

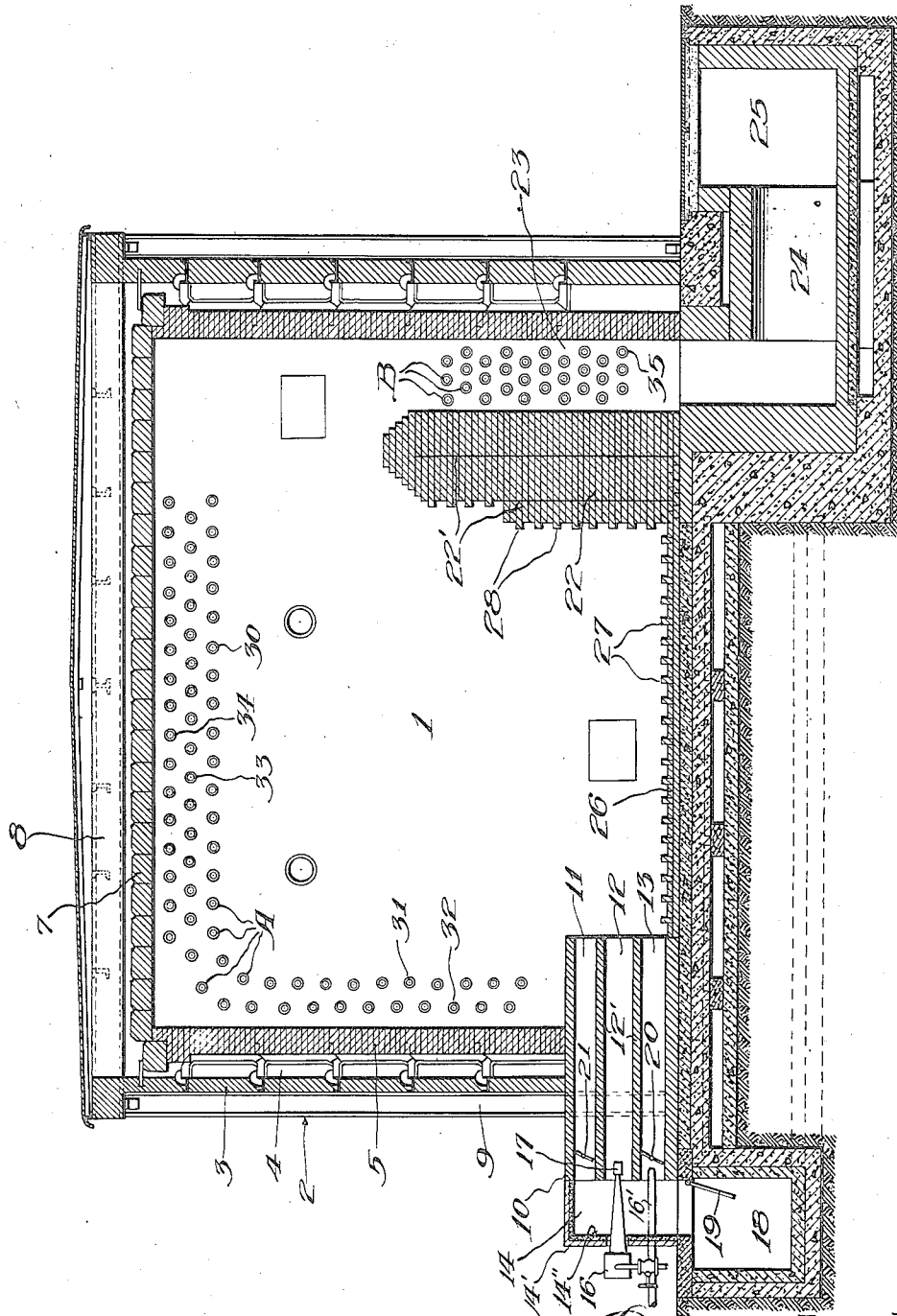
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METHOD OF PRODUCING LUMINOUS FLAME IN FURNACES

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METHOD OF PRODUCING LUMINOUS FLAME
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4 Claims. (Cl. 158—117.5)

This invention relates to improvements in a combination radiant heat and convection heat furnace, and has for its principal object a method for producing a more luminous flame and hence a flame capable of radiating a greater amount of heat.

The furnace for practicing the method of the invention has a combustion block having disposed therein a plurality of ducts or tunnels opening into the combustion chamber of the furnace. The combustion block is constructed separately from the furnace proper and is provided with three or more separate longitudinal tunnels, one disposed above the other. The middle tunnel is the combustion tunnel and is adapted to convey the products of combustion into the combustion chamber. Immediately above the combustion tunnel is disposed an air tunnel through which a controlled proportion of the total amount of air supplied to the furnace passes. The air passing through the last mentioned tunnel unites, in the combustion chamber, with the other combustion products issuing from the middle tunnel and produces a longer and more luminous flame within the combustion chamber. Through the third and lowest tunnel, steam or other inert gas may be admitted to the combustion chamber to provide a control of the ratio of heat supplied to the radiant and convection tubes.

