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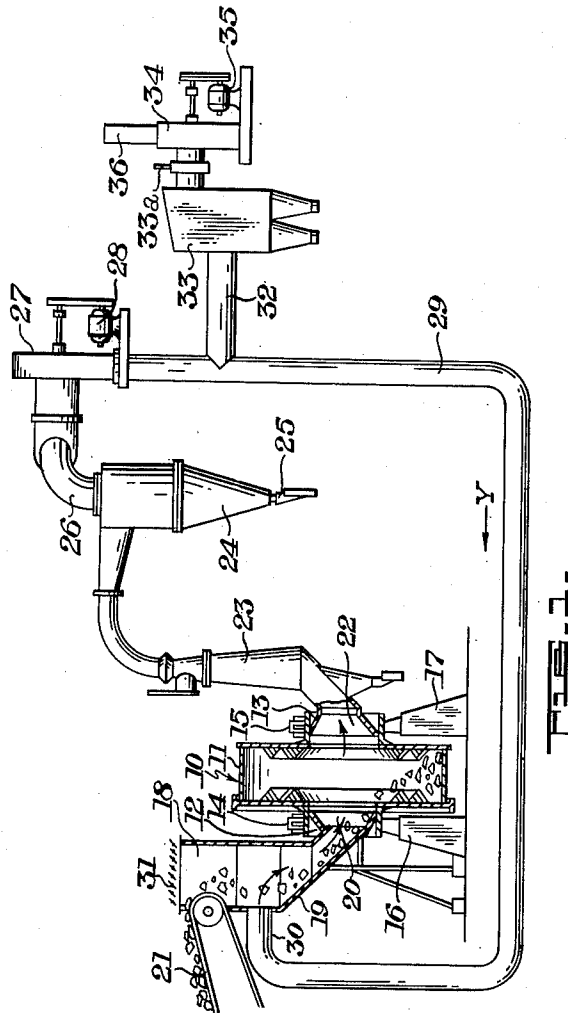
D. WESTON

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CLOSED CIRCUIT AIR SWEEPED ROTATING DRUM MATERIAL REDUCTION
SYSTEM, WITH AIR DRAWOFF TO DUST COLLECTOR, AND
AIR ENTRY CONTROL MEANS ADJACENT MILL INLET

Filed Oct. 26, 1951

2 Sheets-Sheet 1



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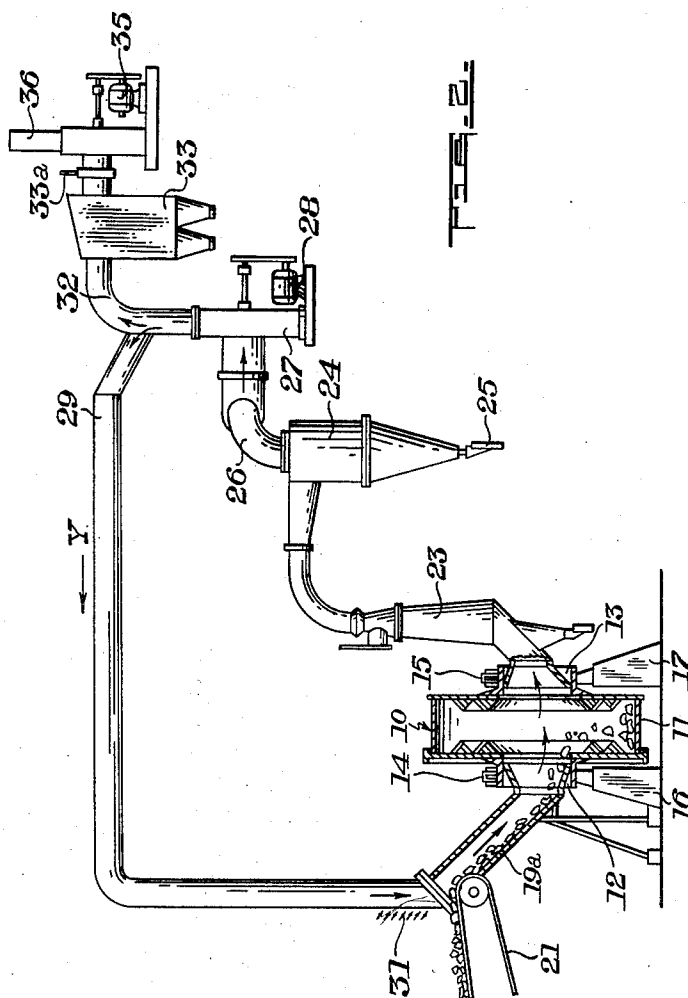
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UNITED STATES PATENT OFFICE

