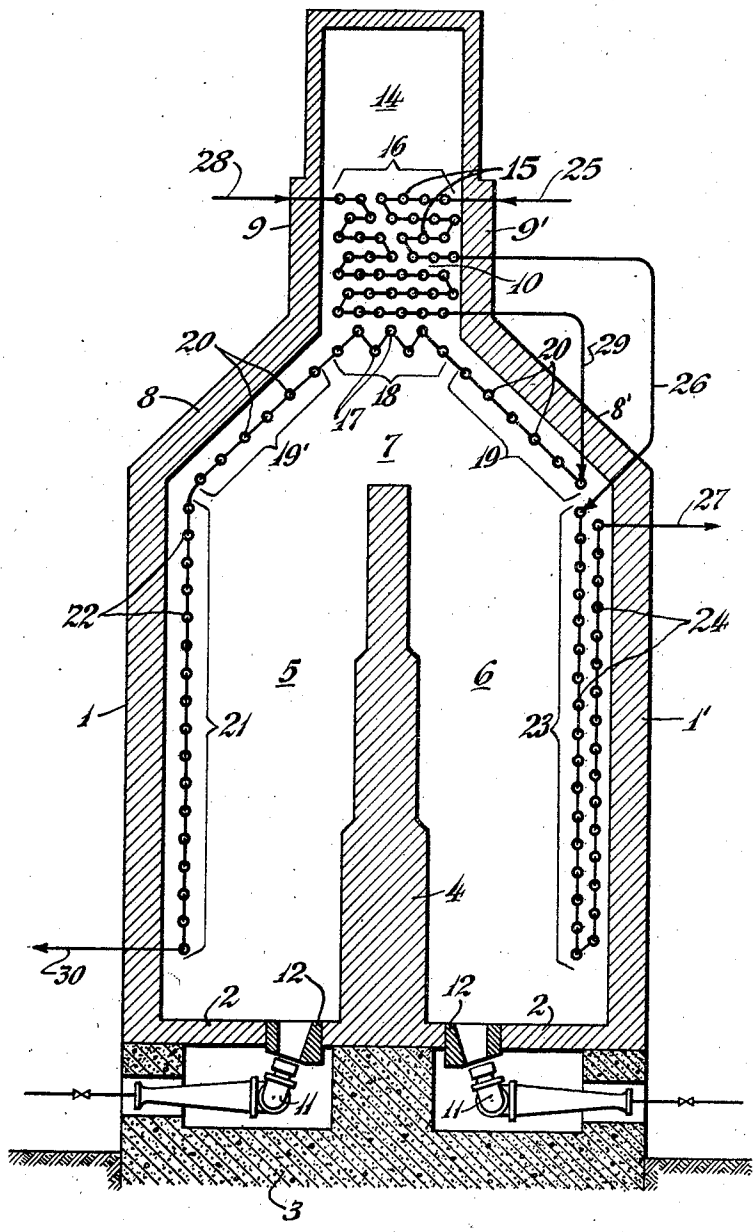
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HEATING OF FLUIDS

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HEATING OF FLUIDS

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The invention is directed to the heating of hydrocarbon oils to the high temperatures required for their pyrolytic conversion and particularly relates to an improved form of heater adapted to accomplish the simultaneous conversion of separate streams of oil under independently controlled heating conditions.

The features and advantages of the invention will be apparent to those familiar with the art with reference to the accompanying diagrammatic drawing and the following description thereof. The drawing is a cross-sectional elevation of a heater embodying the features of the invention.

Referring to the drawing, the heater here illustrated has refractory side walls 1 and 1', a refractory floor 2, a foundation 3, a central refractory wall 4 resting on the foundation and extending vertically upward within the furnace between the refractory end walls which do not appear in the view here illustrated.

The central wall 4 divides the lower portion of the heater into separate combustion and heating zones 5 and 6. These zones merge above wall 4 in a space 7 defined by the end walls of the heater, not illustrated, and the inwardly sloping walls 8 and 8'. The sloping walls 8 and 8' connect at their lower ends with walls 1 and 1', respectively, and are connected at their upper ends with the respective substantially vertical walls 9 and 9' which, together with the end walls of the heater, define a fluid heating zone 10 of smaller cross-sectional area than the lower portion of the heater and disposed centrally above wall 4.

A row of burners 11 disposed beneath floor 2 and adjacent opposite sides of the refractory central wall 4 communicate through firing ports 12, provided in the floor, with the combustion and heating zones 5 and 6. Flames and hot combustion gases issuing from the burners are directed in a substantially continuous sheet against opposite sides of wall 4 and travel upwardly thereover to heat the same to a highly radiant condition. Heat is transmitted from the flames and hot combustion gases and from the hot refractory faces of wall 4 to walls 1 and 1' and to the surface of tubular elements disposed, as will be later described, adjacent walls 1 and 1'. The resulting combustion gases from which substantial quantities of radiant heat have been extracted pass from combustion and heating zones 5 and 6 into zone 7 wherein they commingle and supply heat to the tubular elements disposed adjacent the sloping walls 8 and 8' and the commingled combustion gases thence pass upwardly through fluid heating zone 10 and supply heat to the fluid conduits disposed in this zone by direct contact therewith, the gases finally being discharged from the heater through flue 14 to a suitable stack, not illustrated.

