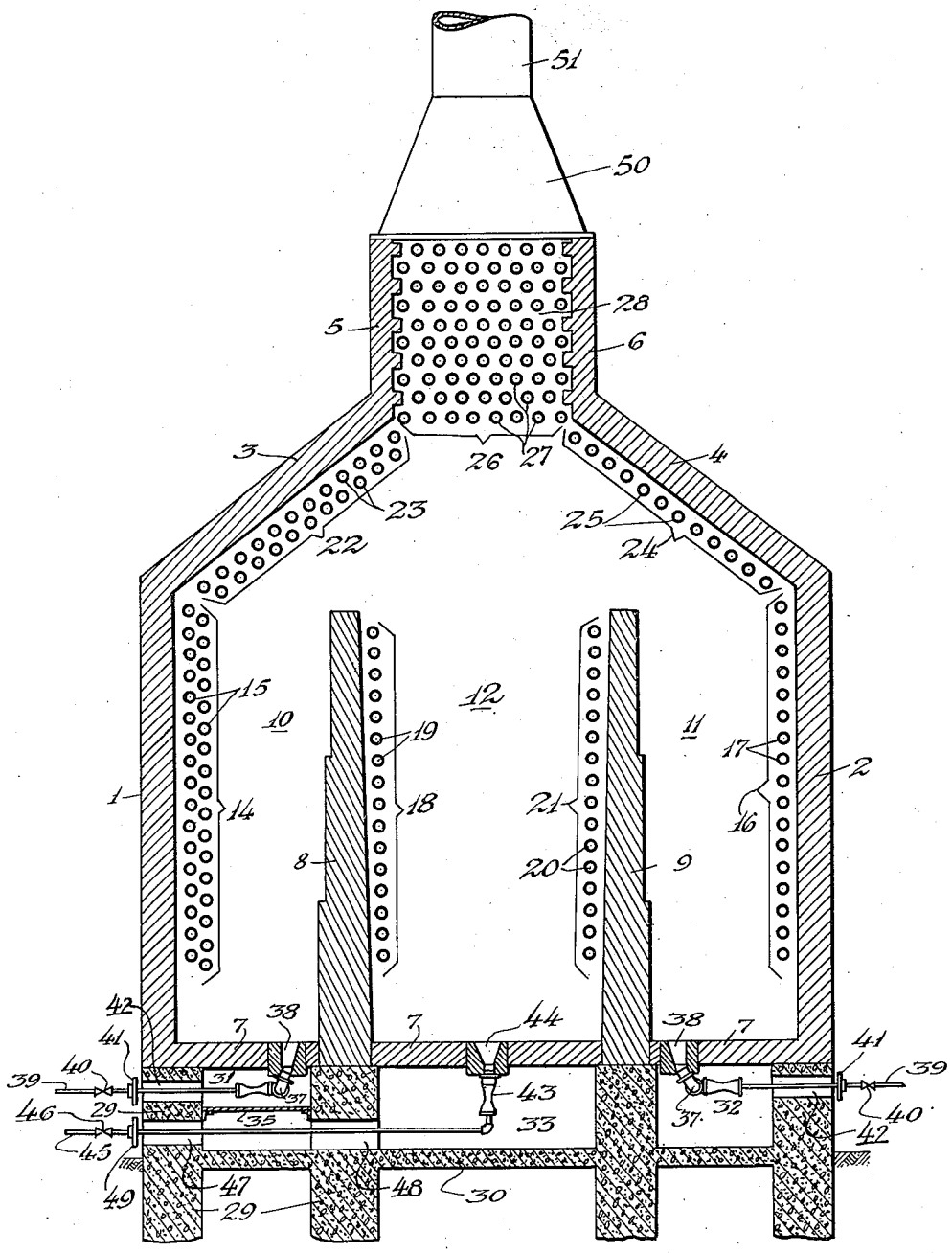
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HEATER FOR FLUIDS

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HEATER FOR FLUIDS

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The invention relates to an improved form of heater for fluids which is particularly advantageous as applied to heating hydrocarbons to the high temperatures required for their thermal or catalytic conversion. The features of the invention will also be found useful in numerous other applications wherein it is desired to heat one or more streams of fluid with relatively high rates of heat input.

