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METHOD OF AND APPARATUS FOR MULTIPLE STAGE WET GRINDING

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Fig. 1,

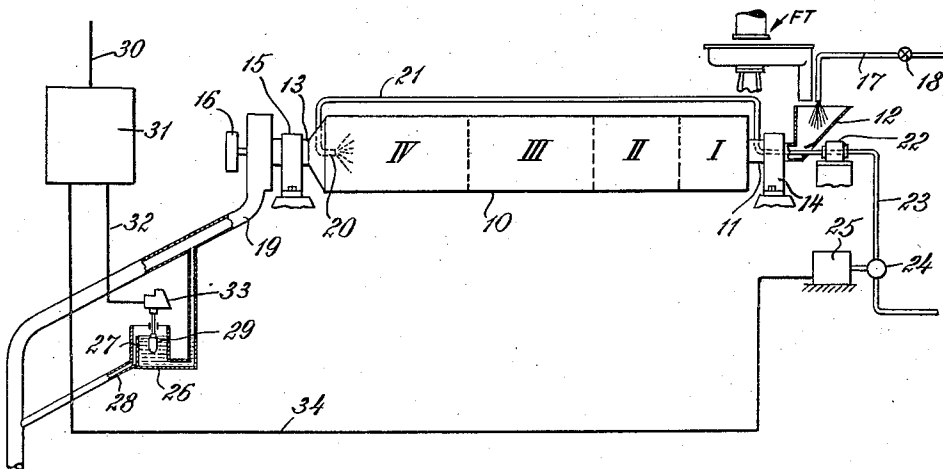
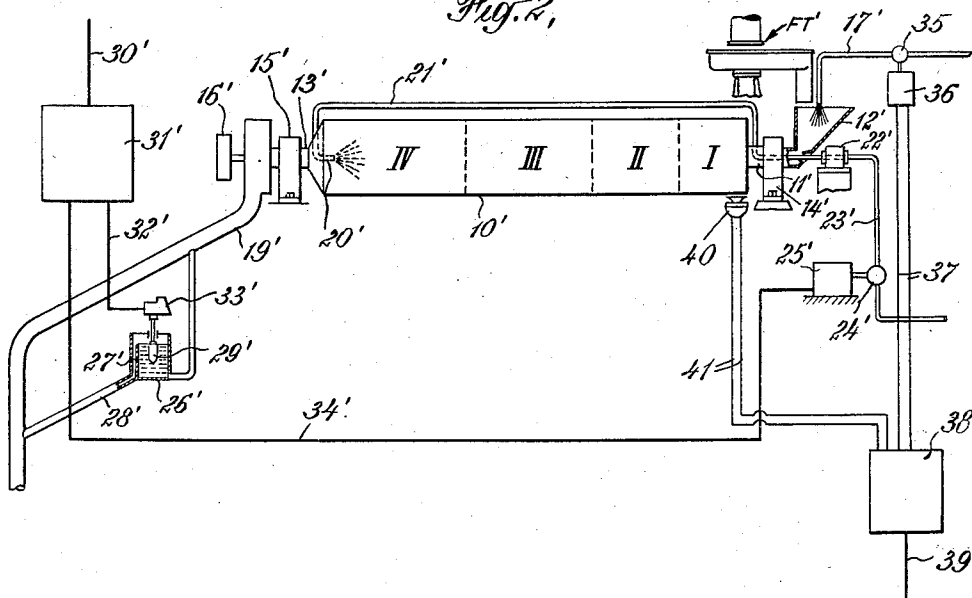


Fig. 2,



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METHOD OF AND APPARATUS FOR MULTIPLE STAGE WET GRINDING

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3 Claims. (Cl. 241—21)

This invention relates to wet grinding in a mill subdivided into a series of compartments through which the material travels as it is being ground. More particularly, the invention is concerned with a novel method of wet grinding in multi-compartment mills, which affords a close control of the amount of water in the slurry issuing from the mill, so that excess water in the slurry is avoided and savings in the cost of fuel for burning the slurry are effected. In addition, the invention includes a mill installation, in which the method may be advantageously practiced.

