United States Patent

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[54] **ROTARY KILN WITH END AND INTERMEDIATE DISCHARGE**
5 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **263/33,** 214/18
[51] **Int. Cl.** **F27b 7/32**
[50] **Field of Search** ..... 263/33, 53; 214/18 RK

[56] **References Cited**

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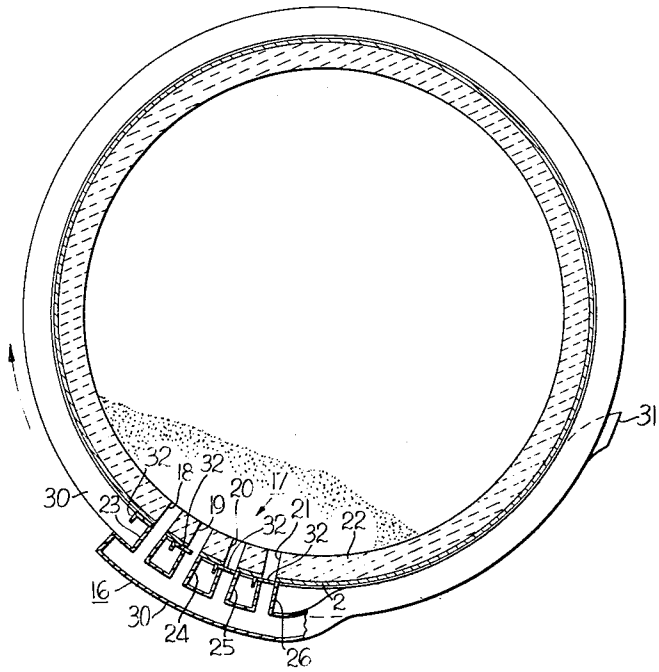
ABSTRACT: A rotary kiln is disclosed having, in material flow sequence, a drying zone, a preburning zone and a calcining zone. A provision is made for discharging a controlled portion of material from the kiln which has been dried but not calcined. Such a provision includes several radial passages projecting through the kiln shell in a common radial plane located along the kiln at approximately the end of the drying zone adjacent the preburning zone. A duct piece for each passage is connected on one end to a passage at the outer periphery of the kiln and the other end of each duct is connected to a conduit which encircles the outer periphery of the kiln shell for about one and one-quarter turns. An adjustable valve is provided in each duct to control the flow of material out of the kiln and into the encircling conduit. The encircling conduit terminates in a discharge opening which is a sufficient circumferential distance from the passages through the kiln shell, so that at least one portion of material is within the encircling conduit at all times and blocking the entry of atmospheric air into the kiln.



