

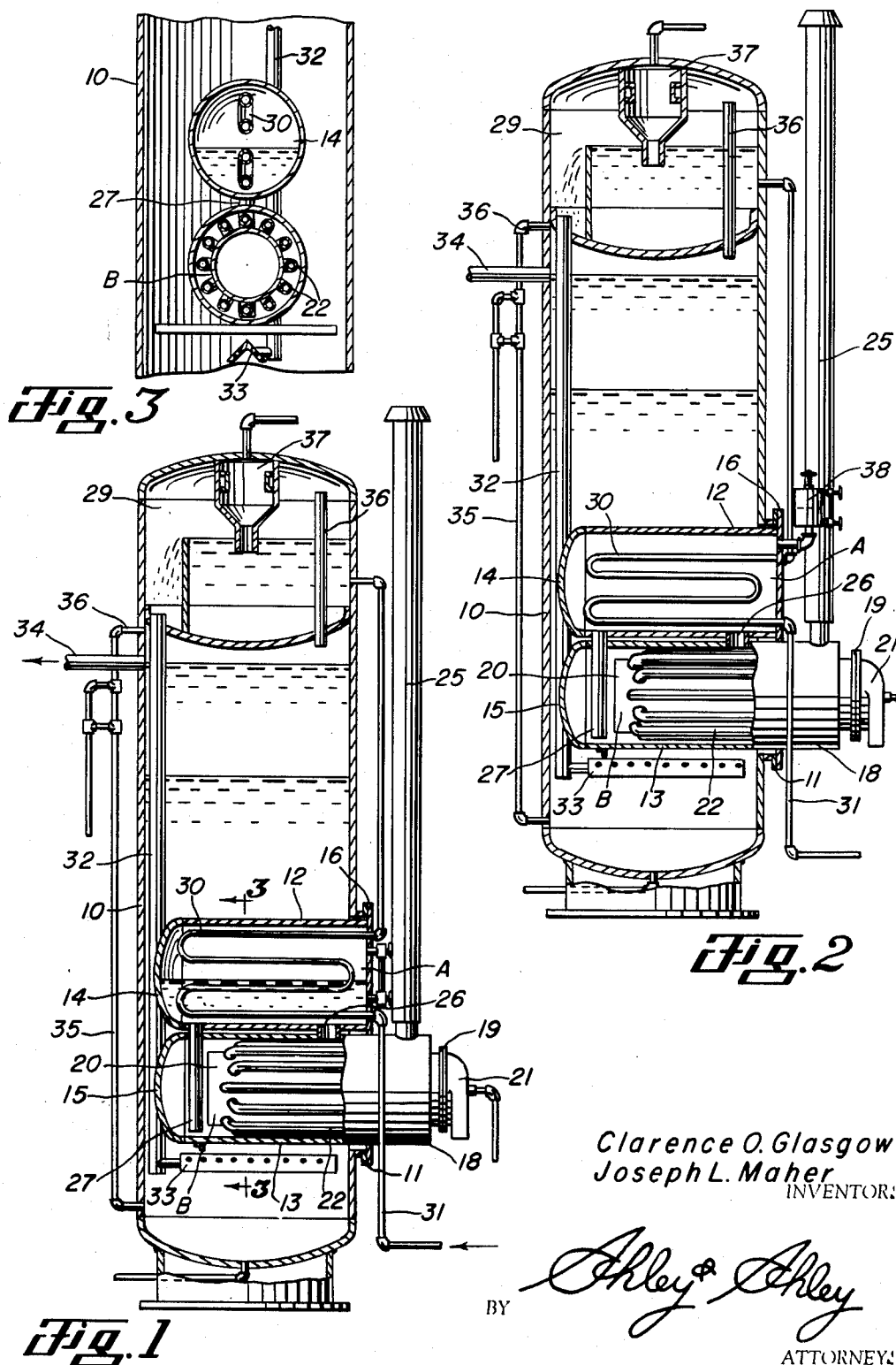
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SYSTEMS FOR TREATING OIL WELL EMULSION STREAMS

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SYSTEMS FOR TREATING OIL WELL EMULSION STREAMS

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6 Claims. (Cl. 210—52.5)

This invention relates to new and useful improvements
in apparatus for treating oil field emulsion streams.