The drawing comprises a sectional view taken through the furnace proper at right angles to the tubes.

Referring more in detail to the drawing, 1 indicates generally the combustion chamber of a furnace, designated as a whole at 2. The walls of the furnace are of accepted design and are built up of an outer wall of ordinary brick 3 and an inner wall of refractory brick, or the like, 5, providing an air space 4 therebetween. As is common practice, the air space 4 can serve as a preheating zone for air utilized in the combustion process.

The roof of the combustion chamber 1 comprises a series of suspended refractory bricks 7 supported from suitable steel work 8, which in turn is supported primarily by a plurality of up-standing "I" beams 9.

A combustion block 10 is positioned at the lower front portion of the furnace 2, and in this instance, comprises a group of three horizontally disposed tunnels 11, 12 and 13, being the upper, middle and lower tunnels, respectively. The structure 10 as a whole is preferably constructed separate from the remainder of the furnace, so that changes can readily be made in the event a different type of fuel is to be used. Hence, these changes can be made without disturbing the setting of the furnace proper. A plurality of combustion blocks 10 may be used, depending upon

the capacity of the furnace and the grade and type of fuel used.

Tunnels 11, 12 and 13 communicate at one end with the combustion chamber and at the other with a compartment 14 provided at the front end of the structure 10. The walls and roof which define the outer portion of the compartment 14 are preferably constructed of metal or the like 14' lined with a suitable insulating material 14".

Positioned in the front wall of the compartment 14 is a conventional burner 16, which may be an oil, gas, pulverized fuel burner, or burner for any other fuel. If desired, two or more fuels may be arranged to be burned simultaneously.

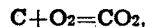
A nozzle 17 of the burner 16 extends into the central tunnel 12, wherein combustion takes place. The walls 12' which define the central tunnel 12 are preferably constructed of a super-refractory material so as not to be injuriously affected by the high temperatures produced by the burner flame. Air for combustion is supplied through a duct 18 which preferably traverses the length of the furnace 2, and communicates with the compartment 14. A damper 19 may be provided at the point of communication of the duct 18 and compartment 14, and controls the total amount of air admitted to the combustion chamber 1.

The tunnel 13 is disposed immediately below the tunnel 12 in the combustion block 10, and runs parallel thereto. The purpose of this tunnel is to admit steam to the interior of the combustion chamber in order to control the luminosity of the flame. The steam is admitted to the tunnel 13 by means of the usual steam nozzle 16'. A damper 20 may be provided in the tunnel 13 which can be closed when it is desired not to admit steam, in which case the tunnels 11 and 12 are the only ones in operation.

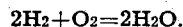
The function of the steam is to further increase the radiant properties of the flame in the combustion chamber, first, by increasing the H₂O concentration of the gases in the combustion chamber, and secondly, by retarding the combustion reaction because of the breaking up of the steam in presence of carbon to form CO and hydrogen. The reaction rate of



is slower than the reaction rates of



or



Therefore, much longer, and consequently more luminous flames can be obtained with the introduction of steam at the point of combustion than without the steam. The amount of steam introduced will, therefore, determine the extent of

formation of CO and the luminosity of the flame produced. Since the reactions between carbon and steam, and CO₂ and steam are endothermic, the introduction of steam into the combustion chamber at a point before combustion is completed, will reduce the temperature of the zone immediately around these reactions. The consequent combustion of CO to CO₂ is an exothermic reaction and raises the temperature of the zone where this reaction is completed. The introduction of steam, therefore, provides means of effecting the temperature distribution in a combustion chamber along the path of travel of the gases, and can be used to partly compensate for the progressive loss of heat in the gases, on account of radiation to the radiant heat absorbing surfaces. Aside from the effects of the steam on the heat absorption by the tubes exposed to radiant heat, the steam also influences the heat absorption in the so-called convection section, as the steam present increases the radiant properties of the gas and, therefore, the heat input in the convection section from the gases at a given initial temperature.

The tunnel 11 is disposed longitudinally in the combustion block 10 and is immediately above the tunnel 12, running parallel thereto. I have found that upon mixing all the air, admitted from the duct 18, with the combustible materials in the tunnel 12 a short non-radiant flame is produced. This is obviously undesirable inasmuch as the tubes A are designed so as to be heated by radiant heat. Hence, I have provided the tunnel 11, controlled by a damper 21, which is adapted to convey a proportion of the total amount of air received from the duct 18, to the combustion chamber 1. In this manner the proportion of air passing through the tunnel 11 does not mix with the combustible materials conveyed through the tunnel 12 until the same have issued into the combustion chamber. In this manner I have found that a long luminous flame is produced which radiates heat very efficiently. By proper manipulation of the damper 21 a control of the radiant quality of the flame may be had, and hence a control of the heat applied to the tubes A.

