Feb. 11, 1936. R. M. HARDGROVE 2,030,448

FEED CONTROL FOR MILLS

Original Filed May 29, 1928 3 Sheets-Sheet 1

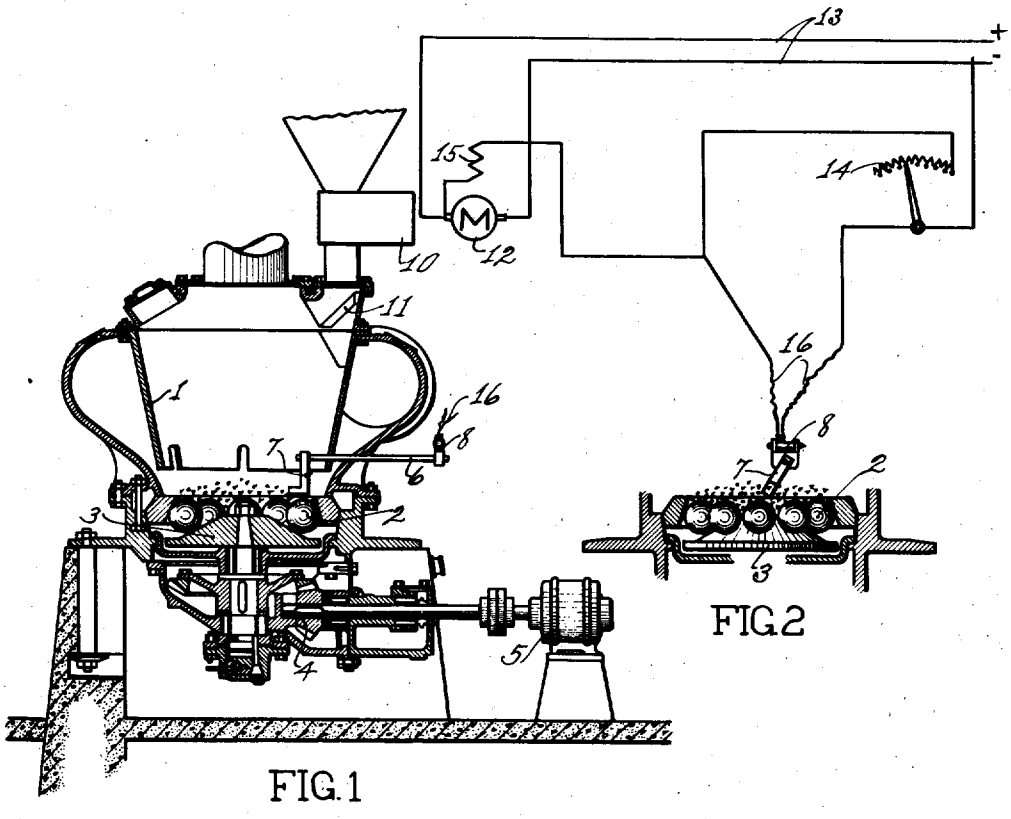

FIG. 1

FIG. 2

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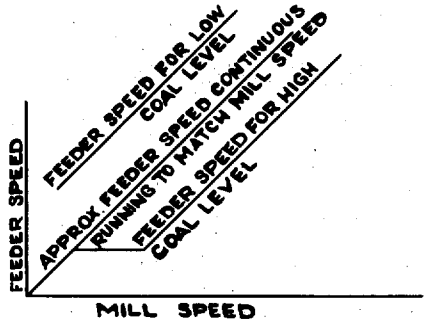

