

Aug. 8, 1933.

B. E. MEURK

1,921,689

METHOD AND APPARATUS FOR SEPARATING LIQUIDS

Filed Nov. 14, 1929

5 Sheets-Sheet 1

Fig. 1.

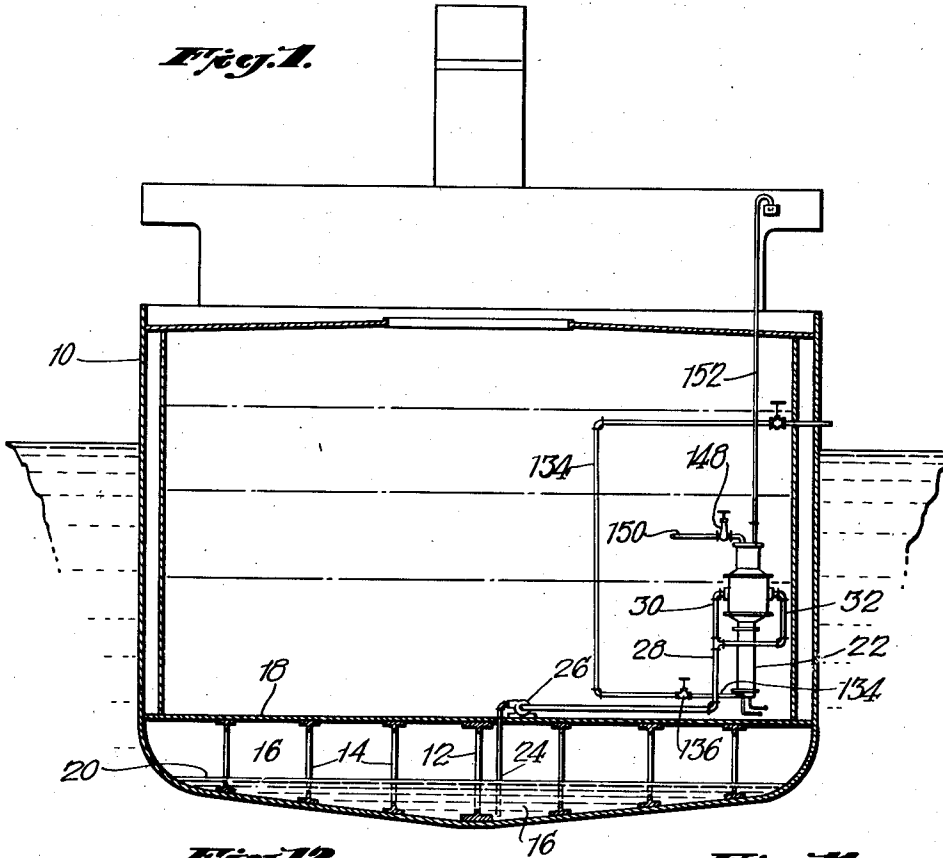


Fig. 12.

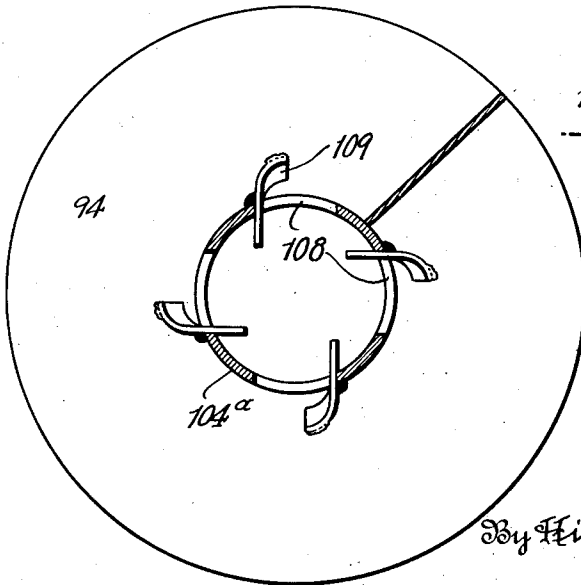
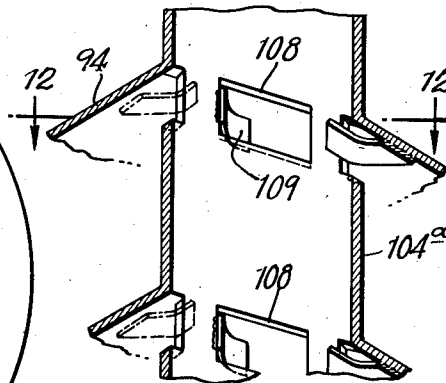


Fig. 11.



