Oct. 25, 1949. L. B. MILLER ET AL 2,486,050

METHOD OF FORMING HEAT INSULATION

Original Filed June 29, 1942

Fig. 1

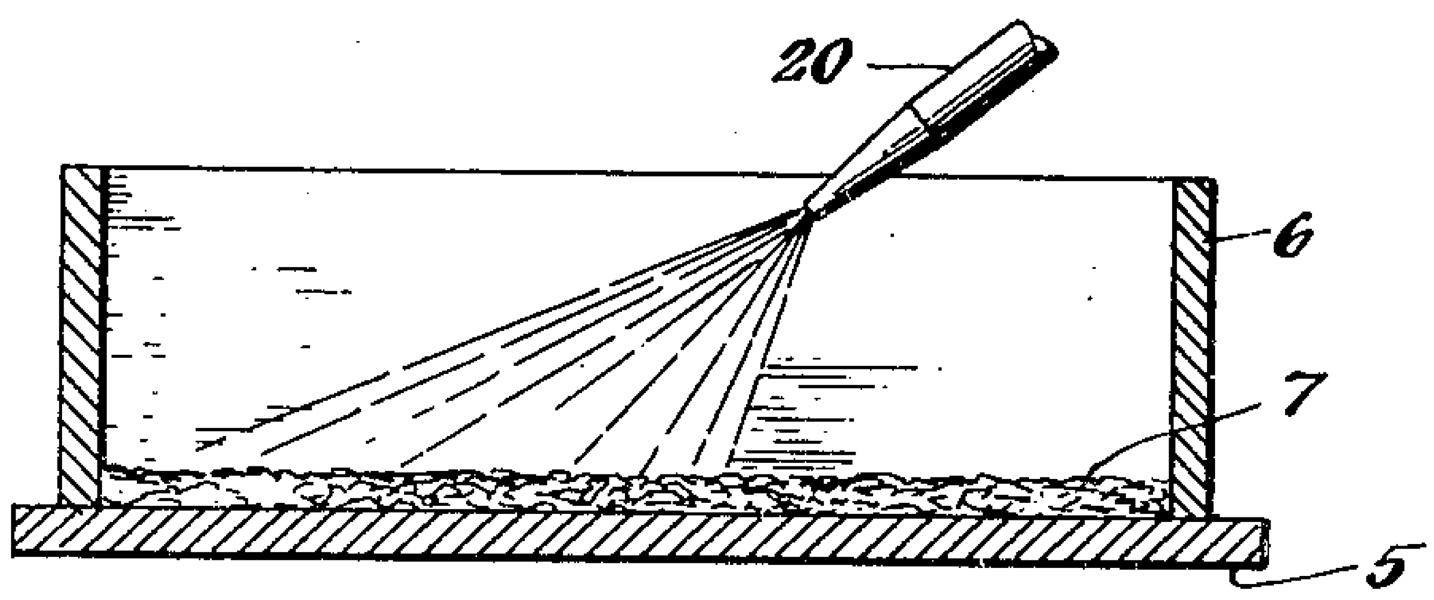


Fig. 2

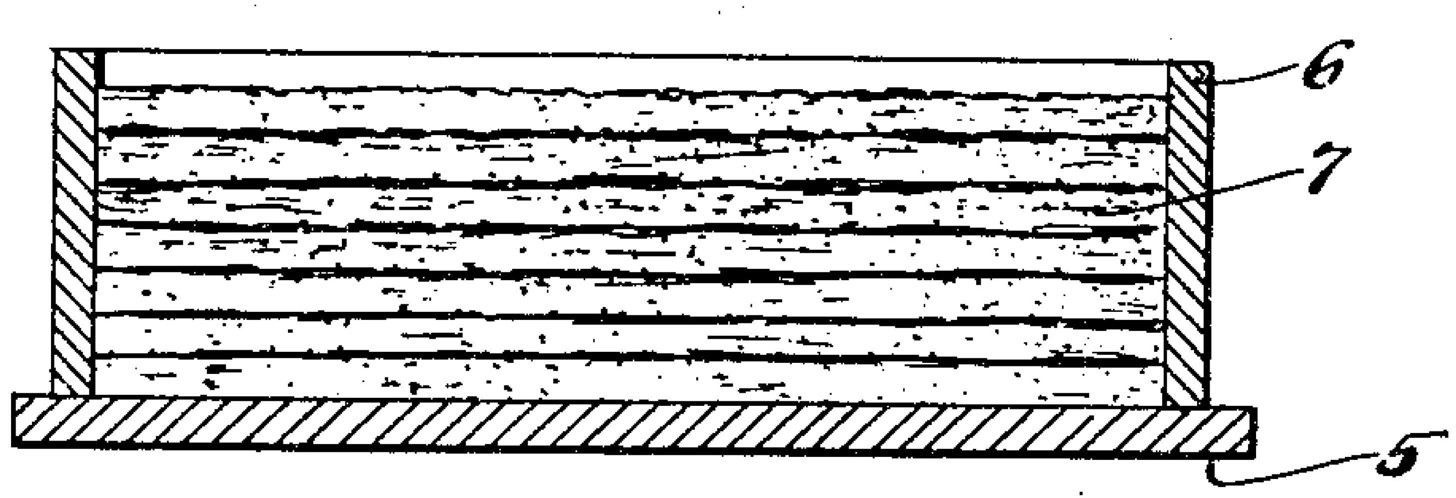


