

June 26, 1962

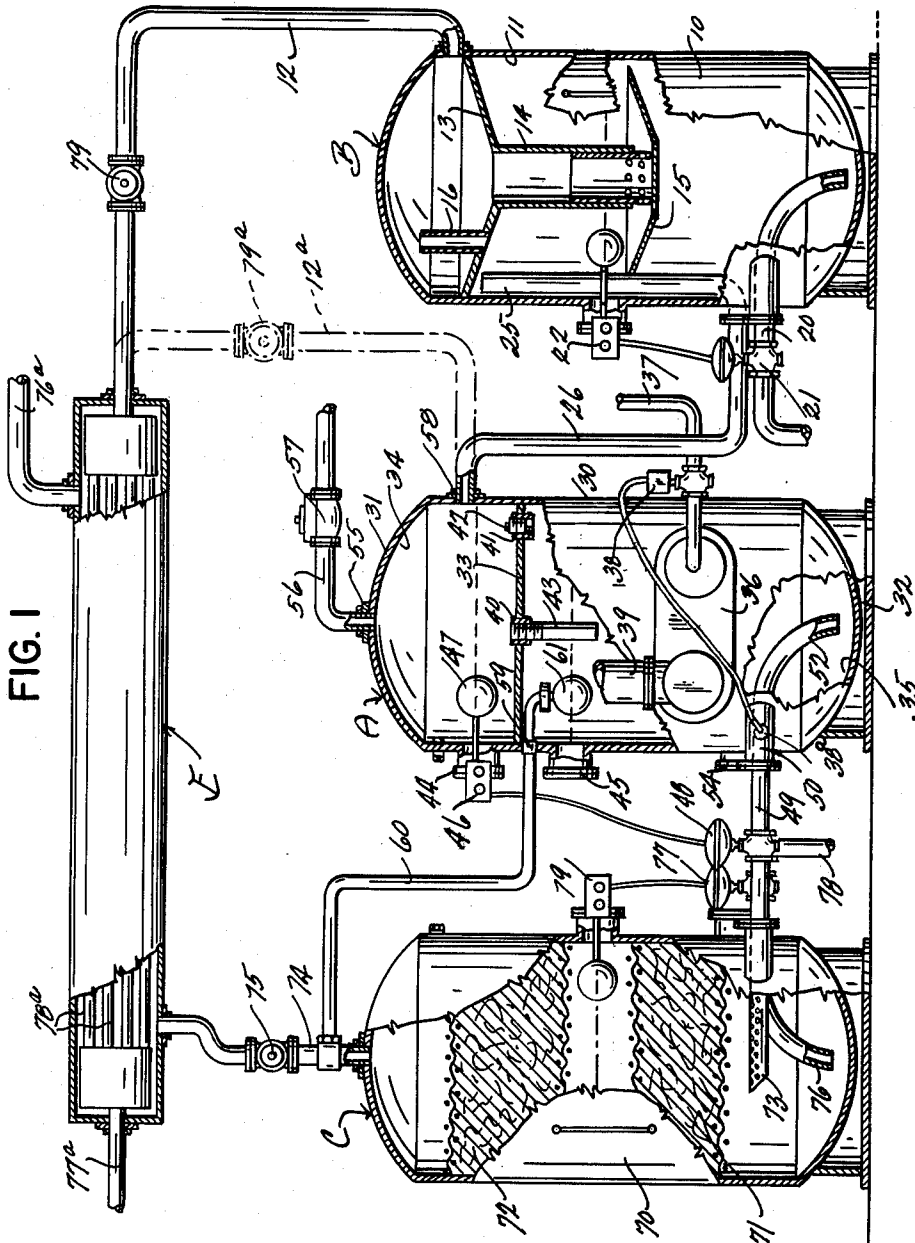
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3,040,499

