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[54] METHOD FOR ADJUSTMENT OF THE HEAT GENERATING PROCESS IN A ROTARY KILN WITH A HEAT EXCHANGER ETC.

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 810,844, Mar. 26, 1969, abandoned.

[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **263/32**

[51] **Int. Cl.** **F27b 7/02**

[58] **Field of Search** .....263/32, 33; 236/15 B

[56] **References Cited**

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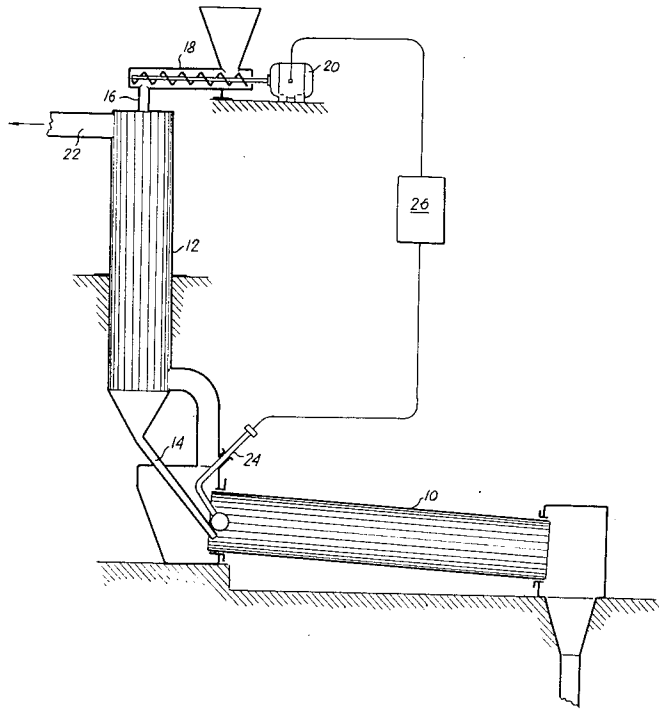
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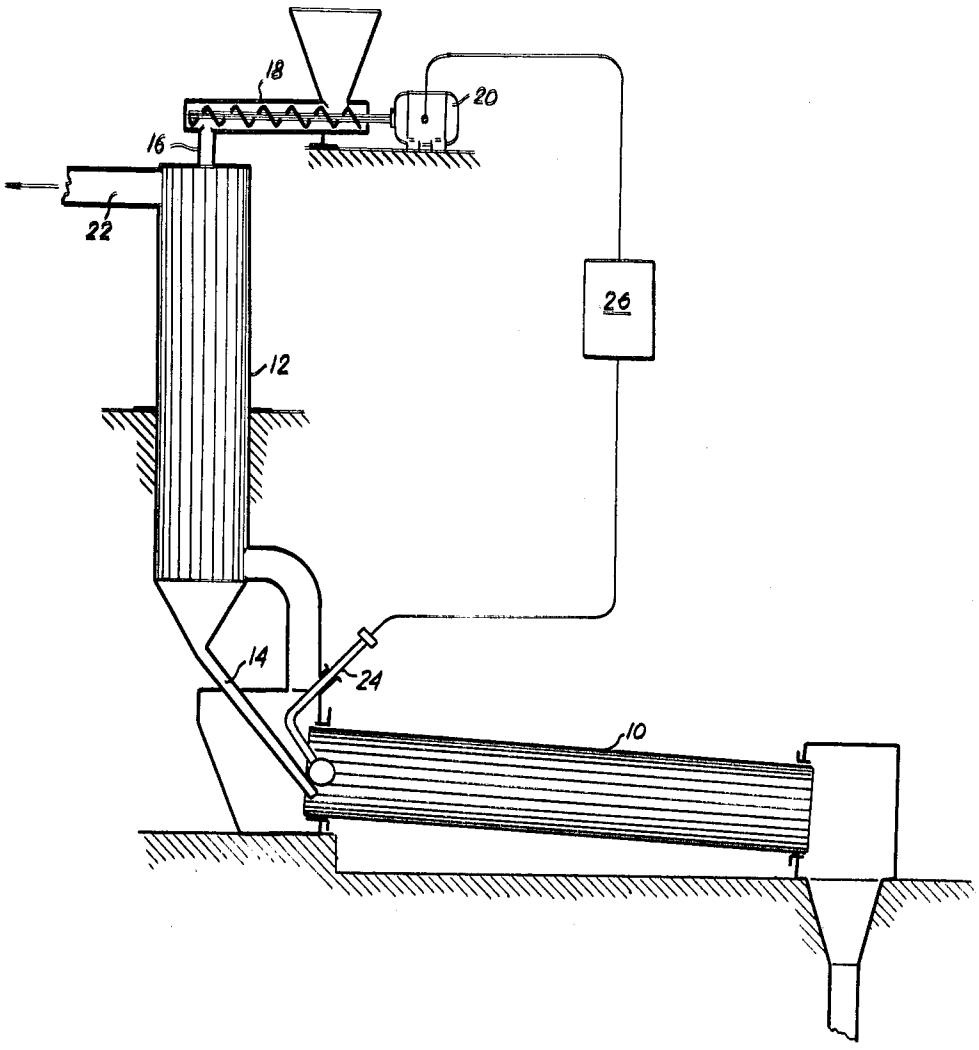
[57] **ABSTRACT**

A rotary kiln system employing a pre-heater for feeding material to the kiln. A temperature sensing device is placed in the gas outlet of the rotary kiln and control means are provided to regulate the rate of feed of raw material to the pre-heater in response to variations in sensed temperature from a predetermined level.

