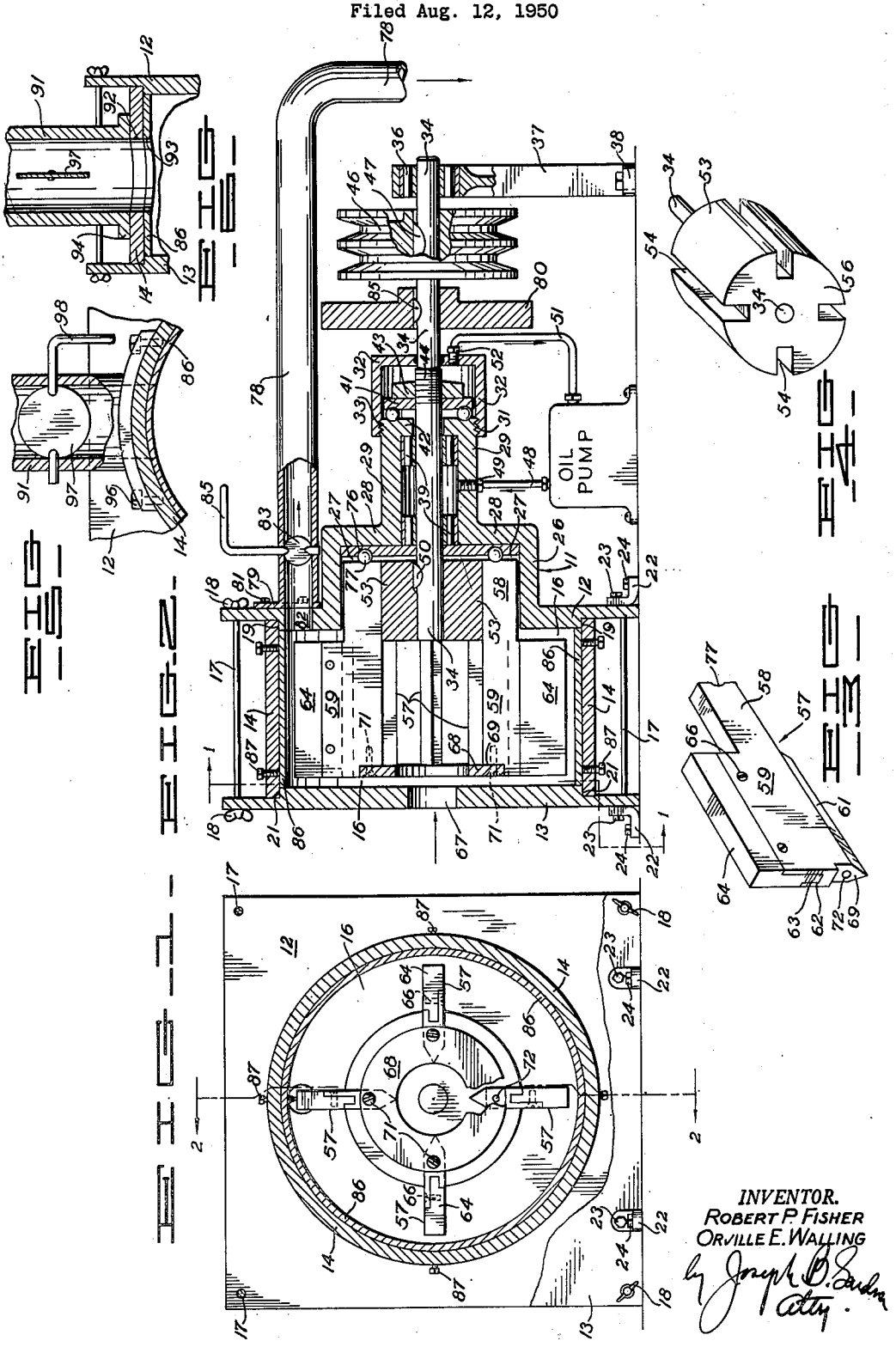
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CENTRIFUGAL IMPACT PULVERIZING APPARATUS

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CENTRIFUGAL IMPACT PULVERIZING APPARATUS

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This invention relates to apparatus for pulverizing any type of material, including mineral matter, metals or like substances in either a dry or liquid phase, and is particularly directed to mechanism for thoroughly decimating such material whereby the latter may readily be separated into its component physical parts by means of suitable amalgamating or other equipment.

