Feb. 15, 1938. L. A. MEKLER 2,108,688

FURNACE

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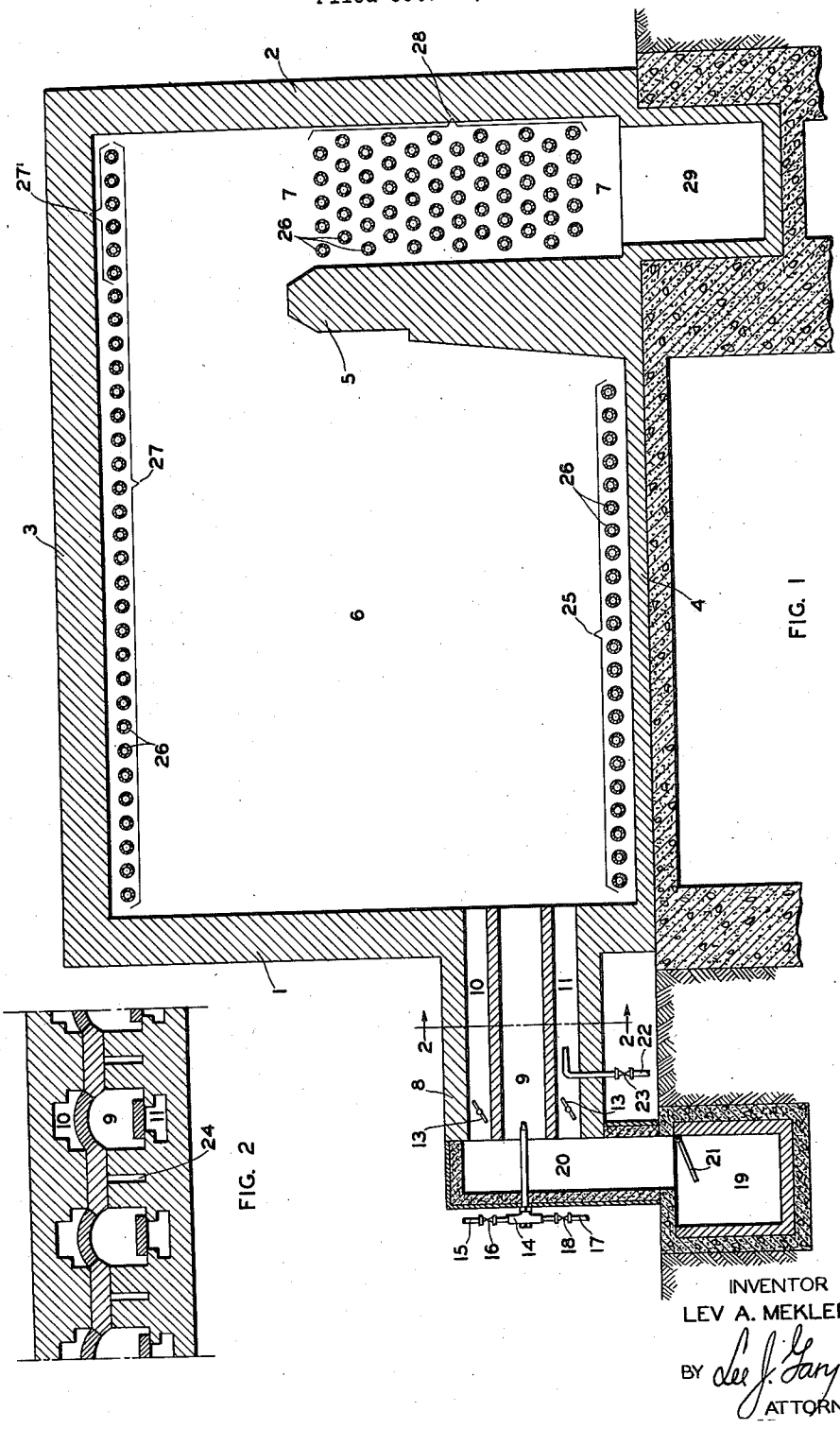


FIG. 1

FIG. 2

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This invention particularly refers to an improved form of furnace for the heating of fluids of the type employing both radiant and convection heat and which is of particular advantage as applied to the heating of hydrocarbon oils to the high temperatures required for their pyrolytic conversion. This application is a continuation in part of my prior application Ser. No. 365,552, filed May 23, 1929, now Patent No. 1,984,687.

