Sept. 26, 1939. G. T. ELLIS 2,174,318

UNIT TANK HEATER

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Fig. 1.

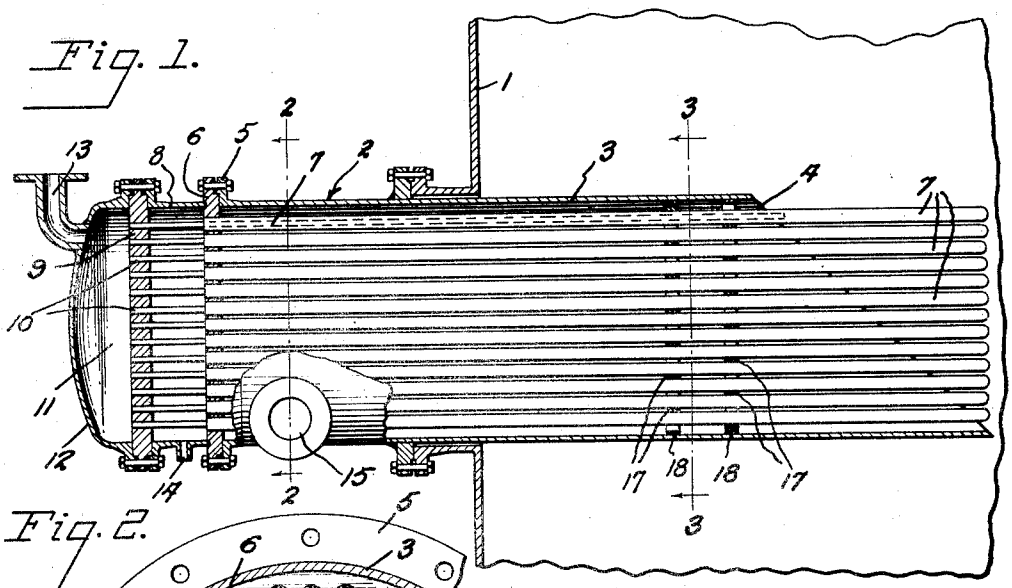


Fig. 2.

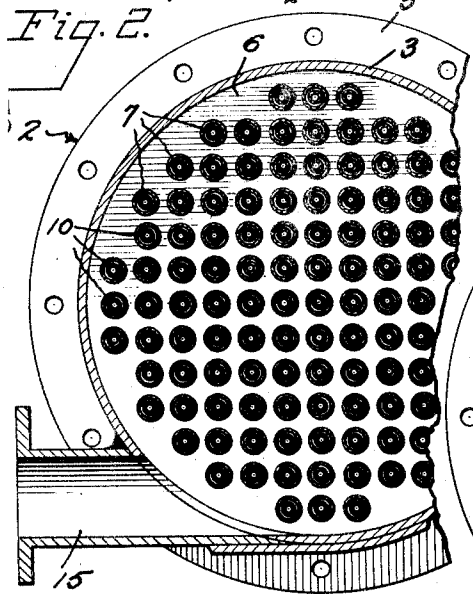


Fig. 3.

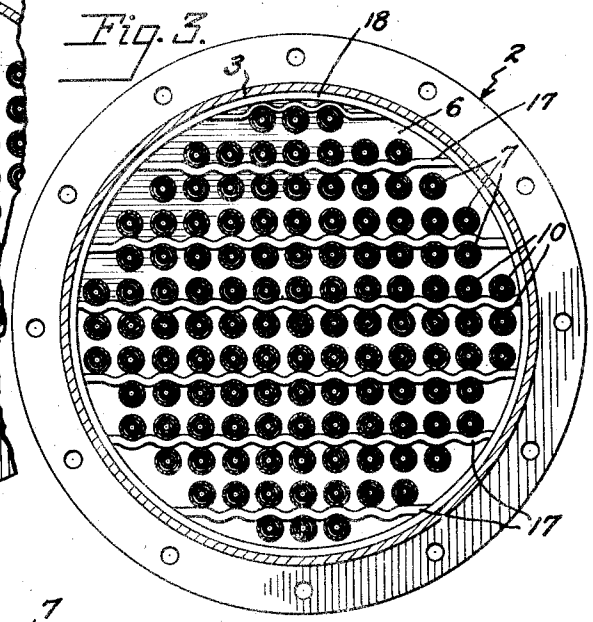
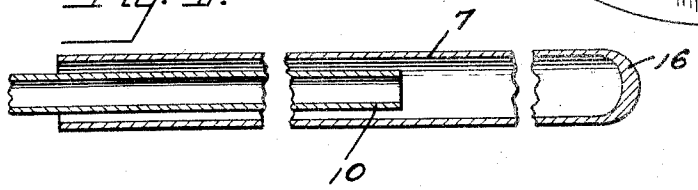


