Aug. 13, 1940. R. E. WILSON 2,211,708

HEATER CONSTRUCTION

Original Filed Dec. 28, 1933 3 Sheets-Sheet 1

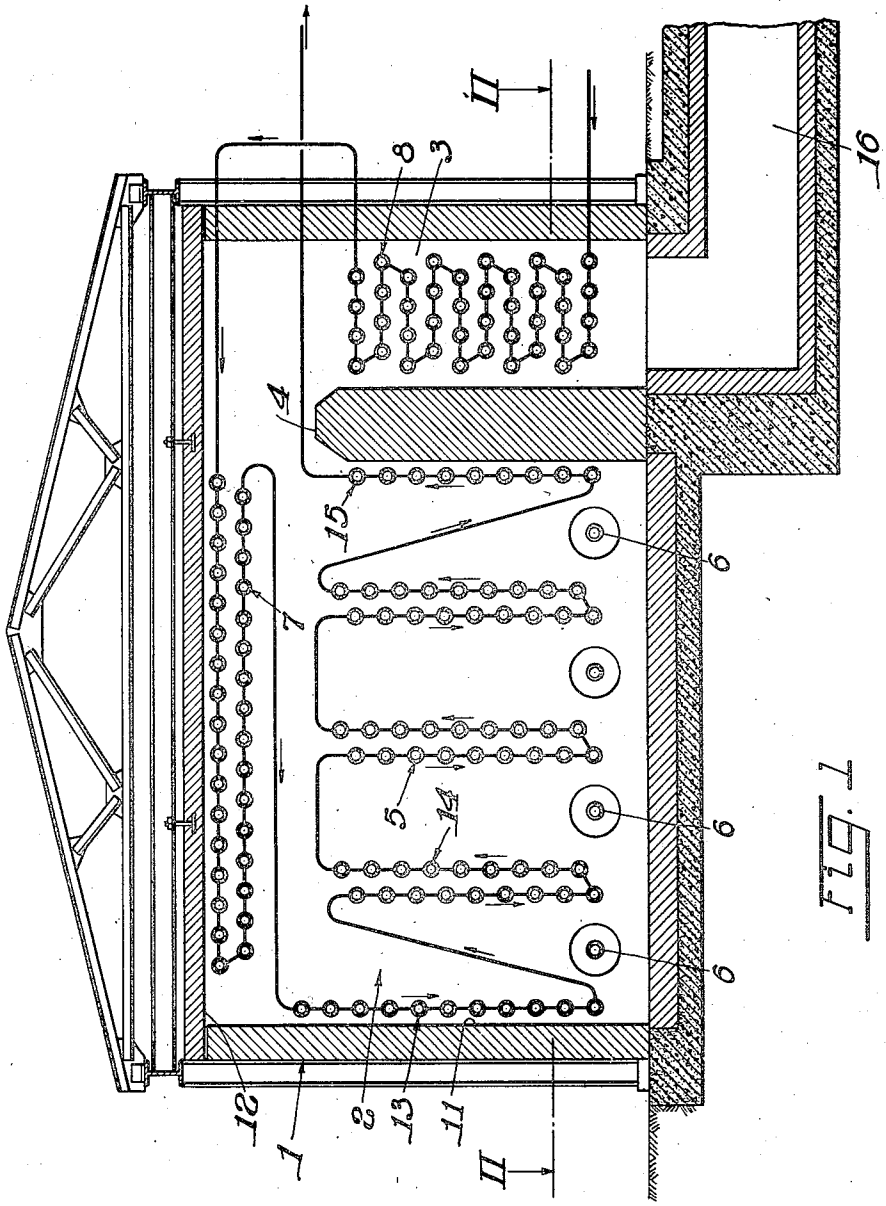

Fig. 1

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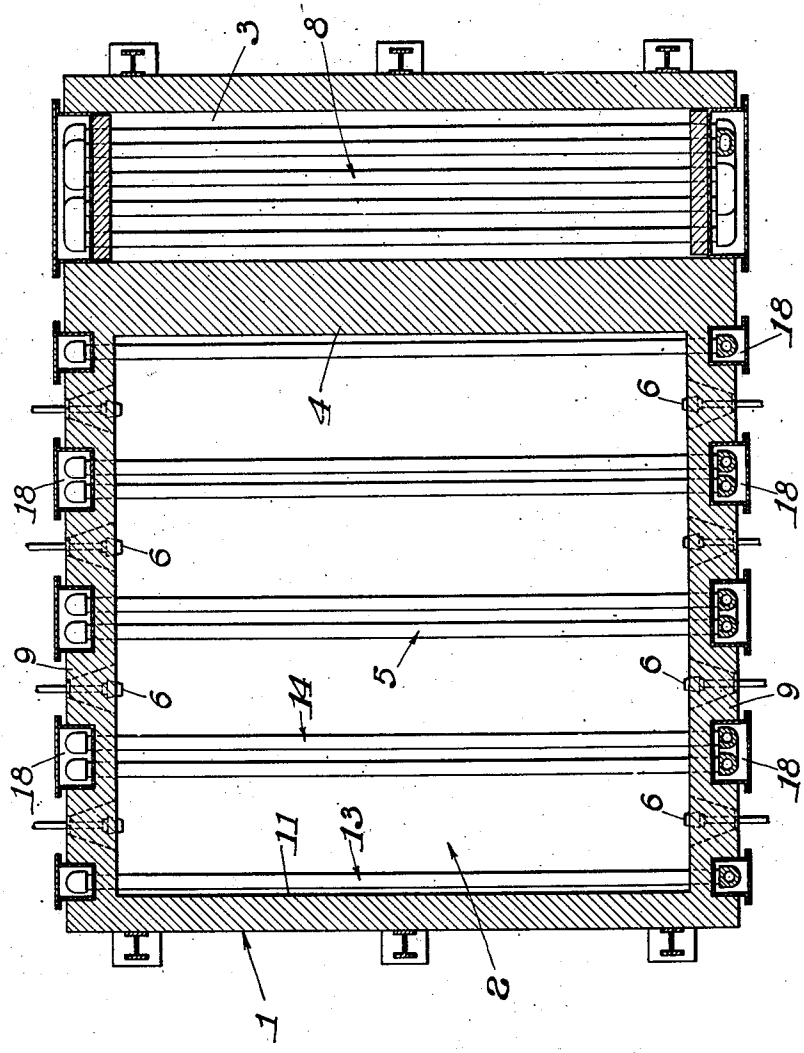

