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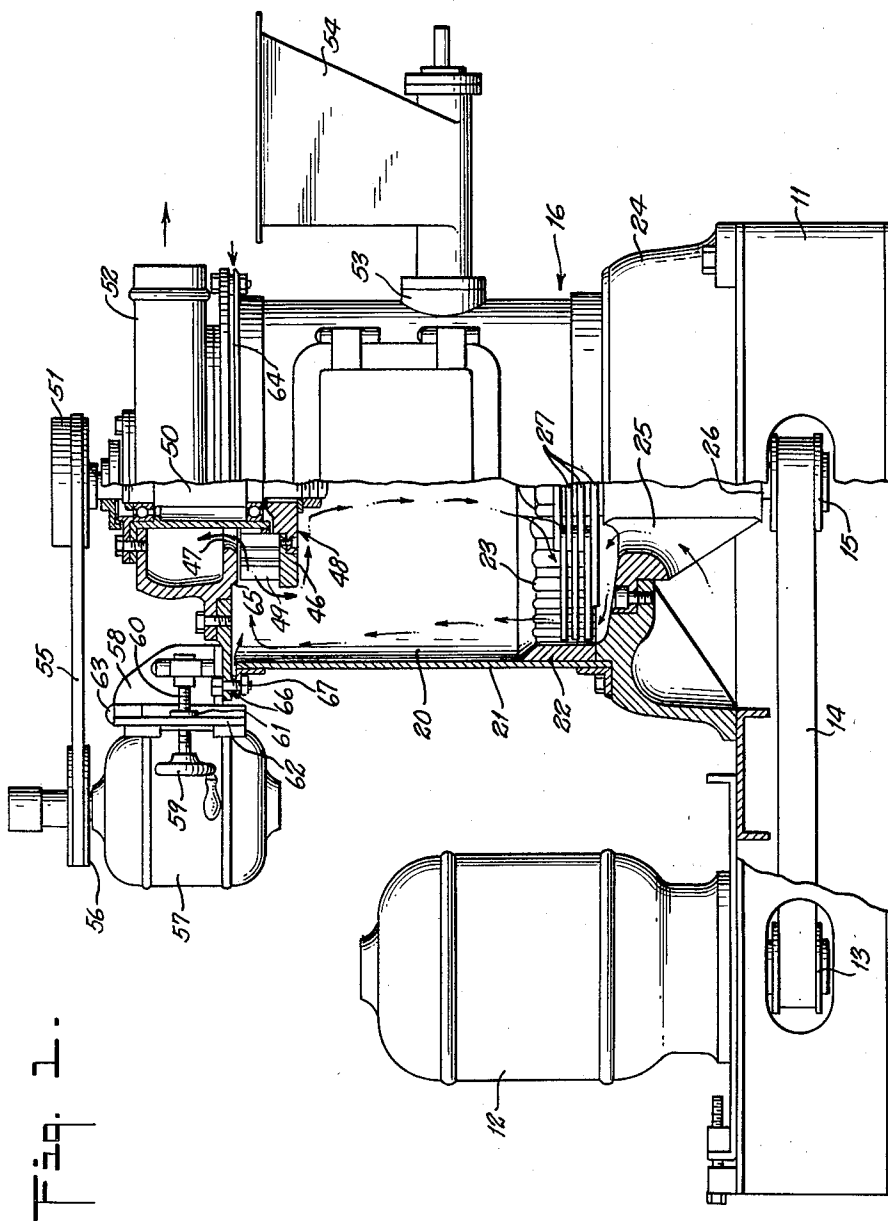
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VERTICAL PULVERIZING MACHINE

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VERTICAL PULVERIZING MACHINE

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This invention is concerned with a vertical pulverizing machine. More specifically, the invention involves an improved machine of this type for producing superior results in a more efficient manner.

An object of the invention is to provide an improved vertical pulverizing machine which has separate shafts with individual drives, one for the rotary pulverizer at the bottom of the machine and one for the separator at the top thereof. In this manner a superior control over the product being pulverized may be had and the final product will have greater uniformity of particle size and better density than heretofore possible.

