Oct. 25, 1927. 1,646,448

E. C. D'YARMETT

OIL DISTILLING APPARATUS AND METHOD

Filed April 2, 1926 4 Sheets-Sheet 1

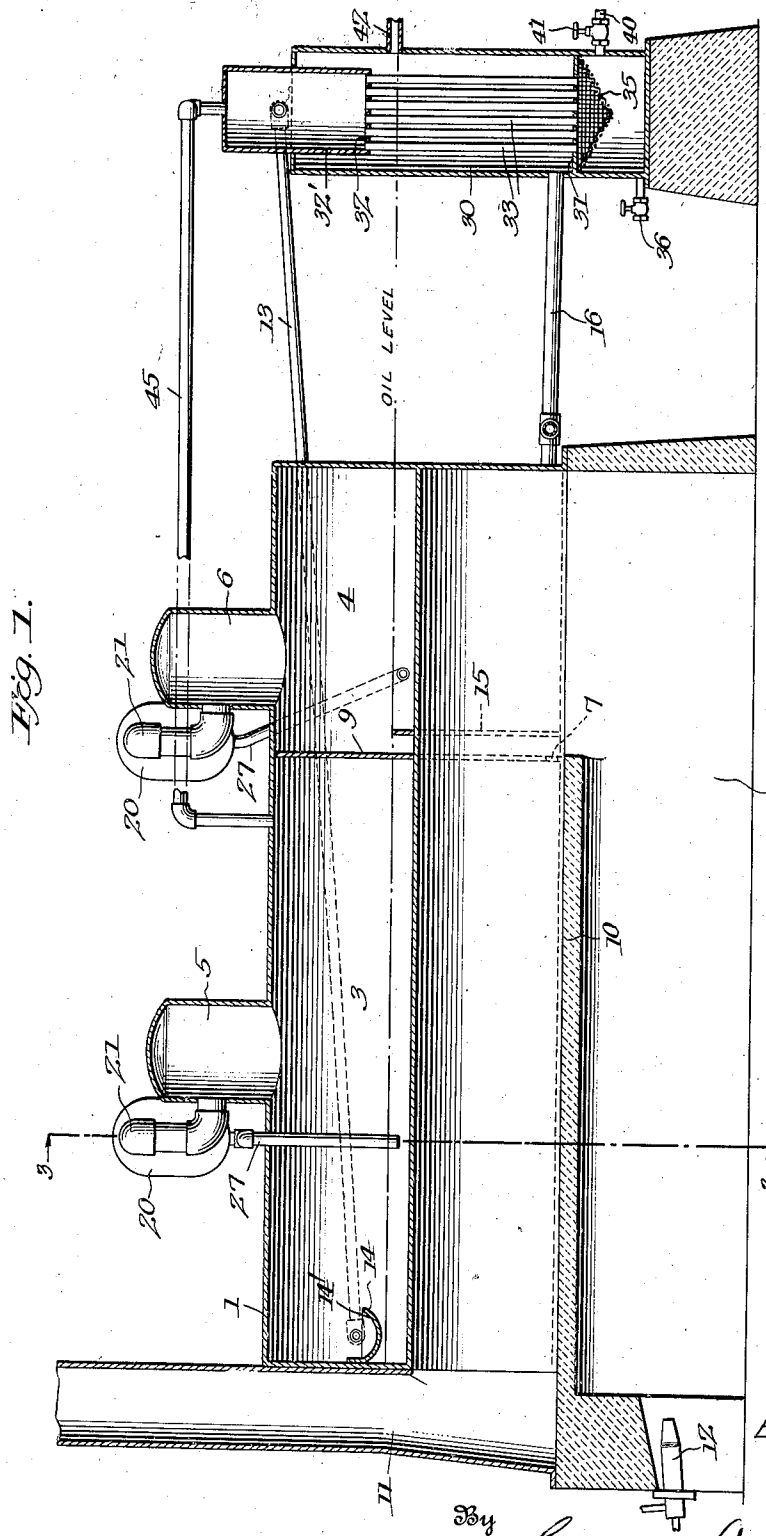

Fig. 1.

