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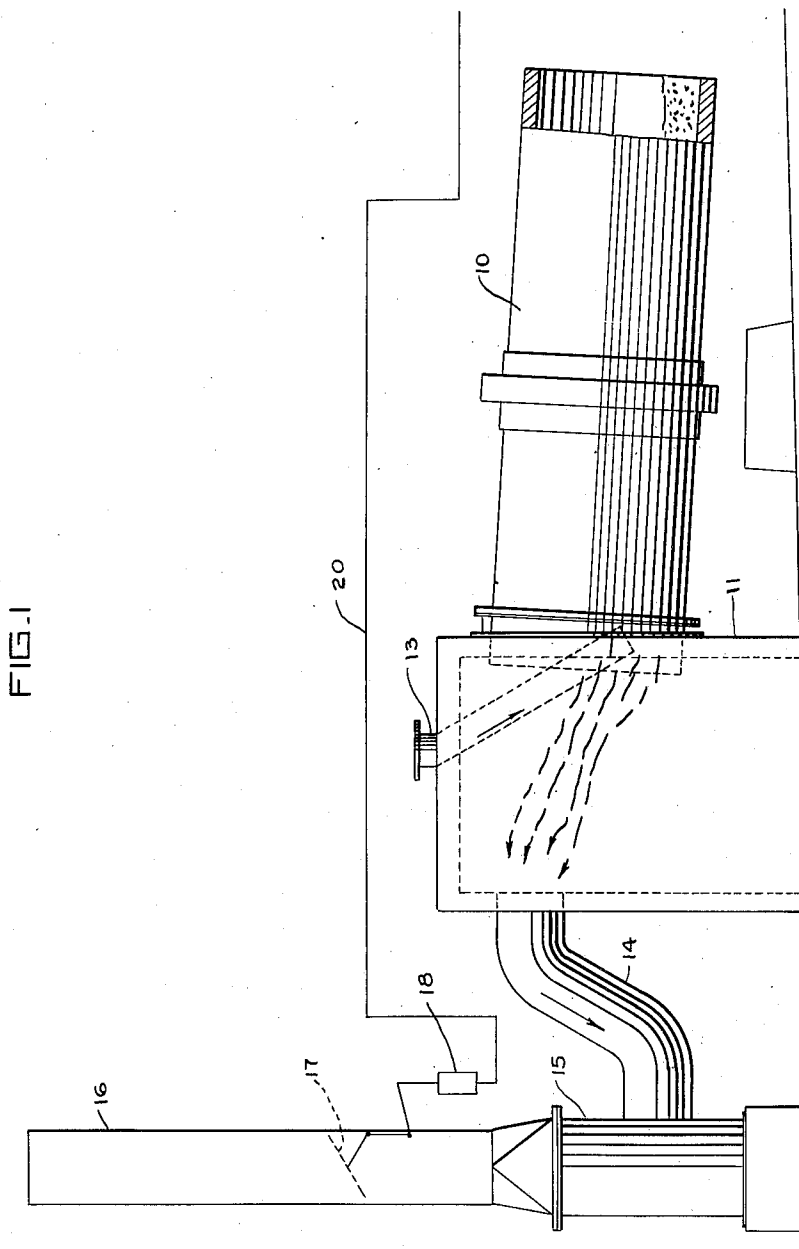
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MEANS FOR ROTARY KILN TEMPERATURE CONTROL

