Nov. 30, 1948. C. S. REED 2,454,943

HEATER FOR HYDROCARBON FLUIDS

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Fig. 1.

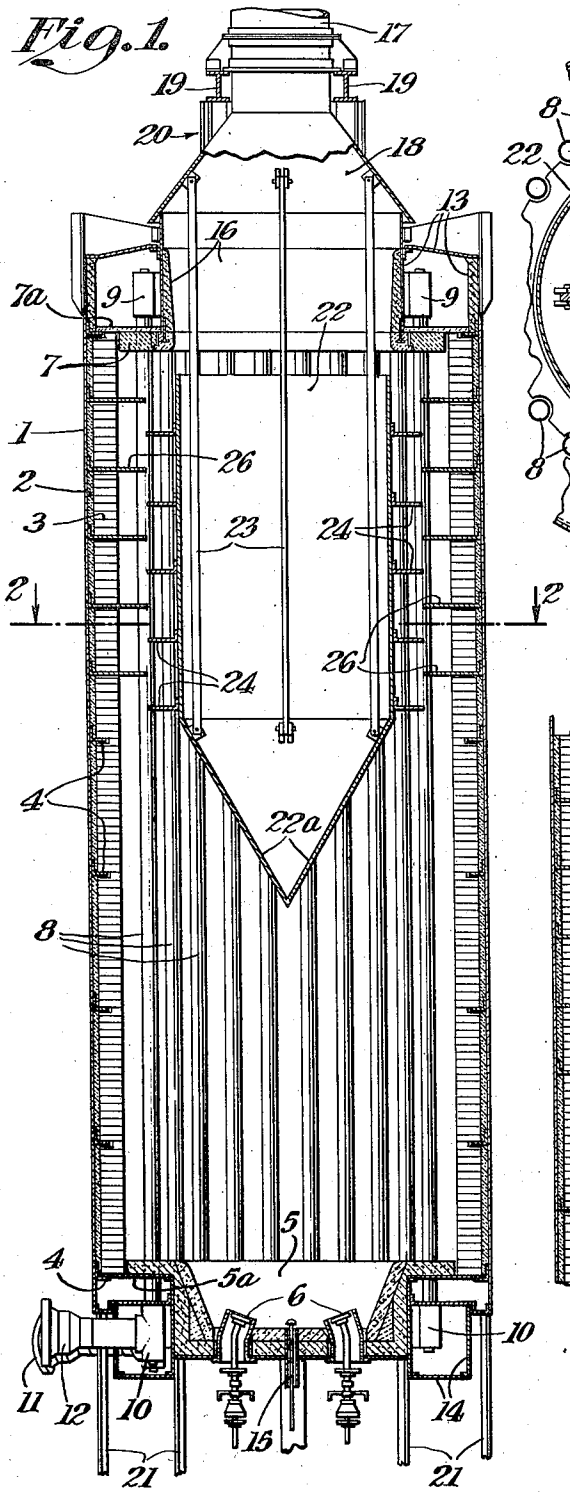


Fig. 2.

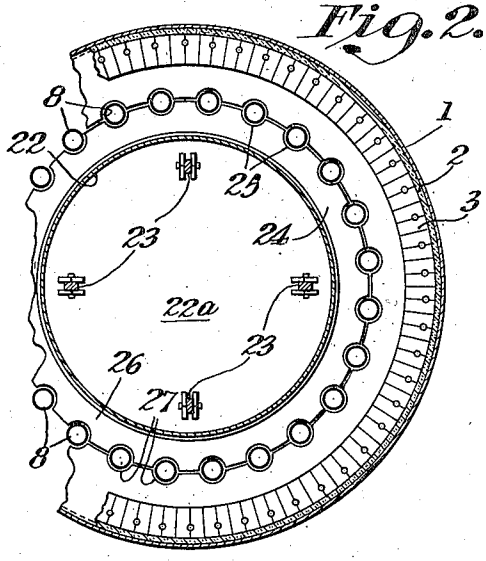
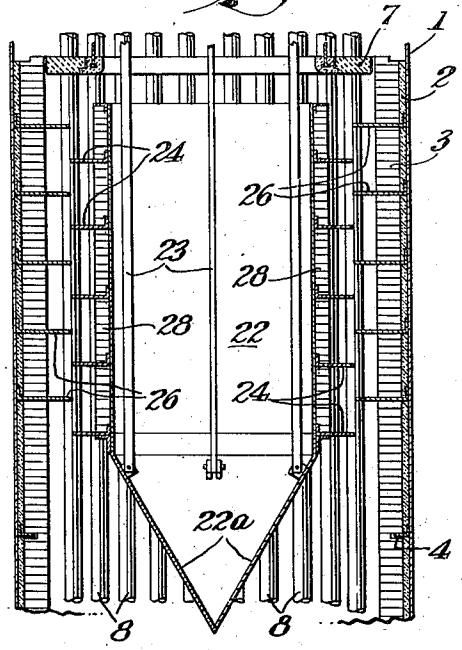


Fig. 3.