HEATER STAGE TREATMENT FOR HYDROCARBON EMULSIONS

Filed May 14, 1956

3 Sheets-Sheet 1



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FIG. 2

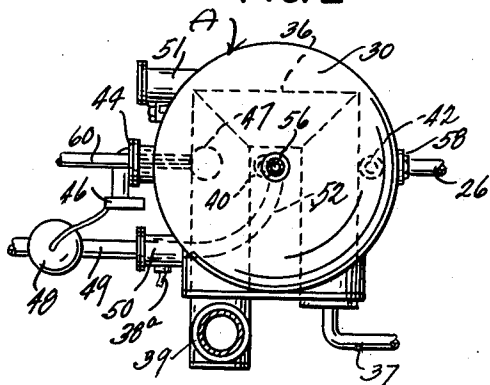


FIG. 5

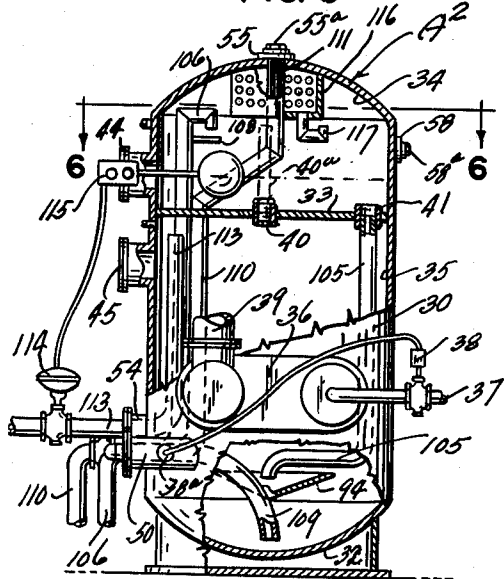


FIG. 6

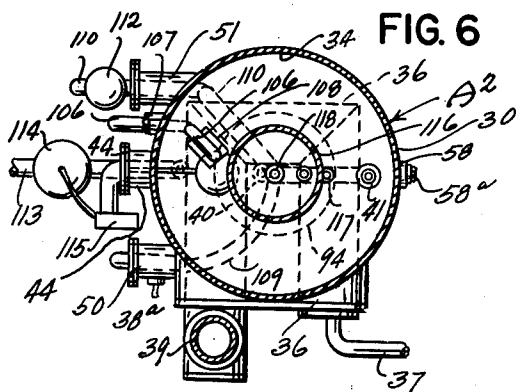


FIG. 3

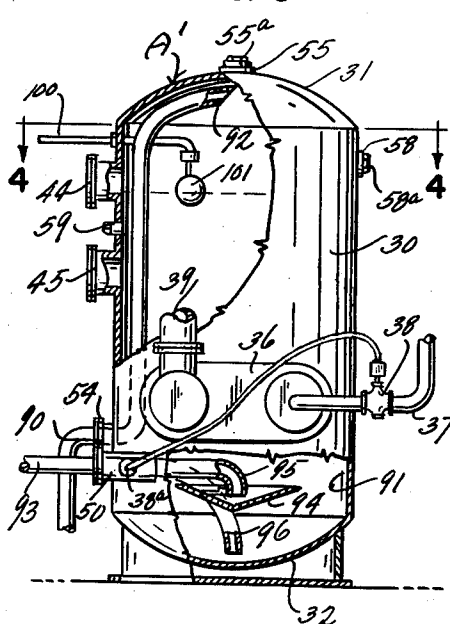
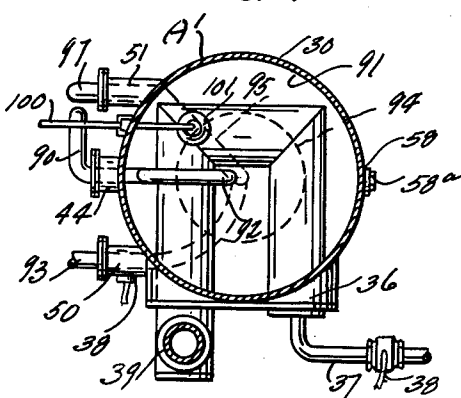