As a special feature of the present invention, the main furnace structure is divided into a combination combustion and heating chamber and a fluid heating chamber. A fluid conduit comprising a plurality of tubular elements disposed to receive heat predominantly by radiation from the materials undergoing combustion within the furnace and the hot refractory walls of the furnace is located within the combustion and heating chamber. Another fluid conduit comprising a plurality of tubular elements is located in said fluid heating chamber in the direct path of flow of the combustion gases passing from the combustion and heating chamber to the stack whereby convection heat is imparted thereto by direct contact with said combustion gases.

As another special feature of the present invention, one or a plurality of firing tunnels are provided communicating with the combustion and heating chamber of the furnace through which firing tunnels combustible fuel and air are independently supplied in regulated amounts to the combustion and heating chamber. Fuel of any suitable form is preferably supplied together with a regulated quantity of the air required for its combustion through a centrally located combustion compartment in each firing tunnel and additional quantities of air may be supplied in regulated amounts direct to the combustion and heating chamber through separate air ducts located adjacent the combustion compartment in each firing tunnel. Steam may also be supplied in regulated amounts to the combustion and heating chamber either alone or together with regulated quantities of air and is preferably introduced beneath the flames in the combustion and heating chamber by supplying the same through an air duct located beneath the combustion compartment of the firing tunnel.

The provision for controlling the relative amounts of fuel and air supplied to the combustion chamber and for independently controlling the proportion of the total air supplied to the combustion chamber with the fuel and separately supplied thereto permits more accurate control over the characteristics of the flame in the combustion and heating chamber, particularly with respect to its length and luminosity, than is otherwise possible and means are thereby afforded for obtaining a better separation of radiant and convection heat when desired, between the combustion and heating chamber and the fluid heating chamber of the furnace and a better control is thereby exerted over the heating conditions about different portions of the fluid conduit. This is particularly desirable in the heating of hydrocarbon oils to the high temperatures required for their pyrolytic conversion in that better control is obtainable over the type of heating curve obtained which control is important and in many cases essential to the successful conversion of various types of oils. The use of steam in the manner provided by the present invention also serves as a means of obtaining better control over the heating conditions about different portions of the fluid conduit.

Fig. 1 of the accompanying diagrammatic drawing is a sectional elevation of one specific form of the furnace embodying the features of the present invention.

Fig. 2 is a fragmentary cross-sectional view of the firing tunnels taken along a vertical plane indicated by the line 2—2 in Fig. 1.

Referring to the drawing, the main furnace structure comprises side walls 1 and 2, a roof 3, a floor 4 and end walls which are not indicated in this particular view of the furnace, all of which are of conventional form and may be constructed, all or in part, of suitable refractory material such as firebrick or the like. A bridge wall 5 divides the interior of the furnace into a combustion and heating chamber 6 and a fluid heating chamber 7.

Firing tunnels 8 communicate, in the particular construction here illustrated, through side wall 1 of the furnace with combustion and heating chamber 6 and preferably a plurality of firing tunnels, or a continuous structure such as illustrated in Fig. 2, extends across the entire length of the furnace in such a manner that substantially uniform heating conditions may be maintained along the length of the combustion and heating chamber (between the end walls of the furnace). Each firing tunnel or each cell of the firing tunnel, in case a single continuous tunnel structure such as shown in Fig. 2 is provided, comprises a combustion compartment 9 and air ducts 10 and 11 located, respectively, above and beneath combustion compartment 9. Preferably, the walls of compartments 9, which are exposed to contact with the materials undergoing combustion therein, are