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Fig. 4.

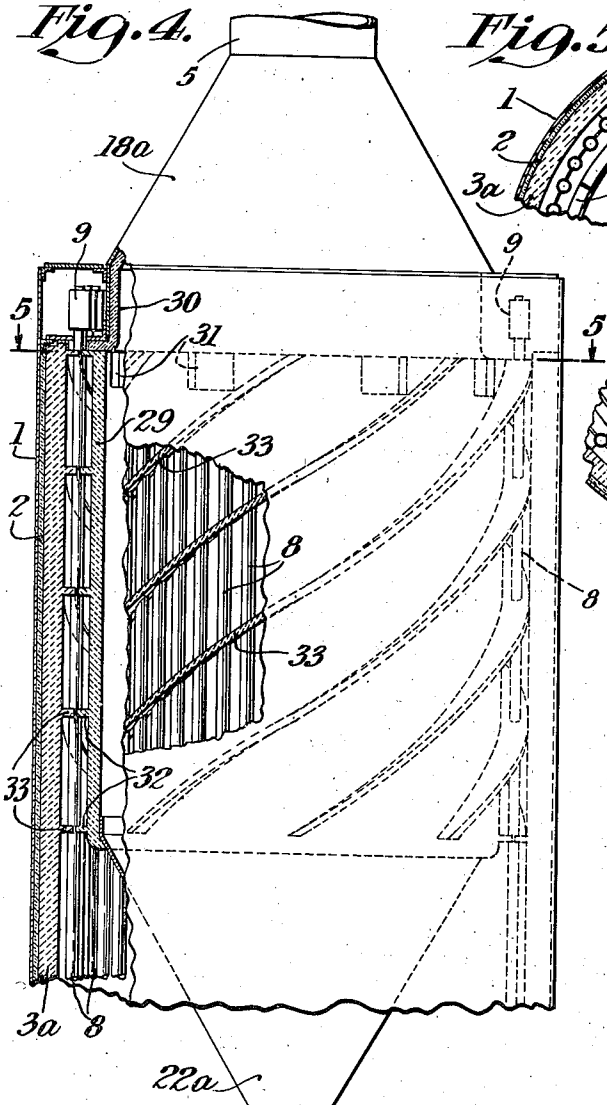


Fig. 5.

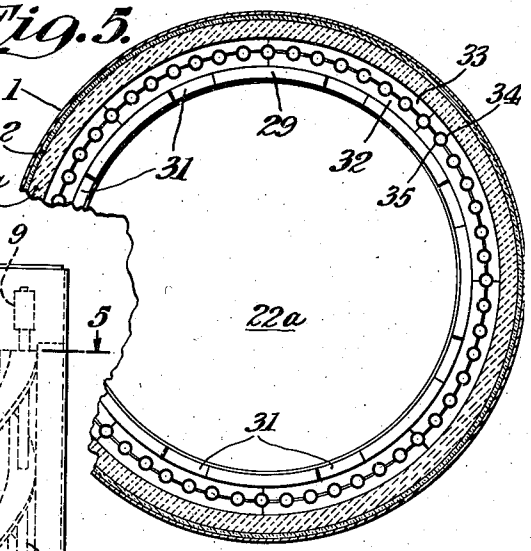


Fig. 6.