Another object of this invention is to provide downward deflecting surfaces on the rotary hammers in the pulverizer. Such deflecting surfaces increase the efficiency and quality of the final product by tending to draw the particles downward that strike the upper row or rows of hammers, so that a maximum number of the particles will be held in the path of the impact surfaces of the hammers for obtaining the pulverizing action.

Another object is to provide a slot or other type of air inlet, at the top of the vertical chamber of the pulverizer so as to avoid a build-up of material around the upper periphery of the chamber. Such build-up of material would take place in the absence of the air inlet feature, and tend to cause large quantities of material to break off periodically and fall back down to the pulverizer section. These lumps or pieces of material tend to cause objectionable surges in the load on the pulverizer drive to the extent that it will surge and thus impair the efficiency of the action and operation of the machine.

Still another object of this invention is to provide a pulverizing machine having improved characteristics such that a batch of material ground therein to any given fineness has an improved density. Increase in density is desirable in practically all materials that are pulverized for various reasons depending upon the given material. One of the reasons for desirability of increased density is economy in packaging.

In addition, an object of the invention includes providing a machine, the efficiency of which is markedly improved, whereby it tends to run considerably cooler than machines heretofore. For this reason a machine according to this invention is able to process certain materials, e.g. castor wax which would tend to heat up excessively in prior machines, so that even when Dry Ice was used it was not feasible to process this material.

Briefly, the invention is concerned with a vertical chamber with a coaxial air inlet at the lower extremity thereof. The chamber also has a coaxial outlet at the upper extremity with a rotary separator juxtaposed in near proximity therewith. The chamber also has a material feed inlet situated between said extremities of the chamber for laterally introducing the material to be pulverized into the chamber. In addition, the machine has a rotary pulverizer including pivotally attached hammers as well as vertical sidewalls surrounding the hammers,

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the pulverizer being situated coaxially with, and adjacent to the air inlet. In such a machine an improvement comprises means for independently driving said separator and said rotary pulverizer in order to improve the action and efficiency of the machine, and to provide improved control of particle size.

The above and other objects and principles of the invention are set forth in greater detail below and described in connection with the drawings, wherein like reference numbers refer to like parts throughout, and wherein:

Fig. 1 is an elevation partly broken away to show the interior construction;

Fig. 2 is an enlarged detail view partly in cross-section showing the pulverizer section with pivoted hammers;

Fig. 3 is a downward, fragmentary view taken along the line 3—3 of Fig. 2; and

Fig. 4 is a detailed cross-section view taken along the line 4—4 of Fig. 2.

In Fig. 1 there is illustrated a view of the entire vertical pulverizer and classifier including a base 11 which supports a motor 12 in addition to the pulverizing machine per se. The motor 12 has its output driving a pulley 13 that is connected by means of a belt 14 to a similar pulley 15 on drive shaft 26 of a pulverizer device or section 16 of the machine. The machine has a cylindrical chamber 20 that is formed by a cylindrically-shaped wall 21 which has an insert 22 at the lower extremity thereof. This insert 22 forms a vertical wall around the pulverizer section 16 and has on the inner surface thereof vertical serrations 23 for causing the currents of air being drawn through the machine to take a vertical direction. The cylindrical outer wall 21, which forms the sides of chamber 20, rests on and is clamped to a lower manifold or air intake 24, which in turn is bolted in place on the base 11 of the entire machine.

Intake manifold 24 has an open internal construction such that there is an annular air inlet 25 which surrounds and acts as a bearing for shaft 26 to which the pulley 15 is attached. The shaft 26 has at the upper extremity thereof a group of discs 27 securely attached thereto.

As seen in Fig. 2, the discs 27 are separated by spacers 28 and all attached together by means of a plurality of rivets 29, only one of which is illustrated in Fig. 2. The discs 27 act as supports for a plurality of pivoted hammers, e.g. hammers 30, 31 and 32. Each of the hammers is pivotally carried by the group of discs 27 which support a pivot pin 33 with spacers 34 on either side of each of the hammers 30, 31 and 32 to center the same between the adjacent discs 27. The whole set of hammers and discs as thus constructed is clamped in place at the upper extremity of the shaft 26, by means of an upper clamping plate or disc 35 which is held in place by a collar 36 that is threaded onto an upper threaded extension 37 of the shaft 26. There is also a lock nut 38 threaded onto the extension 37 of the shaft 26 to positively secure the collar 36 in place.