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OIL DISTILLING APPARATUS AND METHOD

Filed April 2, 1926 4 Sheets-Sheet 2

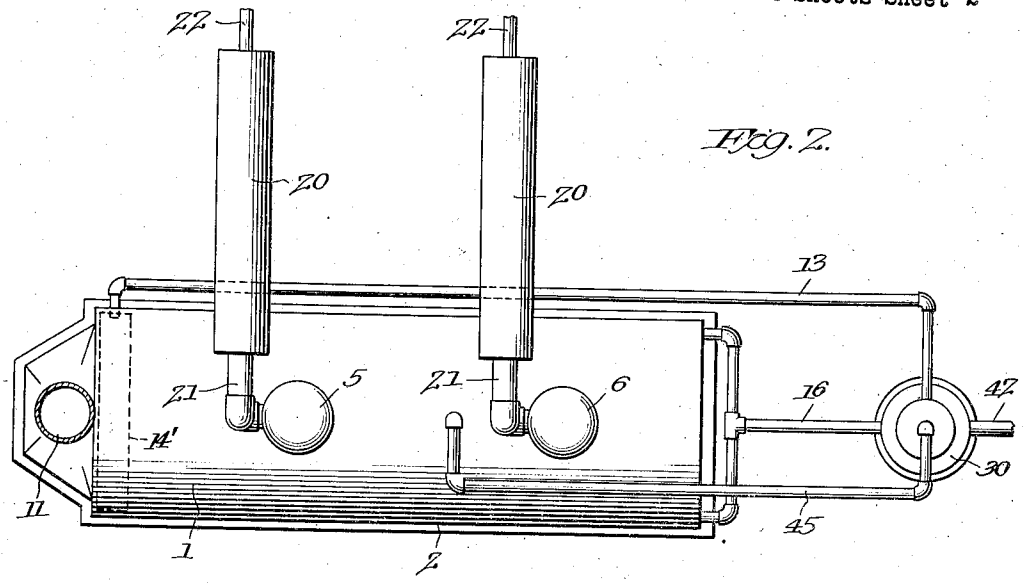

Fig. 2.

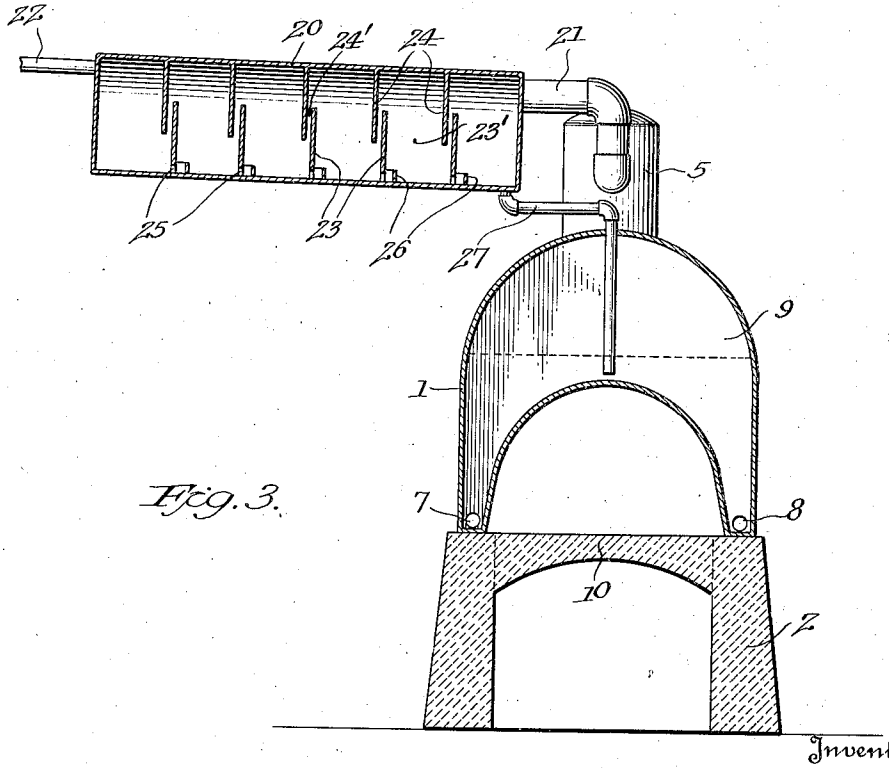

Fig. 3.