Fig. 3

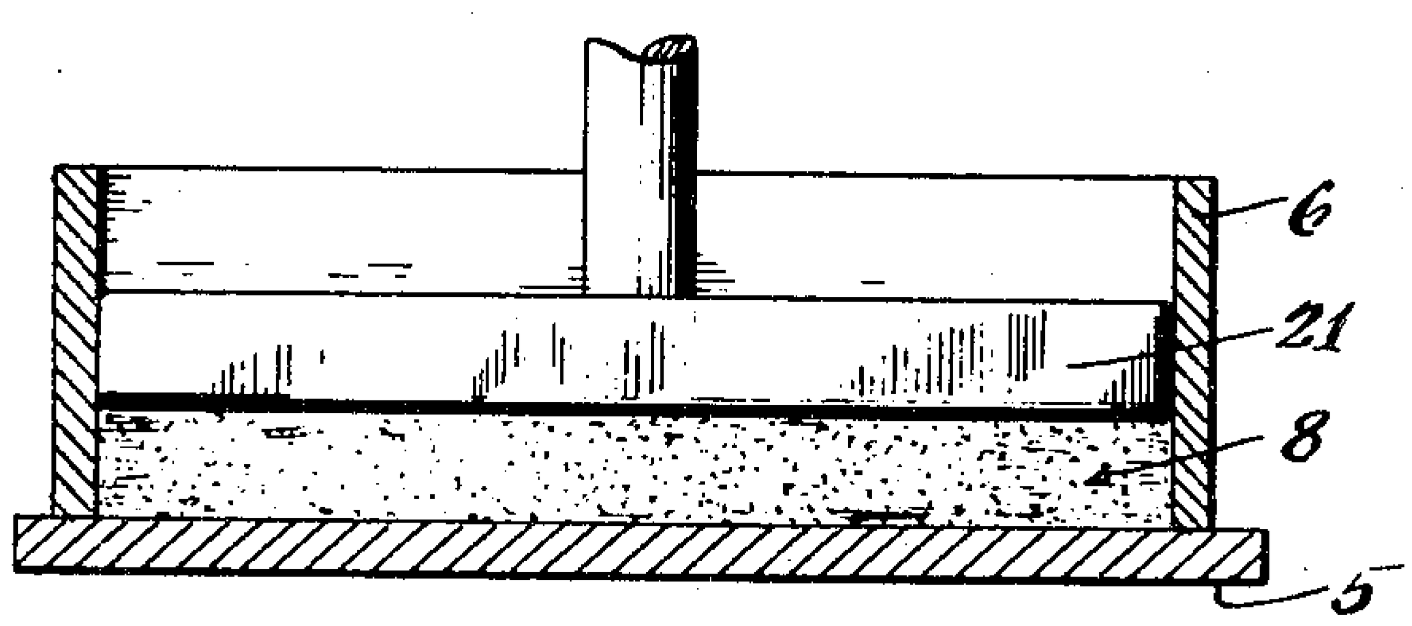
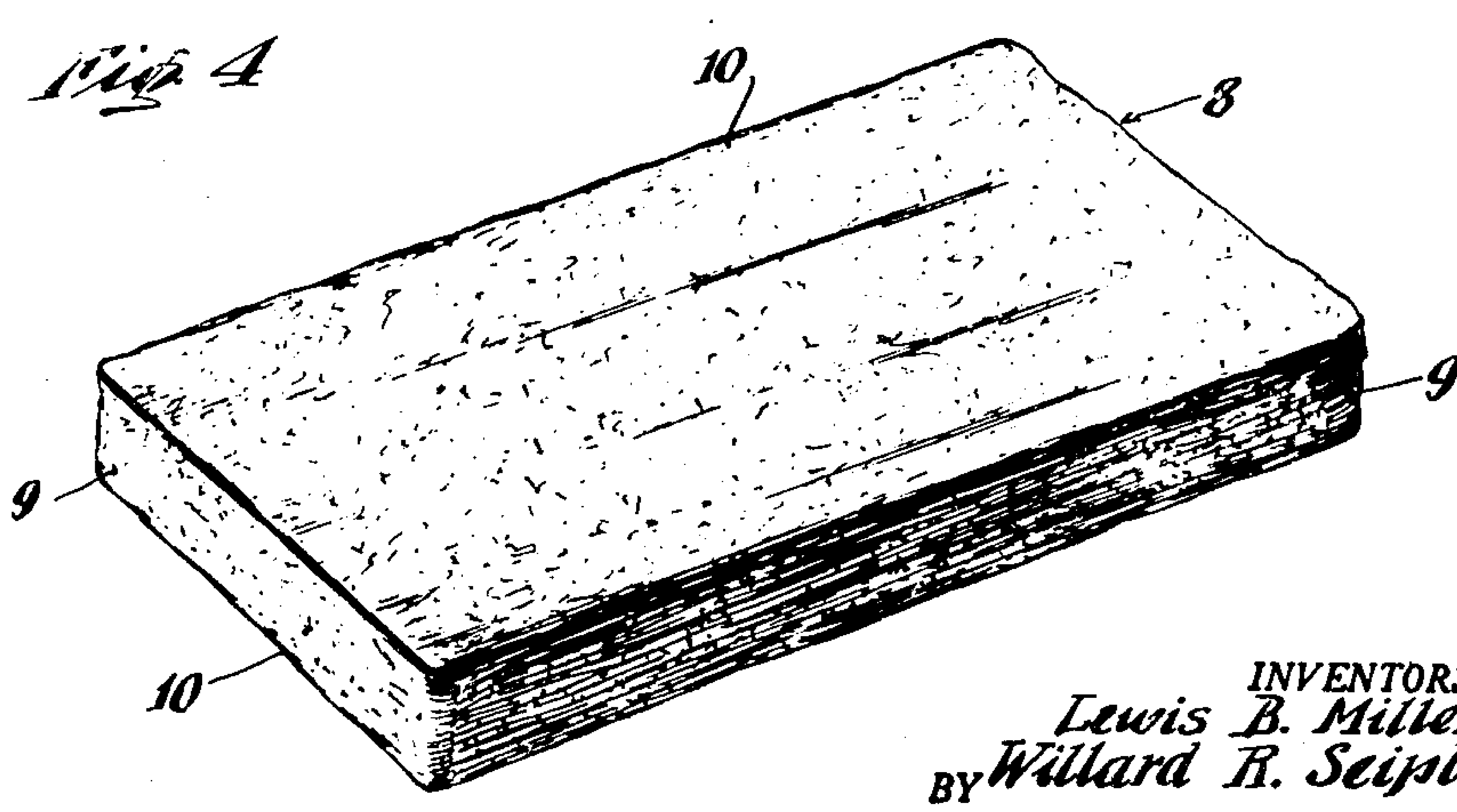