The structures disclosed in this application are partly
disclosed in our co-pending applications Serial No.
775,118, filed September 19, 1947, refiled as application
Serial No. 263,164 on December 26, 1951, now Patent
No. 2,625,915, issued January 20, 1953, and application
Serial No. 775,120, filed September 19, 1947, now aban-
doned. This application is a continuation-in-part of the
aforementioned co-pending applications.

Heretofore, many methods have been utilized for the
heating of petroleum emulsion streams to aid in the
breaking of the emulsion and the subsequent stratification
of the streams into separable oil and water phases, along
with the removal of at least a portion of the gases present.
The heating of such emulsion streams presents a consider-
able number of problems due to certain characteristics of
the emulsion stream itself. Obviously, it is highly desir-
able to heat the emulsion to the proper temperature at
which most efficient breaking and separation takes place,
but at the same time, provision must be made for pre-
venting the attaining of excessive temperatures which
have a number of harmful results.

To begin with, a number of heating systems have in
the past been employed for emulsion treaters, wherein an
emulsion stream is processed in order to break the emul-
sion and allow segregation of the components thereof. In
some instances, steam coils have been employed with
considerable success, but the main objection has been the
expense of providing a boiler for the heating of such
treaters. Obviously, the provision of a boiler for the
supplying of steam merely to heat a single vessel is not
feasible or practical because of such expense, and be-
cause of the constant attention and servicing that such
a boiler requires. Also, an exposed boiler is particularly
impractical because of the unusual radiation losses and is
economical only if insulated at considerable expense with
the consequent increase in maintenance costs and in-
creased difficulty encountered in moving the boiler from
one location to another.

Therefore, a simple heater, which extends interiorly
of the emulsion treater, has been developed, and has
been used with some degree of success. Such a heater
comprises a simple fire tube within the emulsion treater,
the emulsion stream passing in direct contact with the
outside wall of the heater, while a simple gas burner passes
hot combustion gases through the interior of the tube.
Thus, the emulsion stream is heated by direct contact with
the flame-heated wall of the tube. Necessarily, the wall
temperature of the heater is high, and this contacting of
hot metal with an unstable and corrosive liquid, such as
crude petroleum or petroleum emulsions may, and fre-
quently does, create an extremely severe scaling and cor-
rosion problem. There are almost invariably "hot spots"
in the wall of the heater and additionally accelerated
scaling and corrosion occurs at these points.

The problem of scaling has been especially severe as
will be readily apparent upon an examination of the fluids

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which are being handled, and the conditions they must
undergo in this type of heater. A petroleum emulsion
consists primarily of hydrocarbon gases, crude petroleum,
and water having considerable quantities of salts and other
compounds dissolved therein. While the various com-
ponents of the emulsions are combined into a partially
homogeneous mixture which is sometimes very difficult
to break or separate, an emulsion will and does undergo
marked decomposition at excessive temperatures, along
with a considerable degree of precipitation or separation
of solids and the evolution of valuable gases. Specifically,
raising the petroleum portion of the emulsion to an exces-
sively high temperature often causes volatilization of
lighter fractions of the petroleum with the probable sub-
sequent loss of these fractions as well as the "cracking"
and "coking" of the hydrocarbon material to form a com-
bination deposit on the heater tube in the nature of a
scale.

The water portion of the emulsion normally contains
considerable quantities of dissolved or suspended salts or
other compounds such as sodium chloride and sodium car-
bonate or bicarbonate. Subjecting this portion of the
emulsion to excessive temperatures will result almost in-
variably in a precipitation or settling out of a portion of
the dissolved or suspended salt so as to form a cake or
scale on the heater tube. Also, the carbonates or bicar-
bonates may be decomposed to evolve gases and create un-
desirable turbulence, while additional deposits are formed
upon the heater tube. Even though such deposits do not
always adhere to the heater tube, they may be dispersed
through the emulsion and the subsequently separated
water so as to hamper the disposal later on of said water
in manners to be described more fully hereinafter.

These undesirable effects upon these two portions of
the emulsion stream are aggravated by the undue turbu-
lence created by the evolving of the various gases or
vapors, such turbulence being highly undesirable in an
emulsion treater as detrimental to the proper settling
and stratification of the oil and the water components.
Thus, excessive heating of the emulsion stream tends to
some extent to defeat the very purpose for which the heat
is originally introduced, that is, the efficient separation
and stratification of the water and the oil components
which form a large percentage of the emulsion.