Filed July 10, 1945

2 Sheets-Sheet 1



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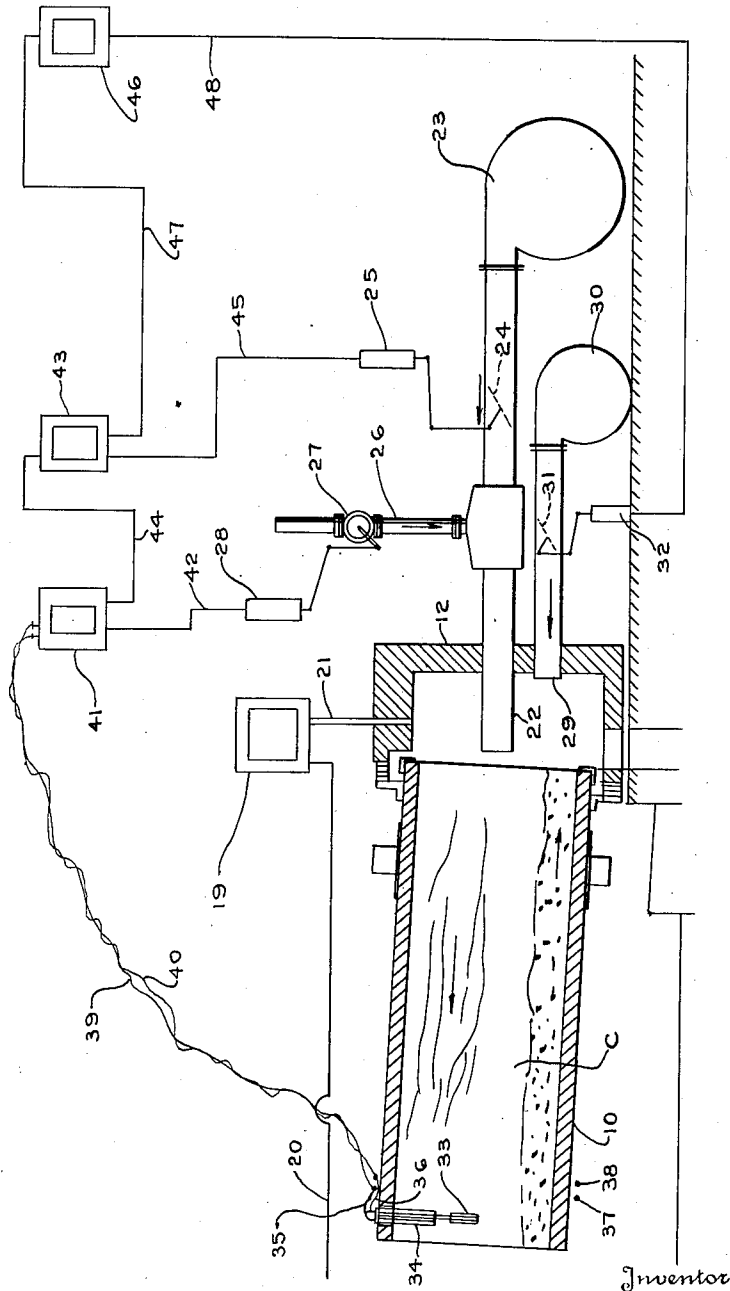
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MEANS FOR ROTARY KILN TEMPERATURE CONTROL

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2 Sheets-Sheet 2

FIG. 2



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## UNITED STATES PATENT OFFICE

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## MEANS FOR ROTARY KILN TEMPERATURE CONTROL

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1

This invention relates to method and means for heating kilns of the rotary type and has as its principal object the maintenance of the temperature in such a kiln as nearly constant as possible.

In ordinary practice a mixture of fuel and primary air, the latter being a percentage of the total air required for combustion, is injected into the output end of the kiln and secondary air is drawn in through openings around the kiln hood. In accordance with the present invention I provide a definitely regulable secondary air supply, and, more particularly, I provide for maintaining a fixed proportion of secondary air to primary air and of both to the fuel while varying the total delivered volume inversely in accordance with temperature changes in a zone of the kiln.

The material traversing the kiln passes first through a drying zone, then through a zone in which it is brought up to calcining temperature, and then through a calcining zone which begins a substantial distance in advance of the output end. Variations in the temperature at the output end are largely the result of temperature changes which occur, from one cause or another, farther up in the kiln, and so to attempt to regulate the burner in accordance with the temperature at the hood, as is commonly done, is to attempt to cure a deviation long after it has occurred. In accordance with the present invention, I correct by reference to temperature changes at the entrance or beginning of the calcining zone and, consequently, I am enabled to maintain a substantially constant heat condition throughout the latter. Since the calcining zone is the critical zone of heat application, I am thus enabled to produce a highly uniform product.

An automatic system of control in accordance with the invention is shown in the accompanying drawings by way of example, and in these drawings,

Figure 1 is a side elevation of the input end of a kiln installation and

Figure 2 is a vertical longitudinal section of the same installation at the output end of the kiln.

