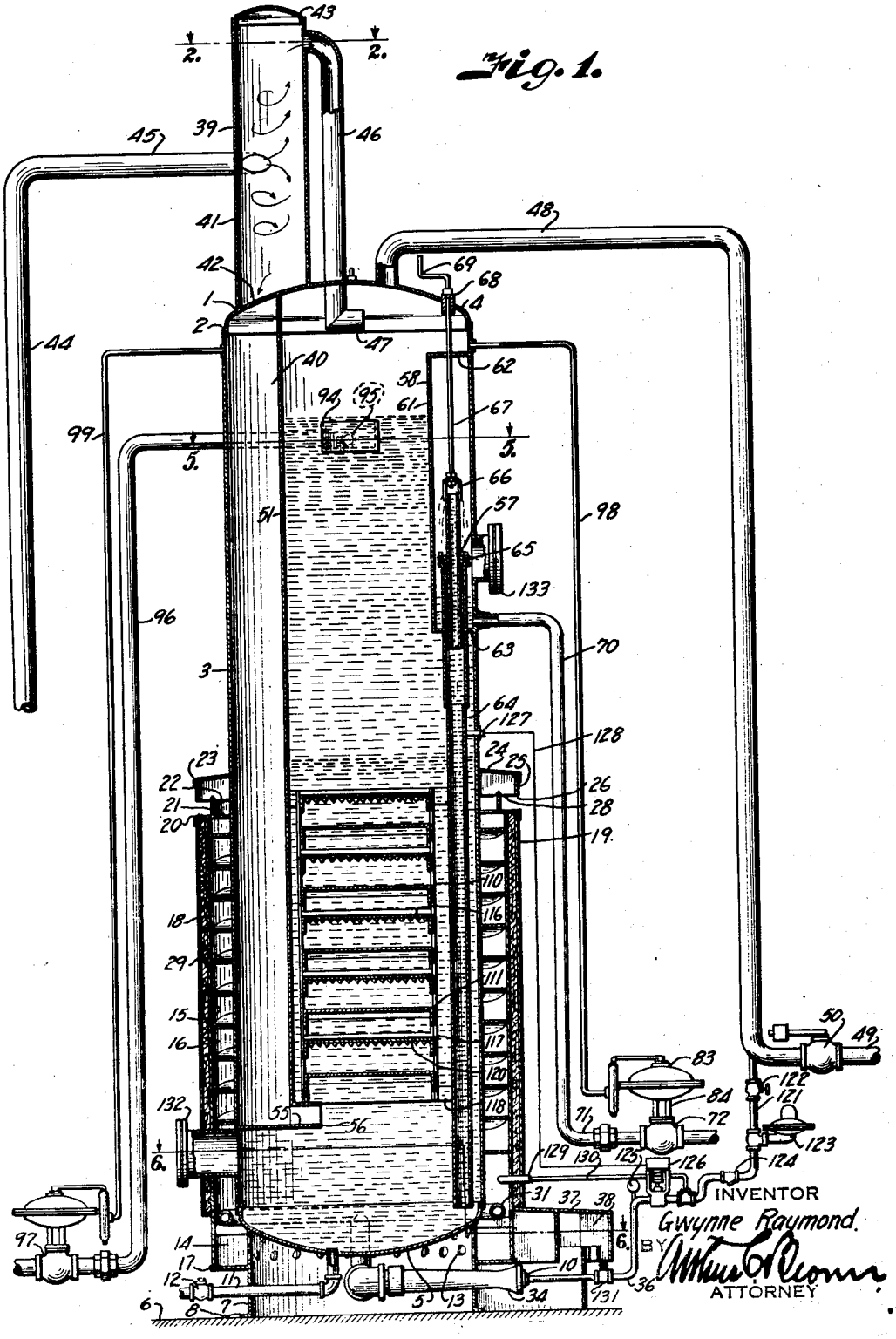
July 25, 1939. G. RAYMOND 2,167,160

APPARATUS FOR TREATING LIQUIDS

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Fig. 1.



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APPARATUS FOR TREATING LIQUIDS

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Fig. 2.

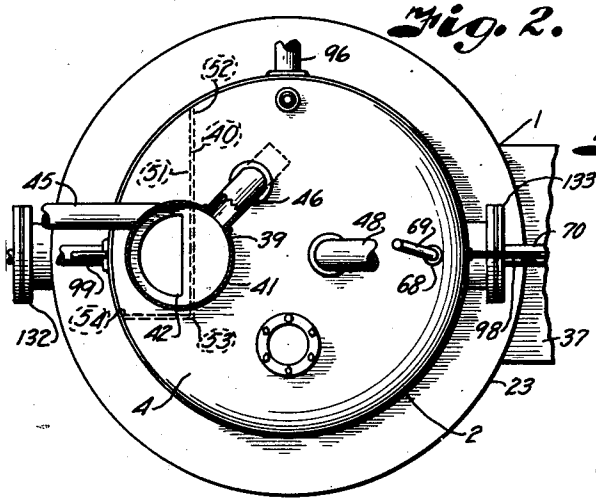


Fig. 3.

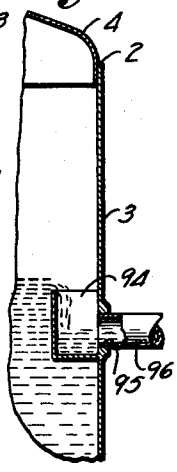


Fig. 4.