In most wet grinding operations, as, for example, in the cement industry, the raw cement mix slurry issuing from the grinding mill contains more water than is necessary to permit the slurry to be conveniently pumped through pipe lines from the slurry basin to the kilns. As all the water in the slurry must be driven off in the burning operation, any water in the slurry beyond that necessary to produce a slurry of desirable viscosity for pipe line flow represents a fuel loss. In order to control the amount of water in the slurry, it is now the practice to regulate the feed of raw material, water, or both raw material and water to the mill in an attempt to maintain the slurry at constant viscosity. However, since all the water is introduced into the first compartment of the mill and it takes as much as half an hour for the raw material to pass through the mill, there is a long lag between the time that an adjustment in the feed is required and the time when the desirability of the adjustment is known and the adjustment can be made.

We have found that satisfactory grinding in the first compartments of the mill can be effected, even though the feed includes an amount of water less than is required to produce a slurry of the desired viscosity, and that it is only in the advanced stage of fine grinding in the last one or two compartments of the mill that the full quantity of water for the desired slurry should be present.

The present invention is, accordingly, directed to a method of wet grinding, in which the feed to the first compartment includes all the raw material and a part of the water required for a slurry of desirable viscosity, and the remainder of the water required for such a slurry is introduced into the last compartment or compartments of the mill. The amount of water fed into the mill at the discharge end is regulated to maintain the slurry at a substantially uniform viscosity and, for this purpose, a viscometer may be employed. The response of the viscometer to changes in viscosity in the slurry supplied to it operates the means for controlling the supply of water to the final compartment or compartments of the mill and, since the time required for passage of the material through the fine grinding stage of the mill is relatively short, a close control of the viscosity of the slurry can be maintained and wide fluctuations in viscosity avoided.

In the practice of the method of the invention, the supply of water to the first compartment may be intro-

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duced at a constant rate in relation to the feed of raw material but, when the raw material varies from time to time in grindability, the charge of material in the first compartment will vary accordingly. Under such conditions, it is desirable to vary the rate of feed as the charge in the first compartment varies. The grinding noise from the first compartment is a measure of the charge of raw material in that compartment, the noise decreasing as the charge increases and vice versa. The variations in the supply of water to the first compartment with variations in the charge may be effected manually or automatically by means of known devices, which produce a response varying with the grinding noise and useful in adjusting the control means for the water supply.

For a better understanding of the invention, reference may be had to the accompanying drawing, in which

Fig. 1 is a diagrammatic view, partly in elevation and partly in vertical section, showing one form of mill installation for use in the practice of the method of the invention; and

Fig. 2 is a view similar to Fig. 1 showing a modified form of mill installation.

In the installation shown in Fig. 1, the mill 10 is of a well-known type and includes a shell subdivided by internal partitions into grinding compartments designated I, II, III and IV. The mill is provided at its feed end with a trunnion 11, through which material to be ground is introduced from a hopper 12, and the ground material is discharged through a hollow trunnion 13 at the opposite end of the mill. The trunnions are mounted for rotation in bearings 14, 15 and the mill may be rotated in any suitable manner, as, for example, by means of a prime mover connected to the mill through a coupling 16.

The material to be ground is supplied to the hopper at a controlled rate by any suitable means, such as the conventional feeding table FT, and the water is supplied through a pipe 17 discharging into the hopper and containing a control valve 18. The finished slurry is led from the mill through a pipe 19 leading to a slurry receptacle not shown.

A nozzle 20 is mounted to discharge axially into the last compartment IV of the mill and is supplied with water through a pipe 21 permanently mounted on the mill and extending lengthwise thereof and projecting axially out through trunnion 11 and the hopper. Pipe 21 terminates within a stuffing box 22 and water is supplied to the stuffing box by a pipe 23 containing a control valve 24 operable by a regulating device 25.

Part of the slurry leaving the mill through pipe 19 enters the vessel 26 of a viscometer of conventional construction, the vessel containing a partition 27, over which excess slurry flows to leave the vessel through pipe 28 and be returned to pipe 19. The partition insures that a constant volume of slurry will be contained within vessel 26 and the rotating element 29 of the viscometer extends into the body of slurry. The viscometer is operated by current supplied through a cable 30 leading to a switch box 31, from which current is fed through cable 32 to the device 33 driving element 29. The viscometer is of the type which develops a voltage varying with the viscosity of the slurry and the voltage is transmitted to switch box 31 through conductors in cable 32 and is then transmitted through cable 34 to regulator 25 for the water supply valve 24.