FIG. 4



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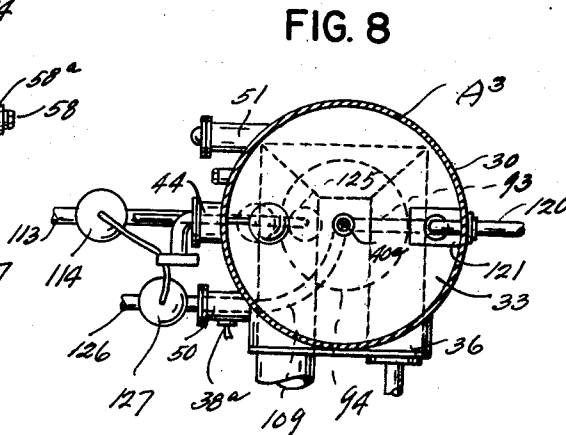
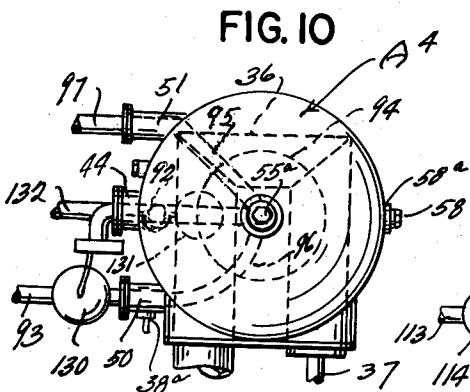
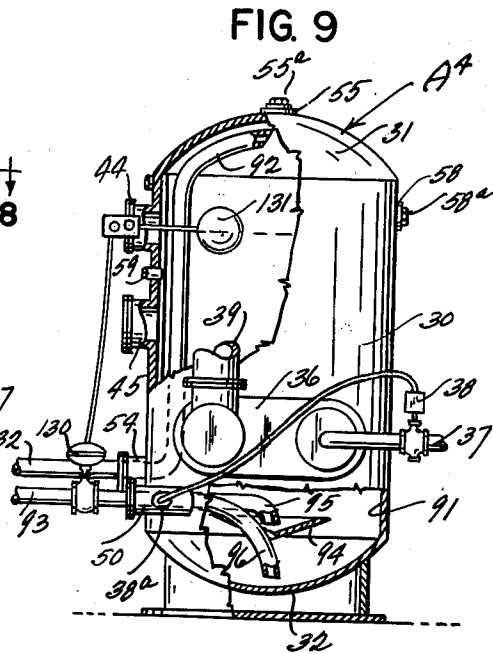
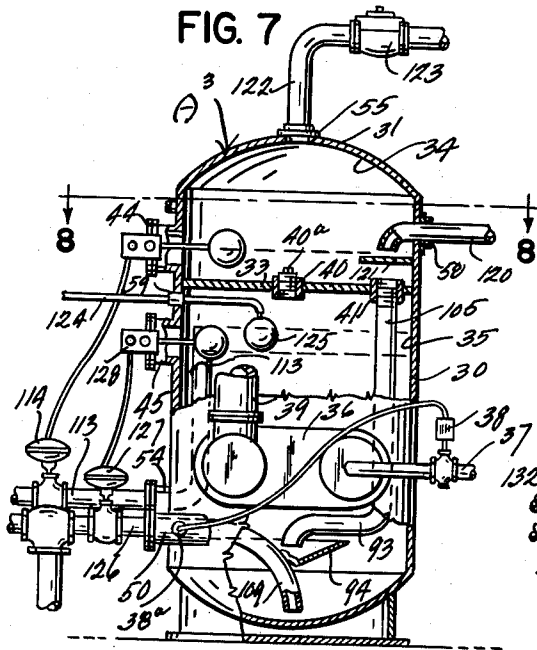
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HEATER STAGE TREATMENT FOR HYDROCARBON EMULSIONS

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HEATER STAGE TREATMENT FOR
HYDROCARBON EMULSIONS

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Filed May 14, 1956, Ser. No. 584,818

9 Claims. (Cl. 55-166)

This invention relates to improvements in means for the separation of oil, gas and water from petroleum emulsions.

This application is a continuation-in-part of my co-pending application Serial No. 425,523, filed April 26, 1954, now U.S. Patent 2,864,502, dated December 16, 1958.

The primary object of this invention is the provision of improved heater means for the breakdown of petroleum emulsions.

A further object of this invention is the provision of an improved heater for use in multiple stage superatmospheric pressure systems for the breakdown of petroleum emulsions.

A further object of this invention is the provision of an improved heater so constructed as to be adaptable for serving in various systems, depending upon the constituent parts of the emulsified petroleum to be treated.

A further object of this invention is the provision of an improved emulsion breakdown heating tank wherein petroleum emulsions may be properly treated for the most efficient control of the constituent parts with a minimum of resulting corrosion and alkaline deposits.

A further object of this invention is the provision of an improved heating means for use in the multiple stage treatment of hydrocarbon emulsions wherein the hydrocarbon emulsions are treated under down flow conditions and under superatmospheric pressure for resolving the constituent parts of it whereby to obtain an increased gravity oil.

A further object of this invention is the provision of an improved heater for use in a multiple stage treatment of hydro-carbon emulsions wherein the emulsion is treated under up flow travel and under superatmospheric pressure for increasing the gravity of the resultant oil.