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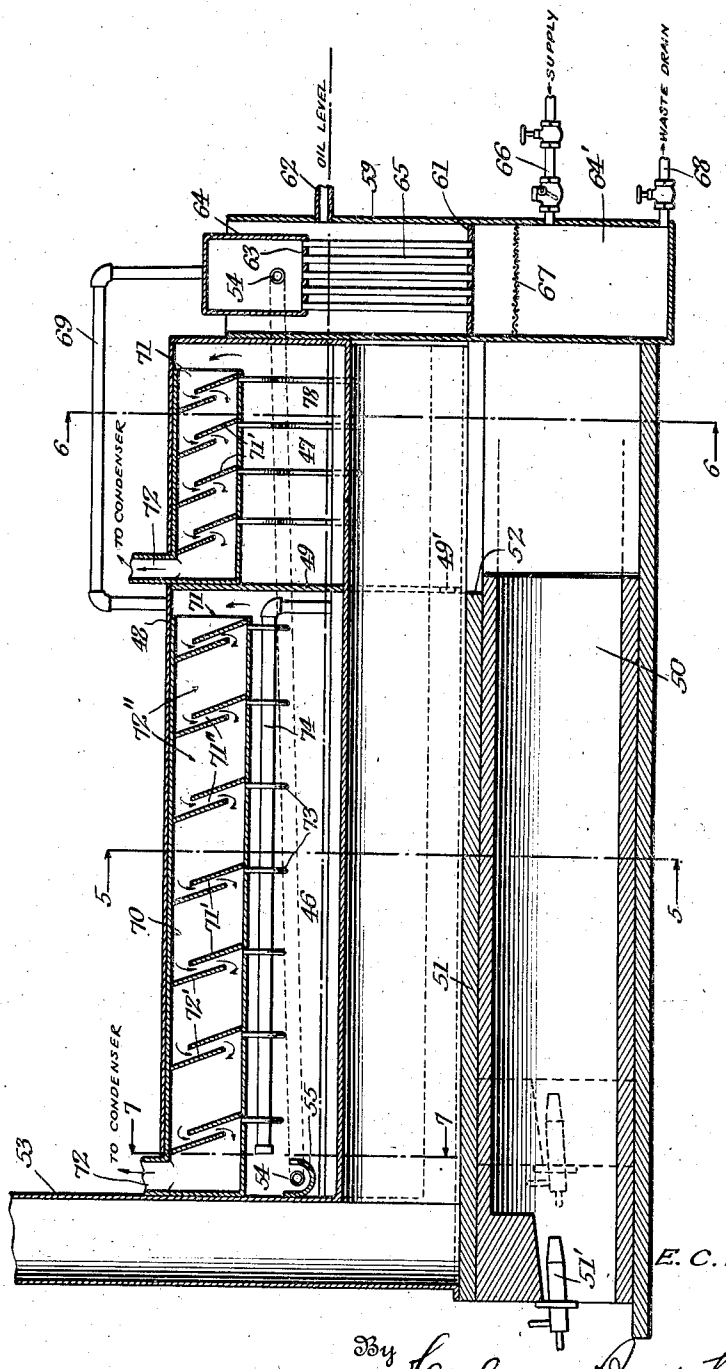
OIL DISTILLING APPARATUS AND METHOD

Filed April 2, 1926 4 Sheets-Sheet 3

Fig. 4.



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OIL DISTILLING APPARATUS AND METHOD

Filed April 2, 1926

4 Sheets-Sheet 4

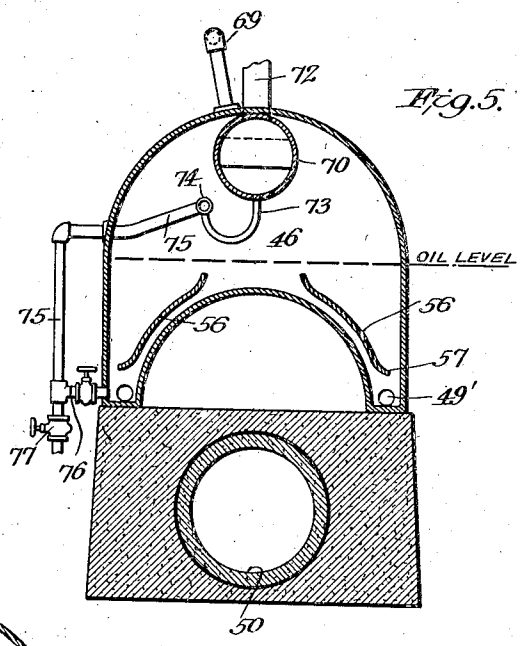

Fig. 5.

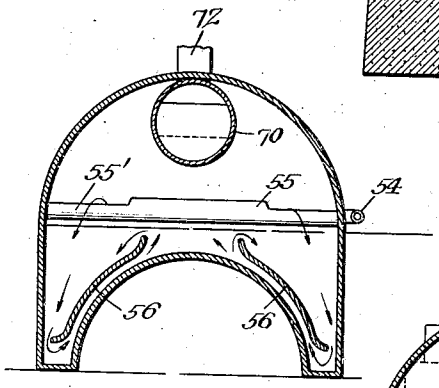

Fig. 7.