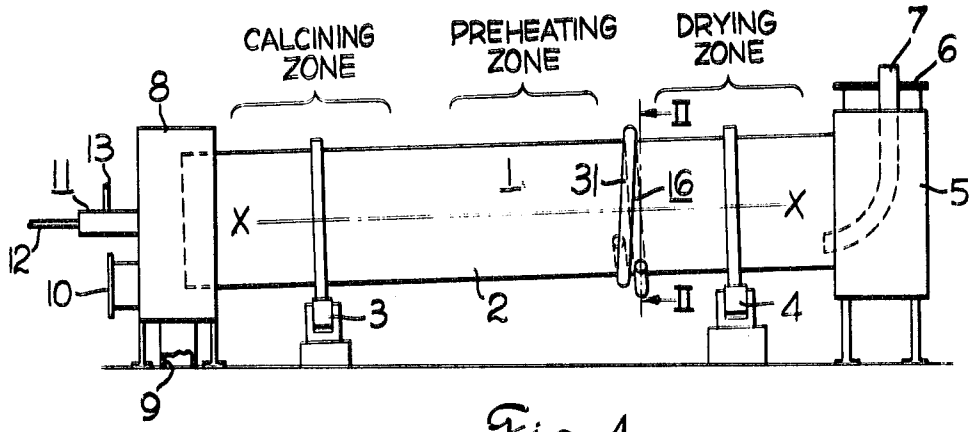


Fig. 1

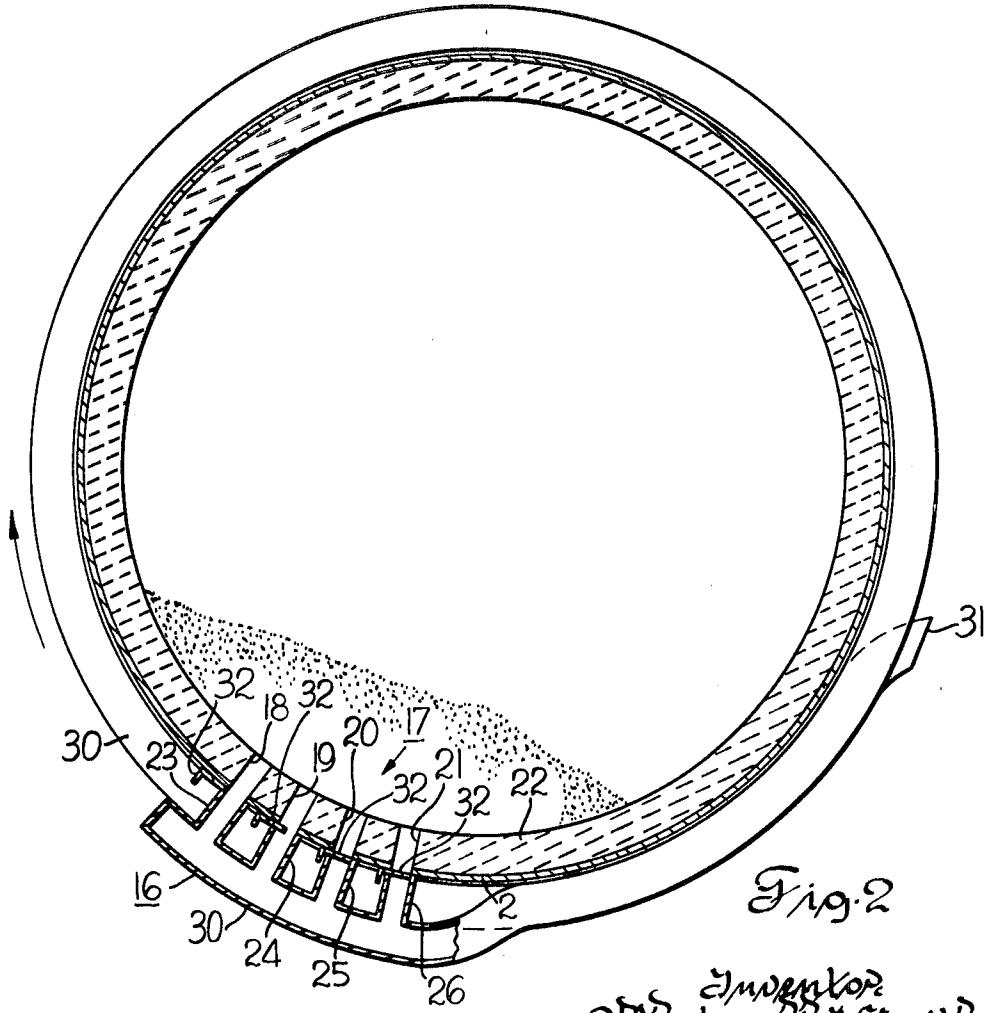


Fig. 2

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ROTARY KILN WITH END AND INTERMEDIATE DISCHARGE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to rotary kilns and in particular to rotary kilns having a kiln shell with a provision for discharging a portion of material passing therethrough at a location intermediate feed end and discharge end of the shell.

2. Description of the Prior Art

Rotary kilns having a kiln shell with a provision for discharging some of the material passing therethrough, at one or more locations between the ends of the kiln shell, are shown in patents such as U.S. Pat. No. 1,731,457 of 1929, U.S. Pat. No. 2,019,397 of 1935; and U.S. Pat. No. 2,039,062 of 1936. According to such prior art, hinged gate valves (as shown in FIGS. **1** and **2** of U.S. Pat. No. 1,731,457) and rotating paddle wheel valves (labeled **36** in U.S. Pat. No. 2,019,397 and U.S. Pat. No. 2,039,062) have been taught as devices for discharging material, from locations intermediate the ends of a kiln shell, without admitting atmospheric air into the kiln. Thus known prior art requires actuation of a moving part each time the kiln turns to discharge material through or past such a part. It is a principal object of the present invention, as will hereinafter be described, to eliminate dependence upon the actuation of such a moving part.

SUMMARY OF THE PRESENT INVENTION

A rotary kiln according to the present invention, as will appear from the description to follow, not only achieves the aforesaid principal object relative to the described prior art, but also is particularly adapted for heating minerals for which there is a market need for the material in both a calcined condition and a dry but uncalcined condition. The market for such materials that have been dried but not calcined is sometimes a relatively small market that does not easily justify the purchase, installation and operation of drying equipment operative solely for producing such dry but uncalcined material. It is therefore another object of the present invention to provide a new and improved rotary kiln having provision for discharging a controlled portion of material at the end of a drying zone adjacent a preburning zone, to provide for the discharge of a marketable dry but uncalcined material as well as a fully calcined marketable material from the discharge end of the kiln and with improved utilization of heat in the gases leaving the calcining and preheating zones.

