106. COMPOSITIONS, COATING OR PLASTIC
86
Cross Reference
Examiner

Oct. 10, 1939. P. S. DENNING 2,175,715

MANUFACTURE OF INSULATING SLABS AND THE LIKE

Filed April 22, 1936

Fig. 1.

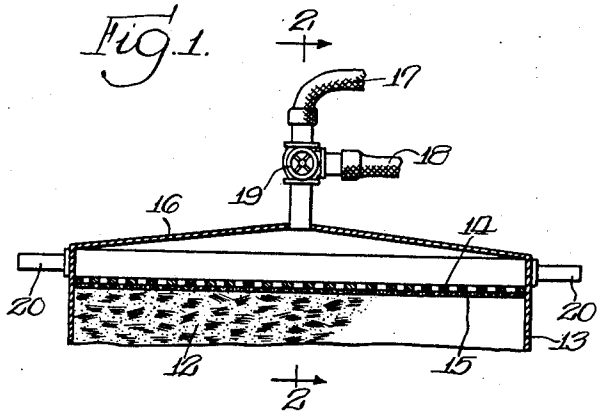


Fig. 2.

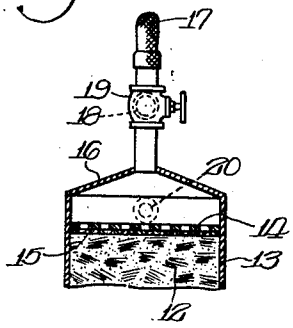


Fig. 3.

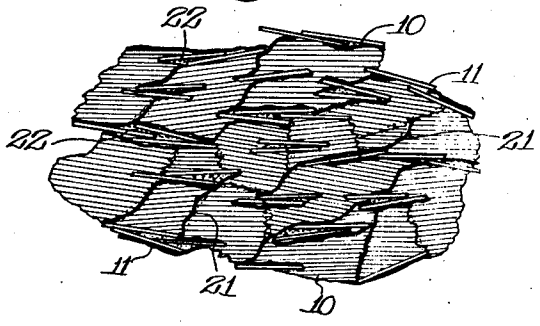


Fig. 4.

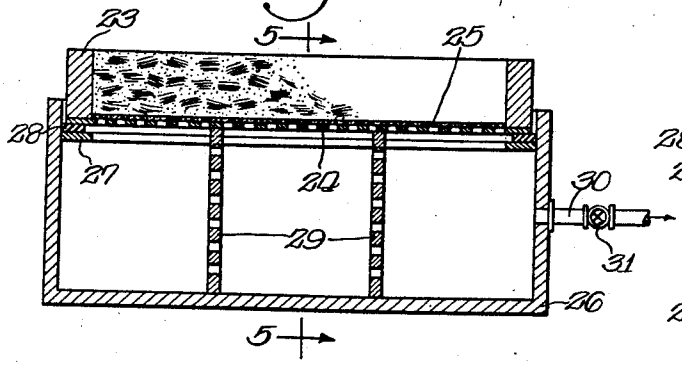
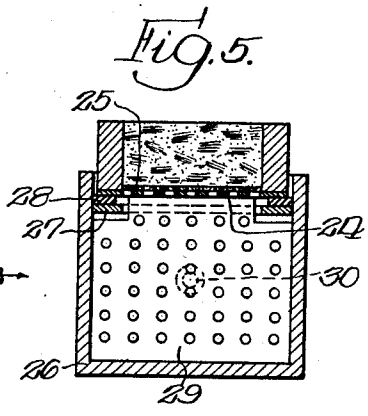


Fig. 5.



Inventor:—
Paul S. Denning,
By Roland C. Rehm Atty.

Patented Oct. 10, 1939 2,175,715

XR

UNITED STATES PATENT OFFICE

2,175,715

MANUFACTURE OF INSULATING SLABS AND THE LIKE

Paul S. Denning, Joliet, Ill., assignor to F. E. Schundler & Co., Inc., Joliet, Ill., a corporation of Illinois

Application April 22, 1936, Serial No. 75,789

5 Claims. (Cl. 92—55)

This invention relates to the manufacture of insulating slabs and the like, and among other objects aims to improve the insulating efficiency and strength of such slabs.

