Jan. 30, 1934. H. T. DARLINGTON 1,944,877

PROCESS FOR REFINING HYDROCARBON OIL VAPORS

Filed June 15, 1927

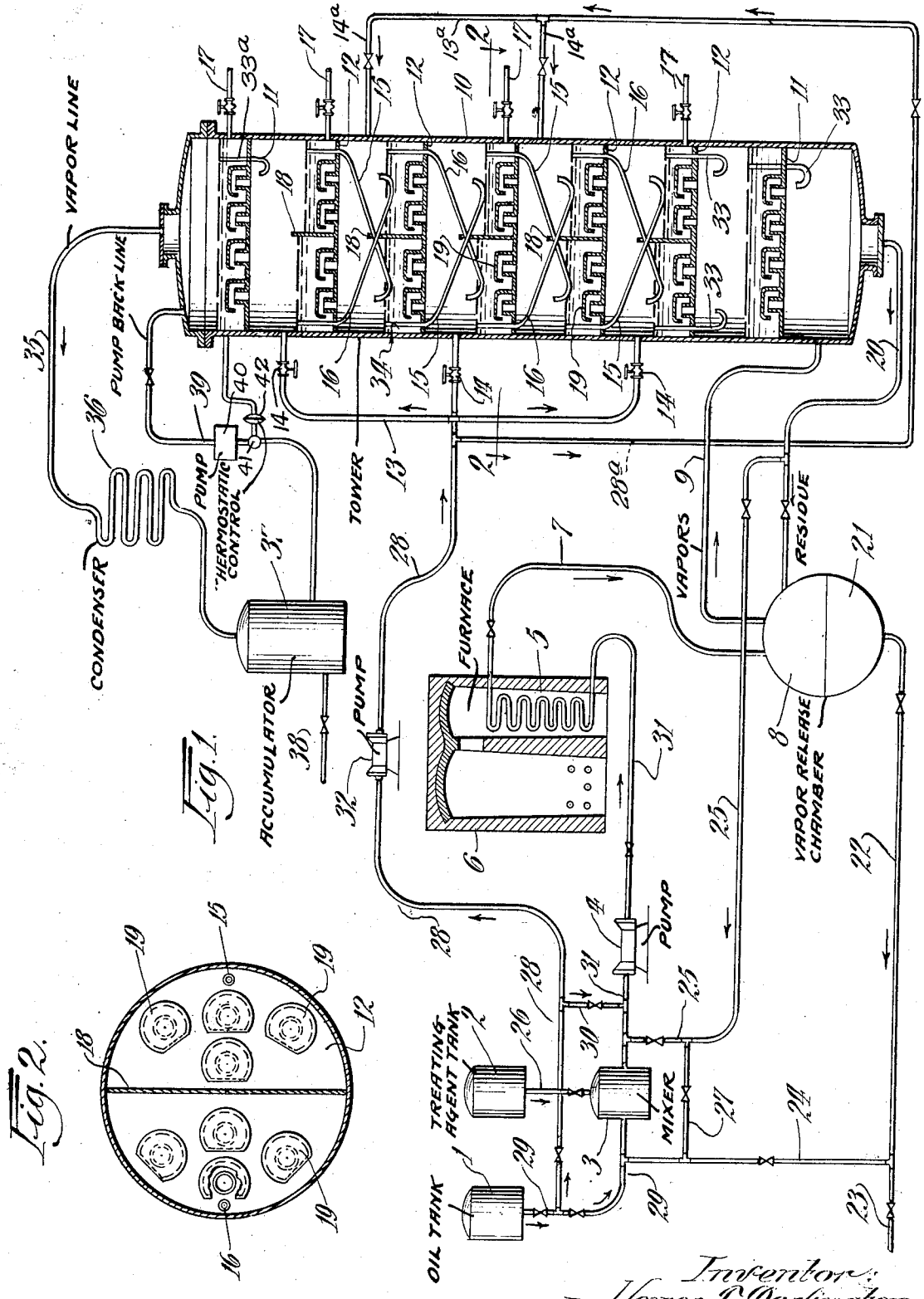


Fig. 1.

