

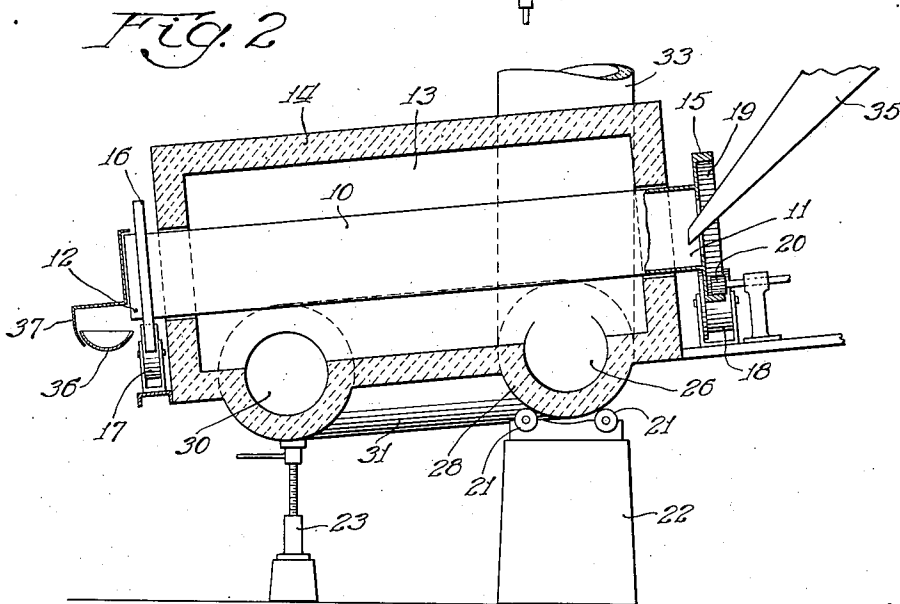
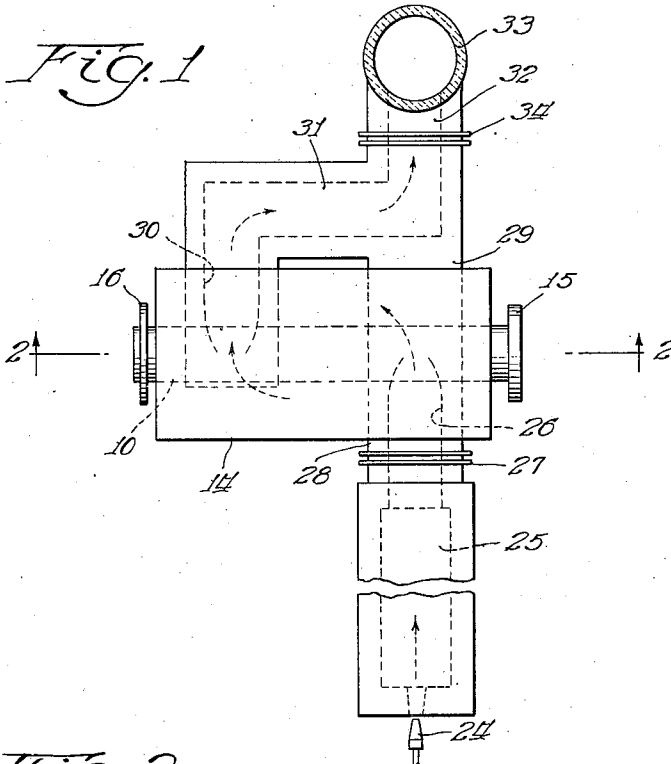
Dec. 9, 1941.

P. S. DENNING

2,265,358

APPARATUS FOR EXFOLIATION OF VERMICULITE

Filed Oct. 5, 1938



Inventor:
Paul S. Denning
By: Roland C. Rehm
Att.

UNITED STATES PATENT OFFICE

2,265,358

APPARATUS FOR EXFOLIATION OF
VERMICULITE

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

Application October 5, 1938, Serial No. 233,445

2 Claims. (Cl. 263—34)

This invention relates to apparatus for exfoliation of vermiculite and similar materials and, among other objects, aims to improve the quality of the exfoliated material and the efficiency and economy of the process and apparatus for exfoliating it.