FIG. 2

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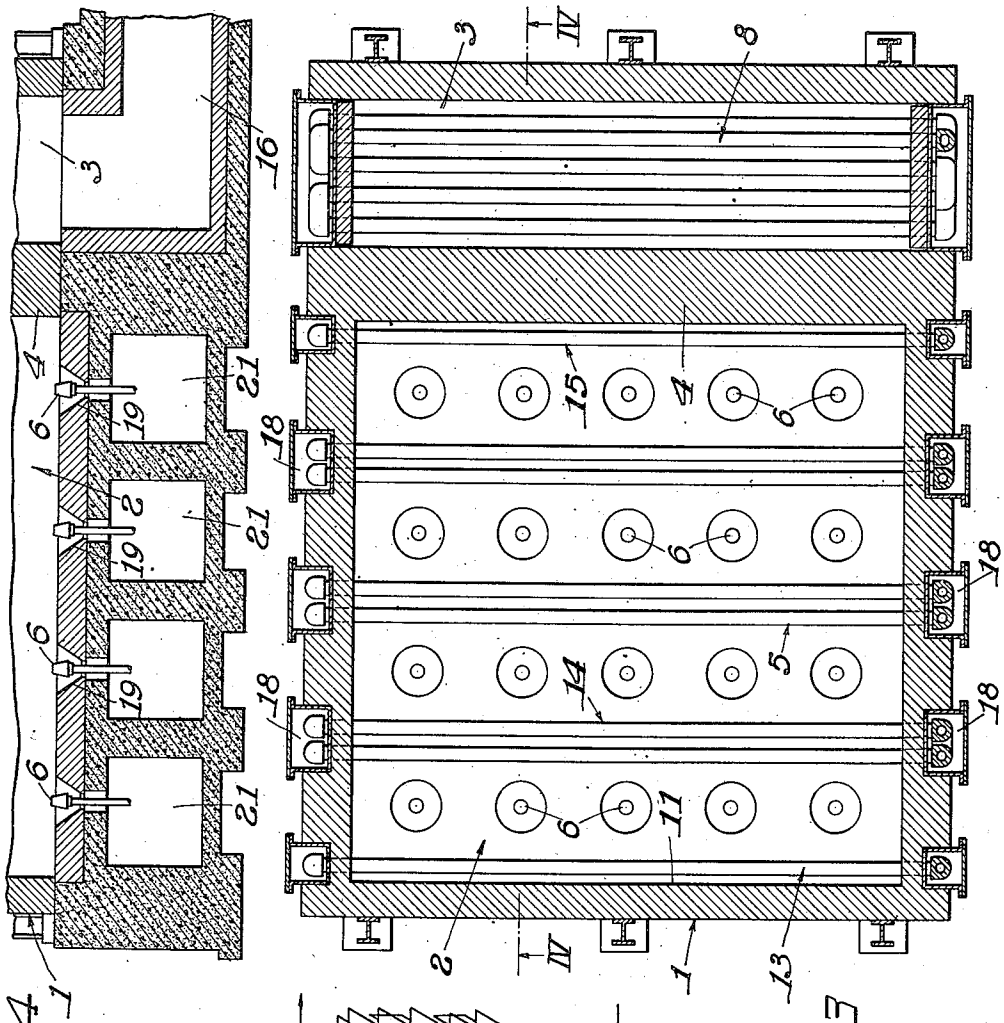

FIG. 4

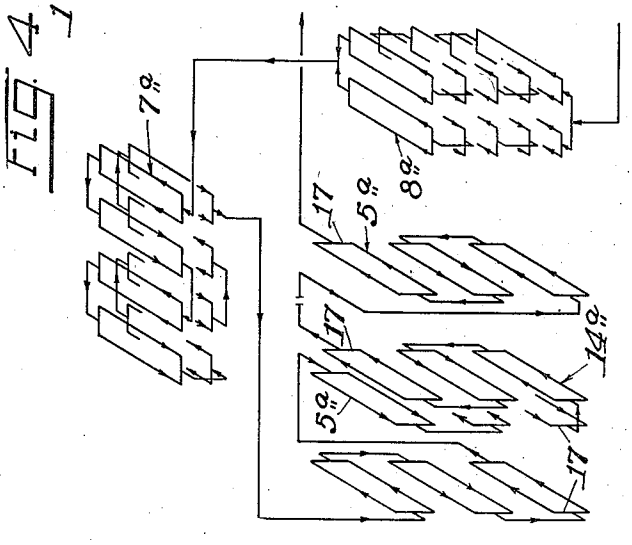

FIG. 5

FIG. 3

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UNITED STATES PATENT OFFICE

2,211,708

HEATER CONSTRUCTION

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Continuation of application Serial No. 704,272, December 28, 1933. This application June 16, 1937, Serial No. 148,556

4 Claims. (Cl. 196—110)

This invention relates to improvements in pipe stills and preheaters and more particularly to apparatus of the type applicable for use in accelerated heating processes such as that involved in the "quick cracking" of hydrocarbons.

An object of my invention is to provide a pipe still or furnace type heater wherein maximum exposure of the tubes in the combustion chamber of the furnace to the radiant heat of the burner flames is attained.

Another object is to provide a pipe still or heater of the character described, incorporating a plurality of radiant tube banks the tubes of which are directly exposed on all sides to the radiant heat of the flame.

