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M. B. CHURCH

GRINDING AND TEMPERING DRY MATERIALS

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Fig. 1.

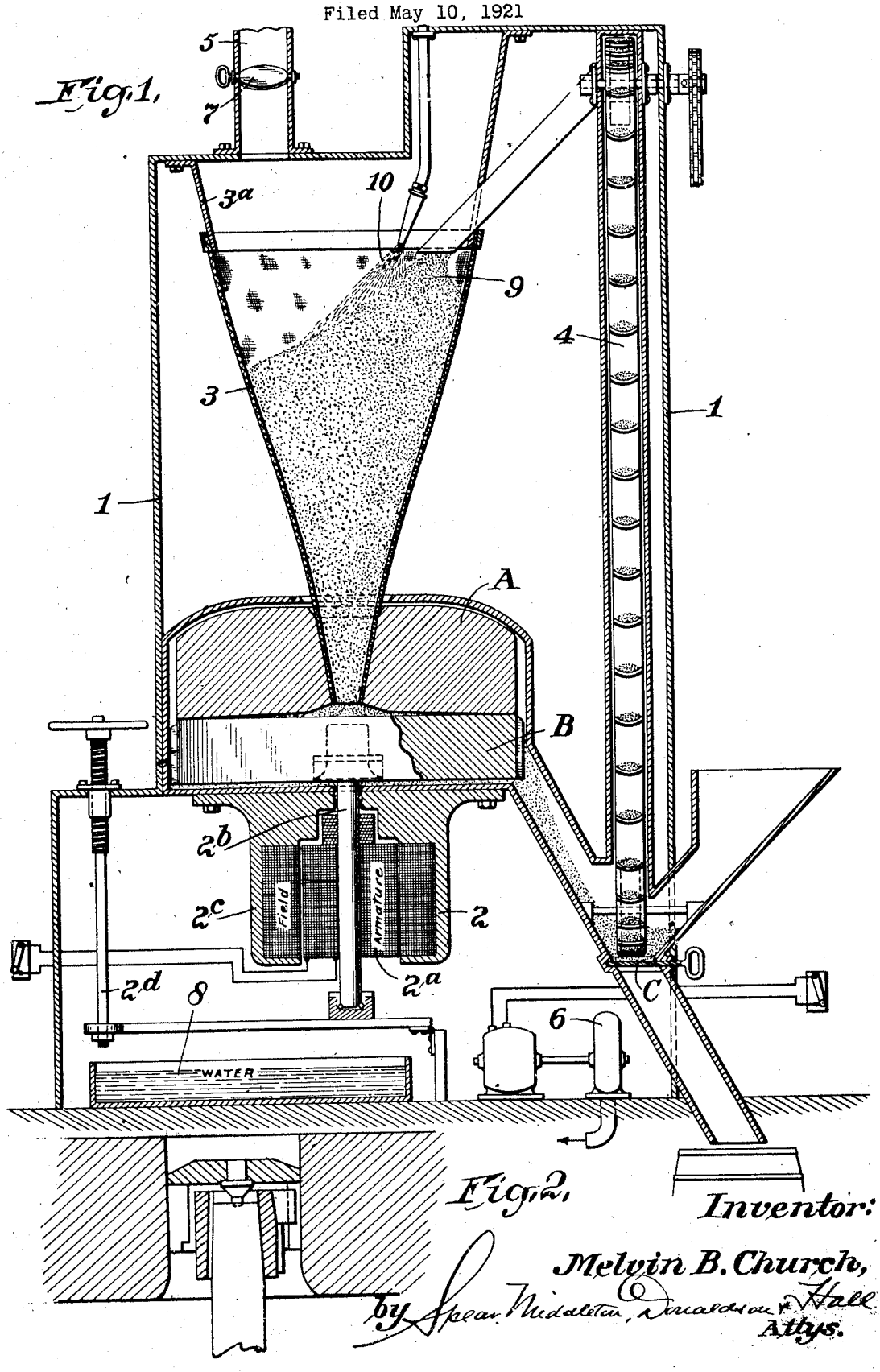



Fig. 2.

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# UNITED STATES PATENT OFFICE.

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## GRINDING AND TEMPERING DRY MATERIALS.

Application filed May 10, 1921. Serial No. 468,398.