of suitable super-refractory material such as, for example, silicon carbide or the like, capable of withstanding the high temperatures normally prevailing in the combustion compartment. Each of the air ducts 10 and 11 is provided with a suitable damper 13 and a suitable sliding damper or the like (not shown) may be provided, when desired, at the mouth of combustion compartment 9, although when, as in the case here illustrated, means are provided for controlling the quantity of total air supplied to the combustion chamber a damper will not ordinarily be required at the mouth of combustion compartment 9. Preferably, when a continuous firing tunnel structure such as indicated in Fig. 2 is provided relatively small air ducts 24 are provided between adjacent cells or compartments of the firing tunnels in order to cool the side walls of combustion compartments 9 and prevent rapid destruction of the refractories. No method of controlling the relatively small amount of air supplied through tunnels 24 will ordinarily be required, although suitable dampers or the like (not shown) may be provided, when desired.

Fuel of any desired form such as oil, gas or pulverized solid fuel is supplied by means of a plurality of suitable burners, one of which is indicated in Fig. 1 at 14, to combustion compartments 9, the amount of fuel supplied to each compartment being controlled, in the case illustrated, by means of a valve 16 in pipe line 15 while air or steam for atomization of the fuel may be supplied to each burner through a pipe line 17 and valve 18. Air, preferably in preheated state, is supplied, in the case here illustrated, from a main air duct 19 to compartment 20 communicating with compartments 9, 10 and 11 of each of the combustion tunnels and the total quantity of air supplied to the combustion chamber may be regulated by means of damper 21.

Steam may be admitted to combustion and heating chamber 6 and is preferably supplied to this chamber beneath the flames through compartments 11, for example, of each of the firing tunnels, to each of which it may be supplied by means of a pipe line 22, controlled by valve 23. It is also within the scope of the invention to supply steam through ducts 10, for example, above the flames issuing from the mouth of combustion compartments 9 although means for accomplishing this, which may be similar, for example, to pipe line 22 and valve 23, are not shown in the drawing.

A fluid conduit 25 comprising a plurality of horizontally disposed parallel tubes 26 is located, in the case here illustrated, adjacent the floor 4 of combustion and heating chamber 6. Another fluid conduit 27, comprising a plurality of horizontally disposed parallel tubes 26, is located, in the case here illustrated, adjacent the roof 3 of the furnace and another fluid conduit 28, comprising a plurality of horizontal rows of horizontally disposed parallel tubes 26, is located, in the case here illustrated, within fluid heating chamber 7 of the furnace.

When the furnace is utilized for the treatment of a single stream of fluid the various tube banks 25, 27 and 28 may be connected in any desired sequence and preferably adjacent tubes in each bank are connected at their ends in series by means of suitable return bends or headers, of any well known form (not shown), which are preferably located outside the furnace. However, when desired, different portions of the same bank or different banks of tubes may be connected in parallel. It is also within the scope of the present invention to employ the furnace for the simultaneous treatment of two or more streams of the same fluid or of different fluids. As applied to the simultaneous treatment of two or more streams of the same fluid any desired flow arrangement may be employed which will permit substantially equal heating of both streams. As applied to the simultaneous treatment of two or more streams of different fluids any desired flow arrangement may be employed which will permit heating of the different fluids each under the conditions most suitable for their treatment. The general direction of flow of the fluid through any tube bank may be either concurrent or countercurrent to the direction of firing and the general direction of flow of the combustion gases or the direction of flow of the fluid being heated may be varied in different portions of the same tube bank. In general, the invention is not limited to any specific flow arrangement and no particular flow arrangement is claimed as a novel feature of the invention.

The invention is also intended to include modifications to the specific form of fluid conduits illustrated and described, for example, tube bank 25 or 27 or both may comprise two or three parallel rows of tubes instead of a single row with the different rows arranged either in staggered formation or otherwise. Also, the tubes of either or both of the tube banks 25 and 27 may be disposed parallel to the direction of firing instead of at right angles thereto, as illustrated, or, when desired, the furnace may be fired from one or both sides instead of from the end, as illustrated, firing tunnels of the general type illustrated preferably being employed, however, in any case. Tubes may also be disposed, when desired, along the side walls and/or along the end walls of the furnace without departing from the scope of the present invention.

