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HEATING HYDROCARBON FLUIDS

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FIG.1.

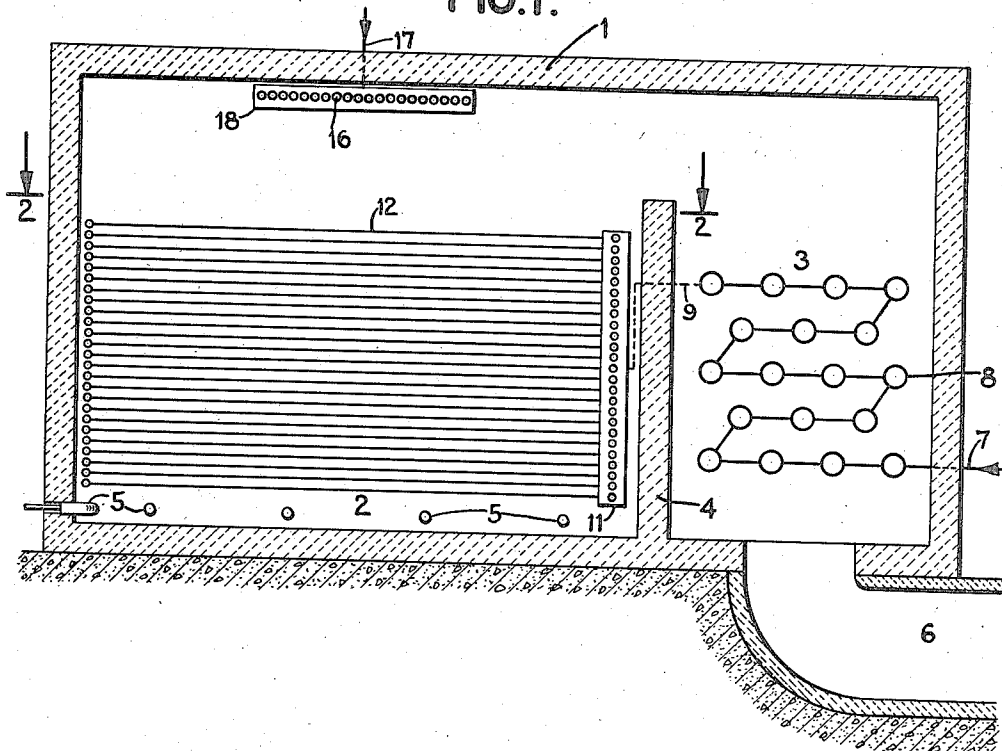
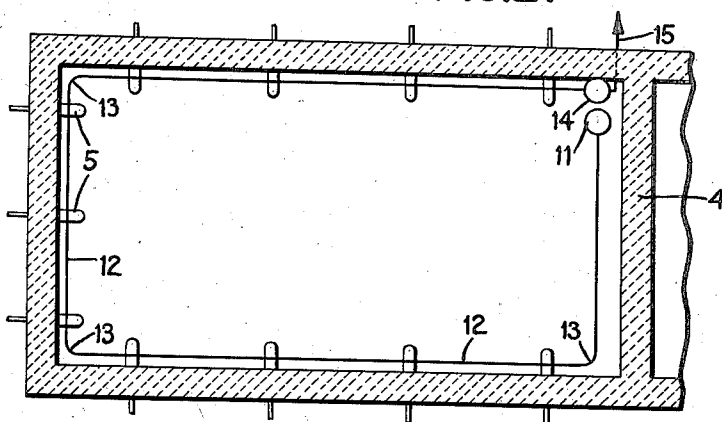


FIG.2.



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HEATING HYDROCARBON FLUIDS

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2 Claims. (Cl. 196—47)

This invention relates in general to the heating of hydrocarbon fluids and more especially to heating hydrocarbon fluids to elevated temperatures in a rapid manner by providing a large ratio of heating surface to the volume of hydrocarbon fluid being heated.

More specifically, this invention relates to improvements in heating hydrocarbon fluids in an apparatus wherein a multiplicity of parallel paths are provided for a stream of hydrocarbon fluid to thereby greatly increase the amount of heating surface available for a given quantity of fluid being heated at any one time.