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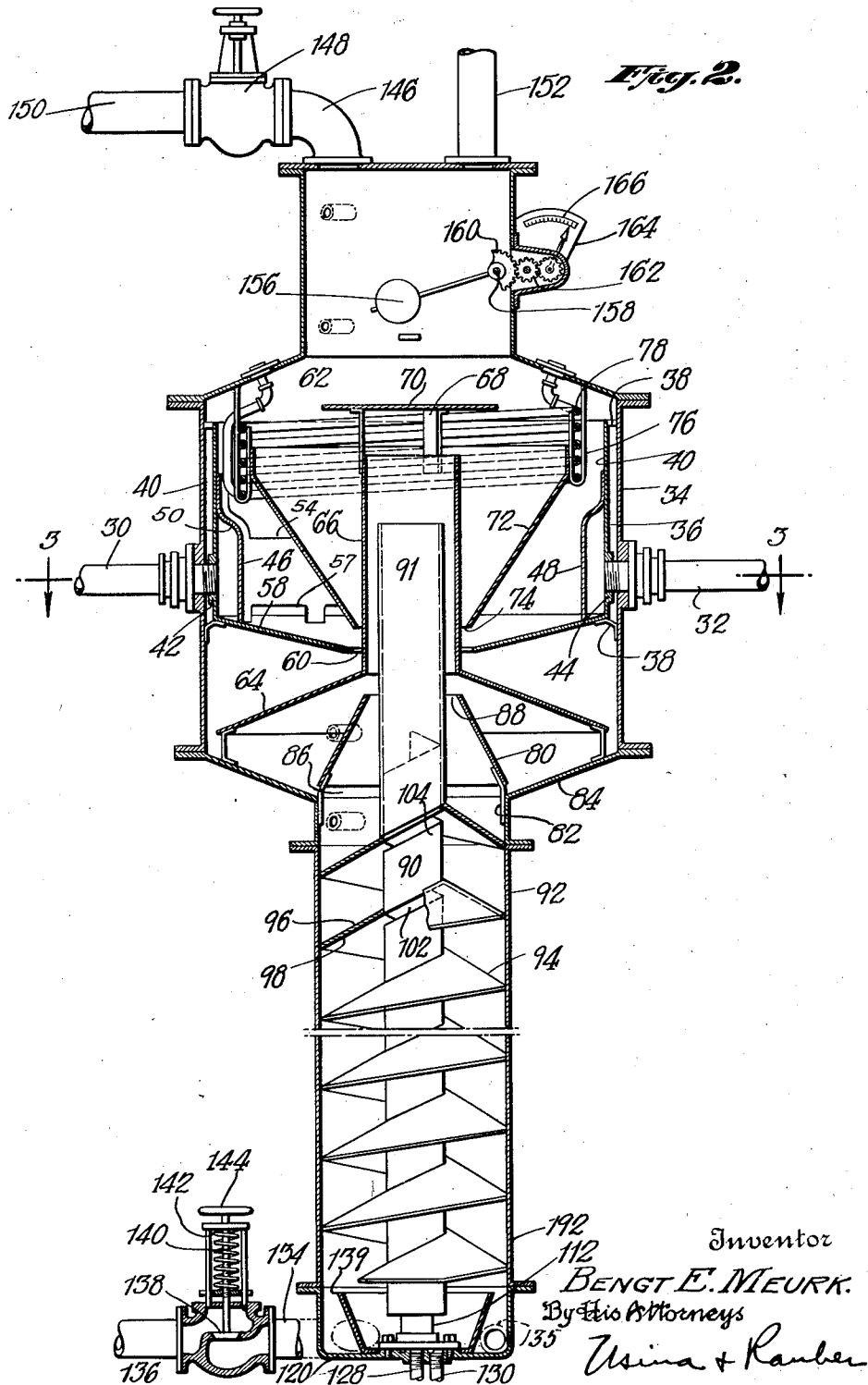
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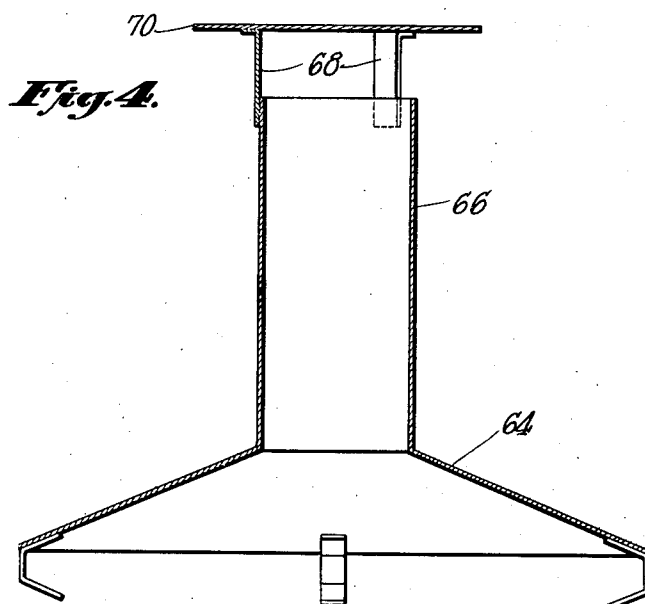
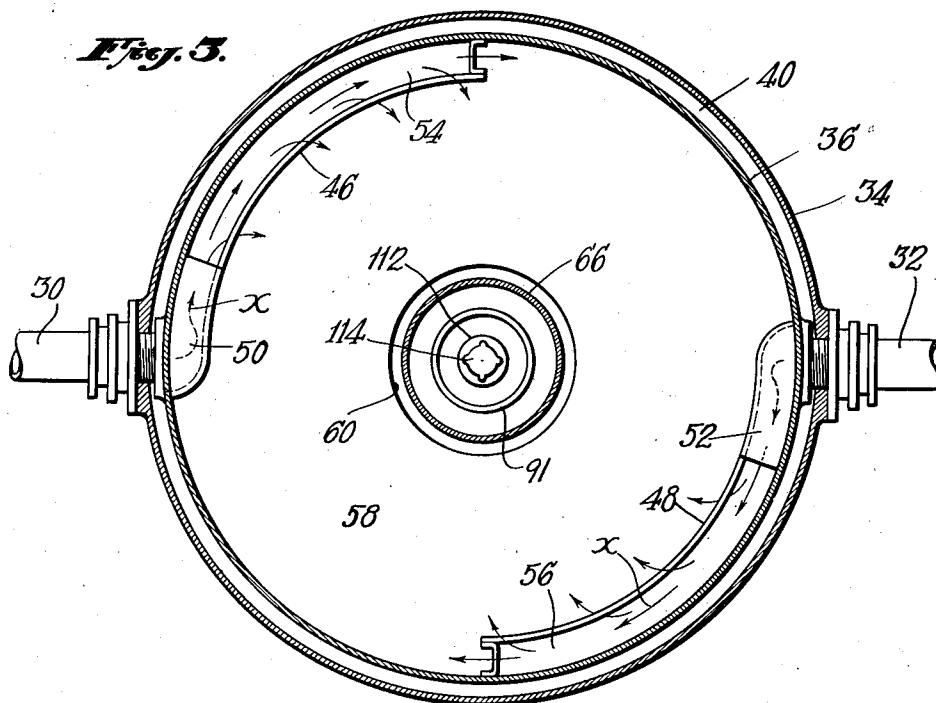
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METHOD AND APPARATUS FOR SEPARATING LIQUIDS