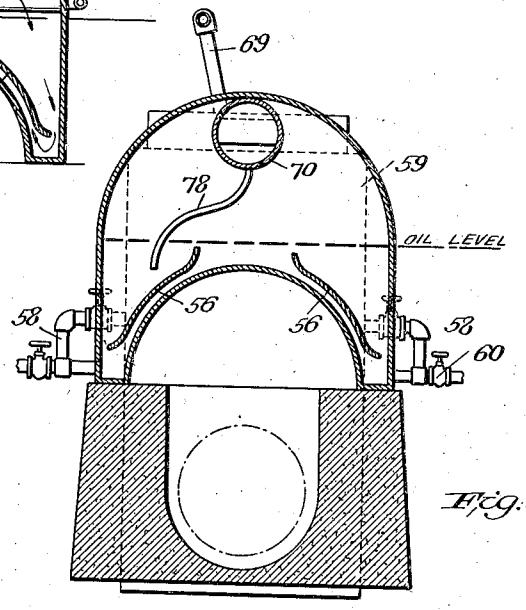

Fig. 6.

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UNITED STATES PATENT OFFICE.

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OIL-DISTILLING APPARATUS AND METHOD.

Application filed April 2, 1926. Serial No. 99,311.

The present invention relates to improvements in methods of and apparatus for oil distillation, and more particularly to methods and apparatus for fractional distillation.

An object of the invention is to provide a method of fractional distillation which is extremely simple and may be practiced with a minimum amount of personal supervision and attendance.

A further object of the invention is to insure the elimination of entrained liquid from vapors given off at various stages, and also to thoroughly subject the oil in the still to heat in such a way that any vapors given off will entrain a minimum amount, if any, of the liquid.

With respect to the apparatus, objects of the invention are to provide an apparatus structure which may be conveniently operated, to provide means for maintaining automatically a predetermined and constant level of oil in the still, such means preferably being effective, also, to heat the oil before its introduction into the still.

A still further object of the invention is to provide a compartment still heated by a single furnace effective to raise the oil in the several compartments to different temperatures.

In carrying out the method, the oil is heated in a still having a plurality of chambers arranged, preferably, over a single furnace, the oil being adapted to pass from one compartment to another, and being raised in each compartment to a predetermined temperature.

The vapors are taken off from each compartment or chamber, and directed through a dephlegmator in which the vapors and any entrained liquid follow a tortuous course. The path through the dephlegmator is arranged so that it has upwardly and downwardly directed portions, the vapors and liquid passing more slowly or with less velocity in the upwardly directed portions than in the downwardly directed portions. This is accomplished by providing a series of alternate upwardly and downwardly directed baffles arranged in pairs with narrower spaces forming the downwardly directed portions between the members of each pair than the spaces forming the upwardly directed portions which are between the separate pairs. This arrangement produces a relatively high velocity or rapid travel in the downward movements of the vapors as compared to the travel in the upward passages between the separate pairs of baffles. The rapid downward and slow upward movements cause any entrained liquid or unvaporized oil to be thrown out of the vapors as they travel through the tortuous course, and when the vapors leave the dephlegmator for the condenser, they contain no entrained oil or liquid of any kind.

Within the still, and preferably within every compartment, baffles are arranged in such a position that the oil travels not only from one compartment to the other, but also it has a movement at an angle to the longitudinal travel, and in which it circulates upwardly over a heated zone, and downwardly through that portion of the still less exposed to heat. This method of circulating the oil in its travel through each compartment prevents the generating of large quantities of steam at a time, should any water be carried into the still with the oil, and the small quantities of steam generated will pass from the still without entraining substantial quantities of oil, if any at all.

A further feature of the invention resides in the provision of a vessel into which the unvaporized oil is discharged and having an overflow at a fixed level adapted to maintain a desired oil level within the still. This vessel may be used not only to maintain a desired oil level in the still, but by conducting the oil to the still therethrough in operative heating contact with the unvaporized oil, the latter preliminarily heats the oil before its introduction into the still.

The above described features of the invention will be made clearer by a description of the embodiments of the invention which are disclosed in the accompanying drawings, wherein:

Figure 1 is a vertical longitudinal sectional view through an apparatus constructed in accordance with the invention.

Figure 2 is a plan view.

Figure 3 is a transverse section substantially on the line 3—3 of Figure 1.

Figure 4 is a vertical longitudinal section through a modified form of apparatus.

Figure 5 is a vertical section on the line 5—5 of Figure 4.

Figure 6 is a vertical transverse section on the line 6—6 of Figure 4, looking in the direction of the arrows.

Figure 7 is a vertical sectional view on a line 7—7 of Figure 4.