A further object of this invention is the provision of an improved heater construction for the treatment of various types of hydrocarbon emulsions wherein the constituent water, oil and vapors are so handled as to dispose of maximum water content of the emulsion and provide an enriched oil product.

Other objects and advantages of this invention will be apparent during the course of the following detailed description.

In the accompanying drawings, forming a part of this specification, and wherein similar reference characters designate corresponding parts throughout the several views:

FIGURE 1 is a view, partly in section and partly diagrammatic, showing one form of heater together with a conjunctive system that may be used in down flow treatment of petroleum emulsions.

FIGURE 2 is a fragmentary plan view of the heater stage of FIGURE 1.

FIGURE 3 is a side elevation, partly sectional and partly diagrammatic, of another form of heater for down-flow treatment.

FIGURE 4 is a cross sectional view of the heater of FIGURE 3; the view being taken substantially on the line 4-4 of FIGURE 3.

FIGURE 5 is a side elevation, partly in section and partly diagrammatic, of still another form of heater, for up flow oil treatment.

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FIGURE 6 is a cross sectional view of the heater of FIGURE 5, taken substantially on the line 6-6 of FIGURE 5.

FIGURE 7 is a side elevation, partly in section and partly diagrammatic, of still another form of heater, for up flow oil treatment.

FIGURE 8 is a plan view of the heater of FIGURE 7.

FIGURE 9 is a side elevation, partly sectional and partly diagrammatic, of still another form of heater that may be used in upflow multiple stage treatment of petroleum emulsion.

FIGURE 10 is a plan view of the heater of FIGURE 9.

In the drawings, wherein for the purpose of illustration are shown five different forms of heaters and wherein the structural features of the tanks of the heaters are so standardized as to enable rearrangement of the details thereof for optimum treatment of emulsified petroleum, according to the characteristic parts thereof, the letter A may generally designate one form of heater, B and C a free water knockout and a filtering stabilizer respectively used in conjunction with the heater A in multiple stage treatment as shown in FIGURE 1. Part of this multiple stage treatment may include a heat exchanger E, which receives the hot demulsified oil from the filtering and stabilizing stage C for initially heating the emulsified petroleum to a predetermined temperature that will best serve the purpose of controlling and manipulating it through the various stage treatments A, B and C, for the most beneficial recovery of the constituent parts.

Referring now to the free water knockout B, more fully described in my U.S. Patent 2,864,502, dated December 16, 1958 and co-pending application Serial No. 608,624, filed September 7, 1956, now Patent No. 2,996,188, issued August 15, 1961, the same includes a tank 10 having a chamber 11 therein. The petroleum emulsion enters the tank 10 via the pipe line 12, above a partition 13 and then passes through tube 14 onto a deflector 15 and thence to the bottom of the chamber 11.

Equalized pressures in the compartments at opposite sides of the partitions 13 are maintained by means of pipe 16.

Water separated from the emulsion will flow through a pipe 20; the flow thereof being regulated by dump valve 21 operated by a conventional float type torque tube liquid level control 22.

A pipe line 25 is vertically disposed inside of the chamber 11, for outlet of the free water released emulsified oil through pipe line 26 and into the heater A. Line 26 also serves as an outlet for some of the rich gases given off from the emulsion.

The heater A is used to treat emulsions in down flow travel of the same in tank 30 which is of the same size and capacity as the tank 10, having outwardly bulged top and bottom walls 31 and 32. The chamber of the tank 30 is subdivided by means of a horizontal partition 33, closer to the top wall 31 than the bottom wall 32, into an upper compartment 34 and a lower larger compartment 35.

The tank 30 supports a detachable U-shaped heater 36, preferably somewhat below the halfway distance in the height of the compartment 35. The heater uses casing head gas as its fuel, admitted through a pipe 37, having a valve 38 associated therewith. The furnace 36 is bodily removable from the tank 30, and it includes an upstanding stack 39 externally of the tank. It will be noted from the dotted lines shown in FIGURE 2 that the U-shaped furnace pipes extend substantially entirely across the chamber 35.

The partition wall 33 is provided with a central internally screw threaded nipple 40 and a second screw threaded nipple 41. These nipples have passageways normally communicating the compartments 34 and 35 and

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are intended to receive different plugs and pipes, depending upon the type of emulsion to be treated. In the stage A shown in FIGURES 1 and 2, the nipple 41 receives a detachable screw plug 42 to seal off communication of the tank compartments, but nipple 40 receives a short down flow pipe 43 having a passageway communicating the compartments 34 and 35 and opening into the latter, spaced above the furnace 36.