As may well be expected, the deposit of material upon
the heater tube greatly reduces its heating efficiency and
ultimately results in actual physical failure of the tube
which necessitates its removal and replacement with the
consequent expense and loss of operating time of the
treater. Since the wall temperature of such a directly fired
gas heater tube may easily reach a temperature of 800° F.
or higher, the contacting of a metallic tube at such elevated
temperatures with a relatively unstable liquid which is
corrosive in nature and which readily deposits heavy
scales, provides a situation in which accelerated corrosion
of the heater tube is encouraged. Necessarily, it is of
considerable benefit to avoid the creation of such condition
and to maintain the heater tube at a temperature at which
precipitation and volatilization of components of the
emulsion stream are avoided, along with excessive scaling
and corrosion. The present invention overcomes substan-
tially all of these difficulties by means of a heat ex-
change medium which is relatively inert and serves to
protect the fluid being heated against the application of
excessive heat, while also protecting the hot walls of the
heater from accelerated scaling and corrosion.

There are many reasons why it is desirable to have
such a heater constructed as to be insertable as a unit
into the interior of the emulsion treater. One reason is
that a unitary structure is achieved which may be shipped
and installed as substantially one main element and re-
quires only one foundation or base. Another is that what

otherwise would be heat losses from the heater is absorbed by the liquid in the treater rather than being dissipated to the atmosphere. Still another is that materials are conserved because it is not necessary to provide a separate housing and separate installation for the heater, along with connecting pipes and the like which are subject to leakage, heat dissipation, scaling, and corrosion.

An important object of the invention is to provide an improved emulsion treater having means for supplying heat to an emulsion stream at controlled or limited temperature levels by means of a heat exchange fluid, and for pre-heating the emulsion stream by passing the latter stream in heat exchange relationship with the heat exchange fluid.

Other objects and advantages of the invention will be apparent from a reading of the following description of the structure and operation of one embodiment of the invention.

In this application and the claims appended thereto a number of defined terms will be used for the sake of simplicity.

The terms "heat-unstable liquid" and "heat-unstable fluid" will be used to designate any liquid or fluid which tends to deposit scale or cake on an excessively heated surface, to display corrosive properties, to decompose in the presence of heat, to lose components by vaporization in the presence of heat, or from which solids may precipitate in the presence of heat, or which may undergo other undesirable changes in the presence of elevated temperatures such as petroleum, petroleum emulsions, salt-bearing liquids such as water, and like fluids.

The terms "heat-stable liquid" and "heat-stable fluid" will be used to designate liquids or fluids which do not deposit scale or become corrosive within reasonable temperature limits and which exhibit a substantial minimum of undesirable or harmful properties when in contact with a hot surface, such as hot metal, within the range of ordinary flame temperatures, examples being fresh water, ethylene glycol, commercial heat-transfer fluids, and the like.

A construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawing, wherein an example of the invention is shown, and wherein:

Fig. 1 is a vertical, sectional view of an emulsion treater constructed in accordance with this invention,

Fig. 2 is a view similar to Fig. 1, and showing a modification of the invention, and

Fig. 3 is a fragmentary, vertical, sectional view taken at right angles to Fig. 1 and on line 3—3 of the latter figure.

In the drawings, the numeral 10 designates an emulsion treater tank through which flows or in which is disposed an emulsion or a heat-unstable liquid to be heated. This invention does not contemplate primarily the heating of such liquids within a treater to temperatures in excess of 250° F. However, higher and especially lower, temperatures may be obtained and employed in accordance with the treating problem at hand. Therefore, specific reference to operating temperatures has not been made.

Nor is the invention to be limited to the use of specific heat exchange mediums (although fresh water is chiefly used) or to certain liquids to be heated. This method and means for heating is particularly adapted to emulsion treating, but the nature of such emulsions varies considerably in accordance with the source of the same as well as the conditions under which they have been produced. Petroleum emulsions represent a raw product which is fluid in nature and of widely variable composition. They are often corrosive and are relatively unstable, and provision must obviously be made for adapting the degree of heating accomplished to the characteristics of the par-

ticular emulsion at hand. Therefore, it is sometimes necessary to heat certain emulsions to 110° F. or 120° F. for efficient separation, while other emulsions must be heated to much higher temperatures. For this reason also, specific operating temperatures have not been included.