Referring to the drawing in which corresponding parts are designated by the same reference characters in the different figures, the apparatus comprises a casing 1, which is interiorly divided into a plurality of distilling compartments arranged in series, each compartment being provided with a suitable outlet for vapor generated therein, and the casing containing the series of distilling chambers or compartments being supported above the combustion chamber of a single furnace 2.

In the particular embodiment of the invention illustrated, the apparatus includes but two distilling chambers or compartments, 3, 4, the vapor outlets from which communicate, respectively, with domes, 5, 6.

Preferably, the casing 1 is of the cross-sectional form shown so that the distilling compartments are of the so-called "wagon type". That is, the bottom of each compartment is of upwardly directed concavo-convex form, and the top of the casing is curved. This form of distilling chamber permits the heavier portions of oil being treated to sink to the bottom at the sides of the distilling chamber, while the lighter portions of oil are received on top of such lower, more highly heated, body.

The two distilling compartments referred to communicate through passages 7, 8, formed at the bottom and sides of the intermediate partition 9, and, as shown, the combustion chamber of the furnace is separated from the bottom of the compartment or chamber 3 by a horizontal baffle or partition 10. This causes the flame and products of combustion to pass first to the space beneath the distilling compartment 4, or the last compartment of the series if more than two are employed, and then return over the top of the baffle 10 to reach the outlet stack 11. Any suitable type of furnace may be employed, the one illustrated including a burner conventionally illustrated at 12.

The relative heat range of each section or distilling compartment of the apparatus is partially controlled by the length thereof in relation to the other compartments or distilling chambers. For example, with an apparatus of the form particularly illustrated, wherein it is assumed to be desirable to employ temperatures in the compartment 3 ranging from 100 to 400 degrees, or through a range of 300 degrees while the temperatures in the compartment 4 will vary from 400 to 500 degrees, or through a range of 100 degrees, the compartment 3 is three times as long as the compartment 4.

The number of distilling compartments, and the relative lengths of each will, of course, be increased and relatively proportioned as appears desirable.

It will be understood, of course, that the compartment length is only one factor in the temperature range, another primary factor being the amount of heat supplied by the furnace, it being possible, of course, to increase or decrease the heat supply by suitable adjustment of the burner 12.

The oil to be treated is supplied to the upper portion of the compartment 3 through a pipe 13, the outlet end of which extends through the side wall of the casing 1, and over a relatively shallow concave pan or receptacle 14, extending transversely of the distilling chamber. This pan serves as a supply nozzle for the inlet pipe, and the oil flows over the free edge 14′ into the body of the chamber. Since the pan is at all times substantially entirely full, the discharge will be in the form of a narrow stream extending entirely across the chamber, and thus there is substantially an equal supply of oil for the opposite sides of the chamber.

As the oil moves through the chamber 3 toward the compartment or chamber 4, due to the infeed pressure, the lighter portions or fractions will remain at the top and the heavier portions settle to the sides and bottom of the compartment. The time required for the oil to pass through the compartment 3 is sufficient to insure that all the lighter fractions thereof will be vaporized and driven off through the outlet within the dome 5, while the heavier fractions will pass through the openings or passages 7, 8, in the partition 9, into the second chamber or compartment 4. The baffle 15 is provided in the second chamber so that the oil entering this chamber is caused to rise and flow over the upper edge of the baffle onto the body of heated oil within the compartment. The vapors generated in the compartment 4 pass through the outlet in the top thereof into the dome 6, while any unvaporized oil passes therefrom through a pipe 16 to a vessel which will be hereinafter more particularly described.

Means is provided whereby the liquid entrained with the vapors passing through either of the domes 5 and 6 is separated before the vapors are conducted to a condenser (not shown). Preferably, this separating means or dephlegmator comprises a cylindrical casing 20, one end of which communicates through a pipe 21 with the vapor dome of the distilling chamber and at the opposite end the casing is provided with an outlet pipe 22 leading to a suitable condensing apparatus (not shown). The casing has positioned therein a series of alternately arranged downwardly and upwardly projecting baffles 23, 24, which form a tortuous path having upwardly directed branches 23′

and downwardly extending branches 24'. It will be observed that the upwardly extending branches or portions of the passage are considerably wider or of greater area than the downwardly extending branches which results from the fact that the pairs of baffles are spaced apart at greater distance than the individual members of each pair.

The purpose of this construction is to impart to the traveling vapors and any entrained liquid an increased velocity as they travel downwardly; the rapid downward and relatively slow upward movements cause any entrained liquid or unvaporized oil entrained with or carried along by the vapors to be thrown out of the same. It is thought that this result is effected principally at the points below the downwardly extending baffles where the vapors and entrained liquid having had their velocity increased in passing through the narrow passages 24' substantially reverse their direction of travel; and the centrifugal or whip-like action upon the vapors causes the liquid to be separated therefrom. This action of the baffles is, of course, assisted by the effect of gravity, due to the arrangement of the branches of the tortuous path in vertical planes, although, of course, the same effect would be produced to a less extent if the branches were disposed in other than vertical planes. When the vapors leave the dephlegmator after having travelled therethrough, they contain no entrained oil or liquid of any kind.

