June 19, 1934. O. A. LABUS 1,963,275

PROCESS OF TREATING VERMICULITE

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Fig. 1.

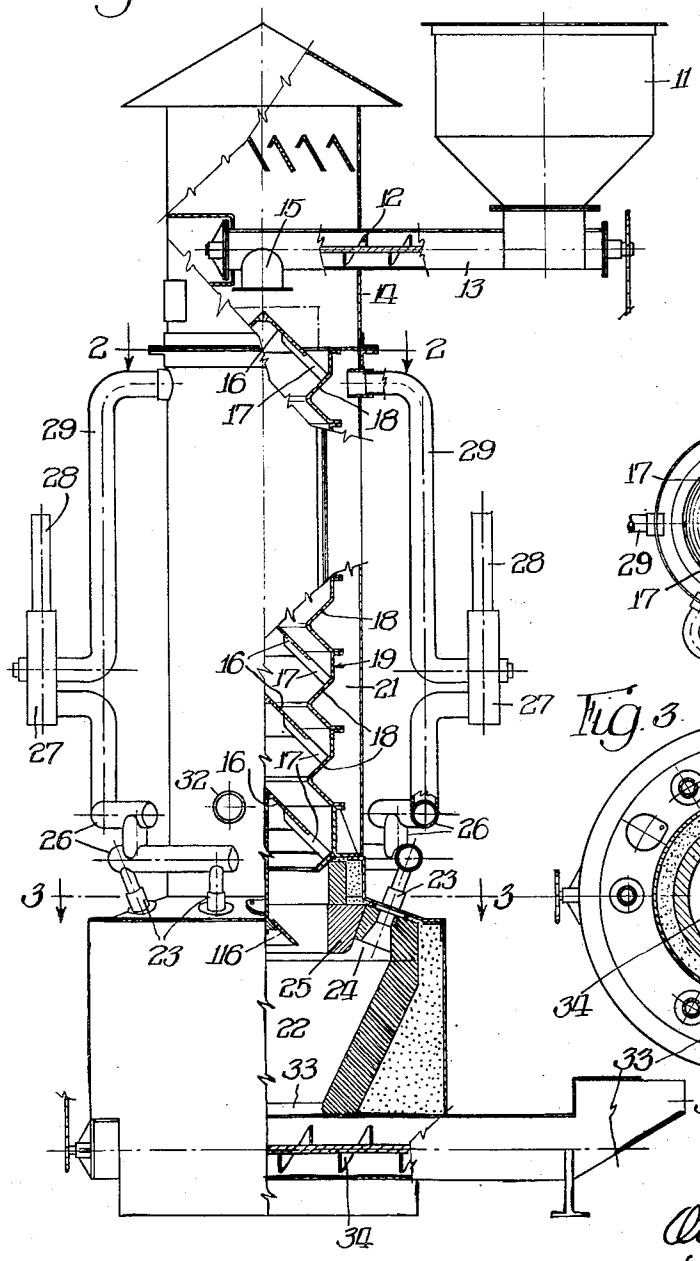


Fig. 2.

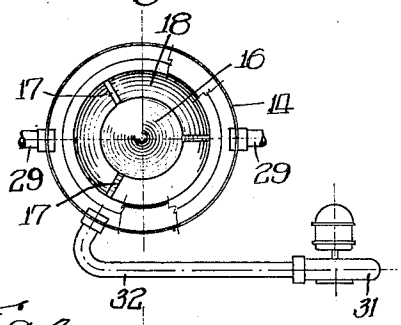
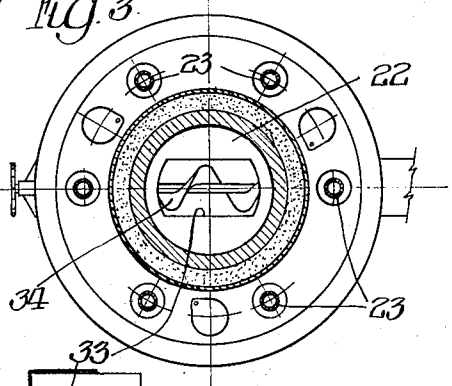


Fig. 3.



Inventor:
Otto A. Labus
By Walter M. Fuller
Atty.

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PROCESS OF TREATING VERMICULITE

Otto A. Labus, Wisconsin Rapids, Wis.

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14 Claims. (Cl. 252—1)

My invention relates to an improved and novel process employed in the transmutation or chemical transformation of micaceous minerals, such as those of the vermiculite group, whereby appropriate heat treatment of such a vermiculite ore changes it into a stable, expanded, more or less plastic, inorganic, highly-cellular material especially adapted for use as a heat-insulating medium.