Proceeding now with the description of a particular embodiment for carrying out this method as illustrated in the drawings, the treater tank 10 receives a heating unit A through a flanged opening 11 in one side wall of the vessel. The heating unit includes an upper chamber or drum 12 and a lower chamber or drum 13, both drums being in the shape of elongate cylinders having their inner ends closed by suitable dished plates 14 and 15, respectively. The drums are disposed horizontally with the vessel and have their longitudinal axes aligned parallel to one another in a vertical plane. The outer end of the upper cylinder is closed by being welded to the upper portion of a vertical plate 16 of such size and shape as to cover the flanged opening 11, said plate being secured to the flange by suitable bolts. The lower drum 13 has its outer section 18 extending through the lower portion of the plate 16 and projecting outwardly therebeyond. An annular, external flange 19 is provided on the extreme outer end of the outer section 18 of the lower drum for receiving a boiler unit B.

The boiler unit B comprises a fire tube 20 having a suitable burner structure 21 secured in its outer end. The tube 20 extends axially of the lower drum 13 and carries a plurality of return fire tubes 22 and which have their open outer ends communicating with an annular smoke box surrounding the extreme outer end of this tube. A smoke stack 25 extends upwardly from said smoke box to conduct the combustion gases from said box.

The upper and lower drums are connected by a pair of conductor pipes 26 and 27. The outermost conductor 26 extends between the upper wall of the lower drum and the lower wall of the upper drum, while the inner conductor 27 extends from the opposite end of the lower wall of the upper drum to a point within the lower drum and positioned adjacent the lower wall thereof.

A suitable heating or heat transfer medium or heat-stable fluid such as fresh water or ethylene glycol is contained within the drums 12 and 13. The boiler unit B is thus immersed in said fluid or transfer medium which is carried at a level in the lower half of the upper drum. In this manner, the heat generated within the boiler unit is transferred by thermal conduction to the heat transfer medium, and the latter circulates within the heating unit comprising the upper and lower drums, through the thermo-siphon established by the pair of conductors extending between said drums. A portion of the medium may be vaporized by the heating to create a relatively small pressure within the heating unit, so that it may be desirable to utilize suitable safety connections such as pressure release valves, temperature controls, and the like. Suitable provision is also made for filling and draining the boiler unit with the heat transfer medium.

This method or system also contemplates heat exchange by a low pressure steam system contained within an emulsion treater. Thus, a pressure of 10 or 15 pounds per square inch may be carried within the upper and lower drums, such pressure being generated by heating of the heat exchange medium by the boiler unit B. In some instances, improved emulsion heating is obtained by such vapor phase heat transfer, especially where relatively high heat input is required or desirable.

Of course, additional or different safety connections may be necessary or desired under this increased operating pressure, and such is contemplated.

The structures described, while simple in operation, possess many advantages and features not heretofore supplied by previous heaters, and make possible the utilization of the improved emulsion treating method which this invention contemplates. The fire tube, being surrounded

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by a blanket of non-corrosive heating fluid, is protected against decomposition and accelerated scaling, rusting, and other undesirable or harmful effects. In addition, since the tubes are immersed in a fluid selected for its efficacy as a heating exchange medium, the former may operate more efficiently due to the improved heat transfer condition inherently contributed by such a fluid. "Hot spots" are reduced in size and intensity and a general overall reduction of scaling, corrosion and the like, and of high "film" or heat transfer resistance, along with an increase of heating rate and efficiency results. At the same time, turbulence and vaporization are minimized because of the uniform moderate heating achieved.

The heating medium, having increased heat content or being vaporized due to its contact with the fire tube, rises through the conductor 26 by reason of its reduced density. The medium will exist in both liquid and vapor forms at this point, so that stratification of the dissimilar phases occurs within the upper drum. As the heat content of the heating medium is dissipated through the walls of the upper drum, condensation and cooling occurs whereby the density of the medium or fluid is increased and it seeks the level of the lower drum by passing downwardly through the conductor 27 to the lower portion of the lower drum where it is again heated by the boiler unit. Thus, a continuous heating and cooling of the heating fluid occurs, setting up a thermal convection circuit of the heated medium into the upper drum and the return of the less heated medium into the lower drum. Thus, insofar as the circulation of the heated medium or heat exchange fluid is concerned, the upper drum may be termed a conductor for the heat exchange fluid in its thermosiphonic circuit.