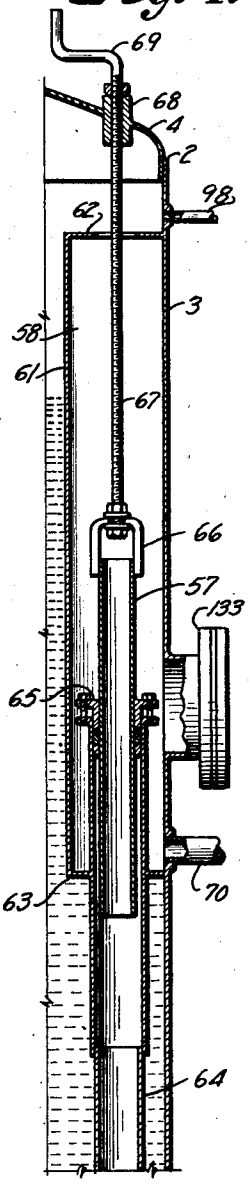


Fig. 5.

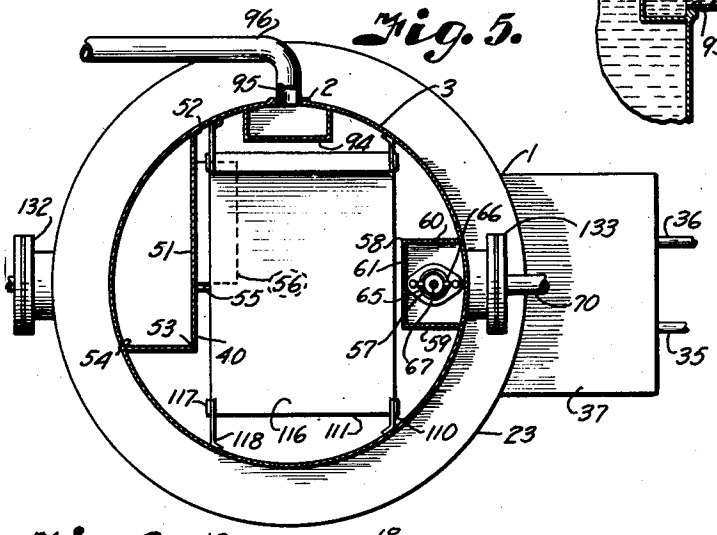
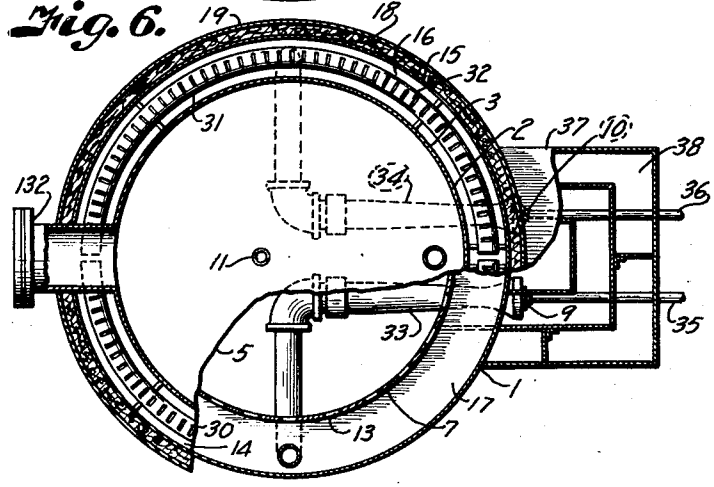


Fig. 6.



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Fig. 7.

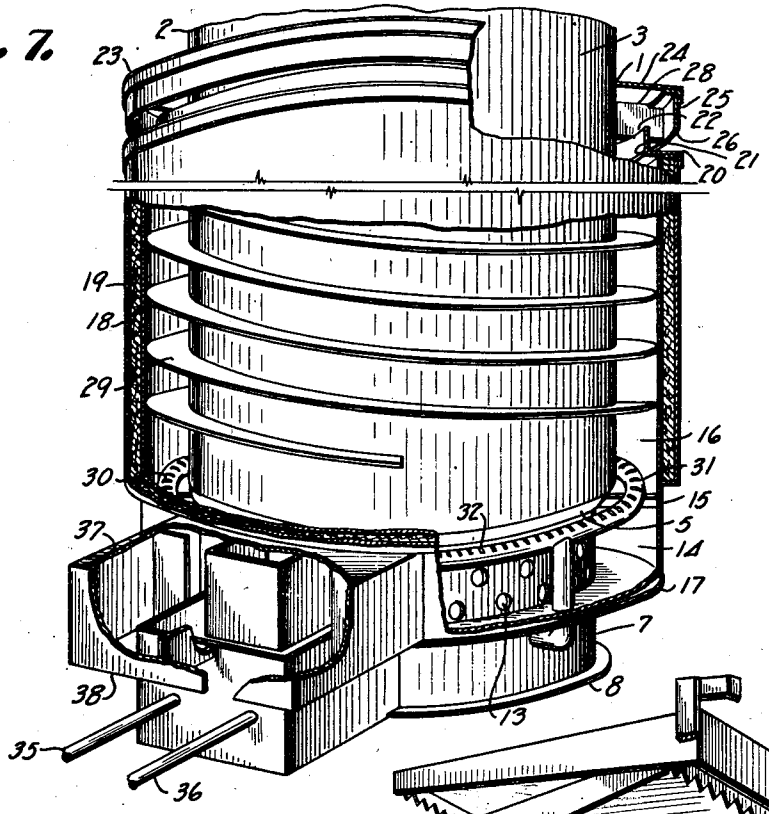


Fig. 8.

