Oct. 3, 1939. H. HARDINGE 2,174,630

CLASSIFICATION SYSTEM FOR PULVERIZED MATERIALS

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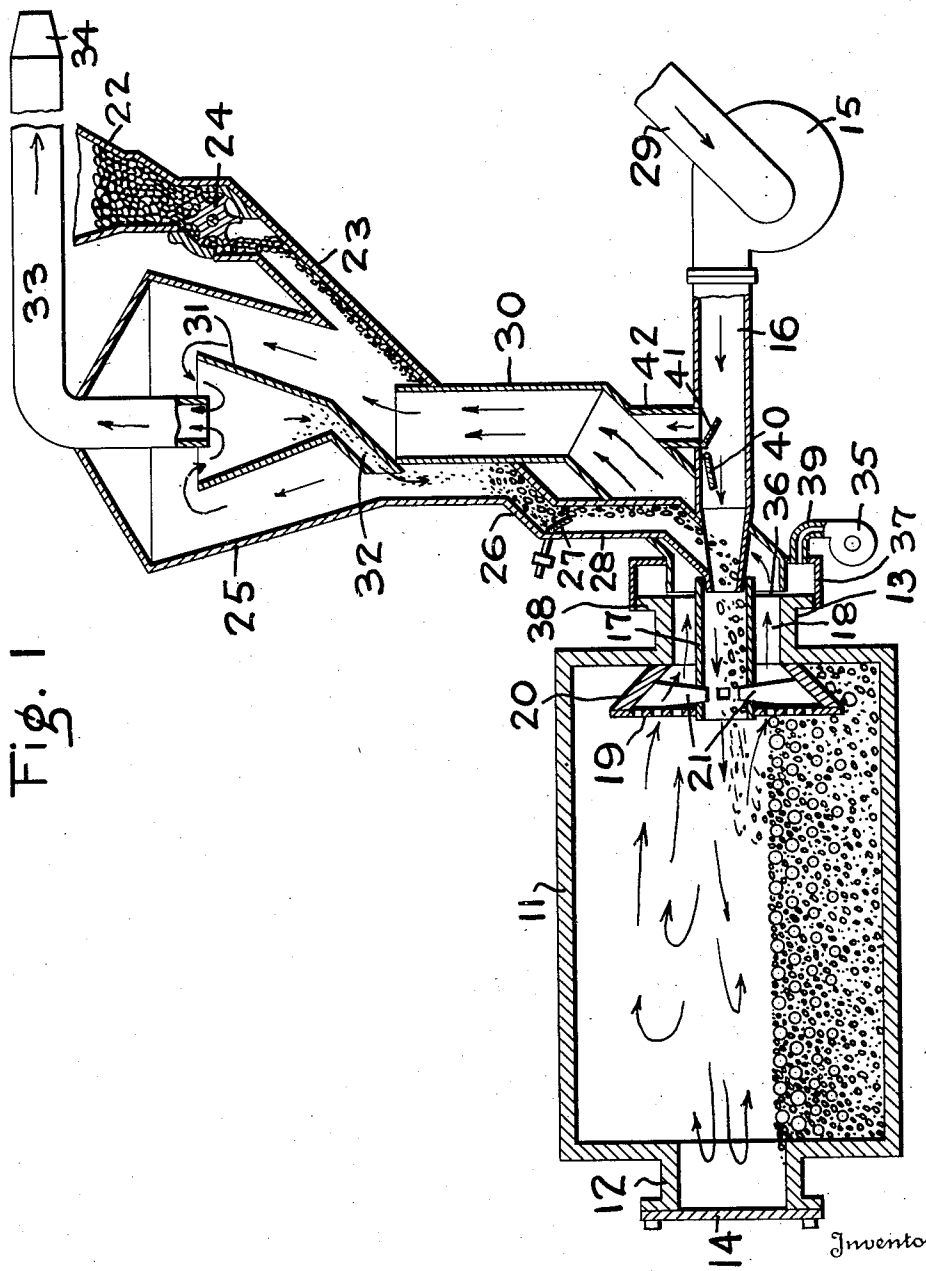


