April 24, 1934. D. C. DRILL 1,956,377

INSULATING MATERIAL AND METHOD OF MAKING

Filed Nov. 30, 1932

Fig. 1.

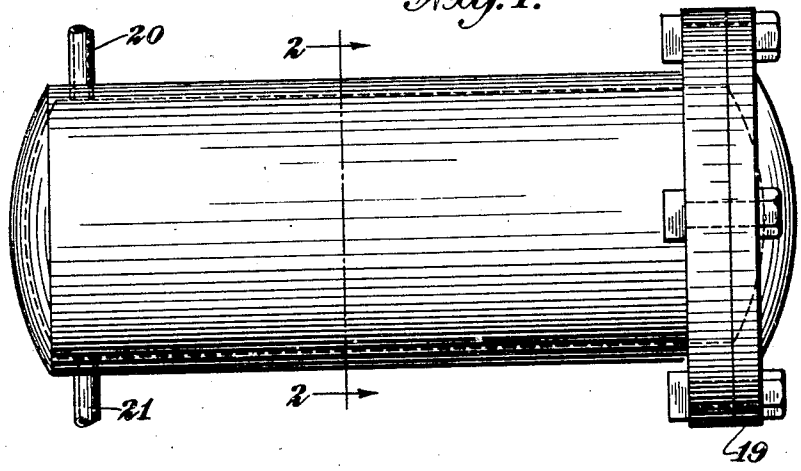


Fig. 2.

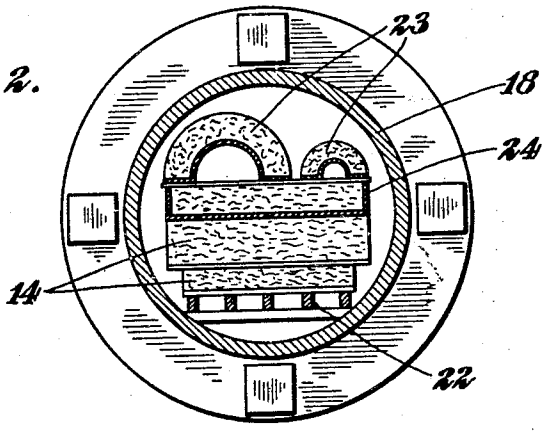


Fig. 4.

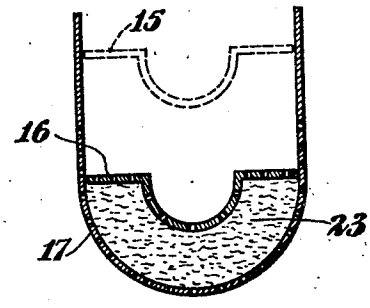
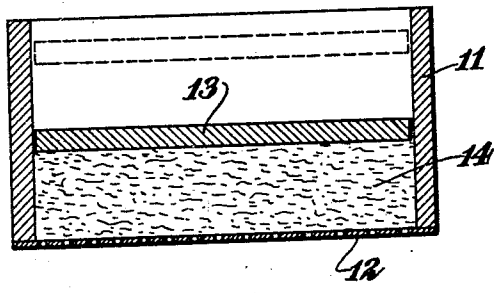


Fig. 3.



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INSULATING MATERIAL AND METHOD OF MAKING

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Application November 30, 1932, Serial No. 644,988

12 Claims. (Cl. 18—47.5)

This invention relates to a material for general heat (and cold) insulating purposes, and for acoustical correction. It relates more particularly to a relatively rigid or non-yielding material.

The chief feature of the invention consists of manufacturing such a material using a calcined or fused and expanded material such as mineral wool as a raw material. The fused material, however, undergoes a transformation during the process so that the fibrous character of the original rock wool is materially changed, or if frothed slag is used its vesicular structure is partly modified.

The exact nature and reaction of this change is only partly understood, but the result is that a yielding fibrous material is changed to a material which is comparatively rigid, and which has apparently a structure which consists of adhered powders following the structure of the original fibers to a slight extent only. If a comminuted vesicular material is used, a bond is formed between the particles.

The advantages of the material are that it contains practically no organic matter, or none at all; it is not subject to decay or deterioration; it will stand relatively high temperatures; it may be easily waterproofed so as to be suitable for low temperatures; it is light, relatively strong; and it has high heat insulating value. The advantages of the process are that it may be carried out readily by means of simple apparatus, that it involves very inexpensive materials, and that the product may be molded accurately to shape while in wet or plastic condition, and that practically no shrinkage or other change in size or shape occur during the subsequent treatment and drying.

The full nature of the invention will be understood more readily from the accompanying drawing and the following description and claims.