One or more openings 25 may be provided in the lower edge of each of the upwardly extending baffles 23 through which liquid separated from the gaseous portion of the vapor passing through the separator may return to the lower end of the separator casing 20, and, by way of a pipe 27, be returned to the distilling chamber or compartment.

It will be understood that the separator casing 20 is inclined slightly so that any liquid collected therein will drain freely toward the pipe 27 and the distilling compartment or chamber. To prevent gases from passing through the openings 25, a small rib or dike 26 is provided interiorly on the bottom wall of the casing 24 adjacent each baffle 23, said dikes or ribs acting to retain a small body of liquid over the openings 25, thus preventing the passage of gas therethrough without materially obstructing the flow of separated liquid to the return pipe 27.

The relation of the baffles 23 and 24 above referred to may, of course, be varied as desired, but very advantageous results have been effected when said parts are so related that the downward movements of the vapors in passing through the separator casing occupy about one-twelfth of the distance that is provided for the upward movements.

As before stated, the heated unvaporized oil is withdrawn from the last distilling compartment of the series through a pipe 16 which leads to a vessel 30. This vessel has an overflow 42 which is arranged substantially in a plane coinciding with that of the desired oil level in the still. This arrangement permits the vessel 30 to maintain automatically a predetermined level in all of the still compartments.

A further feature of the invention consists in constructing the compartment 30 so that it serves not only as means to maintain an oil level within the still, but also as a heat exchanger for the purpose of imparting heat to the crude oil before its introduction into the still.

To accomplish this, the vessel 30 may be divided into separate chambers by transverse partitions 31, 32, the latter being joined with a cylindrical vertical partition 32'. Pipes 33 communicate with a portion of the casing 30 beneath the partition 31 and that portion within the cylindrical wall 32'. Crude oil may be introduced into the casing below the partition 31 from which it passes upwardly through the pipes 33 into the upper chamber formed by the wall 32'. A screen or filter 35, arranged across the lower ends of the pipes 33 prevents any sediment in the crude oil from being conducted to the still, and a drain 36 is provided for removal of such sediment. A main supply 40 controlled by cut-off valve 41 permits introduction of the crude oil supplied to the still.

It will be understood that the heated unvaporized oil delivered to the chamber 30 of the combined level control and heat exchanger is excluded by means of the pipes 33 and partitions 31, 32', from the supply of fresh oil being conducted to the still, but by circulating around the pipes 33, it preliminarily heats the oil and may then pass through the overflow pipe 42 from the chamber. As will be observed, the pipe 13 communicates with the upper portion of the chamber formed by the walls 32, 32', and there is also in connection with this chamber a pipe 45 through which any vapor which may be generated therein is conducted to the still compartment 3, whereby the pressure in the distilling apparatus and the heat exchanger is equalized; thus the oil will flow by gravity through the pipe 13 to the still.

Referring to Figures 4, 5 and 6, there is shown in these views, a preferred form of apparatus for carrying out my improved method.

In this preferred embodiment, the distilling chambers or compartments 46, 47 are formed within a casing 48 by means of a transverse partition 49 having openings 49

therein through which the oil unvaporized by the heat in the compartment 46, may pass to the compartment 47.

The casing has the same cross-sectional shape as that of Figures 1, 2 and 3, with the bottom upwardly arched and the top curved. This form permits the heavier portions of oil being treated to sink to the bottom at the sides of the arched bottom, while lighter portions are received on top of the lower or more heated oil body.

The compartments may be heated from a combustion chamber 50 arranged beneath a horizontally extending partition or baffle 51, which terminates at 52 approximately on a line with the rear end of the compartment 46. The combustion chamber 50 is provided with any suitable source of heat such as the burner 51', and, preferably, it is mounted for sliding movement beneath the baffle or partition 52, so that as illustrated in dotted lines in Figure 4, it may be moved longitudinally to vary the point at which the products of combustion pass upwardly and reverse their course to travel beneath the bottom of the still compartments to the stack 53. This construction causes the flame and products of combustion to pass first through the space beneath the secondary distilling compartment 47, or the last compartment of the series if more than two are employed, and then to return from the top of the baffle 51 to reach the outlet stack. Adjustment of the combustion chamber 50 may vary the distance of travel of the products of combustion beneath the compartments, and also direct the latter against the rear wall of the casing for a purpose which will be later described.