Both drums are relatively hot and within the same temperature range so that there is a constant transfer of heat to the contents of the treater 10 from both drums. The overall quantitative transfer of heat approaches the input of the burner since the heat radiation from the heating unit, which is lost by dissipation to the atmosphere from the previously used separate units and the pipes connecting them to the vessels, is instead absorbed by the contents of the treater. The units of heat which escape through the smoke stack represent a relatively small percentage due to the low specific heats of the combustion gases and the efficient heat transfer effected by the fire tube structure. As pointed out before, the nature of the heating medium protects the boiler unit as well as enhances its thermal efficiency.

The utilization of this fluid as an intermediate conductor of heat also protects the emulsion contained within the treater 10 and provides a more desirable and uniform mode of introducing heat into said treater. Since the hottest portion (the vapor phase) of the heating medium will not be at a temperature greatly in excess of the boiling point of the heat transfer medium at whatever pressure exists within the heating unit, and the coolest portion of the medium is not greatly below such point, the entire exterior wall of the unit will be kept at substantially uniform temperature with no "hot spots" or locally increased rates of heat transfer. Therefore, the objectionable features of ordinary heaters set out hereinbefore are substantially eliminated. Scaling along with localized "coking" on the outside of the heater, and decomposition, along with excessive volatilization of the liquid within the treater is rendered negligible if not prevented entirely.

The treater shown in Fig. 1 includes the tank 10 having a preliminary separation chamber 29, which may be of any suitable type or structure, disposed in its upper portion. The heating unit A is carried in the lower half of the tank and is provided with any desirable type of pipe coil 30 within the upper drum 12. An emulsion inlet pipe 31 extends upwardly to the chamber 29, the coil 30 being connected into said pipe whereby influent emulsion passes through the former. Thus, the incoming emulsion is

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heated by the hot liquids and vapors within the upper drum and enters the chamber 29 in a somewhat warmed or heated condition. For this reason, the preliminary separation of the emulsion into its constituent components along with the coalescing of "free" water and removal of excessive gas is greatly enhanced and a larger proportion of such separation occurs prior to the introduction of the emulsion stream into the lower portion of the lower portion of the tank. In this manner, the load placed on the lower portion of the tank is reduced and separation and stratification of large portions of the emulsion take place almost immediately upon its entry into said lower part of the tank. The heat available from the body of salt water and the heating unit is thus utilized to a large extent to heat and break the "tighter" portions of the emulsion since the heating unit is not encumbered and hampered by the presence of large quantities of "loose" emulsion. The latter, having already been separated to a considerable degree, enters as relatively distinct oil and water phases which pass rapidly to their respective levels in the tank. This rapid flow is engendered by the comparatively sharp difference in the gravities of the oil and water. The as yet unbroken emulsion has a more intermediate gravity, usually nearer that of water than that of oil, and therefore tends to pass upwardly over the drums 12 and 13 at a relatively slow rate whereby its heating, and subsequent breaking or separation, is greatly facilitated. As it separates, its components of course move more rapidly toward their proper levels. In this manner, the output of the heating unit is directed toward more efficient and certain results, and the overall efficiency and efficacy of the emulsion treater is enhanced.

The emulsion, after preliminary separation in the chamber 29, passes downwardly through a conductor 32 to a spreader 33 positioned beneath the heating unit A. Because of its gravity, the emulsion flows upwardly through the body of heated water present, around the drums 12 and 13, and is properly broken and separated. Oil is taken off near the upper end of the lower portion of the tank by a pipe 34, while water is drawn off from the lower end of the tank by a water leg 35. The structure of the water leg is such as to maintain the desired water level within the tank and acts, through the well-known principles of syphons, to remove water only as it is introduced by the influent emulsion. The body of heated water is thus kept at a substantially uniform level at all times.

Suitable pressure equalization lines and pipes 36 connect the various outlets and compartments of the tank so that the gravity and syphon flow by which the tank operates, is not hindered or adversely affected. A small gas scrubbing chamber 37 is provided in the upper end of the chamber 29 for removing entrained and/or readily-condensable liquids from effluent gas being conducted from the tank.