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Fig. 5.

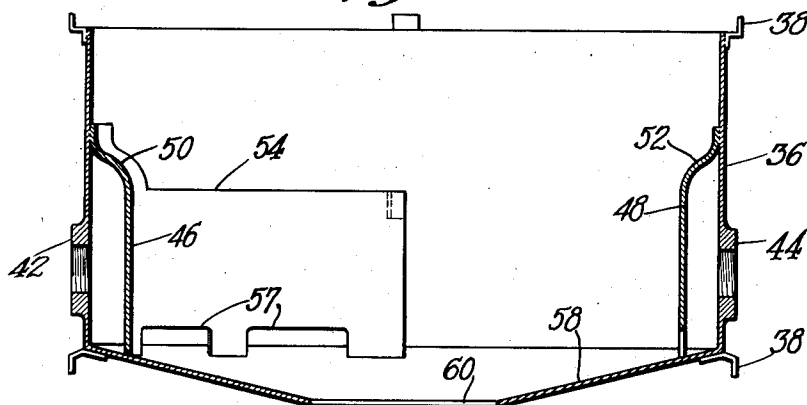


Fig. 6.

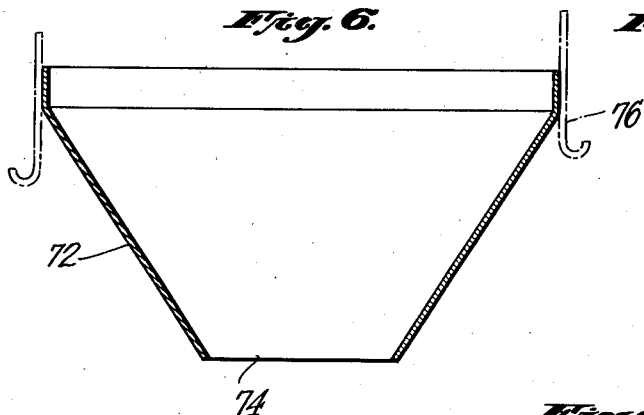


Fig. 6^a.

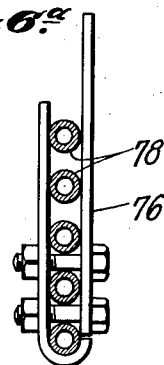


Fig. 8.

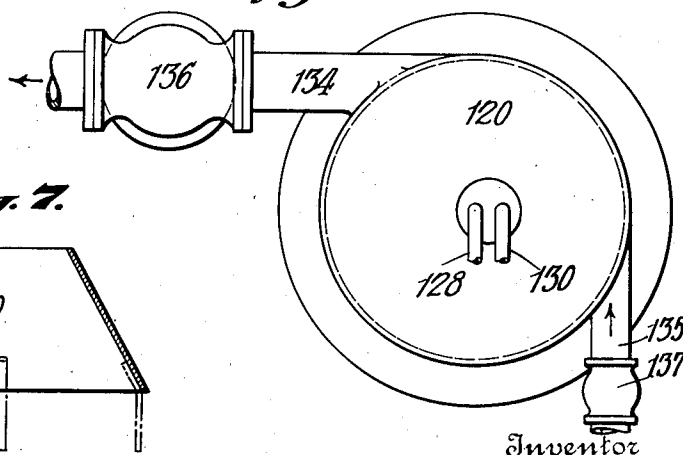
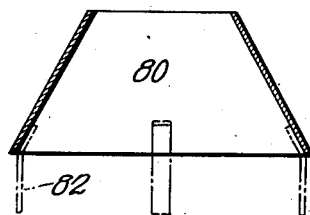


Fig. 7.



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Fig. 9.