Fig. 2.

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Patented Jan. 30, 1934 1,944,877

UNITED STATES PATENT OFFICE

1,944,877

PROCESS FOR REFINING HYDROCARBON OIL VAPORS

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Application June 15, 1927. Serial No. 198,935

4 Claims. (Cl. 196—36)

One object of my invention is to increase the quantity of gasoline produced during the topping of hydrocarbons.

Another object of my invention is to reduce to a minimum the quantity of crude oil heated by direct means, such as by a fire or the hot gases in a smoke stack, and thus to lessen the formation of permanent gases and the deterioration of the oil stock.

Another object is to produce better and more uniform oil-stock for use in subsequent processes by topping in such manner that the heat is very evenly distributed and the treatment therefore uniform.

Another object is to conserve fuel by heating the oil largely by heat exchange.

Another object is to produce and selectively separate, as the result of a single topping process, several distinctive products, such as gasoline, kerosene, straw oil, gas oil and a heavy oil adapted for cracking or for manufacture into lubricating oil.

Still another object of my invention is to condition certain portions of the oil and condensate for further treatment by dispersing, suspending or incorporating in them desirable treatment agents.

Other objects of my invention are to increase the topping yield, to decrease the corrosive effect of topping on the apparatus used and to have a minimum quantity of residuum and that of such character and quality that it may be readily made into a usable and valuable product.

A further object of my invention is to provide an apparatus adapted for performing the various operations by which I attain my several objects.

In the topping of crude petroleum oil where no substantial cracking is done or desired, I have found that the addition of one or more of certain treating agents increases the quantity and the quality of certain desirable products, such as gasoline, and has other very advantageous effects, especially when such agent is present in dispersed discrete small particles held in suspension.

These advantageous effects, I find, are enhanced when the heating of the crude oil is done principally by heat exchange and a relatively very small portion of the oil is brought into contact with a source of direct heat, and when heating, vaporizing and separating are done in certain definite ways as hereinafter set forth.

I have invented an apparatus in which these operations can conveniently be performed in the desired manner, which also has some very desirable features peculiar to itself.

A description of this apparatus will help to make clear the nature of my process and the function and inter-relation of the several operations comprised in it.

In the drawing:

Figure 1 is a somewhat diagrammatic view of the apparatus showing it partly in sectional elevation; and

Fig. 2 is a plan view of the compound or divided bubble-cap plate used in the dephlegmator on line 2—2 of Fig. 1.

The principal units of the apparatus are a source of supply of any suitable character for crude oils or other liquid hydrocarbons to be topped, shown as oil supply tank 1; a suitable source of supply for treating agent, such as treating agent tank 2; a mixer 3 of any suitable type; heating tubes or coil 5 in a furnace 6 or provided with any other suitable means of heating, with a pump 4 in the valve controlled pipe line 31 leading from the mixer 3 to heating tubes or coil 5; a vapor release chamber 8 of any suitable type; a combined dephlegmating and vaporizing tower, which for the sake of brevity I shall call a tower 10; a pump 32 in supply line 28; a condenser 36 of any approved type for condensing gasoline or other vapors, and an accumulator tank 37.

The tower 10 is divided longitudinally into a plurality of sections by bubble-cap plates 11, 12, each containing a plurality of capped bubble openings 19. The intermediate bubble-cap plates 12, that is, ordinarily all the bubble-cap plates except the topmost 11 and the lowest 11, are each divided by a division plate 18 into two equal or nearly equal parts. I may, if I desire, increase the number of undivided bubble-cap plates 11 and put one or more of them in tower 10 at the top or at the bottom, or interpose one or more of them where I please between compound or divided bubble-cap plates 12, or I may substitute a divided bubble-cap plate for lowest bubble-cap plate 11. Ordinarily I prefer to arrange them as shown in the drawing, Figure 1; with an undivided plate 11 at the top and another at the bottom and compound or divided plates 12 in between.