Fig. 4



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METHOD OF FORMING HEAT INSULATION

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7 Claims. (Cl. 154—28)

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This invention relates to heat insulation, and particularly to insulation adapted for use over a wide range of heat conditions and up to relatively high temperatures.

The object of the invention is to provide an insulation which will have low density for the relatively high temperature which it is adapted to withstand.

A further object is to provide an inexpensive, adaptable process for the production of such insulation composed of a combination of fibrous and powdery materials.

In the accompanying drawing

Figs. 1, 2 and 3 are diagrammatic views illustrating one method of producing the insulation, and

Fig. 4 is a perspective view of the insulation in rectangular block form.

The raw materials are composed of fibers, a powdered filling material and a powdered binder. Preferably the fibrous material is asbestos in the form of amosite, this being in proportion of 25–40%. The powdered filler is diatomaceous earth in proportion of 35–45% and the powdered binder is bentonite in proportion of 25–30%, all of the proportions being by relative dry weights.

In the formation of the insulation the raw materials are first proportioned and dry mixed so that the powdery materials are well blended and distributed among the asbestos fibers giving a very open, fluffy structure. This fluffy material is then spread in a thin layer 7 on a base or on a movable support, such as an endless belt or rotary table in case of a continuous process. In Fig. 1 of the drawings the base 5 has a layer 7 of the material within a surrounding rim or retainer 6.

The thin layer 7 of raw materials is then uniformly moistened by a very fine spray of water, it being important merely to moisten the surfaces of the fibrous and powdery particles and not to overwet the mixture at any point. The amount of moisture added is from one and a half to three times the dry weight of the mixture, and preferably this moisture will be held within two to two and a half times the dry weight.

Preferably an air spray nozzle 20 is used to effect the moistening, the water being atomized by an air jet so as to form a cloud or mist penetrating and permeating the layer 7 from surface to surface.

Successive layers 7 are then accumulated on top of each other one by one as indicated in Fig. 2, each layer of the fibrous powdery mixture being dampened down as above described by means of an atomized spray, the mixture of materials in

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dampened form thus being built up to desired depth on the base plate, belt or table.

The accumulated dampened mass of asbestos, diatomaceous earth and bentonite is still in open fluffy form and is now compressed to a thickness and shape corresponding to the desired density and the use to which it is to be put. For instance, as indicated in Fig. 3 with the block insulation, plunger 21 may be used within the rim or retainer 6 to press the layers into more compact form, designated 8, this compacting being variable in amount depending upon the desired density of the final insulation. The result is a rectangular insulating block 8 as illustrated in Fig. 4 with the upper and lower surfaces 10 and the edge surfaces 9. In this block the tendency is for the fibers, particularly the long ones, to run flatwise with the layers; however, in each layer the fibers may run in all directions and may even run from one layer to another, and entangle with the powdery materials, all of the surfaces of the mixture being evenly dampened.

The shaped piece is then dried driving off the moisture and developing the adhesive bond of the bentonite between the particles of diatomaceous earth and between the asbestos fibers and the other materials, the particles of the whole mass being thoroughly cemented together to impart great strength to the block as a whole.

During this drying the bentonite is subjected to a heated moisture-laden atmosphere as the wetting water is vaporized and the bentonite is supplied with moisture from the mixture of fibers and diatomaceous earth, the great surface areas of which adsorb the atomized moisture. If desired, this moisture treatment may be accentuated by steaming the shaped pieces for a few minutes before drying further to develop the binding effect. After drying the shaped and dried pieces are ready for packaging.