An object of the present invention is to provide simplified apparatus in which incoming material may be subjected to a combination of different forces and impacts all of which tend to thoroughly pulverize the same as it passes through the mechanism.

Another object of the invention is to provide apparatus of the type described for receiving and pulverizing hard solid material in a rapid continuous flow process with little or no danger of the apparatus jamming due to the reception of oversize pieces of material or from other reasons and causes.

A still further object of this invention is to provide a pulverizer of the aforementioned type in which the parts of the mechanism subjected to maximum wear and strain may easily be replaced without necessitating major overhaul or other costly operations.

Yet another object of the invention is to provide apparatus of the foregoing description in which means are provided to reduce the turbulence normally created by high speed rotors whereby the rotor efficiency is greatly increased and the centrifugal force utilized to hurl the incoming material against the rotor casing will be maintained at a substantially constant level.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention which is illustrated in the drawing accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawing and description may be adopted within the scope of the invention as set forth in the claims.

Referring to the drawing:

Figure 1 is a front view, partly in section, of the apparatus of our invention, taken along the plane indicated by line 1—1 of Figure 2.

Figure 2 is a longitudinal cross-sectional view of the apparatus taken along the plane indicated by line 2—2 of Figure 1.

Figure 3 is a perspective view of one of the rotor blades used in the apparatus.

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Figure 4 is a perspective view of the rotor mounting element.

Figure 5 is a view similar to Figure 1 showing a modified form of outlet, portions of the view being cut away to conserve space in the drawing.

Figure 6 is a view similar to Figure 2 showing the modified outlet arrangement, with portions of the view being cut away.

In broad terms, the apparatus of our invention is designed to receive a quantity of crushed rock or the like, rely on suction to assist in drawing the material into the mechanism, utilize rotor blades to strike the incoming material, and centrifugally hurl the same against a hardened peripheral surface so as to pulverize the material, and remove the pulverized material through a discharge passage for such further treatment as may be necessary.

Apparatus to carry out the foregoing may assume a variety of forms, but we have found that mechanism of the type disclosed in the drawings will adequately serve the necessary functions and is able to pulverize material so that it is capable of passing a 900 to 1000 theoretical mesh screen of the Tyler standard, although in normal operations, a 400 mesh material is sufficiently fine to permit subsequent physical separation of desirable components of the material. As here shown, the apparatus comprises a rotor housing 11 which includes a rectangular rear end wall 12, a rectangular front end wall 13, and a substantially circular peripheral wall 14, such walls cooperating to provide a cylindrical chamber 16 in which the rotor blades are disposed, as will be hereinafter described. Walls 12, 13 and 14 are preferably detachable so that access to chamber 16 is readily available, and as indicated in the drawing, bolts 17 extend through apertures in walls 12 and 13, and suitable wing nuts 18 are threadedly engaged thereto to secure the walls in place. Peripheral wall 14 is disposed between the end walls and is arranged to be seated as circumferentially extending shoulders 19 and 21 provided in rear and front walls respectively. The housing 11 may be secured to any suitable base structure by means of angle clips 22 fastened to the lower edges of walls 12 and 13 by bolts 23, similar bolts 24 fastening the clips to the base material.

Rear wall 12 is provided with a rearwardly extending circular wall 26 of smaller diameter than the wall 14 so as to provide a diametrically reduced second chamber 27 axially aligned with and in flow communication with main chamber 16. The rearmost end of chamber 27 is defined

by a transverse wall member 28 formed integrally with wall 26, an axial extension 29 thereof being threaded at its distal end as at 31 to receive a cap member 32 similarly threaded as at 33 to form a closure for the previously described structure.