I desire to refer to my application, Serial No. 233,328, filed March 8th, 1918, covering a method of multiple-grinding, which uses my patent millstone method of June 13, 1882, designed for grinding dry or powdered materials, as ground gypsum.

In the present drawings

Figure 1 is a diagramatic view of the apparatus.

Figure 2 is a sectional view of part of the lower stone and the means for balancing it on the upper end of the vertical shaft.

I take any type of grinding mill or attrition apparatus and install it, and all of its manipulating apparatus, within an enclosure 1. For some purposes, its driving apparatus 2 is also located within said enclosure.

The object of enclosing the whole apparatus is to permit regulation and control of the condition of the air within; to dry it out or to moisten it or to regulate the temperature of the air within the enclosure, and of the material to temper it, while it is being ground or cycled through the bin and mill during the multiple-grinding or triturating process described in said pending case. Essential elements in this apparatus are a bin or storage receptacle 3 for the bulk of material to be treated in one operation and elevating and carrying means 4 to carry the material to the bin and to feed it to the grinding or triturating mill A. B. and to pass the material a multiple of times from bin to millstones and from millstones to the bin according to the degree of fine division, or triturated, or of calcined, dry, moist, or tempered condition of the material being dealt with.

This enclosure is to be built of material having capacity to allow air to pass through its walls or to retain it as may be required and to act as an insulator against the passage of heat or cold to or from the interior and to and from the material being treated within the enclosure. The enclosure must be provided with means to allow moisture to pass off as through a stack 5 at the top or to be drawn off by an air pump 6 and to produce more or less vacuum within the enclosure in case the material requires such treatment. Also a valve 7 to close or open the outlet as may be required; also means 8 for supplying moisture to the air within, if required. This latter may be accomplished by means of a trough of water within the enclosure or by any suitable means, the trough being merely representative of any means adapted for the purpose.

When I employ an under-runner millstone to do this grinding or triturating, or a disk of metal, revolving horizontally, I use a bin or container of canvas or similar flexible, and, preferably porous material, to hold the charge of material to be dealt with, to avoid the usual troublesome forming of openings through the center of the body of the material in the bin and to keep the body of material moving while the grinding is proceeding. This bin I construct with evenly tapering sides, starting wide enough at the top, about thirty inches, and long enough, about ten feet, to hold about 2000 pounds of the powdered material, such as gypsum, to be treated in the multiple handling of the whole batch. This bin tapers down to about six inches and extends through the eye of the stationary upper stone A and of the full diameter thereof so that the flexible material will press against the sides of the opening or intake of the stone above the running disk. The lower discharge opening is close to the surface of the lower running stone B. With this canvas bin I am able to dispense with all other means for feeding the material. With it the material is fed from the bulk in the bin uniformly to the space between the disks. One of the disks or stones has an inverted dished form and the face of the other is level and preferably both have smooth faces. I have the dish preferably about exactly as described below. The revolving action of the disk at the opening of the lower end of the bin which terminates very close to the running disk, draws the powdered material, as I have found, between the disks and fills the opening between them more or less according to speed of the running disk. In dealing with gypsum, which has been ground first to ordinary gypsum plaster grade, I cycle this through this multiple-grinding system between the disks, dished and smooth, as above described, until it is reduced to an exceedingly fine state of subdivision so that it all passes through a 350 wire mesh screen with the aid of water, and this was estimated microscopically to be as fine as two-thousand five-hundred mesh and the particles to $\frac{1}{5000}$ of an inch in size, and although so very fine, this gives no

trouble in feeding through the canvas bin automatically to and through the mill and delivering it uniformly from between the disks.

This I did with uncalcined gypsum which ordinarily gives trouble in feeding from a bin or through a mill, even when ground to ordinary grade as land plaster; and notwithstanding the somewhat moist nature of the raw gypsum, I did not find it necessary to hoe or force the material by hand as is usually found necessary in feeding gypsum, even when calcined, from a bin, nor did I find it necessary to tap the side or shake the flexible sided bin to prevent the forming of the openings through the body of material being cycled, or to cause an even flow to the mill; but on the contrary the raw gypsum passed freely and uniformly from the top opening of the canvas bin to the stones.

When any section of the canvas bin is filled, the walls, being flexible, and so under stress from the pressure of the weight of the material within yields towards the center when the pressure against the sides is relieved, by the forming of open spaces within the mass and thus closes the openings as fast as any are formed. This takes place at the bottom near the running disk which draws the whole bottom portion of the mass from wall to wall, and so on as the mass settles down, from the top to the bottom.