The invention may be readily understood by reference to one illustrative embodiment thereof described in the following specification and illustrated in the accompanying drawing.

In said drawing:

Fig. 1 represents a plan view of the expanding apparatus; and

Fig. 2 is a longitudinal vertical section thereof taken on the plane 2—2 of Fig. 1.

Exfoliated or expanded vermiculite is an alteration product of particles of micaceous minerals, such as biotite, which exfoliate or expand to many times their original size upon the application of heat, to produce a material of extremely light weight (as low as four pounds per cubic foot). These minerals are variously named, generally depending upon the locality where found. For convenience, the term "vermiculite" will be used as a generic term to include those micaceous minerals which, like vermiculite, possess the property of exfoliation or expansion.

Since the weight or density of the expanded vermiculite is one index of its insulating efficiency, it is particularly desirable to reduce its weight as much as possible by securing a maximum expansion of the materials, without, however, impairing other physical characteristics. Reduction in weight is also desirable from the standpoint of cost per unit volume of insulation.

In the illustrative apparatus, the exposure of the particles to expanding temperatures is controlled to avoid production of brittle and friable granules which result from over exposure to expanding temperatures. During exposure to such expanding temperatures, the granules are maintained in relatively loose condition so as to be somewhat separated from each other to secure more effective exposure to expanding temperatures and to relieve the individual particles of the pressure of adjacent particles which would otherwise interfere with maximum expansion. During expansion the particles are relatively soft and offer little resistance to compression, and for this reason also the granules should not be heavily burdened by adjacent material. Moreover, in highly heated condition the bond between the cleavage planes is so weak that it is easily ruptured by an exterior load on the particles, allowing the steam which would otherwise distend

the cleavage planes to escape freely and to leave an incompletely expanded granule.

The illustrative apparatus is also capable of adjustment to varying conditions and demands. Small granule sizes require a shorter exposure to heat than larger sizes, and the time of exposure to expanding temperatures is, therefore, adjusted to the size of the granule. The capacity of the apparatus may also be adjusted to permit the continuous operation so essential to efficiency and long life of the apparatus. High temperature furnaces deteriorate rapidly when subject to intermittent operation. Moreover, considerations of economy require continuous operation; and for this reason adjustment in rate of output to demand is important. Adjustment in rate of output to minimize the need for storage space is of particular importance for a bulky material such as exfoliated vermiculite. Adjustment in time of exposure may also be made in the present apparatus to compensate for the different temperature conditions arising from variation in the rate of output of the apparatus.

Apparatus heretofore available has not been adequately flexible as regards size of granules treated or variations in rate of production. Inefficient expansion of granules or inferior quality has attended substantial variation either in granule size or rate of production.

I have found that when the particles of vermiculite are exposed to expanding temperatures (from 1600° to about 2000° F.) only long enough to effect expansion, and such expansion is permitted to take place freely (i. e., with the particles more or less out of contact with each other and more completely and efficiently exposed to expanding temperatures), the particles will expand to their maximum size and will be relatively tough or in so-called plastic condition, as distinguished from friable.

The best results as regards control of the exposure to heat are obtained by pre-grading and conditioning the particles of vermiculite as to moisture content, and then exposing the same to uniform temperature conditions, e. g., by exposing the sized and conditioned particles to expanding heat for uniform or predetermined periods. This is fully described in my copending application, Serial No. 23,015, filed May 23, 1935, of which this application is a continuation-in-part, and is repeated here briefly for convenience. Uniform exposure will produce uniform results on uniformly sized and conditioned particles. It is necessary, therefore, merely to determine experimentally what temperatures and what du-

ration of exposure are best suited for a given size of particle.

The sizing of particles is advantageously effected by passing the material as it comes from the mine through a low temperature drier, such as a rotary drier, and thereafter passing the same through crushing apparatus, such as a hammer mill to reduce the material to smaller sized particles. Thereafter the material is screened to classify it into classes of uniformly sized particles. By thus predrying the material, the sizing of the material is much more efficient since the fine materials and dust no longer adhere to the larger particles as is the case if classification be attempted while the material is in the moist condition characteristic of mine-run material.