The division plates 18 are of sufficient height to prevent liquid on either side from intermingling, that is, higher in each instance than the liquid levels maintained in adjacent sections by overflow lines 15 and 16, but they are not high enough to interfere with the commingling of gases and vapors in the space above the liquid and below the next higher bubble-cap plate.

Overflow lines 15 and 16 are provided for bub-

ble-cap plates 12 and are so shaped and positioned that the overflow from one side of a bubble-cap plate 12 will be carried to the other side of the bubble-cap plate 12 just below it.

Topmost bubble-cap plate 11 has one overflow line 33*a*, so placed that overflow from the topmost bubble-cap plate 11 will be carried to one section only of bubble-cap plate 12 just below. That section and sections of divided bubble-cap plates 12 below it alternately overflow first to the opposite side of the next lower stage, and then back and forth at succeeding lower stages being set apart for condensate exclusively. The other sections of said divided plates are for oil stock, which may be unheated when introduced. Both sections of the lowest divided bubble-cap plate 12 overflow through overflow lines 33 into lowest bubble-cap plate 11.

The intake ends of the constituent pipe sections of the overflow line 16, connecting the sections set apart for oil, and the constituents of the overflow line 15 in the other section of the same plate, are so located that the oil level 34 in any oil section may be at the proper level to provide the necessary cooling without too greatly expediting the intake and downflow of unheated oil.

A plurality of valve-controlled means 14 are provided in connection with the line 13 for separately charging unheated oil into the sections of bubble-cap plates 12 in tower 10 for the further purpose of severally regulating the temperature as desired in the spaces devoted to oil. I may increase or decrease the number of these inlet means 14 and may if I wish provide an inlet means 14 on every oil level, and, I may provide lines 28ª, 13ª and 14ª to supply oil to the oil pools in staggered relation on the opposite side of the tower so that each oil pool of the series may be separately fed.

A plurality of valve controlled means 17 are also provided for selectively and separately withdrawing condensate from one level or a combination of levels in the tower 10. These means 17 may be increased or decreased in number.

A conduit 35 is provided for withdrawing uncondensed vapors from the top section of the tower 10 to the cooling means 36 whence condensate passes to accumulator tank 37. A line 39 is provided for returning condensate from the tank 37 to the tower 10 to regulate the temperature at its upper end and thus control the nature of the overhead. The line 39 may be provided with a pump 40 and with a valve 41 which may suitably be regulated by a thermostatic device shown diagrammatically at 42 which is actuated by the temperature of the condensate on the uppermost plate 11.

Line 20 is for withdrawing oil from the tower 10 and transferring it to vapor release chamber 8, or by line 25 and the pump 4 to heating tubes or coils 5, or through valve controlled lines 25, 27 and 29 to the mixer 3.

The pipe line 9 connects tower 10 with the vapor release chamber 8, and provides means for passing hot vapors from the latter into the tower 10.

The vapor release chamber 8 has an outlet for liquid 21 with contained treating agent (when it is used) through a valve controlled pipe line 22 either through the valve controlled line 24 to the mixer 3 or to a valve-controlled discharge outlet 23, to be withdrawn for any desired use, such as cracking, for which, ordinarily, since it contains dispersed treating agent and has been bled of lighter fractions, it is well conditioned.

In practice, I draw crude oil or other oil stock from the oil supply tank 1, or any other source of supply into the mixer 3 through the valve controlled line 29. I also draw a treating agent or a combination of treating agents chosen as adapted to best secure the desired results with the particular oil being treated, from the treating agent tank 2, and introduce it into the mixer 3 by the pipe line 26. Having mixed the oil, and treating agent, I pass them through valve-controlled pipe line 31 into heating tubes or coil 5, using pump 4 to promote their passage and subject them to pressure. I may, however, omit the treating agent, though I seldom do, and then I pass the oil direct from oil supply tank 1 through valve-controlled pipe lines 29, 28, 30 and 31 and pump 4 direct to the heating tubes or coil 5.