Fig. 4.



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Fig. 5.

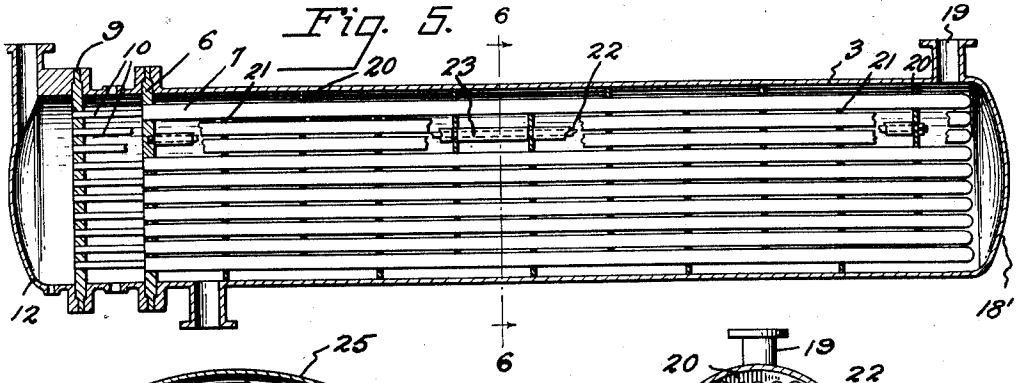


Fig. 9.

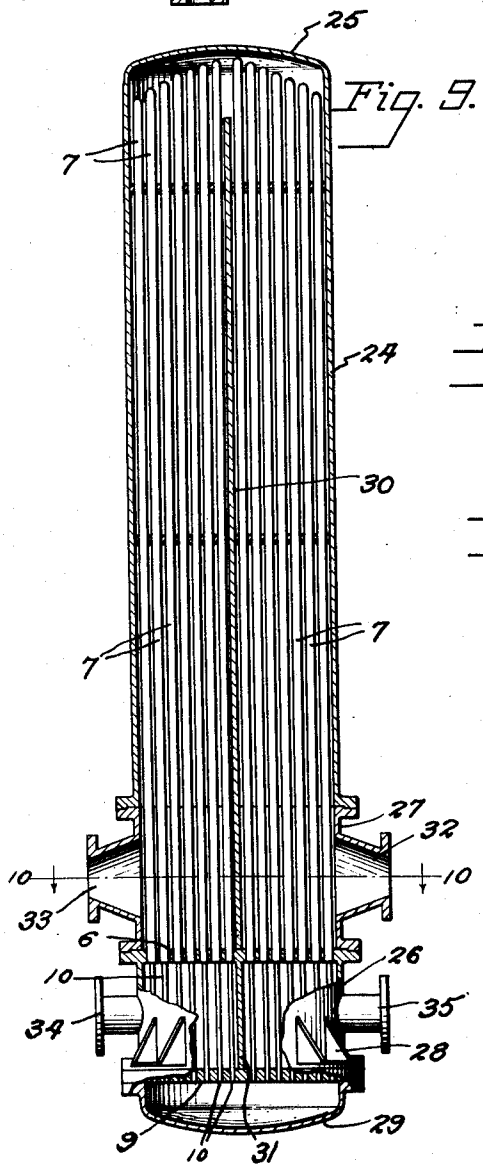


Fig. 6.