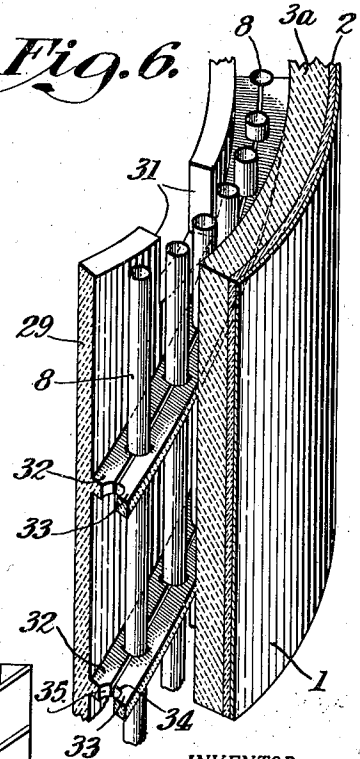
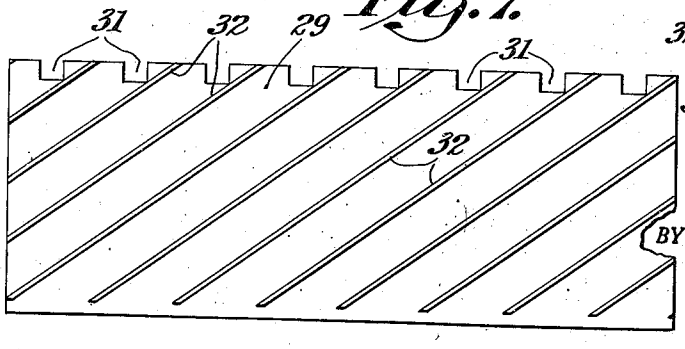


Fig. 7.



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HEATER FOR HYDROCARBON FLUIDS

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Application July 17, 1945, Serial No. 605,612

4 Claims. (Cl. 196—116)

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This invention relates to improvements in heaters of the type having heating tubes disposed within a furnace chamber and wherein provision is made for conducting combustion within the chamber in a manner to raise the temperature of a hydrocarbon fluid, as it is passed through the tubes, to a desired distillation point, or to a cracking point, predominantly by radiant heat received from such combustion.

An important object of the invention is to provide such a heater with improved means for effecting heating of the tubes by convection as well as by radiant heat, within a single chamber.

Another object of the invention is to provide a highly efficient convection heating feature of improved design within a heater of the vertical tube type wherein an annular series of heating tubes surrounds a combustion region within the lower portion of an upright furnace chamber and wherein the products of combustion escape from the upper end of the chamber.

Another object of the invention is to provide such a convection heating feature designed for long service without repair or replacement of parts.

These and other objects and advantages of the invention will appear from the following description and from the accompanying drawings.

In the drawings:

Fig. 1 is a vertical sectional view of a heater embodying one form of the convection heating feature;

Fig. 2 is a horizontal section on the line 2—2 of Fig. 1, upon a larger scale and partly broken away;

Fig. 3 is a vertical sectional view of a portion of the heater, showing a modified form of the central deflector which forms part of the convection heating feature;

Fig. 4 is a view, partly in elevation and partly in section, of the upper portion of a heater embodying a further modification of the convection heating feature;

Fig. 5 is a section on the line 5—5 of Fig. 4, partly broken away;

Fig. 6 is a sectional perspective view of a portion of the heater shown in Fig. 4, disclosing details of construction of the convection heating feature; and

Fig. 7 is a development of the periphery of a portion of the central deflector, indicated in Fig. 4, showing the arrangement of the baffles borne by said deflector.

Figs. 1, 2 and 3 show my invention embodied in a heater of the vertical tube type. The structure of the heater includes a vertical cylindrical shell 1 lined with heat insulation 2. Inwardly of the heat insulation, there is a refractory wall 3 formed, in the present instance, of blocks or bricks of ceramic or other suitable refractory material. For supporting the bricks, a number of rings 4 are secured to the inner side of the shell in vertically spaced positions. These rings have inwardly projecting flanges forming ledges bearing the weight of the bricks. The lower end of the shell is closed by a hearth 5 of refractory material and formed with a depressed central portion within which burners 6 are located. At the upper end of the shell a flat ring 7 of refractory material is fitted within the brick wall, and the wall, the hearth and the ring 7 define the furnace chamber of the heater. Within said chamber there is an annular series of vertical heating tubes 8. The tubes are disposed near the brick wall and are equidistant from the axis of the shell. The upper end portions of the tubes project through holes in the ring 7 and through holes in an annular tube sheet 7a overlying the ring. The lower end portions of the tubes project through holes in the margin of the hearth 5 and through holes in an annular tube sheet 5a underlying said margin.