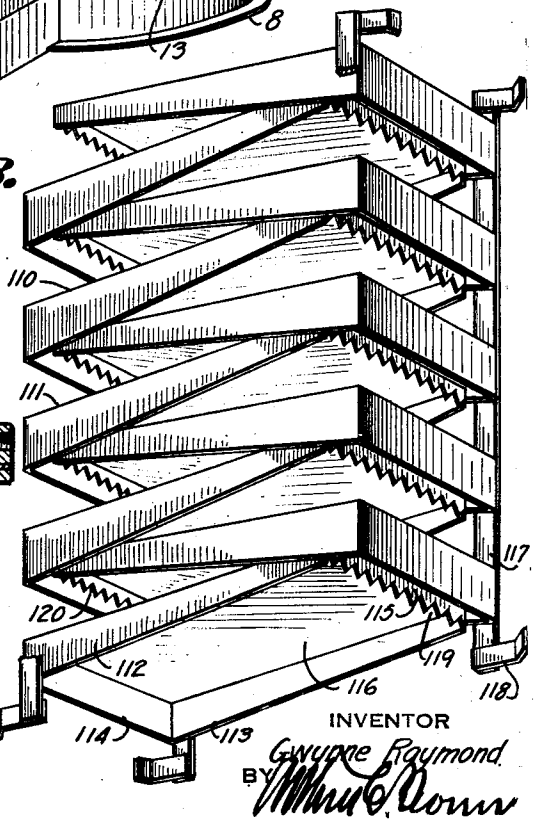
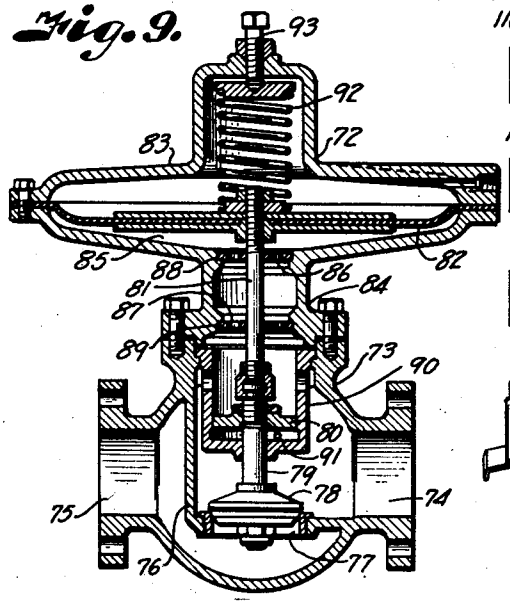


Fig. 9.



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Fig. 10.

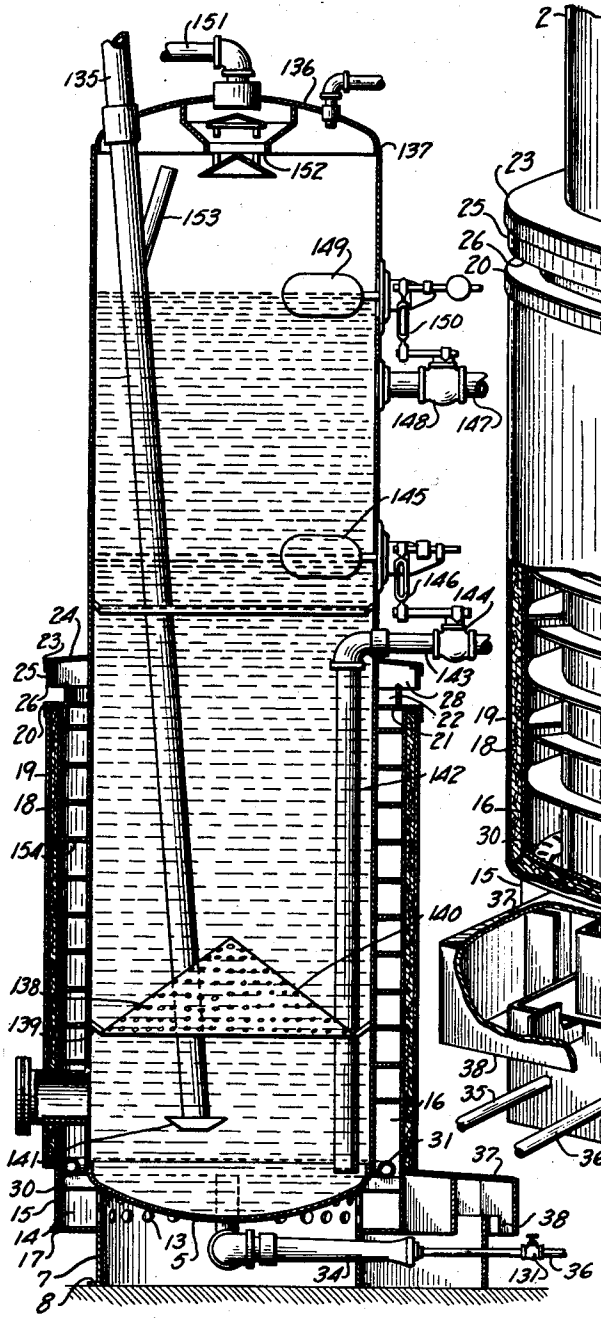
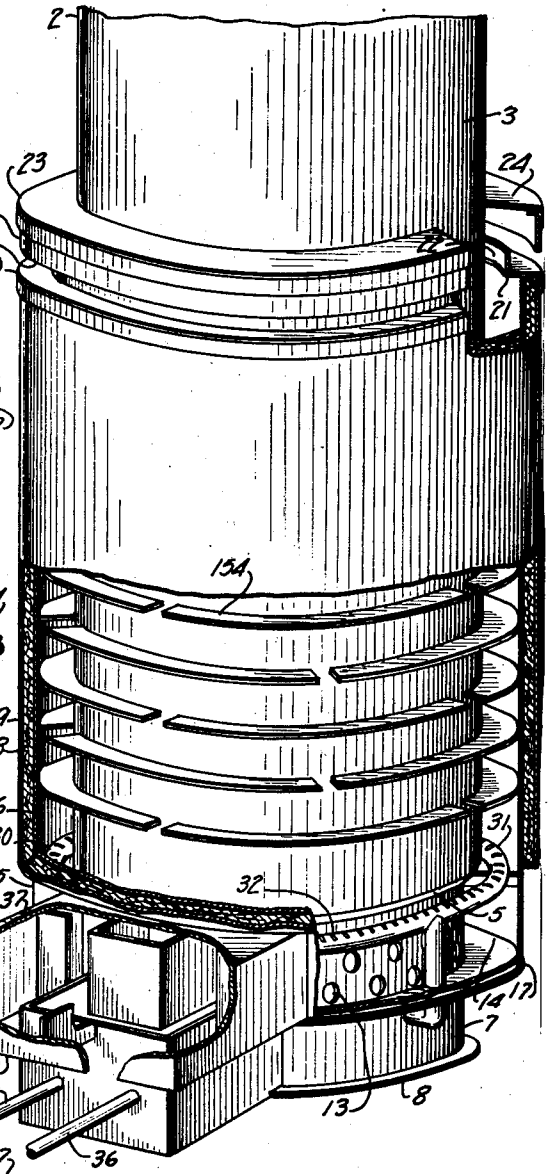