Fig. 1

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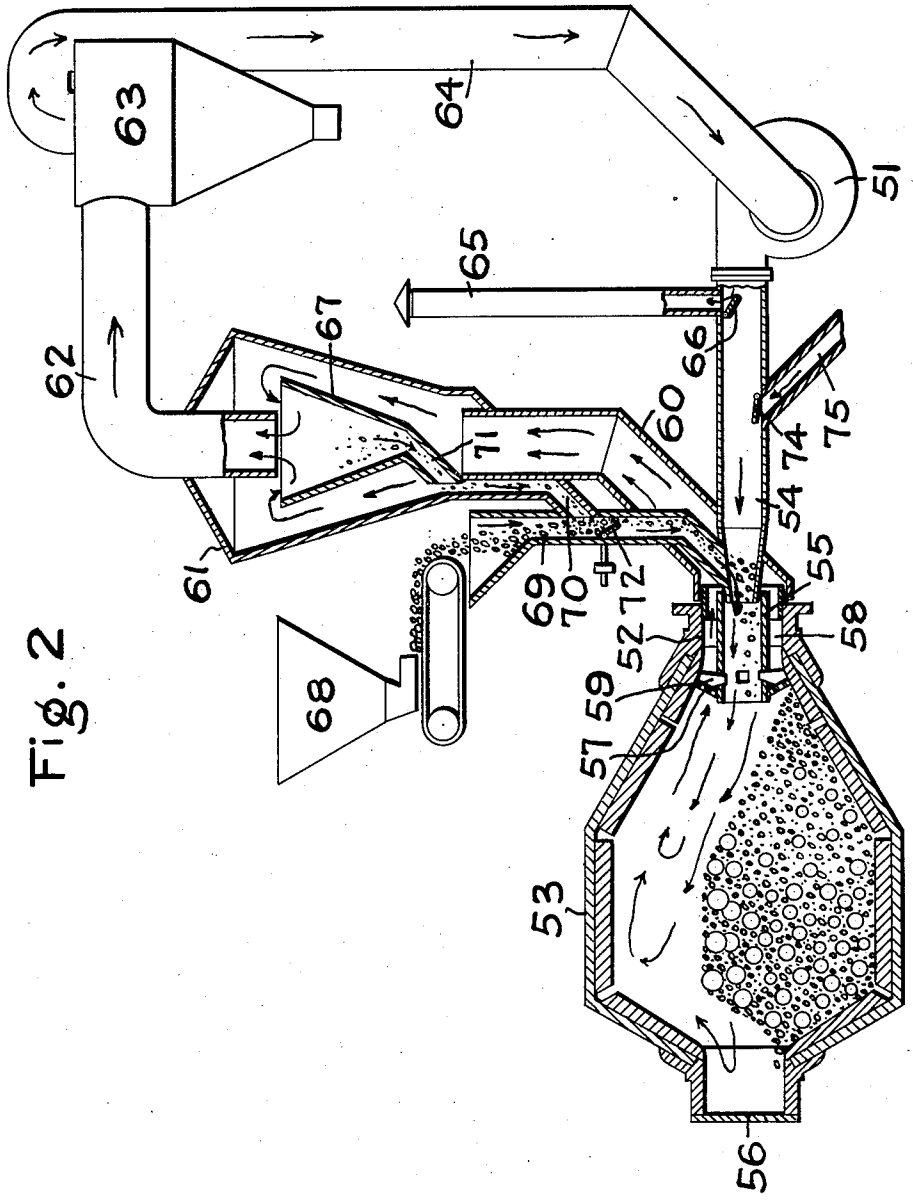


Fig. 2

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CLASSIFICATION SYSTEM FOR PULVERIZED MATERIALS

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3 Claims. (Cl. 83—9)

This invention relates to grinding mills and pulverizers, and more particularly to a system for classifying the material pulverized in the mills or pulverizers.

An object of the invention is to provide an improved pulverizing apparatus in which the feed, oversize, and air all enter and leave at the same end of the apparatus.