With the fluid conduits arranged, as illustrated in the drawing, the tubes of bank 25 are heated predominantly by radiation from the materials undergoing combustion in combustion chamber 6 and the hot refractory walls of the furnace. Preferably, as indicated in the drawing, the floor bank 25 is depressed somewhat below the outlet from firing tunnels 8 in order to prevent impingement of the flames against the tubes of this bank and minimize washing of the tubes with the hot combustion gases. The tubes of bank 27 are subjected to heating by radiation from the materials undergoing combustion in combustion chamber 6 and from the hot refractory walls of the furnace and are also subjected to appreciable heating by convection, due to contact of the tubes with the hot combustion gases, particularly in the portion of this bank adjacent bridge wall 5. The tubes of bank 28 are supplied with convection heat by direct contact with the hot combustion gases which pass from combustion chamber 6 over bridge wall 5 downward through fluid heating chamber 7 to flue 29, from which they may pass to a suitable stack (not shown). Combustion gases and hot refractory walls of the furnace impart appreciable heat to the upper two or three rows of bank 28 by radiation while the succeeding rows are heated predominantly by convection. When desired, the tubes of bank 27 above fluid heating chamber 7, which portion of bank 27 is designated in the drawing as 27', may be eliminated, in which case a somewhat greater quantity of radiant heat will ordinarily be imparted to the upper rows of bank 28.

By controlling the ratio of fuel and air supplied to the combustion chamber and by independently controlling the amount of the air supplied to the combustion chamber with the fuel through combustion compartments 9 of the firing tunnels, relative to the amount of air separately supplied to the combustion chamber through ducts 10 and 11, the length and luminosity of the flames in combustion chamber 6 may be controlled to a degree impossible with conventional firing arrangements. For example, by employing a relatively large amount of excess air and by introducing a major portion of the total air to the combustion chamber through combustion compartment 9, together with the fuel, the visible portion of the flame issuing from the mouth of compartment 9 will be very short and the flames in combustion chamber 6 will be substantially of non-luminous character. By reducing the total amount of excess air and supplying a major portion of the air through combustion compartment 9, together with the fuel, somewhat longer flames of a more luminous character may be obtained. With a small amount of total excess air and a major portion of the air supplied through ducts 10 and 11 to combustion chamber 6 the length of the visible or luminous portion of the flame may be materially increased and by increasing the total volume of excess air and supplying a major portion thereof through ducts 10 and 11 longer flames of somewhat decreased luminosity may be obtained.

In this manner better separation of radiant and convection heat may be obtained, when desired, in the two heating chambers of the furnace and the proportion of available heat imparted to the tubes in combustion and heating chamber 6 relative to that imparted to the tubes in fluid heating chamber 7 may be varied over a wide range to suit requirements.

It is also possible by varying the amount of air supplied to the combustion chamber through air ducts 10 above the combustion compartments 9 relative to the volume of air supplied to the combustion chamber through ducts 11 beneath combustion compartments 9 to control, within fairly wide limits, the heat supplied to floor bank 25 relative to that supplied to roof bank 27. A large amount of air introduced through air ducts 10 will tend to form a protective layer above the flame and concentrate heat along the floor of the furnace while the opposite result may be obtained by introducing a large proportion of the air through ducts 11 beneath combustion compartments 9. The introduction of steam to the combustion and heating chamber, as provided by the present invention, will serve to temper or blanket the flame and reduce the rate of heating in the vicinity of the steam.

I claim as my invention:

1. In a furnace having a combustion chamber, the combination of a firing structure adjacent the lower portion of the furnace and comprising a central firing tunnel and a pair of air ducts, one disposed above and the other below the central tunnel, means for supplying a controlled mixture of combustible fuel and air through said central firing tunnel to said combustion chamber of the furnace and means for separately supplying independently controlled amounts of additional air to the combustion chamber through each of said air ducts.