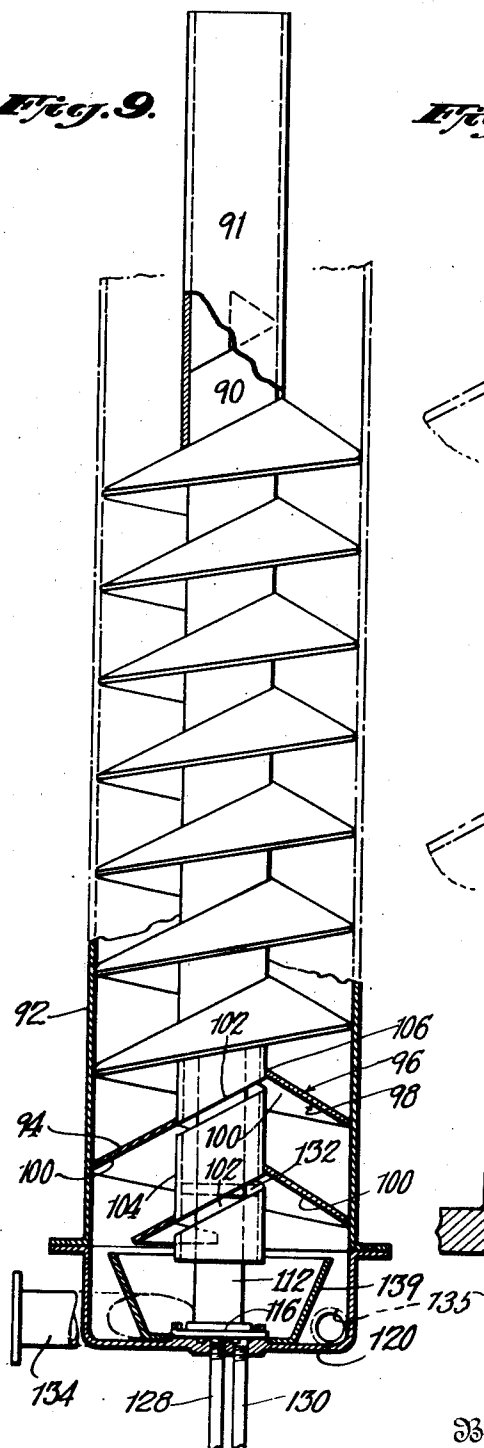
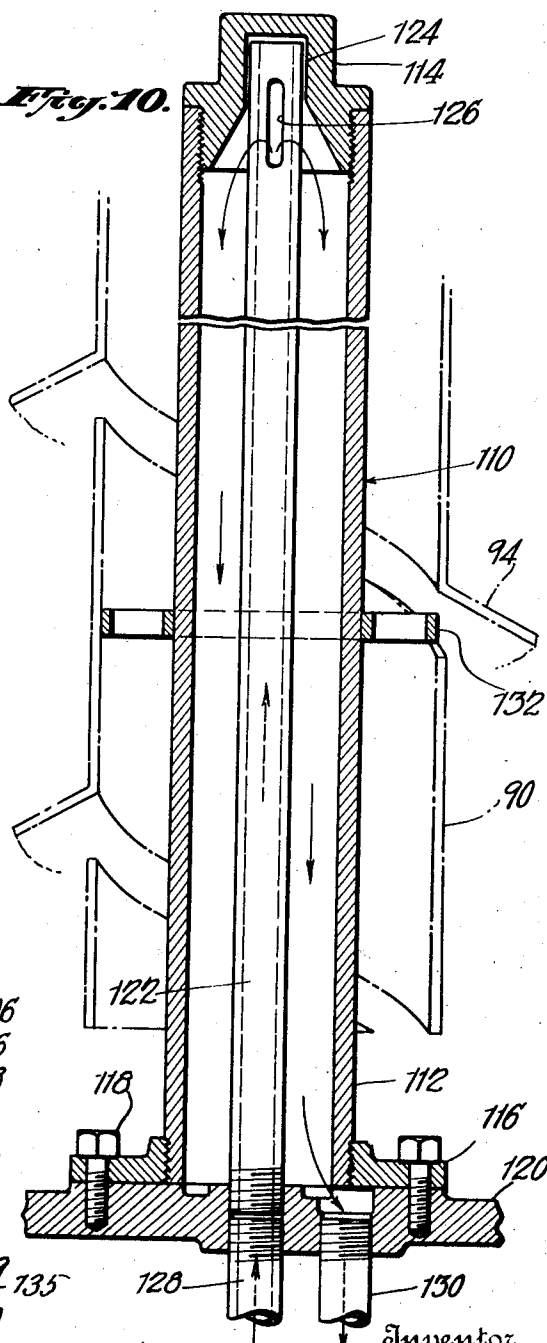


Fig. 10.



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR SEPARATING LIQUIDS

Bengt E. Meurk, Upper Montclair, N. J.

Application November 14, 1929
Serial No. 407,247

15 Claims. (Cl. 210—51)

This invention relates to improvements in a method and apparatus for separating liquids differing in specific gravity. While not limited thereto the apparatus described herein is particularly adapted for separating fuel oil from bilge or ballast water pumped from the bottom of a ship.

