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(54) Heating method for burner

(57) A billet 52 is heated in a furnace 50 by hot gases from a burner 10 fired by natural gas fed via a valve 64. Primary air is fed via a valve 62 from a fan which also feeds supplementary air. The gas and primary air are in stoichiometric proportions. Supplementary air mixes with the heated flow from the combustion chamber to give a cooled flow of 750°C or less. The rates of flow of the gas and primary air are controlled by the valves 60, 62 and by a controller 66 so as to reduce to zero the difference between a temperature in the furnace sensed at 68 and a desired temperature set in the control system 66. In modifications (i) the supplementary air flow rate is controlled by the controller in addition to, or instead of, the gas and primary air (ii) the gas or primary air or each is individually controllable.

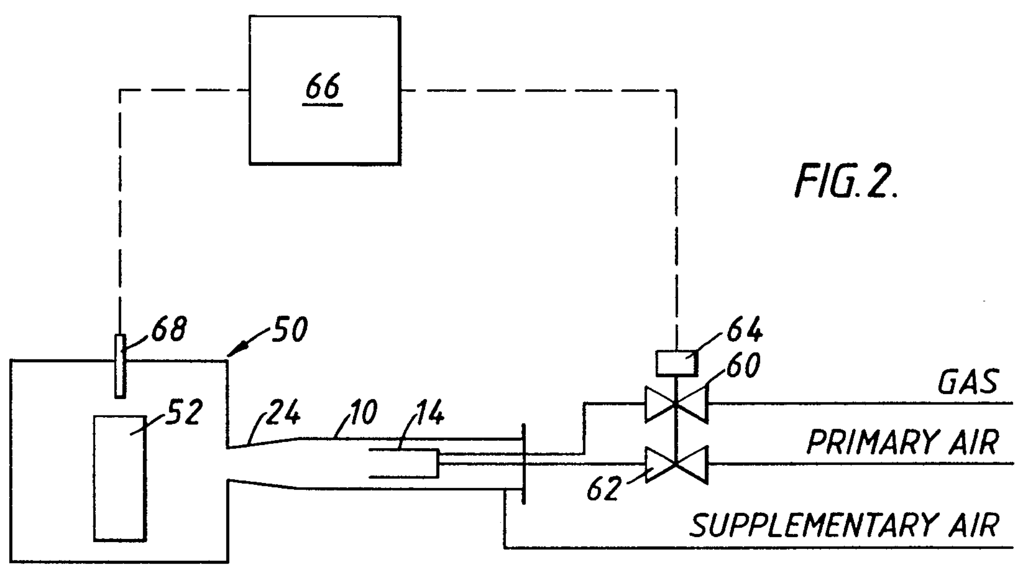

FIG. 2.

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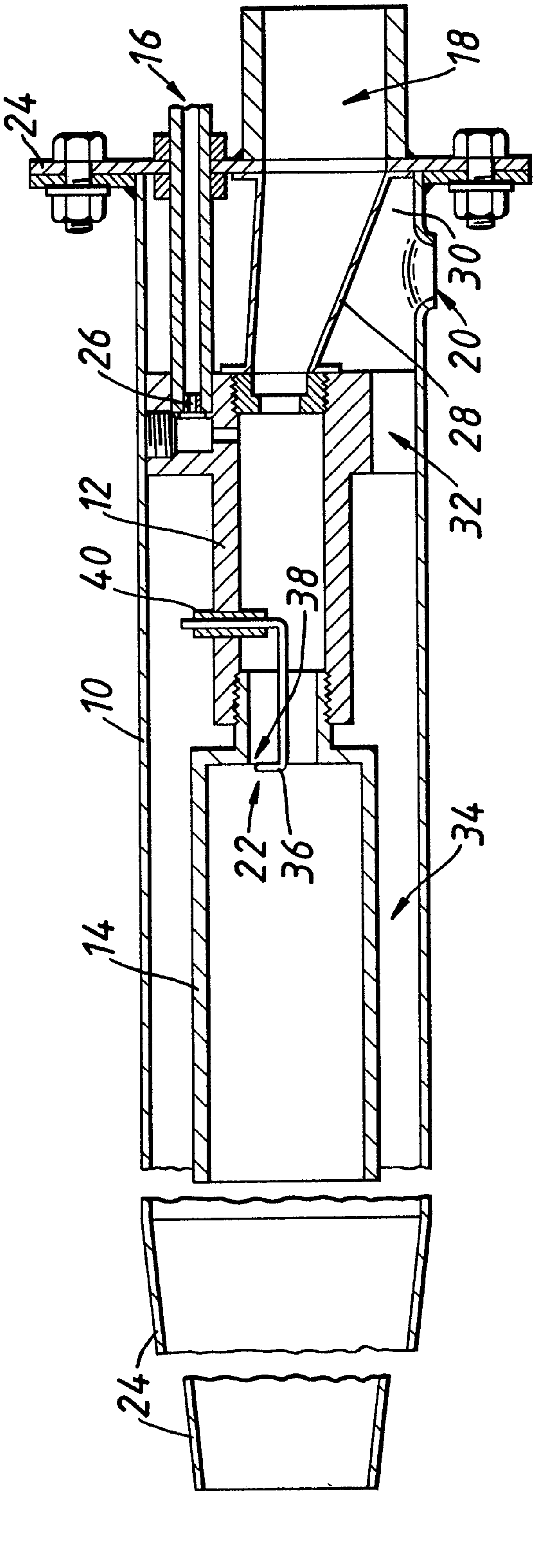
FIG. 1.