By this method insulation which will withstand 1000° to 1200° F. may be made with a density of six to eight pounds per cubic foot and insulation withstanding a temperature of 900° to 1000° F. may be made with a density as low as 3.9 pounds per cubic foot and with sufficient strength for usual service conditions. A light weight high temperature thermal insulation will result when the mixture is compressed under a pressure of about fifty pounds per square inch or less to give a final product weighing eleven pounds per cubic foot and capable of withstanding a temperature of at least 1900° F. and in the neighborhood of 2200° F. to 2300° F. for the higher pressures and densities.

The density of the final product will depend upon the degree to which the dampened mixture is compressed and this can be very accurately predetermined depending upon the insulating surface to which the product is to be put. A very superior high temperature insulation of great strength and durability is produced at densities from eleven to fifteen pounds per cubic foot, the latter corresponding to a maximum density of the wet compressed mass of 60 pounds per cu. ft. For instance, at the lighter weight of eleven pounds per cubic foot, the hardness is 1.9 by Pusey and Jones test, the linear shrinkage at 1900° F. is 1.05% and the strength is such that the blocks three feet in length may be held horizontally by a grip at one end surface.

At a density of 12.0 the modulus of rupture is 30.0, the Pusey and Jones hardness 1.10 and under the Navy abrasion test the percent loss in ten minutes is 43 and in twenty minutes 67. At 850° F. the modulus of rupture is 17.6 and the linear shrinkage 0.35%; at 1100° F. the modulus of rupture is 14.3 and the linear shrinkage is 0.59%; at 1500° F. the modulus of rupture is 13.7 and the linear shrinkage 1.10%; and at 1900° F. the modulus of rupture is 19.8 and the linear shrinkage is 1.77%, these latter figures being on the basis of a six hour soaking heat, subjecting the whole piece to the temperature indicated. Under normal conditions of usage insulations are subjected to high temperatures only upon one side and any thermal deterioration encountered is therefore in general less in practice than under the conditions of the test.

In conductivity the present insulation is very low being only about 50% of the standard high temperature insulations up to 700° F., and is distinctly superior in the lower ranges of temperature, i. e., below 1000° F. The higher densities and larger proportions of diatomaceous earth render the insulation more effective at higher temperatures and the composition of a corresponding block or other shape may be varied to be denser at the portions adjacent the heated surface. Larger proportions of the diatomaceous earth may also be used at these portions of the insulation by correspondingly varying the composition of the successive layers 7 and variations in density may be effected by subjecting the earlier deposited layers to separate higher compacting pressure so that a plurality of pressures successively lower in intensity are used to produce the block or other shape.

The material in dampened form is relatively plastic and may be pressed to any desired shape and will retain this shape during drying. No pressures are required in the drying operation and the material is self-setting in that the drying operation does not require the shape to be retained in the shaping mold.

The drying shrinkage of the blocks is negligible and they may be cast substantially to the exact size of the finished piece.

This insulation is relatively simple in manufacture and low in cost and widely adaptable to different conditions of use.

The heat insulation of this invention combines mineral fibers, such as asbestos or rock wool with powdery particles, to give a highly porous unit structure withstanding a very high temperature in proportion to the density of the insulating material. It maintains its form under continuous six hours heating at least to the temperatures as above described. The withstood temperature or the maximum temperature to which the material may be applied without failure is considerably dependent on the composition of the product. The light weight product composed of bentonite and fiber in the ratio of about 30–70 has a density variable ordinarily from about four pounds per cubic foot to eight pounds per cubic foot and will tend to disintegrate beyond usefulness above a temperature of about 900° F. With less fiber and with some diatomaceous earth the density will in general vary from about eight pounds per cubic foot to twelve pounds per cubic foot with disintegration setting in above 1200° F. A third type of composition using still less fiber and more diatomaceous earth (30 parts fiber, 40 parts diatomaceous earth and 30 parts bentonite) will shrink somewhat above 1900° F. and will be used at densities of eleven pounds per cubic foot to sixteen pounds per cubic foot. Thus the maximum temperature is relatively high in relation to the density of the insulation.

