Sept. 2, 1958 F. L. KALLAM 2,849,991

FLUID HEATING UNIT

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FIG. 1

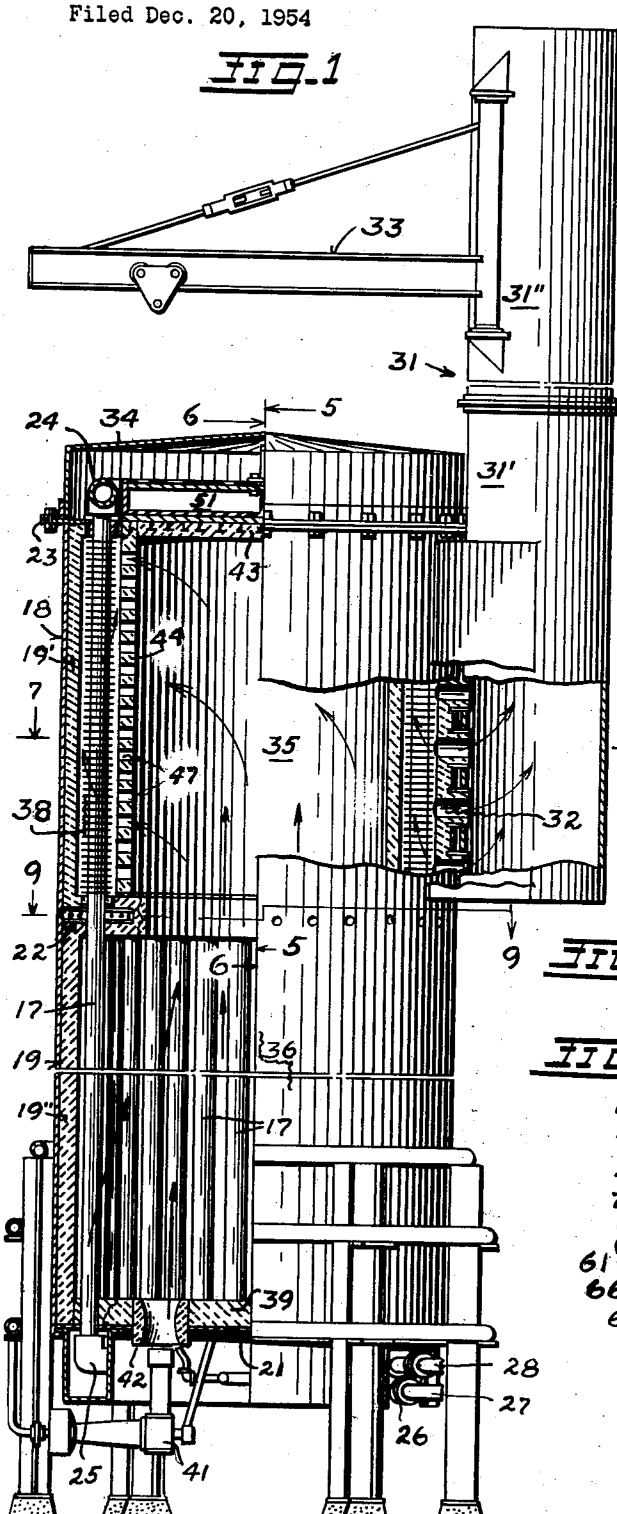
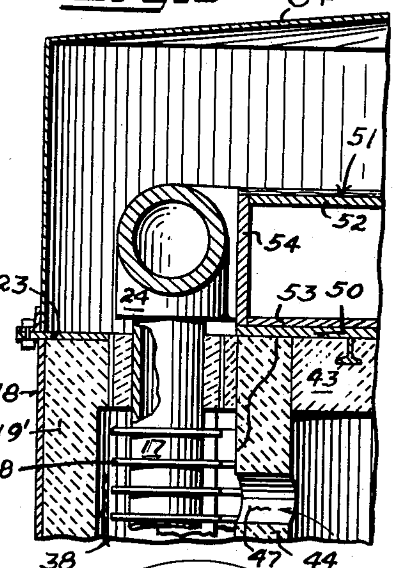