Another object of the invention is to provide an improved pulverizing apparatus in which the material is fed to a grinding mill in such a manner that it mingles with the dry oversize material discharged from a classifier prior to coming in contact with dry air being conducted to the mill, so that the wet feed is partially dried, thereby enabling the fresh dry air which subsequently contacts the feed to quickly remove or absorb moisture in the feed before the feed enters the mill.

With the foregoing and other objects and advantages in view, the invention consists in the preferred construction and arrangement of the several parts which will be hereinafter fully described and claimed.

In the accompanying drawings:

Figure 1 is a general view, partly in vertical section, and partly in elevation, showing one form of the invention in connection with a cylindrical ball mill; and

Fig. 2 is a view, similar to Fig. 1, of another form of the invention in connection with a conical mill.

Referring to the drawings and especially to Fig. 1, the material pulverizing and collecting system may be characterized as a closed-circuit system in which fluid currents, such as air, are circulated throughout the system. It includes a pulverizing mill 11, which may be of any well-known construction having hollow trunnions 12, 13, at each end, the trunnion 12 in the instant case being closed by a plate or cover 14, so that only the trunnion 13 at the other end of the mill is open.

The air or other elastic fluid which conveys the fine product is caused to circulate continuously through the system by a blower 15, which discharges directly into the open end 13 of the mill 11 through fixed conduit 16 and rotating conduit 17.

Conduit 17 is mounted in the discharge hollow trunnion 13, being spaced a suitable distance from the interior of said trunnion, so as to provide an annular space 18 for the dust and fluid leaving the mill 11.

The inner end of conduit 17 projects into the mill 11 a suitable distance, and a grate 19 extends from the inner portion of said conduit outwardly to a conical ball rejector 20 extending inwardly from the end wall of the mill 11.

Extending from the wall of the ball rejector 20 to the conduit 17 and located on the outer side of the grate 19, are lifters 21, the purpose of which will be hereinafter described.

It is usual to feed material into pulverizing mills automatically. The material descends from a bin into a hopper 22 and is permitted to pass into chute 23 by means of a rotary pocket feeder 24.

Feeders of this type are known as an air-lock type of feeder and such feeders are adapted to prevent positive pressure from being carried upwardly into the hopper 22. However, it will be understood that any type of feeder which would choke off the air from entering the hopper will be satisfactory.

The feed from chute 23 passes in and around the bottom of a classifier 25 and enters conduit 26. In passing through the classifier 25, the feed joins with the oversize dropped from the classifier. This helps to dry the wet feed, as the oversize is very dry, and mingling with the feed, picks up any free moisture and has the advantage of absorbing this moisture over a large surface area so that the air also entering the mill 11 will evaporate this moisture more rapidly than if the feed were placed in contact with the air without first mingling with the oversize.

Below the conduit 26 is a movable gate 27, which is provided to prevent back pressure of air from entering the lower portion of the classifier 25 before it should. The gate 27 is so balanced that pressure of the oversize and the feed on top of it, overcomes the back pressure of air below, and the oversize and feed trickle down past the gate into conduit 28, and from thence enter the conduit 16 near the inner end of said conduit 16.

The blower 15 draws air in the suction conduit 29 from an outside source, and if appreciable moisture is present, it is preferable to provide means for supplying hot air through conduit 29, as this hot air will dry the moisture in the feed more rapidly than cold air, as is well known in the art. The hot air then travels through conduit 16 and mixes with the feed and oversize entering conduit 16 from the feed conduit 28 and conveys the feed and oversize by forced draft through the rotating conduit 17 into the mill 11.

As shown by the arrows, Fig. 1, the air after entering the mill 11 reverses and flows out-

wardly through the grate 19 and into the annular space 18 between conduit 17 and trunnion 13. The ball rejector 20, heretofore referred to, forms a pocket and the lifters 21 pick up any tramp oversize, small balls and refuse which may lodge between the grate 19 and the ball rejector 20. The oversize then slides down the lifters 21 as they rotate with the mill 11 and enters the conduit 17 where the air forces the oversize back into the mill 11.

The air circulating through the mill 11 picks up the fine product in the form of dust, and carries this dust outwardly through the grate 19, and annular space 18, and conduit 30, to classifier 25.