Fig. 11.



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Fig. 12.

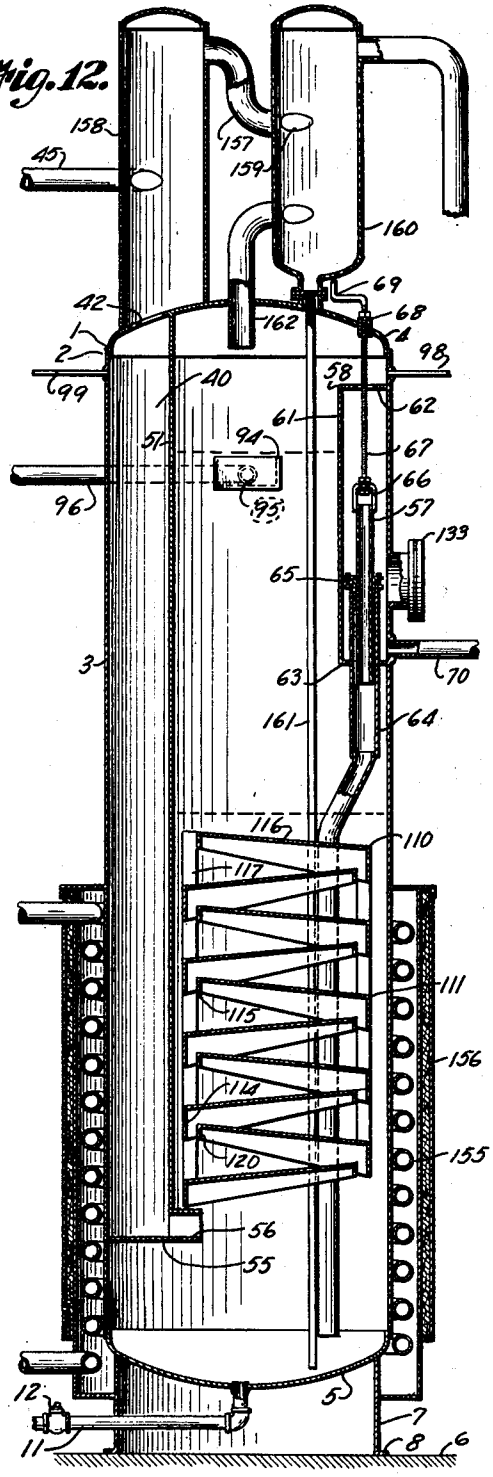
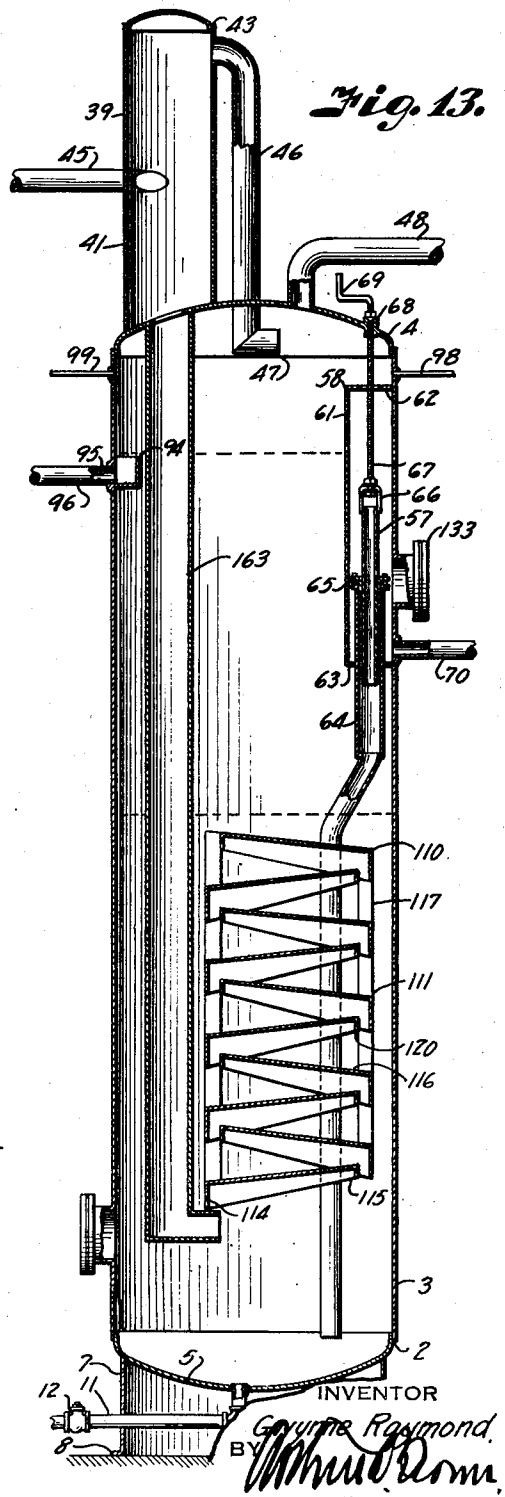