The oil to be treated is supplied to the upper portion of the first distilling compartment 46 through a pipe 54, the outlet end of which extends through the side wall of the casing 48, and over the relatively shallow concave pan 55. This pan extends transversely across the distilling chamber, and at substantially opposite sides of the longitudinal intermediate portion of the arched bottom has its forward edge cut away (Figure 7) so that the oil therein will flow over its forward wall in two separate streams, each of which is substantially co-extensive with the cut away portions 55'. The trough is provided primarily for the purpose of directing the oil downwardly only at opposite sides of the arched bottom where there are provided longitudinally extending baffles 56, the lower edges 57 of which are spaced from the side walls to provide passages through which the oil will travel downwardly as indicated by the arrows (Figure 7), and upwardly over the heated arched bottom.

It will be understood that the oil travels longitudinally of each compartment, due to the infeed pressure and also in two substantially distinct circular streams around the baffles 56. That is to say, the oil circulates not only longitudinally of the still, but also upwardly over the heated arched bottom between the latter and the baffles, and then downwardly outside the baffles through that portion of the still less exposed to heat. This method of circulating the oil prevents the generating of large quantities of steam at a time, should any water be carried into the still with the oil, and the small quantities of steam produced at any given time will be discharged without entraining substantial portions of the oil, if any at all.

The time required for the oil to pass through the compartment 46 is sufficient to insure that all the lighter fractions thereof will be vaporized while the heavier fractions will pass through the openings 49' into the second distilling chamber or compartment 47 within which, as will be observed, the baffles 56 are arranged to function in the same manner as in the compartment 46.

Any oil unvaporized in the compartment 47 passes through pipes 58 to a vessel or chamber 59, or may, by means of a valve controlled branch 60, be discharged from the still without introduction into the chamber 59. The vessel 59 has a partition 61 and an overflow discharge opening 62, which is arranged to control automatically the level of oil within the still compartments. As will be understood, the level of oil within the still cannot exceed the plane of the overflow discharge opening 62 which is arranged to control automatically the level of oil within the still compartments.

This vessel may be constructed to serve also as a heat exchanger as in the previously described embodiment of the invention.

For this purpose, the vessel 59 is divided into several compartments by means of the partition 61 and an upper partition 63 forming a cylindrical compartment 64. The chamber of the compartment 64 communicates with a compartment 64' below the partition 61 through pipes 65. The oil for the still is introduced into chamber 64' through pipe 66 and will flow upwardly through the pipes 65, which are surrounded by the heated unvaporized oil from the still; thus the fresh oil supply is preliminarily heated before it reaches the chamber 64, and passes therefrom through pipe 54 to the first compartment of the still.

It will be observed that in the embodiment of the invention the casing 59 is immediately adjacent the rear end of the flue beneath the still, so that the heat from the products of combustion which pass upwardly at the rear end of the combustion chamber may be directed against the same to assist the unvaporized oil from the still in preliminarily heating the fresh oil supply in the heat exchanger. As in the construction previously

described, a conduit or pipe 69 may connect the upper end of the chamber 64 with the initial compartment of the still to equalize the pressure and permit the gravitational flow of the oil through pipe 54 to the compartment 46; and further, any sediment which is prevented from passing upwardly by screen 67 in compartment 64′ may be drained therefrom by the drain pipe 68.

The vapors from the still compartments are, as in the embodiment of the invention first described, conducted through a dephlegmator for the purpose of separating therefrom any entrained liquid. The dephlegmators are in the preferred embodiment, positioned within the still casing so as to have maintained therein, a high degree of heat which will prevent condensation of any vapors before they pass from the dephlegmator. Each dephlegmator comprises a substantially cylindrical casing 70, having an inlet opening 71 adjacent the rear end of the compartment and an outlet 72 extending through the top wall of the casing 48, this opening conducting vapors to a condenser (not shown). Within each dephlegmator is positioned a series of alternately arranged upwardly and downwardly extending baffles 71′, 72′, respectively. These baffles are preferably inclined to the vertical instead of being arranged in exact vertical planes as in the construction illustrated in Figure 3. This inclination lengthens the tortuous path for the vapors and entrained liquid. As in the former construction, the baffles are arranged in distinct pairs forming downwardly extending branches 71″ which are narrower or of less area than the upwardly extending branches 72″, the arrangement serving to increase the velocity of the vapors and entrained vapors in their downward movements, and giving slower upward movements. The advantage of this construction is substantially the same as that pointed out with respect to the dephlegmator illustrated in Figure 3, but by positioning the dephlegmator within the still compartment, the heat of the still prevents condensation of vapors before they pass from the dephlegmator, and, moreover, the inclination of the baffles lengthens the path of the vapors within the casing 70.

