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HEATING FURNACE AND METHOD OF OPERATING THE SAME

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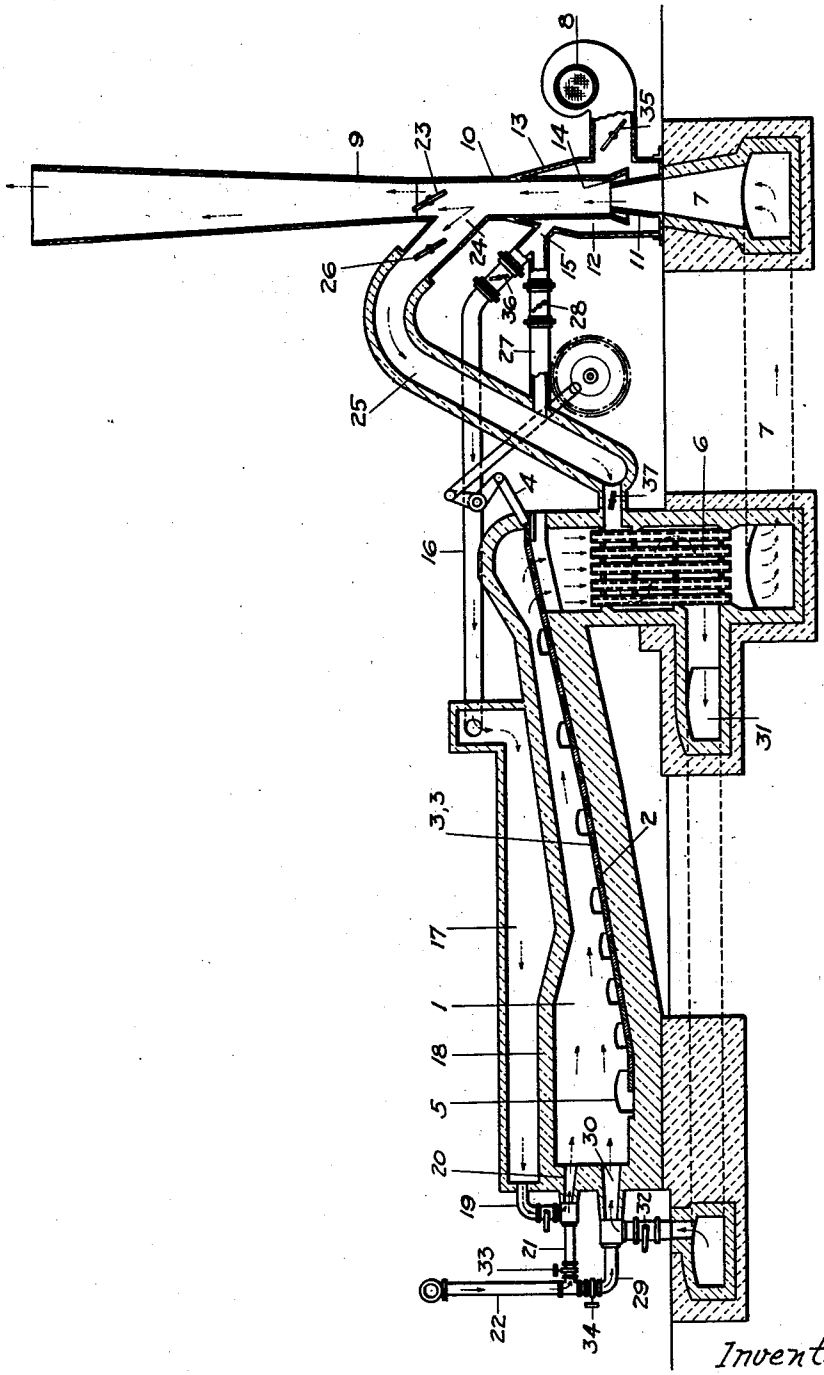

Inventor
Gustav A. Merkt.
By Geo. H. Kennedy Jr.
Attorney.