In addition to improving the radiant quality of the flame issuing from the tunnel 12, the passing of the air through the tunnel 11 and the steam through the tunnel 13 tends to cool the walls 12' of the combustion tunnel 12 and hence prevents undesirable overheating of the said walls 12' due to the intense heat developed in the combustion tunnel 12. Further, in thus cooling the walls 12', the air and the steam are preheated, before they enter the combustion chamber 1.

A bridge or baffle wall 22 is positioned in the combustion chamber 1 disposed oppositely to the combustion block 10, and running the entire length of the said combustion chamber. To prevent buckling and distortion due to stresses set up in the wall 22 by the difference in temperature of the two sides of the same, the said wall may be constructed in several sections, as indicated at 22'.

A space 23 is provided between the wall 22 and the rear wall of the furnace. The gases from the chamber 1 are adapted to pass over the wall 22 and downwardly through the space 23 to a conduit 24 which leads to a stack 25. The floor of the combustion chamber proper may be constructed of a refractory brick or the like 26, the said brick being laid irregularly, as shown at 27, as are the bricks 28 on the inner side of the wall 22. The provision of the irregularly placed bricks 27 and 28 is for two reasons, to provide a dragging action

on the products of combustion and facilitate a thorough mixing of the fuel and the air, and the complete combustion of the fuel before the products of combustion enter the convection section, and to provide a larger amount of incandescent refractory surface which acts as a catalytic agent in the process of combustion and assures better flame conditions with poor fuels.

A plurality of tubes are positioned in the space 23 behind the wall 22, as has been hereinbefore described, and are preferably disposed parallel to the said wall. This group of tubes will hereinafter be referred to as the convection section. Another group of tubes A may be positioned adjacent the roof and front wall of the combustion chamber 1. This group will be referred to as the radiant section and will be designated by rows as follows: The lowest row of roof tubes 30; the outside row of wall tubes 31; the inside row of wall tubes 32; the second row of roof tubes 33; and the top row of roof tubes 34.

In the heating of fluids, particularly in the cracking of hydrocarbon oil, the charging stock may be admitted to the bottom portion of the convection section, as indicated at 35. The oil is ordinarily heated in this group of tubes by the convection gases from the combustion chamber 1 that pass over the bridge wall 22 and down through the space 23. As the oil is heated it rises in the convection pipes and flows countercurrent to the flow of the convection gases.

It is apparent that I have provided a method of varying the degree of luminosity of a flame in a heating furnace, and hence a method of controlling the amount of heat applied to a section of tubes depending for their heating upon radiant heat.

I am aware that many modifications may be made without departing from the spirit of this invention, and, therefore, I do not wish to be limited to the specific disclosure except as necessitated by the prior art.

I claim as my invention:

1. In the operation of heating furnaces, the method of producing a luminous flame which comprises partially burning fuel in admixture with air in a confined passageway, discharging the burning fuel from said passageway into the furnace, introducing steam and additional air into the furnace beyond said passageway and commingling the same with the burning fuel adjacent the point of introduction of the latter to the furnace, and completing the combustion of the fuel in the furnace.

2. In the operation of heating furnaces, the method of producing a luminous flame, which comprises partially burning fuel in a mixture with air in a confined passageway, discharging the burning fuel from said passageway into the furnace, introducing steam and additional air into the furnace and commingling the same with the burning fuel adjacent the point of introduction of the latter to the furnace, the additional air and the steam being introduced respectively above and below the burning fuel discharging from said passageway into the furnace, and completing the combustion of the fuel in the furnace.

3. In the operation of heating furnaces, the method of producing a luminous flame which comprises partially burning fuel in admixture with air in a confined passageway, discharging the burning fuel from said passageway into the furnace, introducing steam and additional air in separate streams into the furnace beyond said passageway and commingling the same with the

burning fuel adjacent the point of introduction of the latter to the furnace, and completing the combustion of the fuel in the furnace.

5 4. In the operation of heating furnaces, the method of producing a luminous flame, which comprises partially burning fuel in admixture with air in a confined passageway, discharging the burning fuel from said passageway into the furnace, simultaneously flowing steam and addi-

tional air in separate streams contiguous to said passageway, then introducing separate streams into the furnace and commingling the steam and additional air with the burning fuel adjacent the point of introduction of the latter to the furnace, and completing the combustion of the fuel in the furnace.

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