July 2, 1940. L. WILSON ET AL 2,206,378

APPARATUS FOR HEATING FLUIDS

Filed Aug. 11, 1938 2 Sheets-Sheet 1

Fig.1.

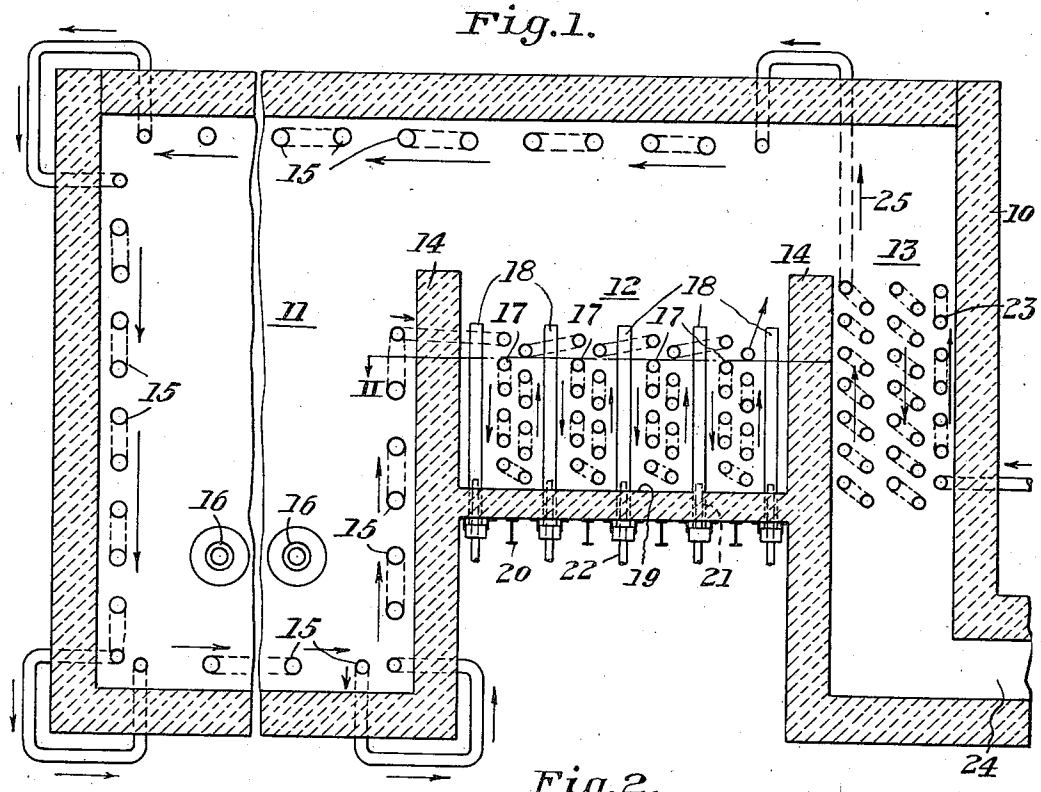
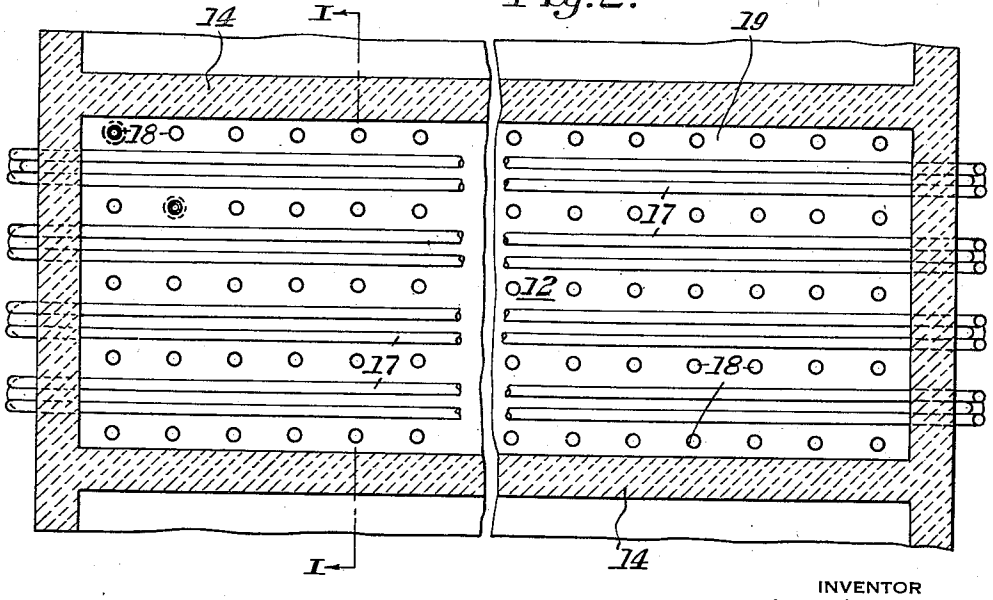


Fig.2.