Having heated the oil to the desired degree, I pass it through the valve-controlled pipe line 7 to the vapor release chamber 8, and pass the hot vapors therefrom into the tower 10 at a point near its base through the pipe line 9. As soon as the hot vapors begin to enter the tower 10, I pass cool unheated oil from the oil supply tank 1 through the pipe line 29, to and into the pipe line 28, or, preferably and usually, I pass unheated oil with incorporated treating agent from the mixer 3 through the pipe line 30, to and into the pipe line 28. From the pipe line 28 with the aid of the pump 32, I pass the oil or the oil and contained treating agent into the tower 10 at one or more points through the line 13, using means 14 for the purpose. Or I may supply all or part of said oil to the tower 10 through pipes 28ª, 13ª and 14ª.

I so regulate the introduction of unheated oil that it together with the condensate formed and gradually cooling will sufficiently cool the ascending vapors so that all will condense except the fraction, generally gasoline, which I desire to withdraw while still a vapor, and condense in the condenser 36. By admitting the unheated oil to the tower 10 at different levels when and in such quantities as I please, I am able to regulate dephlegmation very accurately and by thus hastening or retarding the cooling and condensation in any one or more sections, I can, to a substantial degree, determine the character of the condensate produced in a particular section.

Because of the division by division plates 18 of intermediate bubble-cap plates 12, and because of the shape and arrangement of the overflow lines 15, 16, condensate formed in the tower 10 above the topmost bubble-cap plate 11 and not withdrawn, and condensate returned to the tower 10 from the accumulator tank 37 via the valve-controlled pipe line 39, if any be so returned, passes from topmost bubble-cap plate 11 onto a section of the bubble-cap plate 12 next below it, on which there is nothing except condensate—mostly condensate formed in the space just above it—and thence overflows from section to section, with condensate formed in such sections, first on one side and then on the other of the tower without coming into contact with crude or other oil stock, while oil stock passes down alternate sections concurrently, but out of contact with condensate, other than that formed within it, or in opposite space just above it, until the oil stock and any condensate that has not been withdrawn reach the lowest bubble-cap plate 11, and there commin-

gle. Meanwhile, hot vapors bubble up through the various bubble-cap plates and through both oil stock and condensate, and are cooled and in part condensed.

The condensate, during a part at least of its descent, loses heat, and the oil stock is gradually heated by the vapors and by condensate until, as they both reach the bottom bubble-cap plate 11, or pass from it to the zone of most intense heat below, both are to some extent volatilized and in part return upward in the form of hot vapors.

By my method of passing condensate from side to side of the tower 10 as it descends while passing oil separately down in like manner I provide a series of alternate pools of condensate and oil on bubble-cap plates 12 through which vapors must pass as they ascend. As a consequence all vapors pass alternately through oil and condensate, and when, as is usually the case, the oil contains a treating agent the vapors as they pass through the oil receive substantial treatment by such agent. The hot vapors as they pass up through the oil, or it descends through them, evaporate the more volatile constituents of the oil. I therefore in this manner condense and evaporate simultaneously on the same level of the tower 10.

Treatment agents also aid in the transformations wrought in the oil for all the oil, both that on bubble-cap plates and that descending has treating agent dispersed through it and working in and on it. By regulating the intake of hot vapors and unheated oil, I can and ordinarily do maintain the temperature best calculated to effectuate topping with the subjection of a minimum quantity of oil to direct heat.

I may generate hot vapor introduced into the tower 10 from oil taken from the supply tank 1, but, except when starting operations, I frequently take oil from the bottom of the tower 10 to the heating tubes or coil 5 for vaporization, replenishing the supply of treating agent or agents from time to time as necessary by sending the oil en route through the mixer 3 and there adding them. By vaporizing the hot oil, I conserve heat, hasten operations, and work more efficiently. Such heating in the tubes or coil 5 is under pressure applied by the pump 4, but I so heat the tubes or coil 5 that the oil is in major part vaporized at nearly normal pressure.