Mounted for rotation in the housing 11 is an axially aligned shaft 34 which terminates at its forward end approximately at the rear end in a bearing 36 journaled in a suitable vertical support member 37 which may be secured to the aforesaid base structure by bolts 38. Support bearings 39 are also provided along the length of the shaft to support the same, and in order to eliminate axial movement in the shaft as the latter is rotated, we provide a thrust bearing 41 engageable on one side by an inwardly extending shoulder 42 of extension 29 and on the other side thereof by a nut 43 threadedly engaged to a threaded portion 44 of the shaft disposed within cap member 22. In this matter, the shaft will be firmly supported and prevented from any undesirable end play.

Suitable means may be provided for rotating the shaft 34, and as here shown, such means comprise a sheave 46 keyed to the shaft at 47, the sheave being rotatable through one or more V-belts connected to a motor of any desirable capacity. As such belts and motors are well known in the art, they have not been shown in the drawing for purposes of simplicity. Obviously, if desired, other means, such as direct gearing, could be utilized to impart the requisite rotary movement to the shaft.

In order to insure proper bearing lubrication, we prefer to utilize a force-feed system, such system including an oil pump and a pressure conduit 48 entering the space between bearings 39 by means of a fitting 49 secured to extension 29. Oil is permitted to return to the pump by means of conduit 51 which receives the oil from a fitting 52 at the end of cap member 32 after it has passed through bearing 41 as well as bearing 39.

Mounted in the chamber 27 for rotation with shaft 34 by a key 50 is a substantially cylindrical solid rotor member 53 provided with a plurality of axially extending rectangular grooves 54 for a purpose to be hereinafter described. It will be noted that shaft 34 and the front face 56 of the rotor 53 do not enter the chamber 16 for any appreciable distance, thereby leaving the chamber substantially unobstructed for receiving material and in which the latter may be pulverized. As here shown, four grooves are provided, but it will be evident that any suitable number may be utilized, so long as they are equally spaced and no unbalance will result. Fixedly received in the grooves are a plurality of rotor blades 57, each of which comprises a mounting portion 58 adapted to enter one of the grooves, such portion being transversely enlarged axially forward of face 56 to form the inner rotor blade portion 59. This latter portion is beveled along its lower edge 61 to provide a knife-like shearing edge, and includes an axially extending groove 62 long its outer edge to receive the tongue 63 of the outer rotor blade portion 64. When the tongue and groove are in place, the inner and outer blade portions may be secured together by means of screws 66 preferably being countersunk so that the assembled blade portions will present a smooth unobstructed surface. It will be seen that the blades 57 extend into the chamber 16 and are equally circumferentially spaced around the same.

After the blade portions 58 have been seated in the grooves 54 of the rotor 53, they may be secured thereto by welding or similar processes as it will be understood that on rotation of the shaft and rotor, the centrifugal force created will tend to throw the blades radially outwardly. Also, as it is contemplated to rotate such elements at speeds in the neighborhood of 5,000 R. P. M., it will be desirable to statically and dynamically balance the assembled shaft and rotor assembly to prevent unbalance and vibrations during operation.

Front plate 13 is provided with an axially aligned central aperture 67 through which the material is fed into chamber 16, and to prevent the turbulence normally created at a fan inlet, as well as to prevent the blades 57 from whipping or becoming relatively displaced, an annular deflector plate 68 is secured to the front edges of the blades. Plate 68 is arranged to be seated in a notched portion 69 provided at the inner front portion of blade 59, the plate being secured to the blades by means of screws 71 extending into aperture 72 of blade 59.

As previously explained, the thrust bearing 41 is utilized to prevent axial movement of shaft 34, but as the rotor assembly extends beyond the forward end of the shaft, we have further provided a second thrust bearing 76 having its flat face disposed against wall 28, and the balls arranged to ride in grooves 77 in the rear edge of blade portion 58 as well as on the rear face of rotor member 53. In this way, the rotor assembly is more securely arranged against displacement in either a radial or axial direction. Also, to insure a smoother running apparatus, a counterweight 80 is secured to the shaft by a key 85, such weight tending to reduce the excessive torque on the shaft created by the axially displaced rotor assembly.