4 Claims, 1 Drawing Figure



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METHOD FOR ADJUSTMENT OF THE HEAT GENERATING PROCESS IN A ROTARY KILN WITH A HEAT EXCHANGER ETC.

This is a Continuation-in-Part copending application by the same inventor, Ser. No. 810,844, filed Mar. 26, 1969 entitled "METHOD FOR ADJUSTMENT OF THE HEAT GENERATING PROCESS IN A ROTARY KILN WITH A HEAT EXCHANGER," now abandoned.

BACKGROUND OF INVENTION

The present invention relates to apparatus and method of operating kiln systems and in particular to the method for adjusting the uniformity of the heat generating process therein.

The use of rotary kilns for the treatment of granular, or fine grain material such as limestone, sand and other aggregate raw material as for cement production and the like is well known. Conventionally such kilns are preceded by a pre-treating heat exchanger through which the raw material is fed. During the course of burning the aggregate an endothermic reaction, at high temperature, take place within the kiln which varies with changes in the nature of the raw material the kiln conditions, the heat supply and other factors.

The maintenance of uniformity of heating conditions of the burning aggregate is one of the main requirements of an economical operation and of the ability to obtain high quality products. In actual practice the equilibrium between heat supply and the amount of raw material is generally achieved by the adjustment of the fuel supply based on measured temperature of the material in the burning zone or by determining the quality of the product at the output end of the kiln. The major drawback of this method is the frequent variations of the performance of the heating unit according to the instantaneous conditions and its slowness of response, for instance due to variations in supply of raw material. As the performance varies from any predetermined optimum, non-uniformity of the heating process result in an unfavorable efficiency and quality of production. A further drawback is that the relatively complicated combustion process initially adjusted to optimum condition, is altered by variations in regulation of the fuel supply and a number of other conditions, as for instance the supply of combustion air, the shape of the flame and similar factors which must be adjusted.

The time interval between the origin of the deviation in the supply of raw material into the rotary kiln and the time this deviation is determined in the burning zone, is proportional to the speed of advance of the material in the rotary kiln and is therefore relatively long. The delay between the origin of the deviation and the moment of any possible interference of compensation for the buring process is therefore relatively large, greatly contributing to an unfavorable influence on the uniformity of the performance.

This object as well as others will be found in the following disclosure.

SUMMARY OF INVENTION

In accordance with the present invention the amount of raw material supplied to the rotary kiln is adjusted in response to variations in the temperature of the gases at their outlet from the kiln with respect to a predefined optimum temperature. By making this adjustment the combustion process is continuously balanced so that the outgoing gas is maintained at as near to possible constant level and with minimum variations of temperature. An efficient supply of raw material and the maintenance of all values related to the burning process on a constant level is thus achieved.

In carrying out the present invention a thermometer or other gaseous heat sensing device is inserted at the material inlet end of the kiln (equivalent to the outlets for gases exiting therefrom) and the temperature of the effluent gases are measured. The thermometer is connected to a suitable control mechanism, or transducer where the sensed temperature is converted into a signal for directly controlling the feed of the raw material to the intake of the heat exchanger.

As a result of such an arrangement variations in temperature of the kiln are measured at the most effective and sensitive position, at the place where the incoming feed and the dried raw material effluent cross.

Full details together with further explanation of the advantages of the present invention follow herein.

BRIEF DESCRIPTION OF DRAWING

The attached drawing is a schematic view of drying apparatus which is adapted to the present method and which illustrates its operation.

DESCRIPTION OF INVENTION

The drawing and the following description are kept brief, avoiding recitation of well known structures and details of kilns, or heating apparatus structures. Those skilled in this art will readibly have available to them from the prior literature and their knowledge those details omitted here.

As seen in the figure, a rotary kiln **10** is supported at each of its ends to rotate about its longitudinal axis. A pre-heater for the raw material such as a vertical heat exchanger **12** is mounted adjacent to the entry end of the kiln **10** and is connected therewith with a delivery conduit **14**. The heat exchanger **12** has a inlet open **16** connected to screw feed mechanism **18** which is driven by motor **20**. The arrangement shown is purely schematic and is intended merely to be illustrative of the types of arrangements possible for kiln and heat exchangers. Both units as well as the feed mechanism **18** are conventional in nature, and operate in the well known manner. The kiln and exchanger may be set at other angles relative to each other or to the ground. Other conventional auxilliary apparatus such as heaters, conveyors, etc. are provided.