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HEATING FURNACE AND METHOD OF OPERATING THE SAME

Gustav A. Merkt, Worcester, Mass., assignor to Morgan Construction Company, Worcester, Mass., a corporation of Massachusetts

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The present invention relates in general to metal heating furnaces and their operation. More particularly, the invention contemplates an improved arrangement for stratified firing of such a furnace, by which is created for the material on the furnace hearth a flame blanket protecting the same against the oxidizing action of the high-temperature combustion that takes place in the upper part of the furnace chamber. Other and further objects and advantages of the invention will appear from the following detailed description thereof, taken in connection with the accompanying drawing, in which the single figure is a sectional view of a billet heating furnace to which the invention is applied.

Referring to said drawing, the furnace therein shown provides the usual elongated heating chamber 1, having a floor or hearth 2 preferably inclined downwardly toward the discharge end of said chamber. Along this floor or hearth 2 the billets 3, 3, have a progressive broadside movement, under the influence of the usual mechanical pushers 4, which act on each freshly-charged billet and thereby effect the step-by-step advancement of all the billets lying on the hearth; after each action of the pushers 4, the farthest-advanced billet, having traversed the full length of the chamber 1, is discharged by any suitable means, not shown through an opening 5 at the hotter end of said chamber.

The travel of flame and combustion products in said chamber 1 is from left to right, as shown by the arrows, there being at the cooler or chaging end of said chamber suitable openings, not shown, for the downward passage of the hot waste gases to a recuperator 6. The gases are drawn downwardly through the tubes of recuperator 6, and thence through the outlet passage 7 by the action of aspiration produced thereon by air under pressure, supplied, for example, by a blower 8. Said blower 8 is operatively associated with a discharge duct 9 of Venturi form, arranged to receive the said waste gases from passage 7 and to discharge the same in part to the atmosphere.

To this end, the lower end of the throat portion 10 of duct 9 is in telescopic spaced relation with a tubular member 11 at the terminal of the outlet flue or passage 7, the arrangement being such that all of the outgoing gases are delivered within said throat portion 10. The air under pressure supplied by the blower 8 is received in a chamber 12 that is formed by a casing 13 in surrounding relation to the parts 10 and 11, and the annular space 14 between said parts provides a restricted annular nozzle through which a portion of the air under pressure in chamber 12 is admitted, at relatively high velocity, to the throat portion 10, where it mixes with and entrains the waste gases coming from the furnace by way of recuperator 6 and flue 7. In this way, a portion of the air under pressure supplied by blower 8 procures the drafting of the furnace by aspiration of the products of combustion therefrom.

Another portion of the air supplied under pressure by the blower 8 is used for supporting the combustion of the fuel burned in the furnace. To this end, an outlet connection 15 from the chamber 12 provides an air pipe 16 for delivering said air under pressure to a chamber 17 preferably overlying the roof 18 of the heating chamber 1. In this way, said air is heated in advance of its delivery by a pipe 19 to a burner opening 20 in the front wall of the furnace, where also is admitted to the heating chamber 1, for high temperature combustion in the presence of said air under pressure, the major supply of fuel for the heating of the furnace charge. Such fuel, which may be oil, coke oven gas, natural gas, or the like, is here shown as conveyed to the burner opening 20 by a branch pipe 21 leading from a fuel supply main 22; the complete combustion of the same, for the production of extremely high temperature within the furnace chamber, is supported by a plenteous and preferably excess supply of heated air under pressure to the burner opening 20, arranged, as shown, well above the furnace hearth.