When I use my multiple millstone grinding system, mentioned above, and described more particularly in my pending application above mentioned, which also refers to my mill patent of 1882 using two smooth horizontal stones in combination with the canvas bin to act as the uniform feeding means, I find it preferable to have the degree of dishing or dished opening between the disks or stones regulated to the exact form as follows: Starting at a zone about four inches from the eye, the depth of the space between the stones is to be $\frac{1}{8}\frac{1}{6}$ of an inch. From this zone to the eye, the depth can vary to suit the size of the material fed into it. From this zone where the regular dish starts the depth of the space diminishes gradually to a flat face at the skirt sufficient for the staffing to level the faces of the disk. The dish is required to make room for the material which is to spread out thinner over the face of the disk as it is propelled by centrifugal force, making it travel by a circuitous movement round and round the face of the stone until it reaches the periphery of the stone. This perfection of dish I reached after recent extensive practical tests by changing the contour of the face of the stone many times. The first or deeper dishing may be such as to extend to a point farther from the eye than the four inches described, and still work well but the mill is thus robbed of a part of its effective grinding surface or capacity which requires such proportions as to hold and rub the particles of material together to grind them by attrition, without setting the stones so that the faces will abrade each other, when running without the material between them. The grinding and delivering and intaking capacity of the mill is increased by increasing its R. P. M. I found in practice that with a 36 inch stone I ran this at 350 R. P. M., the capacity of the mill was doubled over that obtained when the same stone was run at 250 R. P. M. In these tests I stopped the stone with the eye full of ground raw gypsum to change to a smaller pulley on the line shaft for slower speed, the feed between the disks from the eye full of gypsum continued to be delivered properly at the slower speed. Extra heavy bands are placed on the stone to permit of very much higher speed up to say 1000 to 2000 R. P. M. of the 36″ disk. I may make the disk of cold rolled steel to permit of practically unlimited speed and thus obtain increased results accordingly.

By running the disks apart and using a cooling bin to pass the material in and carrying it back to the bin, I so treat it until as finely divided as required; or triturated, with more or less pressure on the material for abrasion as may be required, I am able to use disks at very high speeds without excessive heating of the mill or material.

When a large quantity of material is to be carried in a bin, I may build the lower portion only, to hold about 500 to 1000 pounds, with the opening at the top about 30 inches, letting this opening enclose the lower discharge opening of a bin $3^a$ above made from sheet metal or wood or any suitable material in form to support the heavy weight. The walls of the upper bin form substantially continuations of the wall of the lower canvas bin and at the same inclination in respect thereto. The opening into the canvas part being so large that the material will not arch over it nor will small holes form in the upper part through the mass, because the whole bottom of the upper bin is kept open by the discharge of the material from the canvas bin having a top opening of the size approximately, as given above, and because the whole body of material is moving slowly downward from the top of the canvas bin.

Whereas by this multiple method of handling the material within the enclosure to grind the composition I do not require air or other separating means to obtain an extremely fine subdivision, I do not by my multiple method change the proportions of the composition as must happen where floating or sieving is employed.

In describing my multiple grinding method in the foregoing I have had in view its use, amongst others, making the plastic gypsum described by Professor W. E. Emley, Chief of the Section of the U. S. Bureau of Standards having in charge, gypsum, lime and sandbricks. The Emley invention consists of plastic calcined gypsum, and the process of producing the same, which comprises, briefly, the grinding of calcium sulphate and controlling the percentage of water contained in the finished product, by grinding it in the presence of its water content, or supplying additional water thereto, before or during the grinding operation to make up for that lost during the grinding.

My improved apparatus herein described is intended to carry out the Emley and other processes.

I have before mentioned that I may calcine the gypsum by this multiple-method apparatus enclosed by walls with means to let the air and moisture pass off until it is desired to again retain the air and moisture within the enclosure. By this method I am enabled to use raw gypsum or material having more or less water content, as suggested in Mr. Emley's specifications or to introduce to the gypsum the amount of water content required in Mr. Emley's specifications.