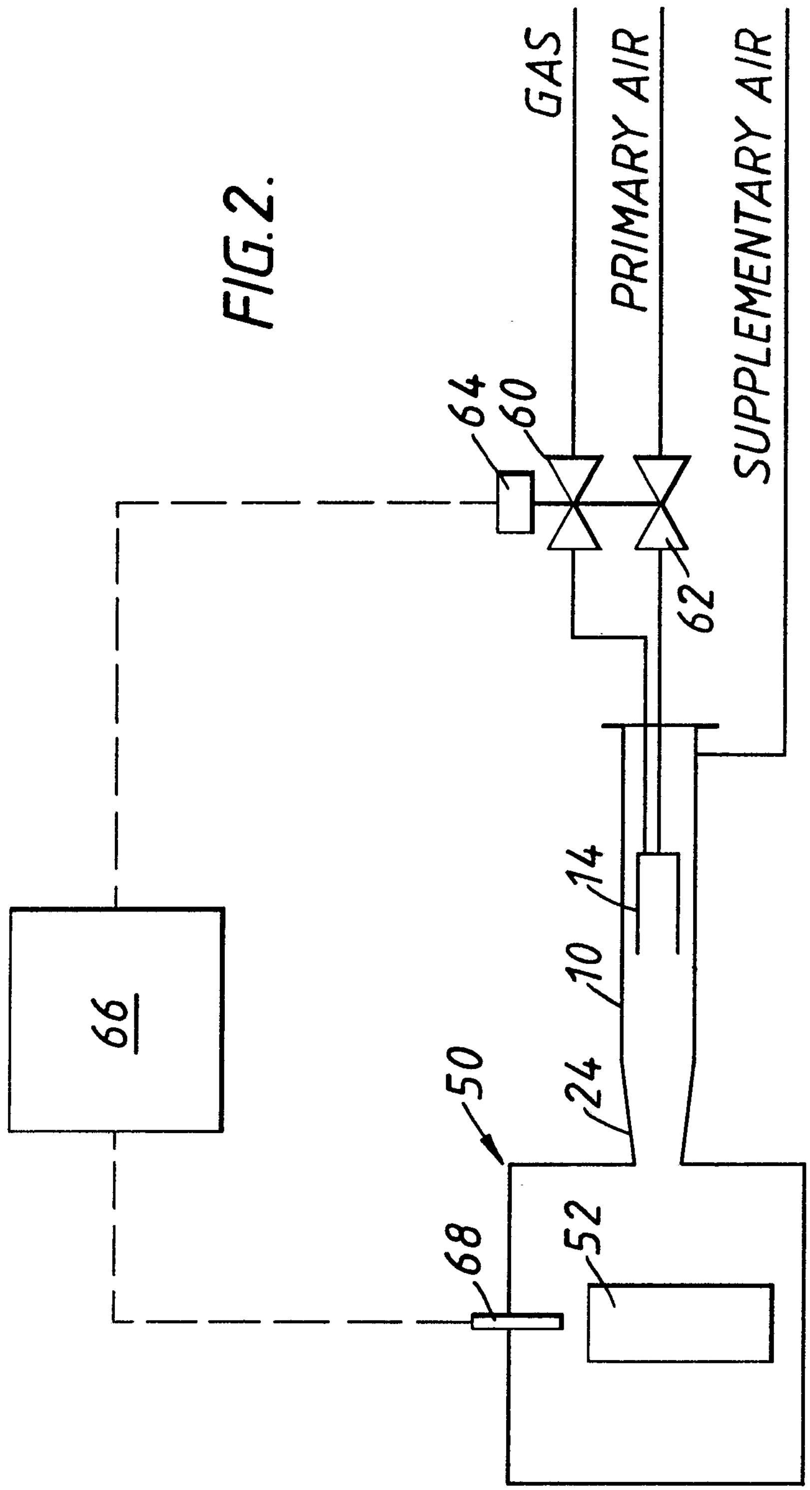


FIG. 2.

SPECIFICATION

Heating method and system

The invention relates to heating methods and systems and particularly, though not exclusively to methods and systems by which articles are heated by products of combustion from gas-fired burners.

Conventional gas burners generally operate at a stoichiometric ratio of gas to air. This makes for efficient operation, particularly where high operating temperatures are required. For many articles the required heating temperature is relatively low, typically less than 750° Celsius. For example, in the case of reheating aluminium billets for extrusion processing the required temperature is some 500° Celsius. Effective control of heat transfer to the billet when heated in a direct-fired chamber requires an adequate flow of gases at a suitable temperature across the billet. As the temperature of the billet approaches the set point, it is desirable to lower the temperature of the gases from the burner in order to control the billet temperature at the set point. That requirement cannot be met by conventional burners, the products of combustion of which are at a relatively high temperature.

The object of the invention is to provide a heating method and system by which the heating gases have a relatively low temperature which can readily be controlled.

It has been proposed in US patent specification No. 3816061 (Guth) to mix air with the products of the primary combustion of the fuel. However, in that proposal the object is to achieve a very high temperature flame issuing from a torch by using the added air to ensure secondary combustion and to leave no fuel unburned. Accordingly, the gases finally issuing from the burner are hotter than the gases produced by the partial combustion of the fuel in the primary air.

The object of the invention is to provide a heating method and system by which the temperature of the heating gases can be controlled at temperatures which are lower than the temperature of the gases which result from the combustion of the fuel in the primary air.

A method of heating, according to the invention, comprises mixing a fuel stream and a primary air stream, effecting combustion of the fuel in the mixture to produce a hotter flow, mixing the hotter flow with a supplementary air stream to produce a cooler flow than the hotter flow, passing the cooler flow to a site to be heated, sensing temperature at the site, and varying the rate of flow of at least one of said streams so as to reduce the difference between the sensed temperature and a desired temperature.

