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KILN SYSTEM AND METHOD

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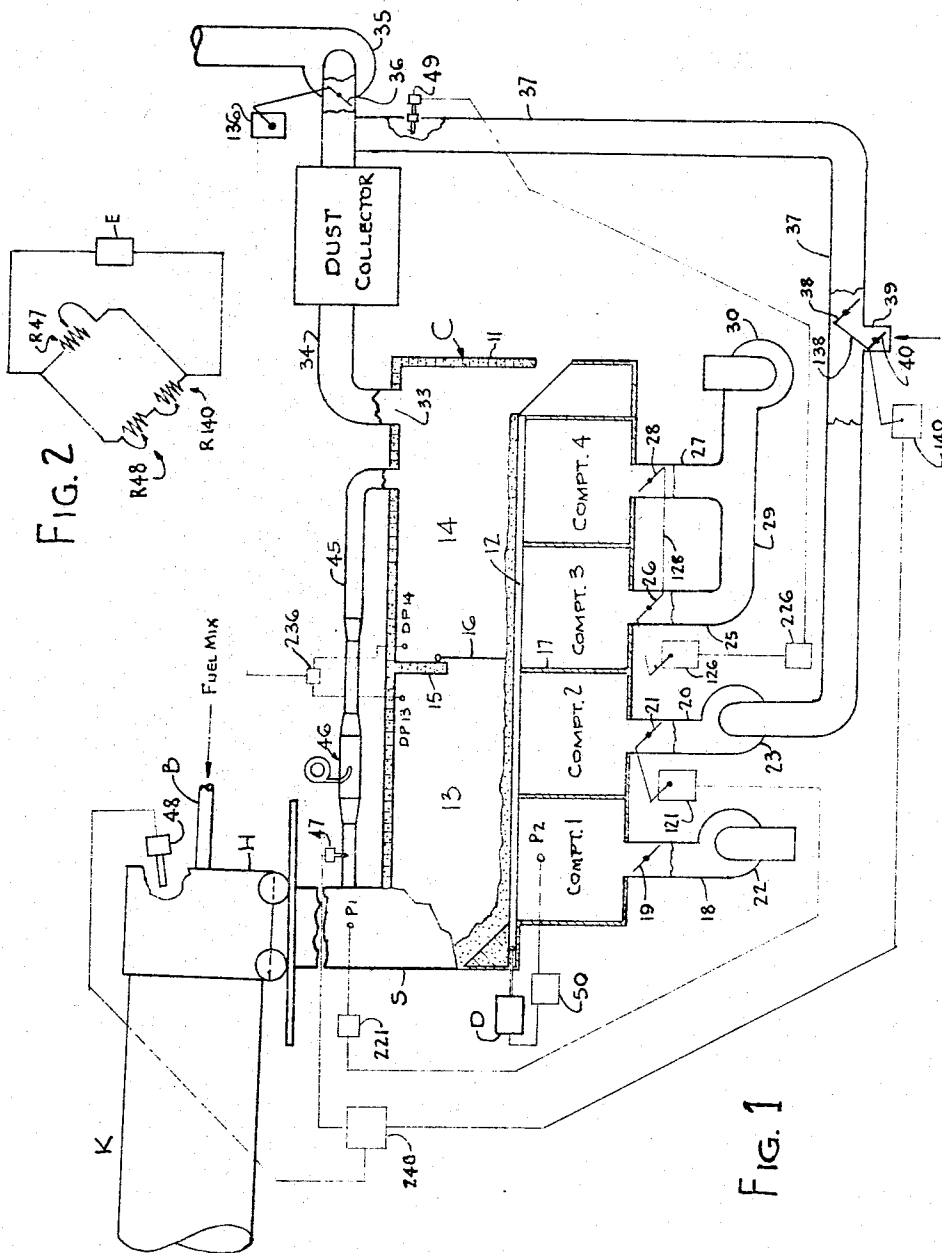


FIG. 1

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KILN SYSTEM AND METHOD

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8 Claims. (Cl. 263—32)

The present invention is concerned with the treatment of materials in kilns, and is more particularly concerned with stabilization of the kiln operation.