A further object is the provision of a still, of the character described, wherein all of the tube headers are readily accessible from a point outside of the furnace walls for cleaning or replacement of the tubes.

Other objects, the advantages, and use of the invention will become more apparent after reading the following specification and appended claims, and after consideration of the drawings forming a part of the specification, in which:

Fig. 1 is a vertical sectional view of a pipe still constructed in accordance with the invention,

Fig. 2 is a sectional view substantially along the line II—II of Fig. 1,

Fig. 3 is a view similar to Fig. 2 of a pipe still illustrating another embodiment of the invention,

Fig. 4 is a fragmentary sectional view along the line IV—IV of Fig. 3, and

Fig. 5 is a diagrammatic view illustrating a modification of the fluid flow circuit disclosed in preceding Figs. 1 to 4 inclusive.

In general the pipe still selected for illustration herein comprises a conventional brick housing 1 providing a combustion chamber 2 and a convection section 3 separated from the combustion chamber by a vertical bridge wall 4, a plurality of vertical banks of radiant tubes 5 in the combustion chamber, groups of burners 6, projecting through the side walls and/or floor of the combustion chamber, between each of the vertical banks of radiant tubes 5, roof tubes 7, and convection or absorption tubes 8 located within the convection section 3.

With reference particularly to Fig. 2 of the drawings, it will be noted that the vertical banks of radiant tubes 5 virtually divide the combustion chamber into a plurality of vertically extending sections. In the present instance I have chosen to arrange the tube banks so as to divide the combustion chamber into four such sections, each having its own array of burners, although it will be apparent that the number of tube banks employed may be varied at will to suit the particular requirements for which the pipe still or furnace is designed.

The burners 6 may be arranged in groups of two for each section of the combustion chamber, one extending through each of the side walls 9 of the combustion chamber. This arrangement of the burners, one at each end of the several combustion sections, serves to provide substantial uniformity of radiant heat to the radiant tubes 5 forming the lateral confines of the so-called sections, thus to aid in the efficient transfer of heat to the fluid and vapor contents of the tubes.

In Fig. 1, I have illustrated an arrangement of the tubes 5 comprising the vertical banks in the radiant or combustion chamber of the furnace whereby each tube may be subjected, without interference from adjacent tubes, to the radiant heat of burners 6 located at opposite sides of the tube. This arrangement is characterized by the staggering of the tubes of one vertical rank, or the bank, with respect to the remaining vertical rank, of the bank, so that a tube in one rank may not have a shielding effect upon any other tube in the adjacent rank. As a result of this arrangement both sides of the tubes in each bank are equally subjected to the direct radiant heat of the adjacent burners with the exception, obviously, of the first and last single tube ranks located adjacent to the forward wall 11 of the combustion chamber and bridge wall 4 respectively.

I have indicated, schematically, in Fig. 1, the flow diagram preferably employed. It will be noted that the input or "fresh feed" enters the furnace tubes through the lowermost of the convection tubes 8, and after passing upwardly through the convection tubes, is conducted through the roof tubes 7, which may be suspended, in the conventional manner, from the roof wall 12 of the furnace, and thereafter through the forward vertical bank 13 of the radiant tubes 5. The course of the fluid through the radiant tubes, as may be seen by the schematically illustrated header connections is from the lower end of the rank 13 downwardly through the next adjacent of the two ranks making up the vertical bank 14, and upwardly through the remaining rank and thereupon through the balance of the radiant tube banks in the same manner, and finally through the

rearward bank 15 of the tubes 5 located upon the bridge wall 4.

Inasmuch as the hot gases from the burners 6 follow a course in the general direction of the bridge wall 4 and thereafter flow over the bridge wall, the heat applied to those tubes making up the rearward banks in the combustion chamber of the furnace will receive added heat by convection. This characteristic of the furnace materially aids in the principal objective of the furnace, that of accelerated heat transfer to the fluid contents of the tubes. The several banks of radiant tubes 5 may be expected to provide some baffle effect so that a substantial portion of the hot gases is urged upwardly between the banks from the adjacent group of burners and thereafter caused to flow toward the bridge wall 4 and finally through the convection section into a flue 16 leading to the furnace stack.