In the operation of the mill installation shown in Fig. 1, water for grinding is discharged at a constant rate into hopper 12 along with the raw material. The amount of water so supplied is inadequate to produce a slurry of a consistency, which can be conveniently transferred through pipe lines, and the remainder of the water required to produce slurry of the desired consistency is

introduced into the last compartment of the mill through nozzle 20 under the control of valve 24. Valve 24 is in turn controlled by the response of regulator 25 to the viscometer and, if the viscosity of the slurry increases, the viscometer causes regulator 25 to open valve 24 to increase the amount of water supplied to the final stage of grinding. If the viscosity decreases, valve 24 is correspondingly regulated to make the appropriate adjustment in the quantity of water supplied to the last grinding stage. Since changes in viscosity of the slurry being discharged are quickly detected by the viscometer and corresponding changes can be made at once in the amount of water supplied to the last stage of grinding, it will be apparent that, in the installation described, a close control of the consistency of the slurry can be maintained, so that the presence in the slurry of more water than is required for pipe line flow is avoided. Accordingly, in the burning of the slurry, only the minimum amount of water must be driven off.

The installation shown in Fig. 2 is intended for use in the grinding of material varying in grindability and is provided with means for regulating the amount of water fed to the first compartment of the mill. The installation is generally similar to that shown in Fig. 1 and corresponding parts are identified by the same reference characters with prime marks. In the installation of Fig. 2, the water supplied to hopper 12' through pipe 17' is controlled by a valve 35 operated by a regulator 36. The regulator is connected through conductors 37 to a switch box 38, to which current is supplied through cable 39. A microphone pick-up device 40, which is disposed close to the first compartment of the mill and is connected to the switch box through conductors 41, delivers impulses to the switch box, which are amplified therein and transmitted to regulator 36, so as to adjust valve 35 to control the supply of water delivered to the hopper inversely with variations in the grinding noise. The microphone device may be of any appropriate forms, such as those disclosed in U. S. Patents 2,136,907, issued November 15, 1938, and 2,405,059, issued July 30, 1946.

In the installations illustrated, the water introduced into the mill for the purpose of reducing the viscosity of the slurry and giving it a final consistency suitable for pipe line flow is supplied through nozzles 20, 20', which are shown as discharging into the last compartment. It is to be understood, however, that the water is to be used in the final stages of grinding and, in some installations, it may be desirable to discharge the water into more than one of the compartments at the discharge end of the mill. Accordingly, in the appended claims, it is to be understood that the reference to the "last compartment" is intended to apply to one or more of the compartments at the discharge end of the mill.

We claim:

1. A method of controlling the viscosity of a slurry to be burned and produced by grinding material in a mill having a series of grinding compartments, through which

the material passes, which comprises introducing into the first grinding compartment with the material to be ground a quantity of water insufficient to convert the ground material issuing from the mill into a slurry of a desired viscosity and conveniently transferred through a pipe line, grinding the material in the mill compartments ahead of the last compartment without addition of water, introducing water into the last grinding compartment, and regulating the supply of water to the last grinding compartment in response to variations in the viscosity of the slurry issuing from the mill to maintain said slurry at the desired viscosity.

2. A method of controlling the viscosity of a slurry to be burned and produced by grinding material in a mill having a series of grinding compartments, through which the material passes, which comprises introducing into the first grinding compartment with the material to be ground a quantity of water insufficient to convert the ground material issuing from the mill into a slurry of a desired viscosity and conveniently transferable through a pipe line, varying the supply of water to the first grinding compartment inversely with variations in the grinding noise in said compartment, grinding the material in the mill compartments ahead of the last compartment without addition of water, and introducing water into the last grinding compartment in response to variations in the viscosity of the slurry issuing from the mill to maintain said slurry at the desired viscosity.

3. A mill installation which comprises a mill having a shell divided into grinding compartments by partitions, an inlet at one end of the shell leading into the first grinding compartment, an outlet at the other end of the shell leading from the last grinding compartment, means for introducing material to be ground into the first grinding compartment, means for introducing water into the first grinding compartment, and means for supplying water to the last grinding compartment, said means including a pipe attached to the shell to rotate therewith and having a discharge end within the last grinding compartment and an intake end extending axially of the shell beyond one end thereof, a stationary supply pipe, and a connection between the stationary pipe and the intake end of the pipe attached to the shell.

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