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CLOSED CIRCUIT AIR SWEEPED ROTATING
DRUM MATERIAL REDUCTION SYSTEM
WITH AIR DRAWOFF TO DUST COLLECTOR
AND AIR ENTRY CONTROL MEANS ADJA-
CENT MILL INLET

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Application October 26, 1951, Serial No. 253,399

Claims priority, application Canada
October 16, 1951

1 Claim. (Cl. 241—48)

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The present invention relates to a rotating-drum material-reduction mill. The application is a continuation-in-part of my copending United States application Serial No. 203,861, which was filed on January 2, 1951.

In copending application Serial No. 203,861, I disclosed a rotating-drum material-reduction mill of the type in which the material to be reduced and a stream of air are directed into one side of the mill (hereinafter termed the "upstream" side), and the air stream passes through the mill in general parallelism with the axis of rotation of the mill, entraining particles of a selected size range and carrying them out through the other side of the mill (hereinafter termed the "downstream" side), whereupon the majority of the reduced particles are collected from the air stream but the air of the stream is left with a higher dust and moisture content than when it entered the mill, and in which a major portion of the air which has passed through the mill is normally conveyed from the downstream to the upstream side of the mill by a return air duct and redirected through the mill. The present invention is particularly concerned with the substantially closed circuit mill described in the preceding sentence.

In the above-mentioned copending application I also described an "open-circuit" mill in which all the air passed through the mill drum to sweep out the reduced particles is first passed through a product collector (where the reduced particles are drawn off), and then through a dust collector, whence the air is exhausted usually at a point outside the mill building. Since air may be drawn through the mill at a rate of some 100,000 cu. ft. per minute, those skilled in this art will realize that the capital and maintenance costs for the dust collector will be high. With the substantially closed circuit mill of the present invention, only a small percentage, e. g. 10%, of the circulating air is drawn off and passed through the dust collector, so that the capital and maintenance costs of the closed circuit dust collector are considerably less than in the case of the open circuit.

Furthermore, when a mill is operated in open circuit as described in the above-mentioned copending application, a considerable quantity of air is drawn in at the upstream side of the mill and is discharged on the downstream side of the mill at a point remote from the mill. Normally, this air will be drawn from within the mill building, and, after passage through the mill, it is usually discharged outside the mill building. In

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the winter time, the air within the mill building will normally have been heated, and since the rate at which this air is drawn into the mill may be, for example, 100,000 cubic feet per minute, it will be readily appreciated that the constant discharging outside the mill building of such a volume of air will impose considerable strain upon the mill building heating means. Furthermore, heat is developed during the reduction which takes place in the mill and heat is also developed by the fan used to draw the air through the mill. In the case of an open circuit operation where the air drawn through the mill is discharged outside the mill building, a substantial amount of the heat units produced by the reduction and all of the heat produced by the fan are wasted.

The apparatus of my invention may be defined generally as the improvement in a rotating-drum material-reduction mill of the type in which the material to be reduced and a stream of air are directed into the upstream side of the mill and the air stream passes through the mill in general parallelism with the axis of rotation of the mill, entraining particles of a selected size range and carrying them out through the downstream side of the mill, whereupon the majority of the reduced particles are collected from the air stream, and the air of the stream is left with a higher dust and moisture content than when it entered the mill; which comprises a return air duct linking the upstream and downstream sides of the mill and forming a substantially closed circuit, a dust collector, means for passing a portion of the air which enters said return air duct to said dust collector, means associated with said dust-collector for discharging the air passed through the collector at a point remote from the mill, and an air-entry control means in the circuit, preferably at the upstream side of the mill.

According to one embodiment of the invention, a chute is located on the upstream side of the mill, a conveyor delivers the material to be reduced to the chute, the return air duct terminates in this chute at a point below the delivery end of the conveyor, and the return air duct is substantially horizontal in its terminal region adjacent the chute. The chute is preferably formed in two sections, namely an upper vertically disposed section and a lower inclined section which leads into the mill drum, and the delivery end of the conveyor is preferably located in the upper portion of the vertical section. With such an arrangement, the air which has passed along the return air duct (to be redirected into the mill) transversely enters into the stream of material which

is falling through the chute. In this manner, air classification is effected on the upstream side of the mill, and particles of the material being fed to the mill which are so small that they require no reduction, are carried through the mill by the air stream, without being subjected to the reducing action of the unit.