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In the present instance, the tubes 8 are all serially interconnected by return bends 9 and 10 at the upper and lower ends respectively, of the tubes, and the series has an inlet 11 and an adjacent outlet 12, both located at the lower end of the heater. However, different groups of tubes of the series may be connected into different flow circuits, if desired. An annular housing 13 encloses the return bends at the upper ends of the tubes, and an annular housing 14 encloses the return bends at the lower ends of the tubes, for heat conservation. The burners 6 are gas burners and they are preferably of a directional type. Their upper ends are inclined and they are mounted for individual rotative adjustment on vertical axes so that the flame from any one of the burners may be directed toward a selected group of the tubes. An oil burner 15 is also provided at the center of the hearth. At the upper end of the furnace chamber a collar 16 of refractory material extends upwardly from the aperture of the ring 7 and defines the outlet for gaseous products of combustion from the furnace chamber. Said collar is connected to an exhaust stack 17 through a hood 18 at the base of the stack. The stack and the hood are supported by beams 19 which form part of a frame structure 20 borne by the shell, and the collar 16 and the ring

1 are supported by the shell. Legs 21 at the lower end of the shell support the entire heater structure.

The lower portions of the tubes 8 are heated predominantly by radiant heat from the combustion within the lower portion of the furnace chamber, and the present invention provides for increased transmission of radiant heat to said portions of the tubes and also provides for efficient transmission of heat of convection to the upper portions of the tubes. For these purposes, a drum-like deflector 22 is supported centrally within the upper portion of the furnace chamber, within the space surrounded by the tubes. The deflector comprises a cylindrical body of substantial vertical length and of an external diameter materially less than the internal diameter of the series of tubes, to afford a surrounding space of material width between the deflector and the tubes. The lower end of the deflector is in the form of an inverted cone 22a and tapers downwardly from the periphery of the cylindrical body of the deflector. The deflector is supported suspended in a position coaxial with the shell 1 by links 23 whose upper ends are pivotally attached to ears borne by the hood 18 and whose lower ends are pivotally attached to ears borne by the deflector and located within the cone 22a. The vertical position of the deflector is such as to dispose its upper edge spaced from the outlet of the furnace chamber. Preferably, the deflector is made of a heat resistant metal alloy such as stainless steel, for example.

The deflector bears a series of flat annular baffles 24 surrounding the cylindrical body of the deflector and vertically spaced therealong. The inner edges of these baffles are upturned and secured by welding, or otherwise, to the deflector. The baffles extend radially outward toward the tubes and have notches 25 receiving the inner portion of the periphery of the tubes. The shell 1 bears a series of vertically spaced flat annular baffles 26 having upturned outer edges welded, or otherwise secured, to the shell, and these baffles extend radially inward, between the bricks of the refractory wall 3 and across the space between said wall and the tubes. At their inner edges the baffles have notches 27 receiving the outer portion of the periphery of the tubes, and the baffles are disposed at levels intermediate the levels of the inner baffles 24. The baffles 24 are all of the same external diameter and the baffles 26 are all of the same internal diameter. The external diameter of the baffles 24 is also less than the internal diameter of the baffles 26 so that the former can pass the latter baffles in assembly and disassembly of the parts. Preferably the notches 25 and 27 of the baffles are large enough to afford substantial clearance between the edges of the baffles and the tubes. Thereby, the necessity for accurate shaping and fitting of the baffles is avoided and removal of the tubes is also facilitated.

In the operation of the heater the hydrocarbon fluid is admitted through the inlet 11 and passed through the tubes in succession to the outlet 12. In the course of its passage through the tubes the fluid is heated predominantly by radiant heat transmitted from the combustion within the lower region of the furnace chamber directly to the lower portion of the tubes. This direct radiant heat is supplemented by reflection of radiant heat from the conical lower end of the deflector, located directly over the combustion region. The cone 22a is provided with a good reflecting surface disposed to reflect the radiant heat outwardly and downwardly upon the lower portion of the tubes.

The gaseous products of combustion ascending from the combustion region are deflected by the deflector 22 and are compelled to flow into the space surrounding the deflector and containing the upper portion of the tubes. Within said space the staggered baffles cause turbulence and circuitous flow of the hot combustion gases for efficient transfer of heat of convection therefrom to the tubes. From said space the gases, materially cooled by such heat transfer, flow past the upper edge of the deflector and through the furnace chamber outlet to the stack 17. Thus, efficient radiant heating of the tubes is obtained within one zone of the furnace chamber and efficient convection heating of the fluid is obtained within another zone of the chamber.

Fig. 3 shows a convection heating feature precisely like that just described, and shown in Figs. 1 and 2, except that the periphery of the cylindrical body of the deflector is faced with a refractory brick wall 28. The provision of this wall enables the body of the deflector to be made of a less expensive metal. The baffles 24 project outwardly between the bricks of the wall 28.