While the production of sufficient heat for the furnace requires the high flame intensity obtained by such fuel burning in the presence of an excess of heated air under pressure, it is nevertheless well recognized that such combustion is apt to expose the materials on the furnace hearth to a destructive oxidizing action, due to excess of the hot air supply. It has heretofore been proposed to maintain a protective blanket of reducing flame over the materials on the hearth by the introduction, at a lower level than burner opening 20, of fuel that is burned in the presence of an insufficient supply of air. I have discovered, however, that much better, more certain, and more controllable results in the creation of a protective reducing flame blanket are obtained when the air supply therefor is diluted by waste furnace gases; to this end, my invention provides for a recirculation of a portion of the outgoing current of waste gases delivered to the discharge duct 9 in the following manner.

As shown in the drawing, the duct 9 is equipped with a valve or damper 23, and inwardly of the same said duct provides a branch 24 communi-

cating with a flue or passage 25. The waste furnace gases from flue 7, in admixture with and entrained by the air under pressure delivered through nozzle 14, pass upwardly in part through duct 9 for discharge to the atmosphere, and in part are diverted into passage 25,—the volume of the so-diverted mixture being dependent upon the position of the valve or damper 23 and upon the position of a second valve or damper 26, arranged in the branch connection 24. This diverted current of air and waste gases in passage 25, supplemented or not as required by additional air from chamber 12, (connected to passage 25 by a pipe 27 having a shut-off valve 28), is employed to support a suitable combustion of fuel delivered by a branch pipe 29 from supply main 22 to a lower-level burner opening 30 in the front wall of the furnace. To this end, such diverted mixture of air and waste gases is preferably led by passage 25 into contact exteriorly with the tubes of recuperator 6, for the absorption of heat from waste gases flowing, as aforesaid, through said tubes; such diverted mixture then passes by way of flue 31 and pipe 32 to the burner opening 30, where it is used to support the combustion of the fuel there supplied.

The result of such combustion of fuel in the presence of a regulated mixture of air and waste furnace gases is emergence from the low-level burner opening 30 of a luminous and radiant flame extending practically the entire length of the heating chamber 1, and directly over the furnace hearth,—said flame being of a reducing or non-oxidizing character on account of the dilution of the combustion supporting air therefor with waste gases, and serving to blanket and protect the charge on the hearth from the oxidizing action of the excess air supply for the higher-temperature combustion taking place in the upper part of the heating chamber 1 in connection with the fuel delivered by the burner opening 20. This flame blanket, notwithstanding its protective characteristics, furnishes a highly efficient medium for transfer to the materials on hearth 2 of the heat produced in the upper part of chamber 1 by the combustion, with an excess of air, of the fuel delivered through the burner 20. In this way, my invention obtains a highly efficient heating of the materials on the hearth 2, with a minimum of destructive scaling and oxidization of said materials. It will be understood from the drawing that the apparatus of my invention is subject to close adjustment and regulation, to control, both quantitatively and qualitatively, the fuel supply, the air supply, and the recirculation of waste gases; for example, by the employment of suitable valves 33 and 34 in the fuel pipes 21 and 29, respectively, and by the employment of a regulating valve or damper 35 in connection with the blower 8; in addition to which the air under pressure that passes to the upper burner opening 20 may be regulated in volume by a valve or damper 36 in pipe 16, while the volume of the diverted mixture of air and waste gases supplied to the lower burner opening 30 may be regulated by a valve or damper 37, here shown as interposed between the passage 25 and the flue 31.

By my invention, the desired protective flame blanket, instead of being produced by fuel combustion in the presence of an insufficient supply of air, is produced by fuel combustion in the presence of a mixture of air and inert gases; this gives better control over the luminosity and length of the flame than would be the case if air alone were used. Furthermore, the chemical character of the flame blanket emanating from lower burner opening 30 is such as to protect the furnace charge from oxidization, since the percentage of oxygen supplied, although sufficient for practically complete combustion of the fuel, is nevertheless much smaller in relation to the volume of the total mixture than would be the case if no inert furnace gases were recirculated.