In this connection it should be understood that the particles of vermiculite are flat or flake-like in character. The material, having the characteristic laminated structure, breaks up more readily along its cleavage planes than transversely thereto. Hence the particles are relatively thin transversely to their cleavage planes as compared with the dimensions of the flat face of the particles. It has been found that particles of uniform face area do not vary more than 10% in thickness. Therefore, in screening the particles through the ordinary square mesh screens, the sized materials are substantially uniform not only in the size of their flat faces but in thickness of the particles. This results in an improved product. On the other hand, sizing the particles by thickness alone is not practical since by ordinary methods there is too great a variation in the other dimensions of the particles.

The moisture content of the particles thus treated is also substantially uniform.

To secure uniformity of operation regardless of the season of the year, the material is heated to a uniform temperature prior to introduction into the expander. Among other advantages this avoids the need to adjust the apparatus for variation in temperature of the material at different seasons of the year. For this purpose the material is warmed to temperatures about 100° to 150° F. Heating to remove all the free moisture is not essential, but it is desirable however that the free moisture content of the particles be uniform and this uniformity is brought about by the initial drying of the material above described. Moisture, so long as the content is uniform, involves no difficulty since its presence in the material does not produce variation in expanding temperatures but merely absorbs a constant quantity of heat. While some absorption of moisture may take place after the conditioning treatment, the absorption will be practically uniform in particles of a given size. When exposed for uniform periods to expanding heat, the expansion of sized particles of uniform water content will be substantially uniform and produce a material of uniform plasticity without any appreciable proportion of friable material.

The expanding chamber of the illustrative apparatus is here shown in the form of an inclined rotary tube 10 adapted to receive the raw, sized and treated vermiculite at its upper end 11 and to discharge it at its lower end 12. Heat is, in this instance, applied externally of the tube by a heating chamber 13, the walls 14 of which are advantageously provided with a refractory lining.

The rotary tube may advantageously be made from some high fusion point or corrosion-resisting metal, such as so-called stainless steel, to maintain its strength and to prevent the rapid

corrosion which would otherwise occur at high temperatures. To secure an adequate heat input, the heating chamber temperatures are from 200° to 300° F. higher than the desired temperatures inside the tube, the latter remaining from 1600° F. to about 2000° F. The internal diameter of the tube may, of course, vary. I have found a satisfactory diameter to be about 16 inches. In substantially larger tubes, their interior may advantageously be provided with ribs or baffles which prevent movement of the particles through the tube by mere sliding and accentuate the desired tumbling action necessary to maintain the particles in relatively separated condition. The tube is advantageously provided adjacent its ends with circular rails 15 and 16 supported for rotation on spaced flanged rolls 17 and 18 in the conventional manner. The rail 15 is here shown provided with internal gear teeth 19 meshing with driving pinion 20 by means of which the tube is rotated at the desired speed.

The rotation of the tube in conjunction with its inclination maintains the granules in relatively separated condition for the aforesaid purposes by producing a bounding and tumbling action of the granules through the tube. While the time of exposure to expanding temperatures must be substantially longer than the time which would be consumed by free fall of the granules through the tube, the time must nevertheless be limited to avoid excessive exposure with the resultant production of defective material. Such control over the time of exposure is effected by adjusting the inclination of the tube. As stated above, such time of exposure varies not only with the size of the particles expanded but with the volume of material passing through the tube. In the present instance, the furnace is supported adjacent one end on roller supports 21 carried on the pier 22 and its opposite end is carried on a support 23, in this case in the form of a jack whose height may be varied. While the rate of travel of the material through the tube depends somewhat on the rate of rotation of the tube, regulation by this means is impractical since the rate of rotation of the tube should primarily be adjusted to maintain the granules in an adequately free or separated condition without excessively agitating them while in weakened condition.

