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FURNACE AND METHOD FOR HEATING FLUIDS

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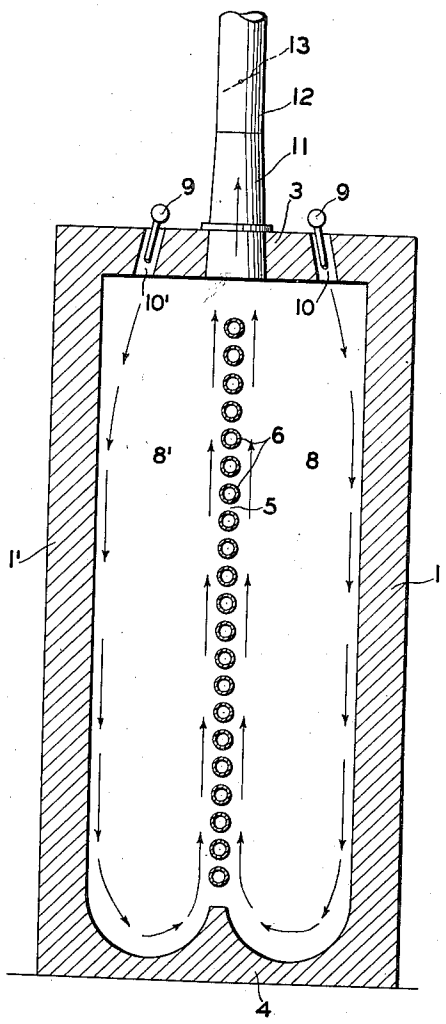


FIG. 1

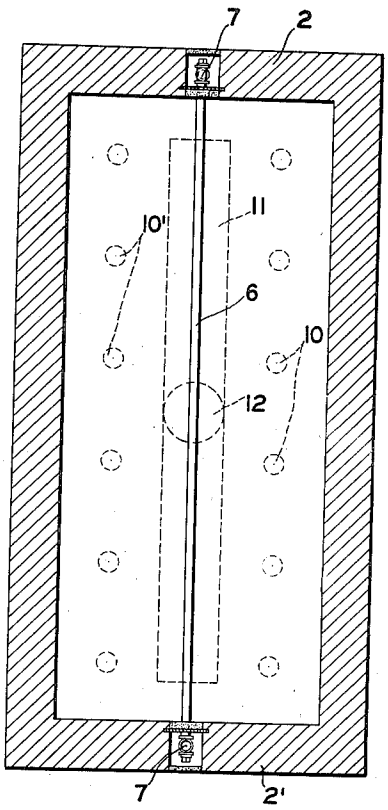


FIG. 2

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FURNACE AND METHOD FOR HEATING FLUIDS

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7 Claims. (Cl. 196—116)

This invention particularly refers to an improved form of furnace, particularly adapted to the heating of hydrocarbon oils to the high temperatures required for their pyrolytic conversion, of the type wherein opposite sides of the tubes, comprising the fluid conduit through which the oil is passed, are subjected to substantially equal rates of heating.

More specifically the invention embodies the improved method of operating improvement to this type of furnace which comprises supplying radiant heat to opposite sides of the tubes of the fluid conduit from flames and heated refractory surfaces and simultaneously supplying convection heat to opposite sides of the tubes by passing thereover a stream of hot combustion gases in a direction countercurrent to the direction of the flame.

The method of heating provided by the present invention permits a more uniform distribution of heat to various portions of the fluid conduit, the maximum radiant heat input to the tubes occurring in that portion of the heating coil or fluid conduit wherein the convection heat input is at a minimum, the input of radiant heat gradually decreasing as the convection heat input increases. Thus, the radiant and convection components of the total heat imparted to the tubes have a counter-balancing effect, the increasing intensity of one tending to counteract the decreasing intensity of the other.

The accompanying diagrammatic drawing, together with the following description thereof, will serve to more clearly illustrate the features and advantages of the present invention. Fig. 1 of the drawing is a sectional end elevation of a furnace embodying the features of the present invention, and Fig. 2 is a sectional plan view of the same structure.

Referring to the drawing, the main furnace structure comprises side walls 1 and 1', end walls 2 and 2', a roof 3 and a floor 4.

A centrally located vertical row 5 of tubes 6 comprises the heating coil or fluid conduit. The tubes extend horizontally between the end walls 2 and 2' of the furnace and, in the case here illustrated, are connected at their ends in series by means of suitable return bends 7. It will be understood that, although not illustrated in the drawing, parallel flow through the tubes of the fluid conduit may be employed, when desired, suitable headers (not shown), being provided in this case at opposite ends of the tubes. When series flow is employed through tubes 6 the general direction of flow through the tube bank may be either upward or downward, as desired.

Combustion zones 8 and 8' are provided on opposite sides of heating coil 5 and suitable burners 9 supplied with fuel of any desired form supply combustion products to zones 8 and 8' through burner ports 10 and 10', respectively, located, in the case here illustrated, in roof 3 on opposite sides of the heating coil. A flue 11 located above tube bank 5 in the roof 3 of the furnace permits the passage of combustion products to a suitable stack 12, controlled by damper 13.