In the heating of hydrocarbon fluid to elevated temperatures, such as cracking temperatures, it is often desirable to heat the fluid to the required temperature as rapidly as possible. By rapidly heating the hydrocarbon fluid to the desired temperature, it is possible to carry out the desired reaction without the disadvantages that might flow from continuously heating the hydrocarbon fluid, to the desired temperature for a prolonged period of time.

In accordance with my invention, a stream of hydrocarbon fluid is preferably preheated to an elevated temperature, but to a temperature where inappreciable cracking occurs. This heating may be accomplished in a convection heating chamber of a furnace receiving combustion gases from the combustion or radiant heating chamber. The combustion or radiant heating chamber, as contemplated by my invention, is provided with a multiplicity of heat-absorbing tubes on each wall which cover at least a portion of each wall and preferably the majority thereof, with all of the tubes on any one wall being connected in parallel.

The preheated stream of hydrocarbon fluid from the convection heating chamber is introduced, as contemplated by my invention, into a manifold which is connected with the parallel arranged tubes in the combustion chamber. The hydrocarbon fluid flows from the manifold in a multiplicity of much smaller streams, as determined by the number of tubes connected in parallel to the manifold, through the combustion or radiant heating chamber. By dividing the main stream of hydrocarbon fluid into a multiplicity of smaller streams for passage, say once, in small tubes around the combustion chamber, there is provided a much larger ratio of tube surface, that is, heating surface, to tube volume, that is, volume of hydrocarbon fluid in any one tube, which results in much more rapid heating of the hydrocarbon fluid than

would be the case if the preheated stream was caused to flow progressively and serially through larger tubes arranged on the walls and/or roof of the combustion chamber in the conventional manner in order to accomplish the desired heating of said hydrocarbon fluid. It will thus be apparent that each of the multiplicity of small streams is individually heated to an elevated temperature during the passage of each stream in the tubes around the walls defining the combustion or radiant heating chamber.

My invention further contemplates a plurality of tubes connected in parallel and disposed upon the roof of the combustion or radiant heating chamber. These roof tubes are preferably utilized for passing a second stream of oil there-through to be heated to the desired elevated temperature, the same fundamental principle being applied to this stream as the other, that is, providing a large ratio of heating surface to hydrocarbon fluid volume to thereby make possible the more rapid heating of this stream of hydrocarbon fluid.

In order to make my invention more clearly understood, I have shown in the accompanying drawing, means for carrying the same into practical effect without limiting the improvements in their useful application to the particular construction which, for purposes of explanation, has been made the subject of illustration.

In the drawing:

Figure 1 is an elevational view, partly in section, of an apparatus embodying my invention.

Figure 2 is a plan view of part of the apparatus taken along line 2—2 of Figure 1.

Referring to the drawing wherein like parts in the two views are designated by the same characters, and more particularly to Figure 1, there is shown a furnace setting 1 having a combustion or radiant heating chamber 2 and a convection heating chamber 3, the chambers 2 and 3 being separated from each other by a bridge wall 4. The combustion chamber 2 is provided with a plurality of burners 5 disposed in any suitable manner but preferably in the two side walls and the end wall thereof. The hot products of combustion produced by the burners 5 pass upwardly through the chamber 2, over the bridge wall 4, through the convection heating chamber 3 and are withdrawn from the convection heating chamber 3 through a flue 6 leading to a suitable stack, not shown.

Hydrocarbon fluid to be heated to an elevated temperature is introduced into a line 7 from which it is passed to a plurality of interconnected

tubes 8 disposed in the convection heating chamber 3 in such a manner as to be swept by the hot combustion products passing therethrough. The individual tubes 8 have been shown as connected in series, although it is to be clearly understood that these tubes may be connected in parallel if desired. The hydrocarbon fluid passing through the heat-absorbing tubes 8 is preheated therein to an elevated temperature, preferably to a temperature where inappreciable cracking occurred. The thus preheated hydrocarbon fluid after passing through the heat-absorbing tubes 8 is conducted by means of a line 9 to the combustion chamber 2.