It will be noted that the lowest disc 27a extends radially out close to the tips of the hammers 30, 31 and 32. This then acts as a shield to keep particles of the material being pulverized from falling directly down the air inlet opening 25 near the hub of the rotating hammers. This arrangement also causes the path of flow of the air which is drawn in through inlet 25 to be deflected outward to the periphery of the pulverizer section 16 and thus to draw the pulverized particles of material upward vertically near the periphery of the main chamber 20.

In some cases fan blades (not shown) may be attached to the underside of the bottom disc 27a to produce some positive (above atmospheric) air pressure in the air intake. The purpose of such positive pressure as thus created would be to neutralize the negative pressure existing at the level of the material feed intake in the cham-

ber 20. It is to be understood, as will appear more fully below, that the air through the machine is circulated by being drawn through from the outlet. Consequently there will be some draft in through the material feed, and with certain materials this might be objectionable. However, neutralizing the pressure with the proper sized fan blades would overcome this difficulty.

It will also be noted that whereas a plurality of hammers, such as hammers 30, 31 and 32, are employed around the periphery of the discs 27, and any desired number may be employed, it is preferred to use four hammers in each row, i.e. four hammers around the discs 27 at each of the three vertically-spaced levels. Furthermore, it is particularly to be noted that although in Fig. 2 the hammer 31 is shown directly in line with the hammers 30 and 32, this is for simplicity of illustration only, since it is preferred to situate the four hammers that are located in the row with hammer 31, staggered relatively to hammers 30 and 32, so that the pivot pins equivalent to pin 33 for the middle row of hammers (corresponding to hammer 31) will be situated at about 45° around discs 27 relative to the pivots 33 for hammers 30 and 32. This arrangement provides better action since the particles that are deflected from any given layer or row of hammers will have space for allowing the next lower row of hammers to come around and pick up these particles, with the least interference. In this manner an improved efficiency of the pulverizing action is had.

Referring to Fig. 3, it will be observed that the hammers, as typified by the hammer 30 there illustrated, include a hard-material faced tip section 43. These hard-faced hammer elements 43 may be constructed of various materials having required hardness and durability. For example, a facing material of "Stellite" has been found to be very satisfactory. This material may be welded onto the tip of the hammers and then ground smooth to provide a flat surface for the desired hammer action.

It will be noted that on the top two rows of hammers, typified by hammers 30 and 31 in Fig. 2, each hammer is constructed with a downward deflecting surface 44. This surface is constructed by providing a beveled or angled leading edge as is clearly illustrated in Fig. 4. The action of this deflecting surface is such as to cause particles of the material to be deflected downward into the path of the lower oncoming hammers so that a better action of the material being pulverized is had. To elaborate on this action it may be pointed out that whereas heretofore with a flat-surfaced leading edge, particles striking the shank of the hammers would be deflected at random, but a high percentage would be deflected radially outward. For this reason it would appear that apparently a certain area would be set up where particles were merely circulating as deflected from the shanks of hammers rather than being carried into the path of the active face tips 43 of the hammers for pulverizing action; whereas with the beveled edges, or deflecting surfaces 44, the particles are deflected down where they will be carried rapidly into the path of the hammer tips 43.

Returning to Fig. 1, it is to be noted that the chamber 20 has, at the upper extremity thereof, a material-and-air outlet 47 which is concentric with the chamber 20 and surrounds the structure supporting a separator 48. The separator 48 is rotary in its action and is constructed of a plurality of vanes 49 which are radially situated relative to the axis of separator 48 that includes a disc like support 46 and has a main shaft 50 that is rotated by means of a pulley 51. The vanes 49 act in a well-known manner to reject particles over a given size, or mass, by reason of centrifugal action. The particles that are lighter and/or smaller than those which the centrifugal force will reject, are carried radially inward through the vanes 49 by the currents of air which are being drawn through the machine, and out an outlet pipe 52.