FIG. 2



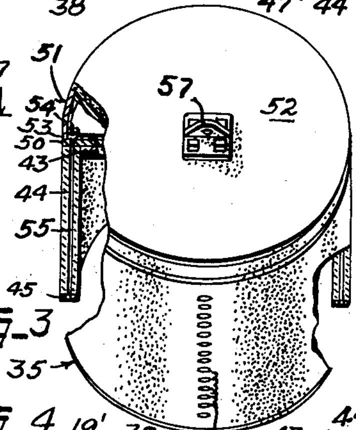
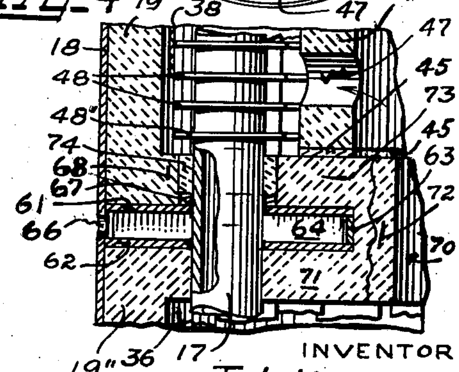


FIG. 3

FIG. 4



INVENTOR
F. L. KALLAM
BY Henry N. Young
ATTORNEY

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FIG. 5

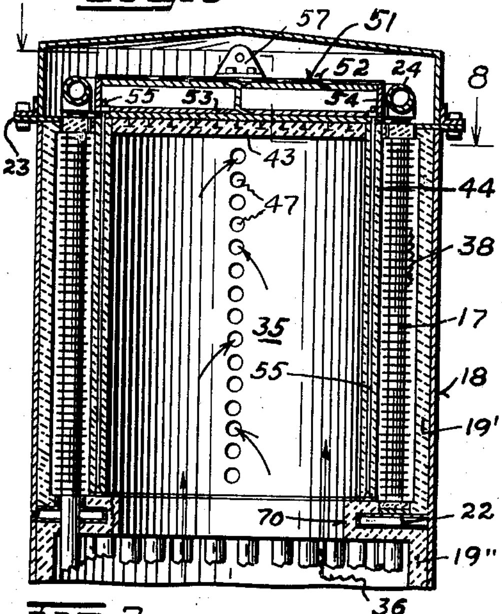



FIG. 6

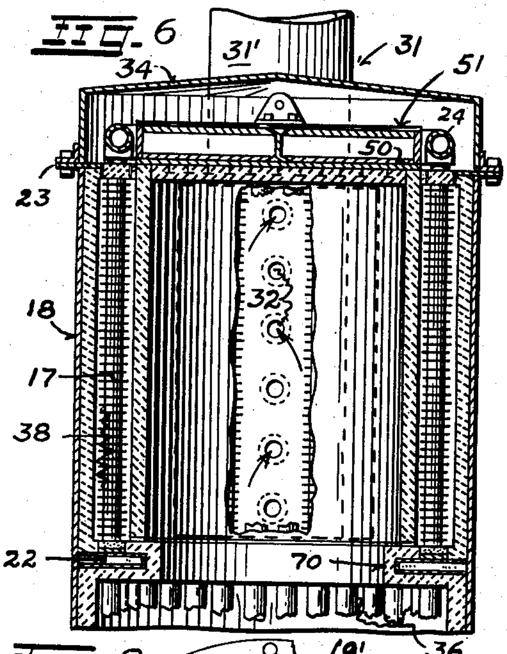



FIG. 7

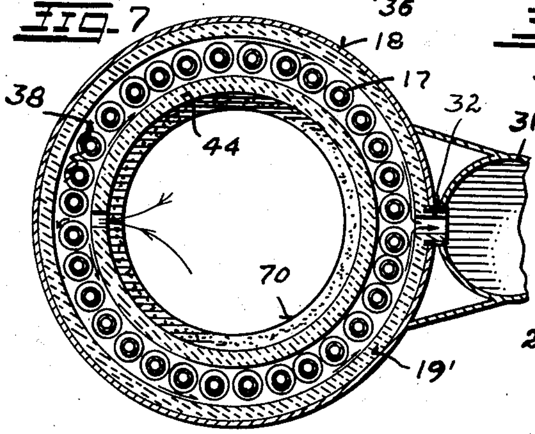



FIG. 8

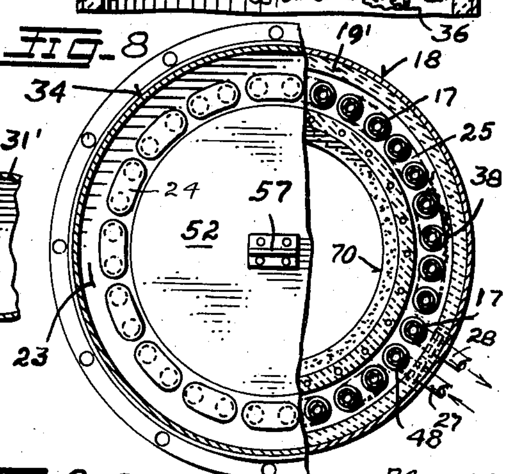



FIG. 10

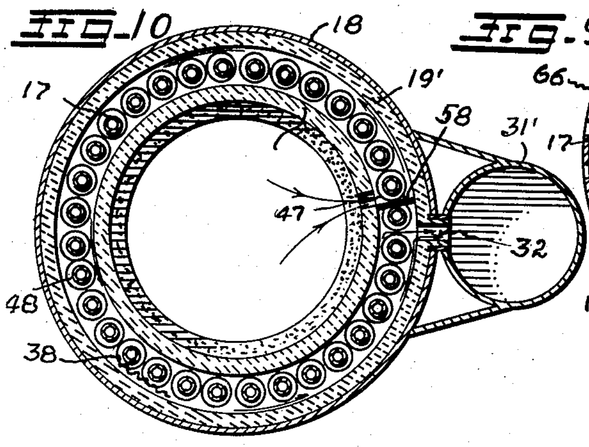
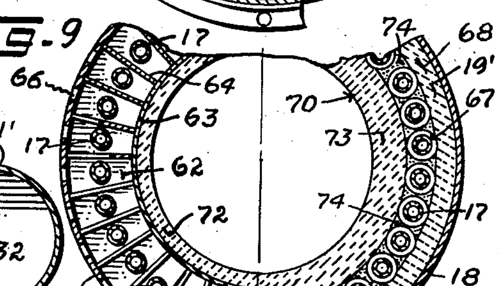



FIG. 9




INVENTOR

F. L. KALLAM

BY Henry N. Young

ATTORNEY

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2,849,991

# FLUID HEATING UNIT

Floyd L. Kallam, Pasadena, Calif., assignor to Industrial Engineers, Inc., Los Angeles, Calif., a corporation of California

Application December 20, 1954, Serial No. 476,471

2 Claims. (Cl. 122—510)

The invention relates to a unitary heater or furnace providing successive coaxial zones of hot-gas heating for a tube-carried fluid by radiation and convention respectively.

A general object of the invention is to provide a particularly efficient heat exchange in an annular convection zone of a heater of the present type.

Another object is to provide for the ready incorporation of a novel baffle member used in defining the annular convection zone in heaters of a well-known type.

A further object is to provide for a complete circulation of the heating gases circumferentially through a circular bank of fluid-carrying tubes in the convection zone of the heater.

An added object is to provide a heater structure which is particularly adapted for utilizing a baffle member of the presently disclosed type.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth or be apparent in the following description of typical embodiments thereof, and in the accompanying drawings, in which,

Figure 1 is a partly sectional elevation of a vertical-tube liquid heater provided with the features of my invention.

Figure 2 is an enlarged fragmentary sectional view showing a portion of the structure shown in section in Figure 1.

Figure 3 is a broken-away perspective view of a special baffle member which is utilized in carrying out the present invention.