Fig. 13.



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UNITED STATES PATENT OFFICE

2,167,160

APPARATUS FOR TREATING LIQUIDS

Gwynne Raymond, Oklahoma City, Okla.

Application June 22, 1936, Serial No. 86,533

2 Claims. (Cl. 183—2.7)

This invention relates to apparatus for treating liquids, particularly flowing liquids such as those discharged from an oil well and which usually consist of a mixture of oil and water, or an oil and water emulsion combined with gas.

When the flow is in the form of emulsion it is necessary to break the emulsion in order to free the oil and this is accomplished by discharging the oil flow into a separating and treating apparatus wherein the gas is liberated and the emulsion broken up by the action of heat, usually in conjunction with a chemical, the liberated gas being utilized as a fuel for supplying the necessary heat. Where gas occurs in abundance along with oil, fuel economy is negligible, but in many cases only a small quantity of gas is present with the oil and in such instances it is necessary that the fuel be used sparingly to avoid the requirement of additional fuel from an outside source.

It is, therefore, a principal object of the present invention to provide an apparatus of this character wherein the liquid is entirely freed from gas prior to heating and the gas is efficiently utilized in heating the liquid to aid in breaking the emulsion.

It is also an object of the invention to provide an apparatus of this character with an improved valve gear in order to discharge the separated and treated liquids entirely free of gas.

Other objects of the invention are to provide an apparatus of this character with separate gas liberating and liquid treating chambers; to promote safety of operation; to provide for preliminary heating of the oil passing from the gas liberating chamber to the treating chamber so as to eliminate any gas that might be driven off incidental to heat applied in the treating chamber, thereby preventing gas liberation which would interfere with settlement of the liquids; and to provide means for positively holding back all of the vapor from the gas outlet line.

In accomplishing these and other objects of the invention, I have provided improved details of structure, the preferred forms of which are illustrated in the accompanying drawings, wherein:

Fig. 1 is a vertical section through a flow treating and separating apparatus embodying the features of the present invention.

Fig. 2 is a horizontal sectional view through the apparatus on the line 2—2 of Fig. 1.

Fig. 3 is a detail fragmentary section through a side wall of the treating chamber, particularly illustrating the separated oil outlet.

Fig. 4 is a similar fragmentary section through the side wall of the treating chamber, particularly illustrating the adjustable weir for discharging the water or the heavy separated liquids.

Fig. 5 is a horizontal section through the treating chamber on the line 5—5 of Fig. 1.

Fig. 6 is a similar horizontal section through the heater end of the treating chamber, particularly illustrating the burner arrangement.

Fig. 7 is an enlarged perspective view of the lower end of the treating chamber particularly illustrating the burner chamber and the spiral flue encircling the wall of the treating chamber.

Fig. 8 is a perspective view of the flow retarding baffles that are located in the treating chamber.

Fig. 9 is an enlarged section through one of the valves for controlling discharge of liquids from the apparatus.

Fig. 10 is a vertical section through a modified form of the invention.

Fig. 11 is a view of the lower end of the treating chamber, particularly illustrating a modified form of flue construction.

Fig. 12 is a vertical section through a further modified form of apparatus wherein the treating chamber is heated by means of a steam coil encircling the wall thereof, and showing a secondary gas liberating chamber connected into the system.

Fig. 13 is a vertical section through a still further modified form of apparatus wherein the heater mechanism is omitted.

Referring more in detail to the drawings:

1 designates a flow treating apparatus constructed in accordance with the present invention, and which is shown as including a substantially elongated cylindrical tank 2 arranged on end and having a cylindrical wall 3 closed at the ends by heads 4 and 5, the lower end of the tank being spaced from a suitable foundation 6 by means of a base 7 comprising a cylindrical plate having its upper edge welded to the outer face of the lower head 5 and its lower edge terminating in a lateral footing flange 8. The base 7 provides suitable space for accommodating the burner connections 9 and 10 and a drain pipe 11 having a shut-off valve 12. The upper part of the base is provided with a plurality of openings 13 through which air is passed into the bottom of a burner chamber 14.