Outlet means for the material is provided, and as here shown, includes a conduit 78 provided with a flange 79 whereby the conduit may be secured by bolts 81 or similar fastening means to rear wall 12. It will be noted that the conduit opens into the rear end of chamber 16 through an opening 82 provided in wall 12 adjacent the periphery of the chamber so that all material entering the chamber will be required to pass radially outwardly as well as rearwardly before it may enter the discharge conduit, and thereby be subjected to a maximum amount of pulverizing action during its travel through the apparatus. To regulate the flow of air and material in the conduit 78, a butterfly valve 83 is provided therein which may be adjustably positioned by means of handle 85. This valve will also serve to regulate suction in the chamber 16.

To protect the peripheral wall 14 from being dented or injured by the material, we prefer to provide a replaceable liner 86 which is arranged to lie on the inner surface of wall 14 in contiguous relation thereto. Such liner may be secured in place by set screws 87 or other suitable members. It will be evident that the liner will protect the wall 14 from action of the material in the chamber, and as it may be constructed of a hardened material, and as it is readily replaceable, the normal life of the apparatus will be greatly increased.

We will now discuss the operation of the foregoing apparatus. Material such as quartz is fed toward the inlet 67 by a gravity or screw

conveyor or other suitable mechanism. Such material, of course, must be of a size permitting the same to pass through the inlet opening, and it will be understood that as the material is fed to the machine, the shaft, rotor member, and rotor blades are in rotation, the latter creating a partial vacuum in chamber 16 to aid in drawing material through inlet 67. By varying the speed of the shaft or positioning of butterfly valve 83, the suction in chamber 16 may be controlled to only permit materials of desired size to pass out with the discharging air stream. It will be seen from the drawing that the inner edges of deflector 68 and blades 57 are disposed radially outwardly from the inlet opening thereby creating a large unobstructed area in chamber 16 extending rearwardly of the inlet. This will permit the entering material to be fed rapidly into the apparatus with little danger of jamming due to a localized accumulation of material.

As the pieces of material enter the chamber, they will be subjected to a plurality of forces, all of which combine thoroughly to break down and pulverize the same. The primary forces are those created by the rotating blades, which may be described as impact or striking forces and centrifugal force. It is believed that a piece of material will first be struck by one or more of the blades which are preferably rotated at approximately 5,000 R. P. M. This impact will tend to shatter or otherwise break up the piece and also, due to the beveled surface on the inner edges of the blades, a piece striking the same will be sheared so as to further assist in the pulverization thereof. Then, because of the rapid rotation of the blades and the high centrifugal force the pieces of material will be hurled at very high velocities toward the liner 86, and upon striking the same, will be further broken up. Although the exact action in the chamber cannot be readily observed, it is believed that the finely pulverized material will be blown out through the discharge conduit 78, while larger fragments will continue to be struck by the rotating blades until the air stream can pick up the pulverized particles and discharge the same.

As the rotor blades are made up of two pieces, it will be apparent that the outer portions 64 which receive the maximum impact loads, can readily be replaced as they become worn. However, as the shaft and rotor element 53 are disposed rearwardly of chamber 16 in which the pulverizing takes place, these parts will not be subjected to undue impact loads, and can be used for extended periods of operation without requiring repairs of any nature. The elements receiving the maximum wear, namely, the rotor blades 57 and the liner 86 can be easily removed and replaced by opening the housing 11.

In place of the heretofore described outlet, we have found that in pulverizing certain types of materials, a discharge opening provided in the peripheral wall 14 is advantageous. Such an alternate arrangement is indicated in Figures 5 and 6 of the drawing, and includes a conduit 91 axially aligned with apertures 92 and 93 provided in peripheral wall 14 and liner 86 respectively. The conduit may be attached to the casing by means of a flange member 94 secured to wall 14 by means of screws or bolts 96. A butterfly valve 97 is operatively inserted in conduit 91 for purposes previously set forth which may be adjusted by means of a handle 98.

For most operations, it is sufficient if the pulverized material is capable of passing a 400 mesh screen, but if finer or larger particles are desired, the rotor speed and butterfly opening in the selected discharge conduit can be adjusted only to permit particles of a selected size to be carried out with the discharge air stream.