As a further aid to quick heating the tubes may be of relatively small diameter with respect to the size of tube customarily employed in the conventional type of tube still or heater. When such tubes are employed I prefer to arrange the tubes in multiple pass as in the manner illustrated diagrammatically in Fig. 5. In the flow diagram of Fig. 5 the radiant tubes 5*a* are arranged with adjacent vertically aligned pairs connected in parallel, through suitable manifolds 17 which may be located in the header boxes 18 of the still or furnace wall structure. The roof tubes 7*a* may be similarly arranged to increase rate of flow. If desired, the multiple pass arrangement of the tubes 5*a* may be carried out in the same manner as are the convection tubes 8*a* in Fig. 5. In this event the arrangement would obviously apply only to the intermediate banks 14*a* each comprising two vertical ranks, the adjacent pairs of tubes, one in each rank being connected in parallel. The same arrangement is applicable, if desired, to the roof tubes 7*a*.

The number of tubes in each multiple pass should be determined from the required rate of flow and diameter of the individual tubes. When tubes of small diameter are used I prefer to employ heat resistant alloy tube spacer (not shown) to prevent sagging of the tubes.

In Figs. 3 and 4 I have illustrated another embodiment of the invention differing from that heretofore described only as to the disposition of the burners 6. Instead of arranging the burners along opposite side walls 9 as shown in Figs. 1 and 2, one pair between each pair of adjacent tube banks, I locate all of the burners along the floor of the combustion chamber 2, in a plurality of rows, one row between each pair of tube banks. Openings 19 through the floor of the combustion chamber are provided through which the burners 6 extend so as to direct their flames upwardly between the banks of radiant tubes. Passageways 21 may be formed in the furnace foundation to permit an operator to adjust and service the burners.

While all of the species of the invention herein illustrated and described have included a general flow diagram wherein the fluid to be treated passes in succession through the convection tubes 8 or 8*a*, the radiant roof tubes 7 or 7*a*, and the radiant tubes 5 or 5*a*, it may be found that for some purposes an arrangement wherein the fluid flows from the convection tubes into the radiant tubes 5 or 5*a* and thereafter through the radiant roof tubes is more desirable.

I have provided in the pipe stills or furnaces herein described relatively simple construction which is admirably fitted for use in the "quick cracking" of hydrocarbons as well as "non-cracking" distillation processes requiring rapid heating without cracking. In addition, the advantageous structural characteristics of the ordinary type of pipe still or preheater have been entirely preserved, such as ready access to the tube headers 18 in both combustion and convection sections as for cleaning or the removal of the tubes for repair or replacement and the disposition of all of the burners 6 where they may be reached easily for adjustment or repair.

While I have described my invention by the use of specific examples it is not intended that such details shall be regarded as limitations upon the scope of the invention except insofar as included in the accompanying claims.

This application is a continuation of my application Serial No. 704,272, filed December 28, 1933.

I claim:

1. Apparatus for heating hydrocarbon oil to cracking temperature comprising a combustion chamber, a plurality of vertical banks of interconnected heat-absorbing tubes disposed in said combustion chamber and arranged in a plurality of spaced parallel banks to divide the combustion chamber into a plurality of parallel heating sections, means for connecting tubes in each bank to cause hydrocarbon fluid to pass through all of the tubes of one bank prior to entering the tubes of another parallel bank, means interconnecting the groups of interconnected heat-absorbing tubes in series for conducting oil therethrough in succession, separate means for producing hot products of combustion disposed intermediate successive vertical banks, said separate means and said vertical banks being adapted to cause a relatively large portion of said hot products of combustion to pass through substantially the entire space between vertical banks to thereby heat the hydrocarbon fluid passing through the tubes by heat radiated directly from the hot products of combustion and absorbed on both sides thereof, and means for removing hot products of combustion from said heating sections adjacent one end of the combustion chamber whereby tubes in the vertical banks nearest the point of removal of the hot products of combustion from the combustion chamber receive added heat by convection from the hot products of combustion.

