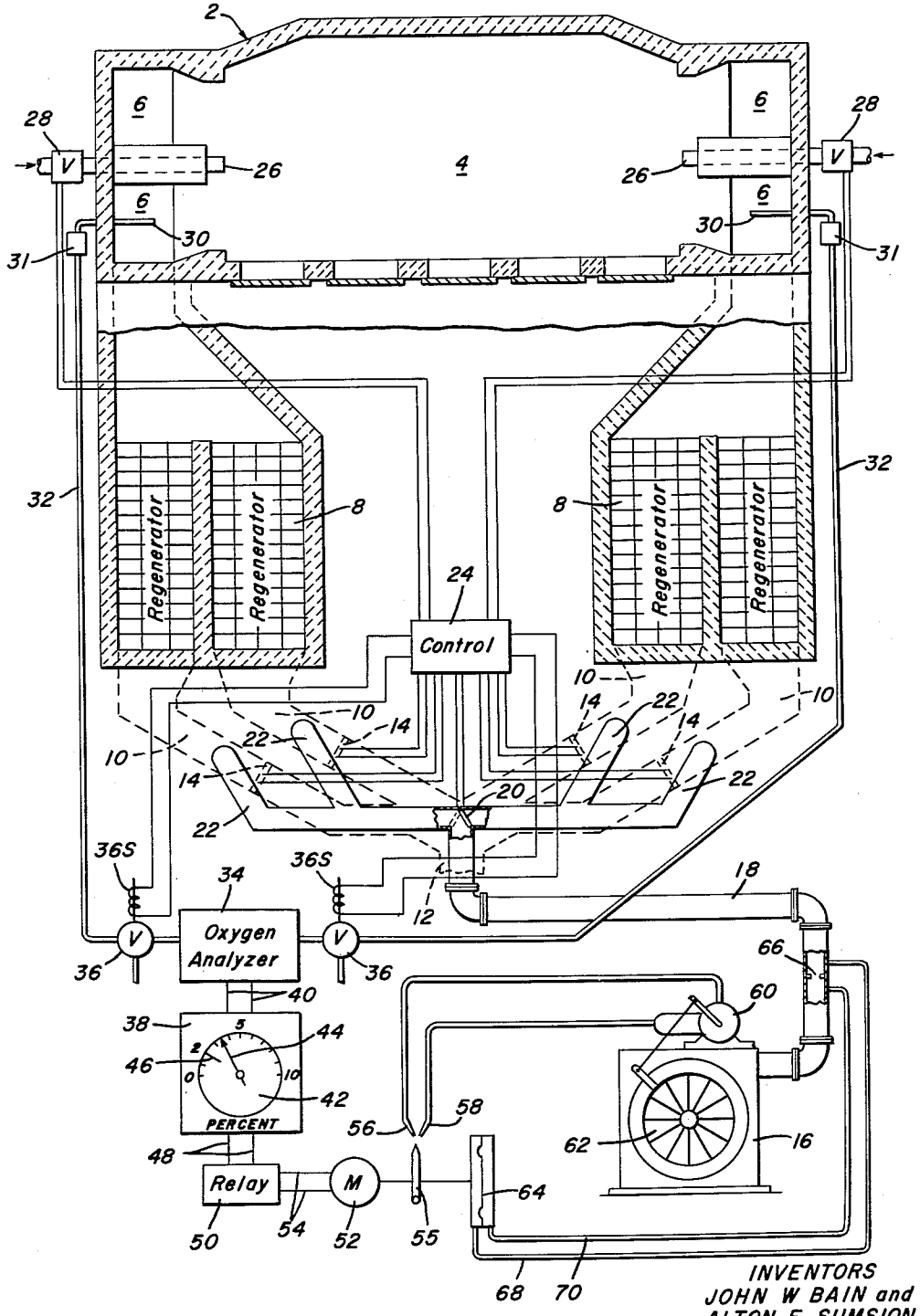
Jan. 2, 1962 J. W. BAIN ET AL 3,015,357

METHOD OF CONTROLLING THE OPERATION OF AN OPEN HEARTH FURNACE

Filed Jan. 23, 1958



INVENTORS
JOHN W BAIN and
ALTON E. SUMSION
By Donald G. Dalton
Attorney

United States Patent Office 3,015,357 Patented Jan. 2, 1962

3,015,357

METHOD OF CONTROLLING THE OPERATION OF AN OPEN HEARTH FURNACE

John W. Bain, Provo, and Alton E. Sumsion, American Fork, Utah, assignors to United States Steel Corporation, a corporation of New Jersey

Filed Jan. 23, 1958, Ser. No. 710,657
1 Claim. (Cl. 158—117.5)

This invention relates to a method of controlling the operation of a regenerative furnace and more particularly an open hearth furnace for making steel. In the operation of open hearth furnaces the fuel and air requirements vary during different stages of the heat because of the chemical reactions that take place, changes in furnace pressure and air leakage, etc. Prior to our invention the control of fuel and air flow was generally done in one of two ways. In one, the fuel-air ratio was based on a calculated pattern with the ratio varying during various stages of the heat. The ratio and fuel flow were varied manually during various stages of the heat with the air through the regenerators being controlled proportionally to fuel flow. In the second, the desired air flow was set on the basis of waste gas analysis and the fuel flow was automatically controlled from this setting of air. Neither of these methods of operation are entirely satisfactory. Too much fuel will be used at various stages of the heat and/or the actual air used will be greater or less than that necessary for proper combustion. In neither case are all the variables present in the operation of the open hearth furnace compensated for.

It is therefore an object of our invention to provide a method of operating an open hearth furnace wherein a fuel pattern is set for heat requirements and the air automatically adjusted for best efficiency.

