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HEAT CONTROL METHOD AND APPARATUS

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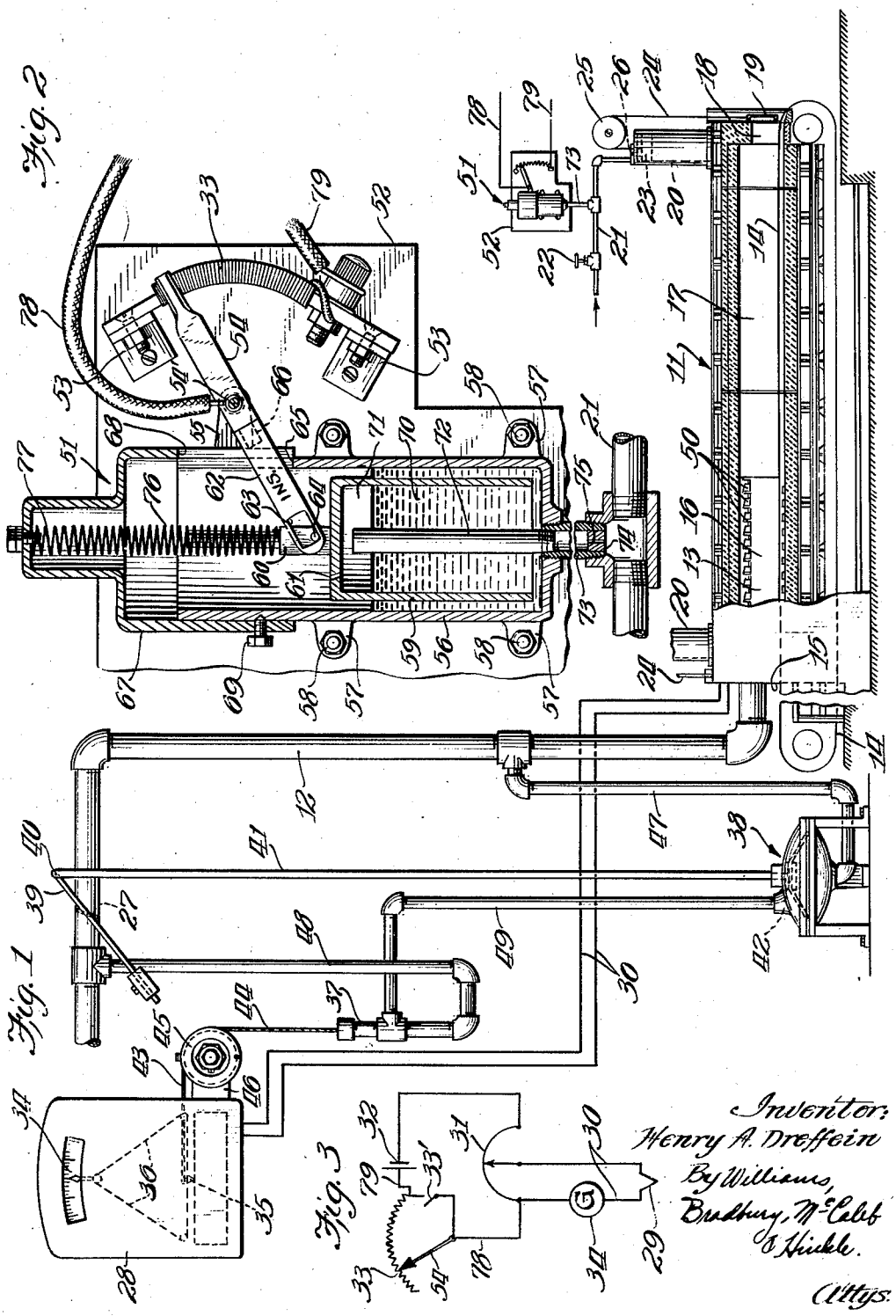

Fig. 2

Fig. 1

Fig. 3

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HEAT CONTROL METHOD AND APPARATUS

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10 Claims. (Cl. 236—1)

This invention relates in general to furnaces, and has more particular reference to a novel heat control method and apparatus for controlling the temperature within a furnace.