It will be appreciated that, with the apparatus described, a goodly portion of the air induced into the mill continues to re-circulate through the mill, and the heat lost from the mill building (the loss being in the air which leaves the dust collector) will be small.

It will be appreciated by those familiar with this art that the air which leaves the product collecting device on the upstream side of the mill will have a higher dust and moisture content than the air originally introduced into the mill. The dust content builds up in the air circulating through the circuit since, despite the fact that there is very little overgrinding, some extremely fine material is produced in the mill drum. While some of this extremely fine material will be eliminated with the material drawn off from the product collector, some will remain entrained in the air stream and will pass into the return air duct. The moisture content builds up since water is continuously being vaporized in the mill during the reduction, the crushing and grinding in the drum developing heat. (The water which vaporizes is originally introduced to the mill with the feed, an entirely dry feed being a practical impossibility in commercial ore processing.) If the mill and its return air duct constituted a completely closed circuit, the dust and moisture content of the air being re-circulated would build up to such a point that the ability of the dust and moisture laden air passing through the mill to carry off the reduced material, would be detrimentally affected. A portion of the air which enters the return air duct is drawn off and passed through the dust collector, and when the dust has been recovered from this air, the dust-freed air is discharged at a point remote from the mill. This discharging of air also prevents moisture saturation of the system. With the constant removal of a controlled amount of air in the above manner, the mill of the invention can be so operated that the dust and moisture content of the air passing through the mill can be controlled to maintain optimum operating conditions. The air-entry control valve is preferably located on the upstream side of the mill and can be operated to control the amount of new air being introduced into the system, either from outside or from the interior of the building. It will also be appreciated that some mill ambient air will find its way into the system in the region where the delivery end of the conveyor enters the system.

In drawings which illustrate embodiments of the invention:

Figure 1 is a diagrammatic illustration of one embodiment, the view being an elevation partly in section, and

Figure 2 is a diagrammatic elevation partly in section of another embodiment.

Referring first to Figure 1, a mill according to the invention may be noted, which is the same mill as that illustrated in Figure 2 of the above-mentioned copending application Serial No. 203,861. The mill proper is generally represented by reference numeral 10. The mill proper consists of a drum 11 which is vertically disposed and is rotatable about a horizontal axis. Any

conventional means may be employed for imparting the rotational drive to the mill, and it has been deemed unnecessary, therefore, to illustrate the drive. At opposite sides of the drum 11 there are hollow trunnions 12 and 13. Trunnions 12 and 13 are mounted in suitable bearings 14 and 15, carried by supports 16 and 17 respectively. A chute consisting of a substantially vertical section 18 connected to an inclined section 19 is located on one side of the mill. The inclined section 19 terminates at a central opening 20 in hollow trunnion 12. A conveyor 21 is partially shown in Figure 1. The delivery end of the conveyor terminates just within vertical chute section 18 and is capable of delivering the material which is to be reduced to the upper region of that section, whence the material will fall vertically through section 18.

On the opposite, or downstream side of the mill drum 11, a central outlet 22 leads through the hollow trunnion 13, and a passage 23 leads from opening 22 to a product collector 24, such as a cyclone collector of known construction, in which a predetermined size of product can be collected and drawn off at the point 25. Collector 24 is connected by a suitable line 26 to a fan 27, driven by a motor 28. Fan 27 serves to draw the air through the mill and carry the reduced material to the product collector 24. All the air drawn through the mill by the fan 27 is discharged into a return air duct 29 which links the upstream and downstream sides of the mill, forming a substantially closed circuit. The air drawing into the mill and discharged by fan 27 into return air duct 29 travels in the direction of the arrow Y. Return air duct 29 terminates in the vertical section 18 of the chute at a point below the delivery end of the conveyor 21. It will be noted from Figure 1 that return air duct 29 is substantially horizontal in its terminal region (as indicated at 30), adjacent the chute section 18. An air-entry control valve 31 is operable to open or close the upper end of chute section 18.

A conduit 32 leads from air return duct 29 to a dust collector 33. A portion of the air which passes along duct 29 may be drawn along conduit 32 into dust collector 33 by means of a fan 34 driven by a motor 35 and having an exhaust duct 36.