Fig. 1 is an elevational view of apparatus suitable for heat-treating the material on a small scale.

Fig. 2 is a section taken on line 2—2 of Fig. 1 and in the direction of the arrows.

Fig. 3 is a diagrammatic view shown in central section of a mold suitable for forming the product into rectangular shape.

Fig. 4 is a diagrammatic drawing shown in central section of a mold suitable for forming the product into a half section of pipe insulation.

The method of carrying out the process consists of the use of mineral wool fiber or other slag material, and a considerable excess of water. The mineral wool may have a composition approximately as follows:

	Per cent
Silica	38
Alumina	12
Iron oxide	2½
Lime	27
Magnesia	17
Miscellaneous	3½

This composition is subject to considerable variation, according to the source of the slag or rock used. The miscellaneous item consists of a trace of surface moisture and a small amount of alkali metals, magnesia, and about .3 of 1 per cent of mineral oil.

The mineral wool for use in this process may be partly separated from the shot, which is an inherent part thereof, by tearing apart and tumbling in a screening device which permits part of the shot to fall through and retains most of the fiber. Also during, or after the wet mixing, the shot may be allowed to settle while the fiber is drawn off, thus effecting a partial separation of the shot from the fiber. Expanded slag may be air floated or water floated to separate the heavier portions.

The foregoing formula represents what is known as a relatively unstable mineral wool or slag composition—i. e., one that will decompose in the presence of moisture at high temperatures. It is partly due to this decomposition reaction that the process takes place. Wool that contains over 44 percent silica is less suited to this process due to the slowness with which it decomposes. Wool which contains less than 35 percent silica is not preferred for this process, because it packs to a greater density in the molding operation. This will be explained hereinafter. The mineral wool mixed with five to ten parts its own weight in water may be the only materials used in the process. The water may be what is known as hard water, which contains small amounts of calicum bicarbonates and other salts in solution. Small amounts of other materials have been admixed with the mineral wool with satisfactory results, such as sodium silicate, lime, magnesium, sub-carbonate, magnesium silicate gel, asbestos fiber, and clay; but none of these materials is essential to the process.

The mixing operation for a fibrous raw material as commonly carried out, is of a conventional type used in the rock wool products industry. It consists in delivering the mineral wool in loose form—i. e., lumps of varying size, say ¼ to 10 inches,

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into a mixer which contains water, and stirring the wool and water mixture until the wool is separated into clots of about ½ inch maximum size, and a large percentage of the mineral wool fiber is distended or separated so that it is in suspended condition in the water and occupies the water space between the clots. This may be called a semi-modulated condition. The process will function with the wool fully fibered out in the mix so that all clots are destroyed. It will also function with the wool felted in dry condition and then wet or saturated with water. For production purposes, however, the semi-modulated condition described above is preferable for most forms of the product.

After the mineral wool has been mixed with water, as described above, it is run into a pressure mold of some sort such as shown in Fig. 3. The mold consists of sides 11, screen or perforated bottom 12, and pressure plate 13. The wool and water mixture is allowed to drain until it forms a wet pad in the mold, and then pressure is applied thereto until the desired density is reached. This density may vary within wide limits, but in the present form of the invention, it usually varies between 15 and 21 pounds per cubic foot in the final product. Comparing with this 100 to 150 pounds per cubic foot for solid masonry, it is evident that this material is of a different class. The mold may be so shaped as to form a rectangular block such as shown by No. 14 in Fig. 3. The mold may be of the shape shown in Fig. 4, which form is adapted to mold a half section of pipe insulation. In Fig. 4 the wet pad before pressing may occupy position 15 shown in dotted lines; after pressing the inner plate 16 may be in position shown. Both the inner plate 16 and the outer casing 17 of the mold may be perforated to permit drainage of water, and the perforations may be covered with canvas or other fabric to prevent the material from being extruded through the holes.