FIG.5

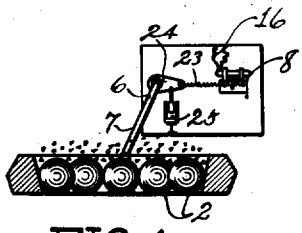

FIG.4

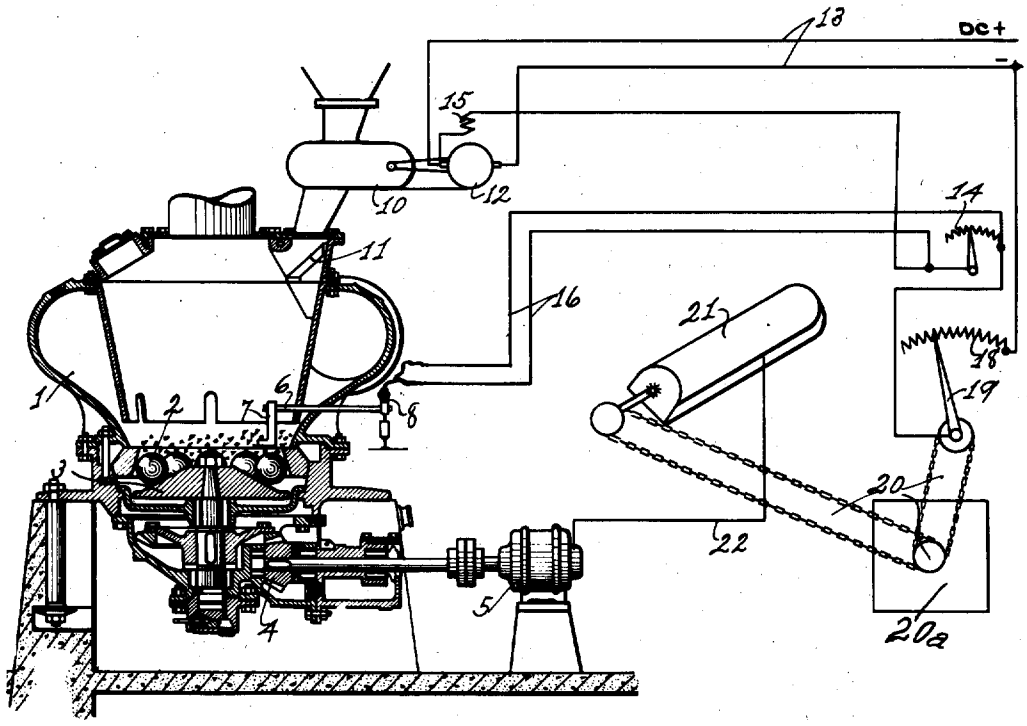

FIG.3

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FEED CONTROL FOR MILLS

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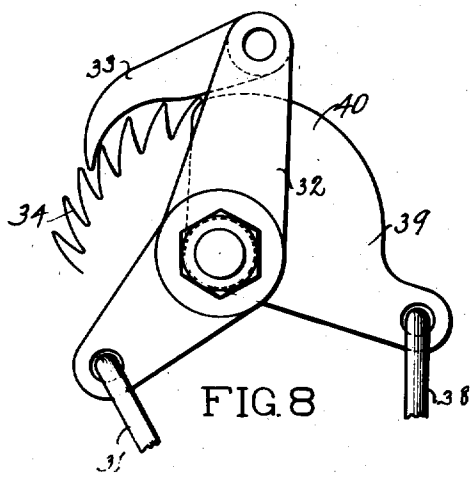

