United States Patent

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[54] **METHOD OF CONTROLLING THE RATE OF FEED TO AN EXTRANEOUSLY ENERGIZED AIRSWEPT MILL**
4 Claims, 1 Drawing Fig.

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[50] **Field of Search** 241/19, 24, 34, 52, 53, 97

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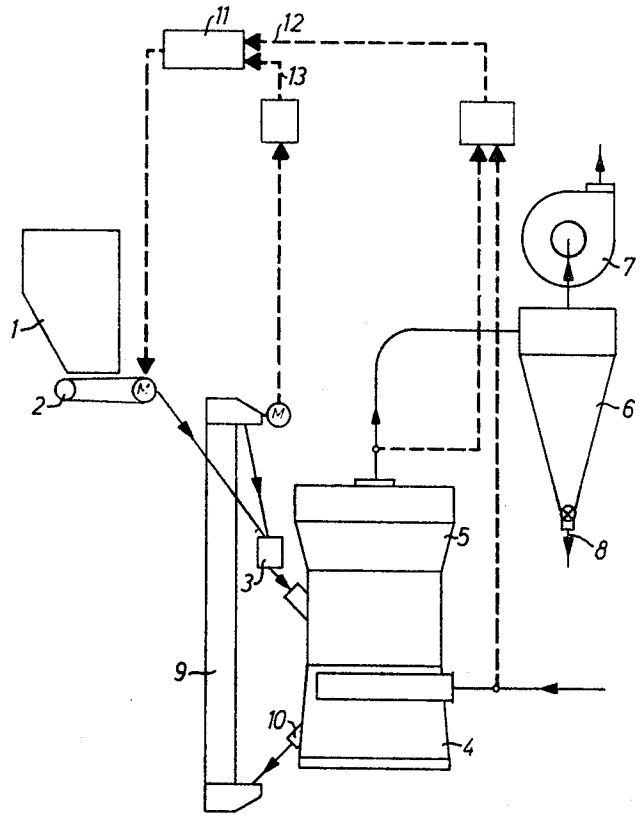
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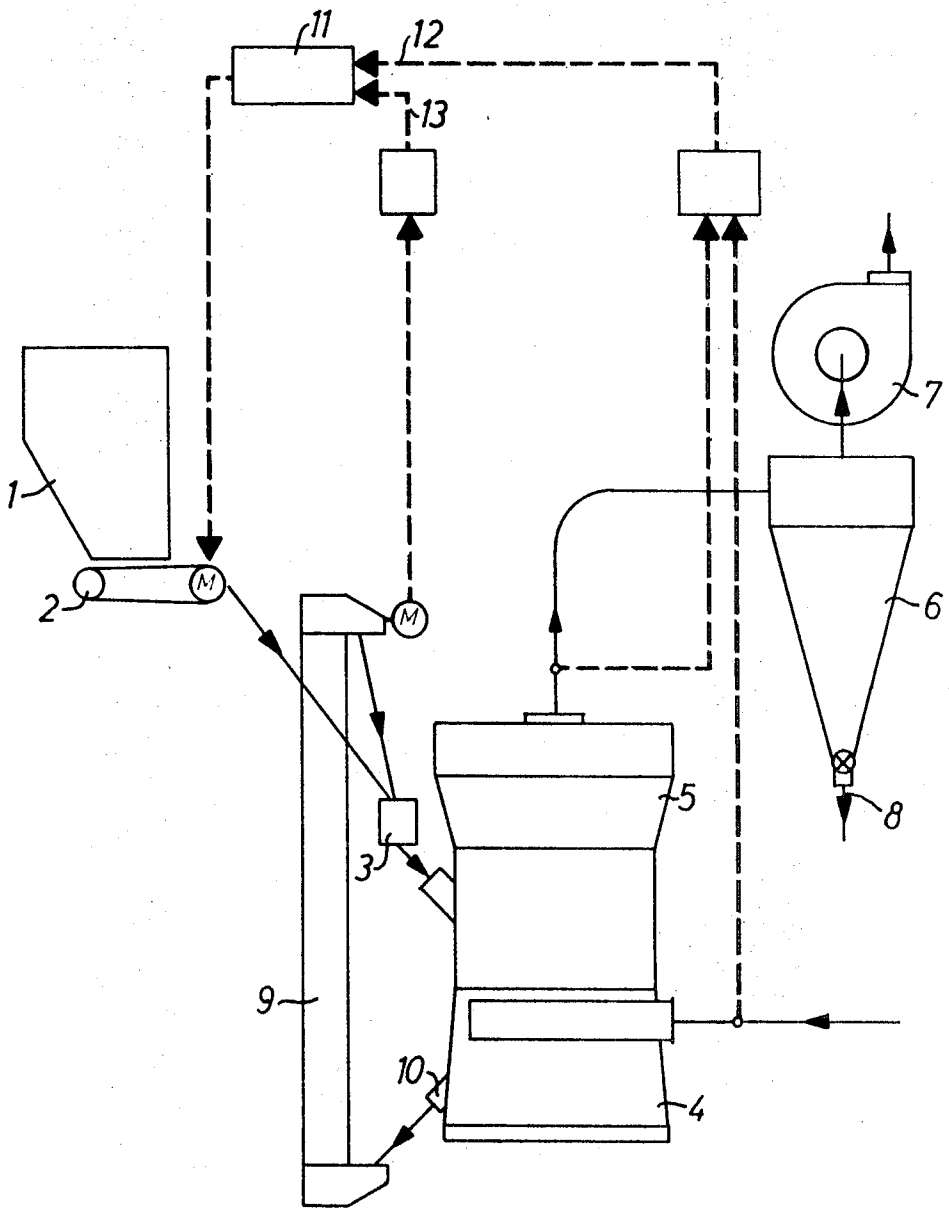
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ABSTRACT: In the controlling of the rate of feed of fresh material to an extraneously energized airswept mill from which only part of the output of material is extracted by the air stream and a further part deposited from the mill is refed mechanically to the mill, a control signal is derived from the degree of fullness of the mill, and a control signal is derived from the amount of material mechanically refed to the mill. One of the two control signals is used to control the nominal or target value of the rate of feed of fresh material, and the other control signal is used to control the actual value of such rate of feed.