The burner chamber 14 is formed as a lower part of a flue or hot gas passageway that is provided circumferentially of the wall 3 by an outer cylindrical wall 15 concentric with the wall 3 and of sufficient diameter to provide an annular space 16 therebetween. The wall 15 extends below the lower end of the tank 2 and is closed by a ring 17 preferably welded to the collar 7 at a point below the openings 13 and having its outer peripheral edge welded to the lower edge of the wall 15 to close the bottom of the burner chamber 14. The portion of the wall 15 aligning with the tank 2 is covered by an insulating material 18 enclosed in an outer jacket 19 for retaining the heat generated within the burner chamber. The upper edge of the wall 15 is closed by a cap-shaped ring 20 having its inner periphery 21 spaced from the wall 3 to provide an annular outlet 22 for spent products of combustion.

The gas outlet 22 is protected by an inverted canopy 23 including a cone-shaped roof portion 24 fixed to the wall 3 and having its outer periphery provided with a downwardly depending skirt 25 arranged with its bottom edge 26 spaced from the cap-shaped ring 20 to provide for the gas from the outlet 22. The skirt portion of the canopy is braced from the cap ring 20 by suitable brackets 28 arranged in spaced relation about the periphery thereof, as best shown in Fig. 1.

In order to retard movement of the hot products of combustion arising from the burner chamber and to retain them in heat exchanging relation with the wall 3, the passageway 16 is divided by a helical baffle 29 wound about the periphery of the wall 3.

Located in the bottom of the burner chamber and spaced above the openings 13, are substantially semi-circular burner sections 30 and 31 arranged in concentric relation therewith and having slot outlets 32, the burner sections being supplied through connections 9 and 10 which include primary air mixing conduits 33 and 34 that are connected with gas supply lines 35 and 36 located within a compartment formed by a lateral extension of the base 7 and having its upper portion covered by a suitable canopy 37 cooperatingly spaced above the extension to form an air inlet 38 for the primary air supplied to the mixing conduits of the burner connections. With the burners and mixing conduits so housed they are shielded from high winds that might tend to interfere with the burner action.

Mounted on the head 4 of the tank 2 is a primary gas separating chamber 39 including a cylindrical tank of smaller diameter than the treating tank and supported on and in off-center relation therewith so that the axis of the chamber is in substantial alignment with a flume 40 extending vertically within the treating chamber. The chamber 39 includes a cylindrical wall 41 having its lower end welded to the upper surface of the head 4 about a substantially semi-circular opening 42 therein and having its upper end closed with a head 43 to form a fluid-tight compartment.

Liquid to be treated, including the contained gas, is delivered to the apparatus through a pipe 44 having its upper end terminating in a lateral bend 45 communicating tangentially with the wall of the chamber 39 so that the liquid is discharged circumferentially for spiral movement toward the opening 42. The gas is thus thoroughly scrubbed and readily separated from the liquid so that it rises toward the upper end of the chamber, for discharge through a pipe 46 connected with the chamber and extending downwardly through the head 4 into the treating tank, the pipe terminating in a lateral bend 47 opening under a gas discharge pipe 48 that is connected with the head 4. The pipe 48 extends laterally and downwardly away from the treating tank where it terminates in a lateral bend 49 that is provided with a gas pressure regulating valve 50 whereby a predetermined pressure is retained within the treating chamber. Any liquid that might be carried over with the gas can settle out in the gas and pressure equalizing space in the upper end of the treating chamber so that the gas is ordinarily entirely free of entrained liquid when it is passed out through the pipe 48.

The flume 40 is preferably formed by a plate 51 that is welded to the inner side wall of the tank 2, as at 52, and which has its opposite edge terminating in a right-angular bend 53 that is welded to the tank wall, as at 54, the upper end of the partition being welded to the inner surface of the head 4. The lower end of the partition terminates adjacent the bottom of the treating chamber and cooperates with a plate 55 to form a projecting outlet nozzle 56 for the outlet of liquid gravitating through the flume from the opening 42.

The flume, constructed as above described, is an important feature of the invention for the reason that when cold liquid descending from the gas separating chamber encounters hot oil, gas is liberated to cause a boiling or turbulent condition that would ordinarily interfere with settling action of the liquid in the treating chamber, but with the flume constructed as described, one side portion thereof is in direct contact with hot products of combustion moving through the flue passage and the cool oil is efficiently heated enough that any gas that would be liberated in the treating chamber is vaporized in the flume. The gas upon being liberated moves upwardly through the relatively large flume into the gas separating chamber for discharge through the pipe 46. Since the oil has been heated sufficiently in the flume to vaporize the gases, there is no possibility of gas being generated within the substantially quiescent liquid undergoing treatment within the treating chamber.

The liquid, upon flowing into the treating tank, accumulates therein and is heated by the products of combustion traveling through the tortuous passageway as provided by the spiral passageway encircling the periphery of the tank. The liquid in the treating chamber separates by gravity so that the heavier constituents, such as water, collect in the bottom of the chamber, and lighter, such as the oil, collect above the water in the upper portion of the chamber, the level of the water in the tank being regulated by an adjustable weir 57, as now to be described.

Fixed to the inner face of the wall 3, within the upper end of the treating chamber, is a compartment 58 including spaced side walls 59 and 60 having one edge welded to the side wall of the tank and having their opposite edges connected by a plate 61, the upper and lower ends being closed by partitions 62 and 63. Extending through the lower partition 63 is a water discharge pipe 64 having its lower end extending to substantially the bottom of the tank and its upper end projecting within the compartment 58 and provided with a stuffing box 65 in which is slidably mounted the adjustable weir 57.