The tank 30 is provided with tubular flanged control connections 44 and 45, respectively opening into the compartments 34 and 35 immediately at opposite sides of partition 33. They are intended to receive torque tube liquid level controls, etc. In the stage A, only the connection 44 supports a torque tube liquid level control 46 having a pivoted float 47 which operates in the compartment 34 at the level of emulsified oil supplied thereto for automatically actuating a flow control valve 48, in a line 49 which communicates the tanks of the stages A and C.

The tank 30 at its lower end is provided with outlet connections 50, 51 and 54 which may receive various pipes, etc., for the control of the various parts of the product being treated. In the system shown in FIGURE 1, connections 51 and 54 are sealed but the connection 50 has the pipe 49 connected thereto. This pipe extends into the compartment 35 and is downturned at 52, centrally opening into said compartment 35 near the bottom wall 32.

The top wall 31 of the tank 30 has a central nipple 55, which in the form A has a pipe line 56 leading off therefrom provided with a pressure regulating valve 57. This line 56 is intended to carry off formation gases to any desired location. The pressure regulating valve 57 maintains a constant pressure of 30 pounds superatmospheric in the top of the tank, although this pressure may be varied as desired.

The line 26 from water knockout tank 10 is connected to the tank 30 at nipple 58 (FIGURE 1) for carrying emulsified oil and gas into compartment 34 above partition 33. A nipple connection 59 is provided in the tank 30 immediately below the partition 33 adapted to receive a gas line 60 which extends into the tank compartment 35 directly under the partition wall 33. A float controlled valve 61 is provided for admitting gas to this line 60 depending upon the level of liquid in compartment 33 as indicated by the lower dotted line in FIGURE 1. The outer end of the pipe 60 may connect in an oil outlet pipe leading off from the tank C.

Emulsified oil at low temperatures from knockout A is passed downwardly over hot oil arising from the furnace tubes. This downflow feed continually aids in preventing corrosion and alkaline deposits settling upon the burner pipes. This stage is important because rich vapor ends do not necessarily escape with the formation gas discharged from the line 56. They are trapped and transmitted through the line 60 into the body of recovered oil in which they are condensed and admixed therewith. The gas which passes out of the line 60 is substantially at a temperature of 60° F., since it is partially cooled by the incoming emulsion.

It has been before mentioned that the emulsified oil entering the compartment 34 is at a temperature of approximately 60° F. Above the heater in the compartment 35 it is heated to substantially 140° F. in order to break the emulsion.

It will be noted that up to this point there is an absolute control of pressures in the stages A and B; the continuous flow treatment taking place in a closed system, with the tanks A and B full of fluid at all times, with the exception of gas displacement areas. Back pressure control within the system results in increased gravity of the oil because of the condensing of rich vapors during such treatment.

Turbulence exists in the compartment 35 above the burner pipes due to thermo siphonic action of the liquid

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within the compartment. Fractionation occurs at the burner tubes; the light ends being condensed by the incoming colder emulsion. The gases which do not condense rise into the vapor trap at the top of the compartment 35 and are vented into the advance system as will be subsequently described.

It is to be understood that pressures may be so regulated so as to insure maintenance of the proper superatmospheric pressures upon the product. It is even possible to do away with the escape of formation gases at the top of the tank C through the plugging of the nipple 55, if so desired.

Both oil and water of the broken emulsion pass out through line 49 into the separation stage C because this keeps the fluid in the best viscous condition. This type heater is best adapted to be used for taking care of emulsions coming from a surging well.

The fuel valve 38 is opened and closed by a thermostat device 38^a located in the tank connection 50 where it is operated by the temperature of the oil and water flowing into line 49.

Referring now to the filtering and stabilizing stage C, more fully described in my U.S. Patent 2,864,502, dated December 16, 1958, the same includes a tank 70 of the same volumetric capacity as the tanks 10 and 30. The tank 70 has two spaced filters 71 and 72 located therein.

The heated broken emulsion enters tank 70 through the pipe line 49 leading from the heater A, being discharged into the tank by nozzle 73. It passes through the primary and secondary filters 71 and 72 respectively and thence out through pipe line 74. In pipe line 74 is disposed a pressure regulating valve 75 for holding the desired superatmospheric pressure in the tank 70.