Reference numeral 10 designates a kiln mounted for rotation on a slightly inclined axis and rotatable by any suitable means in the usual manner. The input end of the kiln extends into a dust chamber 11 and the output end into a fire hood 12. A feed conduit 13 extends from above the dust chamber into the input end of the kiln and a conduit 14 leads from the dust chamber to a suction fan 15 whose output goes to a stack 16.

2

Pivoted in the stack is a valve or damper 17 and reference numeral 18 designates an actuating device therefore. The device 18 is under the control of a control instrument 19 through a connection 20, the instrument 19 being connected into the fire hood through a tube 21 so as to reflect the pressure condition in the hood, damper 17 being correspondingly automatically adjusted to correct deviations from the required condition. This draft control arrangement is, in itself, not new but is conventional equipment.

Extending through the vertical wall of the hood substantially centrally of the output end of the kiln is a burner tube 22 which, at its outer end, is in connection with the discharge of a fan 23, a damper or valve 24 being disposed in the tube for the regulation of the primary air supply and being adjustable by an actuating device 25. Between valve 24 and the hood a fuel supply pipe 26 is led into tube 22 and a regulating valve 27 in pipe 26 is adjustable by means of an actuating device 28.

Below tube 22 a tube 29 is led through the vertical wall of the hood and has its outer end in connection with the discharge of a fan 30, this secondary air supply being regulable by a damper or valve 31 in tube 29 adjustable by means of an actuating device 32.

Reference numeral 33 designates a thermocouple supported at the inner end of the calcining zone C at the center line of the kiln by an insulator 34 which extends radially through the wall of the kiln. Conductors 35 and 36 from the thermocouple are respectively connected to collector rings 37 and 38 mounted on the exterior of the kiln. The collector rings are in connection through wires 39 and 40 with a control instrument 41 which controls the actuator 28 through a connection 42. Control instruments of this type are well known and are on the market in many suitable forms so that particular description is believed to be unnecessary. Such an instrument is shown, for example, in the patent to Leeds No. 1,332,182 of February 24, 1920.

Reference numeral 43 designates a control instrument which is responsive to the instrument 41 through a connection 44 and controls actuator 25 through a connection 45. Reference numeral 46 designates a similar control instrument responsive to instrument 43 through a connection 47 and controlling actuator 32 through a connection 48.

Any suitable fuel such as gas, oil or powdered coal, can be supplied through pipe 26 as regulated by valve 27. Assuming that gas is the fuel, instrument 41 is manually adjusted for the sup-

3

ply of a given volume, the setting causing actuator 28 to adjust valve 27 accordingly. Assuming that 10,000 cubic feet per minute of air must be supplied, and that 80% should be primary air, instrument 43 is manually set so that actuator 25 will position valve 24 for the delivery of 8,000 cubic feet per minute. This means that 2,000 cubic feet per minute of secondary air will be required and instrument 46 is accordingly manually set so that actuator 32 adjusts valve 31 for this delivery, ordinarily with some excess.

Assuming that a temperature of 1800° is required to be maintained at the inner end of the calcining zone, the setting of instruments 41, 43 and 46 will be maintained as long as the thermocouple is subjected to that temperature. As previously mentioned, the thermocouple 33 is at the center line of the kiln and, hence, is never buried in the material, but is always directly exposed to the hot gases for the direct reflection of their temperature. The action of the thermocouple is, consequently, not confused by intermittent immersion in the material but is always directly responsive to the temperature of the combustion gases. This is a feature important to most efficient operation under the invention.

Should there be a drop in temperature at the thermocouple, instrument 41 at once responds and causes the actuator 28 to operate valve 27 for an increased fuel supply. At the same time, instrument 43 responds to instrument 41 and causes valve 24 to be further appropriately opened. Also, at the same time, instrument 46 responds to instrument 43 and causes valve 31 to be further appropriately opened. If the temperature rises at the thermocouple the supply of fuel and air is decreased with maintenance of proportions. When the temperature has been restored, from either direction, the valves are again in normal adjustment. In this manner the ratio of total air to fuel is always maintained as is also the predetermined proportion of primary air to secondary air.