The nature of the invention may be readily understood by reference to illustrative methods of manufacture embodying the invention and illustrated in the accompanying drawing.

In said drawing:

Fig. 1 is a sectional elevation of a mold for making flat slabs;

Fig. 2 is a section thereof on the plane 2—2 of Fig. 1;

Fig. 3 is an enlarged section of a portion of an insulating slab or the like illustrating the arrangement of the aggregate in the slab;

Fig. 4 is a sectional elevation of another form of mold for making a slab; and

Fig. 5 is a section thereof taken on the plane 5—5 of Fig. 4.

In the present insulating slabs, exfoliated vermiculite is employed as the insulating aggregate. Exfoliated vermiculite is an alteration product of particles of certain micaceous minerals such as biotite, which exfoliate or expand to many times their original size upon the application of heat, to produce a granular material which is an efficient insulator, highly refractory, and extremely light in weight. When exfoliated, the extremely thin and polished laminae which characterize the structure of the granules, are very slightly separated (the slight separation between the laminae causing the expansion of the granules), and the expanded granule has a pair of opposite flat faces which are parallel to the plane of cleavage of the material, i. e., parallel to the laminae. The general nature of the exfoliated granules is shown in Fig. 3 wherein an attempt has been made to illustrate (on an enlarged scale) a portion of an insulating slab. The aforesaid flat faces of the granules are therein designated by the reference character 10 and the multitude of slightly separated laminae are designated by the reference character 11.

I have discovered that if the exfoliated vermiculite granules be arranged in a slab with the aforesaid granule faces substantially parallel in relation to each other and to the faces of the slab, the latter is not only much stronger but has a substantially higher insulating efficiency in a direction through the thickness of the slab, i. e., perpendicular to the face of the slab. It will be understood that the effective insulating action of a slab is in the direction of its thickness. One explanation of the foregoing improvement in the slab is that individual laminae and the laminae of adjacent granules, when the latter are arranged in the foregoing parallel relationship, tend to overlap or felt together (thereby increasing the strength of the slab); and that the granules have much greater insulating efficiency (i. e., a higher "K" factor) in a direction perpendicular to their laminae than in any other direction.

I have further discovered that the granules in the slab may be given the aforesaid parallel arrangement by molding the same in a mold while suspended in a liquid vehicle. For example, the granules are suspended in a slurry, i. e., a soupy or sloppy mixture, containing a cement or binder. This mixture is molded and the liquid vehicle is drained through one face of the mold during which the granules of vermiculite (which are lighter than the liquid) are arranged flatwise, i. e., with their flat faces parallel to the face of the mold through which the liquid leaves.

During the mixing of the slurry, a substantial number of granules are split into individual laminae or into thin flat plates comprising several laminae. These "felt" together, i. e., arrange themselves in overlapping relation with each other and with the thicker granules, thereby contributing materially to the strength of the slab. Indeed, it is possible for the laminae to arrange themselves in such intimate overlapping relation as to make the slab relatively impervious, thereby substantially retarding the draining away of the liquid. To facilitate "dewatering", a small proportion of fiber, such as asbestos fiber is added to the slurry. The fibers probably act to separate the overlapping laminae sufficiently to facilitate dewatering. Whether or not this is the explanation of the action of the fibers, they do operate to hasten dewatering. The fibers also act to prevent migration of the cement with the liquid, holding the cement uniformly distributed through the slab. This function of the fiber is not fully understood. Probably the cement is adsorbed upon or adheres to the fibers. Both as an aid to dewatering and to maintain uniformity of cement distribution, the action of the fiber is more pronounced than one would expect from the small proportion employed.

The extent to which the granules are split up into laminae or thin plates does not impair the insulating efficiency of the slab since in the slab the parallel arrangement of the laminae (which is responsible for the high insulating effi-

ciency in a direction perpendicular to the laminae) is preserved.