The adjustable weir includes a tube having its lower end telescoped within the pipe 64 and having its upper end projecting into the chamber and provided with a bail 66. Fixed to the bail 66 is a rod 67 having threaded connection with an internally threaded bearing member 68 incorporated in the head 4 of the tank. The end of the rod extends outwardly through the head 4 and terminates in a crank 69 by which the rod may be rotated to adjustably vary the height of a weir relatively to the static level of fluid carried in the treating chamber.

When the static head of fluid in the treating chamber reaches the height that balances the static head of fluid in the discharge pipe, water will be displaced through the discharge pipe and flowed over the weir 57 into the compartment 58 from where it flows through a discharge pipe 70 that extends downwardly along the side of the tank to terminate in a lateral bend 71 leading to control valve 72.

The control valve 72 is best illustrated in Fig. 9 and includes a valve body 73 having inlet and outlet connections 74 and 75 separated by a partion 76 provided with a valve port 77 for flow of water from the inlet to the outlet side of the valve. Normally closing the port 77 is a valve 78 having a stem 79 connected through a check piston 80 with a stem 81 of a diaphragm 82, the diaphragm 82 being carried in a housing 83 formed as a part of the valve bonnet 84. The lower side of the diaphragm cooperates with the valve housing to form a pressure chamber 85 that communicates with the interior of the valve through ports 86 and 87 that are provided in plates 88 and 89 which guidingly support the diaphragm stem. Mounted within the valve body and retained by the valve bonnet is a check cylinder 90 slidably supporting the check piston and the wall thereof is provided with ports 91 which complete communication between the pressure chamber 85 and the inlet side of the valve.

Located on the opposite side of the diaphragm is a coil spring 92 having one end engaging against the upper face of the diaphragm and its opposite end against an adjusting screw 93 whereby the valve is normally retained in seated position to close flow through the valve port 77. It is thus obvious that when the water flows through the pipe 70 it is normally stopped by the valve 78 so that the liquid accumulates in the delivery pipe to provide a hydrostatic head independent of the head of liquid carried in the treating chamber, the valve being so adjusted that when the hydrostatic head in the discharge pipe reaches a certain value the pressure thereof, acting on the diaphragm 82, will effect opening of the valve 78 to allow automatic discharge of the water accumulating in the pipe 70.

The check piston 80 is moved in the check cylinder responsive to opening and closing action of the valve so as to check the closing thereof and allow discharge of liquid from the pipe 70. The check also prevents chattering of the valve against its seat and provides for more positive operation.

The oil accumulating in the treating tank is skimmed off by flowing over the rim of a collecting box 94 having an outlet 95 connected with a discharge pipe 96. The discharge pipe 96 leads outwardly from the tank and terminates in a downward bend to form a vertical leg wherein the oil collects for the reason that flow is normally interrupted by a valve corresponding to that illustrated in Fig. 9. When the hydrostatic head of oil in the pipe reaches a certain value, the valve is automatically opened to allow discharge thereof and when the hydrostatic head drops below a certain value the valve automatically closes to stop flow therethrough.

In order that the valves may operate freely responsive to hydrostatic heads of fluid in their respective discharge lines, the chambers formed in the upper portion of the diaphragm housings are connected with the gas space in the treating tank by means of pipes 98 and 99 respectively, as clearly shown in Fig. 1.

To retard travel of the liquid through the treating chamber, I provide a series of baffles 110 which are shown as including a series of inverted pans 111 each having side walls 112 and 113 and end walls 114 and 115 connected by a top 116. The pans are carried in superimposed relation on posts 117 secured to brackets 118 connected with the wall of the tank in such position that the lowermost baffle is supported directly over the outlet 56 of the flume. The baffles are arranged so that they are inclined upwardly in alternate relation so that the liquid admitted from the flume flows upwardly to engage the upper wall of the lowermost baffle and travels toward the end 115 thereof where it flows through notches 119 and gravitates upwardly through the water and chemical collected in the bottom of the treating chamber until stopped by the next baffle, whereupon the liquid flows along the top wall thereof to the opposite end and through similar notches 120 to the next baffle and so on until the liquid finally passes through the notches of the top baffle. During the retarded travel of the oil, the oil and water emulsion is broken incidental to the heat and treating chemical, the water remaining at the bottom of the treating chamber and the oil rising to the top.

As fluid rises in the chamber, the oil flows into the collection outlet and then into the discharge pipe from where it is drained periodically according to hydrostatic level therein by automatic operation of the valve 97. Excess water accumulating in the bottom of the tank is displaced by the hydrostatic head of the water and oil through the pipe 64 and weir 57 into the chamber 58 from where it flows into the pipe 70 and is periodically drained therefrom by automatic operation of valve 72, as above described.

As previously pointed out, the separated gas is utilized as a fuel for the burners, as now to be described. Connected with the gas discharge pipe 48 at the bend thereof is a branch pipe 121 having a shut-off valve 122 and a pressure regulating valve 123 so that gas is delivered from the pipe 48 through the pipe 121 at a predetermined pressure. The pipe 121 extends downwardly and connects with the burner pipes 35 and 36 leading to the mixing chambers of the respective burners. Interposed in the line 121 are various fittings such as a screen 124 and a pressure gage 125. Also interposed in the line is a thermostatically operated valve 126 which is actuated responsive to temperature of the liquid contained in the treating chamber, which temperature is transmitted to a bulb 127 having connection with the thermostat through a line 128 as in conventional thermostat construction. It is thus apparent that the thermostat may be so set that when the liquid in the treating chamber reaches a predetermined temperature the thermostat will operate to shut off flow of gas to the burners. However, when the temperature drops, the thermostatic valve will automatically function to again turn on the gas which is ignited by means of a pilot 129 supplied with gas from the pipe 121 through a branch connection 130.