Figure 4 is an enlarged fragmentary sectional view showing a portion of the structure shown in section in Figure 1.

Figure 5 is an axial section taken at the line 5—5 in Figure 1.

Figure 6 is a fragmentary sectional view taken at the line 6—6 in Figure 1.

Figure 7 is a fragmentary section taken at the line 7—7 in Figure 1.

Figure 8 is a section taken on the stepped line 8—8 in Figure 5.

Figure 9 is a fragmentary sectional view taken at the line 9—9 in Figure 1.

Figure 10 is a section taken at the plane of Figure 7, and showing an alternative installation of the baffle member in the present heater assembly.

As particularly illustrated, the features of my invention are incorporated in the structure of an industrial liquid heater having a circular bank of liquid-carrying tubes **17** extending axially through a cylindrical combustion and heat-transfer chamber defined within an upright cylindrical metallic shell **18** of circular cross-section provided with a heat-insulation lining **19** disposed between it and the tubes. In the present structure, the tubes **17** extend through and between shell-carried lower and intermediate and upper tube plates **21** and **22** and **23** respectively. The tubes **17** are connected in pairs at their tops above

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the tube plate by U-bend, or junction box, fittings **24**, and adjacent tubes of the pairs are connected at their bottoms by like U-bend fittings **25**, except that adjacent said tubes of one pair thereof are connected at their bottom ends by elbow fittings with intake and discharge pipes **27** and **28** extending radially of the heater, whereby the tubes of their bank are connected in series between the pipes **27** and **28** in the arrangement taught in U. S. Patent No. 2,634,712, which issued to me on April 14, 1953. The upper and intermediate tube plates **23** and **22** are annular, and the present tube assembly is suitably supported from the intermediate tube plate **22** in a manner to provide for and permit the necessary longitudinal free thermal expansions of the supported heater parts.

At its upper end and at one side thereof, the shell **18** mounts an upright stack assembly **31** comprising a cylindrical base portion **31'** extending in generally tangential relation to the shell portion opposite said section and upwardly of the plane of the intermediate tube plate **22**, and has its flue passage suitably connected with the interior of the shell by connecting radial discharge ports **32** provided in a longitudinal line along the shell, the bottom of the stack section being closed. An upper stock section **31''** mounted above the base section **31'** mounts a crane arm **33** for use over and from over the top of the shell **18** which is closed by a suitable cap member **34** encloses the top ends of the tubes **17** and the top tube fittings **24** and is removably mounted on the top of the shell portion; the crane arm **33** is provided for use in installing and removing the shell cap **34** and a cylindrical baffle member **35** which comprises an element of the present structural and operative combination, said baffle member being operatively supported within the tube array at its top and upon the intermediate tube plate **22**.

It will now be noted that the heat-exchange space within the shell **18** is divided at the intermediate tube plate **22** into a lower part **36** which provides a chamber for heat exchange by radiation, and that the cylindrical baffle member **35** is cooperative with the radially opposed shell portion above the tube plate **22** to define about the baffle an annular chamber **38** which comprises what may be termed the convection zone of the heater. The bottom of the lower chamber **36**, which comprises the radiation zone of the heater, is defined by the lower tube plate **21** and an overlying lining **39** of fire brick or the like, beneath which one or more suitable fluid burners **41** are provided for discharging flame jets into the chamber through a jet passage provided through a tubular member **42** mounted in the chamber bottom. Alternatively, hot gaseous combustion products from a separate combustion zone may enter the heating chamber through the members **42** for accomplishing the present tube-heating purpose. Also, the hot gases which are to provide a tube-heating stream through the chamber **36** are not necessarily combustion products, and may, for instance, comprise air which has been electrically, or otherwise, heated within or without the chamber.