The hydrocarbon fluid passing through the line 9 is introduced into a manifold 11 shown as positioned in the combustion chamber 2, although it may be outside thereof. The combustion or radiant heating chamber 2 is provided with a multiplicity of heat-absorbing tubes 12, preferably of small internal diameter, which extend around the four walls of the combustion chamber 2 to form a heating coil. As contemplated by my invention, the tubes on each wall which form a part of the coil section are connected in parallel, that is, the hydrocarbon fluid introduced into the manifold 11 is divided into a plurality of streams, each of which passes through an individual tube 12. The tubes 12 forming the continuous path for each parallel path of hydrocarbon fluid are connected at the corners of the furnace setting by suitable 90° return bends 13. It will be evident from the foregoing that the oil leaving the manifold 11 is divided into a multiplicity of parallel streams for passage through the tubes 12 extending once around the combustion chamber 2. By dividing the main stream of hydrocarbon fluid into a multiplicity of parallel streams in the manner shown, there is provided a much larger ratio of heating surface to hydrocarbon fluid volume than would otherwise be the case.

The hydrocarbon fluid after passing as separate streams through the parallel tubes 12 on the back wall of the furnace is conducted to a manifold 14, also shown as positioned within the combustion chamber 2 although it may be on the outside, wherein it may be quenched, from which the heated stream of hydrocarbon fluid is withdrawn through a line 15 for passage to other equipment, such as a soaking chamber or evaporator, for further treatment.

The hydrocarbon fluid passing through the heat-absorbing tubes 12 is rapidly heated to an elevated temperature, such as to the desired cracking temperature, preponderantly by the radiant heat absorbed by the tubes.

It will be noted that the parallel arranged tubes on each of the walls defining the combustion chamber cover the majority thereof and all of the tubes on any one wall are connected in parallel. It will be apparent that the furnace setting may be enlarged in order to provide sufficient space for another heating coil similar to the heating coil composed of the tubes 12 but disposed either above or below the tubes 12. Thus it will be possible in accordance with this modification to provide still added heating surface for the hydrocarbon fluid being treated.

My invention further contemplates the heating of a second stream of hydrocarbon fluid in the apparatus described. As shown, there is provided a multiplicity of roof tubes 16 connected in parallel. This group of tubes is connected to a manifold at each end thereof, the stream of

fluid flowing in parallel paths through these tubes.

The second stream of hydrocarbon fluid may be passed through a line 17 into a manifold 18 disposed adjacent the roof and the side wall of the furnace setting shown in Figure 1. This stream of hydrocarbon fluid is divided into a multiplicity of parallel streams for passage through the tubes 16. From the tubes 16 the parallel streams enter a manifold, not shown, but similarly disposed on the other side of the furnace setting, and in which the hydrocarbon fluid may be quenched. From this manifold the hydrocarbon fluid is conducted through a line, not shown, to suitable equipment, such as an evaporator or a soaking chamber for further treatment.

The second stream of fluid passing through the groups of parallel connected tubes 16 is heated to elevated temperature preponderantly by the radiant heat absorbed by these tubes, although it will be evident that these tubes also receive some convective heat.

If desired, separate groups of parallel connected tubes disposed adjacent the roof of the chamber 2 may be provided each group for a manifold at each end, and the groups connected between manifolds by a suitable line.

If desired the group of roof tubes 16 may be dispensed with thereby leaving the roof of the furnace bare. By having both a bare roof and a bare floor, it will be evident that reflected or re-radiated heat from both of these surfaces is possible. Consequently the group of parallel arranged tubes 12 receives not only the direct radiation from the products of combustion passing through the combustion chamber 2 but also re-radiation from both the floor and roof of the furnace setting.

When the groups of tubes 16 are not included in a heating apparatus in accordance with my invention, the parallel arranged tubes 12 on the four walls of the combustion chamber 2 may be arranged around the horizontal axis of this chamber instead of the vertical axis as shown. Thus, these groups of tubes may be disposed on the floor and roof of the combustion chamber connected by vertical tubes on each of the side walls. With this arrangement, as in the other, all of the tubes are connected in parallel so that the hydrocarbon fluid passes only once around the combustion chamber. It will be apparent with this arrangement that the front wall and the bridge wall are bare, burners being disposed in the front wall with the products of combustion traveling horizontally from the burners to the bridge wall, thus exposing all the tubes to substantially the same degree of heat. The bridge wall may be provided with suitable openings for passage of the products of combustion to the convection heating chamber.