The invention exceeds prior kiln systems in that it uses a source of heated air, which is typically wasted in prior systems, in an arrangement which compensates for temperature and flow variations anywhere along the system and which exhibits a previously unattainable stability and efficiency.

In general the preferred form of kiln system according to the present invention comprises a kiln with a cooler communicating with the material discharge of the kiln. The cooler is subdivided into at least first and second chambers for differential cooling, with the first chamber being arranged to receive the material from the kiln.

Separate gas supplies are provided for passing a gas, preferably air, through the material in each chamber. By way of suitable ducting the gas from the first chamber is passed into the kiln. The gas from the second chamber is vented by way of an exhaust system, with a variable portion being drawn off for use as at least part of the supply of gas to the first chamber.

The volume of gas supplied the first chamber is regulated by a controlled responsive to the pressure of the gas discharging from the first chamber into the kiln. The ratio or proportion of the volume of second chamber gas drawn off for the first chamber, with respect to the total supply to the first chamber, is regulated by a proportioning control responsive to the temperature of the gases discharging from the first chamber into the kiln.

A supplemental control, responsive to variations in the temperature of the material in the kiln, is coupled to the proportioning control to provide an override control.

Preferably, a controller responsive to the temperature of the second chamber gases, discharging via the exhaust means, is provided to regulate the supply of gas to the second chamber to provide a uniform temperature.

A better understanding of the invention may be derived from the following description and the accompanying drawings, in which:

FIG. 1 is a generally schematic representation of a preferred embodiment of the invention, and

FIG. 2 is a schematic diagram of a type of dual input electrical controller.

As shown in FIG. 1, the discharge end of the kiln system comprises a rotary kiln K terminating in a kiln hood H carrying the usual burner band communicating with the stack S of a cooler C. Different types of kilns or coolers from those shown may be used if desired.

The cooler C includes a suitable refractory lining 11 and a movable grate assembly 12. The zone of the cooler above the grate assembly is subdivided into a first chamber 13 adjacent the kiln and a second chamber 14 by a partition 15 extending downwardly from the roof and having a hinged portion 16 for closing against the material bed on the grate assembly.

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The zone of the cooler below the grate assembly 12 is subdivided by partitions 17 into four compartments. Compartments 1 and 2 receive ducts 18 and 20 from fans 22 and 23, respectively. The ducts 18 and 20 are provided with valves or dampers 19 and 21. Compartments 3 and 4 receive branch ducts 25 and 27 from a header 29 supplied by a fan 30. The branch ducts 25 and 27 are provided with dampers 26 and 28.

The second chamber 14 has an outlet 33 communicating with an exhaust duct 34 extending from the intake of an exhaust fan 35. Preferably, a suitable dust collector is provided in the duct 34, as shown schematically. The duct 34 has a damper 36 therein and a tempering-gas conduit 37 communicating therewith at a point intermediate the outlet 33 and the valve 36.

The tempering conduit 37 also communicates with the intake of the fan 23 supplying compartment 2, and has a damper 38 therein. Between damper 38 and the fan 23, the conduit 37 has a short branch 39 opening to the atmosphere and having a damper 40 therein.

The damper 40 is operatively linked to the damper 38 by an arm 138, so that closing motion of one of the two dampers produces a simultaneous, complementary opening of the other, and a resultant proportioning of the relative amounts of atmospheric and tempering gases to be supplied to the fan 23.

The cooler stack S communicates with an aspirating duct 45 having an aspirator 46 therein and which opens into the second chamber 14, thereby obviating the need for separate dust collection for the aspirating system. The aspirating system has a thermocouple 47 or the like therein and draws gases from the stack for temperature measurement at a point shielded from any radiant heat from the hot material.

