating body having the foregoing properties while using a minimum amount of binding or stiffening material to accomplish the same.

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corporating in a bat a stiffening or binding material which will maintain its properties through wide temperature ranges, and will not sag or become brittle as the temperature rises or falls.

Heretofore numerous binders have been suggested and used for bonding together mineral wool fibers into bats. Most generally such materials as asphalt, gypsum, starch, rosin, linseed oil, glue, sodium silicate, pitch or the like have been attempted. These binders generally are water soluble or thermoplastic. If water soluble, they have for that reason proved unsatisfactory when subjected to moisture conditions. If thermoplastic, they are unsatisfactory when subjected to certain temperature conditions. Various other disadvantages have attended the use of these materials as, for example, the rosin is subjected to oxidation and embrittlement after only a short period during the life of the bat; sodium silicate attacked the fibrous material particularly if it contained an alkaline constituent.

We have discovered that a fibrous bat having highly superior properties may be produced by incorporating in the bat, by the method of the present invention, a very small amount of thermosetting, condensation product. This may be and preferably is combined with an incompatible oleaginous lubricant such as oil, fatty material, or the tempering oil emulsion patented and described in the Williams and Bone Patent No. 2,083,132, or their patent No. 2,107,284.

Various thermosetting condensation products may be used, as, for example, phenol formaldehyde, urea formaldehyde, or various modifications and variations of these synthetic thermosetting materials which may be made by one skilled in the art to produce a resin originally in a liquid state, and finally in a hard, strong, solid mass. For ordinary purposes Bakelite, originally as water soluble material, has been found very satisfactory for use in the present invention.

A small amount of the thermosetting stiffening agent may be added to the tempering oil or lubricating mixture and applied directly to the blasted fibers. Preferably, however, the combination is first emulsified with water and then sprayed on the glass fibers as they are building up to mat formation upon a conveyor.

Various proportions of materials may be used, although it has been found that a small proportion of only about $\frac{1}{2}\%$ to $1\frac{1}{4}\%$ of Bakelite per weight of wool is sufficient for ordinary purposes.

When minute amounts of about $\frac{1}{2}$ to $\frac{3}{4}$ of a percent are used, the bat has materially in-

creased stiffness and resilience, and reduced limpness, but it is not rigid or stiff. With increased amounts, the bat assumes a semi-rigid form, and with the higher amounts, a fair amount of rigidity and strength are attained. The bat is still resilient and tough and can withstand considerable bending or compression stress without destroying its properties.

The finished bat may thus have about $\frac{1}{2}$ to $2\frac{1}{2}\%$ thermosetting stiffening agent, about an equal amount of stearic acid, oleic acid or other fatty acid or soap, generally about 1%, acting as an emulsifier if desired, and a suitable amount of oil incompatible with the thermoset stiffening agent, such as hydrocarbon oil, for instance, bright stock hydrocarbon oil, mineral oil, paraffin oil, petroleum oil or the like in amounts of about 2% or so, as desired. Metallic soap, waxes, fats, ammonia or the like may also be added to increase water repellancy of the bat if desired. Bentonite or the like may be added to act as an emulsifier, and to increase the heat insulating properties of the bat.

The method of applying the emulsion or mixture of lubricant and binder may be similar to any of those now in use. Ordinarily it is preferable to spray the mixture onto the fibers as they build up into mat formation and are continuously withdrawn in mat formation. It is desirable to accomplish this process over the fiber deposition zone in order to control the deposition and preferably to apply sufficient heat to evaporate the aqueous phase of the emulsion, leaving the lubricant and binder or stiffening agent distributed over the fibers. After removal from the deposition zone, it is desirable to heat treat the stiffening agent and cause it to polymerize into a final set, thus adding stiffness and a controlled amount of rigidity and resilience to the bat. This may be accomplished by any of the usual methods as, for example, by passing the material between rollers or between caterpillar belts having hot air or the like passing continuously therethrough in order to impart sufficient heat to polymerize the thermosetting agent. The caterpillar belt will also hold the bat down to a predetermined fixed dimension as the thermosetting binder hardens.

The reason why such a small amount of binder, as, for example, an amount less than or about 1% incorporated in the bat by the method of the present invention can effect such striking increases in strength and stiffness of the bat is not fully understood, although several reasons have been advanced to explain the phenomenon. From observations under a microscope, it was noted that at a large number of intersections of fibers, it appeared that the stiffening agent congregated in very small amounts and coated the intersections with rounded smooth concave surfaces in a manner similar to a fillet, thus im-

parting high structural strength with a minimum quantity of material.

In accomplishing this desirable distribution, the thermosetting material originally in liquid form has a high wetting power and distributes itself at the intersections in this manner. When hardened, however, it tends to retain this form and thus structurally assume an ideal contour with respect to the adjacent fibers. The small amount involved, however, avoids rigidity to a point of brittleness, and permits the product to achieve a certain amount of flexibility and yieldability under stress.

It is also considered possible that the oleaginous lubricant would form a uniform, homogeneous coating over the individual fibers, and that an incompatible thermosetting resin acts as a binder or stiffener independently. The lubricant over the fibers, however, would provide a sufficient amount of yieldability so that the bat would attain a high degree of resilience and strength without causing excessive rigidity and embrittlement of the individual fibers.

Various modifications and variations may be resorted to within the spirit and scope of the present invention as defined in the appended claims.

We claim:

1. The method of producing a light weight, strong, resilient fibrous bat of glass fibers, which comprises simultaneously depositing from a gaseous atmosphere, glass fibers and an aqueous emulsion of petroleum oil, an emulsifying agent, and a thermosetting aldehyde condensation product in water-soluble form, evaporating the aqueous phase of said emulsion and forming a loose, fluffy mat of glass fibers having the remaining constituents of said emulsion and the aldehyde condensation product disposed over the fibers, the incompatible nature of said oil and the said condensation product causing the two to separate on the fiber surfaces, and then applying heat to thermally set said condensation product to convert it to a water-insoluble state and stiffen said mat.

2. The method of producing a light weight, strong, resilient fibrous bat of glass fibers, which comprises simultaneously depositing from a gaseous atmosphere, glass fibers and a fiber-treating material comprising an emulsion of oleaginous lubricant in water and a partially reacted phenol formaldehyde in water solution incompatible with said lubricant, removing the water from said treating material and forming a loose, fluffy mat with the lubricant and the phenol formaldehyde distributed as two phases over the fiber surfaces, and then completing the reaction of said phenol formaldehyde to cause said mat to stiffen into bat form.

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