Preferably, the rates of flow of the fuel stream and the primary air stream are varied in unison so as to keep the ratio of fuel to primary air constant. The rate of flow of the supplementary air is kept constant.

Alternatively, the rates of flow of the fuel and primary air streams are kept constant and the rate of flow of the supplementary air is varied.

As a further alternative, all three streams are varied.

A heating system for performing the method according to the invention comprises a burner and supply means to supply the fuel stream and the primary and supplementary air streams to the burner, the burner having a combustion section which produces the heated flow and having downstream of the combustion section a mixing section which produces the cooler flow, a sensor at a site to be heated, the site receiving the cooler flow, and control means operable to control said supply means at least so far as one of said streams is concerned to reduce the difference between the temperature sensed by the sensor and the desired temperature.

One form of the method and one embodiment of a heating system will now be described by way of example to illustrate the invention with reference to the accompanying drawings, in which:-

Figure 1 is a disagreement longitudinal section through a burner used in the system; and

Figure 2 is a diagram showing the heating system including the burner shown in Fig. 1.

Fig. 1 shows a gas-fired burner having the following main parts; an outer tube 10; a cylindrical mixer section 12; a cylindrical combustion chamber 14; a fuel gas inlet 16; a primary air inlet 18; a supplementary air inlet 20; and an igniter arrangement 22.

The burner has a mild steel mounting plate 24 at the rear end of the tube 10, which is made of stainless steel, including the tapered nozzle 24 at its leading end. The combustion chamber 14 and mixer section 12 are of mild steel. Fuel, such as natural gas, for example, is supplied via the inlet 16 and via a control port 26 to the mixer section 12. The fuel is mixed in that section with primary air supplied from a fan (Fig. 2) connected to the inlet 18. The inlet 18, is connected to the mixer section 12 by a tapered duct 28 extending across an inlet chamber 30.