Any liquid separated from the vapors within the dephlegmator of the first compartment is carried off by means of short pipes 73 to a header 74, which, at one end, has a branch 75 (Fig. 5) extending through the wall of the casing, and from which the oil may be either returned to the still compartment 46 for further distillation through a valve-controlled branch 76, or withdrawn through a valve-controlled pipe 77. The dephlegmator casing 70 of the final compartment 47 has leading therefrom adjacent each of the upwardly extending baffles 71, a liquid discharge pipe 78, each pipe being laterally and downwardly directed (Figure 6) so that the liquid will be discharged below the level of the oil in the chamber and will, with the oil above and outside the baffle plates 56, pass downwardly and then upwardly inside the baffle over the arched heated bottom of the compartment.

It will be understood, of course, that numerous modifications may be made in the structures illustrated and described without departing from the invention.

Although the still, as shown, is mounted upon a fixed base, it is of very light and compact construction, particularly that form illustrated in Figures 4, 5 and 6, and hence may be readily applied to a portable or wheeled base, which, of course, is within the scope of the invention.

I claim:—

1. In a dephlegmator for removing entrained liquid from hydrocarbon vapors, a casing, and a plurality of alternately arranged upwardly and downwardly extending baffles in said casing forming a tortuous course having successive upwardly and downwardly directed portions, said baffles being arranged to vary intermittently the velocity of the vapor and liquid and being inclined with respect to said casing whereby to provide an extended course in the casing.

2. In a dephlegmator for removing entrained liquid from hydrocarbon vapors, a casing, and a plurality of alternately arranged upwardly and downwardly extending baffles in said casing forming a tortuous course having successive upwardly and downwardly directed portions, said baffles being arranged to impart to the vapors and entrained liquid relatively rapid downward and relatively slow upward movements through said course, the upwardly extending baffles being inclined forwardly and the downwardly extending baffles being inclined rearwardly in said casing whereby to provide an elongated course.

3. In a dephlegmator for removing entrained liquid from hydrocarbon vapors, a casing, and a pluality of alternately arranged upwardly and downwardly extending baffles in said casing forming a tortuous course having successive upwardly and downwardly directed portions, said baffles being arranged in spaced pairs, the spaces between the separate pairs being longer than the spaces between the individual members of each pair, and the pairs of baffles being inclined with respect to the casing whereby to provide an elongated course.

4. In an oil distilling apparatus, the combination of a distilling chamber having an outlet for vapor generated therein, means for heating said chamber, means for supplying oil to be treated to said chamber, means for conducting unvaporized oil from said

chamber, means for separating the liquid and gaseous parts of vapors generated in the distilling chamber comprising a casing connected with the distilling chamber and positioned therein, said casing being provided interiorly with means for causing the vapor passing therethrough to travel in a tortuous path having upwardly and downwardly directed portions with the downwardly directed portions of less area than the upwardly directed portions, whereby to remove the liquid from the vapor.

5. In an oil distilling apparatus, the combination of a distilling chamber having an outlet for vapor generated therein, means for heating said chamber, means for supplying oil to be treated to said chamber, means for conducting unvaporized oil from said chamber, means for separating the liquid and gaseous parts of vapor generated in the distilling chamber comprising a casing connected with the distilling chamber and positioned therein, a series of alternately arranged downwardly and upwardly extending baffles within said casing compelling the vapor passing through the casing to travel in a tortuous path, the downwardly directed portions of which are of less length than the upwardly directed portions, whereby to remove the liquid from the vapor, said upwardly extending baffles being inclined forwardly in the casing and the downwardly extending baffles being inclined rearwardly whereby to provide an elongated path.

6. In an oil distilling apparatus, the combination of a distilling chamber having an outlet for vapor generated therein, means for heating said chamber, means for supplying oil to be treated to said chamber, means for conducting unvaporized oil from said chamber, means for separating the liquid and gaseous parts of vapor generated in the distilling chamber comprising a casing connected with the distilling chamber and positioned therein, a series of alternately arranged downwardly and upwardly extending baffles within said casing compelling the vapor passing through the casing to travel in a tortuous path having upwardly and downwardly extending branches, the upwardly extending branches being of greater area than the downwardly extending ones, said upwardly extending baffles being inclined forwardly in the casing and the downwardly extending baffles being inclined rearwardly whereby to provide an elongated path.

In testimony whereof I have hereunto set my hand.

EDWARD C. D'YARMETT.