Where electric power is available, I prefer in using my type of millstone mill, to grind by attrition or for any kind of grinding with an under-running horizontal disk, I prefer to drive the stone by means of an armature $2^a$ built around the spindle $2^b$ of the stone. This I accomplish with the field frame $2^c$ attached to the frame of the mill and means $2^d$ to permit of moving the armature while running laterally within the air gap, between it and the field to adjust the stone up or down, by means of its lighter bar to vary the space between the disks running apart, the lower stone being balanced on the top of the spindle. This not only acts to save power as in all directly connected motor drives but steadies the balanced lower running stone without contact with the upper stone as in my multiple grinding described herein. This also enables me to have the driving motor within the small space provided by the enclosure.

The canvas bin mentioned, to be effective as proposed as an automatic feeding aid, must be directly over the mill and the elevating means should be adapted to carry the material straight up to the top of the bin, substantially, in cycling the material through the multiple system. This I propose to accomplish with an air pump using the same air, as that within the enclosure, and, to save space within, I may have the carrying means and the driving means outside of the enclosure and a tight spout provided from the mill discharge to the carrying means and from that to the bin at the top over the mill; and where I must use ordinary cup and belt means to do the elevating, I will enclose the legs which contain the belt and cups, within air-tight extensions of the enclosure.

When more heat is desired within the enclosure to treat any kind of material, than is generated by the grinding and driving means, I can introduce it without disturbing the air, by carrying it in the form of electric current to electric heating coils within, or by applying heat to the outside of the enclosure when it is made of metal.

For some kinds of grinding or treatment of materials by means of my multiple grinding with millstones or disks, or by the use of any type of mill, I will set a pair or a nest of mills so that one will deliver its material to another, and from that to more if need be, and where it is desired to temper gypsum, as above described, using the same air in cycling, or passing the material through a mill a multiple of times, I will enclose each mill as described in the foregoing, and either have the nest of mills within one general enclosure or have the enclosures connected by air-tight spaces or with air-tight conduits running from the one to the other and thus maintain the same degree of moisture or temperature throughout the system.

In case where it is desirable to keep the whole body of material moving because of the tendency for the particles to adhere together or to settle together in a packed condition when not moving, my canvas bin described, from which the whole mass contained therein is drawn from all of its space from wall to wall, as in this case where the revolving disk draws the material from the bin, provides for such continuous movement of the particles throughout the whole mass.

In making the retarded gypsum of commerce, the present practice usually followed is to mix a dry retarder made with animal matter and lime, with the neat calcined gypsum in a mixing box, and sometimes a fiber, such as sawdust, is added in the mixer. With my method described in the foregoing, I can introduce such dry retarder and fiber and the mixing is thus done incidently, during the cycling of the material through the system. Where the fiber to be used is of that nature that no more grinding is required than is done by the saw or other means used, I can defer the addition of the fiber until the last part of the cycling when I place the stones far apart so that no grinding takes place while they assist in the thorough mixing of the retarder through the mass.

When the retarding element is animal matter, as described in my patent of 1875, No. 161,591, this method makes it possible to use such animal matter in liquid form, as where it comes direct from the rendering tanks of glue works or packing houses..

When I use the liquid retarder in connection with the method and apparatus which I wish to cover by this application, I introduce it in the form of spray as at 10 by means of a pump, or the usual spraying apparatus, as described in my Patent No. 487,608 of 1882. This spray I introduce at the top of the bin, preferably to mix with the gypsum as it enters the enclosure at 9 and just before the cycling is finished that sufficient mixing of the retarder may be accomplished, during the one or more cycles through the system. As only about one pound of such retarder is required per hundred pounds, the free water content will be dissipated or diffused through the mass so that no further drying is needed.

I can also by the same means take the ordinary form of crushed gypsum as it comes from the rock crusher where the aggregate of the mass is, say, below one inch in size, and by placing the lower disk far down so that the opening between the disks is, say, one fourth of an inch at the skirt, while the crushed rock passes through the stones the first time, then I bring them nearer together for the further cycling of the material and I so reduce the rock to about land plaster grade by thus passing the second time, through the stones.

By the method and means described in the foregoing, I am able to take the raw gypsum into the apparatus and discharge it in a finished, dehydrated, tempered and retarded condition with or without grinding beyond the first ordinary grinding of the raw gypsum, or the neat gypsum, ground exceedingly fine, thus making either product ready for the market with the one handling, i. e., to place it into and take it away from, the apparatus when finished.