In place of the bentonite or in conjunction with it, other binders may be used, such as kaolins or other clays in temperatures up to 1900° F. Silicates may be used in place of the bentonite, but only up to temperatures of about 700° F. while gums and other emulsified or water soluble organic binders may be employed up to about 200–300° F. To give temporary strength at normal air temperatures and facilitate handling before and during application of the insulation, a small percentage of a water soluble gum may be added as an additional binder. Other fiber may also be used in place or together with the amosite such as chrysotile and amphibole asbestos up to 1900° F., rock wool or glass wool up to 1000° F. or organic fibers up to 200° F.

In the formation of these insulations the characteristics are controllable by the proportions of the ingredients and by the compacting pressures employed making the insulation widely adaptable while at the same time maintaining a relatively low density in proportion to the temperatures involved. This represents not only a saving in weight and material over prior insulations but is accompanied by a lower conductivity as above explained.

The product of the process of this invention is described and claimed in our copending application Serial No. 448,928, filed June 29, 1942, now Patent No. 2,448,186, granted August 31, 1948, of which the present application is a division.

We claim:

1. The method of forming heat insulation comprising dry mixing particles of a powdery binder with fibrous particles evenly distributed in the mixture and depositing the mixture as an open fluffy mass of homogeneous composition throughout and sufficiently porous to be permeated by a moistening mist, atomizing water to form a mist and directing said atomized mist into and through said mixture to evenly penetrate and permeate the same and wet the surfaces of the powdery and fibrous particles, limiting the amount of mist to a range from 1½ to 3 times the weight of the dry mixture to thoroughly penetrate the mass and moisten the surfaces of the particles of the mixture and develop the adhesive bonds of the binder particles while maintaining the relative distribution of said binder particles in the mixture, compressing said mass of moistened fibers and powdery particles to a predetermined thickness corresponding to a density not exceeding 60 pounds per cu. ft. while continuing to maintain the distribution of the binder particles among the fibrous particles, and then drying said compressed mass into a light, porous, self-sustaining

unit of substantially said predetermined thickness and a density of about 3.9 to 15 pounds per cu. ft.

2. The method of forming heat insulation comprising dry mixing particles of a binder with mineral particles and fibers evenly distributed in the mixture, spreading said mixture as an open fluffy layer sufficiently porous to be permeated by a subsequent moistening mist, atomizing water to form a mist and directing said atomized mist into said layer so as to penetrate and permeate the layer from surface to surface, limiting the amount of moistening mist to a range from 1½ to 3 times the weight of the dry mixture to thoroughly moisten the surfaces of the particles of the mixture and develop the adhesive bonds of the binder particles while maintaining the relative distribution of said binder particles in the mixture, accumulating a number of similarly spread and moistened layers of open fluffy mixture to desired amount, compressing the said accumulated layers of moistened fibers and particles to a predetermined thickness corresponding to a density not exceeding 60 pounds per cu. ft. while maintaining the distribution of the binder between the particles and fibers, and drying the said compressed mass into a light, porous self-sustaining unit of substantially said predetermined thickness and a density of about 3.9 to 15 pounds per cu. ft.

3. The method of forming heat insulation as set forth in claim 2 in which the moistening by the mist treatment is limited in amount to a range of 2 to 2.5 times the dry weight of the mixture of fibrous and powdery particles.

4. The method of forming heat insulation as set forth in claim 2 in which the mineral particles comprise diatomaceous earth.

5. The method of forming heat insulation as set forth in claim 2 in which the binder is powdered bentonite.

6. The method of forming heat insulation as set forth in claim 2 in which the fibers are asbestos, the mineral particles are of diatomaceous earth and the particles of binder are of bentonite.

7. The method of forming heat insulation as set forth in claim 2 in which the fibers are asbestos in proportion of 25 to 40%, the mineral particles are of diatomaceous earth in proportion of 35 to 45% and the particles of binder are of bentonite in proportion of 25 to 30%.

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