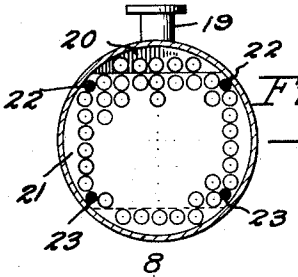


Fig. 7.

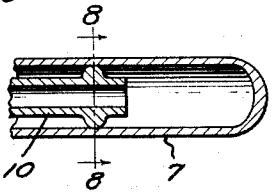


Fig. 8.

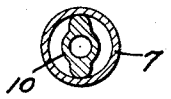
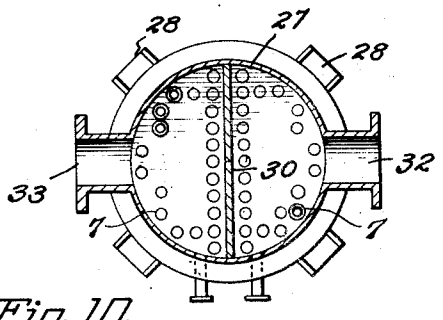


Fig. 10.



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UNITED STATES PATENT OFFICE

2,174,318

UNIT TANK HEATER

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Application April 14, 1936, Serial No. 74,365

9 Claims. (Cl. 257—198)

This invention relates to unit tank heaters intended to be installed in large storage tanks for viscous liquids, and designed for the localized heating, in the region of the point of withdrawal, of only approximately the quantity of the liquid which is to be withdrawn, for the purpose of reducing its viscosity sufficiently to facilitate drawing it off.

Heaters of this type are known and may comprise a shell extending into the tank having an open inner end for receiving the viscous liquid and containing a steam coil for heating the liquid as it passes through the shell. The suction side of a discharge pump opens into the opposite end of the shell.

In previous tank heaters of the type described the steam coils have included return bends at their outer ends, which have the effect of a series of bars across the mouth of the shell, obstructing the entrance of the viscous liquid into the shell, with the result that the pump could not be worked to its full capacity due to drawing a vacuum at its induction end.

One of the objects of the present invention is the provision in an open ended unit tank heater of a system of steam tubes which make individual end presentation toward the open inner end of the shell, whereby to minimize their obstructiveness to free flow into said shell.

Another object of the invention is to provide in a heater of the class described, a shell, the open end of which terminates in a plane inclined to the axis of the shell, for making the area of the open end greater than its d'ametrical cross section.

Still another object of the invention is the employment of a steam coil with the individual end presentation feature in combination with modified forms of shell for general purposes of heat exchange without reference to the immersion of the heater in a body of liquid for the localized heating of the same.

Other objects of the invention will appear as the following description of a preferred and practical embodiment thereof proceeds.

In the drawings, throughout the several figures of which the same characters of reference have been employed to designate identical parts:

Figure 1 is a longitudinal section through a unit tank heater embodying the principles of the present invention;

Figure 2 is a cross section taken along the line 2—2 of Figure 1;

Figure 3 is a cross section taken along the line 3—3 of Figure 1 showing the tube supports;

Figure 4 is a longitudinal section through one end of a steam tube;

Figure 5 is a modified form of the invention in which the steam core is employed in a horizontal heater for general heat exchanging purposes;

Figure 6 is a section taken along the line 6—6 of Figure 5;

Figure 7 is a longitudinal section through the end of one of the steam tubes;

Figure 8 is a section taken along the line 8—8 of Figure 7;

Figure 9 is a longitudinal section through a vertical type of heat exchanger; and

Figure 10 is a cross section taken along the line 10—10 of Figure 9.