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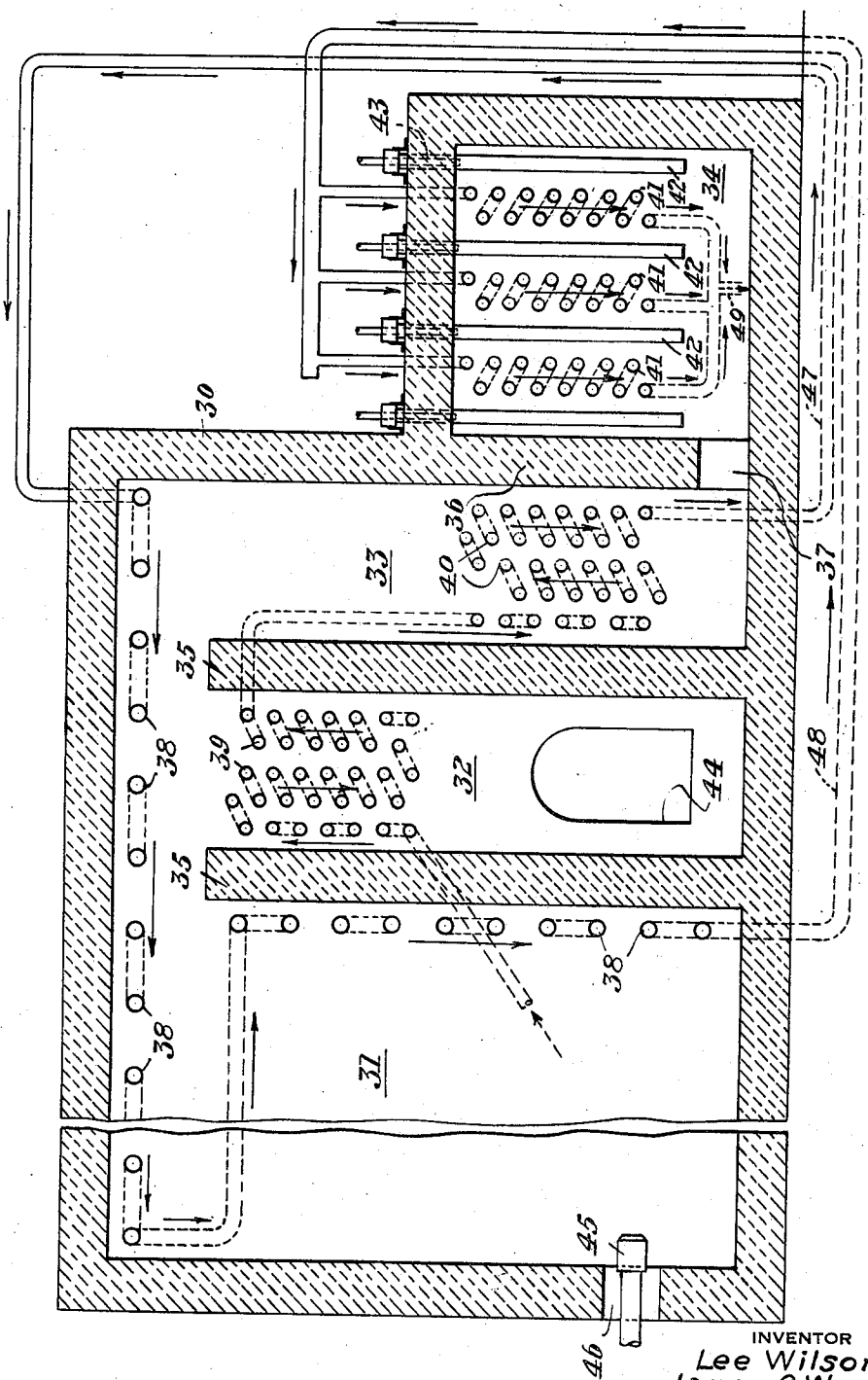


Fig. 3.

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APPARATUS FOR HEATING FLUIDS

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Application August 11, 1938, Serial No. 224,325

2 Claims. (Cl. 196—116)

This invention relates generally to the heating of fluids. It will be described herein as applied to oil cracking stills but it will be understood that it may likewise be applied to other processes wherein the heating of fluids is involved.