Briefly, material fed through the feed means **18** is preheated in the exchanger **12** and delivered for final treatment through conduct **14** to the oven. The gases developed in the oven flow in the counter or reverse direction out of the delivery conduct **14** through the heat exchanger **12** and then out of an exhaust **22**.

According to the present invention the temperature of the outgoing gases from the kiln is sensed by placing a sensor such as thermometer **24** at the gas outlet or material inlet of the kiln. The thermometer **24** is connected to a suitable control **26** mechanism such as a transducer or other converter for changing the sensed thermal condition into a suitable electrical or mechanical signal. The converted signal is fed directly to the motor **20** which controls the feed mechanism **18** feeding the raw material to the pre-heater or heat exchanger.

The control mechanism includes suitable circuitry, in addition to the transducer, for providing a signal sufficient to continuously control the rate of feed, and infact, to initiate or discontinue feed if necessary. Relays, transformers and other equipment may also be provided in the control means to regulate auxilliary parts or units of the system such as the fuel and air supply for combustion.

The thermometer is placed at the center of the technological operation where variation in temperature is most senstive and most responsive. Unlike the known processes, it is therefore more rapidly responsive to the actual variations and fluctions in the heat conditions within the oven, as it may be effected by all factors. Sensing is thus independent of any one factor such as the condition of the heat exchanger, moisture of the raw material, the final product, or supply of fuel. In general however, the thermometer is capable of sensing a synthesis of the variable factors by being at the center and cross roads of the gas flow and most important at the point which is most sensitive to any disproportionate heat condition which is likely to occur (i.e.; the rotary kiln where the maximum part of the endothermic reaction takes place).

In response to the sensed thermal signal material at an increased or decreased rate, or even at more or less quantity, is fed to the system through the heat exchanger to thereby bring

the heat condition back to the predetermined balance and maintain uniformity of the heat generation process. The maintenance of uniformity in the heat generating process can be made without variation in the fuel supply, or other factors, more difficult to control than the material feed. These other factors may therefore be maintained easily at almost contant levels.

The control mechanism is preferably provided with a regualting circuit which is operable not only to control the rate of feed but to disconnect the feed entirely in the event of a complete breakdown of the combustion process. Also the circuit may contain means for disconnecting the fuel supply (not shown) to heat the kiln and even the rotation of the kiln if desired as well as the feed of raw material thereto, in the same event. This is an advantageous derivative of the present invention since the sensing thermometer will rapidly sense any breakdown in the effluent gas long before the same breakdown can be sensed by more conventional methods and the immediate control or shut down of the kiln can be effected before the source of heat can do damage.

A uniform burning process with an optimum output of the whole arrangement is thus achieved with a higher mean output for a given time unit, lower production costs and better quality of the product. As the major heat consumption is in the rotary kiln and the speed of advance of the gases is high, the time delay between the origin of the disturbance of the process and its determination is very small, so that this method enables a prompt and quick interference and compensatory action into the heat process just at the start of some deviation from normal conditions. In addition the required adjustments of the process are simpler and easy to survey as only a single value has to be obtained and a simgle factor (raw material feed) changed in order to achieve a correct and uniform burning. The present process also enables simple means to be employed for performance of this change which can be easily surveyed.

In case of some failure of the burning process, the regulating circuit comprising the thermometer and control mechanism, maintaining constant conditions for a correct burning of the fuel, can be disconnected through the use of appropriate circuit means.

It will thus be seen that by the simple arrangement and process herein disclosed a highly advantageous operation of granular heating apparatus is obtained. It will be obvious to those skilled this art, that various modifications and changes may be made depending of the exact type of kiln, heat exchange or feed system used. Accordingly the present disclosure is intended to be illustrative only.

What is claimed is:

1. The method of controlling the uniformity of the heat generating process in kiln apparatus having a feed mechanism for supplying raw material, a pre-heater, and a rotary kiln arranged in tandem with each other, said material passing through said pre-heater into said kiln and effluent combustion gases passing in a counter flow from said kiln into said pre-heater, comprising the steps of sensing the temperature of the gas effluent from said kiln, and controlling the feed of said raw material to said kiln at the point between said rotary kiln and said pre-heater when the combustion gases exit and the raw material enters the kiln in response to variations in said sensed temperature from a predetrmined level.

2. The method according to claim 1 wherein the temperature of said effluent gas is continuously sensed and the rate of feed of said raw material is continuously controlled.

3. Apparatus for controlling the combustion process of kilns having a feed mechanism for raw material, a pre-heater and a rotary kiln arranged in tandem with each other, said material passing from said pre-heater into said rotary kiln and the gases of combustion counter-flowing from said kiln into said pre-heater, comprising a temperature sensing device located at the point of gas outlet and material inlet of said rotary kiln, and means responsive to said sensing device for controlling the feed mechanism to regulate the feeding of said raw material to said kiln with respect to said variations in the temperature of the gas sensed.

4. The apparatus according to claim 3 wherein said temperature sensing means comprises a thermomter mounted at the feed inlet to said rotary kiln, and said control means comprises a circuit including a transducer and signal generating means for operating said feed mechanism to regulate the rate of flow of said feed.

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