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METHOD OF CONTROLLING THE RATE OF FEED TO AN EXTRANEOUSLY ENERGIZED AIRSWEPT MILL

BACKGROUND OF THE INVENTION

This invention relates to a method of controlling the rate of feed to an extraneously energized airswept mill, wherein only part of the circulating material is extracted from the mill in the air stream, while a further part of this material deposited from the mill is refed to the mill by mechanical conveyor means.

The term "extraneously energized mill" is used herein to mean any grinding mill other than an autogeneous mill containing no grinding elements in which the material tumbles and shatters itself.

It is known to operate extraneously energized mills purely as airswept mills. The entire quantity of ground material is then extracted pneumatically in the air stream. With such mills the feed rate is satisfactorily controlled according to the pressure differential across the mill or some other parameter characteristic of the degree to which the mill is filled.

A disadvantage of this type of mill lies, however, in the relatively high specific energy consumption of the exclusively pneumatic extraction of the ground material. In order to reduce energy consumption, extraneously energized mills have therefore been developed wherein only part of the circulating material is extracted from the mill in the air stream, while a further part of the material deposited from the mill is refed to the mill by mechanical conveyor means. Since such mechanical conveyance requires less energy than pneumatic conveyance, a reduction in specific energy consumption can be achieved in this manner.

These extraneously energized mills with partly mechanical and partly pneumatic extraction of material have also previously been controlled by parameters characteristic of the degree to which the mill is filled, in particular by the pressure differential in the air stream passing through the mill. It is found, however, that in general optimum output cannot be produced by such controls. A further disadvantage is that control by pressure differential alone does not respond quickly enough to changes in the grindability, moisture content, grain size and other properties of material freshly supplied to the mill. Extraneously energized mills operated by the known method therefore tend to run too full. Since considerable time and labor is involved in stopping and emptying the mill after it runs too full, mills with partly mechanical and partly pneumatic extraction of material, which are controlled according to the pressure differential only, are not operated up to the load limit of the mill. Consequently the mill is not working at its optimum operating point.

SUMMARY OF THE INVENTION

The object of the invention is to provide a method which avoids these disadvantages, permitting optimum control of the rate of feed to an extraneously energized mill with partly pneumatic derived partly mechanical extraction of material, and in particular permitting the mill to function at its most favorable working point, i.e. its load limit.

According to the invention this object is achieved in that control signals are derived from both the degree of fullness in the mill and the amount of mechanically conveyed circulating material, one signal being used to affect the nominal value and the other the actual value of the feed rate adjustment.

Two basic variations of this method are possible:

Either the control signal derived from the degree of fullness in the mill can be allowed to affect the nominal value, and the control signal derived from the amount of mechanically conveyed circulating material the actual value of the feed rate adjustment, or vice versa.