The objects of my invention include the provision of a novel control apparatus and method particularly applicable to rolling mill furnaces or furnaces for the heat treating of metal packs of sheets, bars, and the like, wherein a greater furnace output is obtained without endangering the products being heated even during a mill delay or during a decrease in the rate at which the products pass through the furnace; whereby the temperature of the furnace is regulated in accordance with the rate at which products are passed through the furnace; whereby to provide an auxiliary temperature control automatically controlling or regulating the furnace temperature in accordance with the rate of passage of materials through the furnace; whereby such automatic auxiliary temperature control actuates or co-acts with a main temperature control to vary the rate of fuel and/or air supply of the furnace, and thereby to vary the furnace temperature in accordance with the rate of passage of materials through the furnace; whereby over-heating of the products is avoided even during a delay in the passage of the materials through the furnace; whereby to combine such an auxiliary temperature control with a furnace having a charging end zone at a relatively high temperature and a relatively long discharging end zone at a temperature slightly above the temperature of the products to be treated, and thereby to increase the output of the furnace, effectively distribute the heat and avoid the over-heating of the products in the high temperature charging end zone during a delay in the passage of materials through the furnace; and whereby to provide novel and improved apparatus for accomplishing the objects of the invention.

Other objects and advantages of the invention will be apparent from the following description and from the accompanying drawing, in which similar characters of reference indicate similar parts throughout the several views, and in which:

Fig. 1 is a diagrammatic view of a furnace equipped with the novel heat control apparatus embodying the features of my invention;

Fig. 2 is an enlarged cross section of a detail shown in Fig. 1; and

Fig. 3 is a schematic view of a potentiometer circuit.

While I do not wish to limit my invention to a particular furnace construction, I have illustrated it as applied to a furnace 11 for heat treating metal packs of sheets, bars, and the like, or other products whereby the heated products from the furnace may subsequently be treated as by rolling.

This furnace 11 is supplied with fuel and/or air by means of a supply main or pipe 12 for supplying and distributing heat from a heater portion 13 to metal packs or other products adapted to be conveyed by a suitable conveyor 14 from the charging end 15 of the furnace to a charging end zone 16, a discharging end zone 17 in the furnace 11, and thereafter to the discharge end 18 of the furnace as the heat treated products are required or used in a subsequent treatment, such as rolling.

The furnace 11 is provided with charge and discharge doors 19 which are controlled by suitable door operating means for opening and closing the doors 19 as material or products are delivered to and from the furnace. The door operating means may be electrically actuated or, as shown in Fig. 1, may include a cylinder 20 at each end of the furnace, having a pressure supply source 21 controlled by a valve 22 for supplying pressure to a piston 23 in each cylinder to open the doors 19, each of which is connected to a piston 23 by a cable 24 passing over a pulley or sheave 25. Opening the valve 22 admits door opening pressure to the cylinder 20. When the valve is closed, the pressure in the cylinder is reduced by a bleed aperture 26, and the door is closed.

A valve 27 in the supply pipe 12 is adjustable in response to furnace temperature variations by any suitable means, such as a pyrometer control for varying the fuel and/or air supply rate to counteract the change in furnace temperature causing the adjustment of the valve 27.

Briefly, the temperature control means includes a pyrometer 28, a detailed description of which is unnecessary to complete understanding of my invention. It might be well, however, to point out by way of explanation that such pyrometers usually include, as schematically shown in Fig. 3, a thermo-couple 29 mounted in the furnace 11 and supplying electrical potentials proportional to furnace temperatures to leads or conductors 30. The potentials from the thermo-couple are compared with known potentials of opposite polarity obtainable from a voltage divider 31 connected across a battery 32, and a rheostat or variable resistor 33, by means of a galvanometer 34. The galvanometer is balanced and shows

no deflection when the voltage divider 31 or the rheostat 33 is so adjusted that the unknown potential from the thermo-couple is equal to the potential from the voltage divided.

Such pyrometers usually employ a temperature responsive member or indicator 35 which may be driven, as diagrammatically shown by broken lines 36 in Fig. 1, from or actuated by the galvanometer 34.

This temperature responsive member 35 is employed to control an actuating means or a valve 37 for actuating valve operating means, such as a pressure responsive or diaphragm motor 38, suitably linked or connected to the valve 27 by a rockable valve arm 39 pivoted at an end 40 to a link or rod 41 connected as at 42 to the valve operating means 38, the temperature responsive member 35 being for this purpose operably connected to suitable translating means including cable connectors 43 and 44 extending between the member 35 and a rotatable or rockable connecting member 45, and between the valve 37 and the member 45, respectively. The member 45 is secured at a side of the pyrometer 28 by means of a mounting bracket 46 for controlling the valve 37.

The pressure responsive or diaphragm motor 38 is supplied with pressure by pipe fittings 47 from the supply pipe 12 at the furnace side of the valve 27 and with pressure from the supply side of the valve 27 by pipe fittings 48 and 49 communicating with the pipe 12 and the valve 37 and communicating with the pressure responsive motor 38 and the valve 37, respectively.