The heater herein provided is of the general type employing a plurality of separately fired cells with tubular fluid conduits disposed adjacent a refractory wall in each cell to receive direct radiant heat on one side from flames and hot combustion gases passing through the cell and receive reflected radiant heat on the opposite side from the adjacent refractory wall.

The features and advantages of the invention will be apparent to those familiar with the art from an inspection of the accompanying diagrammatic drawing and the following description thereof.

The drawing represents a cross-sectional elevation of one specific form of the heater provided by the invention.

Referring to the drawing, the form of heater here illustrated comprises substantially vertical refractory side walls 1 and 2, sloping refractory walls 3 and 4 extending upwardly and inwardly from walls 1 and 2 to other vertical refractory outer walls 5 and 6, a floor 7 and end walls, not shown.

Interior refractory walls 8 and 9, spaced from each other and from the side walls 1 and 2, are provided within the heater and extend from the floor to a level adjacent the upper extremity of walls 1 and 2.

The space within the heater between walls 1 and 8 comprises a combustion and radiant heating zone or fired cell 10. A similar, separately fired, combustion and radiant heating zone or cell 11 is disposed between walls 2 and 9. Another independently fired combustion and radiant heating zone or cell 12 is disposed centrally within the heater between walls 8 and 9.

A bank 14, comprising in the case illustrated two vertical rows of horizontally disposed tubular fluid conduits 15 is located within cell 10 adjacent the interior surface of wall 1. Another bank 16, comprising, in this instance a single vertical row of horizontally disposed tubes 17, is located in cell 11 adjacent the inner surface of wall 2. Another bank 18, comprising in the case illustrated a single substantially vertical row of horizontally disposed tubes 19, is located within cell 12 adjacent wall 8 and a similar bank 20 of tubular fluid conduits 21 is disposed in cell 12 adjacent wall 9. Another bank 22, comprising in this instance two substantially parallel rows of horizontally disposed tubes 23 is located adjacent and substantially parallel to the sloping wall 3. Another bank 24, comprising in this instance a single row of horizontally disposed tubes 25, is located adjacent and substantially parallel to the sloping wall 4. Another tube bank 26, comprising a plurality of superimposed rows of horizontally disposed tubes 27, is located in the fluid heating zone 28 defined between walls 5 and 6.

The entire furnace structure is mounted upon a suitable foundation which, in this instance, comprises a vertical wall 29 disposed beneath each of the walls 1, 2, 8 and 9, a floor 30 disposed beneath and spaced from the refractory floor 7 and suitable footings, not illustrated. Burner compartments 31, 32 and 33, individual to the respective combustion and heating zones 10, 11 and 12, are provided between floors 7 and 30 and between the foundation walls 29. An opening 42 is provided in each of the outer foundation walls 29 beneath walls 1 and 2 and openings 47 and 48 are provided through the foundation walls 29 beneath walls 1 and 8 respectively. A partition 35 separates the space between the partition walls 29 beneath walls 1 and 8 and between floors 7 and 30 into the upper burner compartment 31 and a lower compartment which communicates with burner compartment 33 through opening 48.

A horizontal row of burners, one of which is indicated at 37, is provided within burner compartment 31 and these burners communicate with combustion and heating zone 10 through firing ports 38 provided in floor 7 adjacent the lower end of wall 8. Fuel is supplied to each of the burners 37 through a line 39 and control valve 40 and air is admitted in regulated amounts to burner compartment 31 through opening 42 by adjustment of a suitable damper 41 provided at the mouth of the opening. The air thus admitted to compartment 31 passed through burners 37 to mix with the fuel and form a combustible mixture which is projected upwardly into zone 10 and burned adjacent the surface of wall 8 within this zone. The flames and hot combustion gases issuing from burners 37 and burner ports 38 are directed upwardly at an angle against and over the surface of wall 8, heating the latter to a highly radiant condition and direct radiant heat is transmitted from wall 8 and from the flames and hot combustion gases passing thereover to one side of the tubes of bank 14. Reflected ra-

diant heat is transmitted from wall 1 to the opposite side of these tubes.