This and other objects will be more apparent after referring to the following specification and attached drawings, in which:

The single figure is a schematic sectional plan view of an open hearth furnace with the controls of our invention connected thereto.

Referring more particularly to the drawing, reference numeral 2 indicates an open hearth furnace having the usual hearth 4, uptakes 6 and regenerators 8. A flue 10 leads from each of the regenerators 8 to a common flue 12 which leads to a stack (not shown). A damper 14 is located in each of the flues 10. A fan 16 is connected to a conduit 18 having a reversing valve 20 therein. A separate conduit 22 leads from the reversing valve 20 to each of the flues 10 on the furnace side of the valve 14. A control 24 controls the operation of dampers 14 and valve 20. A burner 26 is located at each end of the hearth 4. Flow of fuel to the burners 26 is controlled by means of valves 28. The control 24 controls the operation of the valves 28. The mechanism so far described is conventional.

A water cooled sample tube or probe 30 is located in each of the uptakes 6. A sampling station 31 draws the waste gas sample through the tube 30. A conduit 32 leads from the sampling station 31 to an oxygen analyzer 34. This oxygen analyzer may be of any standard type but is preferably a thermo-magnetic oxygen analyzer unit as shown in Leeds & Northrup catalog No. 7803–F. A three-way valve 36 located in each of the conduits 32 will permit flow to the analyzer 34 in one position and in a second position will exhaust gases to the atmosphere. Each of the valves 36 is provided with an operating solenoid 36S which is connected for operation by the control 24. The analyzer 34 generates an electrical impulse which is connected to a recorder controller 38 through lines 40. The recorder