One of the leading aims of the invention is to provide a process or method for the heat treatment of the mineral in a manner hereinafter presented in detail which has certain distinct advantages resulting in a highly efficient heating procedure, a greater volumetric yield of the finished product per unit of mineral heated, a positive control of the heat application to effect complete transmutation of the mineral mass, and a reduction to a minimum of the element of time of contact of the mass with the higher temperatures at which the transmutation or chemical change occurs.

The exfoliation, distension or enlargement of various types of vermiculite by subjecting the mineral to heat at high temperatures, either by indirect means or by subjecting the mineral to the action of gases of combustion, is not novel, but such procedures have well defined disadvantages and do not anticipate the features of the present invention.

By the old methods of operation the mineral is heated at the comparatively high temperatures at which exfoliation takes place without preliminarily thermally preparing the mineral mass for such treatment or without preheating the mineral at temperatures below that at which such distension or enlargement occurs to reduce to a minimum the heat demand required for complete transmutation of the mineral mass with a minimum interval of contact of the mass with the heat at high temperatures considerably above that at which exfoliation takes place.

In the methods heretofore practiced by which the mineral at normal atmospheric temperatures and otherwise thermally-unprepared for chemical modification or transmutation is subjected directly to elevated temperatures considerably above that at which exfoliation occurs, portions of the mineral masses or granules are subjected to excessive heating before the other particles are sufficiently heated, with the result that a product is produced which is more or less undesirable for employment as a heat-insulating medium, because it is more or less readily friable and comparatively easily comminuted; and, furthermore, portions of the mineral mass may be only partially rather than completely transmuted.

Under practical operating conditions, the granules of the mineral are not uniform in size and shape when subjected to the heating process which also has undesirable influences on the transmutation operation where no consideration is given to reducing the stated inequalities of the mineral to be treated.

One of the particular advantages accruing from the employment of my improved process is the proper and adequate thermal preparation of the mineral ore to reduce to a uniform condition the inequalities of heat content common with micaceous minerals, especially those of the vermiculite group, directly preceding the heat treatment for its transmutation through which its enlargement or distension is brought about.

The specified mineral in its natural condition contains a variable amount of free moisture and also moisture held by adsorption, both of which moisture contents have a marked influence in the hindrance to rapid and uniform heat transmutation of the mineral particles.

It is well known that vermiculite when subjected to heat at high temperatures exfoliates or swells in large degree, but this phenomenon is not an explosion of the mineral mass being rather a progressive exfoliation from its outer surfaces to the adjacent, laminated, inner mass.

This peculiar or characteristic reaction to heat may be more or less aptly termed "defensive heat resistance", because the outer surfaces of the mineral mass which are directly exposed to the heat become exfoliated first and form a high resistance to the heat flow into the inner mass of the mineral, due to the fact that these transformed or modified surfaces are of a highly cellular formation of good heat-insulation qualities and they assume a color change from the original dark shades of the mineral to a brilliant hue with an added heat resistance due to reflection.

This combined resistance to rapid, uniform, and complete transmutation of the mineral by the driving off of its water of crystallization or of constitution is minimized to a degree where practically only the actual heat to cause such change is the function of the high temperature stage of the new and improved process in which the mineral is first sized and then preheated at a low heat gradient until the entire mass of all granules of mineral is brought to a temperature slightly below that at which exfoliation begins, which is approximately 300° Fahrenheit, this preliminary heating driving off the free and adsorbed moisture, which initial treatment is distinctly desirable in order to render the process more expeditious, to secure later maximum expansion of the material and to reduce the friability of the product to a minimum, since the mineral granules are receptive to heating without the occurrence of the heretofore-stated objectionable resistance.

This preheating stage of my process is subsequently but directly followed by a high-tempera-

ture heating characterized by a heat gradient above the temperature at which exfoliation occurs, but, of course, temperatures in excess of the fusion temperature of the vermiculite are avoided.

The new process may be described more specifically in connection with the apparatus illustrated in the drawing by means of which it can be conveniently and commercially practiced.

In this drawing:—

Figure 1 is a partial elevation and partial vertical section of the heating appliance;

Figure 2 is a horizontal section on line 2—2 of Figure 1; and

Figure 3 is a horizontal section on line 3—3 of Figure 1.