It has been the practice heretofore in cracking hydrocarbon oils, to pass the oil through banks of heat absorbing tubes and to supply heat to the tubes by the combustion of fuel in the immediate neighborhood thereof. This practice has prevailed for many years even though there are serious objections thereto. In the first place, the direct impingement on the tube banks of the flames resulting from the combustion of fuel in the immediate neighborhood exerts an eroding action on the tubes which renders them unfit for further service after a relatively short time. A further objection is the coking of the oil on the interior of the tubes which results from localized hot spots. These are occasioned by the inability of the still operator to control the temperature of various portions of the still. When the hot combustion gases have been formed, their subsequent course is determined solely by the draft through the furnace and it has proved impossible even with the aid of baffles, dampers, etc., to maintain the desired temperature in different portions of the still.

We have invented an apparatus for heating fluids which overcomes the aforementioned objections to the previous practice in the construction and operation of oil stills and is characterized by further features of advantage which are of value in other fields. In a preferred form and practice, the invention consists in passing the fluid to be heated through banks of heat absorbing tubes and heating such tubes substantially exclusively or at least principally by direct radiation. As a source of radiant heat, we prefer to employ heat-radiating tubes disposed adjacent the banks of heat exchange tubes, and having burners mounted to discharge hot combustion gases therethrough. The heat-radiating tubes are thus heated to radiant temperature and radiate heat directly to the still tubes. We also utilize heating of the still tubes by direct contact of combustion gases therewith by limiting direct contact of the gases with the tubes to zones in which the velocity and temperature of the gases have been reduced somewhat from their initial maximum values. We also employ the countercurrent principle by introducing the oil to be heated to the minimum temperature zones of the still and then passing it through the zone of maximum temperature.

A few typical forms of stills embodying our invention are illustrated diagrammatically in the accompanying drawings and the following detailed description should be read with reference thereto. In the drawings:

Fig. 1 is a transverse sectional view through a still;

Fig. 2 is a partial sectional view taken substantially along the line II—II of Fig. 1; line I—I of Fig. 2 indicates generally the plane on which the section of Fig. 1 is taken; and

Fig. 3 is a view similar to Fig. 1 showing a modified form of still.

Referring now in detail to the drawings and, for the present, to Figs. 1 and 2, a typical embodiment of our apparatus includes an enclosed chamber 10 of any desired construction. In the illustrated embodiment, the chamber 10 includes compartments 11, 12 and 13 defined by baffle walls 14. Banks of heat-absorbing, still tubes indicated generally at 15 are mounted on the sides, bottom and top of the compartment 11 by any suitable mounting means (not shown). Burners 16 are mounted in an end wall thereof and discharge hot combustion gases into the compartment for heating fluid circulating through the banks 15.

Banks 17 of heat-absorbing tubes are disposed in the compartment 12, being supported thereon by any convenient known structure. Heat-radiating tubes 18 are positioned in rows between the banks 17 and extend upwardly from a hearth or the like 19 carried on structural members 20. A burner 21 is mounted in the lower end of each of the tubes 18 and pipe connections 22 extend therefrom to a supply of a suitable fuel. The upper ends of the tubes 18 are preferably open so that combustion gases are discharged therefrom after passing the length of the tubes, into the upper portion of the compartment 12.

The compartment 13 is provided with a heat-absorbing tube bank 23 and communicates with a stack (not shown) by means of a passage 24. The combustion gases discharged by the burner 16 and tubes 18 will thus pass through the compartment 13 in direct contact with the tubes of the bank 23.

The tubes of the several banks 15, 17 and 23 are so connected that the fluid traversing them follows the course indicated by the arrows 25. Suitable means such as pumps and the like are provided for circulating fluid through the tubes and the necessary control valves installed at the proper points. These details are not shown on the drawings (which are largely diagrammatic)

because they represent merely conventional practice.

As will be noted by tracing the arrows 25, the oil or other fluid to be heated enters the bank 23 at the bottom thereof and then flows through the banks 15. From the latter, it passes through the banks 17 successively. Gases and vapors resulting from the heating of the oil are taken off by suitable means and delivered to appropriate apparatus for further processing. By this arrangement, the entering oil is subjected to the heating action of the combustion gases on their way to the stack after giving up most of their heat to the banks 17 and 15. The banks 15 are heated by the combustion gases delivered by the burners 16. The banks 15 need not be heated to a relatively high temperature and since the gases from the burners 16 do not impinge thereon at high velocity, the life of the tubes forming the banks 15 is not seriously shortened by the direct contact of the gases therewith. In the zone of the maximum temperature, the compartment 12, the tubes of banks 17 are protected from the impingement of maximum temperature gases thereon at high velocity and are heated substantially exclusively by direct radiation. This arrangement effectively solves the problem of short tube life which has heretofore been experienced, particularly in the maximum temperature zones wherein the heat-absorbing tubes were subjected to the impingement of combustion gases at high temperatures and considerable velocities.