By adjusting or varying the setting of either the rheostat 33 or the voltage divider 31, the member 35 will be moved by the deflection of the galvanometer 34, thus operating the valve 37 to vary the pressure, and actuating the motor 38 whereby the fuel and/or air supply valve 27 in the pipe 12 and hence the furnace fuel and/or air supply rate will be so adjusted as to tend to produce a change in temperature corresponding to the adjustment or variation of either the rheostat 33 or the voltage divider 31.

To increase the output of the furnace or mill, the furnace 11, or, at least, the zone 16, is provided with walls 50 constructed of insulating brick having a low heat conductivity compared with ordinary fire brick and substantially non-absorptive thermally to permit high temperatures without the wall absorbing heat and radiating this absorbed heat back to the furnace when it is desired to reduce the furnace temperature. By carrying the charging end zone 16 at this higher temperature, the rate of passage of materials through the furnace may be correspondingly increased, because less time of heat treating is required at such high temperatures. The discharging end zone 17 of the furnace 11 in the practice of my invention, is carried at a temperature slightly above the temperature of the material to be heated, and is relatively long as compared to the high temperature charging end zone 16 for the purpose of providing proper heat distribution and application, even while the materials are being rapidly conveyed through the furnace.

While the voltage divider 31, the rheostat 33, or a switch 33' shunting all or a portion of the rheostat may be adjusted to vary, regulate, or control the furnace temperature, I prefer to adjust the rheostat so that the high temperatures permissible by virtue of the non-absorbing walls 50 will be automatically controlled to prevent overheating of materials in case of a lesser rate of passage of such materials through the furnace or a mill delay or temporary shutdown.

The rheostat 33 may be varied or adjusted as the materials are charged in to the furnace or discharged from the furnace through furnace doors 19. I prefer to adjust the rheostat 33 in accordance with the rate of operating the discharge door. As the material passing through the furnace 11 reaches the discharge end 18 of the furnace, the valve 22 is operated to open the door 19 and permit the discharge of the material. The more rapid the rate of passage of materials through the furnace, the more often it will be necessary to open the door 19, and hence the more often to operate the control valve 22.

I utilize the pressure of air flowing in the pipe 21 not only to open and close the discharge door 19, but also to operate a pressure responsive device or gasometer 51 for varying or adjusting the rheostat 33 attached, as shown in Fig. 2, to a mounting plate 52 by means of lugs or brackets 53 and having a slidable contactor 54 pivotally mounted on a lug 55 projecting from a side of the gasometer 51.

This gasometer 51 comprises a container or casing 56 having mounting lugs 57 for securing the casing to the plate 52 adjacent the rheostat 33 by means of bolts or screws 58. A movable member or bell 59 having a lug or arm 60 at the top thereof and a bleed or leak aperture 61 is carried in the casing 56. A rheostat actuating arm 62 of any suitable insulating material is provided with a slot 63 for pivotally securing the arm to the lug 60, as shown at 64, and extends through a slot 65 in the casing 56 to a suitable connection 66 with the slidable contactor 54. The casing 56 is provided with a cover or cap 67 having a slot 68 registering with the slot 65 and held on the casing by retaining screws 69. The slot 63 in the actuating arm 62 serves not only to compensate for the variable distance between the pivot 54' and the lug 60 as the bell 59 reciprocates in the casing 56, but also to provide for sufficient play in the movement of the bell to prevent operation of the rheostat upon slight changes in the rate of opening and closing the door 19.

The casing 56 may be partially filled with a liquid 70, such as water, so as to form an enclosed chamber 71 between the liquid 70 and the top of the bell 59 when the bell is in its lowermost position. In order to operate the gasometer and to vary the rheostat 33 as the rate of opening and closing the discharge door, I connect the chamber 71 to the pressure supply source 21 between the valve 22 and the cylinder 20 by a pipe 72 extending above the liquid level in the casing and providing communication between the chamber 71 and a pipe fitting 73 extending between the casing 56 and the pressure supply pipe and having a reducer nipple 74 therein. The nipple 74 is provided with a metering orifice 75 for determining the quantity of air supplied to the chamber 71 at each opening of the valve 22 to open the door 19.

The gasometer 51 has a flexible spring 76 secured at one end to the lug 60 and at its opposite end to a set screw 77 carried by the cover or top member 67 so that as the bell 59 rises, the pressure in the chamber 71 increases, thereby increasing the outward flow of air through the bleed or leak aperture 61 and resulting in a definite position of the bell for every rate of discharge of materials from the furnace 11. I may utilize this movement of the bell to gradually vary the resistance or to operate the switch 33'. In the

latter event the switch may be so positioned with respect to the actuating arm that, at any desired position of the bell, the switch 33' will be operated to change the furnace temperature.