After the pressing operation, the material is removed from the mold by inverting the mold, or taking it apart, and it is then placed in an autoclave or pressure vessel, such as shown in Figs. 1 and 2. This consists preferably of a steel shell 18, which is provided with a heavy flanged cover 19 that may be clamped or bolted in position. The autoclave is provided with a high pressure steam supply 20 and a drain pipe 21. The autoclave has some form of rack, such as 22, which supports the product free of the sides and permits the steam to surround it. The product as shown consists of various slabs or material 14 and sections of pipe insulation 23. The product may, during treatment in the autoclave, be confined on two or more sides by a mold 24, or it may be merely supported after the material is suitably placed in the autoclave. Live steam at a pressure of about 100 pounds a square inch is admitted, and this pressure is maintained for about 16 to 20 hours. In general, the pressure must be higher and the period of treatment longer if the mineral wool contains a high percentage of silica—i. e., an unstable wool requires less time and less pressure. A coarser material requires longer time and higher pressure also. The above conditions are given as being generally satisfactory for a wool of the composition given previously. During this period of treatment, the wool reacts in some way in itself or with the other materials present and loses a considerable part of its fibrous structure. It acquires, at the same time, a sort of cellular or rigid bonded structure, which is characteristic of the finished product. At the end of the period of treatment, the pressure is released gradually to atmospheric pressure and the treated material is withdrawn. It is then dried at a temperature of, preferably, about 225° F. It may be air dried or dried at higher temperatures in some instances.

One possible explanation for the change in character of the fused material during treatment may be a hydration and hydrolysis of the unstable mineral wool, as follows:

The original material is in the form of calcium and magnesium silicates and aluminates. These compounds, however, being slightly unstable, change in part to calcium hydroxide, magnesium hydroxide and hydrated silica and alumina, which in turn react again to form bulky silicates and aluminates. The necessary oxygen and hydrogen for the reaction are supplied by the water which is present, and the speed of the reaction is greatly increased by the high temperature of the steam. All of the above compounds, being bulky and adhesive in character, adhere to form a new structure. The exterior volume of the new compounds, however, remains approximately the same as that of the original material. Water is nearly all driven off in the drying process so that the composition of the resulting material is almost identical with the original slag or fused rock. It is possible, however, that the compounds have rearranged themselves into a different form of chemical combination which accounts for the more earthy appearance of the finished product.

The examples given are of common types of expanded slag materials and are to be taken in an illustrative and not a limiting sense. The invention contemplates any high temperature moisture reaction for the purpose of solidifying comminuted slag materials into a definite shape without material increase in density during the solidifying operation.

In some forms of the process a considerable part of the original fused material remains unchanged but sufficient reaction takes place at the contacts between the particles to cement the unit into a rigid expanded structure.

The dried product may, in some instances, require trimming to size, but ordinarily, for insulating or fire-proofing purposes, it may be shipped just as received from the driers. For acoustical purposes, the surface should usually be dressed.

What I claim is:

1. A molded insulating material composed of calcium and magnesium silicates and aluminates in powdered form, said materials being adhered in a rigid structure which follows the original expanded material from which they are formed.

2. A process for forming insulating material comprising the steps of admixing mineral wool with water, forming into units, heating the formed units in the presence of moisture to change the structure of the wool and drying the product.

3. A process of forming insulating material comprising the mixing of relatively unstable expanded fused mineral material with water, molding into units heating the formed units in the presence of moisture to effect a partial decomposition of the fused material, and drying the product.

4. A process for forming an insulating material comprising the mixing of mineral wool with water, molding into units, heating the units in the presence of moisture and at a high tem-

perature for a sufficient time to cause appreciable change in the structure of the unit, and drying the product.

5. Process of forming insulating material comprising the mixing of mineral wool which contains more than 30 percent and less than 45 percent silica with water, molding into units, treating at high temperature in the presence of moisture to cause an appreciable change in the fibrous character of the unit, and drying the product.

6. Process for forming insulating material comprising the mixing of mineral wool with water, molding into desired shape, treating with steam under sufficient pressure and for sufficient time to effect a change in the fibrous character of the mineral wool, and drying the product.

7. Process of forming insulating material comprising the separating of mineral wool from part of the shot which it originally contained in dry state, mixing the separated wool with water, molding the mixture to shape, heating the molded shapes in the presence of moisture to increase the rigidity of the product and drying.

8. A process for forming insulating material comprising the mixing of mineral wool with water, allowing part of the shot content thereof to settle out, molding the mainly fibrous portion thereof to desired shape, heating the molded shapes in the presence of steam to increase the rigidity of the product, and drying.

9. A process for forming insulating material comprising the mixing of mineral wool with more water than it will absorb, molding under pressure to remove part of the water, heating the resultant product to increase the rigidity thereof and drying.

10. Process for forming insulating material comprising the forming of a dry felt mineral wool into desired shape, adding water thereto without essentially altering the shape, heating the resultant product to increase the rigidity thereof and then drying the product.

11. A composite block composed of unchanged fused slag material, decomposed fused material, the decomposed material constituting a bond between unchanged particles, and the combination comprising an expanded structure.

12. A process for forming insulating material comprising mixing crushed frothed slag with water, molding to shape under pressure, treating with heat to effect a cementing of the material, and drying.

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