An outlet pipe 76 is provided at the lowermost portion of the tank 70 for discharging water through a valve 77 into a pipe line 78. The operation of valve 77 is regulated by a float type torque tube liquid level control 79.

The rich gases from heater A flowing through pipe 60 will enter the pipe 74 as shown in FIGURE 1 and mingle with the demulsified oil prior to its release through pressure valve 75.

The demulsified oil passes into the heat exchanger E via the pipe line 74 and thence out through the outlet 76^a to storage. The petroleum emulsion entering the system at 77^a passes through the heat exchanger E in pipes 78^a; being heated therein by the demulsified product, and thence through the pressure regulating valve 79 into pipe 12.

It is entirely possible to operate this system by having the petroleum emulsion flow directly into the heater A, thus eliminating the free water knockout B. In that event the line 12^a has connection with the heat exchanger at its discharge end and leads directly to the nipple 58 of the heater A, as shown in dot and dash lines in FIGURE 1 of the drawings. Pressure regulating valves 79 and 79^a will be used in the lines 12 and 12^a to maintain constant superatmospheric pressures.

The heater A¹ shown in the FIGURES 3 and 4, is another form of my heater used in a multiple stage treatment of petroleum emulsions as described in my U.S. Patent 2,864,502, dated December 16, 1958.

In the heater A¹, the above mentioned control connections 44 and 45 of heater A are sealed off. The nipple 58 is sealed by a plug 58^a. The connection 54 has coupled therewith the inlet line 90 for inflow of the petroleum emulsion into the compartment 91 of tank 30. In the tank 30 of heater A¹ it is not necessary to provide a partition. The line 90 passes upwardly through chamber 91 and has a central outlet 92 opening at the top center of the tank chamber. The nipple 55 is closed by plug 55^a. The emulsion from the line 92 drops downwardly through the chamber 91 towards the tubes of furnace 36. The connection 50 has a line 93 that feeds the heated emulsion into the separator stage C. An inverted cone shaped baffle 94 is mounted in the chamber

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91 between the furnace pipes and the bottom wall 32. This pipe 93 is downturned at 95 for flow of the broken emulsions through line 93 into the separator C. Water discharges from the bottom of the compartment 91 below the baffle 94 through a line 96 which is coupled to the connection 51 of the tank and passes externally of the tank through line 97. A pressure regulating valve may be provided in line 97 if desired.

In the top of chamber 91 a gas line 100 is provided, valve regulated by float valve 101 which operates on the level of liquid within the chamber 91. Thus, rich gases at the top of the heater tank may pass through the line 100 directly to the separator stage C as set forth in my U.S. Patent 2,864,502, dated December 16, 1958.

Referring to the heater A² shown in FIGURES 5 and 6, for use in multiple stage treatment of petroleum emulsions as described in my U.S. Patent 2,864,502, dated December 16, 1958; the tank 30 has the above desired partition 33 and upper and lower compartments 34 and 35. A downwardly extending pipe 105 is connected to nipple 41, which was plugged in the system using heater A above described. The emulsified petroleum enters the tank through a line 106 at the lower part of the tank through a connection 107. Pipe 106 extends upwardly through compartment 35, through partition 33 and opens into the top of compartment 34; discharging the emulsified petroleum upon a spill plate 108. The emulsified petroleum flows downwardly through line 105 and discharges upon baffle 94. If desired, a water dump line 109 may be used, although it is shown plugged in FIGURES 5 and 6.

A gas vent for the heater A² is provided, including a line 110 which has a slotted opening centrally at the top of the compartment 34, at 111, below the closed nipple 55. The gas travels downwardly through the pipe 110 and is coupled to the connection 51 (see FIGURE 6). Externally of the tank the continuation of gas discharge line 110 is provided with a pressure regulating valve 112.

A line 113 is coupled to the tank connection 54 of the heater A² and extends to the separator stage as set forth in my U.S. Patent 2,864,502, dated December 16, 1958. The pipe 113 in the compartment 35 of heater A² opens at its top immediately below the partition 33, as shown in FIGURE 5. The connections 40 and 45 are sealed. The rich gas in the top of the compartment 35 and broken emulsion at the top of this compartment pass downwardly through the line 113 and into the separator stage. The rich gas in compartment 35 is trapped and cannot enter the upper compartment 34. Valve 114 is located in line 113. It is operated by a float control 115 secured to connection 44.