The invention aims to provide a multi-stage separator so that in a case where oil and water are being separated, the oil is continuously topped off throughout its passage through the apparatus. Other important characteristics are the provision of means whereby the materials to be separated are maintained under superatmospheric pressure, this being important as it permits the apparatus to function uniformly on board ship, regardless of whether the ship is sailing in calm or rough seas at a great capacity, where it also can be installed in the existing system of piping. The conical baffling throughout eliminates the angular disturbance. Another feature of the invention relates to the provision of means whereby a thermo-siphon circulation is maintained in the apparatus so that the flow, respectively, of oil and water is accelerated in opposite directions.

Another feature of the invention relates to the novel construction of a substantially helical baffle having a hollow column extending therethrough with ports arranged along the line where the inner edge of the baffle intersects the surface of the column so that as the mixture passes through the apparatus the oil is continuously topped off.

The above and other features will be fully apparent from the following specification when read in connection with the accompanying drawings and the invention will be defined with particularity in the appended claims.

In the drawings:—

Fig. 1 is a somewhat diagrammatic cross section through the hull of a ship showing my improved separator located therein;

Fig. 2 is a vertical longitudinal section through a separator embodying the invention;

Fig. 3 is a horizontal section on line 3—3 of Fig. 1;

Figs. 4, 5, 6* and 7 are detail views of parts shown in Fig. 2;

Fig. 8 is an inverted plan of Fig. 2;

Fig. 9 is a detail view illustrating details of construction of an inner hollow column forming part of the apparatus;

Fig. 10 is a view showing details of a heater adapted to induce a thermo-siphon circulation;

Fig. 11 is a detail view illustrating a modified construction wherein the hollow column is formed of tubing with separate ports therein;

Fig. 12 is a section on line 12—12 of Fig. 11, the arrow in the figure denoting the direction of flow caused by the helix.

Referring in detail to the drawings; 10 represents the hull of a ship which includes a central keelson 12 and a multiplicity of structural members 14. These divide the bottom of the ship into a multiplicity of compartments 16. Over the top of the members 12 and 14 there is a floor-like structure 18. The members 14 and the keelson 12 are all provided with suitable drainage openings so that the mixture of oil and water indicated at 20 which collects in the ship's bottom can flow from the several compartments.

Each ship will usually be provided with one separator, such as indicated as a whole at 22 in Fig. 1. A pipe 24 representing the suction line of the pumping system in the ship extends into one of the compartments 16, of the various sub-divisions within the ship, this pipe being connected with a pump 26 (generally the existing ballast pump) which is adapted to force the mixture of oil and water from the ship's bottom through pipe 28 to the inlet pipes 30 and 32, which are connected as indicated in Fig. 2 to the upper chambered head 34 of the separator.

Within this head, I provide a sleeve 36 (shown in detail in Fig. 5) which is spaced from the inner surface of the head by brackets 38 so as to provide an annular space 40.

The inlet pipes 30 and 32 for the mixture of oil and water to be separated are secured to bosses 42 and 44 located at diametrically opposite points on the sleeve 36. Within this sleeve are quadrant-shaped plates 46 and 48 which are adapted to compel the inflowing liquids to flow in a substantially circular path as indicated by the arrows *x*. Just above the points where the incoming liquid strikes the baffles 46 and 48 there are covered portions 50 and 52. But, beyond the covered portions, the baffles are open at the top as indicated at 54 and 56. Suitable openings such as indicated at 57 are provided in the bottoms of the baffles 46 and 48.

The inflowing mixture of oil and water striking the curved baffles has a sort of whirling motion imparted thereto. Due to the difference in specific gravity of the oil and water the oil tends to travel upward and the water to travel downward in a spiral-like path. This spiral

path of flow being maintained as the liquid travels from the center toward the periphery and back again in the upper separating chamber.

The water flowing downward probably carries a small percentage of oil therewith. This mixture will travel along the inclined annular baffle plate 58 and through the central opening 60 therein. The oil will tend to travel upward along the lower edge of this baffle plate into the annular space 40, the oil continuing to travel upward through this space and into the upper chamber 62 of the chambered head.

Below the inclined annular baffle plate 58 is an oppositely inclined baffle 64 of shallow frusto-conical form. As shown in detail in Fig. 4, this baffle has secured thereto an upwardly extending tube 66. This tube extends through the opening 60 of the inclined baffle 58 and at its upper end has secured, by means of brackets 68, a plate 70.

Surrounding the tube 66 there is a substantially frusto-conical baffle member 72 having an opening 74 at its lower end through which the tube passes, this opening providing clearance for the downward flow of water along the inner surface of the member 72. The member 72 is supported on U-shaped brackets as indicated at 76. These brackets also serve to support a steam heating coil 78 which is provided for the purpose of maintaining the material handled in a suitable fluid condition. It being understood that the fuel oil handled at relatively cool temperatures is of a very viscous nature, somewhat resembling tar.

Below the tube 66 secured to the inclined baffle 64, I provide a small frusto-conical baffle 80 which has secured to its lower edge a number of brackets 82 which in turn are secured to a bottom member 84 of the chambered head.

The lower edge of the conical baffle 80 is spaced away from the inner surface of the bottom member 84 so as to provide an annular passage 86. Similarly the upper edge of the member 80 is spaced away from a hollow column member 91, hereinafter referred to, so as to provide an annular passage 88.

Secured to the lower end of the bottom member 84 and communicating with the interior of the chambered head 34 is an elongated upright shell 92.