Supplementary air is supplied from the same fan to the inlet 20 which opens into the inlet chamber 30. Openings such as 32 lead from the chamber 30 to an annular passage 34 between the inside of the tube 10 and the outside of the mixer section 12 and combustion chamber 14.

The igniter arrangement includes an electrode 36 having a shorter cranked end terminating adjacent the combustion chamber wall to form a spark gap 38. The electrode has a longer cranked end mounted in an insulating sleeve, 40 which extends through an opening in the wall of the mixer section 12. The electrode 36 is connected to a battery terminal (not shown). The other battery terminal and the combustion chamber 14 can be connected to earth by an ignition switch (not shown).

The gas and the primary air mix in the mixer section 12 in substantially stoichiometric proportions. The mixture passes to the combustion chamber and burns to produce a relatively hot flow of heated gases, typically at 1200–1500°C. The supplementary air at around 15°C mixes with the heated flow in the mixing zone extending in the tube 10 downstream of the combustion chamber 14 to produce a cooler flow. The tapered nozzle 24 promotes the mixing of the secondary air and the hot gases from the combustion chamber 14, as well as increasing the velocity of the mixture before it leaves the exit of the nozzle 24.

The relative proportions of hot gases from the combustion chamber 14 and supplementary air are varied in order to achieve the desired temperature at the site at which, for example, an article such as an aluminium billet is to be heated. Fig. 2 shows the heating system in such an example. The heating size is a furnace 50 in which the billet 52 is positioned. The burner shown in Fig. 1 is mounted so that its nozzle opens into the interior of the furnace 50, the nozzle being directed so as to create a rotational flow of heating gases around the billet 52. The gases leave the furnace 50 via an outlet leading to an exhaust stack (not shown).

The primary and supplementary air streams are produced by a common fan (not shown). The supplementary air stream is preferably controllable by a manually adjustable valve (not shown) and the primary air and gas streams are controllable by respective valves 60, 62 which are operable by a common valve motor 64 controlled by a control module 66.

The temperature of the interior of the furnace 50 is sensed by a sensor 68, which produces a signal fed to the module 66. The valves 60 and 62 are operated in unison so that the relative proportions of gas and primary air are kept constant. For example, the proportions are preferably stoichiometric. The module 66 is such that a desired temperature for the interior of the furnace 50 can be set by an adjustable component (not shown) in the electrical control system in the module 66. The control system operates so that the temperature signal from the sensor 68 is compared with the set value of, say, voltage across the adjustable component. The control system produces outputs which drive the valves 60, 62 in senses such that the corresponding changes in the rates of flow of the gas and primary air change the temperature of the hot gases fed into the furnace 50, so as to reduce to zero the difference between the temperature sensed at 68 and the set temperature.

The system and method described have the advantage that the burner conditions are maintained such as to give a stable flame and clean combustion and the velocity of the flow of hot gases fed into the furnace 50, is kept in a range commensurate with efficient heat transfer to the billet by the forced convection process in the furnace. Heat transfer occurs also by radiation from the furnace walls, but the forced convection is dominant.

At the commencement of heating, the difference between the furnace interior temperature and the set temperature is at a maximum. The Control system sets the valves 60, 62 at their maximum open positions so that heated flow from the combustion chamber 14 is at its maximum rate in relation to the rate of flow of the supplementary air. Accordingly, the temperature of the hot gases entering the furnace is at a maximum. As the furnace interior and the billet heat up the difference between the sensed and the set temperatures falls and the valves 60, 62 are progressively adjusted to reduce the rates of the flow of the gas and primary air.

The invention provides relatively large volumes of low temperature gases at velocities suitable for efficient heat transfer. By contrast, a conventional burner under similar conditions may produce relatively low volumes of high temperature gases which are inconsistent with effective temperature control and may give rise to uneven heating of the article. The invention provides a means of adjusting the burner exhaust temperature to suit a given process requirement.

The invention is applicable to the heating of articles other than aluminium billets; for example it can be used in annealing furnaces; or for heating steel ingots.

In a modification (not shown) the temperature sensor engages or is mounted in or on the article eg the billet 52. In other modifications (not shown) the air stream flow rate is controlled by the control system either instead of, or in addition to, the gas and primary air streams. In other modifications (not shown) the gas or the primary air stream, or each of them, is controllable separately.