Regarding the following description of the control systems, it is to be understood that the particular pneumatics or electrical circuitry to be used in the controllers does not form a part of the present invention, and that a great number of suitable forms of controllers are available from several manufacturers.

The total air supply to the first chamber 13 is divided between the fans 22 and 23 serving compartments 1 and 2.

The volume of air delivered by fan 22 to compartment 1 is fixed by presetting the damper 19 at a fixed position to deliver a constant flow to ensure quick cooling of the hot material as it is received from the kiln. This guarantees an adequate cooling flow to protect the metal grates in the hottest zone.

The volume of air delivered by the fan 23 to compartment 2 is modulated by the damper 21. The damper 21 is driven by an operator 121 which is actuated by a controller 221 in response to the pressure of the gases passing from the first chamber to the kiln. The pressure tap P1 serving the controller 221 is shown in the stack S, but may be located where desired in the flow path, such as in the hood H.

The controlled 221, operator 121 and damper 21 function to maintain a stable pressure in the air being supplied to the kiln. Since the supply to compartment 1 preferably is fixed, the modulation is entirely accomplished by the damper 21.

The proportioning of the gas supplied to compartment

2, in terms of the mixture of atmospheric air and tempering air from the tempering conduit 37, is modulated by the proportioning valve system 38 and 40. The dampers 38 and 40 are driven by an operator 140 which is actuated by a controller 240. The controller 240 receives two temperature-actuated input signals. The thermocouple 47 supplies one signal, while the second is supplied by a reading of the temperature of the material in the kiln such as by an optical pyrometer 48.

Some explanation of the working of a dual-signal input controlled may be helpful. FIG. 2 shows an oversimplified, balancing type of electrical circuit which would deliver the required function in an electrical controller. As shown in FIG. 2, a loop from an electrical source E, carries parallel lines having variable units, shown here for simplicity as variable resistors. The resistor R140 driving the operator 140 is provided in parallel with, or in the leg opposite the resistor R47 serving the thermocouple 47 in the cooler stack S.

Therefore, if R47 which is governed by a manual set point to seek a pre-selected temperature, changes to match a change signal from thermocouple 47, as a result of increased temperature of the gases passing to the kiln, the balance of the circuit is restored by R140. With R140 being an integral part of the operator 140, the operator reacts to open damper 40, and close damper 38, thereby simultaneously increasing the amount of cold-air intake and reducing the amount of hotter, tempering-air intake. Conversely, if the received thermocouple signal indicates a lowering stack temperature, the operator 140 proportionally closes the damper 40 and opens damper 38, to increase the hot tempering air portion and lower the cold air portion.

However, an overriding signal may be received from the pyrometer 48, which is reading the temperature of the material before its discharge from the kiln. Obviously, when material discharges at a higher or lower temperature from the kiln, the cooler C temperatures will rise or drop correspondingly, requiring adjustment of the cooling air. Such changes may occur as a result of a variation or change in the feed of raw material to the kiln, or the building or breakaway of a ring of fused material in the kiln, or a flushing of the kiln charge.

The signal then received from the pyrometer 48 changes the resistor R48, upsetting the general balance between the R47 and R140 legs of the circuit. Consequently, R140 will adjust to compensate for the imbalance, and will cause operator 140 to move the dampers 38, 40 to compensate for the change forthcoming as a result of the temperature of the material in the kiln. This enables the system of the present invention to begin compensation for changes as soon as such changes become measurable, instead of waiting until they have become manifest in terms of upset operating conditions.

More sophisticated balancing circuits or controllers than that described above are readily available commercially.

The volume of cooling air delivered to the second chamber 14 is modulated by an operator 126 actuated by a controller 226. The controller 226 moves the damper 26 and, via an arm 128, the damper 28 in response to a thermocouple 49 located in the exhaust system from the second chamber 14, and shown here in the tempering conduit 37. This provides for a uniform temperature in the tempering air delivered through the conduit 37 to the proportioning control at 38/40.