Within this shell, I provide a helical baffle member indicated as a whole at 94. The outer edges of the different convolutions of this helical baffle engage the inner surface of the shell 92 so as to define a substantially helical chamber through which the mixture of oil and water must flow with a somewhat helical whirling motion. The helical baffle 94 is so formed that in cross section it presents upper end lower surfaces indicated at 96 and 98 which are inclined to the horizontal as shown in section in Fig. 9. This peculiar form of helical baffle is of importance because it provides a multiplicity of pockets, as indicated at 100 in Fig. 9, where the oil is adapted to collect in a multiplicity of separate stages as the mixture of oil and water flows through the shell 92. In other words, the oil is topped off at a multiplicity of points along the length of the helical baffle. This topped off oil flows through ports 102 formed in the central hollow column 90. This column is preferably constructed as shown in detail in Fig. 9 wherein it will be seen that it consists of a multiplicity of convolutions 104 which are

spaced apart so as to leave the helical ports 102.

At the upper end of the column, I provide a tubular extension 91 which is fitted over the helically formed portion, this extension 91 projecting into the tube 66 and terminating a short distance below the upper end thereof.

In practice, the column is formed by rolling a plate to form a spiral cylinder of a pitch, slightly greater than the width of the plate. This leaves an open space between the convolutions which forms the port 102 referred to. The helical baffle 94 is welded or otherwise secured as indicated at 106 along the line where the inner edge of the helical baffle intersects the lower edges of the convolutions 104. This method of construction constitutes one of the detailed structural features of improvement. An alternative arrangement, providing ports in the hollow column communicating with the pockets formed by the helical baffle, is illustrated in Figs. 11 and 12. In this alternative construction, the column is in the form of a continuous tube 104^a having a multiplicity of ports 108 formed therein, these ports following the helical line of intersection between the inner edge of the baffle 94 and the surface of the tube 104. In this form of the device, I provide vanes as indicated at 109 which are secured to the edges of the ports 108 and extend therethrough as shown. These vanes serve to accelerate the upward flow of oil through the hollow column.

For the purpose of maintaining active circulation, I provide a heating element indicated as a whole at 110. This element is disposed within the hollow column as best shown in Figs. 9 and 10. This heating element is effective to induce a thermo-siphon circulation of the liquids being handled. Such a circulation is of particular importance in apparatus for separating oil from water as it speeds up the rate at which the material is separated and thereby greatly increases the efficiency of the apparatus as a whole. In the construction illustrated this heating element comprises a cylinder 112, the upper end of which is closed by a plug 114 screw threaded therein as indicated in Fig. 10. The lower end of the cylinder has a flange 116 screwed thereon, which is secured by bolts 118 to a cap member 120, which closes the bottom of the shell 92. A pipe 122 threaded at its lower end is screwed into a threaded aperture in the cap 120, said pipe extending axially of the cylinder 112. The upper end of the pipe is fitted loosely in a socket 124 formed in the plug 114. Near the end of the pipe, one or more slots 126 are formed to permit the escape of steam or other heating medium to the interior of the cylinder 12. The heating medium is supplied to the pipe 122 by a pipe 128 screwed into the bottom of the cap 120. Also screwed to the bottom of this cap there is a pipe 130 forming an outlet for the heating medium. The cylinder 112 has a flange 132 secured thereto at an intermediate point in its length, the outer diameter of this flange being slightly less than the inside diameter of the hollow column 90.

At the lower extremity of the shell 92 there is a tangentially extending outlet connection 134 having a valve 136 connected thereto. This valve includes a valve member 138 having a stem 140 connected therewith which is surrounded by a spring 142 tending to press the valve member 138 on its seat. The valve 136 is com-

monly known as a back pressure valve and is usually provided with a hand wheel 144. The spring pressure exerted may be adjusted by any suitable means to vary the pressing action. Normally the valve spring will be set to prevent discharge of water from the outlet 134 until the pressure within the separating apparatus exceeds a predetermined amount.

Near the lower end of the separator, I preferably provide a water inlet connection 135 having a valve 137 therein and within the cap 120, I provide a substantially conical baffle 139. The baffle 139 prevents the outlet pipe 134 from withdrawing oil from the central portion of the separator. This baffle also serves to deliver water in the peripheral zone of the lower part of the separator when the valve 137 is open. It is to be understood that water is only admitted through the pipe 135 for the purpose of cleaning or flushing out the apparatus or at the initial period when the separator is started in operation the valve 137 being normally closed.

Normally the valve will be so adjusted that water separated from the oil will be discharged at a pressure of approximately twenty-five pounds per square inch.

The mixture fed to the apparatus will usually be delivered at a pressure of approximately twenty pounds per square inch.

The oil separated from the water which collects in the upper chambered head leaves the apparatus through a fitting 146 having a valve 148 therein which in turn has connected thereto a pipe 150 leading to a pipe line communicating with fuel oil storage tanks.

Connected to the top of the chambered head and communicating with the interior thereof is a standpipe 152 which is provided to form an air cushion and vent. This pipe 152 may conveniently be coupled to existing vent pipes extending upwardly from some of the oil storage tanks between decks aboard ship.