Which of these two variations is more desirable in a given case depends on the way the grinding plant is operated. If the greater part of the circulating material is extracted in the air stream and only a relatively small proportion is fed back to the mill by a mechanical conveyor, in general it is desirable to utilize the control signal derived from the degree of fullness in the mill as the primary control signal and act on the actual value of the feed rate control with it. When the control signal derived from the degree of fullness in the mill is thus used as the primary control signal, a nominal or target value for this control signal is established. Then whenever this control signal indicates that the mill is too full, the rate of feed of fresh material is reduced until this control signal again equals the nominal or target value. This nominal or target value, however, is varied in accordance with the amount of material which is being mechanically recirculated. Thus when the rate of flow of the mechanically recirculated material is increased, the nominal or target value of the primary control signal is changed so that the mill will be maintained less full. The conditions are, however, reversed if the greater part of the circulating material is mechanically conveyed and only a residue is pneumatically conveyed. In that case, the signal derived from the rate of flow of mechanically recirculated material will be used as the control signal, in order to change the rate of feed of fresh material whenever the rate of flow of mechanically recirculated material deviates from a nominal or target value. When the signal derived from the rate of flow of mechanically recirculated material is thus used as the primary control signal, the nominal or target value for this primary control signal is varied in accordance with the signal derived from the degree of fullness of the mill. Which of these systems is applied depends on the grinding technique aspects in view of the requirements for drying the ground material.

In obtaining a control signal derived from the degree of fullness in the mill, one may use:

- the pressure differential across the mill,
- the quantity or speed of the air conveyed at a particular point in the conduit system connected to the mill,
- the pressure differential across a cyclone separator,
- the pressure differential across an air current sieve or another part of the air feed system.

In obtaining a control signal derived from the amount of mechanically conveyed circulating material, one may use:

- the power consumption of the bucket conveyor or other conveyor means for mechanically feeding the circulating material,
- the weight of circulating material as determined by a balance,
- the power consumption of a separately powered sieve which may be disposed between the bucket conveyor and the mill inlet.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a diagram of one embodiment of plant controlled by the method of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The material to be ground is extracted from a hopper **1** by a variable-rate feeder **2** and fed through an air seal **3** to an extraneously energized mill **4**. The finished material and part of the circulating material are conveyed by an air stream to a sieve **5**. The finished material passes with the air stream into a cyclone separator **6** where it is separated (arrow **8**). The waste air is fed by a fan **7** to a filter for purification. The coarse material is fed back to the mill **4** from sieve **5**. Part of the circulating material is extracted from the mill (pipe **10**) and fed back to mill **4** via bucket conveyor **9** and air seal **3**.

The feed rate of the feeder **2** is adjusted by a controller **11** that receives a control signal **12** which is derived from the degree of fullness in mill **4**, preferably from the pressure differential across the mill, and which affects the actual value of the control. The nominal value of the control is acted on by a second control signal **13** derived from the quantity of mechanically conveyed circulating material, preferably from the power consumption of the bucket conveyor **9**.

As an additional safeguard, the nominal value of the degree of fullness of the mill is given upper and lower limiting values,

depending for instance on the operating range of fan **7**. The operating range of the circulating bucket conveyor **9** can also be demarcated by a maximum and a minimum value for power consumption.

In view of the above explanation the mode of operation of the control method should readily be understood. If for instance the amount of material dropping from the mill **4** and fed back to it by bucket conveyor **9** is increased by a change in grindability of the material, the control signal **13** fed to the controller **11** reduces the nominal or target value of the signal derived from the degree of fullness of the mill. If the actual value of the control signal **12** remains steady at the instant when the nominal or target value of the control signal is reduced, the feed rate for fresh material is nevertheless reduced, because the nominal or target value for the primary control signal **12** has been changed.

With the embodiment described, all of the circulating material falling from mill **4** is fed back to it by bucket conveyor **9** directly, i.e. without intermediate sifting. Sifting of the dropped and mechanically conveyed fraction of the circulating material is thus deliberately omitted. Extensive tests have in fact shown that the dropped and mechanically conveyed fraction of the ground material contains such a small amount of finished material that the intermediate sifting previously thought necessary and desirable would not pay. The omission of sifting the mechanically conveyed circulating material simplifies the plant and its operation considerably, and in particular avoids constant maintenance of these parts of the plant which are subject to particularly heavy wear in known plants.

Before being fed back into the mill the ground material falling from it preferably only has any iron pieces separated out. This avoids the danger of such iron pieces being fed back into the grinding process and causing damage.

I claim:

1. A method of controlling the rate of feed of fresh material to an extraneously energized airswept mill from which only part of the output of material is extracted by the air stream, a further part deposited from the mill being refed mechanically to the mill, wherein the improvement comprises the steps of deriving a control signal from the degree of fullness of the mill, deriving a control signal from the amount of material mechanically refed to the mill, using one of the control signals to control the rate of feed of fresh material, and using the other control signal to control the target value of the first control signal.

2. A method according to claim **1** wherein the target value of the first control signal is controlled by the other control signal between an upper and a lower limiting value.

3. A method according to claim **1** wherein all of the material deposited from the mill is refed to the mill directly, without intermediate sifting.

4. A method according to claim **1** wherein iron pieces are removed from the deposited material before it is refed to the mill.