The majority of the air which passes through mill drum 11, sweeping from the mill the products reduced to the desired particle size, follows the complete course of return air duct 29 and enters vertical section 18, in a direction substantially at right angles to the stream of material falling vertically through section 18. The air thus introduced passes down inclined chute section 19 into mill drum 11, passage 23, and so on. The fact that the air leaving terminal region 30 of return air duct 29 is directed transversely into the vertically falling stream of material, causes some air classification to occur on the upstream side of the mill in the region of introduction of this air. With this air classification, material which is so small that it requires no reduction in the mill drum, is swept directly through the drum by the air stream, whereby overgrinding, and the marked disadvantages associated therewith, are avoided.

A minor portion of the air which enters return air duct 29 is drawn off by conduit 32 into dust collector 33 by fan 34. Dust carried in such air is substantially completely removed in dust collector 33, and the dust-freed air leaves the system via exhaust duct 36, at a point remote from the

mill. The exhaust duct 36 will preferably extend to a point outside the mill building, since it is unlikely that all the dust which enters conduit 32 could be removed in dust collector 33. The air leaving exhaust duct 36 serves to carry moisture out of the system. It will be appreciated that, by varying the setting of air entry control valve 31 and the speed of fan 34, it would be possible to control the dust and moisture content of the air within the system to maintain the desired operating conditions. For economic reasons fan 34 may be a constant speed fan. In such a case, instead of speed variance, alteration of a damper 33a located in the line between dust collector 33 and fan 34 may be relied upon to control the rate at which the dust and moisture laden air is withdrawn from the system. The dust and moisture laden air carried off along conduit 32 is replaced by new air which enters the system through air-entry control valve 31 and at the point where the delivery end of the conveyor enters the chute. Thus, if it were noted that the dust and moisture content of the air had reached a point where the efficiency of reduction had been lessened, more air would be withdrawn from duct 29 into conduit 32, dust collector 33, etc., and valve 31 would be more widely opened until such time as the preferred operating conditions had been restored.

In certain instances it may not be desirable to have air classification on the upstream side of the mill, and an apparatus according to my invention which would be used in such a case has been illustrated in Figure 2.

The apparatus shown in Figure 2 is very similar to that shown in Figure 1. The elements in the two figures which are functional and structural equivalents have been similarly numbered and will not be re-described in connection with Figure 2.

The points of difference between the two apparatus will now be pointed out. In the case of Figure 2, a single-section inclined chute 19a is employed instead of the two-section chute of Figure 1; and the return air duct 29 of Figure 2 leads directly into the end of chute 19a remote from drum 11. Air-entry control valve 31 is located in return air duct 29 adjacent inclined chute 19a. The delivery end of conveyor 21 terminates just within the upper region of inclined chute 19a (instead of terminating within the upper region of chute section 18). Return air duct 29 seals the end of chute 19a from the mill ambient air. Once again, the only new air which will be introduced into the mill is that which will be introduced around the delivery end of the conveyor and that which is permitted to enter via air-entry control valve 31 when the latter has been opened.

Dust collector 33 and fan 36 function in the same manner as described in Figure 1 so that the dust and moisture content of the air in the system may be controlled. The essential difference between the two embodiments is the fact that the material being fed into the mill for reduction slides along the lower wall of inclined chute 19a, and the flow of air entering the mill is substantially concurrent with the flow of material at all

times on the upstream side, so that air classification does not take place upstream of the mill drum.

What I claim as my invention is:

5 A rotating drum material reduction mill which is of the air swept type and is arranged for operation at sub-atmospheric pressures, said mill comprising a horizontally rotating mill drum whose diameter is appreciably greater than its length; means at the upstream side of said mill drum for admitting to said mill drum, along its horizontal axis, air and material to be reduced; an inclined chute located on the upstream side of said mill drum and leading to said admission means; conveyor means for delivering the material to be reduced to said chute; a return air duct linking the downstream and upstream sides of the mill drum and forming a substantially closed circuit; suction means located in said circuit on the downstream side of the mill drum for drawing a stream of air through said mill drum, whereby to entrain in the stream of air and carry out of the drum, particles of a selected size range; means for collecting the majority of the reduced particles entrained in said air stream, said collection means being located between the downstream side of said mill drum and the said suction means; a dust collector connected to said return air duct by a conduit which communicates with said duct at a point lying between said suction means and the upstream side of said drum; a second suction means, said second suction means being associated with said dust collector and being arranged to withdraw a portion of the air from said return air duct; means associated with said dust collector for discharging the air passed through said collector at a point remote from the mill; and an air entry control means operable to introduce controlled amounts of new air to the circuit; said return air duct terminating in, and closing off, the end of said inclined chute remote from the mill drum; said air entry control means being disposed in the terminal portion of said return air duct adjacent said inclined chute.

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