In Fig. 2 of the drawings, there is illustrated an alternative method of operating the heating unit and of supplying heat to the pre-heating coil 30. As pointed out in conjunction with the description just given of the structure of Fig. 1, the heat exchange fluid may be water or any other suitable material. In this form, an appreciable portion of the heat transferred from the unit B passes through the vapor phase of the heat exchange medium in the upper portion of the upper drum 12, and hence, much of the transferred heat represents latent heat of condensation of the heat exchange medium. The structure shown in Fig. 2 is substantially the same as that of Fig. 1, except that a volume chamber 38 is provided at the upper end of the upper drum 12 so that both the drums 12 and 13 may be maintained full of heat exchange liquid. Such liquid may be water, any of the organic or inorganic heat exchange materials, or any other suitable medium. The principal difference between the two forms of the invention is that one is adapted primarily for use with vaporized heating mediums and the other with liquid mediums.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What we claim and desire to secure by Letters Patent is:

1. An apparatus for treating oil field emulsion streams which includes, a vessel constructed to contain a body of heated liquid, means for maintaining said body of liquid at a predetermined liquid level and for drawing off clean oil from the vessel, a conductor discharging the emulsion stream into said body, a hot fluid generator disposed in the vessel below the predetermined liquid level, the generator being constructed to be immersed in the body of heated liquid for heating said body and emulsion stream to break down the emulsion, a pre-heating conductor in the hot fluid generator and within the vessel, means for conducting an emulsion stream to the pre-heating conductor, means for conducting the emulsion stream from the pre-heating conductor to the first-named conductor, and means for drawing off water from the vessel, the hot fluid generator including an enclosure constructed to contain a body of heat exchange fluid, heating means in the enclosure arranged to be immersed in the body of heat exchange fluid, and the pre-heating conductor being exposed to the body of heat exchange fluid.

2. An apparatus for treating oil field emulsion streams as set forth in claim 1, wherein the hot fluid generator includes, an enclosure having two inter-connected superposed chambers constructed to contain a body of heat exchange fluid, and heating means in the lower chamber arranged to be immersed in the body of heat exchange fluid, the pre-heating conductor being in the upper chamber and exposed to the body of heat exchange fluid.

3. An apparatus for treating oil field emulsion streams which includes, a multi-compartment vessel constructed to contain a body of heated liquid in one compartment, means for maintaining said body of liquid at a predetermined liquid level and for drawing off clean oil from the vessel, a conductor discharging the emulsion stream into said body, a hot fluid generator disposed in the latter compartment of the vessel, the generator being constructed to be at least partially immersed in the body of heated liquid for heating said body and emulsion stream to break down the emulsion, a pre-heating conductor in the hot fluid generator and within the said latter vessel compartment, means for conducting an emulsion stream to the pre-heating conductor, means

for conducting the emulsion stream from the pre-heating conductor to a second compartment in the vessel and from the second compartment to the first-named conductor, and means for drawing off water from the vessel, the hot fluid generator including an enclosure constructed to contain a body of heat exchange fluid, heating means in the enclosure arranged to be immersed in the body of heat exchange fluid, and the pre-heating conductor being exposed to the body of heat exchange fluid.

4. An apparatus for treating oil field emulsion streams as set forth in claim 3, wherein the hot fluid generator includes an enclosure having two inter-connected superposed chambers constructed to contain a body of heat exchange fluid, and heating means in the lower chamber arranged to be immersed in the body of heat exchange fluid, the pre-heating conductor being in the upper chamber and exposed to the body of heat exchange fluid.

5. An apparatus for treating oil field emulsion streams as set forth in claim 3, wherein the hot fluid generator includes an enclosure constructed to contain a body of heat exchange fluid, and heating means in the enclosure arranged to be immersed in the body of heat exchange fluid, the pre-heating conductor being exposed to the body of heat exchange fluid and arranged to be immersed therein.

6. An apparatus for treating oil field emulsion streams as set forth in claim 3, wherein the hot fluid generator includes an enclosure constructed to contain a body of heat exchange fluid, and heating means in the enclosure arranged to be immersed in the body of heat exchange fluid, the pre-heating conductor being exposed to the body of heat exchange fluid and arranged to have at least a portion thereof within the enclosure.

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