In a preferred embodiment of the present invention a rotary kiln having, in material flow sequence, a drying zone, a preburning zone and a calcining zone is provided with means for discharging a controlled portion of material from the kiln which has been dried but not calcined. Such a provision includes several radial passages projecting through the kiln shell in a common radial plane located along the kiln at approximately the end of the drying zone adjacent the preburning zone. A duct piece for each passage is connected on one end to a passage at the outer periphery of the kiln and the other end of each duct is connected to a conduit which encircles the outer periphery of the kiln shell for about one and one-quarter turns. An adjustable valve is provided in each duct to control the flow of material out of the kiln and into the encircling conduit. The encircling conduit terminates in a discharge opening which, being spaced at least one complete turn around the kiln from the passages through the kiln shell, places the discharge opening of the encircling conduit a sufficient circumferential distance from the passages through the kiln shell, so that at least one portion of material being discharged is within the encircling conduit at all times and blocking the entry of atmospheric air into the kiln.

Other features and objects of the invention that have been attained will appear from the more detailed description to follow with reference to an embodiment of the present invention shown in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** of the accompanying drawing shows diagrammatically a side elevation of a rotary kiln feed according to the present invention; and

FIG. **2** is a view taken along line II—II in FIG. **1** and viewing the structure in the direction indicated by arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, a rotary kiln **1** is shown having a cylindrical shell **2** mounted on roller supports **3**, **4** for rotation by drive means (not shown), to turn about a central axis X—X passing therethrough. The kiln **1** has material feed hood **5** enclosing one end of shell **2** and hood **5** defines a gas discharge opening **6**. A feed chute **7** passes through the hood **5** to deposit feed material within shell **2**. A firing hood **8** encloses the other end of shell **2** and provides a primary material discharge opening **9** and a combustion air inlet **10**. The firing hood also is provided with a burner assembly **11** having an inlet **12** for fuel and an inlet **13** for burner air. The operation of the kiln **1**, as will be described later, provides a temperature gradient along the axis X—X of the shell **2** from firing hood **8** to the feed hood **5** which provides for material moving in a counterflow relation to gas flow, a drying zone, a preburning zone and a calcining zone, each labeled accordingly in FIG. **1**.

An intermediate discharge means **16** provides a secondary material discharge from shell **2** at approximately the end of the drying zone adjacent the preburning zone. Referring now to FIG. **2**, the discharge means **16** is provided with passage means **17** comprising a plurality of radially extending passages **18–21** projecting through shell **2** and refractory lining **22** within shell **2**, in a common radial plane II—II in FIG. **1**. Intermediate ducts **23–26** as shown in FIG. **2** are provided which are connected, as by welding, to the outer periphery of shell **2**, to project radially outward from passages **18–21**. An encircling conduit **30** is provided into which each of the ducts **23–26** open to establish material flow communication from the interior of shell **2** through passages **18–21**, through ducts **23–26**, and into encircling conduit **30**. The encircling conduit **30** encircles the outer periphery of shell **2** for at least one complete turn around shell **2** and preferably one and one-quarter turns, and terminates in a discharge port **31**.

Adjustable valve means, shown as a slide valve **32**, is provided in each of the ducts **23–26** for controlling the flow of material out passages **18–21**. The valve **32** in duct **23** is shown in a fully withdrawn position which opens passage **18** for full flow discharge from shell **2** into conduit **30**; valve **32** in duct **24** is shown in a half-withdrawn position which provides a partial flow therethrough and the valves **32** in ducts **25**, **26** are shown in a fully closed position.

In the operation of the described kiln, fuel delivered through inlet **12** to the burner assembly **11** along with air through inlets **10**, **13**, provides the flame and high-temperature combustion gases needed in shell **2**. This combustion establishes a peak temperature within shell **2** that is relatively near, though not adjacent, the end of the shell **2** enclosed by the firing hood **8**, and a decreasing temperature gradient from the location of the peak temperature to the end of shell **2** enclosed by the feed hood **5**. The temperatures within shell **2** therefore define zones wherein the kiln performs its various functions to cause reactions to take place that are required by the desired treatment of the feed material. For example, to calcine $Ca\,CO_3$, this material must be heated to above 1,650° F. because the vapor pressure of CO_2 in $Ca\,CO_3$ (the decomposition pressure) reaches atmospheric pressure at about 1,650° F. Thus a calcining zone extends from the discharge end of shell **2** enclosed by firing hood **8**, toward the feed end of the kiln and terminates at a location where combustion gases are no longer hot enough to heat oncoming material to about 1,650° F. The relatively cooler gases continuing on toward the gas discharge opening **6**, serve to preheat and then dry the oppositely moving material. The end of the drying

zone adjacent the preheating zone, will be located where gas temperatures have raised the temperature of feed material to about 200°–300° F. When feed material from chute **7** has progressed through shell **2** sufficiently to be heated to 200°–300° F., chemically uncombined water will be evaporated therefrom and the material is considered to be dry and to have reached the end of the drying zone. From the drying zone, material passes into and through the preheating zone where gradual and continuous heating continues until at about 1,650° F. the material is considered to have passed on into the calcining zone. It is at the end of the drying zone adjacent the preheating zone, that the intermediate discharge means **16** operate to discharge controlled quantities of dry material which may be marketed or used without calcining.