I find it convenient sometimes to feed additional material into the enclosure while the triturating is being done, as in cases where I add retarder before all of the triturating is done. To do this without introducing air to a substantial degree, I take the material to be so added from the bottom or top of a mass or bulk of it, and so take no flow of air with the material. This I accomplish with one of my screw feeds mentioned herein which draws its supply from the inner body of the bulk and thus the material is forced within the triturating apparatus. Likewise, when I wish to draw a portion of the material from the enclosure, while the triturating is still going on, I discharge it from the apparatus at C into one of my conveyor feeds with which I deliver the material to the shipping packages or final storage bins when finished. This conveyor being covered except where the material is discharged into it, prevents any appreciable quantity of air flowing back into the enclosure where the triturating is going on.

In feeding the material from the outside into the apparatus and in taking material away from the enclosure, the inlet pipe and the outlet pipe are kept full to prevent the ingress of outside air and these feeding and discharge means may consist of screw conveyors.

What I claim is:

1. A triturating apparatus comprising triturating means, a substantially air tight enclosure therefor, and means within the enclosure for feeding substantially dry powdered material to the triturating means, while isolated from the variations in external atmospheric conditions.

2. A triturating apparatus comprising triturating means, a substantially air tight enclosure therefor, and means within the enclosure for feeding the material to the triturating means, and means for maintaining the atmospheric condition within the enclosure at that prescribed, and isolated from varying conditions of the external atmosphere, substantially as described.

3. A triturating apparatus comprising triturating means, and automatic feeding means which passes the dry powdered material through the triturating means a multiple of times, and a substantially air tight enclosure for said triturating and feeding means, whereby the multiple trituration and feeding are carried on under prescribed and substantially maintained atmospheric conditions, substantially as described.

4. A triturating apparatus comprising triturating means, a substantially air tight enclosure therefor, and means within the enclosure for feeding the dry powdered material to the triturating means, said feeding means including a storage bin from which the material automatically feeds to the triturating means, and to which the material is automatically fed back again from the delivery of the said triturating means.

5. A triturating apparatus comprising triturating means, a substantially air tight enclosure therefor, and means within the enclosure for feeding the powered material to the triturating means, and modifying means within the enclosure to attain the desired internal atmospheric conditions, isolated from the varying external atmospheric conditions, substantially as described.

6. In combination, triturating means for dry material, means for feeding dry material thereto, a substantially air tight enclosure for said triturating and feeding means whereby the triturating can be carried on

under prescribed atmospheric conditions within said enclosure and independently of atmospheric conditions outside said enclosure, means for driving the triturating means, and means of adjustment for the triturating means, said adjusting means passing air-tight through the wall of the enclosure whereby the triturating can be regulated without opening the enclosure and changing the atmospheric conditions, substantially as described.

7. In combination with means for treating and passing on or delivering dry powdered material, a bin for holding said material in bulk and in dry condition and delivering it to said means, said bin being of flexible material and tapering downwardly to its point of delivery to the said means, substantially as described.

8. In combination with upper and lower stones of a grinding mill, a bin of flexible material holding dry powdered material in bulk and delivering it to the mill, said bin being of downwardly tapering form with its lower end extending into the eye of the upper stone, substantially as described.

9. In combination with a fixed upper and a lower running stone of a grinding mill for dry material, a bin for holding dry material in bulk, said bin being tapered downwardly, composed of flexible material, and having its lower end extending into the eye of the upper fixed stone, substantially as described.

10. A multiple triturating apparatus comprising triturating means for dry material, a downwardly tapered bin of flexible material discharging the material at its lower end to the triturating means, and carrying means for raising the material from the triturating means to the upper end of the bin, substantially as described.

11. In combination, an upper fixed stone having a central eye, a lower runner stone delivering the powdered material after triturating at the skirt and a tapered flexible bin having its lower end extending into the eye of the upper fixed stone to near the upper face of the lower runner stone, substantially as described.

12. The hereindescribed process of reducing dry comminuted material to an excessively fine state of subdivision, which consists in subjecting raw material in an unseparated condition repeatedly to attrition while being repeatedly subjected to substantially horizontal centrifugal action, said operations being performed in a continuous circuit, and storing said material between successive grindings.

In testimony whereof, I affix my signature.

MELVIN B. CHURCH.