While a large variety of cements or binders may be employed, I have found it advantageous to use magnesium oxy-sulphate cement. This cement is capable of resisting high temperatures (up to 1,800° to 2,000° F.) and is of such greater strength (compared to other available cements) that a relatively smaller proportion may be used to secure a given strength. This results in a relatively greater porosity in the slab and a correspondingly higher insulating value.

By way of illustration, a mixture for the foregoing purposes may comprise 25 pounds of exfoliated vermiculite granules of a —4 to +10 grading, about 2 pounds of fiber such as long fiber asbestos of a 0—8—6—2 Canadian grading, from 4 to 8 pounds of caustic magnesium oxide and sufficient magnesium sulphate solution to give a rather sloppy consistency. Magnesium sulphate solution of 5° to 10° Baumé concentration is satisfactory, but it is not essential that the concentration be kept within these limits. It will be understood that the expression "—4+10 grading" defines granule sizes which will pass through a 4 mesh screen and be retained on a 10 mesh screen.

The reaction between the magnesium oxide and magnesium sulphate solution produces magnesium oxy-sulphate cement. After removal of the liquid, the slab may be discharged from the mold and the cement allowed to set at least partially. Thereupon the slab is advantageously dried in moderate heat of from 400° to 600° F. Improvements in strength is observed if the slabs be permitted to air cure for 24 to 48 hours before introduction into a drier.

The quality of the exfoliated vermiculite aggregate may be substantially improved if it be first floated upon a liquid binder or a liquid constituent of the binder. In the present instance, the exfoliated vermiculite may be floated upon a solution of magnesium sulphate (5° to 10° Bé.) during which all heavy impurities such as rock will sink to the bottom of the solution and only the exfoliated vermiculite granules remain floating on the surface. Since the liquid floating vehicle is a constituent of the binder, it is unnecessary to effect a complete separation of the liquid and vermiculite. It is necessary simply to lift the vermiculite from the liquid, allowing the latter to drain away by gravity. What adheres by capillarity and otherwise to the vermiculite is simply carried into the cement, and the deficiency of the magnesium sulphate solution is supplied by the addition of enough magnesium sulphate solution to produce a mixture of the proper soupy consistency.

In Figs. 1 and 2 is illustrated one form of apparatus for molding slabs 12. It will be understood that the shape of the mold 13 depends upon the particular shape and proportions of slab desired. For example, in making insulating pipe covering slabs, the mold should have a semi-cylindrical or cylindrical contour. One face or bottom of the mold is perforated to allow the liquid to drain therefrom. In the present instance, the perforated bottom comprises a perforated metal supporting plate 14 upon which rests a screen cloth 15 of sufficiently fine mesh to prevent the escape of any of the solid constituents of the mixture. To facilitate the dewatering of the mixture, suction is advantageously applied to the perforated bottom of the mold. As here shown, the bottom is enclosed by a hopper or hood 16 to which a suction line 17 is connected. To fill the mold, it is simply necessary to dip or immerse the same in the vermiculite mixture and to apply and maintain suction until the desired amount of solid material is drawn into the mold. The mold is then withdrawn from the mixture and the suction continued until the mold has been adequately dewatered. After which, the insulating slab may be discharged by the application of air pressure from line 18. A two-way valve 19 is advantageously introduced between the suction and pressure lines 17 and 18, so that suction and pressure may be selectively applied to the mold.

The ends of the mold are preferably provided with trunnions 20 by which it may be readily handled and inverted as desired. For example, the mold may be carried on a continuous conveyor or the like from the supply point to the discharge point and back again. As here shown, the mold may advantageously be carried in inverted position, i. e., with its open face down. This considerably simplifies the filling of the mold which may be effected simply by immersing the mold until, with the aid of suction, the mold has been completely filled with solid material. Thereafter the mold is withdrawn and placed against a supporting surface and air pressure applied to separate the slab from the mold without danger of cracking the slab in its weak condition. This procedure may be subject to some modification for large area molds wherein it may not be possible to prevent the falling away of some solids if the mold be withdrawn in inverted position. In that event, it is desirable to withdraw the mold from the slurry open side up, and thereafter to invert it and discharge the slab as just described.