The hot gases entering or generated in the lower chamber **36** are arranged to flow upwardly therein to and through the central opening of the intermediate tube plate **22** which is defined inwardly of the bank of tubes **17**, and therefore provides thereat a slight contraction of the rising stream of the hot gases which pass upwardly and longitudinally in the lower chamber **36** to provide for a chiefly radiant transfer of heat from the gases to the tubes and so to the liquid stream circulating through the tubes whereby this space comprises a radiation zone of the heater by reason of this major manner of heat exchange therein. It will be understood that the final heat-exchange action of the present heater occurs in the zone **38** in which the convection flow of the heating gases into the stack is responsible for the gas flow relations provided through the heater, and that the heating gas reaching the convection zone 38 is cooler than the heating gas supplied at or to the bottom of the radiation zone provided by the lower heater chamber 36.

A present baffle member 35, it will now be noted, essentially comprises a hollow cylindrical body which has a closed upper end 43, a side wall 44, and is fully open at its bottom edge rim 45 from which it is supported on the intermediate tube plate 22. The side 44 of the mounted baffle member 35 is cooperative with the opposed upper shell lining portion 19′ to provide the annular convection heating zone 38 in which heat exchange takes place by the flow of gases laterally against and about the tube portions therein. The heating gases are arranged to flow from the cavity of the baffle member 35 into the convection zone 38 through a line of openings 47 provided through and along its side 44 as comprising the operative equivalent of a single elongated port thereat. For facilitating the heat exchange action in the convection zone 38, the tube portions within the space may mount annular heat-conducting fins 48 for assuring a maximum heat-exchange action with respect to the liquid stream in the tubes.

As particularly brought out in Figures 2 to 5 inclusive, the baffle 35 has its top 43 and side wall 44 formed of a refractory material, has a rigid metallic plate 50 fixed to and against its upper end 43, and is fixed to a suitable overhead assembly 51 in a manner to facilitate its handling and preserve its entity. In the present structure, the assembly 51 comprises a shallow drum-like structure having the diameter of the baffle and comprising upper and lower circular plates 52 and 53 integrally connected by a cylindrical wall 54, and the baffle 35 is connected to the assembly 51 by tension rods 55 extending longitudinally through its side 44 at spaced points thereabout, and from a ring member providing the rim edge 45 of the baffle to a bolted connection with the bottom plate 53 of the assembly 51. A lifting lug 57 providing an eye for engagement by a hoist hook is provided on the upper side of the member 52 of the assembly 51 for use in installing and removing the baffle by the use of the crane 33.

The present baffle assembly, while carried on the intermediate tube plate 22, is preferably placed in either one of two relations with respect to the row of port openings 32 leading to the stack. In Figures 1 and 5 to 7 inclusive, the baffle discharge port provided by the line of port openings 47 is shown as disposed diametrically opposite the shell discharge port provided by the line of ports 32 whereby hot gases entering the convection zone 38 through the baffle 47 are divided for flowing semi-circumferentially through the convection zone 38 to and through the discharge ports 32 leading to the stack. Figure 10 shows an alternative arrangement in which the convection zone 38 about the baffle is divided adjacent the ports 32 by a radial partition 58, and the baffle ports 47 are disposed at the opposite side of the partition 58 from the ports 32 whereby hot gases entering the convection zone must flow in the same direction completely around the baffle before they reach the stack. With either disclosed positioning arrangement of the baffle 35 in the heating chamber, the peripheral flow of gases in the convection zone 38 to utilize to the fullest the heat remaining in the hot gases after they have left the radiation zone 36 of the heater in which heat exchange initially occurs.

It will now be noted that the intermediate tube plate 22 must have a particularly rigid assembly and support by reason of the fact that the tubes 17 are supported therefrom in their line inwardly of the supporting shell 18. As particularly brought out in Figures 1 and 4 and 9, this tube plate comprises a unitary assembly fabricated of mutually parallel spaced upper and lower annular metallic flat rings 61 and 62 respectively provided with mutually coaxial holes freely but closely receiving the tubes 17 of the bank thereof. The outer peripheries of the rings 61 and 62 are welded or otherwise secured directly to the heater shell 18, and a continuous tubular element 63 is welded or otherwise secured to the inner peripheries of the rings 61 and 62. Spreader plates 64 extend radially and axially in the annular space between the rings 61 and 62, and are welded or otherwise fixed to said rings and the connecting element 63, whereby the assembly provides a rigid cellular tube plate for the tubes 17. For avoiding excess heat effects, the cells of the tube plate assembly 22 are preferably connected with the atmosphere exteriorly of the heater by means of holes 66 provided at points of the shell 18 opposite them.