The classifier 25 has an inner casing 31 along the outside of which flows the current of material-laden air entering through conduit 30. The vortex created within the classifier causes the heavier particles to be cast out of the stream of flowing air. These heavy or large particles leave the inner casing 31 at its lower end 32, which directs such particles towards the fresh feed in conduit 26, and as stated before, helps to dry the incoming feed. Oversize also drops out around the casing of the classifier 25 and in sliding down the sides, also mingles with the incoming feed.

The fines then pass through conduit 33 into a burner 34, if the operation is one using the conventional form of what is known as a unit pulverizer for direct firing of powered fuel.

It will be noted that the blower 15 places the while system under pressure; with a mill under pressure, loss of air would be likely to occur at the joint 36 between the inner end of the non-rotating conduit 30, and the outer end of the rotating trunnion 13 of the mill 11, if no provision were made to prevent such occurrence. Therefore, I enclose the joint 36 with a box 37, which forms a joint with the flange or outer end 38 of the trunnion 13. This joint is made to fit as closely as is practicable by methods ordinarily used.

Connected to the chamber within box 37 by a pipe 39, is a small blower 35, which forces air under sufficient pressure into the joint to prevent the escape of dirty air and oversize from the apparatus at this joint.

In order to control the operation of the device, there is a damper 40 which regulates the amount of incoming air from the blower 15 entering the mill 11.

There is also a damper 41 which regulates the same air, but in this case by-passes the air around the mill 11 directly to the classifier 25, through conduit 42 which connects conduit 16 with conduit 30.

When during operation the capacity is reduced below the rated output of the apparatus by partially closing damper 40, the velocity in the system, particularly in the classifier 25 and conduit 33, may be below the velocity which is sufficient to carry all of the material in suspension. By opening the damper 41, sufficient air may be by-passed the mill 11 to maintain the desired velocity.

Particular attention is directed to the fact that the feed mixes with the oversize and joins with the hot air before the feed enters the mill 11, and, furthermore, that the product and the air leaves at the same end of the mill. This method of operating a pulverizing system is contrary to all previous practices, since heretofore the feed and the air entered at opposite ends of the mill. There is a distinct advantage in this method of operation, not only because the combination of the feed mixing with the oversize and the air, dries the feed, thereby increasing the grinding capacity of the mill, but the whole unit is simple in construction, and there is considerable saving in floor space over the conventional form of pulverizing unit, where there are apparatus at both ends of the mill.

Referring now to the form of the invention shown in Fig. 2, the air or other elastic fluid which conveys the fine product is caused to circulate continuously through the system by blower 51, which discharges directly into the hollow trunnion end 52 of a pulverizing conical type of mill 53, through conduits 54 and 55.

The hollow trunnion end of the mill 53, opposite to the trunnion 52 is closed by a cover plate 56, so that within the mill the direction of the current of air is reversed and in passing through the mill the current of air picks up fine particles which are desired to be collected.

The air, laden with material, passes through grate 57 and leaves the mill through annular space 58 between conduit 55 and trunnion 52.

Lifters 59 pick up any tramp oversize, small balls and refuse, and such material slides down the lifters as they rotate with the mill 53 and enters the conduit 55 where the air forces the oversize back into the mill 53.

The air, laden with material, which leaves the mill through the space 58, passes through conduit 60 and enters the outer chamber of classifier 61, from whence it passes from the classifier through conduit 62.

Conduit 62 is connected with a cyclone dust collector 63 in which the material is relieved from the air by the action taking place within the collector.

The air is drawn from the collector 63 through conduit 64 by means of blower 51, whose suction side is connected with conduit 64.

When the material-laden air enters the outer chamber of the classifier 61, its velocity is lessened and its carrying capacity is reduced, with the result the material of undesired coarseness drops to the lower portion of the inner cone 67 of the classifier.

In the form of the invention shown in Fig. 2, the feeder 68 is located above conduit 69, at its lower end with the inner end portion of conduit 54.

The lower portion of the classifier 61 is connected to conduit 69 by a conduit 70, and the lower portion of the inner cone 67 of the classifier has a depending chute 71, which directs the oversize towards conduit 70.