Means are preferably provided for showing the line of demarkation between the oil and water. This means may comprise a so-called "liquidometer" indicated diagrammatically at 154. This device includes a float 156 pivoted at 158 which is adapted to actuate a sector 160 which is connected through suitable gearing indicated at 162 to actuate a pointer 164 which works over a scale 166. This liquidometer is merely diagrammatically indicated as it is a standard device which can be bought in the open market.

The float 156 thereof is adapted to sink in oil and float in water. The calibration and the accuracy of the instrument is such that the line of demarkation between liquids having a specific gravity of 1.00 and .995 can be readily ascertained, 1.00, representing of course the specific gravity of water. This meter therefore serves to inform the operator accurately as to conditions existing within the apparatus, the float being located in that portion of the apparatus where under normal conditions only oil is supposed to be present. When the liquidometer shows the presence of water at the top of the oil collecting chamber, the operator is warned to shut the valve 148 so as to prevent pumping of water into the fuel oil line.

I contemplate providing means responsive to movements of the liquidometer for automatically actuating the valve 148. This automatic means will include an electro-solenoid responsive to movements of the liquidometer float, which sole-

noid will in turn control power means for opening and closing the valve 148.

This means is not specifically shown and described herein as it forms the subject matter of a separate application Serial No. 462,083, filed June 18, 1930.

In the normal operation of the separating apparatus above described a mixture of oil and water is pumped from the ship's bottom to the pipe 28 to the inlet pipes 30 and 32. This mixture strikes the arcuate or quadrant-shaped baffles 46 and 48 and thereby has a whirling motion imparted thereto. The oil being lighter tends to rise to the surface and much of it passes upwardly to the upper part of the chambered head following the under surface of the cone-shaped member 72.

The heavier mixture flows downwardly along the inclined baffle plate 58. The heavier part of the mixture of oil and water passes downward through the annular space 60 and passes along the upper surface of the inclined baffle plate 64. Some of the oil separates out at this stage and creeps upwardly along the under surface of the baffle plate 64 and up through the inside of the tube 66. The heavier part of the mixture continues its downward journey through the annular space 86 into the shell 92. Some of the lighter oil escapes upwardly through the interior of the frustro-conical baffle 80 flowing up through the inside of the tube 66. The heavier material then flows with a sort of helical motion between the multiplicity of convolutions of the helical baffle 94 and as the mixture progresses downwardly, the oil being the lighter part thereof is successively topped off or separated in a multiplicity of separate stages, this oil escaping through the ports 102 formed between the different convolutions of the hollow column in the construction of Fig. 9 or escaping through the ports 108 in the construction of Fig. 11.

Because of the inclusion of the heating element extending through the center of the hollow column 90 the circulation of the liquids being separated is accelerated and a high rate of separation is secured.

The rich mixture of water and oil traveling upwardly in the central tube 91 is deflected by the baffle 70 at the top and the oil will rise to the top of the collecting chamber and the heavier mixture will proceed on a downward journey again through the annular opening 74 and so again through the entire separator. It is thus seen that a continuous recirculation is constantly taking place.

The liquid reaching the bottom of the shell 92 is substantially pure water which has been depleted of practically all of the oil. The pressure maintained in the apparatus is such that it overcomes the force exerted by the spring 142 and the water normally is discharged continuously. At the same time, it will be understood, that under normal conditions the oil is being discharged continuously through the fitting 146.

An important feature of the invention is the method and means whereby the separation is effected under pressure. Such a pressure system is peculiarly well adapted for use in separating fuel oil from bilge water on board ship because the separating action can be maintained substantially continuously regardless of whether the ship is sailing in smooth waters or in rough seas. Due to the fact that the liquids being separated are under pressure it will be under-

stood that there will be no detrimental sloshing of the liquid due to the motion of the ship. In prior devices, liquids are required to settle out by gravity in open tanks. This is objectionable on board ship because of the emulsifying and mixing occasioned by the motion of the ship.

The described apparatus it will be noted includes sort of a labyrinth of baffles which are effective to separate the oil in a multiplicity of separate stages and this separation is taking place continuously during the transit of the mixture through the apparatus. It will be noted particularly that many of the baffles are inclined with respect to a truly horizontal plane. This inclination is desirable in the separators used on board ship because if the ship tosses on a rough sea there is less interference with the separating action than would be the case if the baffles were truly horizontal.

While I have described quite specifically the details of the embodiments of the invention herein illustrated it is not to be construed that I am limited thereto since various changes in arrangement and a substitution of equivalents may be made without departing from the invention as defined in the appended claims.

What I claim is:

1. A device of the character described including a shell-like structure having a plurality of baffles therein for effecting a multi-stage separation of liquids of varying degrees of specific gravity and a heating element effective to induce a thermo-siphon circulation throughout the entire apparatus, thus effecting the separation in a multiplicity of the separate stages, said heating element extending upwardly from the lowermost portion of said shell-like structure and having a part which is below the lower edges of a plurality of said baffles.

2. A device of the character described including a shell-like structure having a plurality of baffles therein for effecting a multi-stage separation of liquids of varying degrees of specific gravity and a heating element for inducing a thermo-siphon circulation through the entire apparatus, thus effecting the separation in a multiplicity of separate stages, means for supplying a mixture of liquids to be separated under pressure and a valve effective to prevent the discharge of one of the liquids until the pressure exceeds a predetermined amount said heating element extending upwardly from the lowermost portion of said shell-like structure and having a part which is below the lower edges of a plurality of said baffles.