Gases from below partition 33 can be mixed with gases in compartment 34 by removing plug 40 and using a stand pipe 40^a, or maintained separated by plugging and kept in the oil and condensed by cooling to maintain the oil at the desired gravity, as above described.

Surrounding the slotted end 111 of gas discharge pipe 110 is a laterally perforated mist collector 116; condensate collecting therein and discharging through a pipe 117 into the chamber 34. This enables me to obtain a drier gas in line 110.

The heater A² may be used in the treatment of a heavy viscid oil emulsion where the heated water is necessary to maintain the desired fluidity. That is the reason both oil and water discharge into the separator.

The incoming oil from line 105 displaces the heated (140° F.) oil at the bottom of chamber 35.

Referring now to the heater A³ shown in FIGURES 7 and 8, for use in the multiple stage treatment of petroleum as described in my U.S. Patent 2,864,502, dated December 16, 1958, the emulsified petroleum enters the tank 30 of the heater A³ through the line 120. It hits a spill plate 121, and discharges the emulsified oil into compartment 34 as shown in FIGURE 7.

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At the top of heater A³ the tank 30 has a formation gas vent line 122 connected to nipple 55. It is provided with a pressure regulating valve 123 adapted to maintain superatmospheric pressure in the tank 30 of substantially 30 pounds. The nipple 40 is plugged at 40^a.

The oil passes into compartment 35 through a line 105 and is deposited centrally upon a cone type baffle 94, at the turned end 93.

Instead of mixing gas with the emulsified liquid in compartment 35, a gas line 124 is connected with nipple 59. It opens into the top of compartment 35 where the rich gases collect. The line 124 has connections with the separator stage. A float operated valve 125, disposed in the top of the compartment 35, vents the gas into line 124.

In heater A³ the connection 51 is plugged. The broken emulsions discharge through the line 113 into the separator stage, the same as described in FIGURES 5 and 6. A water discharge pipe 126 is connected to the heater at 50 as a continuation of pipe 109. The line 126 is provided with a dump valve 127 automatically controlled by means of a float type torque tube liquid level control 128 coupled to tank connection 45. The float of control 128 operates at the differential density level between the water and oil.

In the heater A³ the incoming oil above the baffle 94 displaces 140° F. heated mixture at the bottom of the tank.

The heater A³ is an up flow type. It takes care of those crude emulsions which have to be water washed in order to break the emulsion.

The heater A⁴ shown in FIGURES 9 and 10 is used for up flow multiple stage treatment of petroleum emulsions as described in my U.S. Patent 2,864,502, dated December 16, 1958.

The heater A⁴ has structural features quite similar to those shown in FIGURE 3. A furnace 36 is provided in the compartment 91 of the tank 30. A lower centrally disposed baffle 94 is placed in the tank 30. An inlet pipe 97 (see FIGURE 10) enters the lower portion of the tank and has a discharge end 95 therein. The oil emulsion flows upwardly through the compartment 91. A water drawoff tube 96 is provided in the tank 30 and is connected to outer disposal pipe 93. An automatically operated dump valve 130 is provided in pipe 93, controlled by a torque float 131 located at the interface level shown by the dotted line in FIGURE 8. Discharge of the broken emulsion takes place at the top of the compartment 91 passing through pipe line 92 under hydrostatic pressure into a line 132 to the separator stage.

In all of the heaters the fuel valve 38 is preferably controlled by thermostatic means operating at connection 50.

I do not wish to be limited to the treatment of petroleum emulsions as these heaters may be used for the treatment of various other emulsions. I have used petroleum emulsions as an example throughout this description for the purpose of clarity.

Various changes in the size, shape and arrangement of parts may be made to the structures herein illustrated and described, without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. In apparatus for resolving hydrocarbon emulsions the combination of a tank having a partition therein subdividing the tank into an upper compartment and a lower compartment, heater means in the tank at an intermediate portion in the height of the lower compartment for heating and resolving emulsions, means for inlet of emulsions into the upper compartment, means for transmitting emulsions from the upper compartment to the vicinity of the heating means in the lower compartment, means for withdrawing water from the lower part of the lower compartment, the point of discharge of emulsions from the upper compartment into the lower compartment being

below the normal level of emulsion in the lower compartment, means for withdrawal from the tank of rich vapor ends from the upper part of the lower compartment above the normal level of emulsion therein, means controlled by the level of emulsion in the upper compartment for withdrawal of resolved oil and water emulsions from the lower compartment, and means controlled by the interface level of water and oil in the lower compartment for withdrawal of water from the lower compartment.