Below the point in conduit 69 at which the conduit 70 is connected, there is a gate 72, similar in function to the gate 27 heretofore described.

In this form of the invention, there will be no back pressure at the point where the oversize enters the mill, as there may be very nearly a neutral pressure, or perhaps a suction, if the mill is operating in balance. This balanced operation is obtained by the blower 51 forcing the air through conduit 54 into the mill 53, and also sucking in air through conduit 64 from collector 63 and classifier 61, thereby creating a push on the one hand and a pull effect on the other.

Vent 65 and damper 66 comprise means by which variations in pressure within the system may be controlled.

In order to prevent leakage of air at the joints, and more particularly to obtain a clean system,

the vent 65 discharges excess air and moisture, as well as places the system as a whole under partial vacuum. The amount of air passage through vent 65 is controlled by regulating the damper 66.

Moreover, if the feed is very wet, hot air must be introduced. In such event, the damper 66 is opened wider to cause a pronounced suction throughout the system, and hot air is then drawn in through conduit 75 from an outside source, the flow of the hot air through conduit 75 being controlled by damper 74.

Even though conduit 75 is on the pressure side of the blower 51, since the whole system is now under a partial vacuum, air will be actually drawn in, since the conduit 54 will be at a negative pressure with respect to the atmosphere.

Thus, there is in this form of the invention, as in the form of the invention shown in Fig. 1, means whereby the feed, oversize, and the hot air all mingle together before they enter the mill 53.

The mill 53 shown in this form of the invention, is of the well-known type of conical mill. Even though the coarse feed is introduced through the discharge end of such form of mill, the coarse feed will migrate to the barrel or center of the mill, where the material will be ground by the heavy balls. There is a distinct advantage of an arrangement of this type over the use of a plain cylindrical mill of the form shown in Fig. 1, since the latter type of mill has no definite way of forcing the coarse material towards the far end of the mill. Accordingly, time must be relied upon to distribute the feed throughout the mill 11 in order to obtain the necessary grinding results.

Having thus described my invention, what I claim is:

1. A rotary drum mill having a combined feed and discharge opening only at one end of the drum and closed at the other end, a blower, an inlet conduit leading from said blower to said drum for conducting air into the drum, a feed conduit for material connected to said inlet conduit exteriorly of the drum, a classifier, a conduit connecting the classifier with said drum whereby dust-laden air circulated through the drum is carried to said classifier, a grate mounted in the drum and spaced from the discharge end of the mill and surrounding but not extending across the inlet conduit whereby the matter discharged from the mill to said classifier-drum conduit passes through said grate and the incoming feed enters the mill unrestrictedly through said inlet conduit, and means between the grate and the discharge end of the drum for removing oversize material caught between said grate and the discharge end of the drum, said last named means having an end portion entering the feed conduit to discharge oversize into said feed conduit.

2. A rotary drum mill having a combined feed and discharge opening only at one end of the drum, a screen mounted within the drum and spaced from the discharge end thereof, said screen having a central opening therein for the incoming feed, means between the screen and the discharge end of the drum for removing oversize material caught between said screen and the discharge end of the drum, said last named means having an end portion entering the central opening to discharge oversize into said central opening.

3. An apparatus of the class described comprising a drum mill containing a plurality of grinding bodies free to move in all directions therein, said mill being closed at one end and having an opening at the opposite end, a horizontal conduit positioned in said opening for delivering heated air under pressure to the mill, another conduit extending from said opening to an air classifier and adapted to convey the ground products suspended in exhaust air to said classifier, a screen mounted within the mill and spaced from the discharge end thereof, said screen having a central opening therein registering with the first mentioned conduit, means between the screen and the discharge end of the mill for removing oversize material caught between said screen and the discharge end, said means having an end portion entering the first mentioned conduit to deliver the oversize to said conduit, means to pass the feed in a relatively turbulent condition through the classifier and in such proximity to the exhaust air from the mill that fines and dust in the feed are removed therefrom, and means to convey the dust-free air and classifier oversize to the heated air conduit where they are dried and delivered to the mill.

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