Located on the side of the chamber 20 between the lower pulverizer section 16 and the upper outlet 47 (with

the separator 48 adjacent thereto) there is a material feed inlet 53. This inlet 53 may have any feasible material feed arrangement, such as a screw-feed or the like (not shown) for feeding in the material to be pulverized from a hopper 54.

It will be noted that the separator 48 is separately driven by means of the pulley 51 attached to the shaft 50. A belt 55 is carried on pulley 51 and pulley 56. The pulley 56 is driven by an electric motor 57 which is vertically attached to the framework of the machine by a bracket 58. The position of the motor 57 may be adjusted for adjusting the tension on the belt 55, by means of a handwheel 59 turning a threaded shaft 60. The shaft 60 is threaded through a collar 61 on a hinged plate 62 to which the motor 57 is attached. The plate 62 is hinged to the bracket 58 by means of a hinge pin 63.

The drive for separator 48 is a variable speed arrangement and may take various forms. That illustrated employs a variable pitch sidewall arrangement on pulley 56 which has a spring bias for causing the flanges of pulley 56 to move axially close together. With such an arrangement the diameter of the pulley 56 upon which the belt 55 will ride may be determined by the tension on the belt as adjusted by means of handwheel 59 and threaded shaft 60. Thus it will be noted that the speed of rotation of the separator 48 may be independently adjusted with respect to the speed of operation of the rotating hammers in the pulverizer section 16.

It is also to be noted that at the upper extremity of the chamber 20 there are certain features for improving the operation of the overall machine. One of these features involves the setting up of a limited-sized opening or slot 64 all the way around the top edge of the chamber 20. This opening may be formed by using shims or washers 66 around the bolts, e.g. bolt 67, which fasten the top onto the walls 21 of the chamber 20. The crack or opening thus formed allows a certain amount of air to enter the chamber 20 at this top edge thereof, and thus will maintain enough air current to continuously dislodge any accumulation of particles of pulverized material which might otherwise build up into sizeable chunks or caked pieces which would finally break off and fall down onto the rotating hammers. In this manner a very undesirable surging in the load applied to the drive of the pulverizer section 16 is entirely avoided.

It will also be noted that there is a downwardly extending hub surface 65 located directly over the separator vanes 49. The purpose of this extension downward into the chamber 20 is to aid in the creation of a flow of air and particles through the vanes 49 in a most efficient manner, i.e. by creating a vena contracta curve for the flow of air and particles through the vanes 49.

Operation

The operation of a vertical pulverizer generally is well-known and need not be reviewed in detail. However, in the interest of clarity as to the operation of and interrelation between certain of the elements of this invention, it is pointed out that the operation of this machine includes the following: A source of suction is connected onto the outlet pipe 52. This source of suction may take various forms, but it has been found that a very satisfactory source is a collector for pulverized materials, which includes fans for drawing air through felt bags in which the pulverized material is gathered.

The air flow thus created causes air to be drawn in through the annular inlet 25 and around the periphery of the pulverizer section 16, where particles leaving the tips of the hammers are picked up and carried vertically near the walls of the chamber 20 up to the top thereof. These particles then approach the separator which rejects the particles or allows them to pass, depending upon the air suction through the outlet 47 and the speed of rotation of the separator 48. The particles of the desired size pass through into the outlet 47 and thence through

the pipe 52. The maximum size that is passed may be varied by adjusting the speed of rotation of the vanes 49 in the separator 48. In this manner the most efficient operation for the machine may be had for any given material being pulverized. It will be noted that changes in the size of particles as processed by the machine may be obtained, without effecting the operation of the pulverizing section 16, which may be rotated at its optimum speed for best results.

It will be observed that particles which are rejected by the separator 48 will fall back down in the central area of the chamber 20 as indicated by the arrows in Fig. 1. Such particles join the material being fed into the chamber via the material inlet 53.