The individual burner lines 35 and 36 may be provided with manually operated shut-off valves 131 so that either one of the burners may be cut off independent of the other.

The tank may be provided with suitable manholes, for example, a manhole connection 132 connected with the bottom of the treating tank and extending through the wall of the burner chamber. The compartment 58 may also be provided with a suitable manhole connection 133 whereby access may be had to the adjustable weir.

Fig. 10 shows a modified form of the invention wherein fluid to be treated is admitted through a pipe 135 extending downwardly through a head 136 of the treating tank 137, which is substantially of identically the same construction as

the tank in the preferred form of the invention. The pipe 135, however, extends downwardly in the tank at an incline so that the lower end thereof terminates adjacent the center thereof and in position to discharge the liquid under a cone-shaped baffle 138 that is supported within the tank by means of brackets 139. The baffle 138 is provided with perforations 140 through which the liquid may rise to the top of the tank. The outlet end of the pipe is provided with a distributor 141 to divert the liquid in an upward direction.

In this form of the invention the water collects within the lower part of the chamber and is discharged through a pipe 142 extending upwardly along the wall of the tank and connects below the water level with a lateral pipe 143 extending through the wall of the tank, the lateral pipe being provided with a shut-off valve 144 as controlled by a float 145 carried on the water level within the tank and having connection with the valve through a suitable float connection indicated at 146, as in ordinary separator construction.

Connected in the side wall of the tank above the pipe 143 is an oil outlet pipe 147 having a stop valve 148 therein that is opened and closed responsive to a float 149 through a link mechanism 150. It is thus obvious that when the oil accumulates in the tank the float rises to open the valve and allow discharge of oil through the valve.

In this form of the invention the gas is discharged from the upper portion of the tank through a pipe 151 that is connected to the center of the head 136. A flow of gas to the outlet pipe is retarded by means of a series of baffles 152 to provide a tortuous passageway therefor so that any liquid carried entrained with the gas gravitates therefrom back into the treating chamber. The gas discharged through the pipe 151 is, therefore, comparatively dry and free of contained liquid. In order to equalize pressure in the pipe 135 and allow free gas to be discharged above the oil, the upper end thereof is provided with a vent pipe 153 located within the gas space of the treating chamber.

The heater flue arrangement in this form of the invention is substantially identical to that of the preferred form, however the partitions in the flue consist of horizontal segmental baffles 154 arranged in vertical, staggered relation so as to provide a tortuous passageway for the products of combustion, as clearly shown in Fig. 11.

The form of the invention shown in Fig. 12 is substantially the same as that illustrated in the preferred form, however the heater construction is different in that the heat is supplied by means of a steam coil 155 wound about the lower end of the treating tank and contained within an insulating jacket 156. In this instance steam is supplied to the coil from a boiler (not shown) that may be supplied with fuel gas separated from the flow of liquid delivered to the treating tank in the same manner as in the preferred form of the invention.

It sometimes happens that some of the water vapor passes with the gas to the gas outlet line or some of the condensable vapors may not condense until they leave the treating apparatus, and this vapor accumulates in and freezes in the gas controlled valve so as to interfere with the operation thereof. In order to prevent this difficulty, I equip the apparatus with a secondary gas separating chamber connected in series with the first chamber, as illustrated in Fig. 12. The gas outlet 157 from the primary chamber 158 is connected with a tangential inlet 159 in the secondary chamber 160 so that the gas is caused to circumvolve around the wall of the secondary chamber to effect separation of any contained moisture. The surface of the secondary chamber also acts to cool and condense the condensable vapors. This moisture and condensate drains from the secondary tank into the treating chamber through a pipe 161 leading therefrom to a point adjacent the bottom of the treating tank. The liquid is, therefore, conducted to the bottom of the treating tank so that it does not interfere with the quiescent separation in the treating chamber. Gas accumulating in the upper portion of the treating tank is delivered therefrom through a connection 162 also having a tangential inlet with the secondary tank so that any condensable liquid vapor carried with the gas accumulating in the upper portion of the tank is caused to move tangentially within the second separating chamber to effect its condensation.

The form of the invention shown in Fig. 13 is substantially the same as that illustrated in Fig. 1, and is used when an emulsion breaking chemical is employed that does not require application of heat, therefore the heating equipment is not provided. The flume is different in that it is formed by a pipe 163 projecting downwardly within the tank and terminates in a lateral bend for discharging liquid under the baffles, as in the preferred form of the invention.

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

1. In an apparatus of the character described, a treating tank having a cylindrical wall, a flume extending downwardly in the tank and having a side thereof formed as a part of said cylindrical wall, means for delivering liquid to be treated to said tank through said flume, a burner chamber encircling the lower portion of the treating tank, a burner in said chamber, and a spiral flue connected with the burner chamber and encircling the tank for conveying products of combustion from the burner in heating relation with the wall of the tank to preliminarily heat the liquid delivered through said flume and to maintain the liquid in heated condition while undergoing treatment in said tank.

2. In an apparatus of the character described, a treating tank having a cylindrical wall, a flume extending downwardly in the tank and having a side thereof formed as a part of said cylindrical wall, means for delivering liquid to be treated to said tank through said flume, a burner chamber encircling the lower portion of the treating tank, a burner in said chamber, a flue encircling the tank for conveying products of combustion from the burner in heating relation with the wall of the tank to preliminarily heat the liquid delivered through said flume and to maintain the liquid in heated condition while undergoing treatment in said tank, and means in said flue forming tortuous passageways for said products of combustion.

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