In yet another modification (not shown) hot gases are extracted from the furnace 50 and fed into the supplementary air stream. For example, the supplementary air flow can be passed through a device designed to use the air flow to draw the hot gases into the air flow. For example, the device is an ejector. Alternatively, the hot gases can be forced into the supplementary air flow by a blower or pump.

CLAIMS

1. A method of heating comprising mixing the hotter flow with a supplementary air

stream to produce a cooler flow than the hotter flow, passing the cooler flow to a site to be heated, sensing temperature at the site, and varying the rate of flow of at least one of said streams so as to reduce the difference between the sensed temperature and a desired temperature.

2. A method according to claim 1, in which the fuel streeam and the primary air stream are varied in unison so as to keep the ratio of fuel to primary air constant.

3. A method according to claim 1 or claim 2, in which the rate of flow of the supplementary our stream is kept constant.

4. A method according to claim 1, in which the rates of flow of the fuel stream and primary air stream are kept constant and the rate of flow of the supplementary air stream is varied.

5. A method according to claim 1 or claim 3, in which one of the two rates of flow, namely of the gas or of the primary air, is varied independently of the other.

6. A heating system for performing the method according to claim 1, comprising a burner and supply means to supply the fuel stream and the primary and supplementary air streams to the burner, the burner having a combustion section which produces the heated flow and having downstream of the combustion section a mixing section which produces the cooler flow, a sensor at a site to be heated, the site receiving the cooler flow, and control means operable to control said supply means at least so far as one of said streams is concerned to reduce the difference between the temperature sensed by the sensor and the desired temperature.

7. A heating system according to claim 6, in which the burner comprises a mixing section receiving the fuel stream and the primary air stream, a combustion chamber receiving the mixture from the mixing section, a tube surrounding and spaced from the combustion chamber and extending downstream beyond the combustion chamber, and annular passage between the combustion chamber and the tube conveying the supplementary air stream past the combustion chamber to a mixing zone in the tube downstream of the combustion chamber to a mixing zone in the tube downstream of the combustion chamber.

8. A heating system according to claim 7, in which the tube has a portion which tapers in the downstream direction towards the open end of the tube.

9. A method of heating according to claim 1, substantially as herein described with reference to the accompanying drawings.

10. A heating system according to claim 6, substantially as herein described with reference to the accompanying drawings.

CLAIMS

Amendments to the claims have been filed, and have the following effect:-

New or textually amended claims have been filed as follows:-

1. A method of heating a site comprising using a burner having a combustion chamber within and spaced from a tube which extends downstream beyond the combustion chamber and communicates with the site, mixing a fuel stream and a primary air stream, effecting combustion of the fuel in the mixture in the combustion chamber to produce a hotter flow all of which issues from the chamber into the tube, mixing the hotter flow issuing from the combustion chamber with a supplementary air stream which is flowing through the tube and which is supplied to the tube at a rate which is predetermined or within a predetermined range to produce in the tube a cooler flow than the hotter flow, passing the cooler flow to the site, sensing temperature at the site, and reducing the difference between the sensed temperature and a desired temperature using control means wholly outside said flows to control the rate of flow of at least one of said streams, the or each controlled stream passing through the control means.

2. A method according to claim 1, in which the fuel stream and the primary air stream are varied in unison so as to keep the ratio of fuel to primary air constant.

3. A method according to claim 1 or claim 2, in which the rate of flow of the supplementary air stream is kept constant.

4. A method according to claim 1, in which the rates of flow of the fuel stream and primary air stream are kept constant and the rate of flow of the supplementary air stream is varied.

5. A method according to claim 1 or claim 3, in which one of the two rates of flow, namely of the gas or of the primary air, is varied independently of the other.

6. A heating system for performing the method according to claim 1, comprising a burner and supply means to supply the fuel stream and the primary and supplementary air streams to the burner, the burner having a combustion chamber within and spaced from a tube which communicates with the site, the tube defining a mixing zone downstream of the chamber in which section said cooler flow is produced and a sensor at the site, said supply means including valve or throttle means wholly outside said flows and operable to vary the rate of flow of at least one of said streams, the or each controlled stream passing through the valve or throttle means, to reduce the difference between the temperature sensed by the sensor and the desired temperature.

7. A heating system according to claim 7, in which the tube has a portion which tapers in the downstream directions towards the open end of the tube.

8. A heating system according to claim 6

or claim 7 the tube opening directly into the site.

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