Referring now in detail to the several figures and first adverting to that form of the invention illustrated in Figures 1 to 4, the numeral 1 represents the wall of a storage tank adapted to contain a body of viscous liquid such, for example, as crude oil. A unit tank heater which is, in general, designated by the reference character 2, is mounted at the side of the tank and extends through the wall 1 as shown. The tank comprises a shell 3 which in the illustrated example has an open inner end 4 terminating in a plane inclined to the axis of the heater so as to give the open end a larger cross sectional area than it would if the shell terminate in a plane perpendicular to the axis of the heater, although the last named construction is within the purview of the invention. The outer end of the shell 3 may be flanged as at 5 and against the flange rests a tube sheet 6 carrying a bundle of spaced, parallel, closed ended, outer tubes 7 which extend into the shell 3, preferably at least throughout its length. As shown, the tubes extend beyond the plane of the inner open end, but while this is advantageous in warming the liquid just prior to its entry into the open end of the shell, it is not essential.

The tube sheet 6 may be bolted to the flange 5 so that by removing the bolts or equivalent securing means the tube sheet with the attached bundle of tubes may be withdrawn from the shell for inspection. This, of course, can only be done when the storage tank is empty to a point below the level of the heater.

A flanged extension 8 is made unitary with the tube sheet 6 in any suitable manner as by welding, and a tube sheet 9 is detachably secured to the flanged extension 8 and carries a bundle of open ended inner tubes 10 of smaller external diameter than the internal diameter of the outer tubes and extending partially therethrough, but

terminating short of the closed ends of the outer tubes. The ends of the inner tubes adjacent the tube sheet 9 open into a common chamber 11 formed within an enclosing head 12 bolted together with the tube sheet 8 with the flanged extension 8. By removing the bolts the head 12 may be taken off, exposing the open ends of the inner tubes which may be thus readily inspected. If necessary, the tube sheet 9 together with the bundle of inner tubes 10 may be drawn out from the shell and from the outer tubes 7.

It is thus apparent that by this simple construction all parts of the heater may be disassembled for inspection or repair. The head 12 has an inlet connection 13 adapted to be connected to a source of steam while the chamber within the extension 8 and between the two tube sheets, which chamber is open to the outer tubes 7, is provided with a connection 14 for the discharge of the exhaust steam and condensate. Steam passes through the inner tubes 10, issues as a jet from the inner open ends of the inner tubes into the terminal portions of the outer tubes and returning, it passes through the annular space between the inner and outer tubes discharging into the chamber within the extension 8. By this arrangement any condensate in the outer tubes is continuously blown out and the tubes are thus at all times 100% efficient. The viscous liquid from the storage tank enters the open end of the shell 3, is warmed by contact with, and proximity to the steam pipes and is drawn out by way of the connection 15 to which is connected the induction side of a pump, not shown.

It is old in the art to have a unit tank heater in which tubes corresponding to the steam tubes 7 are joined adjacent the open end of the shell by transverse portions or return bends, but Figure 4 shows that the outer tubes 7 of the present invention are individually closed at their inner ends 16 and that the inner ends are preferably either rounded or streamlined so as to present the minimum resistance to the admission of viscous liquid from the storage tank to the shell. Figure 4 shows that the closed ends of the outer tubes are preferably thickened so as to withstand the wear and tear incident to the impingement of steam from the inner tubes against said inner ends.

In that form of the invention illustrated, by reason of the inclined oblique terminal plane of the open end of the shell 3 and the fact that the steam tubes extend the full length of said shell, said tubes are in part exposed beyond the limits of the shell so that they impart heat to and reduce the viscosity of the liquid outside of the shell and adjacent the open end thereof preparing it for easy entry into said shell under the pull of the pump. The individual end presentation of the steam tubes 7 minimizes the obstruction created by the presence of the steam pipes still facilitating the inflow of the liquid. Both of these factors together with the enlarged area afforded by the inclined shape of the open end of the shell permits a large capacity pump to be employed without the development of suction at the induction end than is practicable with known forms of unit tank heater.

The tubes 7 are supported within the shell by transverse straps 17 preferably of undulating shape as shown secured at their ends to a ring 18 slidably fitting within the shell 3. Said straps are provided at intervals of two tiers of tubes and there are two such series of straps as shown in Figure 1 with the straps staggered so as to minimize the obstruction of the straps to the flow of liquid.