Heat is supplied to the chamber 13 in the form of high temperature gases produced by oil burner 24. The combustion chamber 25 of the oil burner is connected to the circular inlet passage 26 of the combustion chamber through a collar or sleeve 27 which permits the slight rotation of the apparatus on its roller supports, necessary for adjustment of the angle of inclination of the furnace. The housing 28 for the inlet passage 26 is advantageously made circular to provide a circular surface to rest on the supporting rolls 21. Preferably this circular contour is extended to the opposite side of the furnace as at 29 to provide the circular supporting surface for that side of the furnace. The outlet 30 for the gases is, however, advantageously provided at the opposite end of the heating chamber 13 to require the hot gases to encircle the tube and to traverse the length of the tube in passing to the outlet conduit. As illustrated in dotted lines in Fig. 1, the hot gases enter the chamber 13 tangentially and are guided by its circular interior surface around the tube 10 and thence toward the outlet 30. The latter is connected by cross passage 31 to the outlet 32 (which is in

alignment with the extension 29), leading to the stack 33. Another collar or sleeve 34 is provided in the outlet passage 32 to permit the aforesaid relative rotation. The several gas passages 26, 30, 31, etc., are preferably provided with a refractory lining.

Any appropriate feeding means is employed for delivering the sized and conditioned raw vermiculite to the chute 35 from which it enters the apparatus. The rate of feed is preferably adjusted to demand. The apparatus can then be operated without the accumulation of excessive stocks of exfoliated vermiculite.

The expanded granules are advantageously quickly cooled after their discharge from the apparatus in a humid atmosphere. The humidity may be provided either by introducing steam or a fine spray into the atmosphere surrounding the granules during cooling. For this purpose the granules are preferably carried in a closed chamber or passage during cooling. Excess moisture should be avoided inasmuch as it would tend to increase the weight of the granules. I have found that cooling of the granules in a humid atmosphere very greatly increases their toughness—an exceedingly desirable property. In the present instance the granules are shown discharging on a metal belt 36 which conveys them to storage. The belt advantageously passes them through a surrounding housing 37 which serves to maintain a humid atmosphere with a minimum of added moisture.

I have found that the present apparatus operates efficiently in a wide variety of sizes and particularly in small sizes for low output. For reasons which are not wholly understood, apparatus heretofore available has been efficient in only a limited range of sizes, all at high capacity and unsuited for use in localities having a relatively small demand. The ability to produce exfoliated vermiculite efficiently and of good quality in small capacities is of great importance since the great bulk of vermiculite greatly increases the cost of shipping from a central point of production.

Obviously the invention is not limited to the details of the illustrative process and apparatus since these may be variously modified. More-

over 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 subcombinations.

5 Having described my invention, I claim:

1. Apparatus adapted for exfoliating vermiculite at a low rate comprising in combination an elongated heating cylindrical chamber having openings in the opposite ends, an inclined rotary tube extending through said chamber and projecting outwardly through said openings, said tube being formed of heat resisting metal, a conduit for delivering hot gases to said chamber, an exit conduit for carrying away said gases and having a portion thereof in axial alignment with the delivery conduits, portions of each of said conduits circular surfaces in axial alignment, supporting bearings engaging said surfaces for permitting the tilting of said chamber, means for supporting the opposite end of the chamber for vertical adjustment, means carried by said chamber for rotatably supporting said tube therein, and means for rotating said tube.

2. Apparatus adapted for exfoliating vermiculite at a low rate comprising in combination an elongated heating cylindrical chamber having openings in its opposite ends, an inclined rotary tube extending through said chamber and projecting outwardly through said openings, said tube being formed of heat resisting metal, conduits for delivering hot gases to said chamber and carrying the same away, portions of said conduits being in axial alignment and having circular bearing surfaces thereon, supporting bearings on which said bearing surfaces rest, said portions also having means to permit the same to rotate relatively to the extremities of said conduits, means for feeding vermiculite into the upper end of said tube, means for adjustably supporting the opposite end of said chamber in inclined position and adjustable to vary the inclination of said tube to adjust the time of passage of the vermiculite through said tube, and means including the rotation of said tube for maintaining said vermiculite in relatively separated condition for uniform exposure to the heat.

PAUL S. DENNING.

CERTIFICATE OF CORRECTION.

Patent No. 2,265,358.

December 9, 1941.

PAUL S. DENNING.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 17, claim 1, after "conduits" insert "--having--"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.
Signed and sealed this 4th day of August, A. D. 1942.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)