The operation of the intermediate discharge means **16**, referring to FIG. **2**, results when rotation of shell **2** causes the radial passages **18–21** to pass beneath the bed of material in the kiln. Depending upon the positions of slide valves **32**, controlled amounts of material from the bed pass through passages **18–21**, ducts **23–26**, and into the encircling conduit **30**. As the kiln rotates in the direction indicated by the arrow in FIG. **2**, gravity causes a quantity of material in conduit **30** to move relative to the conduit to remain beneath the shell and beneath the bed of material in shell **2**. Such a quantity of material shall be controlled to be enough to fill the entire cross-sectional space of conduit **30** and block the passage of air into the kiln. Since such a quantity of air-blocking material within conduit **30** must travel, relative to conduit **30**, one and one-quarter turns around shell **2** before being discharged at port **31**, a second air-blocking quantity of material will have passed into conduit **30** before the preceding quantity has passed through port **31**. Thus there is at all times at least one such air-blocking quantity of material in conduit **30** and no mechanical gate or other type of air lock mechanism is needed to keep air from passing into the kiln as dry material is drawn off at the intermediate discharge means **16**.

From the foregoing detailed description of the present invention, it has been shown how the objects of the invention have been attained in a preferred manner. However, modifications and equivalents of the disclosed concepts such as readily occur to those skilled in the art are intended to be included within the scope of this invention. Thus, the scope of this invention is intended to be limited solely by the scope of the claims such as are or may hereafter be appended hereto.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a rotary kiln having a cylindrical shell mounted for rotation about a central axis therethrough, a material feed hood enclosing one end of the shell, a firing hood with a burner and combustion air inlet means enclosing the other end of the shell and operative to burn fuel therein and establish a temperature gradient along the axis of the shell from the firing hood to the feed hood which provides a calcining zone, a preburning zone and a drying zone, and an intermediate discharge means located in the kiln shell to discharge dry material from the kiln that has passed the end of the drying zone adjacent the preheating zone, said intermediate discharge means comprising: material discharge passage means through the shell of the kiln; a conduit connected to the passage means and encircling the outer periphery of the shell for at least one complete turn around the shell, to provide a discharge therethrough of dry material from the kiln and maintain at least one conduit closing portion of such material in the encircling conduit at all times to close off the material discharging means from the atmosphere surrounding the kiln; an intermediate duct between the passage means through the kiln shell and the encircling conduit; and adjustable valve means mounted in the intermediate duct between the passage means and the encircling conduit.

2. In a rotary kiln having a cylindrical shell mounted for rotation about a central axis therethrough, a material feed hood enclosing one end of the shell, a firing hood with a burner and combustion air inlet means enclosing the other end of the shell and operative to burn fuel therein and establish a temperature gradient along the axis of the shell from the firing hood to the feed hood which provides a calcining zone, a preburning zone and a drying zone, and an intermediate discharge means located in the kiln shell to discharge dry material from the kiln that has passed the end of the drying zone adjacent the preheating zone, said intermediate discharge means comprising: material discharge passage means through the shell of the kiln; a conduit connected to the passage means and encircling the outer periphery of the shell for at least one complete turn around the shell, to provide a discharge therethrough of dry material from the kiln and maintain at least one conduit-closing portion of such material in the encircling conduit at all times to close off the material-discharging means from the atmosphere surrounding the kiln; and the material discharge passage means comprising a plurality of radially extending passages in a common radial plane, an intermediate duct connected to and projecting outwardly of each of the passages, and the encircling conduit being connected to each of the intermediate ducts.

3. In a rotary kiln according to claim **2**, an adjustable valve in each of the intermediate ducts for controlling the flow of dry material from the radially extending passages, through the intermediate ducts and into the encircling conduit for discharge therefrom.

4. In a rotary kiln according to claim **3**, said encircling conduit making at least one and one-quarter turns around the shell.

5. In a rotary kiln according to claim **3** each said adjustable valve is a slide valve arranged to move in a plain perpendicular to a central axis through the duct in which each such valve is provided.