It will be understood, of course, that the purpose of a unit tank heater in a storage tank is to heat only the amount of liquid withdrawn instead of heating the entire body of liquid in the storage tank which was the practice prior to the advent of the unit tank heater.

Referring now to that form of the invention shown in Figure 5, the construction may be identical with that already described insofar as the header 12, tube sheets 9 and 6 and the respective bundles of inner and outer steam tubes 10 and 7 are concerned. The shell, however, is closed at its outer end 18' and a connection 19 provided at the outer end for the admission of the liquid to be heated. Within the shell 3 are a plurality of baffles 20 and 21 secured alternately to the upper and lower walls of the shell so that the entering liquid must follow a tortuous course from the outer to the inner end of the shell sweeping the sides of the steam tubes 7 and thus being subjected in its traverse of the heater to the maximum degree of heat transfer. The baffles 20 and 21 are maintained perpendicular to the axis of the shell by means of tie rods 22 extending from the tube sheet 6 to the final baffle at the outer end of the heater. The tie rods pass through perforations in the baffles and support spacers 23 of larger diameter than said perforations and which abut against opposite sides of the baffles.

Figure 9 shows a modification of the invention adapted for general heat exchanging purposes between two liquids, in which the shell 24 is vertically mounted and closed at its upper end 25. The tube sheets 9 and 6 and the bundles of inner and outer tubes 10 and 7 carried thereby, may be identical with corresponding elements in those forms of the invention already described. The shell 24 is tiered serially upon two extensions 26 and 27. The extension 26 has supporting brackets 28 projecting radially therefrom adapted to rest upon concrete supports, and an underlying head 29 is provided forming a chamber into which the inner tubes 10 open. The space within the extension 26 and between the two tube sheets forms a chamber communicating with the outer tubes. A vertical partition 30 divides the shell 24 into two semi-cylindrical halves, excepting near the top of the shell where the partition 30 terminates short of the upper end of the shell forming an over-pass for the liquid circulating in the shell outside of the tubes. An inlet 32 and an outlet 33 are provided at the bottom of the shell 24 on opposite sides of the partition.

The partition 30 continues through the extension 27 to the tube sheet 6, and a continuation 31 of the partition passes through the extension 26 terminating at the tube sheet 9. Thus, likewise, both extensions are divided into two semi-cylindrical halves, the upper extension 27 registering with the halves of the shell 24, while the partition in extension 26 separates the inner tubes 10 and outer tubes 7 into two serial banks. The extension 27 is provided with an inlet 32 and an outlet 33.

In operation, one of the liquids, in heated state, for example, enters the inlet 32, circulates upwardly in the right hand part of the shell, flows over the overpass downward through the left hand half of the chamber within the shell 24 and discharges through the outlet 33. The other liquid enters an inlet 34 on the left side of the

lower extension, circulates through the outer tubes 7 of the right hand bank and returns through the inner tubes 10 of the same bank discharging into the header 29 which acts as an underpass directing the liquid to the inner tubes 10 of the right hand bank through which it flows upwardly, discharging into the outer tubes, and downwardly through the outer tubes into the right hand chamber of the lower extension 26 from which it discharges through the outlet 35.

It will be understood from the above that there is a counter-current circulation in both sides of the shell between the liquids which are in heat exchanging relation and that part of the liquid which is in the shell 24 of highest temperature is in heat interchanging relation with liquid in the tubes of highest temperature while liquid in the shell of lower temperature is in heat exchanging relation with liquid in the tubes of lower temperature, thus at all times maintaining the rate of heat exchange between the two liquids substantially constant.

What I claim is:

1. Immersion type heater comprising a shell, a bundle of spaced steam tubes within said shell extending toward the inner end thereof, said inner end having an opening of such size as to fully expose the end of said tube bundle, said tubes being closed, and unconnected at their inner ends, whereby to provide a minimum aggregate obstructive area to the inflow of liquid into the inner end of said shell, the latter having an outlet adjacent its outer end adapted to be connected to the induction side of a discharge pump.