The initial mixture is sufficiently fluid to allow the laminae and vermiculite granules adequate freedom to arrange themselves during dewatering process. As the liquid drained away, it carries the laminae and granules toward the perforated face, during which movement they naturally shift to bring their flat faces to rest parallel to the perforated face of the mold. The first layer of granules and laminae lie flatwise against the screen cloth and other granules arrange themselves flatwise upon the first layer, and so on, until all the laminae and granules have been arranged in a flatwise condition throughout the thickness of the slab. Such arrangement causes a substantial felting or interlocking of the laminae of the adjacent granules, besides that effected by the overlapping of thin plates and laminae. While the fibers in the mixture do not interfere with the arrangement and overlapping of the laminae, they do prevent the formations of a structure so impervious as to impede dewatering. Moreover, they perform the important function of preventing the migration of the cement with the liquid to the "bottom" of the mold. It will be understood that the smaller granules tend to arrange themselves between the larger granules. The percentage of small granules should, however, be minimized, since because of their small size, they do not respond so efficiently to the arranging action of the liquid, as do larger granules.

It is not essential for the above described action of the fiber that long fiber material be used. Indeed a short fiber asbestos of 0—0—5—11 Canadian grading is fairly satisfactory for this purpose. However, for reasons not fully understood, the longer fibers seem to produce a more rapid dewatering, probably because they can anchor themselves more effectively in the mass

in position to hold the granules and laminae "open", and are not carried with the liquid as it drains through the mass. To the extent that they serve as felting agents, longer fibers are also more efficient than short fibers. If the slab be intended for high temperature use, the fiber employed should, of course, be capable of safely withstanding such temperatures. Asbestos is a satisfactory fiber for high temperatures.

The magnesium oxide combines with a sufficient amount of the magnesium sulphate solution to form magnesium oxy-sulphate cement. The magnesium sulphate solution withdrawn during dewatering can be used again in other mixtures. In Fig. 3 an attempt has been made to illustrate on an enlarged scale, the approximate construction of the slab. Therein the fibers are designated by the reference character 21 and the binding cement by the reference character 22.

In Figs. 4 and 5 is illustrated another form of apparatus for molding the slabs. As there shown, the molds 23 have a perforated bottom comprising a perforated metal plate 24 upon which rests a screen cloth 25. Suction is applied to the perforated face of the mold by a suction box 26 having adjacent its upper edge a seat 27 upon which the mold may rest during the application of suction. A gasket 28 serves to prevent leakage around the edge of the mold. The mold bottom is supported at intermediate points by plates 29, which are perforated to permit access of suction and withdrawal of the liquid.

After dewatering, the suction valve 31 in suction line 30 is closed and the mold may be lifted off the suction box and inverted to discharge the dewatered slab. After the cement has partially set, the slab is dried as aforesaid.

Obviously the slabs may be dewatered by the application of forces analogous to suction, such as air pressure. The use of suction, however, has the advantage of simplicity in not requiring a closed mold.

The form of the mold may, of course, be varied in accordance with the shape of the slab desired. In making a slab for a pipe covering, the face of the mold is preferably semi-cylindrical in shape. Likewise the dimensions of the mold may be varied to suit the size of slab desired.

The slabs are advantageously initially made of substantial thickness, that is from 4½ inches to 6 inches and may be sawed longitudinally into two or more slabs of less thickness. To secure closely fitting joints between the slabs, it is desirable to saw the molded slabs so as to provide absolutely square and true faces. Waste may be minimized by making the slab initially of sufficient thickness to provide a plurality of slabs of less thickness. Because of the arrangement of granules, the slabs split so perfectly under the saw as to leave a very smooth sawed surface. The saw waste may be used again as a part of the finer aggregate.

Obviously the invention is not limited to the details of the illustrative methods or apparatus herein disclosed since these may be variously modified. Moreover, it is not indispensable that all features of the invention be used conjointly since various features may be used to advantage in different combinations and sub-combinations.