Should the character of the gas change, for example, so that more or less total air is required and/or a change in the proportion of primary to secondary air becomes necessary, the situation can be readily met since the control instruments are all independently settable. The ultimate action of all of the control instruments is dependent on the temperature responsive element 33. However, only the reaction of instrument 41 is direct, the reaction of instrument 43 following that of instrument 41, and the reaction of instrument 46 following that of instrument 43.

It will be seen that the described arrangement permits any required proportioning of fuel, primary air and secondary air and that when the proportions have been set on the instruments, they will be maintained under all conditions so that most efficient combustion effect is secured at all times. The effectiveness of the system is further enhanced by positioning the temperature responsive element as described, i. e., at the entrance to the calcining zone and directly exposed at all times to the combustion gases.

It will be understood that the described apparatus is typical and that variations in the form and arrangement of parts are possible under the invention and are contemplated in the claims which follow.

I claim:

1. The combination comprising a rotary kiln having a substantially cylindrical wall, heating means at the output end of the kiln providing a

4

calcining zone extending inwardly from said end for an extended distance to a beginning point spaced a substantial distance from the input end of the kiln, a temperature responsive element, a support for said element carried by the kiln wall projecting inwardly toward the kiln axis substantially at the beginning of said calcining zone and constantly supporting said element above the level of the material traversing the kiln, in continuously exposed relation to the combustion gases, and means controlled by said temperature responsive element for controlling said heating means.

2. The combination comprising a rotary kiln having a substantially cylindrical wall, heating means at the output end of the kiln providing a calcining zone extending inwardly from said end for an extended distance to a beginning point spaced a substantial distance from the input end of the kiln, a temperature responsive element, a support for said element carried by the kiln wall projecting inwardly toward the kiln axis substantially at the beginning of said calcining zone and constantly supporting said element substantially at the kiln axis above the level of the material traversing the kiln, in continuously exposed relation to the combustion gases, and means controlled by said temperature responsive element for controlling said heating means.

3. The combination comprising a rotary kiln having a substantially cylindrical wall, heating means at the output end of the kiln providing a calcining zone extending inwardly from said end for an extended distance to a beginning point spaced a substantial distance from the opposite end of the kiln; said heating means comprising adjustable means for supplying fuel and adjustable means for supplying air; a temperature responsive element; a support for said element carried by the kiln wall and extending toward the kiln axis substantially at the beginning of said calcining zone and constantly supporting the element above the level of the material traversing the kiln in continuously exposed relation to the combustion gases, and means controlled by said temperature responsive element for controlling said fuel and air supplying means.

4. The combination comprising a rotary kiln having a substantially cylindrical wall, heating means at the output end of the kiln providing a calcining zone extending inwardly from said end for an extended distance to a beginning point spaced a substantial distance from the opposite end of the kiln; said heating means comprising adjustable means for supplying fuel and adjustable means for supplying air; a temperature responsive element; a support for said element carried by the exterior surface of the kiln wall, projecting therethrough and extending toward the kiln axis substantially at the beginning of said calcining zone and constantly supporting the element above the level of the material traversing the kiln in continuously exposed relation to the combustion gases, and means controlled by said temperature responsive element for controlling said fuel and air supplying means.

5. The combination comprising a rotary kiln having a substantially cylindrical wall; heating means at the output end of the kiln providing a calcining zone extending inwardly from said end for an extended distance to a beginning point spaced a substantial distance from the input end of the kiln, a support carried by the exterior surface of the kiln wall, projecting therethrough substantially radially toward the kiln axis substantially at the beginning of said calcining zone,

5

a thermocouple carried by the support constantly above the level of the material traversing the kiln in continuously exposed relation to the combustion gases therein and means controlled by said thermocouple for controlling said heating means. 5

6. The combination comprising a rotary kiln having a substantially cylindrical wall; heating means at the output end of the kiln providing a calcining zone extended inwardly from said end for an extended distance to a beginning point 10 spaced a substantial distance from the input end of the kiln, a support carried by the exterior surface of the kiln wall, projecting therethrough substantially radially toward the kiln axis substantially at the beginning of said calcining zone, 15 a thermocouple carried by the support substantially at the kiln axis, constantly above the level of the material traversing the kiln in continuously exposed relation to the combustion gases therein

6

and means controlled by said thermocouple for controlling said heating means.

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