Preferably, as illustrated in the drawing, the burners and burner ports are inclined slightly toward the side walls 1 and 1' of the furnace so that the flame impinges against the side walls. The combustibles are discharged from burners 9 with sufficient velocity to carry the flame downward along the sides 1 and 1' to near the floor 4 of the furnace where the flow of combustion gases is reversed, the gases passing then in an upward direction along opposite sides of the tubes 6 to flue 11 in the roof of the furnace. In this manner the tubes are heated on opposite sides by direct radiation from the flames and by re-radiated heat from the walls of the furnace while convection heat from the hot combustion gases, as they pass upward around the tubes, is superimposed over the radiant heat.

By firing opposite sides of the furnace equally substantially equal heating is obtained on opposite sides of the vertical center line through the tube bank so that each tube receives heat at a substantially uniform rate on both sides. By controlling the air-fuel ratio and the draft conditions the furnace may be fired in such a manner that the decreasing amount of radiant heat from top to bottom of the tube bank is substantially compensated for by the increasing amount of convection heat, due to the counter-current flow of combustion gases over the tubes relative to the direction of the flame. In this manner substantially uniform heating conditions may be obtained throughout the entire length of the heating coil as well as on opposite sides thereof, thus permitting a higher average rate of heating for a given maximum rate than is otherwise obtainable.

It will be understood that although the drawing and the foregoing description is confined to a down-fired, up-draft furnace, the features of the invention may be applied as well to a down-draft furnace fired from the bottom. This will be well understood by those familiar with the

furnace art without the necessity of additional drawings or description, the features involved in both cases being the same, namely, to impart radiant heat to opposite sides of a fluid conduit from flames and from heated refractory surfaces and to impart additional convection heat to the same fluid conduit by passing over the opposite sides thereof simultaneously hot combustion gases in a direction counter-current to the general direction of the flame.

I claim as my invention:

1. In the heating of hydrocarbon oil to conversion temperatures, the method which comprises passing the oil in a restricted stream serially through a plurality of series connected, substantially horizontal tubular elements disposed in a common vertical plane approximately medially between a pair of spaced, parallel furnace walls, projecting flame of substantially uniform heat intensity downwardly along each of said walls opposite said elements and in spaced relation with respect to the latter, reversing the direction of flow of the combustion gases resulting from the flames in the lower portion of the furnace below the lowermost of said elements, and then passing the cumbustion gases upwardly along the opposite sides of said elements between the latter and the flames.

2. A method for heating fluids which comprises passing the fluid through a plurality of heating tubes disposed in a vertical plane between a pair of spaced vertical furnace walls, impinging flame angularly against each of said walls on the side thereof facing the tubes and passing the flames and combustion gases in a vertical direction along said walls, and subsequently passing portions of the combustion gases along both sides of the tubes between the tubes and the flames in a direction counter-current to the direction of movement of the flames along said walls.

3. A method for heating fluids which comprises passing the fluid through a plurality of heating tubes disposed in a vertical plane between a pair of spaced vertical furnace walls, impinging flame angularly against each of said walls on the side thereof facing the tubes and passing the flames and combustion gases in a vertical direction along said walls, then reversing the direction of flow of the combustion gases and passing the same along both sides of the tubes between the tubes and the flames in a direction countercurrent to the direction of movement of the flames along said walls.

4. A method for heating fluids which comprises passing the fluid through a plurality of heating tubes disposed in a vertical plane between a pair of spaced vertical furnace walls, impinging flame angularly against each of said walls on the side thereof facing the tubes and passing the flames downwardly along said walls, and subsequently passing combustion gases resulting from the flames upwardly along both sides of the tubes between the latter and the flames.

5. A method for heating fluids which comprises passing the fluid through a plurality of heating tubes disposed in a vertical plane between a pair of spaced vertical furnace walls, impinging flame angularly against each of said walls on the side thereof facing the tubes and passing the flames downwardly along said walls, reversing the direction of flow of the combustion gases resulting from the flames in the lower portion of the furnace below the lowermost of said tubes, and then passing the combustion gases upwardly along the opposite sides of the tubes between the latter and the flames.

6. A fluid heating apparatus comprising a furnace having a pair of spaced vertical walls, a plurality of heating tubes disposed in a vertical plane between and spaced from said walls, means for projecting flame angularly against and vertically along each of said walls on the side thereof facing the tubes, and means for passing resultant combustion gases along both sides of the tubes between the tubes and the flames in a direction countercurrent to the direction of movement of the flames along said walls.

7. A fluid heating apparatus comprising a furnace having a pair of spaced vertical walls, a plurality of heating tubes disposed in a vertical plane between and spaced from said walls, means for projecting flame angularly against and downwardly along each of said walls on the side thereof facing the tubes, and means in the lower portion of the furnace below the lowermost of said tubes for reversing the direction of flow of the combustion gases resulting from the flames and for passing the gases upwardly along the opposite sides of the tubes between the latter and the flames.

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