Condensate, of course, forms in each section into which tower 10 is divided by bubble-cap plates 11, 12. Since the temperature differs in each section, the condensate formed in each section necessarily differs from that formed in another section. I can, therefore, withdraw products from each condensate bubble-cap plate section separately through means 17 provided for the purpose, doing so frequently enough to prevent a substantial modification of the product by overflow from sections higher up, thus securing as many products as there are such condensate sections, or I may permit one or more condensate sections to overflow into a lower condensate section and remove products from the lower section, thus securing a blended product of a desired character, or several such products when I arrange for several overflow combinations. This selective removal of a variety of products is very advantageous, as is evident. According to the use to be made of them they may be treated as final products or as oil stock ready for further treatment, and may include, besides gasoline taken off at the top, such products as kerosene, straw oil, gas oil, and, from near the bottom of the tower 10, lubricating stock.

The added treating agent seems to act, among other things, as a refiner, with the result that each of the several products are purer than like products of topping as usually done. The gasoline separated is larger in quantity and in many instances of such color and character as to be marketable without further refining. What in most if not all other processes of topping is a residuum, frequently of little or no value, is I find, when crude oil is topped by my process with the use of an adsorbent treating agent, a lubricating stock of superior quality, relatively light in color and free from objectionable tarry matter.

I have found that all treating agents do not work equally well with every crude oil or other oil stock, and that to secure the best results I must vary my treating agent according to the character of the stock to be treated. I have also found that a variation in treating agents is desirable to obtain different results or products from the same oil stock.

I have used many treating agents. Among those which uniformly produce most satisfactory results and which can be used advantageously with practically all kinds of oil which it is customary to top or similarly treat, are hydrated lime, bog iron ore, fuller's earth, acid-treated serpentine, bentonite, clays having the properties of bentonite, and acid-treated glauconite. I do not merely mix these agents with the oil, but I so thoroughly commingle the two that the agent or agents are dispersed, suspended or otherwise incorporated in the oil and are therein substantially in colloidal dispersion.

Treatment of crude oil or other oil stock by my above described process with any one of these, or with a combination, according to the character of the oil, of two or more of these substantially decreases the amount of carbon deposited in tubes and apparatus, prevents corrosion of the tower and other parts, and results in condensation products wholly or substantially devoid of objectionable substances, odor or color.

I have described apparatus peculiarly adapted for topping oil by my process, but my process is entirely independent of the apparatus and may be practiced with any apparatus in which the several steps and operations which make up the process may be adequately performed.

I claim:

1. The process of refining hot hydrocarbon oil consisting in heating and vaporizing oil under pressure, releasing the pressure thereby vaporizing a portion of the heated oil, passing the vapors of oil through a series of successively cooler bodies of condensate and oil alternately, said bodies of oil containing a solid treating agent in colloidal dispersion.

2. The process of refining hot hydrocarbon oil consisting in heating an oil under pressure, releasing pressure and vaporizing the major portion of the oil, passing said vapors alternately through a series of successively cooler bodies of condensate and oil to be vaporized, said oil to be vaporized holding lime in colloidal dispersion, and passing oil and solid treating agent through the said treating means and withdrawing unvaporized oil freed from tarry matter by said agent during treatment.

3. The process of refining hot hydrocarbon oil consisting in heating an oil under pressure, releasing pressure and vaporizing the major portion of the oil, passing said vapors alternately through

a series of successively cooler bodies of condensate and oil to be vaporized, said oil to be vaporized holding fuller's earth in colloidal dispersion, and passing oil and solid treating agent through the said treating means and withdrawing unvaporized oil freed from tarry matter by said agent during treatment.

4. The process of refining hot hydrocarbon oil consisting in heating an oil under pressure, releasing pressure and vaporizing the major portion of the oil, passing said vapors alternately through a series of successively cooler bodies of condensate and oil to be vaporized, said oil to be vaporized holding acid-treated serpentine in colloidal dispersion, and passing oil and solid treating agent through the said treating means and withdrawing unvaporized oil freed from tarry matter by said agent during treatment.

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