controller 38 may be of any standard type but is preferably a Leeds & Northrup Model R Speedomax Type G as shown in their catalog No. 54101–30–C10. The recorder controller 38 includes a chart 42 and an indicating arm 44 which moves in accordance with the amount of oxygen in the gas sample. The recorder is preferably calibrated to indicate from zero to 10% oxygen. An adjustable contact 46 is arranged to be contacted by the arm 44. When the arm 44 contacts contact 46 the controller creates an electrical impulse which passes through lines 48 to a relay 50. Relay 50 may be of any standard type but is preferably an electronic position adjusting type relay such as shown in Leeds & Northrup catalog No. 10874. The relay 50 controls flow of current to a motor 52 through lines 54. The motor 52 is connected to move an oil jet 55 transversely to deliver oil to orifices 56 or 58. Orifices 56 and 58 are connected to a crank type hydraulic cylinder 60 which is connected to operate and adjust louvers 62 of fan 16. Jet 55 is also connected to be moved by a diaphragm 64. An orifice plate 66 is provided in the conduit 18 and impulse lines 68 and 70 lead from each side thereof to opposite sides of the diaphragm 64. The pressure drop across plate 66 is proportional to the flow of air through conduit 18.

Our method is carried out as follows:

A fuel pattern for the duration of the heat is determined and the operator manually changes the fuel flow in accordance with this fuel pattern. The contact 46 is adjusted to the position where it will maintain a desired constant oxygen content in the waste gases. This oxygen content is preferably 2%. Samples of the gases adjacent the probes 30 are continuously obtained and pass through the conduits 32. By "continuously" we mean at closely spaced intervals as compared to haphazardly spaced intervals. If the fuel is flowing from right to left as shown in the drawings, the valve 36 in the left conduit 32 will be positioned to deliver the sample to the analyzer 34 while the other valve 36 will be positioned to deliver the sample to the atmosphere. If the flue gas has more than 2% oxygen therein an electrical impulse will be created which causes the controller 38 to operate the motor 52 to move the jet 55 in the direction which will cause cylinder 60 to move the louvers 62 toward a closed position, thus reducing the air flow through the conduit 18. This causes a drop in the differential pressure across orifice plate 66, thus changing the position of jet 55 to adjust it to the new air flow rate. When the motor 52 stops, jet 55 will be positioned between the orifices 56 and 58 and flow of air through conduit 18 remains constant. When the amount of oxygen in the flue gas falls below 2%, the controller 38 will cause the motor 52 to operate in the reverse direction, thus moving the jet 55 in a direction to cause the cylinder 60 to open the louvers 62 wider to increase the flow of air through conduit 18. This increases the pressure drop across orifice plate 66, thus causing the jet 55 to move. When the motor 52 stops operating the jet 55 will again be positioned between the orifices 56 and 58. When the flow of fuel, air and waste gases through the furnace is reversed by means of control 24, air is delivered to the opposite checker in the usual manner and the control 24 will cause the right hand valve 36 to move to the position where the sample passing therethrough will go to the analyzer and the left hand valve 36 to move to the position where the sample will go to the atmosphere. It will be seen that the control balances the pressure proportional to flow against the impulse from controller 38. The hydraulic control shown utilizes Askania equipment, but other controls may be substituted therefor. While the control of our invention might be used in other types of

furnaces it is particularly adapted for an open hearth where it compensates for evolution of CO gas within the charge itself and for air introduced through the doors and brickwork.

While one embodiment of our invention has been shown and described it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claim.

We claim:

The method of operating an open hearth furnace comprising delivering fuel to opposite ends of the furnace alternately, varying the amount of fuel flow wholly independently of the air supply in accordance with a predetermined pattern based upon the fuel requirements during the various parts of the heat, delivering air through the regenerators to opposite ends of the furnace alternately, the fuel being delivered to one end of the furnace at the same time that the air is being delivered

to that end, continuously analyzing the waste gases for oxygen in the downtake at the end of said furnace opposite the fuel and air delivery end, and independently of fuel flow varying the air flow through the regenerators to the furnace as the oxygen content in said waste gases varies to maintain a predetermined excess of oxygen in said waste gases.

References Cited in the file of this patent

UNITED STATES PATENTS

1,911,831	Leiss	May 30, 1933
2,218,895	Selig	Oct. 22, 1940
2,349,521	Schmidt	May 23, 1944
2,608,351	Smoot	Aug. 26, 1952

OTHER REFERENCES

Hubbell: pages 53–58 of Iron and Steel Engineer for August 1953.