Fig. 3 illustrates a modified structure which is similar in principle to that shown in Figs. 1 and 2. In Fig. 3, a still 30 includes compartments 31, 32, 33 and 34 defined by baffles 35 and a cross wall 36. An opening 37 in the latter connects the compartments 33 and 34. Heat-absorbing tube banks 38 are disposed in the compartment 31 alongside the baffle 35 and adjacent the top or roof of the still. The compartment 32 is provided with heat-absorbing tube banks 39 and compartment 34 with heat-absorbing tube banks 40. All these banks are supported by known means. Banks 41 of heat-absorbing tubes are disposed in the compartment 34 in spaced relation. Heat-radiating tubes 42 are disposed in rows on opposite sides of the banks 41. The tubes 42 project downwardly from the top of the compartment 34 and each of them is provided with a burner 43.

The combustion gases passing through the tubes 42 heat them to radiant temperature. The ends of the tubes are open and the combustion gases discharged therefrom pass through the opening 37 into the compartment 33 and thence around the tubes of banks 40. The gases then pass upwardly around the right hand baffle 35 and downward through the banks 39 to a stack port 44.

A burner 45 is mounted in a suitable opening 46 in the side wall of compartment 31 and delivers hot combustion gases against the tubes of banks 38. As indicated by the arrows, the fluid to be heated is first passed through the tubes of banks 39 then through the tubes of banks 40. From the latter, the fluid passes through a connection 47 to the banks 38 and after traversing the latter it passes through a connection 48 into the banks 41. From the latter, the products formed in the cracking process are taken off through an outlet 49. The combustion gases discharged in the compartment 31 pass upwardly around the left hand baffle 35 and downwardly through the banks 39 and through the stack port 44 in the same manner as the tubes 42.

From the foregoing it will be realized that the structure of Fig. 3 operates on the same principle as that of Figs. 1 and 2, viz., indirect heating of the tube banks in the zone of maximum temperature by means of radiant tubes, and convection heating of the tube banks in lower temperature zones by means of the combustion products discharged by the radiant tubes, as well as other products formed by the combustion of fuel flowing from a burner.

The connections and control valves mentioned above include, of course, valves for controlling the amount of fuel supplied to each burner. By manipulating such valves it is possible to control the temperatures at various points throughout the still in a manner appropriate to the nature of the cracking operation being carried on. If the temperature of any one portion of the still becomes excessive, it is a simple matter to reduce the amount of fuel delivered to the individual burners in a manner such as to correct the abnormal temperature condition.

Further advantages of the invention include the fact that in the zones of maximum temperature the tubes through which the fluid circulates are not subjected to direct impingement of the combustion gases at high velocity. The oil tubes in the zones at highest temperature are heated indirectly or, in other words, by radiation substantially exclusively and it is only in the lower temperature zones in which the temperature and velocity of combustion gases are considerably reduced from their maximum values, that direct contact of the gases with the heat exchange tube is permitted. This prevents the useful life of the heat exchange tubes in the zones of maximum temperature from being shortened by the eroding effect of combustion gases at high temperatures and velocities. At the same time the use of convection heating in the zones of lower temperature raises the overall thermal efficiency of the cracking operation. The indirect heating of the tubes in the zones of maximum temperature has the further advantage that localized hot spots are largely avoided, together with the highly objectionable result usually accompanying such conditions, viz., coking of the oil on the interior of the heat exchange tubes. It will be readily apparent that the invention thus effects a material reduction in the cost of maintaining a fluid heating apparatus such as a still in efficient operating condition.

While we have illustrated and described but a few embodiments of the invention and a preferred practice thereof, it will be understood that changes in the embodiments and practice described may be made without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. In a cracking still, a radiant heating chamber and a convection heating chamber communicating therewith, a plurality of spaced banks of superposed heat-absorbing tubes in said radiant heating chamber, a plurality of substantially vertical heat-radiating tubes between adjacent banks, and a burner in one end of each heat-radiating tube, the other end of each heat-radiating tube being open to discharge combustion products into said convection heating chamber.

2. In a cracking still, a radiant heating chamber and a convection heating chamber disposed side by side and communicating with each other, a bank of superposed heat-absorbing tubes in said radiant heating chamber, a plurality of substantially vertical heat-radiating tubes adjacent said bank, and a burner in one end of each heat-radiating tube, the other end of each heat-radiating tube being open to discharge combustion products into said convection heating chamber, a second radiant heating chamber, heat-absorbing tubes therein, burners for heating it, said second radiant heating chamber communicating with said convection heating chamber, and a stack flue leading from said convection heating chamber.

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