FIG. 8

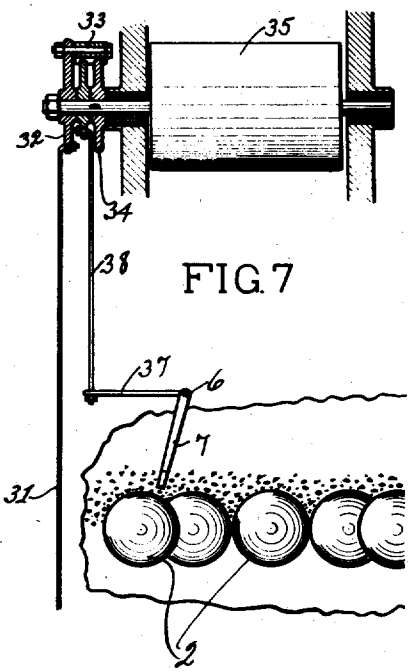

FIG. 7

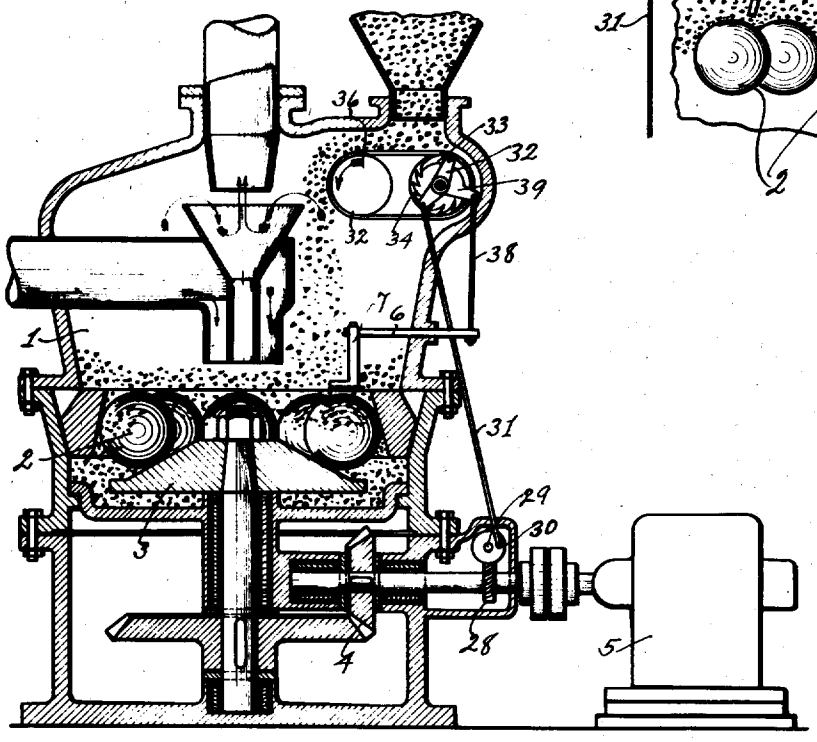

FIG. 6

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2,030,448

FEED CONTROL FOR MILLS

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Renewed July 30, 1932

8 Claims. (Cl. 83—45)

This invention relates to a device by means of which the feed of material to a grinding mill is automatically controlled by the amount of material in the mill that is being ground. The invention is especially applicable to grinding mills for pulverizing coal but is not restricted to this particular use.

The invention will be understood from the description in connection with the accompanying drawings in which Fig. 1 is a vertical section through an illustrative embodiment of the invention; Fig. 2 is a section partly broken away at right angles to Fig. 1; Fig. 3 is a vertical section similar to Fig. 1 showing a modification; Fig. 4 is a section similar to Fig. 2 showing a modification of some of the details; Fig. 5 is a diagrammatic view showing relations between the speed of the mill and the speed of the feeder; Fig. 6 is a vertical section similar to Fig. 1 showing another modification; Fig. 7 is a section at right angles to Fig. 6 showing some of the details on an enlarged scale; and Fig. 8 is a plan view on an enlarged scale showing some of the details.

In the drawings reference character 1 indicates a grinding mill for coal or the like that is provided with grinding balls 2 that rest upon and are driven by a disc 3 that is in turn driven by gear mechanism 4 by means of the motor 5.

A shaft 6 is journaled in bearings in the side wall of the mill 1 and is provided with a depending arm 7 at the inner end thereof. The lower end of the arm 7 extends into proximity with the upper surfaces of the grinding balls 2 and is apt to be struck by the material that is being ground and pushed to the side to turn the shaft 6 when the material reaches a certain depth or accumulates to a certain extent while being ground. A switch 8 is connected to the shaft 6 to make and break contact in an electrical circuit in accordance with the position of the arm 7. The switch 8 is shown as a mercoid switch in which the make and break is made by tilting the switch back and forth.

A coal feeder 10 is somewhat diagrammatically shown and feeds coal through the inlet 11 at the upper portion of the mill 1. The coal feeder 10 is driven by a shunt motor 12 and the rate of feed is governed by the speed of the motor. The electric mains are indicated at 13 and a resistance 14 is connected in series with the shunt field 15 of the motor. A short circuit 16 is provided around the resistance 14 and is open and closed by means of the switch 8.

The operation is as follows: The resistance 14 is adjusted so that the speed of the motor 12 will be slightly greater than is necessary to feed the coal at the proper rate to the grinding mill. When the coal that is being ground accumulates a sufficient amount to strike the arm 7, the switch 8 is closed, thereby short circuiting the resistance 14 in series with the shunt field 15 of the motor 12 and causing the motor to slow down. When the level of the coal that is being ground descends, the arm 7 turns back by gravity and opens the switch 8 thereby speeding up the motor 12.

In the modification shown in Fig. 3 another resistance 18 is connected in series with the resistance 14 and shunt field 15 of the feeder motor 12. The effective portion of the resistance 18 can be varied by a movable arm 19, the position of which is changed in accordance with changes in the amount of fuel required in the associated furnace. The changes in position of the arm 19 are automatically controlled in the modification shown in Fig. 3 by means of a suitable combustion control device, diagrammatically illustrated at 20^a, responsive to a condition or quantity, such as boiler steam pressure, varying with the amount of fuel supplied to the furnace. The arm 19 is controlled by the combustion control device 20^a through a chain and sprocket drive connection 20 so that any adjustment of the control device 20^a will automatically adjust the resistance 18, and thereby vary the speed of the motor 12 and the rate at which the coal is fed to the mill. The control device 20^a is also used to simultaneously control the speed of the mill motor 5 through a chain and sprocket connection 20 to a drum controller 21 and electrical connections 22, as diagrammatically illustrated in Fig. 3. The drum controller 21 may be of any well known type capable of variably controlling the speed of the motor 5. In this way an adjustment of the combustion control device 20^a not only regulates the speed of the motor 5 driving the mill 1 but also regulates the speed of the motor 12 driving the feeder 10. Besides, when the switch 8 is closed by an accumulation of material in the mill 1, as described in connection with Fig. 1, to short circuit the switch 14, and thereby slow down the feed motor 12, the speed of the feeder 10 will be reduced but not entirely to the minimum speed so that there is less shock on the feeder motor 12 as it is reduced only enough to obtain the desired amount of control. The upper line in Fig. 5 shows the relation between the speed of the feeder and the speed of the mill when the feeder is feeding more rapidly than the mill is grinding. The middle line repre-

sents the relation when the two speeds have been adjusted so that the grinding is at the same rate as the feed and the lowest line represents the relative speeds of the feeder and mill when the switch 8 has been closed to slow down the feeder motor 12.