I claim:

1. In the operation of a heating furnace, working with high-temperature combustion in its heating chamber, the improvement which consists in entraining the waste furnace gases by a blast of air on the outgoing side of the furnace, and using the resultant mixture of air and waste gases as a combustion-supporting medium for fuel, in the production of a flame blanket to protect the furnace charge from the oxidizing action of said high-temperature combustion.

2. In the operation of a heating furnace, working with high-temperature combustion in the upper part of its heating chamber, the improvement which consists in entraining the waste furnace gases by a blast of air on the outgoing side of the furnace, and recirculating a portion of the resultant mixture of air and waste gases, as a combustion-supporting medium for fuel introduced to a lower part of such heating chamber, thereby to provide a flame blanket protecting the furnace charge from the oxidizing action of said high-temperature combustion.

3. In the operation of a heating furnace, working with high-temperature combustion of the main fuel supply thereto, the improvement which consists in entraining the waste furnace gases by a blast of air, and using the resultant mixture of air and waste gases as a combustion-supporting medium for a supplementary supply of fuel introduced to the furnace at a lower level than said main supply, for the production of a flame blanket to protect the furnace charge from the oxidizing action of said high-temperature combustion.

4. In the operation of a heating furnace, working with high-temperature combustion in the upper part of its heating chamber, the improvement which consists in entraining the waste furnace gases by a blast of air on the outgoing side of the furnace, recirculating a portion of the resultant mixture of air and waste gases, as a combustion-supporting medium for fuel introduced to a lower part of such heating chamber, thereby to provide a flame blanket protecting the furnace charge from the oxidizing action of said high-temperature combustion, and heating recuperatively said air and waste gases so recirculated.

5. In the operation of a heating furnace, the improvement which consists in supplying air under pressure for supporting the high-temperature combustion of the main fuel supply to the furnace, using a portion of said air under pressure to entrain the waste furnace gases on the outgoing side of the furnace, exhausting a portion of the resultant mixture of air and waste gases to the atmosphere, and using the remainder of said mixture as the combustion-supporting medium for a supplementary fuel supply introduced to the furnace at a lower level than said main supply, and providing a flame blanket protecting the furnace charge from the oxidizing action of said high-temperature combustion.

6. In a heating furnace, a main fuel supply and a supplementary fuel supply, the latter at a lower level than the former, means for supplying air under pressure to support the high-tem-

perature combustion of the main fuel supply, and means for supporting the combustion of the supplementary fuel supply by recirculation of waste furnace gases in admixture with air, for the production of a flame blanket protecting the furnace charge from the oxidizing action of said high-temperature combustion.

7. In a heating furnace, a heating chamber, means for producing high-temperature combustion of fuel in the upper part of said chamber, means for supplying air under pressure for the entrainment of waste furnace gases, and means for diverting a portion of the resultant mixture of air and waste gases to the support of fuel combustion in the lower part of said chamber, thereby to produce a flame blanket protecting the furnace charge from the oxidizing action of said high-temperature combustion.

8. In a heating furnace, a heating chamber, means for supplying air to the upper part of said chamber to support the high-temperature combustion of fuel therein, means for blowing air outwardly through a furnace exit passage to entrain the waste furnace gases, means for heating a portion of the resultant mitxure of air and waste gases by heat from the outgoing furnace gases, and means for returning said heated mixture to the furnace, as the combustion-supporting medium for fuel admitted to the lower part of the heating chamber, for the production of a flame blanket protecting the furnace charge from the oxidizing action of said high-temperature combustion.

9. In a heating furnace, a heating chamber, means for supplying air to the upper part of said chamber, to support the high-temperature combustion of fuel therein, means for blowing air outwardly through a furnace exit passage to entrain the waste furnace gases, means for supplying additional air to a portion of the resultant mixture of air and waste gases, and means for returning the mixture thus formed to the furnace, as the combustion-supporting medium for fuel admitted to the lower part of the heating chamber, for the production of a flame blanket protecting the furnace charge from the oxidizing action of said high-temperature combustion.

GUSTAV A. MERKT.