The independent support of each tube 17 on the tube plate 22 is effected by suitably fixing, as by welding, a ring or collar 67 to the tube below the lower fin 48′ for its direct bearing on the upper ring 61 of the tube plate. By particular reference to Figures 4 and 9, it will be noted that the upper portion 19′ of the refractory shell lining rests upon the upper tube-plate ring 61 and is annularly extended inwardly thereover and beneath the lower fin 48′ and to the tube circle thereat as a flange 68, the edge of the lining base flange so provided being formed with semi-cylindrical notches at each tube, each said notch having a radius slightly greater than that of the collar 67 to permit an upward removal of the tube from its seated position on the tube plate 22.

The top of the lower lining portion 19″ is provided with an inwardly directed flange port 70 having a lower radial portion 71 perforated in the tube circle to freely receive the tubes and providing an annular seat for the tube plate unit 22 at its top face. Inwardly of its plate-supporting seat, a tubular portion 72 of the flange 70 extends upwardly and is surmounted by a radial portion 73 which extends outwardly from the portion 72 in the plane of the flange 68 of the upper lining section 19′ to the circle of the tubes and has its outer edge complementarily notched as the flange 68 for receiving the heater tubes 17. For sealing the tubes 17 with respect to the tube plate 22, the annular spaces defined above the support collar 67 by and between the complementary notches of the flange 68 and the flange portion 73 is preferably sealed with a friable sealing filling 74 of fire clay or the like above the collar 67 whereby to permit an independent upward removal of each tube from the heater. The arrangement of the flange 70 is essentially such that the baffle 35 may supportedly rest upon the portion 73 thereof inwardly of the tubes, it being noted that the metallic tube plate 22 is thermally insulated by the present arrangement from both the radiation chamber 36 and from the convection zone 38.

It will be understood that the present provision for the common support of the tubes 17 and the baffle 35 upon the intermediate tube plate structure 22 provides for the corresponding longitudinal elongation and contraction of the furnace and baffle structures in opposite direction with respect to the tube plate 22 by reason of temperature changes therein whereby thermally induced strains in the assembly are kept at a minimum. Also, most of the present novel features of invention relating to the baffle 35 may be advantageously provided in a furnace having the longitudinal axis of its tube bank horizontal and the stack connections at its upper side.

From the foregoing description taken in connection with the accompanying drawings, the advantages of the present heater construction will be readily understood by those skilled in the art to which the invention appertains. While I have shown and described arrangements which I now consider to be a preferred embodiment of my invention, I desire to have it understood that the showings are primarily illustrative, and that such changes and developments may be made, when desired, as fall within the scope of the following claims.

I claim:

1. In a fluid-heater, a metallic wall defining an upright cylindrical chamber having a closed top end and arranged for the upward heat-exchange flow of initially hot gases longitudinally therethrough and provided with a discharge

port for the gases adjacent its said top end, a bank of liquid-carrying tubes disposed about the periphery of the chamber space and extending longitudinally therethrough, an annular tube plate assembly extending inwardly from the furnace wall in fixed relation thereto intermediate of the chamber and supportedly and sealedly engaging the bank of tubes thereat, said tube plate assembly comprising spaced annular metallic plates connected by the chamber wall and by a tubular wall at their inner edges to define between them an air space which is radially partitioned to define spaced portions having the tubes passing through the different portions thereof, and support flanges fixed to the tubes and resting on the upper plate member of the tube plate assembly, said furnace wall being provided with vent openings opposite each of the said spaced portions.



2. A structure in accordance with claim 1, having a baffle element carried directly on and above said intermediate tube plate assembly and cooperative with the opposed chamber side wall portion and the said plate assembly to provide an annular convection-flow chamber containing corresponding portions of the tubes of the bank thereof.

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