A plurality of horizontal rows of horizontally disposed tubular elements 15 are disposed in fluid heating zone 10 and comprise tube bank 16 which is divided, as will be later explained, into separate portions for separate heating of the two streams of oil undergoing treatment.

Immediately beneath tube bank 16 at the inlet of fluid heating zone 10, two horizontal rows of horizontally disposed tubular elements 17 are provided and form a relatively small bank 18 of tubes which are heated appreciably by both radiation and convection.

A single row 19 of horizontally disposed tubular elements 20 is located adjacent the inner surface of sloping wall 8' of the heater and a similar single row 19' of horizontally disposed tubes is located adjacent the inner surface of the opposite sloping wall 8. The tubular elements of banks 19 and 19' are heated to a considerable degree by radiation and convection from the gases supplied to zone 7 from zones 5 and 6.

A single horizontal row 21 of horizontally disposed tubes 22 is located adjacent the inner surface of wall 1. One side of each of the tubular elements of this bank receives heat by direct radiation from the flames and hot combustion gases and the hot refractory surface of wall 4 and the opposite side of each of these tubes receives reflected heat from the surface of wall 1.

A separate bank 23 comprising two substantially parallel vertical rows of horizontally disposed tubes 24 is located adjacent the inner surface of the refractory side wall 1'. Adjacent tubes in the inner and outer rows of bank 23 are arranged in staggered formation so that one side of each tube receives radiant heat directly from the flames and hot combustion gases and the refractory surface of wall 4, while the opposite side of each of the tubes receives reflected heat from the surface of wall 1'. However, the tubes in the row of bank 23 closest to side wall 1 are partially shielded from direct radiation on one side by the adjacent tubes of the other row and since wall 1' is shielded by two rows of tubes rather than one it will not act as a re-radiator to the same degree as wall 1 which is shielded by only on row of tubes. Thus, the row of tubes of bank 23 closest to wall 1' will be exposed to substantially less severe heating conditions than the tubes in the other row of this bank and may advantageously be em-

ployed, as herein provided and subsequently described, as a soaking section wherein light distillates, such as gasoline, gasoline fractions or naphtha, to be reformed may, after passing through a preceding portion of the heating coil, be maintained for a predetermined time at or near the maximum temperature previously attained.

As previously mentioned, the specific form of heater herein provided is adapted to separately heat two separate streams of hydrocarbon oil to conversion temperature. One of said streams comprises a light distillate, such as gasoline, gasoline fractions or naphtha. This stream, indicated at 25 in the accompanying diagram, is supplied to the upper portion of tube bank 16 and flows in series through a portion of the tubular elements in the uppermost rows in this bank in a general downward direction countercurrent to the general direction of flow of the combustion gases through zone 10 and is thence transferred through line 26 to the exposed row of tubes of bank 23, flowing downwardly in series through the adjacent tubes of this row and thence upwardly in series through the adjacent tubes in the shielded row of bank 23, wherefrom the resulting heated products are discharged through line 27 to suitable separating and recovery equipment not pertinent to the invention and therefore not illustrated.

The other stream of oil to be converted, which is an oil of higher boiling characteristics than the gasoline or naphtha to be reformed and may comprise, for example, kerosene, kerosene distillate, gas oil, light fuel oil or the like, is separately supplied through line 28 to the upper portion of tube bank 16 and in the upper rows of this bank flows in series through the tubes not utilized for heating the first named stream in a general downward direction and thence passes in series through adjacent tubes in each row and adjacent rows of tubes in the lower portion of bank 16 wherefrom it is directed through line 29 to the lowermost tube of bank 19, flowing upwardly in series through the adjacent tubes in this bank to bank 18 wherethrough it passes in series through adjacent tubes in the opposite rows of this bank and is thence directed downwardly in series through adjacent tubes of bank 19'. It finally passes downwardly in series through the adjacent tubes of bank 21 and is discharged from the lowermost tube of this bank through line 30 to suitable separating and recovery equipment not pertinent to the present invention and not illustrated.