Instead of mounting the mercoid switch 8 directly upon the shaft 6, this switch may be pivoted independently and connected by means of the spring 23 to an arm 24 on the shaft 6 as shown in Fig. 4, and a dash pot 25 may be connected to the arm 26 to make the operation more smooth.

In the modification shown in Figs. 6, 7 and 8 the feeder control is entirely mechanical. In this modification a worm 28 is provided on the shaft of the driving motor 5 and drives a shaft 29 that is provided with a crank pin 30 to which a rod 31 is connected. The other end of the rod 31 is connected to one end of a pivoted lever 32, the other end of which carries the pawl 33, which upon being oscillated drives the gear 34 by means of which the roller 35 of the feed mechanism 36 is driven. The feed mechanism consists of a belt passing over rollers by means of which the coal is fed to the mill 1.

The outer end of the shaft 6 to which the arm 7 is attached carries an arm 37 to the outer end of which one end of a rod 38 is connected, the other end of this rod 38 being connected to a cam 39 that is pivoted on the same pivot as the lever 32. The cam surface 40 moves under the pawl 33 and lifts the same so that it will not contact with the teeth 34 when the level of the coal in the mill 1 rises sufficiently high to strike the arm 7, thus stopping the feed of the coal until the arm 7 descends and turns the shaft 6 sufficiently to permit the pawl 33 to contact again with the teeth 34.

The embodiment of the invention illustrated in Figs. 1 and 2 is especially suitable for storage system preparation plants where the grinding mills are operated at their maximum capacities all of the time, and coal level control is required only to insure that the mills are being supplied with coal at the maximum rates at all times, thus not either choking or suffering a loss in capacity. The embodiment illustrated in Figs. 3 to 5 is especially useful in a unit fired mill where the mill speed is to be varied for different capacities, and the feeder speed would also have to vary over a much wider range than would be necessary for storage system plants. The embodiment shown in Figs. 6 to 8 is well adapted either to storage or unit fired operation.

I claim:

1. In a device for controlling the rate of feed to a ball mill having a series of horizontally rotating grinding balls and drive means therefor, a feed mechanism, and means independent of said drive means and operated by the depth of material in the mill to control the feed mechanism.

2. In a device for controlling the rate of feed to a ball mill, a feed mechanism, a series of horizontally rotating grinding balls, and means comprising a pivoted arm operated by the depth of material in the mill to control the speed of the feed mechanism.

3. In a ball mill for grinding coal, a coal feeder, a series of horizontally rotating grinding elements and means comprising a pivoted arm and an electrical make and break switch operated by the level of coal on said elements to control the speed of the feed mechanism.

4. In a grinding mill, a grinding ring, a row of grinding elements, an arm pivoted above the upper surface of said elements as they operate, and means connected to said arm for controlling the operation of said mill.

5. In a mill for grinding coal, a coal feeder, a series of horizontally rotating grinding elements, means for rotating said elements, means for driving said coal feeder comprising a pawl, in driving relation to said coal feeder and in driven relation to said element rotating means, a ratchet operated by said pawl, and a pivoted lever connected to said pawl and operated by the level of the coal on said elements to control the engagement of said pawl and ratchet.

6. In a device for controlling the rate of feed of material to a mill having a series of horizontally rotating grinding balls, a feed mechanism, and means comprising a pivoted arm responsive to the depth of material being ground in said mill for controlling said feed mechanism.

7. In a grinding mill having a stationary mill casing, a grinding surface within said casing, a series of rolling grinding elements contacting with said surface, means forming a space in said mill for the accumulation of material in the course of grinding, drive means for effecting a relative movement between said grinding elements and said surface, a feed mechanism, separate drive means for said feed mechanism, means responsive to changes in a variable quantity affected by the operation of said mill for simultaneously controlling the operation of both of said drive means, and means responsive to the amount of material in said space for independently controlling the operation of said feed mechanism drive means.

8. In combination, a mill for pulverizing solid fuel, means for driving said mill, a feeder for delivering fuel to be pulverized to said mill, means independent of said mill driving means for driving said feeder, automatic control means responsive to changes in a variable quantity affected by changes in the amount of pulverized fuel discharged by said mill arranged to control the operation of said mill and feeder driving means, and automatic control means operable independently of said first mentioned control means to control the operation of said feeder in accordance with the amount of fuel in said mill.

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