3. An apparatus for separating liquids including an upper chambered head, a hollow column opening into said head, a helical baffle secured to said hollow column, a shell surrounding said baffle, the column having an opening or openings adjacent the under-surface of said baffle, and a heating element for inducing an upward circulation through said hollow column and a downward circulation outside of said column.

4. An apparatus for separating liquids including an outer shell, a hollow column extending longitudinally thereof, a helical baffle member secured to said hollow column and extending to the inner surface of said shell and a heating element extending upwardly through the interior of said hollow column and effective to cause a downward flow in the zone exterior of said column and an upward flow in the interior zone of said hollow column.

5. In the device for separating liquids, a hollow column comprising a plurality of substantially helical convolutions with spaces between them to form a port opening and a substantially helical baffle whose inner edge is secured to the lower edges of said convolutions.

6. A separator for liquids comprising a chambered head having a plurality of baffles therein, a hollow column opening into said head, a helical baffle secured to and surrounding said column and means for delivering the mixture of liquids to be separated to said chambered head under a super-atmospheric pressure, a shell opening into said head and surrounding said baffle, an outlet communicating with the interior of said shell, a valve controlling the outflow of liquid from said outlet and effective to retain liquid within said shell until the pressure of said liquid exceeds a predetermined amount.

7. An apparatus for separating liquids including an upper chambered head, a lower shell opening into said head, a helical baffle within said shell, and a hollow column extending through said baffle and having ports along the line where the inner edge of said helical baffle intersects the outer surface of said column, said helical baffle being inclined in vertical section, so that its under surface slopes upwardly toward said ports.

8. An apparatus for separating liquids including an upper chambered head, a lower shell communicating with said head, a helical baffle within said shell, a hollow column within said baffle and extending substantially axially thereof, said column being comprised of a plurality of convolutions with spaces between them adapted to form ports, and said helical baffle being secured at its inner helical edge to the lower edges of said convolutions.

9. An apparatus for separating liquids including an upper chambered head having a plurality of baffles therein, an inlet for the liquid to be separated communicating with said head, a lower shell opening into said head, a helical baffle within said shell, a hollow column extending centrally of said baffle and having ports adjacent the line of intersection between the inner edge of the helical baffle and the outer surface of said column, a water outlet at the lower end of said shell, and an oil outlet at the upper end of said chambered head.

10. An apparatus for separating liquids including an upper chambered head having a plurality of baffles therein, a hollow shell opening into said head, a helical baffle in said shell which imparts a whirling helical motion to the mixture and a hollow column having ports therein opening into the spaces between the convolutions of the helical baffle and means for accelerating the flow of liquid in the apparatus.

11. An apparatus for separating liquids including an upper chambered head, a shell communicating with said head, a hollow column within said shell, a substantially helical baffle surrounding said column and secured thereto at its inner edge, said baffle extending laterally to the inner face of said shell, said column having ports therein directly below the points where the baffle joins the column, said helical baffle being inclined in vertical section so that on any radial line the said inner edge of the part adjacent the column is at a higher elevation than the outer edge of the baffle.

12. An apparatus for separating liquids including an upper chambered head having a plurality of baffles therein, a shell opening into

said head, a hollow column in said shell, a helical baffle in said column in which imparts a whirling helical motion to the mixture, said column having ports therein opening into the spaces between the convolutions of the helical baffle, an inlet pipe for the mixture to be separated connected to said head, a water outlet pipe having a pressure valve therein connected to the lower part of said shell, an oil outlet pipe communicating with the upper part of said head, and a vent pipe connected with said head.

13. An apparatus for separating oil from bilge and ballast water including a sleeve-like member adapted to receive the incoming mixture to be separated, a duct for conveying the mixture to said member and means for imparting a spiral or whirling motion to the mixture so as to increase its path of travel and effect an easy smooth flow, a pump for forcing said mixture of oil, bilge and ballast water to the apparatus under super-atmospheric pressure, valve means effective to discharge the water overboard only after the pressure within the apparatus exceeds a predetermined amount, and a valve outlet controlling the discharge of the oil at a super-atmospheric pressure.

14. In the separation of oil from water, the method which comprises separating the oil from the water in a multiplicity of separate stages, the mixture of oil and water being subjected to

super-atmospheric pressure and caused to flow downwardly in an outer zone with a substantially helical motion, repeatedly topping off the oily part of the mixture and causing the heavier part to flow downwardly and then recirculating the oilier part of the mixture first upwardly through a central zone and then downwardly after part of the oil has been separated in its helical travel through the outer zone.

15. An apparatus for separating oil from bilge or ballast water on board ship comprising a chambered head having a plurality of downwardly pointed cone-like baffles therein, a pump and connections for delivering a mixture of such oil and water to said head under pressure, an upwardly pointed cone-like baffle secured in said head and having an upwardly projecting tube extending through said downwardly pointed baffles, a deflector plate spaced from the end of said tube, a shell secured to the lower end of said head, a hollow column in said shell the upper extremity of which projects into said tube and terminates adjacent said deflector plate, a helical baffle within said shell and surrounding said column, ports in said column adjacent the inner edge of said helical baffle, an oil outlet at the upper part of said chambered head and a pressure controlled water outlet valve at the lower part of said shell.

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