With the general form of heater, arrangement of tubular elements therein and flow through the tubular elements, as above described, the light distillate cracking stock to be reformed is heated to below an active cracking temperature in that portion of bank 16 through which it first passes, attains its maximum cracking temperature or a temperature closely approaching the maximum as it flows through the exposed row of bank 23 and is afforded soaking time in the shielded row of bank 23. The stream of heavier hydrocarbon oil to be converted is subjected to progressively increasing rates of heating and attains its maximum cracking temperature at substantially its point of discharge from tube bank 21. By independently controlling the firing conditions in zones 5 and 6, independent control is exerted over the heating conditions to which each of the separate streams of oil is subjected in the portions of the fluid conduits wherein active cracking occurs and wherein the temperature conditions are critical and, with the flows illustrated and described, the type of heating curve most suitable for effecting the desired conversion of each of said separate streams of oil may be obtained.

I claim as my invention:

1. A heater for fluids comprising, in combination, side and end walls defining the lower portion of a furnace, a central wall dividing said lower portion of the furnace into separate combustion zones, a pair of conversion walls defining the upper portion of the combustion zones, a fluid conduit comprising a substantially vertical row of horizontally disposed tubes located adjacent the inner surface of one of said side walls, a second fluid conduit comprising a plurality of substantially vertical rows of horizontally disposed tubes located adjacent the inner surface of the other side wall, a third fluid conduit comprising tubes adjacent each of said converging walls, means for directing flames and hot combustion gases upwardly through said combustion zones over opposite faces of said central wall, a fluid heating zone disposed above said central wall and in communication with said separate combustion zones, a fluid conduit comprising a plurality of rows of horizontally disposed tubes located within said fluid heating zone in the path of travel of combustion gases passing therethrough from said separate combustion zones, means for passing a stream of fluid to be heated in series through a portion of the tubes of the last named fluid conduit and thence in series through the tubes of said second fluid conduit and means for passing a separate stream of fluid to be separately heated through the remainder of the tubes of said last named fluid conduit, then through the tubes of said third conduit and thereafter in series through the tubes of the first named fluid conduit.

2. A heater for fluids comprising, in combination, side and end walls defining the lower portion of a furnace, a central wall dividing said lower portion of the furnace into separate combustion zones, a fluid conduit comprising a single substantially vertical row of horizontally disposed tubes located adjacent the inner surface of one of said side walls, another fluid conduit comprising a plurality of substantially vertical rows of horizontally disposed tubes located adjacent the inner surface of the other side wall, means for directing flames and hot combustion gases upwardly through said combustion zones over opposite faces of said central wall, a fluid heating zone of smaller cross-sectional area than said lower portion of the furnace disposed above said central wall and communicating with said separate combustion zones, a fluid conduit comprising a plurality of rows of horizontally disposed tubes located within said fluid heating zone, side and end walls defining said fluid heating zone, sloping walls connecting said side walls of the lower portion of the furnace with said side walls of the fluid heating zone, tubes disposed adjacent said sloping walls, means for directing a stream of fluid to be heated through a portion of the tubes of the fluid conduit in said fluid heating zone and thereafter in series through adjacent rows of tubes and adjacent tubes in each row of the second named fluid conduit, means for passing a separate stream of fluid to be separately heated through the remainder of the tubes in the fluid heating zone, thereafter in series through the tubes adjacent

said sloping walls and finally in series through the tubes of the first named fluid conduit.

3. A heater for fluids comprising, in combination, side and end walls defining the lower portion of a furnace, a central wall dividing said lower portion of the furnace into separate combustion zones, a fluid heating zone of smaller cross-sectional area than said lower portion of the furnace disposed above and spaced from said central wall and communicating with said separate combustion zones, side and end walls defining said fluid heating zone, sloping walls connecting the side walls of said lower portion of the furnace with the side walls of said fluid heating zone, means for directing flames and hot combustion gases upwardly through said combustion zones over the opposite faces of said central wall, means for directing combustion gases from said separate combustion zones through the space between said central wall and the fluid heating zone to and through the fluid heating zone, a fluid conduit comprising a plurality of rows of horizontally disposed tubes located within said fluid heating zone, a second fluid conduit disposed within the space between said central wall and said fluid heating zone, a portion of said second fluid conduit comprising horizontally disposed tubes located adjacent said sloping walls and another portion thereof comprising horizontally disposed tubes located immediately beneath said fluid heating zone, a third fluid conduit comprising at least one substantially vertical row of horizontally disposed tubes located adjacent one of said side walls of the lower portion of the furnace, a fourth fluid conduit comprising a substantially vertical exposed row and a substantially vertical shielded row of horizontally disposed tubes located adjacent the other side wall of said lower portion of the furnace, means for directing a stream of fluid to be heated in series through a portion of the tubes of the first named fluid conduit, thence in series through adjacent tubes in the exposed row of the last named fluid conduit and finally in series through adjacent tubes of the shielded row of the last named fluid conduit, means for passing a separate stream of fluid to be separately heated through the remainder of the tubes of the first named fluid conduit, thence in series through the tubes of the second named fluid conduit and finally in series through the tubes of said third fluid conduit.

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