The vermiculite mineral reduced to proper size particles, say from a half-inch down, is introduced into a hopper 11 from which it is fed over into the main portion of the furnace by a screw-conveyor 12 revolved by power in any approved manner and rotating in a shell 13 in which the material is carried forwardly through the wall 14 of the heater to the center of the latter where the shell 13 is fitted with downwardly-directed delivery-outlet 15 located over the center of a tier or series of concentric, vertically-spaced cones or baffles 16, each supported by its legs 17 resting on the corresponding, inwardly-sloping section 18 of a corrugated inner wall 19 spaced inwardly away from the outer wall 14, thereby providing an annular chamber or jacket 21 between them.

As will be readily understood, the mineral granules deposited by the screw-conveyor 12 on the center of the uppermost, cone-shaped baffle 16 slide down the latter in a thin stream in a diverging path on to the topmost wall-section 18 which redirects them inwardly in a converging manner on to the top of the second cone down which they glide as in the case of the first cone or baffle on to the next lower wall section 18, and so on down the whole series.

Such tortuous passage or flow of the mineral particles or granules spreads them out in successive, vertically-spaced, thin, diverging layers through which the ascending combustion-gases can readily pass and transmit a portion of their heat thereto, such particles being more or less reassembled by the converging surfaces 18 before each next distribution.

The lower portion of the heater or furnace has a combustion-chamber 22 directly below and concentric with the lowermost or final distribution cone 116 which is centrally supported from the next cone 16 above in any approved fashion, whereby the mineral granules are delivered downwardly and outwardly into the combustion-compartment in a shallow stream.

As is shown, the combustion-chamber is equipped with a suitable number of equally-spaced, downwardly and inwardly directed fuel-burners 23, 23 which project their flames initially into an upper, annular portion 24 of the combustion-chamber protected from the incoming mineral by a depending or curtain wall 25.

Such burners receive their air and fuel mixture through appropriate piping 26 connected to a pair of mixers 27, 27 of proper design and receiving fuel through conduits 28, 28 and air through pipes 29, 29 connected to the top of jacket 21 into which the air is fed by a blower 31 and a pipe connection 32 to the lower part of such surrounding jacket.

The bottom of the combustion-chamber 22 delivers the finished product through an opening 33 into a screw-conveyor 34 which discharges it at 35.

As will be readily understood, each particle of the mineral mass, which continuously descends over the baffles, is successively subjected, as it bridges the spaces between the lower edges of the cones and the wall 21, to the heat of the ascending products of combustion which escape at the top of the appliance through a stack 33.

Thus the mineral in its travel down the cones, which may occupy a few seconds, is gradually heated to a temperature above 212° Fahrenheit but below 300° Fahrenheit, a suitable temperature being 275° Fahrenheit.

This assures that all of the particles have been heated uniformly throughout sufficiently to drive off their free moisture and the moisture of adsorption, but without effecting any expulsion of water of crystallization or constitution or producing any change in the chemical composition of the mineral.

Nor is the temperature employed sufficient to bring about any substantial exfoliation, distension, or swelling of the mineral granules.

This prevention of excessive temperature in this portion of the apparatus is occasioned by the heat absorbed by the constant stream of incoming raw mineral and the continuous cooling of the baffle-equipped preheating flue by the air cooling the jacket around it.

When the mineral is discharged into the lower combustion-chamber it is rapidly heated above 300° Fahrenheit adequately to cause quick transmutation into a somewhat-plastic, foamy, porous or spongy product of much greater volume and correspondingly less density than the original ore.

The combustion gases in the chamber may be in the neighborhood of 2000° Fahrenheit, but this of course does not mean that the mineral itself reaches such temperature, the mineral by reason of the furnace construction used not coming into contact with the flames directly as they issue from the burners.

The fact that the preheating and the final heating of the mineral occur in a substantially non-oxidizing atmosphere tends to produce a product which is plastic rather than materially friable, as occurs in the ordinary vermiculite-calcining process.

One important advantage of the new procedure resides in the fact that the initial or preliminary heating of the mineral at a comparatively-low temperature rate or gradient prepares the material for maximum transmutation when subjected to the final high heat because each particle then is transformed throughout its mass without encountering a surface change which hinders or retards the necessary internal transmutation throughout for best results.

The apparatus illustrated and described for practicing the new process is continuous in its operation, but it will be apparent that the principles upon which the invention is based are not limited to such continuity of action, since a batch process might be used without, of course, having the advantages which accrue from the employment of the continuous process.

It will be readily understood that the required conditions for satisfactory and efficient practice of the new method can be comparatively easily brought about by regulation of the speed of action of the conveyors and by controlling the working of the burners, thus establishing the proper relation between the feed of the mineral

and the temperature of the gases to the heat of which the mineral is subjected as explained above.