2. A firing device for furnaces comprising a central tunnel, a pair of additional tunnels contiguous to the central tunnel, one disposed above and the other below the central tunnel, means for supplying fuel and air to the central tunnel, and means for supplying independently controlled amounts of combustion controlling medium to each of said additional tunnels.

3. A firing device for furnaces comprising a central tunnel, a pair of additional tunnels contiguous to the central tunnel, one disposed above and the other below the central tunnel, means for supplying fuel and air to the central tunnel, and means for supplying independently controlled amounts of air to each of said additional tunnels.

4. A firing device for furnaces comprising a central tunnel, a pair of additional tunnels contiguous to the central tunnel, one disposed above and the other below the central tunnel, an air compartment communicating with said tunnels at adjacent ends thereof, and means for supplying fuel to the central tunnel adjacent the end thereof in communication with the air compartment.

5. A firing device for furnaces comprising a central tunnel, a pair of additional tunnels contiguous to the central tunnel, one disposed above and the other below the central tunnel, an air compartment communicating with said tunnels at adjacent ends thereof, means for supplying fuel to the central tunnel adjacent the end thereof in communication with the air compartment, and a damper in each of said additional tunnels.

6. A firing device for furnaces comprising a central tunnel, a pair of additional tunnels contiguous to the central tunnel, one disposed above and the other below the central tunnel, an air compartment communicating with said tunnels at adjacent ends thereof, means for supplying fuel to the central tunnel adjacent the end thereof in communication with the air compartment, and means for introducing steam to at least one of said additional tunnels.

7. A furnace having a floor, a roof and a vertical side wall, a horizontal firing tunnel projecting through said side wall near the furnace floor, a pair of additional horizontal tunnels contiguous to the firing tunnel, one disposed above and the other below the firing tunnel, means for supplying fuel and air to the firing tunnel to pass through the latter into the lower portion of the furnace, and means for supplying combustion controlling medium to said additional tunnels to pass through the latter into the lower portion of the furnace.

8. A furnace having a floor, a roof and a vertical side wall, a horizontal firing tunnel projecting through said side wall near the furnace floor, a pair of additional horizontal tunnels contiguous to the firing tunnel, one disposed above and the other below the firing tunnel, means for supplying fuel and air to the firing tunnel to pass through the latter into the lower portion of the furnace, means for supplying combustion controlling medium to said additional tunnels to pass through the latter into the lower portion of the furnace, and a damper in each of said additional tunnels.

9. A furnace having a floor, a roof and a vertical side wall, a horizontal firing tunnel projecting through said side wall near the furnace floor, a pair of additional horizontal tunnels contiguous to the firing tunnel, one disposed above and the other below the firing tunnel, an air compartment communicating with said tunnels at ad-

jacent ends of the latter, and means for supplying fuel to the furnace through the firing tunnel.

10. A furnace having a floor, a roof and a pair of vertical side walls, a bridge wall extending upwardly from the floor between said side walls and terminating short of the roof, thereby forming in the furnace a combustion section and a convection section receiving combustion gases from the combustion section, means for removing combustion gases from the convection section, a horizontal firing tunnel projecting through the side wall of the combustion section near the furnace floor, a pair of additional horizontal tunnels contiguous to the firing tunnel, one disposed above and the other below the firing tunnel, means for supplying fuel and air to the firing tunnel to pass through the latter into the lower portion of the furnace, and means for supplying combustion controlling medium to said additional tunnels to pass through the latter into the lower portion of the furnace.

11. A furnace having a floor, a roof and a pair of vertical side walls, a bridge wall extending upwardly from the floor between said side walls and terminating short of the roof, thereby forming in the furnace a combustion section and a convection section receiving combustion gases from the combustion section, means for removing combustion gases from the convection section, a horizontal firing tunnel projecting through the side wall of the combustion section near the furnace floor, a pair of additional horizontal tunnels contiguous to the firing tunnel, one disposed above and the other below the firing tunnel, an air compartment communicating with said tunnels at adjacent ends of the latter, and means for supplying fuel to the furnace through the firing tunnel.

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