The damper 36 in the exhaust system is modulated by an operator 136 actuated by a controller 236 which seeks a uniform pressure differential between the two chambers 13 and 14, as sensed by the pressure taps DP13 and DP14 on opposite sides of the partition 15. This aids in preventing a short-circuiting of gases from one chamber to the other, and preferably is biased to provide a slightly lower pressure in the chamber 14, so that colder gases do not leak toward the kiln.

A further control, which has been found desirable in most instances, is that of varying the speed of the grate assembly 12 to accommodate varying material flow rates. Compartment 1 is provided with a pressure tap P2 which signals a controller 50, which in turn modulates the speed of the gate assembly drive D. If greater material flow deepens the bed over compartment 1, the resulting increase in pressure drop will cause the controller 50 to speed up the gate assembly, thereby accommodating the higher material flow rate, and vice versa. This arrangement seeks a relatively constant bed depth.

From the above description, it is apparent that the kiln system of the present invention will compensate for each self-changing variable, and will provide a stability of operation previously unattainable.

Various changes may be made in the invention, as it is exemplified herein, without departing from the spirit of the invention or sacrificing the advantages thereof, or departing from the scope of the appended claims.

I claim:

1. A kiln system comprising a kiln, means for discharging material from the kiln into a cooler, said cooler being subdivided into at least a first cooling chamber and a second cooling chamber, said first cooling chamber being arranged to receive the incoming hot material, first draft means for passing a gas through the material in the first cooling chamber and into the kiln, second draft means for passing a gas through the material in the second cooling chamber, exhaust means for removing gas from the second cooling chamber, means for modulating the volume output of the first draft means in response to the pressure of the gas discharging from the first cooling chamber, a tempering conduit communicating with the exhaust means and with the first draft means, said first draft means having an intake conduit in communication with a source of cool gas, intake proportioning means for regulating the relative volume rates of flow through the tempering conduit and the intake conduit, controlling means responsive to the temperature of the gas discharging from the first cooling chamber for controlling the intake proportioning means, and means responsive to the temperature of material within the kiln for exerting an overriding control of the intake proportioning means.

2. A kiln system as set forth in claim 1 including means for modulating the volume output of the second draft means in response to the temperature of the gas being exhausted from the second cooling chamber.

3. A kiln system as set forth in claim 1 in which the first draft means includes two compartments, the first compartment is directly associated with the material inlet, and the means for modulating the volume output of the first draft means is associated with the second compartment.

4. A kiln system as set forth in claim 1 including means for maintaining a constant pressure differential between said first and second cooling chambers.

5. In a kiln system including a kiln and a cooler, a first gas discharge chamber over a hot zone of the cooler and a second gas discharge chamber over a cooler zone of the cooler, a heat-sensing member, an aspirator arranged to draw gas from the first chamber past the heat-sensing member, said aspirator being in terminal communication with the second chamber to discharge aspirated gas and dust thereinto, and means reactive to said heat-sensing chamber for controlling a function of said cooler.

6. The method of stabilizing the operation of a kiln and air-cooler system which comprises dividing the air flow from the cooler into a hot portion and a cool portion, passing the hot portion into the kiln, mixing a part of the cool portion with cold air to supply cooling air to the material associated with the hot portion, modulating the combining proportions of cool-portion air and cold-

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air in relation to the temperature of the hot portion, and imposing an overriding proportion of cool-portion air and cold air in relation to the temperature of the material in the kiln.

7. The method of claim 6 including the further step of 5 modifying the volume of the hot portion of air to maintain a predetermined, substantially constant-pressure supply of gas to the kiln.

8. The method of claim 6 including the further step 10 of modifying the volume of the cool portion of air to maintain a substantially constant temperature for proportioning supply to the hot zone of the cooler.

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