In the further modification shown in Figs. 4 to 7, inclusive, the cylindrical body of the deflector consists entirely of a refractory wall 29. The hood 18a at the base of the stack also extends downwardly to the refractory shell wall 3a, and the annular upper edge of the deflector wall 29 abuts an annular flange at the base of the hood. The hood also has a refractory lining 30. For escape of the combustion gases from the space between the deflector and the surrounding wall 3a, the deflector wall has, at its upper edge, a series of notches 31 of liberal size through which the gases flow to the hood and the stack. The stack, the hood and the deflector are all supported by the shell.

The deflector wall 29 is integrally formed with a series of helical baffles 32 projecting radially therefrom toward the tubes. These baffles are of steep pitch and they make materially less than a complete turn around the deflector. The surrounding wall 3a is also integrally formed with a series of similar helical baffles 33 projecting inwardly toward the tubes and in direct edgewise opposition to the baffles 32. Like the walls which bear them, the baffles 32 and 33 are formed of refractory material. The wall 3a is shown as a continuous piece of refractory but it may be formed of bricks with ribs suitably arranged to form the baffles 33. The baffles 33 have, at their inner edges, notches 34 receiving the outer portion of the periphery of the tubes, and the baffles 32 have similar notches 35 at their outer edges receiving the inner portion of the periphery of the tubes. The notches are large enough to afford a desired clearance around the tubes, and the outside radius of baffles 32 is substantially less than the inside radius of baffles 33, for the purposes previously stated in the description of the form of the invention shown in Figs. 1 and 2.

The baffles 32 and 33 combine to define a series of concurrent or parallel helical channels around the deflector. These channels are all open at their lower ends to the combustion region for flow of the combustion gases into the channels. The notches 31 in the upper edge of the deflector are located so that one of said notches occurs at the upper end of each channel so that the

gases can flow from each channel to the stack. The tubes extend across all of the channels directly in the path of the hot gases so that highly efficient transfer of heat to the tubes is obtained.

It is, of course, to be understood that the foregoing description is merely illustrative and in no wise limiting and that I desire to comprehend within my invention such modifications as are included within the scope of the appended claims.

Having thus clearly described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A heater for a hydrocarbon fluid comprising a furnace chamber, substantially parallel heating tubes arranged over the inner surface of a wall of said chamber, burner means disposed to conduct combustion within a region of the chamber adjacent one portion of the length of said tubes for radiant heating thereof, a deflector disposed inwardly of the tubing and having a wall in opposed face-to-face relation to said chamber wall and overlying another length portion of the tubes, said deflector being constructed and arranged to direct the products of combustion between said walls for convection heating of the portion of the tubes therebetween, a set of transversely spaced concurrent baffles oblique with respect to the tubes extending laterally outward from said deflector wall and having notches at their outer edges receiving the inner portion of the periphery of the respective tubes, a set of baffles spaced similarly to the first-mentioned baffles and similarly oblique extending laterally inward from said chamber wall and having notches at their inner edges receiving the outer portion of the periphery of the respective tubes, said sets of baffles together defining a plurality of oblique concurrent channels for flow of the combustion products therethrough, and the tubes extending across said channels in the paths of the combustion products therein.

2. A heater for a hydrocarbon fluid, comprising an upright furnace chamber having at the upper end thereof an outlet for combustion products, an annular series of substantially vertical heating tubes within said chamber and adjacent to and surrounded by a side wall of the chamber,

burner means disposed to conduct combustion within a region surrounded by a lower portion of said tubes for radiant heating thereof, a deflector within a region surrounded by an upper portion of the tubes and constructed and arranged to deflect ascending products of combustion outwardly against the tubes for convection heating thereof, a set of spaced concurrent helical baffles borne by and extending around and along the said deflector and extending laterally outward therefrom, and a set of spaced concurrent helical baffles borne by and extending laterally inward from said surrounding wall and forming, together with the first-mentioned baffles, a plurality of concurrent helical channels to conduct the products of combustion to said outlet, the tubes extending across said channels in the path of the combustion products therein.

3. A heater for a hydrocarbon fluid, as claimed in claim 2, wherein the outer edges of the baffles borne by the deflector are respectively in opposed relation to the inner edges of the baffles borne by the surrounding wall and have notches receiving the inner portion of the periphery of the tubes, and said edges of the wall-borne baffles have notches receiving the outer portion of the periphery of the tubes.

4. A heater for a hydrocarbon fluid, as claimed in claim 2, wherein the baffles of both of said sets are formed of non-metallic refractory material.

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