It will be seen from the foregoing description that we have provided apparatus which is extremely simple in construction, which will permit rapid pulverization of relatively large quantities of material which may be continuously fed to the apparatus, and which may be operated over long periods of time without requiring skilled attention or major overhaul.

What is claimed is:

1. Apparatus of the character described comprising a substantially cylindrical housing having an inner peripheral surface and a front plate provided with an inlet opening, a shaft journalled for rotation and having a portion thereof in said housing at the end of the latter remote from said front plate, means for rotating said shaft, a substantially solid rotor member secured to said shaft portion and rotatable with said shaft, said member including a plurality of circumferentially spaced axially extending grooves, a plurality of rotor blades mounted in said grooves and extending beyond said member toward said front plate, an annular deflector member releasably secured to the forward edges of said blades with the opening thereof axially aligned with and of a larger diameter than said inlet opening, the outer edges of said blades extending radially outwardly from the outer peripheral surface of said deflector member, means forming an outlet opening adjacent said peripheral surface of said housing, and valve means operatively associated with said opening.

2. In a machine for decimating relatively hard solid material, a substantially cylindrical casing including a front end face having a centrally disposed aperture therein, said casing further having a rearward diametrically reduced portion provided with a rear end face, a shaft journaled for rotation in said casing and terminating at the forward end of said reduced portion, a substantially solid rotor member secured to said shaft and being substantially entirely within said reduced portion, said rotor member being provided with axially extending equally spaced grooves, rotor blades mounted in said grooves and having portions thereof within said cylindrical casing, said blades having end portions thereof adjacent said front end face, said blades having their outer edges extending axially of said casing adjacent the periphery of said casing and having their inner edges spaced radially outwardly from said central aperture and extending axially of said casing, said inner edges further being provided with opposing relatively sharp blades for splitting the material in said casing, outer portions of said blades adjacent said periphery being removable from the other portions of the blades, and outlet means adjacent said periphery and the rear edges of the blades through which the material may be removed from the casing.

3. Pulverizing apparatus including a front end wall, rear end wall and peripheral side wall, said walls cooperating to define a substantially cylindrical material receiving chamber with the axis thereof extending in a generally horizontal direction, said front end wall including an axially aligned material inlet opening, means cooperating with said rear wall to define a second chamber in flow communication and axially aligned with and of a smaller diameter than said receiving

chamber, a rotatable shaft journaled for rotation and having the front end thereof terminating substantially at the front end of said second chamber, a substantially solid cylindrical rotor member mounted on said shaft and substantially completely filling said second chamber, said member including a plurality of axially extending equally circumferentially spaced grooves, rotor blades having rear portions thereof arranged to be seated in said grooves and having radially enlarged front portions extending into said receiving chamber relatively adjacent said front, rear and side walls, means defining a discharge outlet in said rear wall adjacent said peripheral side wall, said blades being provided with notches at the front ends thereof adjacent their radially inward edges, and a member arranged to be seated in said notches and releasably secured to said blades.

4. In a pulverizing mechanism, a substantially enclosed casing having a front wall provided with a material inlet opening in alignment with the axis of said casing, a shaft journaled for rotation in said casing and extending rearwardly thereof for connection to driving apparatus, said shaft being axially aligned with said inlet opening and spaced therefrom to provide a material receiving chamber therebetween, rotor blades secured to said shaft in equal circumferentially spaced relation and extending axially forward of said shaft

to adjacent the inner surface of said front wall, the outer edges of said blades being disposed substantially immediately adjacent the periphery of said casing and the inner edges thereof being spaced apart a distance at least as great as the diameter of said inlet opening, an annular deflector plate having a front surface substantially coplanar with the forward edges of said blades and secured to the latter and having a central opening therein axially aligned with said inlet opening and of a diameter substantially equal to the spacing of the inner edges of said blades, said deflector plate having an outer diameter substantially less than the radial extent of the outer edges of opposed rotor blades, means in said casing forming a discharge opening, and a replaceable liner element within said chamber periphery.

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