It will be noticed that by carrying the charging end zone at a high temperature, materials may be passed through the furnace and heat treated at a greater rate, thereby necessitating more frequent operation of the valve 22 to open the discharge door 19. The more frequent operation of the valve 22 to permit this rapid discharge of materials from the furnace admits air from the pipe 21 to the gasometer, causing the bell to rise against the action of the spring 76 and to vary or reduce the resistance 33. This reduction of resistance connected in the battery circuit of the pyrometer by wires or conductors 78 and 79, unbalances the galvanometer 34, thereby causing the temperature responsive member 35 to move toward the left as seen in Fig. 1, opening the valve 37 to admit pressure to the pressure responsive motor 38 and to cause the valve 27 to admit more fuel to the furnace 11.

In case the rate of passage of materials through the furnace 11 is retarded or stopped entirely, the door 19 is opened less frequently and the air leaks or escapes through the bleed or leak aperture 61, permitting the actuating lever 62 to increase the resistance 33 as the bell descends under the action of the spring 76. This increase in the resistance 33 unbalances the galvanometer, causing the member 35 to move to the right as seen in Fig. 1, and tending to close the valve 27 through the action of the valve 37, and the motor 38, thereby reducing the rate of fuel and/or air supply to the furnace 11 in order to reduce the temperature in the furnace to a value which will not damage the materials delayed or stopped in the furnace.

Thus, my automatic auxiliary furnace control in combination with the non-heat conducting walls provide increased furnace output without endangering materials being treated due to exposing such materials for too long a time to excessive temperatures when the rate of passage of materials through the furnace is decreased, or when the furnace output is for any reason delayed, or when the mill is temporarily shut down. These advantageous results are obtained by adjusting the rate of fuel flow to the furnace inversely as the rate of passage of materials through the furnace whereby to obtain the proper furnace temperatures during either a rapid rate of passage of materials through the furnace or slower rates of passage of material through the furnace.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a furnace, temperature control apparatus comprising a pyrometer having a battery circuit with a resistance therein, an auxiliary controller comprising a gasometer and an arm movable by said gasometer for varying the resistance in said battery circuit, a furnace discharge door, means controlling the operation of said discharge door, said means also controlling the operation of said gasometer.

2. In a furnace temperature control apparatus, a pyrometer having a battery circuit, a resistance in said battery circuit, a gasometer having an arm operatively connected thereto for varying the resistance in said battery circuit, a furnace discharge door and operating means therefor, and means for causing a flow of air to said gasometer simultaneously with the operation of said door operating means.

3. In a furnace, temperature control apparatus including a pyrometer having a battery circuit with a resistance therein, an auxiliary controller including a gasometer and an arm movable by said gasometer for varying the resistance in said battery circuit, a furnace door, and means controlling the operation of said door, said means also controlling the operation of said gasometer.

4. In furnace temperature control apparatus, a pyrometer having a battery circuit, a resistance in said battery circuit, a gasometer having a movable arm for varying the resistance in said battery circuit, a furnace door, operating means for said door, and means for causing a flow of air to said gasometer simultaneously with the operation of said door operating means.

5. In a furnace having a hot zone and a cooler zone, means for varying the temperature in said furnace including a pyrometer having a battery circuit, a variable resistance in said battery circuit, a gasometer for varying said variable resistance, and gasometer control means at said furnace for varying the pressure in said gasometer, whereby to vary said variable resistance in said battery circuit.

6. In a furnace having a discharge door, temperature control apparatus for varying the rate of fuel flow to said furnace as the temperature in said furnace varies, and means for varying the rate of fuel flow to said furnace in accordance with the rate of operation of said discharge door.

7. In a furnace having a discharge door, temperature control apparatus for varying the rate of fuel flow to said furnace as the temperature in said furnace varies, and means for decreasing the flow of fuel to said furnace as the rate of operation of said door to discharge materials from said furnace decreases.

8. In a furnace, temperature control apparatus including a pyrometer having a battery circuit with a variable resistance therein, pressure responsive means having a movable arm for varying said variable resistance in said battery circuit, a furnace door, means controlling the operation of said door and also controlling the operation of said pressure responsive means.

9. In furnace temperature control apparatus for a furnace having a door, pressure responsive means for varying furnace temperatures in accordance with the rate of operation of said door, comprising an air line having an air metering orifice for admitting air to said pressure responsive means, and manually controlled means for controlling air for said orifice and for the operation of said door.

10. In a furnace having a discharge door, furnace door operating means, furnace temperature control apparatus, adjusting means for adjusting said control apparatus whereby to adjust the temperature in said furnace, connections between said door operating means and said adjustment means, and manually operable control means for actuating said adjustment means upon the operation of said door.

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