A specific example of results obtained in pulverizing batches of a certain polystyrene material follows. This material was heretofore subject to melting, even though evaporative cooling was employed. Using a vertical shaft pulverizer according to this invention a certain batch of polystyrene was introduced in the form of solid pieces having a size of approximately equivalent to a three-sixteenth inch cube. No cooling was employed, and no trouble with melting or otherwise was encountered. The grind produced was of a fineness such that ninety-eight and one-half percent (98.5%) passed a standard eighty mesh screen. The separator wheel was run at a speed of fifteen hundred (1500 r.p.m.) revolutions per minute; and the pulverizer rotor (hammers) was run at a speed of six thousand revolutions per minute (6000 r.p.m.).

Another batch of the same polystyrene material was run likewise without cooling. The separator wheel was run at a speed of twelve hundred and fifty revolutions per minute (1250 r.p.m.), and the pulverizer rotor was run at six thousand revolutions per minute (6000 r.p.m.) as before. The final product in this run had a fineness such that seventy-three and three tenths percent (73.3%) passed a standard 80 mesh screen.

While a particular embodiment of the invention has been described with some detail in accordance with the applicable statutes, this is not to be taken as in any way limiting the invention, the scope of the invention being defined by the following claims.

It is claimed:

1. An improved vertical pulverizing machine including a generally cylindrical pulverizing chamber having a centrally located outlet at the top thereof and adapted for operating with a sub-atmospheric pressure therein, a separator associated with said outlet, said chamber having a sharp inside corner at the top thereof, and a limited-sized opening around the periphery of said chamber at the said inside corner thereof to admit air and avoid accumulation of pulverized material thereat.

2. An improved vertical pulverizing machine including a generally cylindrical pulverizing chamber having a centrally located outlet at the top thereof and adapted for operating with a sub-atmospheric pressure therein, a separator associated with said outlet, said chamber having a sharp inside corner near the top thereof, and a limited-sized opening around the periphery of said chamber at said inside corner thereof to admit air and avoid accumulation of pulverized material thereat, and a pulverizer section at the bottom of said chamber including a plurality of vertically-spaced rows of pivoted hammers therein, said hammers extending outside of said pivots and having hard material faces thereon near the extremity thereof on the leading edge thereof, the leading edge of the extensions of said hammers above the bottom row being beveled to form a downward facing surface for deflecting particles of the material being treated downward into the path of the hammers, and the hammers of alternate rows of said hammers being staggered circumferentially midway between the corresponding hammers of the adjacent rows.

3. A vertical pulverizing machine comprising a vertical chamber with a coaxial air inlet at the lower end thereof,

a coaxial outlet at the upper end of said chamber with a rotary separator adjacent thereto and coaxial therewith, a material feed inlet situated between said ends for laterally introducing the material to be pulverized into said chamber, and a rotary pulverizer below the feed inlet and including hammers pivotally attached to a central rotating member, vertical sidewalls surrounding the outer ends of said hammers, said pulverizer being situated coaxially with and adjacent to said air inlet, means for independently driving said separator and said rotary pulverizer at separately selectable speeds, means for directing air from said air inlet only substantially at outer ends of said hammers, whereby oversized material descends substantially centrally into said pulverizer and the pulverized material rises around the periphery of the inner chamber wall vertically carried by air admitted through said air inlet at the lower end of said chamber, and means for admitting a limited quantity of additional air sweeping horizontally into the upper periphery of the chamber to direct the upwardly vertically moving air and fine material away from the inner upper periphery of the wall towards the separator periphery and to sweep out any build-up of material in the upper periphery.

4. An improved vertical pulverizing machine including a plurality of vertically-spaced rows of pivoted hammers in a pulverizing section, said hammers extending outside of said pivots, said hammers having shanks and having hard material faces thereon near the extremity thereof, on the leading edges thereof, the leading edges of the shanks of said hammers above the bottom row being beveled to form downward facing surfaces for deflecting particles of the material downward into the path of the hammers, the shanks of the bottom row of hammers having leading edges which are substantially vertical, said pulverizing section having a cylindrical wall adjacent the extremities of the hammers and opening into a separating chamber above permitting particles to fall downward in the area of the shank portions of the hammers and for pulverized material to rise in the area of the hammers, imperforate plate means below and closely adjacent the bottom row of hammers extending radially substantially to vertically below the outer ends of the beveled shanks for defining an annular opening between the cylindrical wall and the shanks of the hammers, and means for supplying upwardly moving air to said annular opening.

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