A firing arrangement similar to that above described, with the elements thereof designated in the drawing by the same reference numerals 37 to 41 inclusive, is provided for cell 11, which is fired independently of cell 10 and wherein direct radiant heat is transmitted from the hot refractory surface of wall 9 within this zone and from the flames and hot combustion gases passing over the surface of wall 9 to one side of the tubes of bank 16. The opposite side of these tubes is heated by reflected radiation from wall 2.

Another horizontal row of burners, one of which is indicated at 43, is provided in burner compartment 33 for directing flames and hot combustion gases upwardly into zone 12 through firing ports 44 provided in floor 7 substantially midway between walls 8 and 9. Fuel is supplied to each of the burners 43 through a line 45, controlled by valve 46, and air for combustion of the fuel is admitted in regulated amounts to burner compartment 33 about damper 49 and through the openings 47 and 48 and the space beneath partition 35. The air thus admitted to compartment 33 passes through burner 43 to mix therein with the fuel and form a combustible mixture containing any desired amount of excess air.

The flames and hot combustion gases projected upwardly through zone 12 from burners 43 and firing ports 44 supply direct radiant heat to one side of the tubes of banks 19 and 20 and reflected radiant heat is supplied to the opposite side of these tubes from the respective adjacent walls 8 and 9.

Combustion gases which have given up a substantial portion of their heat to the respective tube banks 14, 16, 18 and 20 are discharged from zones 10, 11 and 12 into the space between the sloping walls 3 and 4 and supply bottom radiant and convection heat to the tubes of banks 22 and 24. The tubes of each of these banks receive direct radiant heat on one side from the commingled combustion gases from zones 10, 11 and 12 and are heated on their opposite side by reflected radiation from the respective walls 3 and 4. Heating conditions in bank 22 are, of course, influenced to a greater extent by combustion gases from zone 10 than by those from zone 12 and to a still greater extent than by combustion gases from zone 11. On the other hand, the heating conditions obtained in bank 24 are influenced to a greater extent by the combustible gases from zone 11 than by those from zone 12 and to a still greater extent than by combustion gases from zone 10. Thus, a considerable degree of independent control is obtainable over the heating conditions employed in bank 22, as compared with those obtained in bank 24 and vice versa.

The total combustion gases from zones 10, 11 and 12, after supplying heat to the tubes of banks 22 and 24, pass upwardly through fluid heating zone 28 in direct and intimate contact with the tubes of bank 26 and supply a considerable portion of their residual heat thereto. The combustion gases are thence directed through flue 50 to stack 51.

By independently firing each of the zones 10, 11 and 12, entirely independent control is exerted over the heating conditions obtained in each of these zones and, as previously mentioned, a considerable degree of independent control is exerted over the heating conditions prevailing about bank 22 as compared with those prevailing about bank 24. Relatively high rates of heat transmission to the fluid flowing through the tubes is obtainable in each of these zones and an unusually high degree of flexibility with respect to control over the heating conditions in the several zones is provided in this heater. By selection of suitable specific paths of flow for the stream or streams of fluid undergoing heating through the various tube banks and a suitable sequential or parallel arrangement of the tube banks in this flow, a wide variety of heating curves is obtainable for the fluid undergoing treatment and the type of heat treatment desired may be selected to suit requirements. When desired, it is also easy to obtain either a different type of heat treament or substantially the same heat treatment for two or more separate streams of fluid with the heater herein provided.

The invention is not limited to any specific path of flow for the fluid passing through the various tube banks nor to any specific sequence of flow through the several banks. Ordinarily, adjacent tubes in each bank will be connected in series at their ends by suitable return bends or headers, not illustrated, but it is also within the scope of the invention to provide for the parallel flow of separate streams of the same or different fluid through two or more of the tube banks and, when desired, all or various groups of the tubes in each of any bank may be connected for the parallel flow of separate streams of fluid therethrough. It is also within the scope of the invention to dispose the individual tubes of any or all of the various banks adjacent the side and interior walls of the heater in a vertical rather than a horizontal position and the tubes in either or both of the banks adjacent the sloping walls may extend lengthwise from adjacent the top to adjacent the bottom of the sloping wall rather than from end to end thereof.