2. Apparatus for heating hydrocarbon fluid to conversion temperature comprising a combustion chamber defined by walls, a plurality of vertical banks of interconnected heat-absorbing tubes disposed in said combustion chamber and arranged in a plurality of spaced parallel banks to divide the combustion chamber into a plurality of sections, means for connecting tubes in each bank to cause hydrocarbon fluid to pass through all of the tubes of one bank prior to entering the tubes of another parallel bank, means for interconnecting adjacent groups of interconnected tubes in series for conducting hydrocarbon fluid therethrough in succession from the vertical bank of interconnected tubes closest one of said walls to the bank closest the opposite wall, separate means for producing hot products of combustion disposed intermediate successive vertical banks, said separate means and said vertical banks being adapted to cause a relatively large portion of said hot products of combustion to pass through substantially the entire space between vertical banks to thereby heat the hydrocarbon fluid pass-

ing through the tubes by heat radiated directly from the hot products of combustion and absorbed on both sides thereof, and means for removing products of combustion from the combustion chamber in the same general direction as the hydrocarbon fluid flowing from the tubes closest one wall to the tubes closest the opposite wall whereby tubes in the vertical banks nearest the point of removal of the products of combustion and said opposite wall receive added heat by convection therefrom.

3. Apparatus for heating hydrocarbon fluid to conversion temperature comprising a furnace defined by walls and a roof, a bridge wall separating the furnace into a combustion chamber and a convection chamber, a bank of tubes in the convection chamber, a bank of tubes adjacent the roof of the furnace, a plurality of spaced vertical banks of interconnected heat-absorbing tubes in the combustion chamber to divide the combustion chamber into a plurality of sections, means for connecting tubes in each bank to cause hydrocarbon fluid to pass through all of the tubes of one bank prior to entering the tubes of another parallel bank, means for interconnecting adjacent groups of the vertical banks of tubes in series for conducting hydrocarbon fluid therethrough in succession from the vertical bank of interconnected tubes closest the wall opposite the bridge wall to the bank closest the bridge wall, means for connecting the tubes of the convection section, the roof tubes and the vertical bank of tubes closest the wall opposite the bridge wall for passage of hydrocarbon fluid therethrough in the order named, separate means for producing hot products of combustion disposed intermediate successive vertical banks, said separate means and said vertical banks being adapted to cause a relatively large portion of said hot products of combustion to pass through substantially the entire space between vertical banks to thereby heat the hydrocarbon fluid passing through the tubes by heat radiated directly from the hot products of combustion and absorbed on both sides thereof, and means for removing products of combustion from the combustion chamber in the same direction as the hydrocarbon fluid passing from the vertical banks of tubes closest the wall opposite the bridge wall to the vertical banks of tubes closest the bridge wall whereby the vertical banks nearest the point of removal of the products of combustion from the combustion chamber for passage through the convection chamber and the bridge wall receive added heat by convection therefrom.

4. A method of heating hydrocarbon fluids to elevated temperature which comprises passing the hydrocarbon fluid in series flow through a succession of serially connected and spaced vertical banks of tubes arranged in a combustion chamber to subdivide it into a plurality of heating sections whereby the hydrocarbon fluid flows from the banks of tubes closest one of the boundary surfaces of the combustion chamber in series through said intermediate banks of tubes to the bank of tubes closest the opposite boundary surface, supplying hot products of combustion to each heating section, subjecting the tubes to heat radiated directly from hot products of combustion supplied to each heating section to thereby apply radiant heat to both sides of each of the tubes of the intermediate banks, and withdrawing hot products of combustion from all of said heating sections adjacent one end of the combustion chamber so that there is an increase in the application of convection heat to succeeding vertical banks of tubes as the hydrocarbon fluid flows therethrough in series and greater amounts of convection heat are applied to the banks of the series closest said mentioned opposite boundary surface.

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