In operating in accordance with my invention, a relatively clean gas oil stock may be passed through the preheating tube 8 and therein raised to a temperature short of cracking, say to a temperature of about 800° F. or above. The oil after being preheated in the tubes 8 is passed through the parallel connected tubes 12 wherein it is rapidly raised to a high cracking temperature, such as to a temperature about 1100° F. or higher, preponderantly by radiant heat absorbed by these tubes. Preferably this stream of oil is maintained under a super-atmospheric pressure, for example, from 750 to 4500 pounds per square inch.

A second stream of oil, such as a reduced crude, 75

preferably preheated, may be introduced into the line 17 and passed through the groups of parallel connected tubes 16 to therein be raised to a temperature sufficiently high to accomplish the desired viscosity breaking thereof, as for example, to a temperature of about say 925° F. while being maintained under a pressure of, say, from 50 to 750 pounds per square inch.

It will be noted that my invention avoids connections between the heating coil on the four walls of the combustion chamber and the heating coil adjacent the roof. While a connection may be provided for conveying the hydrocarbon fluid from the four wall heating coil to the roof heating coil, or vice-versa, I prefer not to make such provision in view of the uncontrolled cracking that may take place in such a connection with the resultant coke deposition therein.

The number of parallel tubes 12 comprising the heating coil in the chamber 2 may be varied depending on the amount of heating surface required to raise the oil to a given temperature in a specified time. While I have shown a certain number of parallel connected tubes on each wall, this is merely for illustrative purposes. For instance, the number of parallel connected tubes may vary considerably as from about 20 or 30 to about 150 or more.

It may be desirable in some instances to dispose a group of tubes connected in parallel on only part of the walls in the combustion chamber. For instance, parallel connected tubes may be disposed on only two of the walls, the other two being left bare, or if desired, all of the walls may be covered at least in part with parallel connected tubes and a separate stream of hydrocarbon fluid passed through the tubes on one or more of the walls.

From the foregoing it will be readily appreciated that the various streams of oil heated in an apparatus of the type shown are heated at a much more rapid rate than otherwise would be the case. By providing a multiplicity of parallel tubes, a much larger ratio of tube surface to tube volume is made possible, thereby greatly increasing the rate of heat input to the oil.

The tubes in the combustion chamber 2 are preferably of small internal diameter. For instance, in constructing an apparatus of the type shown, tubes having an internal diameter of about three-eighths of an inch to one inch or higher may be used.

Obviously many modifications will suggest themselves to those skilled in the art, and my invention should be limited only by the limitations imposed in the appended claims, where the true scope thereof is defined.

I claim:

1. The method of heating hydrocarbon fluids to a cracking temperature in an apparatus comprising a combustion chamber, a separate convection heating chamber supplied with furnace gases from the combustion chamber, a single-passage heating coil disposed in the convection heating chamber, and a parallel-passage heating coil disposed in a horizontally arranged bank within the space constituting the combustion chamber about the walls thereof and substantially out of the path of the convection gases flowing to the convection chamber, each of the tubes of which parallel-passage heating coil is of smaller cross-sectional area than that of the single-passage heating coil, that comprises first heating the hydrocarbon fluid in a single continuous stream in the single-passage heating coil in said convection heating chamber and thereafter dividing all of the stream from the convection heating chamber directly into a plurality of continuous streams flowing through the tubes of the parallel-passage heating coil, so that the hydrocarbon fluid flowing in parallel streams in the tubes entirely around the walls of the combustion chamber is heated preponderantly by radiant heat in a plurality of parallel streams of reduced cross-sectional area.

2. The method of heating hydrocarbon fluids to a cracking temperature in an apparatus comprising a combustion chamber, a separate convection heating chamber supplied with furnace gases from the combustion chamber, series connected tubes comprising a heating coil disposed in the convection heating chamber, and a parallel-passage heating coil disposed in a bank extending entirely around four of the boundary surfaces of the combustion chamber and substantially out of the path of the convection gases flowing to the convection chamber, each of the tubes of which parallel-passage heating coil is of materially smaller cross-sectional area than the tubes of the first-mentioned heating coil, that comprises first heating the hydrocarbon fluid in the heating coil in said convection heating chamber and thereafter dividing all of said hydrocarbon fluid from the convection heating chamber directly into a plurality of continuous streams flowing through the tubes of the parallel-passage heating coil, so that the hydrocarbon fluid flowing in parallel streams in the tubes entirely around the combustion chamber is heated preponderantly by radiant heat in a plurality of parallel streams of reduced cross-sectional area.

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