2. Apparatus as described in claim 1 in which the tank connections for outflow of emulsions and water are provided with controls to maintain the products in the tank under superatmospheric pressure.

3. An oil emulsifying heater tank comprising a tank body having a chamber therein, a partition in the upper part of the chamber subdividing the chamber into an upper compartment and a lower compartment, the lower compartment being vertically longer than the upper compartment, a heater means mounted upon the tank extending into the lower compartment intermediate the height length thereof, an oil inlet pipe connected upon said partition communicating the upper compartment with the lower compartment, said pipe extension opening at its lower end into the lower compartment at a location above the heater means and below normal fluid level in said lower compartment, means for admitting demulsified oil to the upper compartment, a pipe line opening into the lower part of said lower compartment below the heater means for conveying broken emulsions and water from said lower compartment to externally of the tank, a valve upon said last mentioned pipe externally of the tank, float means mounted upon the tank operating at liquid level within the upper compartment for opening and closing said valve, and means for withdrawing trapped rich gas vapors from beneath said partition and above the normal level of liquid in the lower compartment, said means including a valve which is float controlled by level of liquid in the lower compartment.

4. A heater tank as described in claim 3 in which fuel supply means is provided for the heater, and thermostat controlled valve means for controlling the fuel supply to the heater operated by the temperature of broken emulsions passing from said tank.

5. Apparatus as described in claim 3 in which means is provided for withdrawal of formation gases from the top of the upper compartment and means is provided for controlling the release of all liquids and gases from said tank so as to maintain a desired superatmospheric pressure upon the contents within the tank sufficient to condense rich vapor ends in the oil of the tank.

6. Apparatus for resolving hydrocarbon emulsions comprising a vertically elongated chambered tank having a partition transversely therein subdividing its chamber into an upper compartment and a lower compartment, means for admitting hydrocarbon emulsions to the upper compartment, a heater in the lower compartment intermediate the upper and lower ends of said lower compartment, means for transferring the hydrocarbon emulsions from the upper compartment to an outlet location in the lower compartment above the heater means for a down-flow heat treatment, means for discharging broken oil and water emulsions from the lower part of the lower compartment, valve means for controlling the discharge of broken oil and water emulsions through the last mentioned means, float means controlled by the level of

liquid in the upper compartment for operating said valve means, means for venting gases from the top of the lower compartment, means for discharging gases from the upper part of the upper compartment above the liquid level therein free of intermingling with the gases vented from the top of the lower compartment.

7. In apparatus for resolving hydrocarbon emulsions the combination of a vertically elongated chambered tank, a partition in the chamber of said tank subdividing the same into an upper compartment and a lower compartment, means for the admission of hydrocarbon emulsions to the upper compartment, a heater in the lower compartment intermediate the upper and lower ends of said lower compartment, means for transferring hydrocarbon emulsions from the lower part of the upper compartment into the lower compartment below the heater means for upflow travel past the heater means to a location above the heater means, means for discharging broken water and hydrocarbon emulsions from the upper part of the lower compartment, means for discharging gases from the upper part of the upper compartment above the normal level of liquid maintained therein, and valve means for the means for discharge of broken hydrocarbon and water emulsions from the tank having regulating means operated by the level of liquid in the upper compartment.

8. In a heater stage system for resolving hydrocarbon emulsions, the combination of a tank having a chamber therein, a transverse partition in the tank chamber subdividing the same into an upper compartment and a lower compartment, a heater in the lower compartment, means for inletting emulsified oil and water into the upper compartment, conduit means connecting the upper compartment with the lower compartment for flow of the emulsions to the vicinity of the heater of the lower compartment, means for releasing gas vapors from the upper compartment, a pressure regulating valve means for said gas releasing means for maintaining the vapor and hydrocarbon emulsions in the upper compartment under superatmospheric pressure, an outlet line for discharging resolved oil from the lower compartment, means for discharging separated water from the lower compartment, a float in the upper compartment actuated by the level of liquid therein, valve means for the oil outlet line, and means connecting the float with the valve means for operating the latter.

9. A heater system as described in claim 8 in which means is provided upon the outlets of the tank for maintaining the upper and lower compartments under superatmospheric pressure sufficient to condense rich vapor ends in the oil of the tank compartments, of substantially 30 pounds per square inch.

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