Having described my invention, I claim:

1. The method of making an insulating slab from granules of exfoliated vermiculite, fiber, and cement wherein the quantity of vermiculite is substantially greater than the quantity of cement, which method is characterized by suspending granules of exfoliated vermiculite together with thin plates or laminae of vermiculite in a cementitious slurry in which the vermiculite is buoyant, said slurry containing a small percentage of fiber, placing the aforesaid mixture in a mold having a perforated bottom, applying suction to draw out the liquid constituent of the slurry, said fiber holding the vermiculite in slightly separated condition to facilitate withdrawal of the liquid, said liquid being withdrawn without substantially compressing the vermiculite so as to leave the latter free to arrange its particles with their flat faces generally parallel to said bottom.

2. The method of making molded insulating material which comprises mixing a large amount of granules of exfoliated vermiculite and a small amount of fiber in a cementitious slurry comprising a relatively small amount of magnesium oxide and a sufficient excess of magnesium sulphate solution to form a slurry, said vermiculite being bouyant in said slurry and being substantially greater in amount than the cement in said slurry, suspending the magnesium oxide and fiber in the slurry by mixing and conveying the same therein uniformly throughout the mass of vermiculite, then placing the mixture in a mold having a perforated face and open to the atmosphere on its opposite face, withdrawing the excess liquid through the perforated face of the mold while leaving the granules of vermiculite free during such withdrawal to arrange themselves with their flat faces generally parallel to the perforated face of the mold, and holding the granules in slightly separated condition by means of the fiber to facilitate withdrawal of the liquid.

3. The method of making molded insulating material which comprises mixing a large amount of granules of exfoliated vermiculite and a small amount of fiber in a cementitious slurry comprising a relatively small amount of magnesium oxide and a sufficient excess of magnesium sulphate solution to form a slurry, said vermiculite being bouyant in said slurry and being substantially greater in amount than the cement in said slurry, suspending the magnesium oxide and fiber in the slurry by mixing and conveying the same therein uniformly throughout the mass of vermiculite, then placing the mixture in a mold having a perforated face and open to the atmosphere on its opposite face, withdrawing the excess liquid through the perforated face of the mold, the liquid as it is withdrawn being replaced by air passing into the material through the open face of the mold, said granules of vermiculite being left free during the withdrawal of the liquid to arrange themselves flatwise in overlapping and felting relationship, and holding the granules in slightly separated condition by means of the fiber to facilitate withdrawal of the liquid.

4. The method of making molded insulation from granules of exfoliated vermiculite which comprises suspending granules of exfoliated vermiculite containing many thin and flat particles in a cementitious slurry formed from a liquid and a solid constituent in which slurry said granules of vermiculite are bouyant, said vermiculite being substantially greater in amount than the cement in said slurry, said slurry containing a small percentage of fiber, placing the aforesaid mixture in a mold having a perforated face, applying air pressure to the liquid constituent of the slurry to remove the surplus liquid through the said face of the mold before the cement sets, said air pressure affecting only the

liquid and leaving the vermiculite free to arrange itself as the liquid leaves the mold into flatwise and overlapping relationship, and causing the fiber to lie between the overlapping vermiculite particles to provide passages for the liquid but preventing movement of the solid constituent of the cement with the liquid.

5. The method of making molded insulating material which comprises mixing a large amount of granules of exfoliated vermiculite and a small amount of fiber in a cementitious slurry comprising a relatively small amount of magnesium oxide and a sufficient excess of magnesium sulphate solution to form a slurry, the proportion of magnesium oxide not exceeding eight pounds per twenty-five pounds of vermiculite, said vermiculite being bouyant in said slurry and being substantially greater in amount than the cement in said slurry, suspending the magnesium oxide and fiber in the slurry by mixing and conveying the same therein uniformly throughout the mass of vermiculite, then placing the mixture in a mold having a perforated face and open to the atmosphere on its opposite face, withdrawing the excess liquid through the perforated face of the mold and during such withdrawal leaving the granules of vermiculite free to arrange themselves flatwise in overlapping and felting relationship, said fibers being located between the granules throughout the mass of vermiculite to hold the magnesium oxide against travel with the liquid.

PAUL S. DENNING.