The invention also specifically contemplates the substitution of a single row of tubes for the two row arrangement adjacent wall 1 or adjacent wall 3, or both, and, when desired, a two row arrangement similar to that shown adjacent walls 1 and 3 may be substituted in any or all of the banks 16, 18, 20 and 24 for the single row arrangement illustrated.

Although the specific form of heater illustrated in the drawing is up-fired with a general upward flow of combustion gases throughout the heater, it is entirely within the scope of the invention to invert the furnace structure and fire in a downward direction with a general downward flow of combustion gases through the heater.

As previously mentioned, a wide variety of advantageous flow arrangements is possible in the improved form of heater herein provided and these may be selected, within the skill of one familiar with the art, and correlated with the firing conditions employed in the independently fired combustion and heating zones, to suit requirements.

I claim as my invention:

1. A heater for fluids comprising, in combination, substantially vertical refractory side walls, substantially vertical refractory interior walls spaced from each other to provide a combustion and radiant heating zone therebetween and spaced from the side walls to provide a separate combustion and radiant heating zone between each side wall and the adjacent interior wall, a substantially vertical bank of tubular fluid conduits disposed adjacent each of the interior walls

in the first mentioned combustion zone, firing means for said first mentioned combustion zone comprising burners disposed adjacent one end thereof for directing flames and hot combustion gases vertically therethrough between said interior walls in direct heat transmitting relation to said fluid conduits therein, a substantially vertical bank of tubular fluid conduits disposed in each of the second mentioned combustion zones adjacent one of said refractory walls thereof and independent firing means for each of said second mentioned combustion zones comprising burners disposed adjacent one end of that refractory wall thereof opposite the tube bank disposed therein for directing flames and hot combustion gases vertically therethrough over the surface of said wall whereby to transmit radiant heat from said wall and from the flames and hot combustion gases passing thereover to the fluid conduits therein, a combustion gas discharge passageway in vertical alignment with the heating zone between said interior walls, inclined refractory walls extending from said side walls to said passageway, heating tubes disposed adjacent said inclined walls, and means for directing combustion gases from said heating zones in heat transfer relation to the tubes adjacent said inclined walls and thence to said passageway.

2. A heater for fluids comprising, in combination, substantially vertical refractory side walls, end walls and a floor defining the lower portion of the heater, upwardly and inwardly sloping refractory walls extending from said side walls to other refractory side walls, a fluid heating zone disposed between the last named side walls, a pair of substantially vertical interior walls disposed substantially parallel to the side walls and spaced apart to provide a centrally disposed combustion and radiant heating zone therebetween, said interior walls also being spaced from the side walls to provide a separate combustion and radiant heating zone between each of the first named side walls and the adjacent interior wall, a substantially vertical bank of tubular fluid conduits disposed adjacent the surface of each of said interior walls within said central heating zone, a substantially vertical bank of tubular fluid conduits disposed adjacent each of the first named side walls in said separate combustion zones, a bank of tubular fluid conduits disposed adjacent and substantially parallel to each of said sloping walls, a bank of tubular fluid conduits in said fluid heating zone, firing means for said central zone comprising burner ports in said floor and burners for projecting flames and hot combustion gases centrally upward into said central zone and therethrough in direct radiant heat transmitting relation with the tubular elements of said tube banks adjacent the interior walls, independent firing means for each of said separate combustion zones comprising burner ports in the floor adjacent the base of each of said interior walls and burners for projecting flames and hot combustion gases over the surface of the interior walls in direct radiant heat transmitting relation to the tubes of said banks adjacent the side walls, means for directing combustion gases from said central zone and from each of said separate combustion zones through the space between said sloping walls in heat transfer relation to the tubular elements of said banks adjacent the latter and therefrom through said fluid heating zone in direct contact with the tubular elements of said bank disposed therein.

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