Such control is maintained that the heat in the main heating chamber is only sufficient to make a materially plastic product, a more or less friable material being produced if the degree of heat is excessive.

The plasticity of the exfoliated vermiculite is further favored by reason of the fact that both steps in the heating process are conducted in a substantially non-oxidizing atmosphere composed in part by the gaseous products of combustion and in part by the steam generated by the expulsion of the moisture from the mineral undergoing treatment.

Additionally, it is to be observed that the heat absorbed by the mineral to effect its transmutation may be of such amount that the temperature of the gases will have been so lowered that they can be employed immediately thereafter for the initial preheating step of the process.

The invention is not limited or restricted to the precise and exact details of procedure herein outlined and various changes may be resorted to without departure from the heart and essence of the invention as defined by the appended claims and without the sacrifice of any of its material advantages, for example, instead of employing burners for the combustion of fuel electric heating may in some cases be resorted to with advantage.

I claim:

1. The process of treating a mineral of the vermiculite group consisting in preliminarily heating the mineral at a sufficiently low temperature gradient both to heat the mineral and to expel its uncombined moisture but below the temperature required to drive off its water of constitution and then directly thereafter heating such preheated mineral at a relatively-high temperature gradient sufficient to expel its water of constitution, whereby to obtain a stable, highly-cellular product through the transmutation of the mineral by the expulsion of such water of constitution.

2. The process of treating a mineral of the vermiculite group consisting in preliminarily heating the mineral at a temperature between 212° Fahrenheit and 300° Fahrenheit for a sufficient length of time both to heat the mineral and to expel its uncombined moisture and then directly thereafter heating such preheated mineral at a temperature above 300° Fahrenheit to expel its water of constitution, whereby to obtain a stable, highly-cellular product through the transmutation of the mineral by the expulsion of such water of constitution.

3. The process of treating a mineral of the vermiculite group consisting in preliminarily heating a continuous stream of the mineral at a sufficiently low temperature gradient whereby all of the fully preheated particles will have reached a temperature to expel their free and adsorbed moisture but below the temperature required to drive off their water of constitution, and substantially immediately thereafter continuously heating such fully preheated stream at a relatively high temperature gradient to quickly convert the mineral particles into a stable highly-cellular product by the expulsion of their water of constitution.

4. The process presented in claim 1 in which the relatively-high temperature gradient heating is insufficient to render the product materially friable.

5. The process presented in claim 2 in which the heating above 300° Fahrenheit is insufficient to render the product materially friable.

6. The process presented in claim 3 in which the final heating is insufficient to render the product materially friable.

7. The process presented in claim 1 in which all of the heating of the mineral takes place in a substantially non-oxidizing atmosphere.

8. The process presented in claim 2 in which all of the heating of the mineral takes place in a substantially non-oxidizing atmosphere.

9. The process presented in claim 3 in which all of the heating of the mineral takes place in a substantially non-oxidizing atmosphere.

10. The process of treating a mineral of the vermiculite group consisting in preliminarily heating the mineral at a sufficiently low temperature gradient both to heat the mineral and to expel its uncombined moisture but below the temperature required to drive off its water of constitution and then directly thereafter heating such preheated mineral at a relatively-high temperature gradient sufficient to expel its water of constitution, whereby to obtain a stable, highly-cellular product through the transmutation of the mineral by the expulsion of such water of constitution, said relatively-high temperature gradient heating being insufficient to render the product materially friable and all of the heating of the mineral taking place in a substantially non-oxidizing atmosphere.

11. The process presented in claim 1 in which all of the heating is effected by substantially non-oxidizing gaseous products of combustion brought into direct contact with the mineral, first to effect the expulsion of the water of constitution of some of the mineral and then to effect the preheating of other portions of the mineral by the same gases after giving up some of their heat for such expulsion.

12. The process of treating a mineral of the vermiculite group consisting in preliminarily heating the mineral at a relatively-low temperature gredient to raise its temperature to a point below but near the temperature required for its exfoliation and immediately thereafter heating such preheated mineral at a comparatively-high temperature gradient to effect its exfoliation.

13. The process presented in claim 12 in which the comparatively-high temperature gradient heating is insufficient to render the product materially friable.

14. The process presented in claim 1 in which all of the heating is effected by the combustion of fuel and in which all of the mineral undergoing treatment is subjected to contact with the substantially non-oxidizing products of such combustion, the portion of the mineral exposed to the preliminary low-temperature gradient heating being also subjected to contact with the steam resulting from the relatively-high temperature gradient heating of another portion of the mineral.

OTTO A. LABUS.