2. Immersion type heater comprising a shell, a bundle of substantially parallel rectilinear spaced steam tubes within said shell extending toward the inner end thereof, said inner end having an opening of such size as to fully expose the end of said tube bundle, said tubes being closed, and unconnected at their inner ends whereby to provide an obstructive area not greater than their aggregate cross sectional area, to the inflow of liquid into the inner end of said shell.

3. Immersion type tank heater comprising a shell the bounding side wall of which terminates in a slope extending downwardly and away from the outer end of said shell, a bundle of spaced steam tubes within said shell extending toward the inner end thereof, intersecting the plane of said slope whereby the end of the tube bundle and length portions of the upper tubes are fully exposed to the exterior of said shell, said tubes being closed and unconnected at their inner ends whereby to provide a minimum aggregate obstructive area to the inflow of liquid into the inner end of said shell, said shell having an outlet adjacent its outer end adapted to be connected to the induction side of a discharge pipe.

4. Immersion type tank heater comprising a shell the bounding side of which terminates in a slope extending downwardly and away from the outer end of said shell, a bundle of spaced steam tubes within said shell extending toward the inner end thereof, intersecting the plane of said slope and terminating in a plane perpendicular to the longitudinal axis of said shell, the end of the tube bundle and length portions of the upper tubes being fully exposed to the exterior of said shell, said tubes being closed, and unconnected at their inner ends whereby to provide an obstructive area to the endwise inflow of liquid into the inner end of said shell not greater than the aggregate cross sectional area of said tubes, said shell having an outlet adjacent its outer end adapted to be connected to the induction side of a discharge pump.

5. Immersion type heater comprising a shell, a bundle of spaced steam tubes within said shell extending toward the inner end thereof, said inner end having an opening fully exposing the end of said tube bundle, said tubes being closed, and unconnected at their inner ends whereby to provide a minimum aggregate obstructive area to the inflow of liquid into the inner end of said shell, the latter having an outlet adjacent its outer end adapted to be connected to the induction side of a discharge pump, said tubes each comprising an inner and an outer member, the inner ends of the outer members being closed and the inner ends of the inner members being open to provide return circulation through said tubes, spaced tube sheets at the outer end of said shell, one supporting the outer members and the other the inner members, one set of members opening into the chamber between said tube sheets.

6. Immersion type of heater as claimed in claim 5, the tube sheets being independently removable from said shell unitarily with the respective sets of tube members which they support.

7. Immersion type heater comprising a shell, a bundle of substantially parallel, rectilinear steam tubes within said shell extending toward the inner end thereof, said inner end having an opening of such size as to fully expose the end of said tube bundle, said tubes being closed and unconnected at their inner ends whereby to provide a minimum aggregate obstructive area to the inflow of liquid into the inner end of said shell, the latter having an outlet adjacent its outer end adapted to be connected to the induction side of a discharge pump, said tubes each comprising an inner and an outer member, the inner ends of the inner members being open to provide return circulation through said tubes, spaced tube sheets at the outer end of said shell, one supporting the inner and the other the outer set of tube members, one set of said members opening into the chamber between the tube sheets.

8. Immersion type heater comprising a shell, a bundle of spaced steam tubes within said shell extending toward the inner end thereof, said inner end having an opening of such size as to fully expose the end of said tube bundle, said tubes being closed and unconnected at their inner ends whereby to provide a minimum aggregate obstructive area to the inflow of liquid into the inner end of said shell, the latter having an outlet adjacent its outer end adapted to be connected to the induction side of a discharge pump, said tubes each comprising an inner and an outer member, the inner ends of the outer members being closed and the inner ends of the inner members being open, to provide return circulation through said tubes, spaced tube sheets at the outer end of said shell respectively supporting the inner and outer sets of tube members, one set of tube members communicating with the chamber formed between said tube sheets, a header for said shell, the other set of tube members communicating with the chamber within said header, means for supplying steam to one of said chambers and a steam and condensation outlet for the other of said chambers.

9. Immersion type tank heater as claimed in claim 8, said header and said tube sheets being separately removable from said shell, and said tube sheets being unitarily removable with the respective sets of tube members which they support.

GUY T. ELLIS.